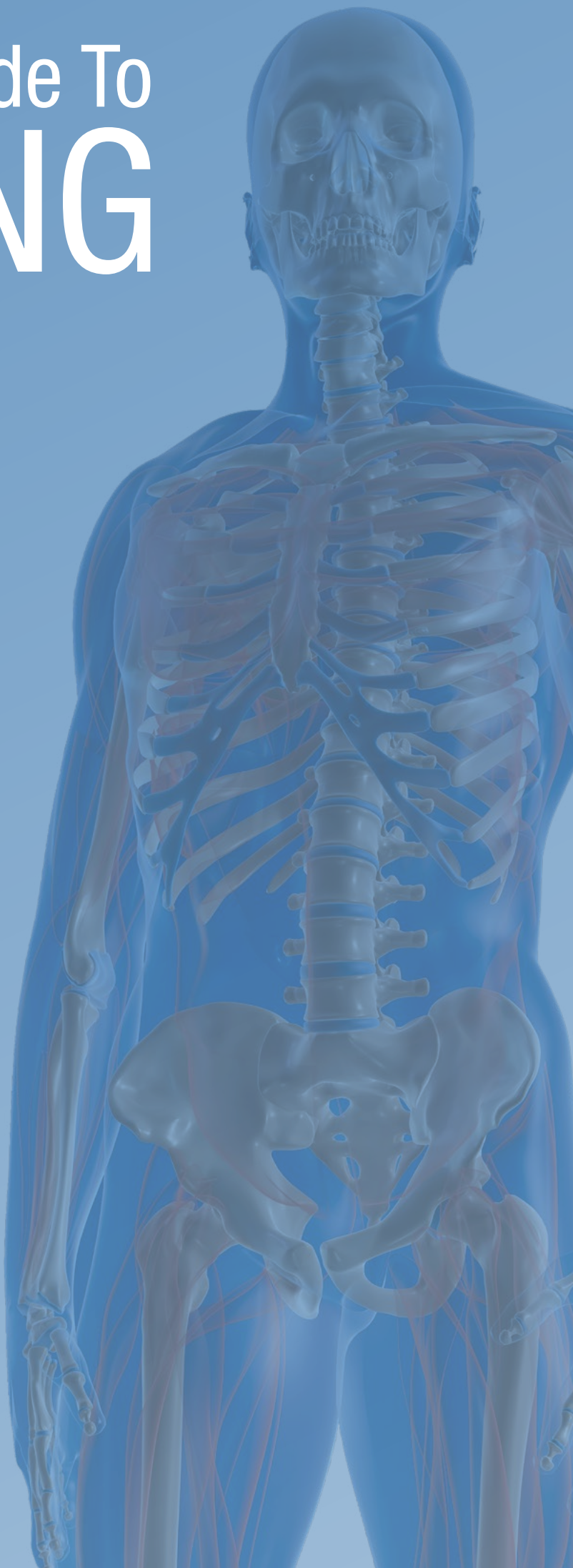
# A Practical Guide To CASTING



# A Practical Guide to Casting

## Foreword

Since the introduction in the 19th century of gypsum plaster, and the development of synthetic casting materials during the 1970's, the correct technique and application of splints and casts has become increasingly skilled, and so the training and professionalism of the orthopaedic practitioner is paramount.

This Practical Guide to Casting provides clear guidelines on the safe application of all types of casts, underpinned by the relevant understanding of the fracture, the soft tissues and the applied anatomy. The professional orthopaedic practitioner, working in a busy casting room, needs an evidence based manual, with clear guidelines and recommendations to ensure that their work is safe and of the highest standard, and the Practical Guide to Casting is the definitive guide to casting.

As well as casting rooms, this guide should be made available anywhere where casts are applied – theatres, the Emergency Department, clinics and wards. It is an invaluable source of information in a clear and easy to read format that will be vital for everyone applying a cast – from a junior doctor or nurse working in the ED through to a highly experienced orthopaedic practitioner.

Matthew Barry

Chair of the British Orthopaedic Association
Casting Committee

British Orthopaedic Association



# A Practical Guide to Casting

## 1st Edition

Published in 1991



The original was written by members of the Royal College of Nursing Society of Orthopaedic Nursing as a service to all those engaged in the art of casting at the initiative of BSN medical Limited.

Reprinted 1994.

## 2nd Edition

Published in 2000 by BSN medical Limited



## 3rd Edition

This edition has been edited and written by
Susan Miles, BSc, RGN, ONC, FETC, Orthopaedic Technician Certificate, National Casting Training Advisor, British Orthopaedic Association and

Beth Tite, Orthopaedic Technician Certificate, Senior Orthopaedic Practitioner, Casting Course Tutor, British Orthopaedic Association

Published in 2012 by BSN medical Limited



## 4th Edition

This edition has been extended and written by
Susan Miles, BSc, RGN, ONC, FETC, Orthopaedic Technician Certificate, National Casting Training Advisor, British Orthopaedic Association and

Beth Tite, Orthopaedic Technician Certificate, Senior Orthopaedic Practitioner, Casting Course Tutor, British Orthopaedic Association

Published in 2019 by Essity



For comprehensive details of contributors to each edition, please see page 122.

## In memory of Susan Miles

BSc, RGN, ONC, FETC, Orthopaedic Technician Certificate

1947 - 2019

**National Casting Training Advisor,**
**British Orthopaedic Association**

Sue dedicated many years to the support and development of students through their BCC education. Imparting her knowledge and ensuring casting standards are continually met, setting both professional and patient focused standards. Because of her hard work, nationally and internationally, there are qualified British Casting Certificate (BCC) holders in over 28 different countries.

Many of those now-qualified students will recount their time at Stanmore and colleagues have shared their admiration for Sue.

We would like to dedicate this, the 4th edition of the Practical Guide to Casting, to Sue in recognition of her work and dedication to the world of Orthopaedics.

Thank you, Sue, from your students, colleagues and friends around the world.





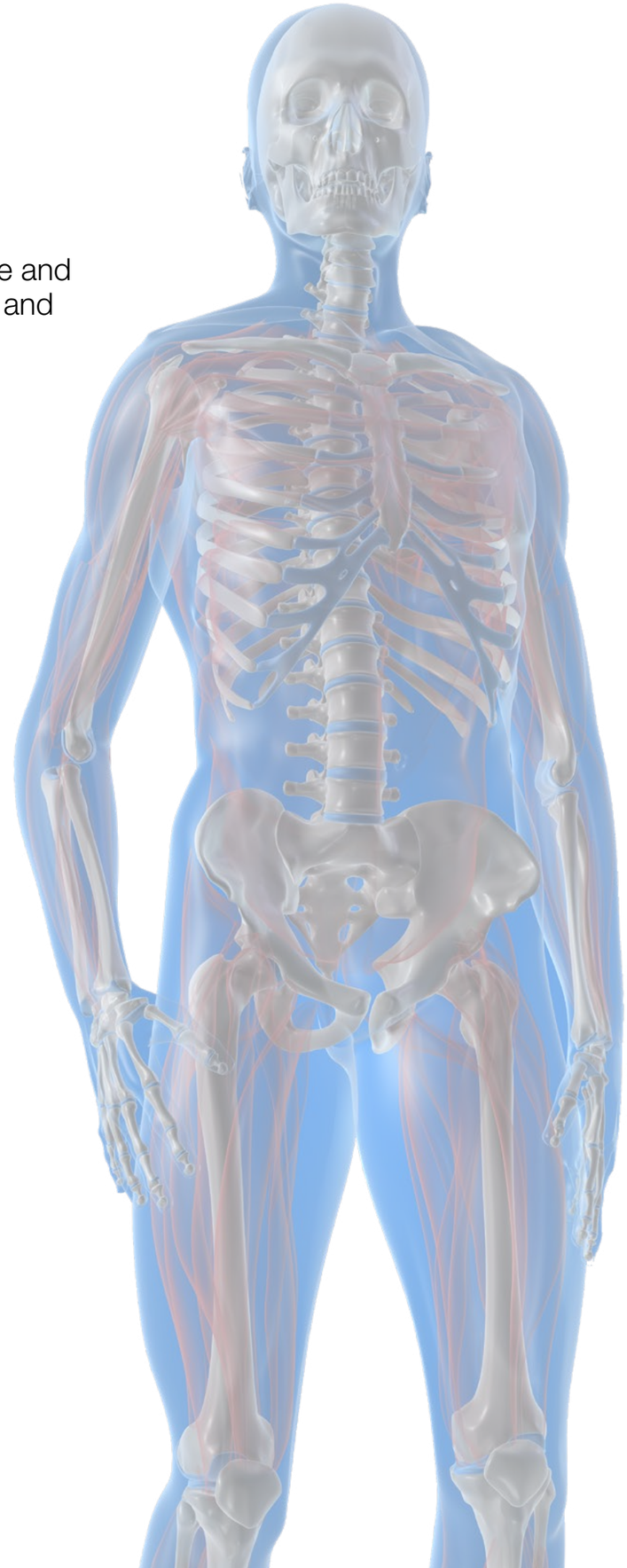
# Contents

# A Practical Guide to Casting

## An Introduction to the Care and Management of Fractures and Orthopaedic Conditions

## Contents





# 1.1 Terminology

A practitioner is someone who engages in an occupation, profession, religion, or way of life. The Concise Oxford Dictionary describes “Technician” as a person “skilled in technique of an art or craft”. Further, it notes him/her as a “person expert in the practical application of science”. Whoever carries out this skill, what the patient requires is certainly an expert in the art or science of the task in hand, a first class cast.

## Orthopaedic Terminology

While working in the Plaster Room, you will want to understand and be conversant with your professional colleagues on all facets of medical and plaster care, and to do that you need to understand the vocabulary.

Although there is standard orthopaedic terminology, some of the language you hear will be unique to that department, part of the local ‘jargon’. Please ask your colleagues for a meaning, for they will have been using these colloquialisms for so long that they will have forgotten that they are not standard English.

## Word Structure

The **root** of a word can comprise any part of the word but always has the same meaning: e.g. osteo-arthritis, periosteum relating to bone (osteo)

A **prefix** is the opening group of letters in a word that direct its meaning: e.g. ab means away from, as in absolve and abduction

A **suffix** is the closing group of letters in a word that direct its meaning: e.g. algia means pain, as in neuralgia

The following table is intended to provide a useful reference source for some of the many words with which you will become familiar in the Plaster Room.

| Meaning | | Example(s) |
|---|---|---|
| *osteo* | bone | *osteoarthritis, periosteum* |
| *chondro* | cartilage | *chondroma* |
| *cyst* | sac | *cholecyst* |
| *ped/pes* | foot | *pes planus* |
| *pneum* | lung | *pneumothorax* |

Prefixes are opening letters of a word that direct its meaning:

| | | |
|---|---|---|
| *a/an* | absence of | *anuria* |
| *ab* | away from | *abduction* |
| *ad* | towards | *adduction* |
| *bi* | two | *bilateral* |
| *endo* | within or inner | *endosteum, endoscope* |
| *epi* | on or upon | *epicondyle* |
| *hemi* | half | *hemiplegia* |
| *hyper* | above or excessive | *hypertension* |
| *hypo* | below or deficient | *hypodermic* |
| *infra* | below | *infraglenoid* |
| *inter* | between | *intervertebral* |
| *intra* | within | *intravenous* |
| *macro* | large | *macroscopic* |
| *micro* | small | *microscopic* |
| *peri* | around or outer | *periosteum* |
| *poly* | many | *polyarthritis* |
| *post* | after | *post mortem* |
| *pre* | before | *premedication* |
| *pseud* | false | *pseudarthrosis* |
| *sub* | under | *subperiosteum* |
| *supra* | above | *supracondylar* |
| *trans* | across | *transdermal* |

Suffixes are closing letters of a word that direct its meaning:

| | | |
|---|---|---|
| *algia* | pain | *neuralgia* |
| *cyte* | cell | *erythrocyte* |
| *ectomy* | to remove | *appendicectomy* |
| *otomy* | to cut into | *osteotomy* |
| *ostomy* | to form an opening | *tracheostomy* |



# 1.2 Health and Safety in Casting

**Please note this chapter does not cover all aspects of Health and Safety in the Plaster Room, but gives an overview. Refer to the Health and Safety Executive (HSE) and check the current regulations.**

Safety in the Plaster Room, and other areas where casting is undertaken, is of paramount importance to both patients and staff.

It is the duty of employees to see that they do not, through negligence, cause harm to themselves, each other, or to their patient.

It is the duty of employers to see that systems exist whereby correct levels of trained staff are available, with the required equipment maintained in good working order to ensure safety of the patient and of the staff.

Education should be available and is essential for safe practice.

**For more information on casting courses see inside back page.**

## Environment

A health and safety assessment of the Plaster Room must be undertaken annually or if the environment changes. Health and safety officers and/or the local HSE will advise and assist if necessary.

- The Plaster Room must be kept clean to prevent the spread of infection
- There must be good lighting to provide adequate inspection of wounds, sutures and pressure points
- There must be adequate ventilation
- The oscillating cast saw must have a dust extractor attached. Where the cast saw is used without an extractor, suitable disposable masks that prevent inhalation of dust must be worn. Refer to HSE 2009
- The floor must be kept dry to prevent staff and patients slipping
- Electrical equipment must be kept away from areas that may become wet and should only be touched with dry hands
- Protective clothing available must include: aprons to prevent clothing becoming wet, or spoilt with casting materials, or infection from blood stained casts; masks to prevent inhalation of dust; gloves to prevent allergies and infection; ear muffs to prevent damage to hearing

## Equipment

**Materials,** chosen after assessment of the patient, and tools appropriate for the task and in good working order, must be assembled before treatment commences.

**Equipment** must always be used according to manufacturers’ product instructions. There must be a regular, recorded, maintenance programme.

- Oscillator saw blades must be kept clean and unclogged at all times, and not used if blunt or worn
- The cast saw must have a vacuum extractor bag attached. This must be emptied regularly and hoses checked for splits; regular testing to check the efficiency of dust extraction should be part of a planned maintenance programme. It is advisable to use plaster shears when removing casts from children
- Knives must be kept sharp and sheathed when not in use
- Scissors that come into contact with the patient must have a rounded or bull-nosed tip to the end of the blades
- The couch must be adjusted to the correct height, be easy to clean and have efficient brakes
- Sharps must be disposed of in a sharps box
- Disposal bags of sufficient size (the correct colour according to local policy) must be available and used
- Electrical flexes must be enclosed in channels and/or tucked away to avoid accidents

It should be remembered that the tools used may injure the patient if not used according to accepted methods and correct practice.

## Staff - Techniques

- A fully completed and signed medical prescription must accompany the patient to the Plaster Room
- The patient’s documents and X-rays must be available before the patient is treated
- Documentation is essential to provide clear evidence of the care planned, the decisions made, the care delivered and the information shared, and a written record of the care undertaken must always be recorded within the patient’s documents as soon as possible after the event. They must be legibly signed, dated and timed. For full information see the NMC code of conduct (NMC 2015). The Plaster Room Register must be a current record of all patients cared for and be completed after each care episode (BOA 2015)
- Staffing levels must be adequate for the workload
- Verbal information must be given before treatment and verbal consent obtained. When treating children or vulnerable adults, please refer to the latest national policy regarding consent and get written guidance from your Trust. Both verbal and written advice should be given afterwards
- Should there be an accident, in order to provide a record in case of possible litigation at a later date, the correct procedures must be followed according to local policy

# 1.2 Health and Safety in Casting

## COSHH (Control of Substances Hazardous to Health)

The COSHH Regulation 2002 updates the previous codes, but the main message is still that the employer must make a suitable and sufficient assessment of risk, in order to enable a valid decision to be made about adequately controlling substances hazardous to health.

If you are in a position where you represent your employer, remember that your Trust/Hospital, Safety Officer and the HSE have guidelines for assessment, and are there to support you.

It is your duty to yourself and to your patient, to ensure that assessment of risk has been undertaken to the standard required by the HSE.

The COSHH regulations place a legal requirement on manufacturing companies to provide information about their products. The guidelines cover both manufacture of the product and its use.

### Disinfectants

Manufacturers' instructions, national and local policies must always be followed.

### Dust

COSHH refers to substances capable of entering the nose and mouth during breathing, and being thereby available for deposition in the respiratory tract. It is important that consideration be given to cast removal, the amount of dust generated and the measures taken for protection.

### Synthetic Materials

Gloves should be worn when handling synthetic casting material, as resin is sometimes difficult to remove from the skin and may cause irritation.

### Body Fluids

Gloves should be worn when in contact with body fluid, clothes or dressings that have been in contact with body fluids.

### Noise

The Control of Noise at work regulations (2005) limit personal daily exposure to 85 decibels for eight hours. If the noise level reaches the region of 80 decibels, everything must be done to reduce the noise, and hearing protectors must be made available. The risk must be assessed by someone competent to carry out this task.

The noise of oscillating cast saws is below that, but becomes louder when the blade starts to bite into a cast. With the added noise of an extractor, it is wise to wear a hearing protector if using a cast saw for any length of time. It may be kind to offer the patient a hearing protector if the cast to be removed is a large one.

Regular staff health monitoring should be undertaken, including tests to ensure hearing loss or lung capacity changes are recognised. (COSHH Health surveillance).

The COSHH regulations place a legal requirement on manufacturing companies to provide information on their products as requested by users of the product.

The guidelines cover both manufacture of the product and its use.

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All casting products mentioned in this guide are supplied by Essity and further information on these products, is available as a Material Safety Data Sheet (MSDS). MSDS's give the following type of information:

- Product name
- Intended use
- Composition
- Physical and chemical properties
- Health hazards
- Fire hazard and emergency action
- Storage precautions
- Transport precautions
- Handling/use/protective clothing
- Disposal
- First aid
- Name, address and telephone number of supplier

**All Essity products have Material Safety Data Sheets and these can be obtained from your Essity Account Manager**

### Further reading

Please visit www.hse.gov.uk for up to date information

Health and Safety Executive HSE Health and Safety Law (2009)

HSE COSHH Control of substances hazardous to health regulations (2002)

HSE The Control of Noise at work regulations (2005)

NMC Code of Conduct (March 2015) Nursing and Midwifery Council

British Orthopaedic Association Casting Standards November 2015, available at:

http://www.boa.ac.uk/events/casting-standards/

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# 1.3 Coping with Life in a Cast

**In addition to the instruction leaflets shown in the Appendices, the following advice can be offered to the patient to help them cope with life in a cast, and shows how to overcome some of the difficulties.**

## Safe Environment

- Whilst in your cast try to move and exercise as regularly or as often as you are allowed to in order to avoid becoming stiff. Change the position of your limb in the cast regularly to avoid constant pressure on one area of the limb.
- Always put your cast shoes on when you get up (providing you are allowed to weight bear). Don't walk just on your cast, you are liable to slip. If possible wear a thick soled shoe on your good foot, to even you up to match the height of the leg in the cast
- Make sure you move loose mats or rugs out of your path so that you don't trip up over them
- Check the rubber ferule on your stick or crutches if you have been using them for some time. If you are using them outside they can wear out very quickly
- Some hospitals will provide you with a cast shoe that totally covers your foot, and some with a cast sandal. If you have only been provided with a cast sandal and you are going out in the rain, do cover your cast to prevent it, and your foot, from getting wet – a variety of specific cast covers are available for purchase (details can be obtained from the Plaster Room staff). Don't leave the cover on for too long or it will cause condensation, and your leg and cast will become wet. Wear the cover over your cast but not over your shoe as that could make it very slippery
- If your cast is plaster of Paris and it gets wet it may become soft
- Don't be tempted to go on the beach in the summer. Sand under your cast will really irritate, and could rub you sore
- If you drop something down your cast you need to have it removed. If not, it will make an indentation in your skin which will turn into a sore. You will have to tell the Plaster Room staff, and let them find the object!
- For babies, toddlers and small children you may be able to obtain adapted prams, carriages and trolleys, which will make life much easier for you and much happier for the child, as they will be able to get out and about without too much difficulty
- You may be able to obtain these from your hospital, or borrow them from support groups
- If you live alone perhaps you ought to consider whether there is someone who could come and stay with you to help. Can you let your neighbours know you are incapacitated so that they can help or keep an ear open for you to call if you need help?

## Hygiene

- Casts must be kept dry at all times
- If the padding under your cast gets wet it will take a long time to dry, and may not continue to protect your skin
- Plaster of Paris casts will soften if they become wet and may not support your injury or operation
- Synthetic casts will not soften or disintegrate when wet, but you cannot dry underneath them. If you bathe or shower in them, the skin under your cast can become very soggy and macerated. If you have stitches or a wound under your cast and you get them wet they may become infected
- Baby wipes are an easy and pleasant way to clean fingers and toes without getting them too wet
- It could be difficult for you to bathe, or shower, or just to wash, but there are various ways you can tackle this
- Before bathing or showering you will need to cover your cast to prevent it getting wet. Use one of the commercial products on the market, (details can be obtained from the Plaster Room staff) to keep it dry. Take care to remove the covering before it interferes with your circulation
- Delta-Dry® waterproof padding is available which allows patients to shower with the cast on, providing the instructions are followed carefully

## Showering

- You may find this easier than bathing, remember to cover your cast as discussed above.

## Bathing

- You may need help to get into the bath, so for the first time it's a good idea to have someone on hand to rescue you in case you can't manage on your own. Get them to fill the bath for you, checking the depth and temperature before you get in. It is generally easier to put the uncast leg in first and when getting out to lead with the cast leg. If you have a leg cast on then you are going to need to support the limb on something to prevent it getting wet and do remember that the water level is going to rise as you get into the bath
- It is easier to empty the water out of the bath, and dry yourself before getting out, rather than trying to struggle out of a bath when it is still full of water. A damp flannel or towel along the edge will help to prevent you slipping when getting in or out
- If you have had an arm cast applied you may find a large rubber glove will keep your hand dry. Persuade your family and friends to wash the areas you cannot reach - your back, feet, hair etc.

# 1.3 Coping with Life in a Cast

## Toileting

- This can be very awkward if you have a large cast, or for babies that are not yet potty trained
- If you have had a long leg cast applied, you will find it easier to sit on the toilet if you can prop your leg up on a stool. Make sure the furniture you are going to use for support is stable and secure
- Commodes can sometimes be hired from the Red Cross or your GP
- Loose, floppy clothes and track suits are easier to pull up and down than fitted clothes
- If your child is in a hip spica or 'frog' type cast, and is not potty trained, tuck a small nappy inside the nursing area at the front and back of the cast, and cover with a larger sized nappy over the cast. It is essential to change the nappy more frequently than usual to keep the cast dry
- If your child is out of nappies and using a bedpan, their upper body should be raised on pillows to keep it higher than their legs. This is in order to prevent soiling of the cast

## Eating and Drinking

- Try to plan ahead if you can. If you are going to be on your own all day it may help to get the family to put what you need within reach. High or low cupboards may be difficult to reach
- Flasks can be prepared in advance with hot drinks or soup. If you cannot carry a tray, or saucer safely, then you may be able to carry a vacuum flask in a bag over your arm, or hanging from one of your crutches
- A tea trolley is useful, you can load it up with a complete meal, and push it in front of you or you can hire one from the Red Cross. Also helpful is a small rucksack for carrying things around the house and leaving your hands free. Jug kettles may be easier to pick up than the traditional shape
- If you are one-handed, and cannot cut food easily baby suction pads help to stop plates moving away from you
- Bowls and spoons are easier to handle than plates, knives and forks
- A mug half full will not spill as easily as a cup
- If you have a below knee cast on it can be very tiring to prepare food; it may help you while standing to support your leg behind you on a padded stool or chair. Do try to sit down whenever you can
- If you have a full leg cast on you may find it easier to perch your bottom on a tall stool when doing the chores at the sink, or using the ironing board
- If you are in a jacket or body cast you will not be able to eat big meals; you should eat little and often. Big meals will probably give you indigestion and make your cast feel too tight. Fizzy drinks, e.g. beers and ales can make you feel very bloated

## Body Temperature

- Wearing a cast is like having an extra layer of clothing on. The problem is that you cannot take it off at will, so you may find yourself becoming too hot. There is not a lot you can do about this. You can try not to put too many clothes on and keep your heating lower than usual. Let the family wear extra clothes if they are chilly. The solution is a lot easier if you are too cold. Obviously the first thing to do is to put on more clothes
- If your leg is in a cast, extra large mountaineering socks or 'leg warmers' will help, especially if they are woollen. Wear a size too big for you so that you trap warm air in the folds and fibres
- Track suit trousers are warm and comfortable
- If your arm is in a cast, mittens, or socks wrapped over your fist may help
- Don't sit too close to a fire. You may not feel the heat until it is too late and your cast is so hot that you have burnt yourself

## Dressing

- Wide, loose clothes, such as track suits, are probably the easiest to put on when you are coping with life in a cast. They are also comfortable and, if you are trying to hide the fact that you have a cast on, they are the clothes of choice
- Extra large mountaineering socks will disguise your cast and fit in with your fashion colours. Even body casts and jackets can be hidden under sweatshirts
- Hook and loop is excellent as a fastening for ease of use and speed when dressing and undressing, and it may be used in some cases to replace zips
- Front fastening bras will help your independence if you cannot reach round behind your back
- Fibreglass casts may catch on tights, frail materials, upholstery, or rub and scratch bare skin. Ask your hospital for stockinette to cover your cast

## Entertainment

- If you are going to be on your own all day and fairly immobile you need to think about how you are going to get through the long hours and amuse yourself. First of all you need to plan for your boredom!
- Buy, beg, borrow or plead for magazines and books. The mobile library can be a boon to you if you are unable to travel far. You can't spend all day reading though, so consider buying or borrowing puzzles and games. Make sure you have the radio, or the control for the television/DVD player, within reach before you sit down or you are deserted for the day
- Perhaps you should consider taking up a new hobby, like tapestry, or model making, or a new language?



# 1.3 Coping with Life in a Cast

## Sleeping

- Sleeping at home in a cast can be harder than you expect, after hospital where everything is geared up for you. Your bed at home is probably softer than in hospital, and you will sink into it, and may find it harder to turn over
- If you need to keep the bedclothes off your legs you can put a kitchen chair with its back placed against the bed, and hang the bedclothes over the top of the back. It will take the weight off you. Alternatively, you can use a cardboard box, with one side cut out, turned onto its side under the bedclothes
- If your partner is being kicked or knocked by your cast limb try covering the cast in something soft. Once again extra large socks can help
- If you need to elevate your leg when you go to bed try a pillow under your mattress, or raise the end of your bed on concrete or wooden blocks
- If you need to elevate your arm, rest it on a couple of pillows

## Mobility

- Coping with life in a cast can be quite exhausting, and getting yourself from room to room may well feel like going on a three mile hike. Going upstairs can feel like mountaineering
- If you have a leg cast on, do put your leg on a padded stool, pouffe, or the sofa when you are sitting down. It will help your circulation, prevent swelling and ease your pain if you have any
- If you have a family, see if you can persuade them to run errands for you. Perhaps there is something you can do in return whilst you are sitting down?

## Walking with Crutches

- Move crutches forward, and then swing your sound leg through to the level of (or slightly in front of) your crutches, with the affected leg following

## Going Upstairs

- Always put the unaffected leg up first, then bring the splinted leg up along with crutches

## Going Downstairs

- Put the crutches down one stair, followed by the affected leg and finally the unaffected leg. You may find the following advice easy to remember - 'up to heaven with your good leg leading you up, down to hell with your bad leg leading you down'!
- Alternatively, you may find it easier to go up and down the stairs on your bottom, taking care not to dent or crack your cast (for advice on the use of crutches see Appendix II)

## How to Get Up if you Fall

If your leg cast, or casts, prevent you from getting back on your feet in the usual way it may help to try the following:

Roll onto your tummy; get onto all fours (or all threes if you are in a long leg cast); pull yourself into a kneeling position (using a stable piece of furniture to help), and then pull yourself into a standing position, straightening the unaffected limb as you go.

We hope these hints and tips may help you cope until the welcome day when you hear your surgeon say 'That cast can stay off now, all is well'.

## Essity Patient Information Booklets

Cast care instructions for patients (including children) can be obtained from your Essity Account Manager

## Support Groups

**SCOPE**
Information and support on all aspects of care.
Enquiries to their helpline -
T: 0808 800 3333
E: response@scope.org.uk
W: www.scope.org.uk

**STEPS** (National Association for Children with Lower Limb Abnormalities)
Enquiries to their helplines -
T: 01925 750271
E: info@steps-charity.org.uk
W: www.steps-charity.org.uk

**SCOLIOSIS ASSOCIATION**
Enquiries to their helpline -
T: 020 8964 1166
E: info@sauk.org.uk
W: www.sauk.org.uk

Further reading Pearson A. (1987) Living in a Plaster Cast. RCN London and Tonbridge. The Whitefriars Press.

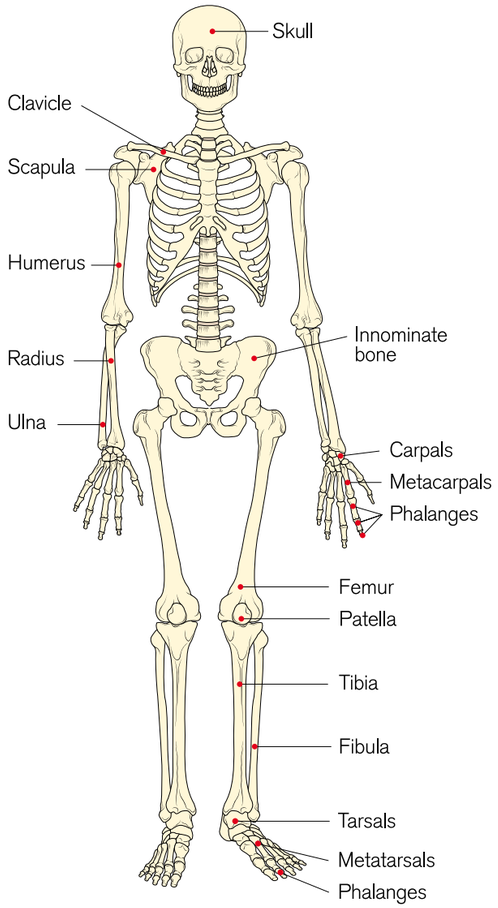
# 1.4 General Anatomy

## The Locomotor Systems

The locomotor systems are those which enable a person to move about, change position, hold articles and handle tools.

They are:

- **The skeletal system of bones and joints**
- **The muscular system**
- **The nervous system**




## The Skeletal System

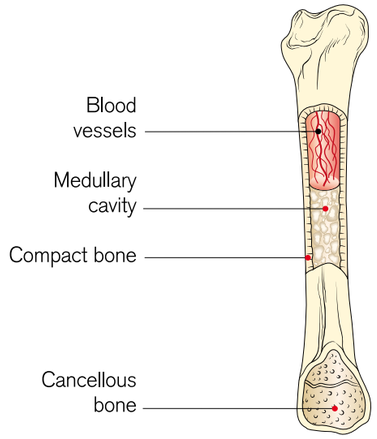
**The skeletal system** is formed of the bones of the skeleton, symmetrically arranged. It is divided into:

- The **appendicular skeleton**, comprising the bones of the upper limb and shoulder girdle (clavicle and scapula) and the lower limb and pelvic girdle (innominate bone)
- The **axial skeleton**, comprising bones of the trunk and head

The skeleton has the following functions:

- It forms the framework of the body
- It is arranged to give protection to vulnerable tissues, e.g. the brain, lungs and heart, spinal cord, ovaries
- It gives attachment for muscles which bring about movement or maintain posture
- It takes part in the formation of joints, which also enable movement to take place
- It supports and maintains the posture of the body
- It is concerned with the use of calcium in the body, and the formation of the various blood cells

## Structure of Bone




Bone consists of one third organic and two thirds inorganic material. Together they contain substances such as collagen, mineral salts, calcium phosphate and carbonate, which makes it both strong and resilient. Bone integrity is maintained by the bone cells' osteoblasts, or bone builders, and osteoclasts, bone consumers. It is a balance between osteoblastic and osteoclastic activity that ensures healthy strong bone. The surface layer, or **compact bone**, is smooth and rigid and gives the individual bone its strength. Various protuberances allow attachment for muscles.

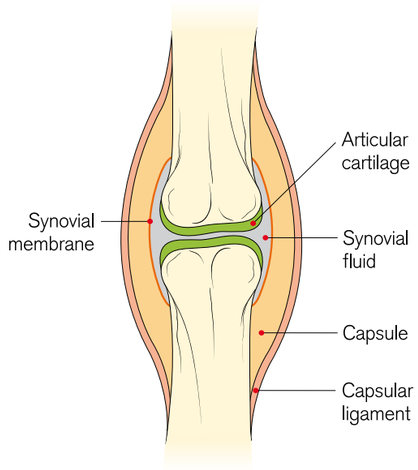
Hollows and grooves on the surface allow room for neighbouring blood vessels and other structures. **Cancellous bone** fills the centre of individual bones. It is spongy in appearance, but firm and rigid to touch. Its structure gives lightness to the bone. Its spaces are filled with the red bone marrow, which produces the **blood cells**. Cavities which lie in the centre of the shaft of long bones are filled with fatty yellow bone marrow. It is along this cavity that intra-medullary nails are inserted.

Joints are sites where two or more bones meet. They are classified as fibrous, cartilaginous or synovial joints ,according to the substance separating the bones within the joint. Of most interest to Plaster Room staff will be synovial joints, because they are mostly freely-movable and hence disease prone.



# 1.4 General Anatomy

## Synovial Joints



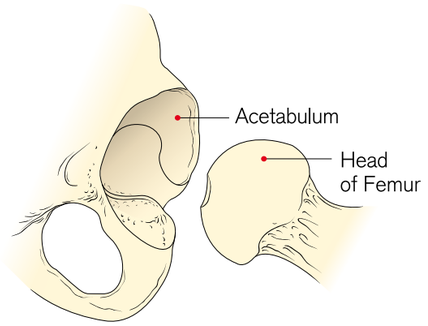

The articulating bone surfaces are smooth and covered with articular cartilage. In healthy joints, the two surfaces of cartilage are in contact with each other and are lubricated by a thin film of synovial fluid.

**Synovial fluid** nourishes and lubricates the intra-articular structures including the articular cartilage. It is produced by the capillary network within the **synovial membrane** which lines the joint capsule and covers any bone within the joint not covered by articular cartilage.

A sleeve of strong fibrous tissue - **the capsule** - holds the two bones together and surrounds the joint. The capsule may be reinforced by strong extracapsular ligaments.

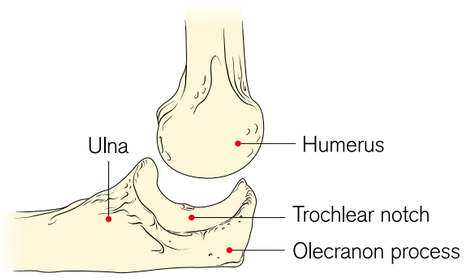
Synovial joints are also classified according to their pattern.

## Ball and Socket Joint



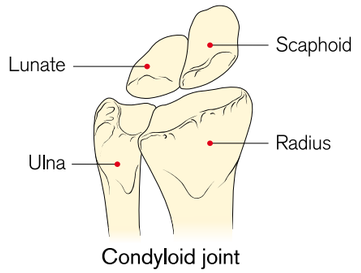

Rounded head on one bone fits into cup shaped cavity on articulating bone, e.g. hip joint or shoulder joint.

## Single Hinge Joint




Usually comprises two bones only and moves in one plane, e.g. ankle joint, interphalangeal joints or elbow joint.

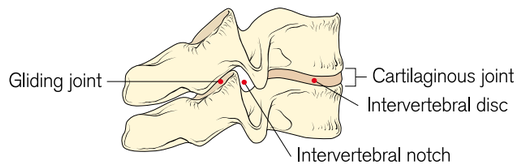
## Composite Hinge or Condyloid Joint




Condyloid joint

Two or more bones capable of moving in more than one plane, e.g. the wrist joint.

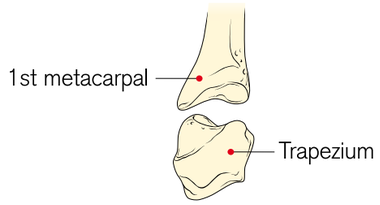
## Gliding Joint




Two flat surfaces slide over one another, e.g. the inter-vertebral joints.

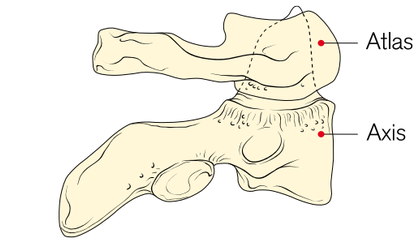
# 1.4 General Anatomy

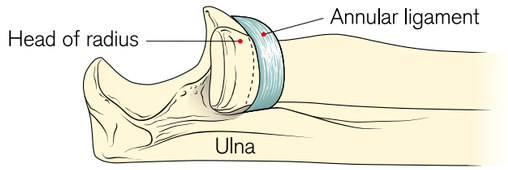
## Saddle Joint




The two bones have convex and concave surfaces that articulate, e.g. 1st carpo-metacarpal joint.

## Pivot Joint



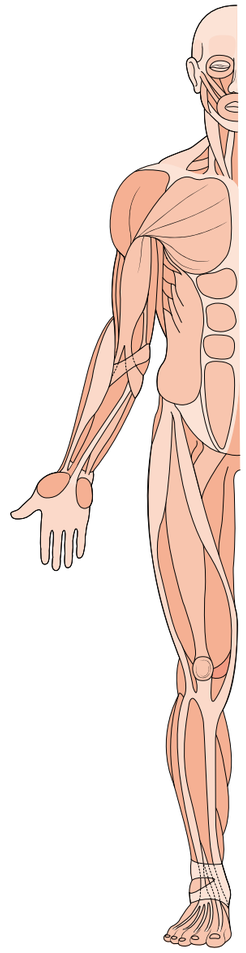

One bone remains immobile while its articulating bone rotates around it, e.g. Atlanto-axial joint or superior radio-ulnar joints.

## The Muscular System

The principle characteristics of skeletal muscle are **contraction** (shortening) and **extension** (lengthening). A muscle consists of the belly or fleshy part of the muscle and usually a **tendon** for attachment to bone. The muscle must cross a joint in order to bring about movement of that particular joint.

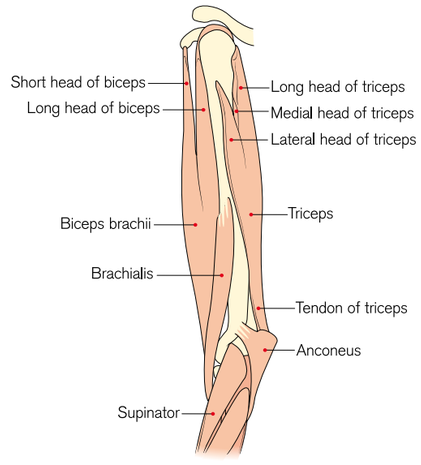
Extension of one muscle is usually brought about by contraction of its opposing muscle. This is the simple basis of movement; for example, if you flex the elbow joint by contracting the agonist, in this case, biceps brachii and brachialis, the triceps, their antagonist will extend. Contract the triceps, in this case the agonist, to extend the elbow joint and biceps brachii and brachialis, the antagonisers, will extend.

Example of the human musculature



Muscle also pads the skeletal framework, forming the flesh which gives the body its shape. In turn it is overlaid with varying amounts of adipose tissue (fat).

MUSCLES OF UPPER ARM






# 1.4 General Anatomy

## The Nervous System

The nervous system, along with the endocrine system, controls the many bodily functions. It comprises the brain and spinal cord, the peripheral nerves and the autonomic nervous system.

In the Plaster Room the most important knowledge is an **understanding of motor function,** which is a combination of muscle and motor nerve action. Peripheral nerves, however, are mixed nerves which carry both motor and sensory neurones.

Neurones carry impulses from one part of the body to another.

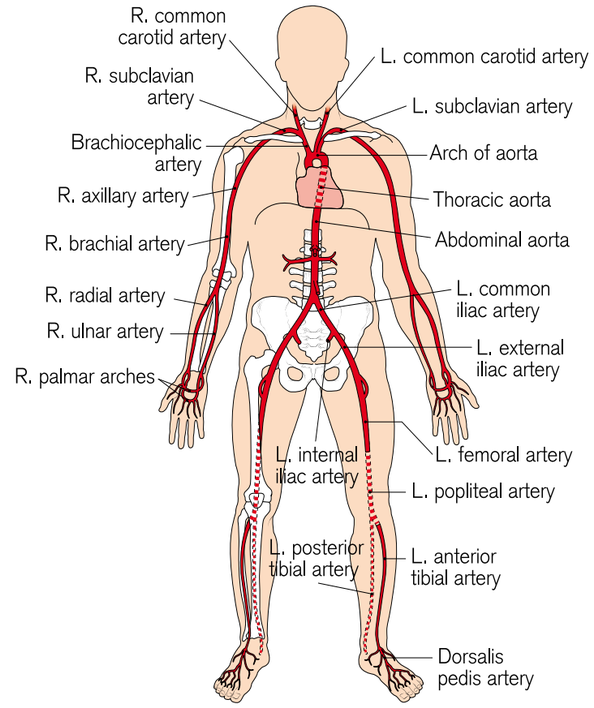
Motor neurones carry impulses from the brain to muscles; sensory neurones carry impulses from the skin and internal organs to the brain.

Both types of neurones work together for the safety of the human body. Injury to any part of the nervous system has damaging consequences, but can vary from temporary bruising with total recovery, as in sitting cross legged or hitting your “funny bone”, to complete transection, leading to total paralysis and loss of sensation.

Peripheral nerves which lie close to the surface are vulnerable especially to the application of casts and splints. This can result in temporary or permanent disability e.g. pressure to the common peroneal nerve as it winds around the neck of the fibula which will result in an inability to dorsi-flex the foot, often called ‘foot drop’.

## The Circulatory System

The circulatory system is made up of the heart, arteries, arterioles and capillaries, the venules and veins. Arteries tend to be more superficial than veins and hence are at **risk of pressure from surface treatments.** Plaster Room staff need to be aware of this risk. The illustration shows the main arteries of the human body.




Aorta and the main arteries of the limbs

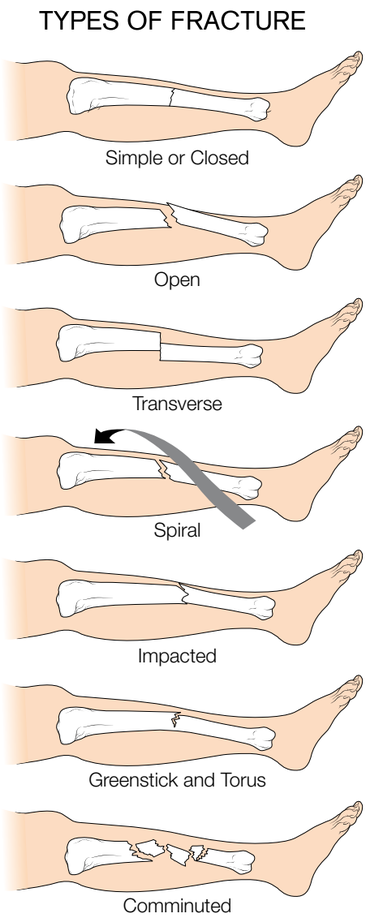
# 1.5 Fractures

## What is a Fracture?

A fracture is defined as “a break in continuity of a bone”. In layman’s terms, a fracture is a break, and a break is a fracture. Often the bone is broken completely across, but occasionally, the break is only on one side of the bone, and we may describe such a fracture to the patient as “greenstick fracture”. These incomplete, greenstick fractures most often occur in children.

## Types of Fracture

Fractures can be classified in a variety of ways. They can be described in terms of what we can find when we examine the patient (that is a clinical classification), or by the appearance of the fracture on an X-ray (the X-ray classification), which essentially is a descriptive system. We can also classify fractures in terms of the factors which have weakened the bone and made it more susceptible to breaking. This latter grouping is the physiological classification.




## Classification of Fractures: by Clinical Features

### Simple or Closed Fractures

All fractures sustain some degree of surrounding soft tissue damage. Provided that soft tissue remains intact, with no adjacent wounds, the fracture can be termed ‘closed’. Even closed fractures may have significant soft tissue damage, such that if the fracture is mishandled, further injury may be sustained, producing compound or complicated fractures.

### Open Fractures

An open fracture (the term compound, sometimes used in the past, is misleading and should be avoided) is any fracture where there is a skin wound which may connect with the fracture site. The major risk here is infection, which if it becomes established in the bone, can be extremely difficult to eradicate. Therefore any suspected fracture with a nearby skin wound should be assumed to be open until the wound is explored in sterile conditions, i.e. in an operating theatre. Any wounds should be covered with a sterile dressing. Intravenous antibiotics should be administered and tetanus prophylaxis given. The size of the wound is of no significance. Sometimes, the bone breaks and tears a small hole in the skin, then disappears back inside. The hole in the muscle however, may be massive, and there may be contaminated material or even fragments of clothing caught in the bone ends. The wound must be thoroughly explored and any fragments or dead tissue removed. If the wound is simply closed, then major infection is the likely outcome.

Open fractures may be further described as ‘direct’ or ‘indirect’. In the direct open fracture, the object which has torn the skin has continued on to break the bone; whereas the indirect compound fracture is created when the bone is bent and tears its way out through the skin.

### Complicated Fractures

In addition to causing damage to the surrounding soft tissue envelope, fractures may cause injury to nerves, arteries or tendons that are in the zone of injury. Assessment of neuro-vascular status of the limb both before and after cast application is mandatory.



# 1.5 Fractures

## Classification of Fractures: by X-ray Appearance

Here we are really describing the fracture as it is seen on an X-ray, so this is very much a descriptive classification. The terms used depict the appearance of the bone, and often give a clue as to the amount of force involved in breaking the bone, or the direction of the force.

### Transverse Fracture

This is the typical injury caused by a direct blow. Note that the bone ends are displaced and angulated. The latter is caused by the force of the blow, but the displacement is caused by the pull of muscles attached to the different ends of the bone. These sometimes pull the bone apart at the fracture site, and unless this is taken into consideration, can make reduction of the fracture difficult.

### Spiral Fracture

Spiral fractures are usually caused by the leg being twisted, e.g. a skiing accident to the leg.

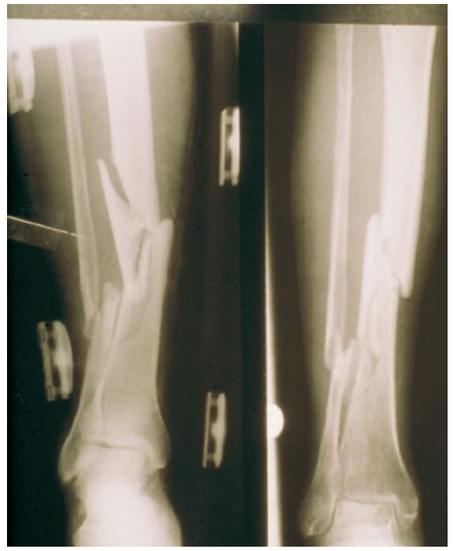
Sometimes these fractures are difficult to hold out to length as the broken ends are quite steep. When these occur in the lower leg, always examine the X-ray carefully, as sometimes the fibula appears to be intact. In fact it will have broken close to the knee and you must make sure that the nerve close by is working properly before, and after, you apply a plaster cast.

### Oblique Fractures

When the bone is broken obliquely, it often signifies a leverage has been applied to the bone. The edges of the bone are sharp, and can cut their way out, so such fractures are often open.

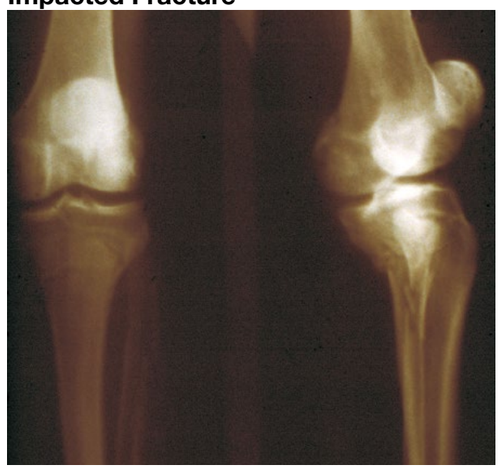
# 1.5 Fractures

### Comminuted Fracture



A comminuted fracture is one where the bone is broken into several fragments. Some of them may be quite small, with a poor blood supply. These fractures, therefore, are slow to heal, and sometimes never unite without further surgery. These two X-rays were taken six months apart and in the later picture on the right there is still no sign of union. The larger fragment of bone, seen in the middle of the left-hand picture, is known as a 'butterfly' fragment from its shape. It takes a lot of force to produce a comminuted fracture, so expect a lot of soft tissue damage and swelling. Circumferential cast applications should be split to allow for swelling. Comminuted fractures are unstable and reduction is more difficult to control in a cast.

### Impacted Fracture

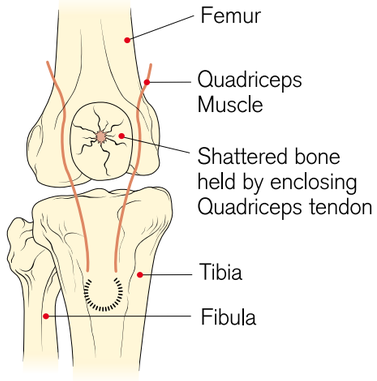


Sometimes the bones of elderly people are broken by a fall, and the broken ends are driven into each other by the force of the blow or by muscle contraction. This can make the fracture very difficult to see, as here, where the tibia is broken just below the knee joint. The clue to the fracture is the angle of the plateau at the top of the tibia, which should be almost horizontal, but in this picture slopes backwards. A better known example of impacted fracture is the Colles' fracture near the wrist.

### Depressed Fracture

When a flat bone is struck by a blunt object, the result is to force a piece of bone inwards (depressed fracture). Two sites prone to depressed fractures are the skull and the pelvis.

### Stellate Fracture




This results when a flat bone is struck by a pointed object, e.g. a kick or a bullet in the knee cap. The result is a star-shaped fracture, like a stone through a window. The fragments of the patella may be held together by the surrounding tendon of the quadriceps muscle.

The above are the most common terms used, but they are purely descriptive, and as such may vary between clinicians.

## Classification of Fractures: by Physiological Factors

Here we are describing a situation where there is some feature about the health or development of the bone which has contributed to the manner of it breaking.



# 1.5 Fractures

### Greenstick and Torus Fractures

The bones of a child are much more pliable than adult bone, and as such an incomplete fracture may occur. Torus fractures, or buckle fractures, occur when one side of the bone may buckle upon itself without disrupting the other side. The word torus is derived from the Latin word 'tori' meaning swelling or protuberance. Children commonly sustain this injury by falling on an outstretched hand. Treatment of a torus or buckle fracture is made by casting the injury for a short duration, usually around three weeks. These injuries tend to heal much more quickly than the similar greenstick fractures.

A 'greenstick fracture' means that one side of the fracture has broken and one side is bent. The name for a greenstick fracture comes from the analogy of breaking a young, fresh tree branch. The broken branch snaps on one side (the outer side of the bend), while the inner side is bent, and still in continuity. Most often the greenstick fracture must be bent back into the proper position and then cast for about six weeks. Greenstick fractures can take a long time to heal because they tend to occur in the middle, slower growing parts of the bone.

### Pathological Fracture

The essence of such a fracture is disease of the bone which has weakened it, so that it breaks with comparatively trivial violence. Sometimes the weakening is the result of generalised bone disease, such as osteoporosis, but sometimes it is the result of a bone tumour, and may be the first indication that the patient has a tumour at all. Fractures in certain places, such as the spine, top of femur or humerus, with a history of trivial violence should always be considered with suspicion. Tumours of the breast, lung, prostate, kidney and thyroid often metastasise to bone.

## The Diagnosis of a Fracture

A fracture is diagnosed by the history of the incident and by a clinical examination of the patient. X-rays can confirm the diagnosis, but may be misleading, sometimes failing to reveal the fracture until signs of union are appearing.

The signs and symptoms of a fracture are:

- Pain
- Swelling
- Deformity
- Loss of function
- Abnormal mobility
- Crepitus

### Pain

Pain is a very common feature of fractures. Usually the patient knows exactly where the pain is felt, and will indicate if you are making it worse. Pain can worsen the patient's condition, so always handle the injured limb carefully. Support the limb and don't allow the bone ends to grate together.

### Swelling

The amount of swelling is no guide to the type of fracture, as it is partly related to the soft tissue damage, but mainly to the blood flow through the injured limb. A fractured leg which has been hanging down will always swell more than one which has been elevated, therefore always raise the injured leg, both before and after a cast has been applied. Once the limb has been splinted, encouraging the patient to move the fingers or toes, as this will also help to reduce swelling.

### Deformity

Sometimes the deformity is typical of the injury, as in a Colles' fracture of the distal radius. Here the deformity is caused by the direction of the force. At other times, the deformity is caused by the action of muscles pulling on the fragments of bone, unopposed.

### Loss of Function

It is not surprising that someone with a fracture avoids moving the limb because of pain. However, once the pain is taken care of by splinting and support, we should expect, and indeed encourage some function of the injured limb, especially movement of the digits. If the patient still cannot move his fingers/toes, then we have to look for other reasons, such as compartment syndrome, nerve injury or a loss of the attachment of the muscles.

### Abnormal Mobility

During examination of the patient, the Doctor will gently feel the bones to assess if they are intact, noting any tenderness or abnormal movement. This is not a task for anyone other than a Doctor, as it is not only painful for the patient, but may do further damage. However, if in the process of moving the patient you notice that his leg bends in an unusual place, take care not to move the limb again until it is supported properly, and report it to the medical officer.

### Crepitus

Crepitus is the grating sound caused by the bone ends rubbing together. It is similar to the sound heard if you rub your hair between finger and thumb. Note if you hear it, but don't go looking for it as it is very painful for the patient.

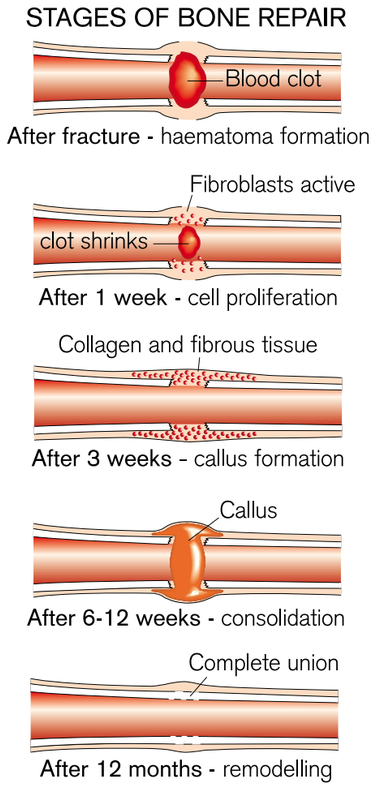
# 1.5 Fractures

## Healing and Treatment of Fractures

### The Healing of the Bone

Bones heal in a slow process, passing through five defined stages:

- Haematoma formation
- Cell proliferation
- Callus formation
- Consolidation
- Remodelling




Initially, there is bleeding from the broken bone ends, and the surrounding soft tissues. This forms a clot or haematoma, which provides a scaffold for new fibrous tissue and bone building cells to move in, leading to stage two.

The early cells are fibroblasts, arising from the periosteum (a membrane around the bone). These convert the blood clot to fibrous material in about ten days, making the fracture “sticky”. The fibroblasts are then replaced by bone building cells called osteoblasts.

The osteoblasts start to produce the first bone around the fracture. At this stage, this begins to appear on an X-ray looking like cotton wool, and is known as callus. The callus may be felt around the bone, and the patient will usually notice that the bone is beginning to feel stronger and less painful.

Over the next few weeks the callus will harden and consolidate and the bone will regain its full strength.

The last stage of the process is the remodelling, when the excess lump of new bone is removed. This is a slow process, carried out by cells called osteoclasts. In children, the remodelling is good enough to remove all trace of the fracture but adults are not so lucky, so there is often evidence of the fracture in the bone for many years.

The speed with which a fracture heals varies with the age of the patient and the size of the bone. Young children heal quickly, adults take longer. Small bones heal quicker than large ones. Other factors such as the general health of the patient, or his nutrition also have an effect on the speed of union of the fracture. The way a fracture is treated also varies the healing. Rigid fixation of the fracture seems to slow the process, whilst too much movement can also prevent union. Early use of a limb, with adequate protection seems to be the best way of encouraging a fracture to heal. The result of all this is that you should never tell a patient how long his fracture will take to heal, as he will be very aggrieved if it takes longer.

### The Aims of Treatment

When we are treating a patient with a fracture, we must determine our aims and priorities; whether we are giving first-aid to the patient, or the definitive hospital treatment. The prime objective must be to consider the whole patient, not just the fractured part. We must therefore impart confidence by our whole approach to the patient; by what we say, and how we say it, as much as by what we do. The way that we handle the patient - in such a manner as to cause as little pain as possible, to safeguard his belongings, to keep him informed of our intentions, and to gain his consent to our actions and invasion of his privacy and person - is the key to a successful outcome, whether we are technician, nurse, or surgeon.

The aims of treatment are to:

- Assess the condition of the patient and priorities
- Reduce the fracture
- Stabilise the fracture
- Prevent deformity
- Restore function

Sometimes all of the stages outlined apply; at others, only one may be required.

### Assessment

The patient may be suffering from a variety of other injuries, many of which, unlike the fracture, offer a much greater hazard to life. These must be dealt with first. For example, is the patient breathing easily? Does he have any difficulty or pain on breathing? Is the blood circulating in the arms or legs? Is he in a state of shock from blood loss? Is there any bleeding, etc? What about pain? It is not within the scope of this document to discuss these aspects of patient care and other manuals deal more fully with this information.



# 1.5 Fractures

There are some points to note concerning the assessment of the fracture. We should check the state of the circulation in the fingers/toes of the injured limb. This should be done when we first encounter the patient, and frequently thereafter, and whenever we have applied any form of splintage. Always do it for yourself, never assume that someone else has done it.

The skin should be pinkish and reasonably warm to the touch once the patient has been inside for a few minutes. Obviously if outside on a cold day you have to take the weather conditions into account. Likewise, with dark skinned patients, you must examine the nails, which are less pigmented. Squeeze the hand (foot) gently. Note if it blanches, and how long it takes the colour to return. If the veins are congested, the skin will be a dusky colour, and will blanch only briefly, filling rapidly once the pressure is relieved. When the arteries are obstructed, the skin will be pale, and cold. The most common finding is of venous obstruction caused by swelling or an over tight splint. If so, slacken the bandages slightly until the colour returns to normal.

### Reduction

By reduction of a fracture we mean to restore the normal alignment of the bone as closely as possible. Absolute alignment is rarely necessary, and sometimes we need not bother about reducing the fracture at all, as the position is satisfactory. The main reason for reduction is to improve the subsequent function of the limb. Reduction may be important for cosmetic reasons in some cases.

After reduction, the bone should be straight, without rotation or angulation. On an X-ray, the bone ends may appear to be displaced slightly, but this, usually, is unimportant, as long as the alignment of the bone is satisfactory.

Reduction may be achieved by manipulation, i.e. manually pulling and adjusting the bone until in position. Adequate pain relief is required to do this, and X-ray control must be available. Alternatively, reduction may be achieved by placing the limb on traction and applying a small force over a longer period of time. Gradually the muscle spasm holding the displaced bones will relax and the bone will come into its correct position.

### Holding the Fracture

Immobilisation of a fracture is not always required. There is evidence that some movement of the fracture site is actually beneficial in stimulating the formation of callus. The movement must be controlled as too much can delay healing. A plaster cast is the most common method of holding a fracture. Other methods include splints, traction, or by internal or external fixation.

Plaster casts, splints and traction all exert their action on the bone via the soft tissues, skin, muscles etc. Fixators are applied directly on or into the bone. External fixators use pins which emerge through the skin and are clamped into a frame. Internal fixation uses plates, screws, pins etc. fastened directly onto or inside the bone.

### Deformity

Preventing deformity is important for cosmetic reasons and very often for functional purposes. Limbs which are bent or twisted do not work as well as they should. Nerves are stretched, muscles weakened, for example. To prevent deformity a good reduction is required, and retained by adequate support. If nerves are injured, we must protect the weakened muscle until the nerves have recovered, by splinting the limb in the appropriate position.

### Function

To restore function we must ensure that the muscles are maintained in a healthy state, that joints are not allowed to become too stiff, and encourage the patient to make as much use of the limb as possible, given the restrictive devices attached to it. Once a cast has set firmly and is strong enough, the patient should use the limb in normal daily activities. This helps to reduce swelling, muscle wastage and fibrosis, and boosts the circulation and healing of the bone. An adequate diet, with protein and minerals is also required, and the patient may need advice on diet.

## Complications of Fractures

A ‘complicated’ fracture is one where there is a problem involving other tissues or organs of the body. The ‘complications’ of fractures are situations which affect the healing of the bone or the recovery of the patient. Some of them arise at the time of the injury, others may be the result of mishandling or mishap. Some may arise later as the fracture heals. There are two complications which affect all fractures, however. They are pain and bleeding.

### Pain

Because pain is a common feature (see ‘The Diagnosis of a Fracture’ page 21), it requires special attention, as it can indicate things are going wrong. Pain also increases shock and makes the patient less able to cooperate and comprehend the information given to him. Pain initially should be treated by suitable methods, usually analgesia, by injection or inhalation. Once the fracture has been treated, pain should begin to diminish slowly. Therefore any apparent increase or change in character of pain must be investigated. An increase in pain may indicate infection, entrapment of a nerve, obstruction of circulation, or later, non-union of the fracture.

### Shock

All fractures bleed from the bone ends and the surrounding soft tissues. In the major bones, the blood loss can be considerable and the patient may be severely shocked, requiring blood transfusion. For example, a haemorrhage into the thigh may be as much as six units of blood, more if the fracture is open. Pelvic fractures also may bleed a lot because the bone is very vascular. Careful and frequent monitoring of the patient’s vital signs is therefore essential when large bones are broken, and resuscitation equipment must be readily available.

# 1.5 Fractures

## Mal-union

This means that the fracture has united, but the position is unsatisfactory, either because the function is impaired, or the cosmetic result is unacceptable.

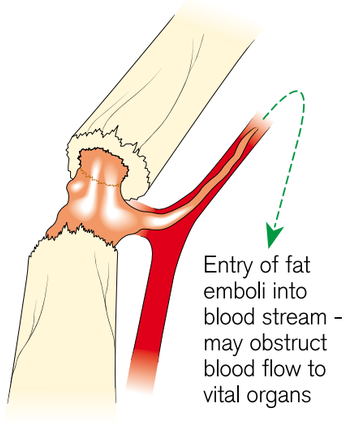
## Delayed Union

Means that the fracture is taking longer to heal than expected. There are several factors which affect the time taken for a fracture to heal, but there are average times for similar injuries. Factors which may impede healing are the type and effectiveness of fixation or splintage, the circulatory state of the limb, the general nutritional state of the patient, and the type of fracture. Comminuted fractures always take longer to heal, for example.

## Non-union

When a fracture shows no signs of healing after twice the expected period we begin to talk about non-union. Changes in the bone ends will be visible on the X-rays, and there will be a decrease in bone density (osteoporosis) in the distal fragment of the bone. Non-union may be due to inadequate reduction of the fracture, inadequate blood supply, death of part of the bone, or soft tissue getting in between the bone ends. Sometimes, too rigid fixation will cause non-union and occasionally, the bone ends are separated by internal fixation or too much traction.

## Fat Embolism




When a bone breaks, microglobules of fat enter the circulation. Usually these are small enough to cause little problem, but sometimes they can coalesce and obstruct the blood flow in the brain, liver, kidneys or lungs. If the patient becomes confused, breathless or passes blood-stained urine within 72 hours of the injury, this complication must be suspected. It can be fatal, but the administration of oxygen for the first twenty-four hours after injury seems to reduce the occurrence of this complication.

## Nerve Injury

Certain nerves are vulnerable to injury at particular sites, e.g. the radial nerve, as it winds around the shaft of the humerus. The state of the nerve supply must be noted in the initial assessment of the patient, and repeated after any treatment of the injury. Sometimes the nerve is affected much later as the callus hardens and entraps it, or perhaps if the bone grows deformed. The result of nerve injury will be paralysis of muscles and a loss of sensation. So a radial nerve injury will produce the deformity known as ‘wrist drop’, where the patient is unable to extend his fingers or wrist.

## Vascular Injury

At certain sites, there is a high risk of injury to the main blood vessels. Frequently there is spasm and temporary obstruction of blood flow, but if unrecognised and not treated, this may become permanent, leading to an ischaemic contracture (Volkmann’s). The first development of interrupted blood supply to the muscles is tightening of muscle fibres, and increasing pain in the belly of the muscle. There will be swelling inside the muscle and the development of a compartment syndrome. This may also be the result of a cast or bandage that is too tight. The action required is to relieve the obstruction as quickly as possible, slacken any bandages, split the plaster, or gently straighten the limb. Get medical assistance urgently as immediate fasciotomy may be required.

The indicators of a developing compartment syndrome are:

- Increasing pain which is out of proportion to that expected by the injury, especially on stretching the muscles
- Pain which does not respond to analgesia
- Pins and needles, or numbness (paraesthesia)
- Increasing paralysis
- Pallor of the limb
- Initially the distal pulses may be normal, but increasing weakness is often observed and then absence of pulse

## Deep Vein Thrombosis (DVT)

Plaster Room staff should be aware of the symptoms of deep vein thrombosis (DVT) and pulmonary embolism, and check patients have been assessed for venous thromboembolism risk before application of a lower limb cast, as per NICE Guidelines. (See page 35 - Complications of Casting for more details.)



# 1.5 Fractures

## Swelling

Swelling may lead to compartment syndrome and ischaemia if constricted by bandaging. Treatment of the swelling involves elevating the limb as high as possible, releasing the bandage and encouraging movement of the digits. If the patient is unable to move them himself then gentle passive movements should be made, moving the joints through their full range.

Gradually the swelling will subside and the circulation improve. Swelling may occur in the hand or foot if the cast is too short at the distal end.

## Pressure Ulcers

Pressure ulcers under casts and splints are caused by pressure or friction. The cast may have insufficient padding over bony prominences, or be too tight or even too loose (See page 36 - Pressure/Cast Sores for further information).

## Infection

Infection is rare in a closed fracture, but is a major risk in a open fracture or following internal fixation. Infection in a bone is very difficult to eradicate, leading to non-union, osteomyelitis and skin breakdown, possibly necessitating amputation. Open fractures must be thoroughly cleaned and any contaminated tissue removed. Antibiotics may be instilled directly into the wound and given systemically, but strict aseptic techniques are an absolute necessity in wound treatment.

## Myositis Ossificans

This is a rare condition where a bony tissue is formed within a muscle near a fracture. It occurs mostly around the elbow or in the thigh. The cause is not known. If it occurs, the limb must be rested until the callus has hardened. It may then be removed.

## Joint Stiffness

Probably the most common complication after the fracture has united. Some of this stiffness is due to the lack of use of the joint, some will be due to muscle weakness, some may be due to fibrosis of the muscles, perhaps due to a mild, undetected compartment syndrome or myositis ossificans. The joint may require manipulation under anaesthesia and intensive physiotherapy before a full range of movement is restored.

## Complex Regional Pain Syndrome (Sudeck’s Atrophy) (Post-Traumatic Reflex Dystrophy)

This is a condition of pain and stiffness which occurs some weeks after the injury. The hand, which is most commonly affected, is puffy, discoloured and moist. Recovery is slow but the hand improves over a few months, during which time pain relief may be required. It should be recognised and physiotherapy instigated as soon as possible.

## Osteoarthritis

Osteoarthritis will develop in joints where the surface is damaged, or as a result of mal-union when the joint is mis-aligned or subject to unusual stresses. Death of underlying bone (avascular necrosis) may also be the cause.

# 1.6 Orthopaedic Conditions

## Infection of Bone and Joints

Antibiotic drugs have revolutionised the prevention and treatment of bone and joint infections, but primary infections are still seen in medical practice.

**Osteomyelitis** is the term used to describe an infection of bone or bone marrow. It may present as an acute infection or in a chronic form, which is nearly always a late complication of an acute form of the disease.

Organisms reach the site of infection by two routes:

- Through the bloodstream from an established infection elsewhere in the body
- Introduction at the time of an open fracture, or as a complication of surgery, although these events are usually avoided by prophylactic antibiotic therapy

The patient presents with severe pain in the affected limb, accompanied by raised temperature and feeling unwell. The affected part may be red and swollen, and the regional lymph glands may be painful and swollen. The erythrocyte sedimentation rate (ESR) and white blood cell count will be raised. It may be possible to obtain pus from the affected part and the organism identified. Antibiotic therapy will be commenced as soon as possible, and may be given parenterally or by mouth, or both. A protective back slab or splint may be ordered for comfort or to prevent pathological fracture where the bone has been eroded.

**Pyogenic arthritis**, sometimes called **septic** or infective arthritis, is where the organism has managed to gain access to the joint cavity and established infection there. The organism gains access by one of three routes:

- From a septic focus, either within the joint vicinity or from a remote site
- Blood borne, usually associated with recent local trauma
- From a penetrating wound, or rarely, as a result of a contaminated intra-articular injection

The causative organism is commonly Staphylococcus aureus and tests will be carried out to identify the appropriate antibiotic. An infected joint will be painful, red and swollen.

The infection usually responds to conservative management including the application of a back splint with elevation in order to rest the limb. As well as antibiotic therapy the patient will require analgesics to control the pain. Once the infection is resolved a period of physiotherapy will be needed to restore full mobility.

**Tuberculosis and tuberculous infection of bone and joints,** the incidence of which has been much reduced due to public health measures over the last five decades, is however, undergoing a small resurgence.

The tubercle bacillus reaches the bone or joint by local spread or by the blood stream, from an active lesion in the lungs or lymphatic system. The common sites for infection are the vertebral bodies, the hip joint or bones of the hands and feet. Efforts to improve the patient's general state of health will be made and antitubercular drugs will be prescribed, and their use continued for at least 6 months. Dependant on where the infection is sited, a back splint or body jacket may be required.

## Arthritis

Two types of non-infective arthritis may be seen in the Plaster Room - rheumatoid and osteoarthritis. Though splints may not be used in the conservative management of these conditions they may be prescribed to support the long term consequences.

**Rheumatoid arthritis** is a chronic, inflammatory disease of joints that is associated with systemic symptoms. At present the cause is unknown. Many joints are affected, often symmetrically, particularly the non-weight bearing joints. The synovial membrane becomes thickened and eventually the articular cartilage is eroded. The subchondral bone may become affected due to secondary osteo-arthritic changes. The patient experiences swelling, warmth, severe pain and stiffness of the joints that is worse after resting. Other problems associated with rheumatoid arthritis are anaemia, vasculitis and problems of the skin, heart and other systems.

There is no specific cure for the disease so treatment is aimed at reducing the symptoms and promoting a mobility that is as free of pain as can be achieved. Drugs in current use are:- non-steroidal anti-inflammatories; disease-modifying, anti-rheumatic drugs (DMARDS) such as methotrexate.or hydroxychloroquine or under some circumstances penicillamine and gold salts may be used; immunosuppressant drugs such as azathioprine.

Aspirin is a useful drug but its continued use may lead to gastric erosion and bleeding. Steroids are effective but because of their serious side effects they are mostly used in short courses. A newer group of drugs called 'biologicals' are being tried.

Surgery is playing an increasing part in the treatment of rheumatoid arthritis. Synovectomy and joint replacements may be used as well as osteotomies and arthrodeses.

Splints will be required and can be made of plaster of Paris or synthetic materials.

**Osteoarthritis** is a non-inflammatory disease of the articular cartilage. It may be **primary**, i.e. occurring without any precipitating cause or **secondary**, i.e. following previous disease or injury involving the articular cartilage.

The joints affected are mainly the weight bearing joints but any joint may be involved. The articular cartilage is eroded and osteophytes develop at the joint margins.

Treatment in the early stages is aimed at relieving pain. Other measures will try to reduce the factors that have led to the onset of the disease such as reducing weight, physiotherapy and exercises to strengthen the muscles and maintain movement.

Surgery plays an important part in the treatment, particularly in the later stages of the disease. There are five types of operation performed:

- **Osteotomy** is used to re-align bone where it is the mal-alignment that is producing the symptoms
- **Replacement arthroplasty** or joint replacement is a common procedure in all our hospitals, in particular the hip and knee
- **Interposition of a silastic prosthesis** as in the interphalangeal joints or ball spacers in the toes



# 1.6 Orthopaedic Conditions

- **Excision arthroplasty** still plays a part in treatment. Though the Girdlestone operation is now used mostly as a salvage procedure following failed joint replacement of the hip, the Keller's operation is still used occasionally as treatment for Hallux valgus
- **Arthrodesis** may be used in some joints where strength is required and replacement is not available

The skills of the Plaster Room staff will often be required in support of these treatments but it is difficult to be specific, as exact roles vary.

## Osteoporosis

Osteoporosis is a disease of bone matrix due to an imbalance between **osteoblastic** and **osteoclastic** activity. There is a reduction in total bone mass. The quality of bone remains normal but the quantity is less. This results in the strength of the bone being reduced and leads to porous bones prone to collapse and fracture. Cancellous bone is most affected and this explains the pattern of fractures that occur as a result. It is referred to as the silent disease, because it can be quite severe before it is recognised, and often a fracture occurs before the condition is suspected. The most common sites for such fractures are the wrist, vertebral column, humeral and the neck of the femur. Osteoporosis, and hence these fractures, is more common in women, though there is increased recognition of the condition in men. The causes may be due to lifestyle, iatrogenic (see Glossary, page 124) or due to physiological changes linked to the ageing process. Osteopenia is a normal aging process of our bones. Oestrogen is a important hormone for maintaining bone quantity because it inhibits bone re-absorption by the osteoclasts. A late menarche or an early menopause, or anything that reduces the levels of oestrogen in the body, is bad for our bones. A family history will increase your likelyhood of the disease. Oral steroid intake has a severe affect on bone mass. Other common factors are lack of activity, smoking, excessive alcohol intake and poor diet in early life.

The aims of management must be in educating the young concerning diet and exercise in order to maximise peak bone mass, which occurs around the age of thirty. This entails ensuring a good calcium and vitamin D intake throughout life and maintenance of physical activity, even a twenty minute walk per day can reduce the risks. Established disease is treated mainly by the bisphosphonate group of drugs, which act either by reducing the activity of the osteoclasts or stimulating osteoblastic activity. Short-term hormone replacement therapy for female sufferers can be useful, where menopausal symptoms are being treated too, although this has to be used carefully to avoid the risks. Testosterone for men is largely still in its experimental phase.

Treating fractures associated with osteoporosis includes surgery for fractures of the neck of the femur and the use of casts for fractures of the wrist, humerus and vertebral column.

Following a low energy wrist fracture, investigations and intervention could reduce the risk of subsequent fractures. In the UK fewer than 30% of patients who suffer from a fracture undergo assessment for osteoporosis. A full history should be taken to establish any medical conditions, family history or lifestyle issues which may put the patient at risk. The diagnosis is made when the DXA scan shows low bone mass.

It is known that if patients follow the health and falls prevention advice, their risk of further fractures will be reduced.

# 1.7 Principles of Casting

**Casting is an art learnt by 'hands-on' practice, but there are certain basic principles which can be helpful. The only way to learn and/or teach, is to do.**

There are many varied techniques in casting procedures, all of which have been proved reliable and effective. We can show only one method for each condition. This method may vary from that with which you are familiar, but the basic principles remain the same and this applies whether using plaster of Paris or synthetics.

The aim of the Plaster Room staff should be to apply a good cast in the correct position whilst attending to the needs of the patient.

### A good cast:

- Is applied in the **correct position**
- Is **functional** - does not obstruct movement unnecessarily, does not obstruct movement of those joints not held in the cast
- **Fits well** - a loosely applied cast does not provide adequate splintage and can cause soreness by rubbing the skin
- **Does not cause constriction** - a cast applied too tightly will obviously restrict blood supply and possibly nerve supply to the limb
- **Is smooth inside** - the bandages applied with an even pressure and without any creases or ridges
- **Is lightweight** - use only sufficient casting materials as necessary, thereby keeping the cast lightweight
- **One whole structure, fully laminated**, not a succession of layers. This is achieved by speed of application and constant moulding to bond the layers

## Care of the Patient

- Check the patient's details and the written instructions
- Give reassurance, explanations and request permission from the patient to proceed. Children need a trusted adult with them for their comfort and support
- Maintain privacy while removing relevant clothing
- Remove, and store safely, any relevant rings or jewellery
- Make the patient as comfortable as possible in the circumstances

## Assess the Patient

- What is the pathology or injury?
- Why is the cast being applied?
- Is there an underlying condition, which may affect the way you apply the cast, e.g. diabetes, rheumatoid disease, neurological impairment or allergies?
- In the case of a lower limb cast, has the patient been assessed for venous thromboembolism risk?
- Look at the skin - is there a wound or redness anywhere?
- A neurovascular assessment of the limb should be undertaken before and after the application of any splint or cast
- Which bony areas will need extra padding?
- Where are the blood vessels or nerves that are close to the surface and may be compromised?
- Is swelling expected?
- Is the cast to be weight bearing?
- Assess the number of staff required to safely hold the patient's limb and apply the cast

Document that these checks have been made and any abnormal findings in the notes. Based on the answers to these questions, decide which padding and materials will be appropriate and gather together the equipment that is required for the application of the cast. Check this will conform to the medical prescription.

## Equipment on a Basic Trolley

- Plaster strips to finish
- Marking pencil
- Knife
- Scissors
- Elbow or knee rest
- Plastic sheeting
- Plastic aprons
- Plastic-covered pillows
- Bucket or bowl of water
- Bowl of water and cloth for washing patient's skin
- Towel
- Rubbish bag
- Instruction leaflet



# 1.7 Principles of Casting

## Helpful Hints When Applying All Casts

**Note: The sizes and amounts of stockinette, padding and casting material listed in the individual cast applications are a guide only to the quantity required for an average sized adult patient.**

### Positioning

The following tips have been found to be useful in practice, but a risk assessment with a manual handling advisor is essential.

Make sure the patient, holder and applicator are in the most comfortable position to avoid lifting and handling problems. Use all the aids available e.g. adjustable height trolleys, knee supports, hoists. Move as close to the patient as possible, bend your knees, keeping your back straight.

Have assistance to hold the limb where needed, for the patient's safety. Do not ask the patient to hold their injured limb themselves as this is uncomfortable, potentially damaging and unsafe. Insist on help if necessary, be your patient's advocate.

### Stockinette

It is usually safer not to use stockinette where swelling is expected. If the cast has to be split the stockinette will wrinkle and crease inside the cast when cut through. Do not use if a fracture is being manipulated.

Do not fold in the stockinette before the first layer of casting material has been applied, otherwise, after the cast has been on a little while, the stockinette and padding will migrate inside the cast and the patient is left with a raw edge next to their skin.

When folding the stockinette back over casting material before it has set, be very careful not to pull it as this creates ridges in the material and can lead to a pressure sore.

### Padding

It is best to pad bony areas with felt, because felt does not compress over time and protects more effectively.

Casts must fit well and so apply a single layer of undercast padding firmly, smoothly and evenly. However, there are many different types of padding available. These vary in thickness and with some types it may be necessary to use a 50% overlap to create a safe layer. Do not make the cast loose by padding too much as this can allow movement of the injury and/or excoriation of the skin. Use 2mm adhesive felt on the edges of casts, especially if the patient is elderly or has delicate skin.

### Casting Materials

It is essential to read product information leaflets and to accept any training offered by the manufacturing companies. Familiarity with the idiosyncrasies of the products is necessary before using them on a patient. There is a great deal to consider when choosing the product to use on a patient. Remember, dipping techniques, setting times, sharpness of edges, roughness or the smoothness of the outside may vary, as well as layers required for strength, rigidity and flexibility.

Most of the information leaflets on products talk about layers required for strength. Below is an illustration of how layers form; if you cover the previous turn of the bandage with the following approximate overlap, the resulting number of layers are as indicated:

1cm overlap on spiral turns = 1 layer

50% overlap = 2 layers

66% overlap = 3 layers

Using strategically placed slabs allows you to cut down the total number of bandages used. Reinforcing the cast in this way keeps the overall thickness to a minimum. This technique has been used with plaster of Paris for many years and works just as well with synthetic casting materials. Thick casts are unnecessary, generate more exothermic reaction during the setting process, and are more difficult to remove.

Some products allow flexibility and this can be used as an advantage, especially at the edges of the cast. Check variations of technique are compatible with the patient's diagnosis and the medical instructions. Always check personally with the Orthopaedic Consultant in charge before using a new technique, and if it is very different from accepted practice, get permission in writing.

# 1.7 Principles of Casting

## Applying a Plaster of Paris Cast


Position limb as instructed. Apply felt to any bony areas and a layer of undercast padding


Soak the bandages


Roll on the bandages starting at one end


Form tucks as necessary to accommodate the changes of limb diameter


Smooth and rub bandages continuously to bond and laminate


Completed cast

### Application

The ideal would be to have sufficient staff for one person to position and hold the limb, one to apply the bandages, one to immerse and soak the bandages and one to comfort and reassure the patient. In practice, however, compromises have to be made and the whole application procedure is frequently carried out with one or two people. However, do make sure there are sufficient staff to support the limb safely. Do not put your patient or assistant at risk.

All equipment is gathered together on a table, trolley or tray. Having decided on the type of padding and decided on the number of bandages to be used (and, if plaster of Paris, unwrapping them), place them away from the water.

Use stockinette with care where swelling is expected. If the limb swells and the cast is split, the stockinette is difficult to cut through and may crease, thereby causing pressure. Do not use if a fracture is being manipulated.



# 1.7 Principles of Casting

## Applying a Plaster of Paris Cast

**1** Position the limb as instructed and maintain it in that position. The medical officer is responsible for positioning the limb, but often this is delegated to the Plaster Room staff. It is important to position the limb before applying the padding. The correct position of the limb, which will be determined by the injury, must be maintained throughout the application and until the cast has completely set, as movement will make ridges in the cast. These ridges might cause pressure sores. Additional staff and the appropriate use of knee rests and other specialist supports may be required to help support the limb effectively.

Prominent bony areas, such as the ulnar styloid, olecranon process, medial and lateral epicondyles of the humerus, patella, the malleolli or the head of fibula may require padding with felt. A covering of undercast padding should be applied firmly, smoothly and evenly.

**2** Soaking the bandages. The water should be lukewarm, 25ºC. Cold water retards and hot water quickens the setting process. Both extremes are uncomfortable for the patient.

The bandage should be held loosely in the palm of the hand, with the first few centimetres unrolled to make it easier to find the end for application. Immerse it in the water according to the manufacturer's instructions. Remove, squeeze very gently and hand it to the applicator, making sure the end is free. Soak only one bandage at a time.

**3** The bandages are then rolled on, starting from one end of the area to be covered, covering approximately one third of the previous turn, smoothly and without tension.

**4** To help the plaster bandage to fit the contours of the limb it is allowed to form tucks. Never twist it or a ridge will be formed.

**5** All the required number of bandages are applied in quick succession, smoothing and rubbing continuously so that the cast bonds and laminates to be one whole structure and not a succession of layers. This will create a cast that is strong, has no wrinkles or ridges and is comfortable to wear. Moulding is done with the palms of the hands as the cast can be dented at this stage. Continue to hold until the cast has set as any movement at this time will cause the cast to crack and ridges to form.

**6** When the cast has finally set, the limb is rested on a pillow. Check the cast is in the correct position. The edges of the cast are trimmed to allow all joints not encased to move freely.

If stockinette was used it should be turned back over the edge of the cast and held in place with strips of plaster of Paris.

Clean the patient's skin and supply a sling or crutches as necessary.

A neurovascular assessment should be made by checking the colour, sensation and movement of the joints at the distal end of the cast.

Make sure the patient has a follow up appointment.

### Cast Care Instructions

Finally, give full verbal and written instructions to the patient on the care of the plaster and the prevention of complications. The written instructions should be clear and easy to understand, with a tear-off strip for the patient to sign to acknowledge receipt. These should include exercise sheets. (See Appendices III, IV, V, and VI for full instructions for the patient). The patient must understand the implications of ignoring the signs and symptoms of complications.

# 1.7 Principles of Casting

## Applying a Synthetic Cast

Apply stockinette and pad bony areas with felt

Position the limb and apply a layer of undercast padding

Soak the bandage

Roll on the bandages, with controlled tension, starting at one end

Maintain the hold by moving only one hand at a time, whilst the bandage is rolled on

Finished cast

### Application

Synthetic casting materials should be used with caution where there is a danger of swelling, for example on fresh fractures or post-operatively. If the cast requires splitting to relieve tightness it will probably require bivalving to allow relief of symptoms. Depending on the material and the number of layers used, a single cut, especially in a below knee cast, may not expand to accommodate further swelling. Consideration of the absorbent nature of all materials used should be made before applying casts in the operating theatre, particularly as blood loss will not easily stain through synthetic materials.

Follow the instructions as for application of a plaster of Paris cast, as far as the application of the padding, except do not unwrap the bandages.



# 1.7 Principles of Casting

## Applying a Synthetic Cast

### Application of the Padding

1 Prominent bony areas, such as the ulnar styloid, olecranon process, medial and lateral epicondyles of the humerus, the patella, the malleolli or the head of fibula may require padding with felt.

2 A layer of undercast padding should be applied firmly, smoothly and evenly. Two firmly applied layers of padding are put around the top and bottom of the limb to be cast. (For fibreglass use a strip of 2mm adhesive felt, allowing it to overlap or turn back over the edges.)

### Application of the Bandages

3 When using synthetic casting materials, consider the strength of the materials and use the correct number of layers as recommended in the information leaflets (see Helpful Hints at the beginning of chapter 1.7 for information on creating layers). Open and soak the first bandage.

The manufacturer's instructions regarding temperature of water and soaking techniques need to be followed.

4 Always commence the bandaging from one end of the area to be covered, rolling it around the limb evenly, and covering half of the previous turn.

The newer, improved products shape to the contours of the limb with just a little adjustment to the tension. Apply as many bandages as are required, according to manufacturer's guidelines, and as quickly as possible to aid lamination (see Helpful Hints Application section, at the beginning of chapter 1.7, for guidance on how to count the number of layers required).

5 Any moulding must be done with the palms of the hands before the cast sets. The newer generation materials conform well to the limb. Remember, when moulding the cast, to hold the area until the cast material has fully set or the mould will spring back. Do not forget to maintain position.

If possible apply the casting material accurately to the whole extent of the cast and turn over the stockinette, catching it in the last layer of bandage. Be very careful, however, not to pull the synthetic material back with the stockinette as this will create a crease at the edge of the cast. A ridge at that area could cause a cast sore and it would also form a bulky edge.

6 When the cast has finally set, rest the limb on a pillow. Check the cast is in the correct position.

Never be afraid to trim the edges, as it is essential to allow full movement of the joints not involved. Trimming can be done with scissors or a knife within a few minutes of the setting. If set hard, small shears or an electric saw may be needed. Take care to pad the cut edges, then hold the stockinette in place with adhesive tape.

Clean the patient's skin and supply crutches if necessary.

A neurovascular assessment should be made by checking the colour, sensation and movement of the joints at the distal end of the cast.

Make sure the patient has a follow up appointment.

### Cast Care Instructions

These are the same as for plaster of Paris casts, except that the drying time for synthetics is only twenty minutes.

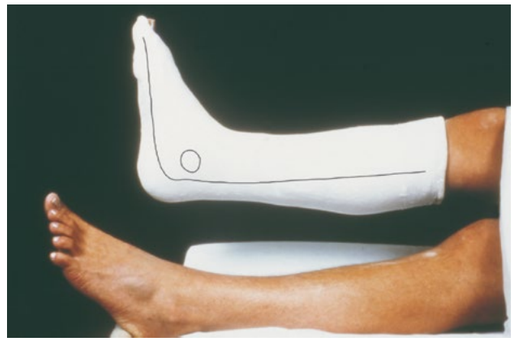
# 1.7 Principles of Casting

## Removal of the Cast

When removing a cast, it should be cut into two halves for the safety and comfort of the patient, and so that either half can be used as a back splint if required. This process is called bivalving. The cutting lines should not pass directly over any bony prominences.

### Equipment Required

- Pencil
- Bandage
- Scissors
- Plaster shears
- Plaster spreaders
- Plaster benders
- Plaster knife
- Plastic sheeting
- Bowl for rubbish
- Electric oscillating saw



### Before you Commence, Assess the Patient

Explain the procedure and obtain consent. Obtain assistance, if needed, to support the cast. If the patient is a child, have they a relative or trusted adult present? A child may accept the shears more readily as the electric saw can be noisy and frightening, so make sure you practice your skills in both methods.

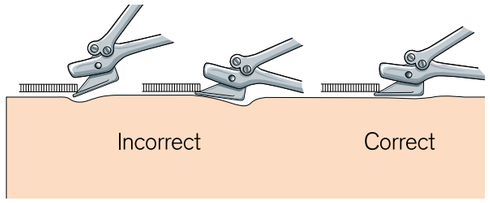
- What is the diagnosis? Is there any underlying pathology you need to consider such as rheumatoid disease, diabetes or lack of sensation? Are there likely to be any pins or Kirschner wires underneath the cast?
- Is the patient elderly with delicate skin?
- Is there swelling or oedema? The skin will cut easily if taut

### Inspect the Cast

- Is it fully padded or is the padding only at the edges? There are many unpadded cast techniques used these days and such casts require extra care and judgement as to whether to use just scissors, shears or electric saw
- Is there blood staining or was the cast applied in operating theatre? Blood soaked padding and gauze can be so hard that the oscillating saw blade will cut straight through to the skin

When you have considered the results of the assessment, decide on the most appropriate way to bivalve the cast.

### Bivalving with Shears




Mark the cutting area, avoiding bony prominences. For example, when bivalving lower limb casts, mark in front of one malleolus and behind the other.

Plaster shears are blunt instruments, which crush the plaster between their jaws. The blade of the shears passes between the plaster and the padding. Keep the blade parallel to the limb. If it is tilted either way, the point or the heel will dig in and/or nip the patient's skin. Do not forget synthetic casting materials can be removed with shears. It just requires practice of the correct technique rather than strength.

After both sides have been cut, the plaster is eased open with the spreaders and the padding cut with the bandage scissors.

### Bivalving with the Electric Saw

The cast saw has an oscillating circular blade, which rubs its way through the hard cast material. It is relatively safe to use if handled correctly. It must be used on dry, padded casts with the blade held at right angles to the cast and a straight cut made without dragging the saw along the cast. Use an 'in and out' motion whilst cutting with the saw. It must be used in conjunction with some type of vacuum to remove dust, in order to comply with current safety regulations. For further Health and Safety details read chapter 1.2.

Do not handle the saw with wet hands or use it on a wet cast.



# 1.7 Principles of Casting

Beware, the saw blade can cut the skin or get hot enough to create a burn in the following cases:

- You drag the blade along the cast, instead of using the in and out motion
- The cast is blood stained, the padding and gauze becomes hard and the saw will cut straight through
- In the presence of swelling or oedema the skin may be taut and therefore easy to cut with the saw
- Through prolonged use
- The cast material is thick
- On larger casts
- The blade is blunt or damaged
- The padding is thin the patient may feel the heat even in normal use
- The cast is unpadded, then special care is needed
- The cast is a resin-based material, so more energy is required to cut through the material and therefore heat is generated

If the patient is moving between departments, the two halves of the cast should be secured with adhesive tape or cotton bandage for safety while in transit. If the patient's fracture or operation is not fully healed there is a real danger that fractures could be displaced, and the patient will not be fully protected without the cast being held in place.

### Skin Care

With permission from the medical staff, the plaster is removed and the skin inspected. Any signs of pressure or careless bivalving must be reported and recorded in the patient's records.

The skin can be washed gently and patted dry. Skin which has been enclosed in a cast for some time will have become dry and scaly, so oil or cream can be applied and should be continued for some days. Warn the patient to be careful when exposing the skin to the sun as it may be more sensitive.

After removal of certain casts some support may be necessary to control swelling. In such cases Soffcrepe® bandages, a tubular support bandage, or a wrist brace such as Actimove® Manus maybe used.

## Complications of Casting

A good casting technique is the best way of ensuring that complications do not occur. Remember that prevention is always better than cure.

All of the following complications can be prevented by good casting techniques and by impressing upon the patient that he must return immediately or seek help if he has any problems whatsoever.

The main complications which may occur are:

- Circulatory and nerve impairment
- Pressure sores
- Stiffness
- Allergic reactions

## Circulatory and Nerve Impairment

### Causes

- Unexpected excessive swelling
- Cast being applied too tightly
- Insufficient padding to allow for expected swelling
- Local pressure on areas where the blood vessels or nerves are close to the skin

Arterial compression causes the extremities of the limb to appear white, then blue, and finally black. The toe or finger nails will remain white when pressed and mobility of the digits will be impaired. If these signs and symptoms are ignored, ischaemia could be permanent.

Venous compression causes the extremities of the limb to appear excessively red and there is pain and sometimes swelling. This will lead onto arterial compression if ignored. Nerve compression gives a 'pins and needles' sensation followed by numbness, limitation of movement and pain.

### Treatment

The medical staff should be informed immediately, as any delay in treatment could have dire results. Elevate the limb except if you suspect compartment syndrome (see page 34). Encourage movement of the extremities and keep them warm. Split or bivalve the cast right down to show the skin, as even one thread left uncut could impair the circulation. Window the cast if there is local pressure on a nerve.

# 1.7 Principles of Casting

## Compartment Syndrome

Compartment syndrome is a complication of fractures and/or soft tissue injuries or surgery. Groups of muscles are surrounded by fascial sheaths. These fascial sheaths create compartments containing muscles, blood vessels and nerves.

In compartment syndrome there is an increase of pressure within these compartments. The rise in pressure may reduce the blood flow locally to the muscles and can ultimately lead to death of tissue and possibly loss of limb. Early diagnosis is essential as a fasciotomy may need to be undertaken immediately.

The indicators of a developing compartment syndrome are:

- Increasing pain
- Pain which is out of proportion to that expected by the injury
- Pain on passive movement of the extremities
- Pain that does not respond to analgesia
- Pins and needles or numbness (parasthesia)
- Muscle weakness
- Initially the distal pulses may be normal, but increasing weakness of pulse is often observed and final lack of pulse

### Treatment of Compartment Syndrome

- The medical staff should be informed immediately, as any delay in treatment could have dire results
- Bivalve the cast and split to skin
- Remove limb from cast and examine. Elevate, but not above heart height (BOA & RCN 2014 & 2016)
- If symptoms persist a fasciotomy would be required

## Deep Vein Thrombosis (DVT)

Plaster Room staff should be aware of the symptoms of deep vein thrombosis (DVT) and pulmonary embolism, and check patients have been assessed for venous thromboembolism risk before application of a lower limb cast, as per NICE Guidelines.**

DVT signs and symptoms:

- Pain in calf
- Oedema
- Sometimes redness
- Pain on palpation
- Homan's sign - pain in the calf on dorsiflexion of the foot

If DVT is suspected, Doppler ultra sound tests should be undertaken.

### Treatment

- Anti-coagulant therapy

**Reference
NICE Clinical Guidelines 92 last updated 2015 – Venous thromboembolism: reducing the risk.
BOA & RCN 2014 & 2016 Peripheral Neurovascular observations for acute limb compartment syndrome.
RCN Publication codes 004 685 & 005 457.

## Pulmonary Embolism (PE)

Blood clots in the lungs.

### Signs and Symptoms:

- Unexplained breathlessness/cough
- Tachycardia
- Later: chest (pleuritic) pain and haemoptysis (coughing up blood)

### Treatment

- Anti-coagulant therapy
- Oxygen therapy

## Pressure/Cast Sores

### Causes

- Uneven bandaging techniques
- Insufficient padding over bony areas
- The cast is too tight or too loose
- Foreign objects inside the cast

### Prevention

Good casting techniques will avoid the above causes.

In addition, advise the patient to change the position of the limb that is in a cast, in order to avoid constant pressure on one area inside the cast.

### Signs and Symptoms

- Burning or blister-like pain
- Local heat
- Offensive smell
- Staining of cast
- Pyrexia in a child

### Treatment

A window is cut in the cast for inspection and the medical staff informed if the skin is broken. To prevent local oedema, the window must be replaced either by temporarily strapping it in place or permanently by re-plastering. If it is not possible to do either, a new lid has to be made.



1.7 Principles of Casting

To determine the site of a foreign object, X-rays may be taken or it could be necessary to change the cast. Early treatment is important because the skin 'dies' from prolonged pressure, the pain disappears and a nasty ulcerated area that can reach down to the bone occurs. It may take months to heal and even require plastic surgery.

## Stiffness of the Joints

Stiffness can occur not only in joints held in the cast, but also in those above and below the cast.

### Prevention

Make absolutely sure that the cast is trimmed correctly to allow full movement of the joints not held in the cast.

In joints that are free from the cast, stiffness can be prevented by making sure that the patient is given good verbal and written instructions to move them. Judicious use of functional bracing helps to prevent stiffness in joints which have to be held within the cast.

### Treatment

For joints which have been encased for some time, physiotherapy may be required when the cast is removed. The same may be true for the joints which were free of the cast, if preventive instructions have not been carried out.

## Allergic Reactions

Occasionally allergic reactions may be caused by certain types of paddings or casting materials. If the possibility of an allergic reaction is anticipated (e.g. a history of skin allergies), the patient should be warned to watch for wetness, discharge or excessive irritation under the cast.

### Treatment

Report the problem to the medical officer. Remove the cast, cleanse the skin thoroughly and re-apply other materials.

# A Practical Guide to Casting

## Casting the Upper Limb

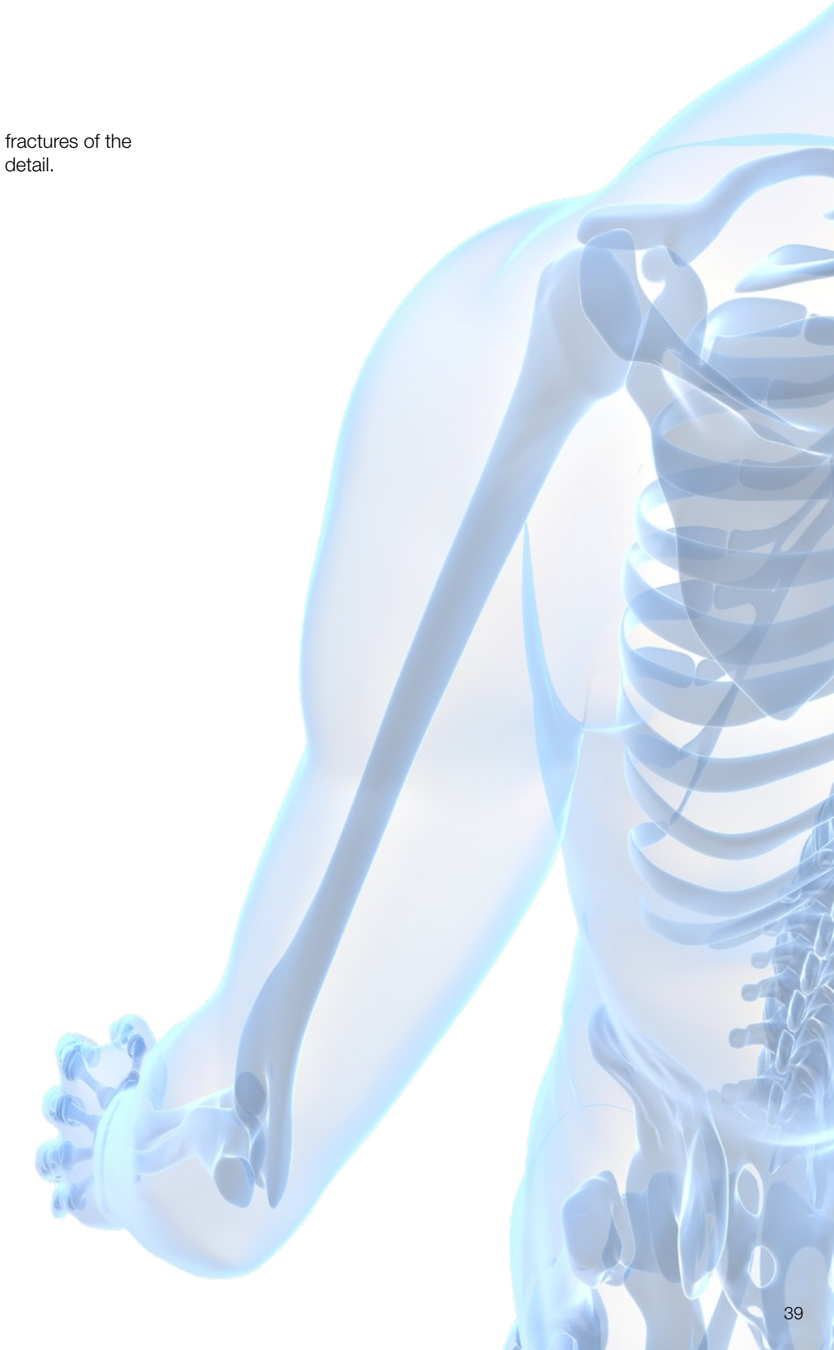
### Contents



Casts used to treat the most common fractures of the upper limb. Each is discussed in more detail.

- Colles' Type/Below Elbow
- Scaphoid
- Bennett's Type
- Below Elbow Slab
- Smith's
- Above Elbow/Long Arm
- Above Elbow/Long Arm Slab
- 'U'- Slab
- Humeral Brace

Brands suggested for each technique covered are an example of what brands can be used. Other brands are available.



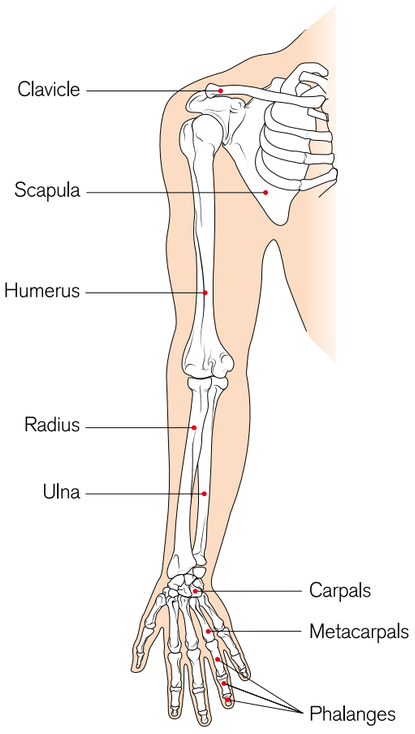
# 2.1 Anatomy of the Upper Limb

The upper limb is constructed for:

- Lifting, moving and carrying articles of all shapes and sizes, within the individual's capability
- The manipulation and use of tools of all kinds, from the most powerful to the most intricate

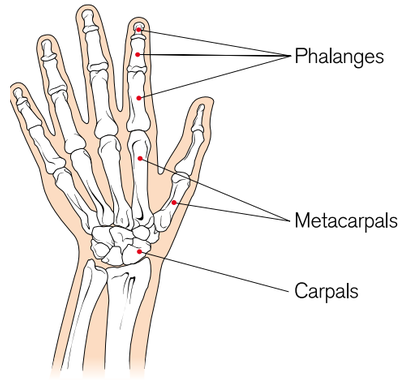
It is made up of the bones, muscles and joints:

- Thumb, fingers and hands – phalanges and metacarpals
- Wrist – carpals
- Forearm – ulna and radius
- Arm – humerus
- Joints – interphalangeal, metacarpalphalangeal, carpo-metacarpal, wrist, radio-ulnar, elbow and shoulder




Anterior view

## Bones of the Fingers, Thumb and Hand



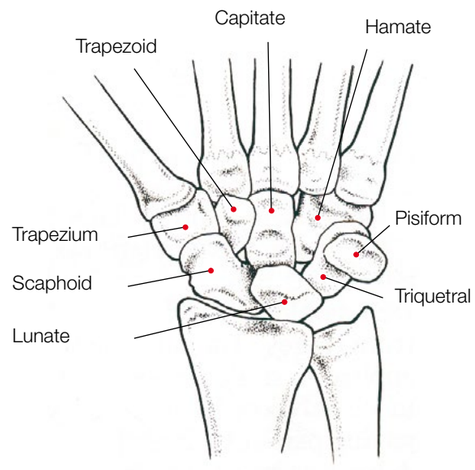

Each finger has three phalanges, the thumb has only two which are thicker and stronger than the others.

The palm is formed of the five long bones - the metacarpals. Four lie parallel to each other, numbers 2-5. The first is set at an angle of approximately 45° to the others, on the lateral side and the proximal phalanx of the thumb articulates with it, giving it its characteristic position.

The knuckles are formed by the heads of metacarpals 2-5.

## Bones of the Wrist

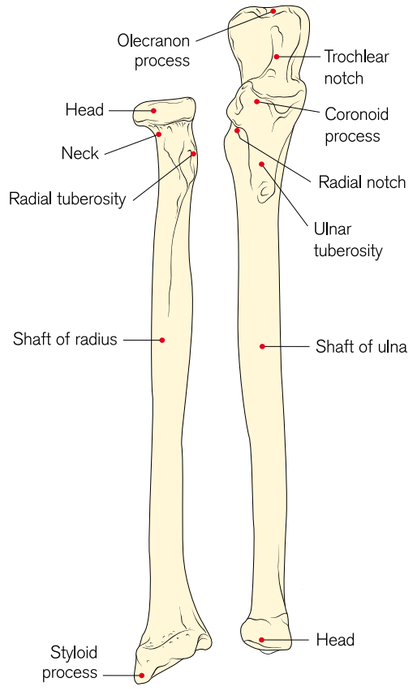
The wrist joint consists of two rows of irregular bones, proximal and distal. From thumb to little finger: proximal row, scaphoid, lunate, triquetral and pisiform. the distal row: trapezium, trapezoid, capitate and hamate. Most important for Plaster Room staff are the scaphoid, which lies in the proximal row and is the most frequently fractured of all the carpal bones, and the trapezium, which articulates with the first metacarpal and pisiform, which can be felt as a bony prominence on the antero-medial aspect of the wrist, in line with the little finger.






# 2.1 Anatomy of the Upper Limb

## Bones of the Forearm




**Right Radius and Ulna** - anterior view

The two long bones of the forearm, the radius and ulna, lie parallel to each other when the forearm is supinated.

### The Radius

Situated laterally, its shaft is expanded distally, to articulate with the scaphoid and lunate. A distally pointing projection is the styloid process, against which the radial pulse can be felt. Proximally, the head, which forms part of the elbow, is a flat disc similar to a £1 coin; immediately below this is the neck of the radius.

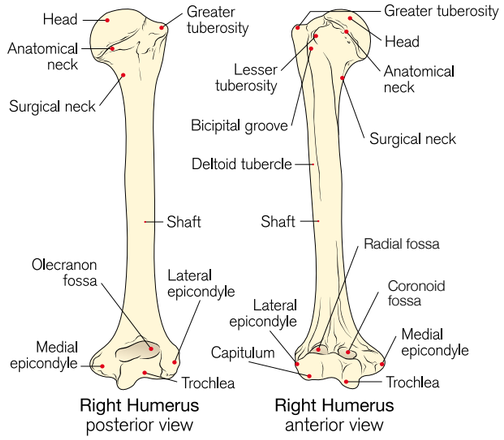
### The Ulna

Situated medially, the shaft of the ulna can be felt along the medial side of the forearm.

The head of the ulna is small and rounded. Attached to it is a pad of fibro-cartilage, which articulates with the triquetral. Proximally, the ulna has two forward projections, which fit into fossae of the same name, at the distal end of the humerus. The anterior projection is the coronoid process and the posterior projection is the olecranon process.

### The Humerus

The long bone of the upper arm.




**Right Humerus** posterior view

**Right Humerus** anterior view

The epicondyles are two protuberances found distally. The medial epicondyle can be easily felt. The ulna nerve lies behind it. If the nerve is briefly compressed against the epicondyle, i.e. if it is knocked, the familiar 'pins and needles' can be felt in the little finger. The lateral epicondyle can be felt more easily with the elbow flexed.

Between the epicondyles are:

- The irregularly shaped articular surface - the trochlea articulates with the ulna, the capitulum with the radius
- The olecranon fossa posteriorly
- The coronoid fossa anteriorly

The shaft - the radial nerve lies adjacent to the shaft posteriorly in a groove - the radial groove. Fractures of the shaft of the humerus are easily complicated by damage to the radial nerve - and wrist drop can be the result. See diagram of the elbow joint over the page.

The proximal end of the shaft has three large protuberances:

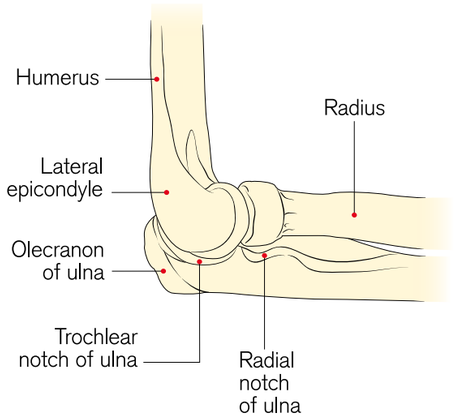
- The greater tuberosity, which gives the shoulder its almost square outline
- The lesser tuberosity, a little lower, on the anterior and medial aspects. The bicipital groove lies between the two tuberosities, the long head of the biceps runs in it
- The rounded head of the humerus, situated on the medial upper corner, is surrounded by a shallow groove - the anatomical neck

The surgical neck is a constriction on the humerus immediately below the tuberosities. It is a frequent site for fractures.

# 2.1 Anatomy of the Upper Limb

## Joints of the Upper Limb

### The Elbow Joint (lateral)




### The Wrist

The eight bones each articulate with their neighbours, at synovial sliding joints.

The distal row articulates with the metacarpals - also sliding joints.

The first carpo-metacarpal joint is different. It is known as a saddle joint; the two articulating surfaces look similar to saddles set across each other. This gives the thumb its wide range of movement, which includes opposition - its ability to move to meet the fingers, which gives us our pinch grip.

The wrist joint is capable of **flexion, extension, adduction and abduction**. The muscles which bring about palmar flexion (flexion) and dorsiflexion (extension) are attached to the medial and lateral epicondyles of the humerus; these muscles form the bulk of the forearm. Abduction and adduction are carried out by the abductor and adductor muscles respectively.

Movement of the thumb (pollex) has a separate group of muscles from the fingers (digits), which enable it to function independently.

The radio-ulna joints are two synovial pivot joints; the inferior, where the ulnar head articulates with a notch on the distal end of the radius; the superior, where the radial head articulates against a notch on the ulna just below the coracoid process.

Movement at these two joints together will cause **supination** of the forearm, with the bones lying parallel, and **pronation** where the radius pivots across the ulna.

### The Elbow

The elbow is a synovial hinge joint. The radial head articulates with the capitulum, the articulating surface of the olecranon process with the trochlea. The joint capsule is strengthened with lateral and medial ligaments, so that flexion and extension can take place. Elbow **flexion** is carried out primarily by biceps brachii and brachialis. The biceps muscle is attached distally to the radial tuberosity so that it also supinates the forearm. Elbow **extension** is carried out by the triceps muscle, which is attached proximally to the lower edge of the glenoid cavity and the posterior surface of the humerus; distally it is attached to the olecranon process of the ulna. The joint space includes the superior radio-ulnar joint.

### The Shoulder Joint

The shoulder joint is a freely movable, synovial, ball and socket joint. It is formed by the spherical head of the humerus, which articulates with the shallow glenoid cavity of the scapula. The capsule is looser than in the hip joint, especially anteriorly and inferiorly. The joint is freely moveable, able to **flex, extend, abduct, adduct, rotate laterally** and **medially** and **circumduct**. However, because of its structure it is much less stable than the hip and dislocates much more easily (see also chapter 4.1).

Many muscles are involved with the movement of the shoulder. The deeper layer is known as the **rotator cuff** which comprises the supraspinatus, infraspinatus, teres minor and subscapularis muscles. They are important factors in stabilising and moving the shoulder joint. Superficially other muscles also contribute to the movement of the joint. **Adduction** is assisted by pectoralis major which is attached medially to the clavicle, sternum and upper ribs and laterally to the front of the humerus. It also rotates the humerus inwards. **Abduction** is assisted by supraspinatus plus deltoid, a versatile muscle which is attached to clavicle anteriorly and spine of scapula posteriorly; laterally it is attached to the greater tuberosity of the humerus. It also contributes to forward flexion and backward extension.

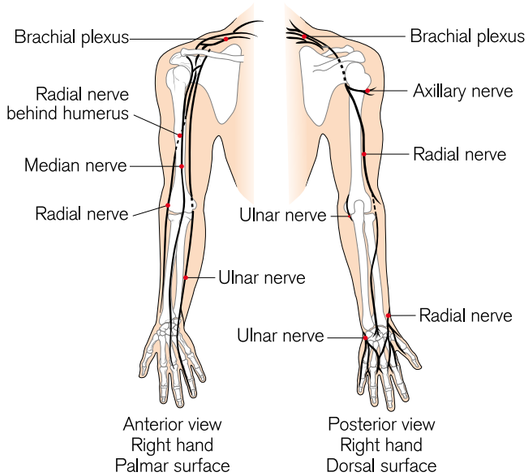


# 2.1 Anatomy of the Upper Limb

## Nerve Distribution of the Upper Limb

The muscles of the upper limb are innervated largely by radial, median and ulnar nerves. Of major importance to Plaster Room staff is the knowledge that the radial nerve innervates the wrist extensors. Damage to this nerve, therefore, will lead to weak or lack of wrist extension, which is also known as wrist drop. The wrist flexors are mainly innervated by the median nerve, which passes underneath the flexor retinaculum which forms the carpal tunnel. Swelling in this area causes carpal tunnel syndrome, resulting in pain in the arm and weak flexion. The ulnar nerve distribution follows the ulnar border of the forearm and hand (see diagram below).

MAIN NERVES TO THE ARMS




The innervation of the hand is by the radial, median and ulnar nerves and is complex. Note the differences between dorsal and palmar surfaces in Fig. 1 and 2.

**Fig. 1**

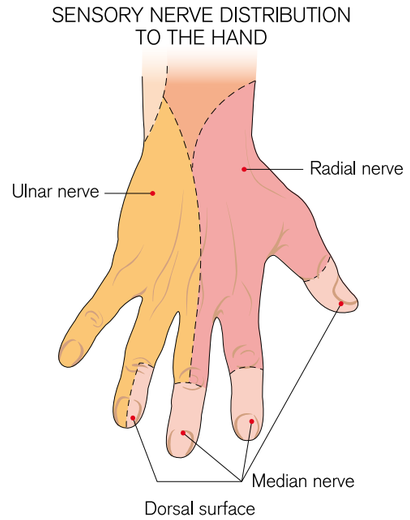
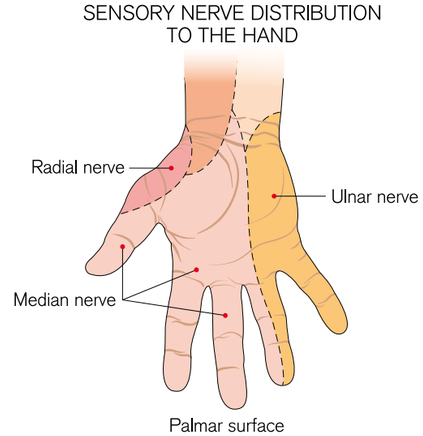



**Fig. 2**




### Further reading

See chapter 1.4

# 2.2 Fractures of the Upper Limb

The table lists the fractures of the upper limb most commonly treated with the involvement of Plaster Room staff.

| | |
|---|---|
| **Humerus** | Neck |
| | Shaft |
| | Supracondylar |
| **Forearm** | Head of radius |
| | Olecranon |
| | Shafts |
| | Distal radius (Including Colles' and Smith's fractures) |
| **Wrist** | Scaphoid |
| **Hand** | Metacarpals (Including Bennett's fracture of the first metacarpal) |
| | Fingers |

With all fractures of the arm, the circulatory state and the nerve supply should be checked frequently, especially before and after any treatment such as manipulation, or application of cast or splint. Remove any rings or jewellery, and nail varnish. Support the injured arm on a pillow or in a sling.

## Fractures of the Humerus

### The Neck of the Humerus

This is the area just below the head of the humerus. It is most commonly broken in elderly people as the result of a fall onto the outstretched hand. Their bones are often more brittle due to osteoporosis. The fracture ends may be driven into each other **(impacted)** and the fracture is therefore quite stable. If the position is satisfactory, the application of a sling or collar and cuff is all that is required. However, if comminuted, more aggressive treatment, such as the application of a cast, may be required.

The main problem developing after these injuries is stiffness of the shoulder and the elbow. There is also a lot of swelling, bruising and discolouration. Once the pain is subsiding, gentle movements of the shoulder should be started. This can be done without taking the arm out of the sling, by leaning forward and allowing the arm to swing slightly. The patient should be referred for physiotherapy.

This region is a common site for pathological fractures secondary to tumours.

### Fractures of the Shaft of the Humerus

The humerus is a large bone, and it takes considerable force to fracture it. The risk of damage to other structures is high, particularly to the radial nerve. The bone may be broken by a direct blow or by a fall from a height.

Usually there is a degree of shortening of the bone, due to muscle spasm, and some angulation. The classical treatment of fractures of the shaft is to apply:

i) Actimove® Sling/Collar and Cuff type product only

ii) 'U' slab and Actimove® Sling/Collar and Cuff type product (see chapter 2.3)

iii) Humeral brace

The radial nerve may be injured, leading to the development of a 'wrist drop'. Assess the ability of the patient to straighten the fingers and wrist of the injured arm. Do this frequently, as nerve palsy may develop as a result of manipulation, or sometimes later as the fracture begins to unite.

The brachial artery is rarely injured, but the circulation may be impaired by swelling or constriction if the cast becomes overtight. As the muscles waste and the cast becomes loose, pressure in the elbow crease may cause problems in the median nerve or brachial artery. These fractures are sometimes fixed, especially if the patient is unconscious or has multiple injuries.

### Supracondylar Fractures of the Humerus

This is a fracture usually occurring in children falling on the outstretched arm. The elbow is displaced backwards, and there is a high risk of injury to the brachial artery and the median nerve.

Treatment may involve manipulation of the fracture under a general anaesthetic, followed by application of a collar and cuff, sometimes with a plaster back slab to maintain position, and/or the fracture may have 'K' wires inserted to hold the position. It is important that provision is made to assess the pulse on the injured arm, and it should be compared to the unaffected arm. The child will be kept in hospital overnight for observation, before discharge home to the care of the parents.

If complications seem to be developing, call medical assistance, then the sling should be slackened, and the arm gently straightened until the pulse returns.

### Dislocation of the Elbow

The elbow joint is very stable, and requires a lot of force to dislocate it. There will be a lot of soft tissue damage and swelling, with a risk of injury to nerves or blood vessels. Check the pulse and nerve supply to the hand frequently.

The dislocation will be reduced under anaesthesia, and the arm placed in a collar and cuff. A plaster back slab may be applied for further stability.



# 2.2 Fractures of the Upper Limb

## Fractures of the Forearm Bones

### The Olecranon Process

The olecranon is the bony point at the back of the elbow. A fall onto the point of the elbow can result in a fracture that goes into the joint. The triceps muscle is attached to the olecranon and pulls the fragments apart. Occasionally, the periosteum holds the fragments together, but frequently they have to be realigned surgically and held with a cancellous bone screw or a tension band wire. The application of a wool and crepe bandage, back slab and/or later, a full cast, is then required.

### The Head of the Radius

A fall on the outstretched hand may produce a crack in the head of the radius. If undisplaced, it may be left to unite, with reasonable results. If badly displaced, it interferes with movements of the elbow, and the usual treatment is to excise the whole of the head. Some surgeons like to insert a prosthetic radial head. A wool and crepe bandage is then applied and gentle exercises commenced.

### Fracture of the Shafts of the Forearm Bones

It is uncommon to break a single bone of the forearm, and when this occurs, the bone may be slow to unite. When both bones are broken, the muscles attached to the opposite ends of the bone can produce displacement of the fragments. It is also possible for cross union to occur where the radius unites with the lower part of the ulna, and the ulna unites with the lower part of the radius. If angulation is not corrected the function of the forearm, especially pronation and supination will be severely impaired. Fractures of the forearm bones therefore are often fixed internally to maintain the alignment.

The arm will frequently be placed in an above elbow back slab or above elbow cast. The position will be with the arm in neutral rotation, but occasionally a position of full supination will be required to correct deformity. Care must be taken to make sure that the top end of the cast is high enough up the arm to prevent the edge of the cast causing pressure on the radial nerve.

The weight of the cast should be taken by a sling. The patient must exercise the fingers and shoulder. Be alert for the development of compartment syndrome.

Two special fractures involving the forearm bones are the Galleazzi and the Monteggia fractures. Both are difficult to treat and usually require some form of internal fixation.

### Galleazzi Fracture

This is a combination fracture of the radius and dislocation of the head of the ulna. (Note the head of the ulna is at the wrist).

### Monteggia Fracture

Here there is a fracture of the ulna with a dislocation of the head of the radius (note the head of the radius is at the elbow).

### Colles' Fracture

A true Colles' fracture is an impacted fracture of the radius within one inch of the wrist joint, with posterior displacement and radial deviation of the distal fragment. The styloid process (small lump palpable behind the wrist) of the ulna is also displaced. The injury results from a fall on the outstretched hand, in older people. Most patients are female. The injury is usually easily recognised from the characteristic "dinner-fork" deformity. Left to itself, the bone would heal rapidly, but often the position of the deformity affects the function of the wrist, and the fracture has therefore to be manipulated under anaesthesia.

Remove any rings or jewellery, and nail varnish as soon as the patient arrives in the department, and support the limb in a sling or on a pillow. Assess the neuro-vascular state and obtain some analgesia for the patient. After manipulation, the wrist will be held in a dorsal plaster of Paris slab, held in place with a cotton or Soffcrepe® bandage. This allows for easy removal in the event of severe swelling. Some surgeons advocate the use of a split or complete cast. This fracture sometimes requires fixation with 'K' wires or a volar locked plate.

An alternative method of fixing the fracture is to use a functional brace, which has the benefit of allowing earlier use of the limb. The wrist is held in a position of palmar flexion, and ulnar deviation.

A sling should be applied, but the patient is encouraged to take the arm out of the sling and exercise the shoulder, elbow and fingers for a few minutes in every hour for the first day and frequently thereafter.

A check X-ray may be taken before the patient leaves the department and again the next day. The plaster back slab may then be completed into a full cast, if the risk of swelling has subsided.

The cast will be worn for five or six weeks initially, then a period of support given by a removable splint may be required.

# 2.2 Fractures of the Upper Limb

There are a number of possible complications arising from this injury. Swelling is very common, but can be minimised by elevation of the limb and exercise of the joints not held in the cast. Elbow and shoulder stiffness may be a cause of considerable disability if allowed to persist. (N.B. The patient may also injure these areas in the fall, but not complain about them initially). Compression of the median nerve in the carpal tunnel will cause pins and needles in the fingers at first and a weakened grip later, if untreated. Non-union is rare, but mal-union due to displacement is frequently found, hence the need for a check X-ray at two weeks, with further manipulation if required.

An occasional problem is that of complex regional pain syndrome (Sudeck's Atrophy) (post-traumatic reflex dystrophy). This is a condition where the hand becomes red, shiny and painful when the plaster is removed. The discomfort clears up in about six months, but is better avoided by encouraging the patient to make as much use of the limb as possible whilst in a cast.

### Smith's Fracture

Sometimes called a reverse Colles' because the displacement is anterior, this injury results from a backward fall, knocking the wrist forwards. The patient is often in middle age. The treatment is to manipulate the fracture and apply an above elbow back-slab or full arm cast. The position of the limb should be the wrist in dorsiflexion, the hand supinated (palm upwards) and the elbow at an angle of 90º. The main problem with this injury is slippage after manipulation and so these fractures often require internal fixation.

## Wrist and Hand

### Scaphoid Fracture

The scaphoid bone is situated on the thumb side of the proximal row of carpal bones, and may be injured by a fall on the outstretched hand or by a blow to the wrist. This is a young person's injury, the typical patient being a young man. Sometimes the fracture does not show up on the initial X-rays, (special views known as 'scaphoid views' are often requested) and should be repeated two weeks later.

In the meantime, if the history and symptoms are suggestive of the injury then it is treated as a scaphoid fracture until proved otherwise. The most significant symptom is pain in the area known as the "anatomical snuff box" on the thumb side of the wrist. The wrist is held in a well fitting plaster cast which incorporates the thumb to the interphalangeal, and holds the wrist in a position of dorsiflexion and radial deviation. When correctly applied, the patient should be able to oppose his thumb and index finger, but not the other fingers. The angle of the wrist is important, because following the fracture, the blood supply to the proximal fragment of the bone may be disrupted, leading to avascular necrosis and non-union. Research has long questioned the need to include the thumb, resulting in an increase of scaphoid fractures being treated in below elbow cast.

The cast is retained in place for six weeks, then an X-ray is taken. If there is no sign of callus the cast may be retained for another six weeks, or a screw fixation performed. Stiffness of the wrist is not uncommon following this prolonged splintage, but will clear up with usage.

### Bennett's Fracture

A Bennett's fracture is a fracture dislocation of the first carpo-metacarpal joint at the base of the thumb.

It is caused by the thumb being knocked backwards, (e.g. a ski-pole injury). The joint is a saddle joint and it can be difficult to hold the fracture in the correct position after reduction. The cast used is known as a Bennett's plaster. It requires traction to be applied to the thumb, with pressure at the base of the thumb whilst the plaster is setting. Alternatively, a reduction under anaesthetic and 'K' wires or a screw are inserted to hold the fracture. The joint may have a limited range of movement after this injury.

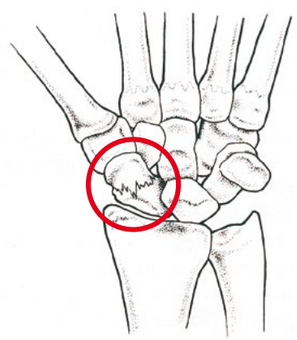
### Metacarpal Fractures

The common cause of fractures to the metacarpals is a punch with the fist. The bone commonly affected is the fifth, which is usually angulated at the neck. If markedly displaced it may need to be straightened and then a slab is applied. The slab should extend along the forearm and to the tips of the fingers on the ulnar side or palmar side. (ulnar gutter or metacarpal slab) The wrist should be held in 45° of dorsiflexion, the metacarpophalangeal joints should be flexed to 90° and the interphalangeal joints should be held in extension. This position is the Position of Safe Immobilistation (POSI) for the hand.

### Fractures of the Fingers

It is rare for fractures of the fingers to be placed in plaster. The common method of treatment is to strap the finger to its neighbour and encourage use. However, an injury known as a Mallett fracture, which is an avulsion fracture of the insertion of the extensor tendon from the terminal phalanx may be put into a plaster which holds the distal interphalangeal joint in extension and the proximal interphalangeal joint in flexion.

**Fractured Scaphoid**





# 2.3 Casts of the Upper Limb

## Below Elbow Plaster Slab

**Equipment Required**

Basic trolley, see page 28 - plus:

**Plaster of Paris**

- Stockinette 5cm
- Soffban® Natural padding 10cm x 1 roll
- Gypsona® 15cm or 20cm x 1 roll or use a slab dispenser of the equivalent size
- Soffcrepe® bandage 7.5cm x 1 roll
- Strips of plaster of Paris
- Actimove® Umerus Sling or broad arm sling

## Above Elbow Plaster Slab

**Equipment Required**

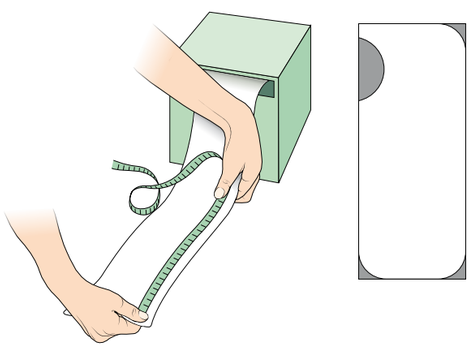
Basic trolley, see page 28 - plus:

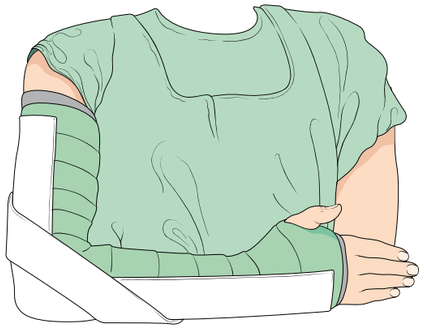
**Plaster of Paris**

- Stockinette 7.5cm (if used)
- Soffban® Natural padding 10cm x 2 rolls
- Gypsona® 10cm x 2 rolls and 15cm x 2 rolls or use slab dispensers 10cm and 15cm
- Soffcrepe® bandage 10cm x 1 roll
- Actimove® Umerus Sling

Slab dispenser

Below elbow slab





### Application

The medical staff may prefer slabs to full casts. These are made by measuring the length required, the extent being the same as for a full cast. Add on 2cm to the length to allow the slab to be long enough to conform to the contours of the limb. The required length is cut from a plaster of Paris slab dispenser 15 or 20cm wide, depending on the size of the patient, or by forming a slab from 15 or 20cm plaster of Paris rolls using five to six layers. The slabs are then shaped, trimming top and lower end as required.

The limb is positioned and padding applied as for a full cast. The slab is folded concertina fashion and dipped into the water, holding the ends and maintaining the concertina folds. It is removed from the water, squeezed gently and straightened out. The slab is then carefully positioned on the limb and smoothed to fit the contours.

It is held in place with a wet crepe or cotton conforming bandage. These must be pre-soaked and squeezed out to avoid further shrinkage. The end of the bandage is fixed with a plaster of Paris strip applied over the area of the slab.

### Application

The ultimate position of the limb will be dependent on the injury and displacement, if any, but will generally be about 90° at the elbow.

Prepare a 15cm or 10cm plaster of Paris slab, depending on the size of the patient, using 5 -7 layers. This slab should be long enough to extend from the axilla to the knuckles of the hand. Remember to allow a little for the slab to conform to the contours of the limb.

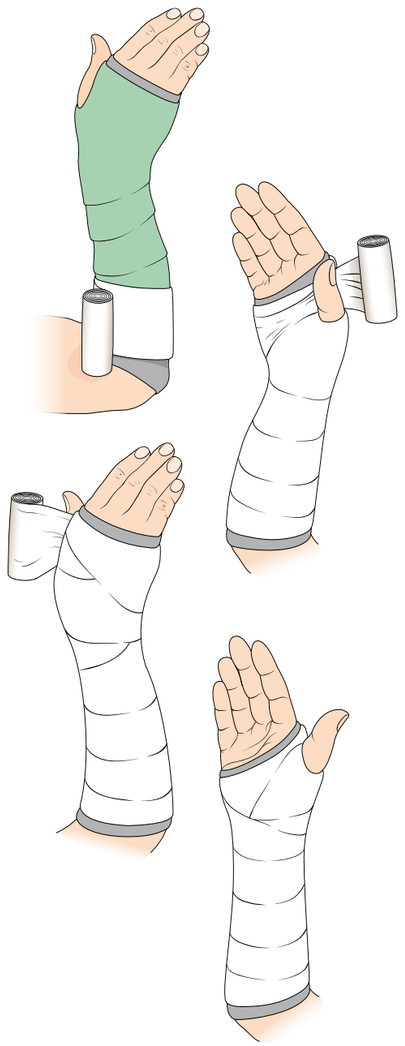
Prepare also 2 x 10cm plaster of Paris slabs of 5 layers and 25cm long. Place these each side of the elbow joint to reinforce it. The whole slab is then held in place by a pre-soaked and squeezed out crepe or conforming cotton bandage. Finish the application as for a below elbow slab.

# 2.3 Casts of the Upper Limb

## Below Elbow or Colles' Type Cast

A 'Colles' cast' is a very loose term used to describe a type of cast applied in the treatment of many wrist injuries and conditions. The wrist should be positioned in slight palmar flexion and slight ulnar deviation, to a greater or lesser degree, according to the amount of displacement of the fracture. The position will be different for other injuries.

The completed cast should extend from just below the elbow - allowing full flexion there - to the knuckles at the back of the hand, and must show the palmar crease, to allow full flexion of the metacarpalphalangeal joints. The thumb should be completely free.



### Equipment Required

Basic trolley, see page 28 - plus either of the following options:

**Plaster of Paris**

- Stockinette 5cm
- Soffban® Synthetic padding 10cm x 1 roll
- Gypsona® 10cm x 2 rolls
- Strips of plaster of Paris
- Actimove® Sling

### Padding

Apply stockinette only swelling is unlikely. The ulnar styloid may require a circle of felt. A covering of undercast padding is applied firmly, smoothly and evenly.

### Application

Casting commences at the elbow end of the cast, rolling from within out so that the bandage is brought up through the grip, thereby spreading the heads of the metacarpals. Pass through the grip twice with the first bandage. Start the second bandage at the elbow end as before, this time taking one further turn through the grip before completing the bandage back up the arm to the elbow. Mould the cast well into the palm.

When the cast is finally set, the limb is rested on a pillow and the cast is trimmed to allow all joints not encased to move freely. Make sure the palmar crease is fully visible to allow full flexion of the metacarpal phalengeal joints.

If stockinette was used it should be turned back over the edge of the cast and held in place with strips of plaster of Paris.

**This applies to all upper limb casts.** Full instructions must be given to the patient on the care of their limb and of the cast. These must be given verbally and in writing. A sling may be required initially, but do not forget to give information on exercises to prevent swelling and finger, elbow and shoulder stiffness. (See Appendices III and IV.) Follow-up care must also be arranged.



# 2.3 Casts of the Upper Limb

**Synthetic**

- Stockinette 5cm
- Non-adhesive felt 2.5cm
- Adhesive felt 2mm thick
- Soffban® Synthetic padding 10cm x 1 roll
- Delta-Cast® Conformable 5cm x 1 roll or 7.5cm x 1 roll
- Tensoplast® Sport cast edge tape 3cm
- Actimove® Sling

### Padding

1 Apply stockinette and pad the ulnar styloid with felt, if prominent. Use a thin layer of non-adhesive felt around the base of the thumb or apply a smaller size stockinette to the thumb.

2 The 2mm adhesive felt may be needed to pad the edges of the cast. A covering of undercast padding is applied firmly, smoothly and evenly.

### Application

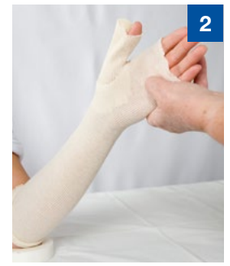
3 Use either 1 x 5cm or 1 x 7.5cm casting bandage depending on the size of the limb. Bandaging commences at the elbow end of the cast, rolling from within out so that the bandage is brought up through the grip, thereby spreading the heads of the metacarpals, using a 50% overlap to create two layers.

4 Make a slightly curved cut to allow the bandage to go through the grip, laying the bandage on carefully.

Continue across the metacarpal heads and around the hand, returning through the grip on the next turn, cutting as before. Twice through the grip is sufficient. Continue with the bandage back up the arm in a single layer, turning in the stockinette at the elbow end, catching it with the last turn of the bandage.

Mould well into the palm and hold until the material has set. Trim, if necessary, to complete, turning in the remaining stockinette and hold in place with the adhesive tape.

5 Completed cast.





# 2.3 Casts of the Upper Limb

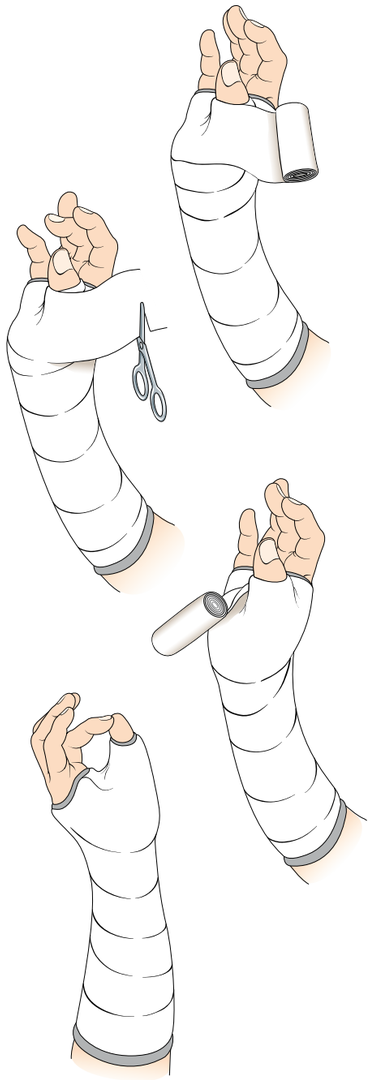
## Scaphoid Cast

The wrist is positioned in slight dorsiflexion with the thumb in opposition, thereby forming the position of grasp.

Place the elbow on the rest and position the hand.

The cast should extend from the elbow to the hand, as for the Colles', but comes up the thumb to the interphalangeal joint, allowing movement of the distal part of the thumb.

We would just like to reiterate that all these positions and extents of the casts are not dogmatic. One has to be guided by the policy of the medical officer.



### Equipment Required

Basic trolley, see page 28 - plus either of the following options:

**Plaster of Paris**

- Stockinette 2.5cm
- Stockinette 5cm
- Soffban® Synthetic padding 10cm x 1 roll
- Gypsona® 10cm x 2-3 rolls
- Strips of plaster of Paris to finish
- Actimove® Sling

### Padding

Apply stockinette to the arm and the thumb. Apply a covering of undercast padding firmly, smoothly and evenly. Make sure the area around the thumb is covered.

### Application

Casting is commenced as before at the elbow, again from within out. After coming up through the grip and across the back of the hand, go round the thumb, making it fit neatly by cutting the plaster of Paris bandage, and being careful not to pull. Three times alternating through the grip and around the thumb are sufficient. Mould well into the palm and around the thumb. An extra roll of 10cm plaster of Paris bandage may be necessary. The remainder of the procedure is as for a Colles' cast.



# 2.3 Casts of the Upper Limb

**Synthetic**

- Stockinette 2.5cm
- Stockinette 5cm
- Adhesive felt 2mm thick
- Soffban® Synthetic padding 10cm x 1 roll
- Delta-Cast® Conformable 5cm x 1-2 rolls or 7.5cm x 1 roll
- Tensoplast® Sport cast edge tape 3cm
- Actimove® Sling




### Padding

1 Apply stockinette to the arm and the thumb. Apply a covering of undercast padding firmly, smoothly and evenly. Make sure the area around the thumb is covered. 2mm adhesive felt could be applied around the interphalangeal joint of the thumb.

### Application

2 Using either 5cm or 7.5cm cast tape, commence casting as before at the elbow, again from within out. Spiral towards the hand with a 50% overlap.

3 After cutting the bandage to go through the grip, pass across the back of the hand, go around the thumb, making it fit neatly by cutting the bandage.

Taking care not to create tension, alternating once more through the grip and around the thumb is sufficient. Continue with the cast tape back up the arm, turning in the stockinette at the elbow end, catching it with a turn of the bandage, and cut off any remaining material. Mould well into the palm and around the thumb. Trim, if necessary, turning in the remaining stockinette, and hold in place with the adhesive tape.

4 Completed cast.

# 2.3 Casts of the Upper Limb

## Bennett's Type Cast

This technique is used for what we have deliberately termed a Bennett's type cast, as the original Bennett's cast incorporated fixed traction, but is now seldom used.

The wrist is positioned in slight dorsiflexion, the thumb is adducted and pressure is applied over the fracture site. As previously stated, this is only one method and one must be guided by the dictates of your medical officer. Before plastering is commenced, an oval piece of felt should be placed at the base of the 1st metacarpal over the fracture site, on top of the stockinette or other padding. Adhesive should never be applied directly to the skin, as under a cast it may cause maceration. The cast extends from just below the elbow - allowing full flexion - to the knuckles at the back of the hand and showing the palmar crease, to permit full flexion of the fingers. It is continued up the thumb just leaving the tip showing.

### Equipment Required

Basic trolley, see page 28 - plus either of the following options:

**Plaster of Paris**

- Stockinette 5cm (this should not be used where swelling is likely to occur)
- Stockinette 2.5cm
- Soffban® Synthetic padding 10cm x 1 roll
- A piece of adhesive felt
- Gypsona® 10cms x 2 rolls
- Strips of plaster of Paris to finish
- Actimove® Sling

### Padding

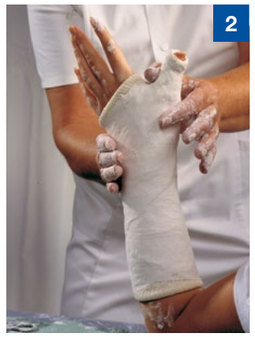
1 Apply stockinette to the arm and the thumb. Apply a covering of padding firmly, smoothly and evenly. Make sure the area around the thumb is covered up to the tip. Apply a small oval of 5mm thick adhesive felt positioned over the fracture site.

### Application

2 Apply the plaster of Paris bandage roll in the same way as for the scaphoid cast, except reduce the size of the cut to allow the material to come up to the tip of the thumb. Mould as described above.

When the cast is completed the patient should be asked to wait for approximately 20 minutes to have a neurovascular assessment.

3 Completed cast.





# 2.3 Casts of the Upper Limb

**Synthetic**

- Stockinette 2.5cm
- Stockinette 5cm
- Adhesive felt 2mm
- Soffban® Synthetic padding 10cm x 1 roll
- A piece of adhesive felt
- Delta-Cast® Conformable 5cm x 2 rolls or 7.5cm x 1 roll
- Tensoplast® Sport cast edge tape 3cm
- Actimove® Sling

### Padding

1 Apply stockinette to the arm and the thumb. Apply a covering of padding firmly, smoothly and evenly. Make sure the area around the thumb is covered up to the tip. Apply a small oval of 5mm thick adhesive felt positioned over the fracture site.

The 2mm felt could be used to pad the edges of the cast.

### Application

Apply the casting bandage in the same way as for the scaphoid cast, except reduce the size of the cut to allow the material to come up to the tip of the thumb. Mould as described on page 52.

When the cast is completed the patient should be asked to wait for approximately 20 minutes to have a neurovascular assessment.

2 Completed cast.


# 2.3 Casts of the Upper Limb

## Above Elbow or Full Arm Casts

The limb is positioned with the wrist in neutral, the elbow at a right angle and the palm facing the body. If applying the cast as one whole, commencement should be at the axilla, bandaging from within out. Try to have the elbow held at 85° whilst applying the bandages, and before setting takes place move the arm down to 90°. This helps to prevent ridges forming on the flexor aspect of the elbow.

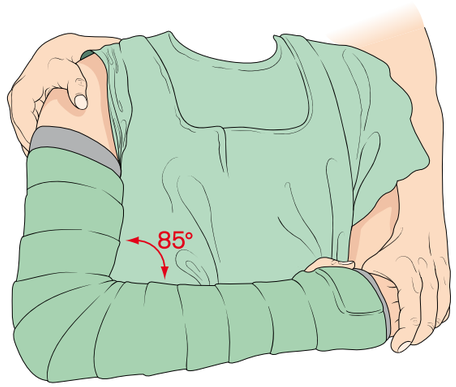
The completed cast should extend from as high up the arm as possible and down over the hand as for the Colles'.

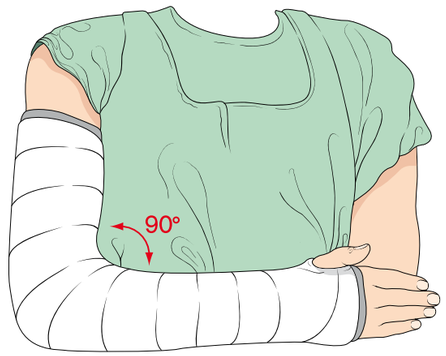
### Equipment Required

Basic trolley, see page 28 - plus either of the following options:

**Plaster of Paris**

- Stockinette 7.5cm (if required)
- Soffban® Synthetic padding 10cm x 2 rolls
- Gypsona® 10cm x 5 rolls
- Strips of plaster of Paris to finish
- Actimove® Umerus Sling or Polysling




### Padding

Apply the stockinette, if used. Cut out or fold down the creased stockinette in the flexor surface of the elbow. A small re-rolled piece of Soffban® can be placed in the flexor surface of the elbow to help prevent anything sitting in to the crease. Apply a covering of undercast padding firmly, smoothly and evenly. An extra layer of padding or a piece of felt may be needed around the elbow to protect the olecranon process and the medial epicondyle.

### Application

Commence the cast at the axilla end rolling from within out. When applying the plaster of Paris roll, aim for the middle of the bandage width to lay across the flexor surface, and apply evenly without missing anywhere.

This cast can also be applied in 2 parts. The below elbow part is often done first. Apply 2 layers of padding at the join. Care must be taken when the top half is joined, to avoid the edge of the lower half pressing into the flexor surface of the elbow.



# 2.3 Casts of the Upper Limb

**Synthetic**

- Stockinette 7.5cm
- Non-adhesive felt
- Adhesive felt 2mm thick
- Soffban® Plus padding 10cm x 2 rolls
- Delta-Cast® Conformable 7.5cm x 2 rolls
- Delta-Cast® Conformable 5cm x 1 roll (spare if required)
- Tensoplast® Sport cast edge tape 3cm
- Actimove® Sling or collar and type product

### Padding

1 Apply the stockinette to the arm, cut out or fold down the creased stockinette in the flexor surface of the elbow.

2 Apply the thin, non-adhesive felt around the thumb and web space as for a below elbow cast or apply a smaller stockinette to the thumb. 2mm adhesive felt may be used around the arm to pad the proximal edge.

A small re-rolled piece of Soffban® can be placed in the flexor surface of the elbow to help prevent anything sitting in to the crease. Apply a covering of undercast padding firmly, smoothly and evenly. An extra layer of padding or a piece of felt may be needed around the elbow to protect the olecranon process and the medial epicondyle.

### Application

3 Use a 7.5cm roll of casting bandage, starting at the axilla end rolling from within out. When rolling the casting tape, aim for the middle of the bandage width to lay across the flexor surface and apply evenly without missing anywhere.

Use 7.5cm roll to continue down the forearm and cut the cast tape to go through the grip twice in the same technique as the below elbow cast. Then come back up the arm with a single layer.

A 2 layer slab of cast tape material can be incorporated to reinforce the posterior elbow area. This cast can also be applied in 2 parts. The below elbow part is often done first. Apply 2 layers of padding at the join. Care must be taken when the top half is joined, to avoid the edge of the lower half pressing into the flexor surface of the elbow.

4 Completed cast.

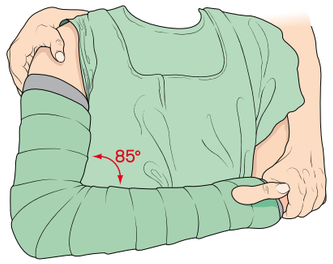
## Smith's Cast

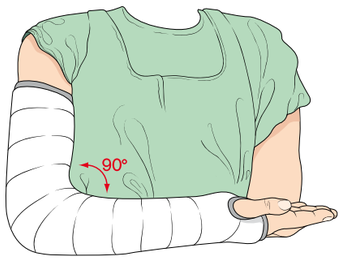
A full, or above elbow, cast will be required with the wrist in dorsiflexion, the forearm supinated (palm upwards) and the elbow at a right angle.

The requirements and application are as for an above elbow cast.







# 2.3 Casts of the Upper Limb

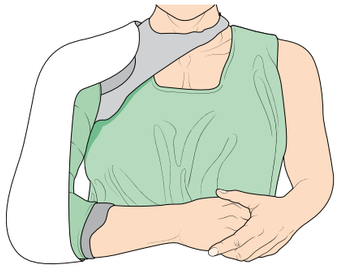
## ‘U’ Slab

### Equipment Required

Basic trolley, see page 28 - plus:

**Plaster of Paris**

- Stockinette 10cm
- Adhesive felt 5mm thick x 1 sheet
- Soffban® Synthetic padding 10cm x 2 rolls
- Gypsona® 15cm slab dispenser
- Soffcrepe® bandage 10cm
- Actimove® Sling or collar and cuff type product



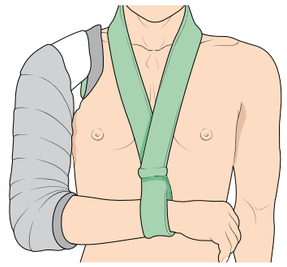
### Padding

Measure and pre-roll a piece of 10cm stockinette long enough to reach from mid-forearm, up the arm and over to the opposite shoulder.

Roll this onto the arm gently, cutting the roll just in front of the axilla and opening it out onto the shoulder up to the neck. Cut the remainder in half and tie gently around the opposite side of the neck or under the opposite axilla.

Apply a large semi-circle of 5mm adhesive felt over the shoulder and a piece around the elbow to protect the olecranon process and the medial and lateral epicondyles. Cover the arm with a layer of undercast padding.

The humerus should be allowed to hang down in a straight line to the body with the elbow at 90º and the palm facing the chest. Do not let the patient lean over to one side or the finished slab will be at the wrong angle and not sit down onto the shoulder.



### Application

Prepare a plaster of Paris slab 15cm wide of 8 -10 layers which is long enough to travel the length of the cast. Add on 4cm to the length to allow the slab to be long enough to conform to the contours of the limb.

1 Apply the slab from the axilla down around the elbow and back up over the shoulder, fanning out the slab over the shoulder and moulding it to fit snugly. Fix in position with a pre-wet crepe or cotton conforming bandage.

2 Apply an Actimove® Sling to support the wrist and allow the arm to hang beside the body using gravity to aid the position of the fracture. This brings the humeral fragments into alignment. Check that there is no pressure on the neck or axilla. Trim the stockinette and turn back over the edge of the slab, holding in position with 2 layer strips of plaster of Paris.



# 2.3 Casts of the Upper Limb

## Humeral Brace

### Equipment Required

Basic trolley, see page 28 - plus:

- Stockinette 10cm
- Delta® Terry-Net 10cm
- Adhesive felt 2mm thick x 1 sheet
- Delta-Cast® Conformable (1 x 7.5cm roll plus 1 x 5cm spare roll)
- Soffcrepe® bandage 10cm
- Tensoplast® Sport cast edge tape 3cm
- Adhesive hook and loop hooks and non-adhesive loops
- Actimove® Sling or collar and type product

This cast may be used once the initial swelling has reduced. The cast should extend from the epicondyles of the humerus allowing full flexion of the elbow to the acromioclavicular joint. With mid-shaft fractures some orthopaedic surgeons may prefer to let the cast finish at the axilla level.

The humerus should be allowed to hang down in a straight line to the body, with the elbow at 90º, with the palm facing the chest.




### Padding

1 Measure and pre-roll a piece of 10cm stockinette long enough to reach from mid-forearm, up the arm and onto the shoulder. Roll this onto the arm gently. Stick a piece of 2mm adhesive felt to protect the sensitive medial aspect of the arm. Place a strip of 2mm x 5cm wide adhesive felt down the lateral aspect of the arm. Apply the Delta® Terry-Net stockinette or a second layer of stockinette.

### Application

Pre-wet and squeeze out the crepe bandage.

Apply a 7.5cm wide casting material from humeral epicondyles to the acromioclavicular joint. You will need two layers of coverage (50% overlap) to reach required strength. Cover with the pre-wet crepe bandage and remove it, when initial set has occurred. Mark the cast for any trimming required.

2 Draw a line down over the felt on the lateral aspect and cut carefully with the electric cast saw. Mark, cut and remove 1cm of cast material alongside the cut already made.

3 This allows for adjustment to the splint. Spread the cast, cut the felt and the Delta® Terry-Net cast liner. Remove the cast gently from the limb.

Where trimming is necessary, pull back the Delta® Terry-Net cast liner from the edge. Trim as marked and test on the patient, checking that they can fully flex the elbow and there is no pressure on the axilla. Use 2mm felt on the edges where needed and turn back the Delta® Terry-Net cast liner over the edges, holding in place with the adhesive tape.

Replace gently on the patient and hold the cast in place with the adhesive hook and loop straps.

4 Apply Actimove® Sling to support the wrist and allow the arm to hang beside the body, using gravity to aid the position of the fracture.

# A Practical Guide to Casting

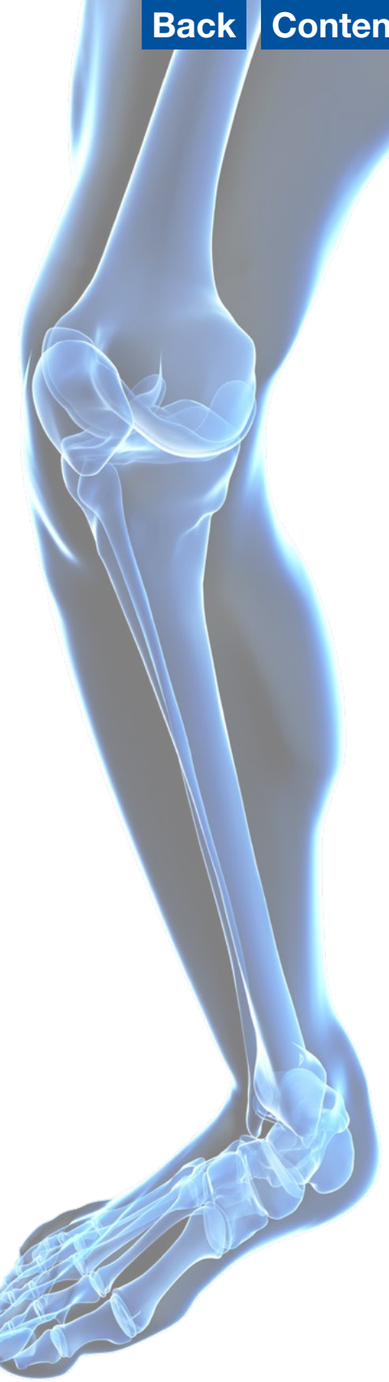
## Casting the Lower Limb

### Contents



Casts used to treat the most common fractures of the lower limb. Each is discussed in more detail.

- Slippers
- Below Knee Cast
- Below Knee Slab
- Tibial Bracing/Sarmiento
- Cylinder Cast
- Broomstick Cast
- Above Knee Cast/Long Leg Cast



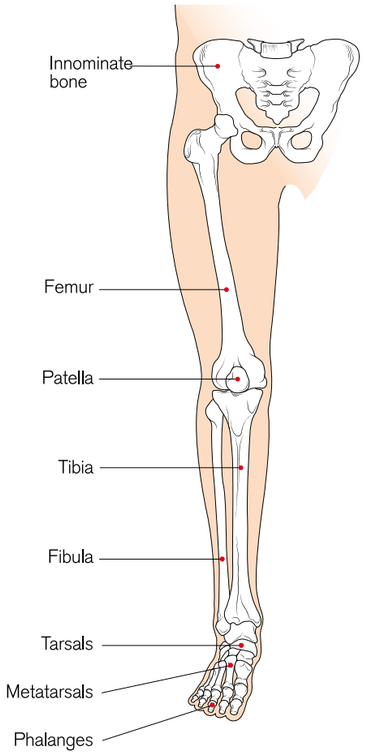
Brands suggested for each technique covered are an example of what brands can be used. Other brands are available.

# 3.1 Anatomy of the Lower Limb

## Bones of the Lower Limb

The lower limb is constructed to carry the body weight and to move the body from place to place.

The lower limb comprises the thigh, knee, lower leg, ankle, feet and toes.




## Bones of the Toes and Feet

Each toe has three phalanges, except the great toe (hallux) that has only two, which are thicker and stronger.

The forefoot has five long bones, the metatarsals, that lie parallel. Each is slightly curved to produce the arches of the foot. The styloid process of the fifth metatarsal can be felt under the skin and connective tissue.

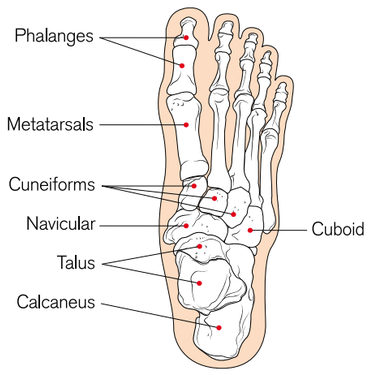
The metatarsal heads are situated at the distal end of the metatarsals, where they form the metatarso-phalangeal joints which are often affected in rheumatoid arthritis.

The hind foot - 7 tarsal bones, variously shaped, are arranged to continue the arch of the foot back towards the heel and the instep.

The talus - forms the highest part of the instep and contributes towards the formation of the ankle.

The calcaneus - (the largest tarsal), the heel bone bears most of the body weight when standing; muscles of the calf are attached to it through the tendo-calcaneus (Achilles tendon).

The remaining tarsals are the navicular, the cuboid and the three cuneiform bones.






# 3.1 Anatomy of the Lower Limb

## Bones of the Leg

### The Tibia

The longer, stronger of the two bones, is placed medially in the leg.

It extends from the knee to ankle and forms part of each of the joints. It carries the body weight through to ankle and calcaneus.

The tibia's distal end is irregular in shape, with a medial downward projection (medial malleolus), which can be identified as the ankle bone, and the shaft extends upwards. It is triangular in cross-section. The anterior ridge (or crest) can be felt as the shin.

Anteriorly the tibial tuberosity provides attachment for the quadriceps tendon and the patellar ligament.

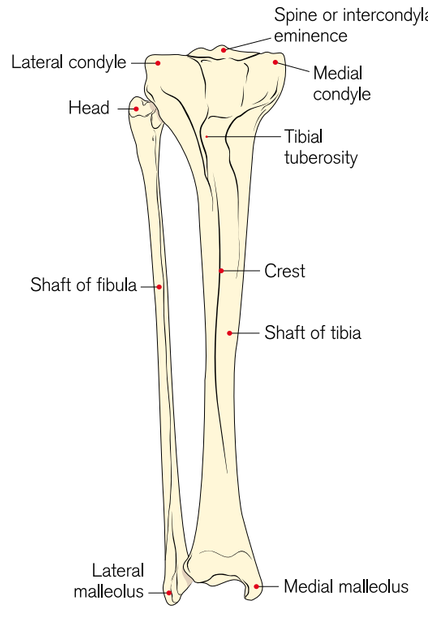
The proximal end of the tibia is expanded to form the medial and lateral tibial condyles, the articulating surface of the tibial plateau, and the intercondylar eminences.

### The Fibula

The fibula is slim and light, lateral to the tibia and its distal, downward projection forms the lateral malleolus (ankle bone).

The proximal fibular head articulates with the inferior surface of the lateral tibial condyle. This can be felt below the knee joint.

The fibula provides attachment for many muscles. It is not involved in weight bearing.




**Right tibia and fibula -** anterior view

### The Patella and Femur

The patella is a sesamoid bone in the quadriceps tendon. It is triangular in shape, with the apex pointing downwards and it articulates with the patellar surfaces of the femur.

The patella can be felt lying under the skin on the anterior surface of the knee.

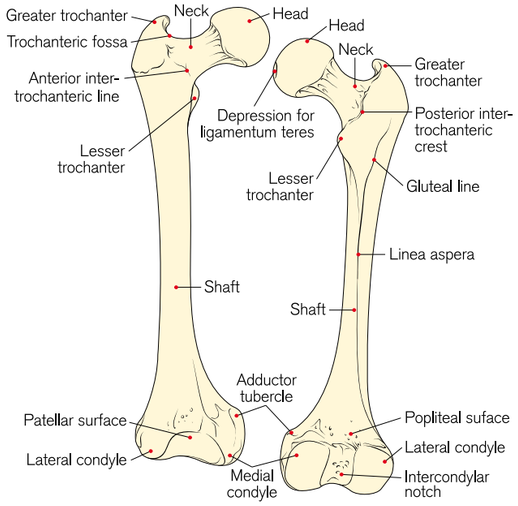
The femur is the long bone of the thigh, the longest and strongest bone in the body, that extends from the knee up to the hip and forms part of both these joints. The femur is slightly bowed to give a forward convex curve to the thigh. Its expanded distal end forms the rounded medial and lateral condyles, separated by the patella surface anteriorly and the intercondylar notch posteriorly.

The femoral shaft is rounded in cross section. Proximally two large projections are present for muscle attachment:

- The greater trochanter, which can be felt at the proximal end of the thigh, beneath the skin
- The lesser trochanter, medially and posteriorly to the shaft just below the level of the greater trochanter

### Femoral Neck

The femoral neck is a medially projecting construction, in adults set at 130° to the shaft of the femur, that carries the femoral head, which is rounded and forms part of the hip.




**Right femur** anterior view **Right femur** posterior view

# 3.1 Anatomy of the Lower Limb

## Joints of the Lower Limb

### Ankle

A synovial hinge joint. Medial, lateral and superior surfaces of the talus articulate with the medial and lateral malleolus and the inferior surface of the tibia. The two long bones are bound together by strong tibio-fibular ligaments. The capsule of the ankle is reinforced by strong ligaments on either side, especially the medial dorsal ligament.

The ankle allows **plantarflexion** (equinus) and **dorsiflexion** of the foot only. Plantar flexion is brought about by gastrocnemius and soleus. These muscles form the bulk of the calf and they insert into the calcaneus through the tendo-calcaneus (Achilles tendon). Dorsiflexion is brought about by tibialis anterior, peroneus tertius and the extensors of the toes.

Other movements of the foot e.g. **inversion** and **eversion,** take place at the subtaloid and midtarsal joints. Inversion is brought about by tibialis anterior and posterior. Eversion is brought about by the peroneal muscles.

### The Knee

The knee is a synovial hinge joint which allows flexion and extension, with a slight degree of rotation, brought about by the articulation of the rounded femoral condyles on the flat tibial plateau. The fibula is not involved. The capsule is reinforced by the strong medial and lateral ligaments.

The patella, which articulates with the patellar surface of the femur, is embedded in the quadriceps tendon, which itself is attached to the tibial tuberosity. Cruciate ligaments forming a cross-arrangement are attached to the tibial eminences and the intercondylar notch, and prevent anterior-posterior movement.

The menisci (or semi-lunar cartilages) are two crescent shaped pieces of fibrocartilage situated on the edges of the tibial plateau and prevent side to side movement.

Bursae (sacs of synovial fluid) are situated around the patella to prevent friction. Knee flexion is undertaken by the hamstring group of muscles and gastrocnemius. Knee extension is undertaken by the quadriceps group of muscles.

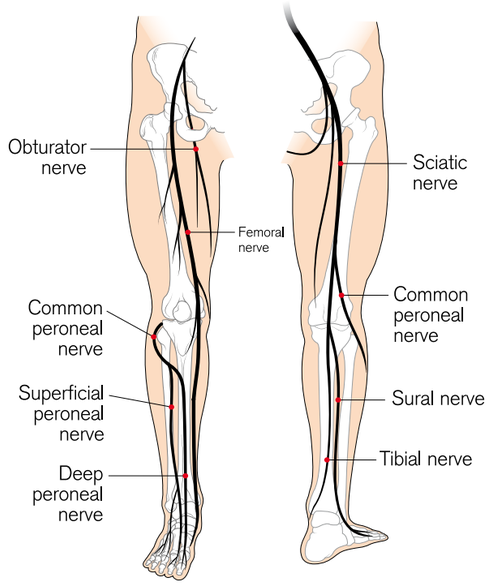
### The Hip

The hip is a synovial ball and socket joint which allows **flexion** and **extension, internal** and **external rotation, abduction** and **adduction** of the lower limb.

It is formed by the articulation of the spherical head of femur (the ball) and the acetabulum of the innominate bone (the socket). Inside the joint is an acetabular pad of fat which acts as a shock absorber, the acetabular labrum and ligamentum teres, which aid joint stability. The capsule completely surrounds the joint and is reinforced by three extra-capsular ligaments, the ilio-femoral, ischio-femoral and pubo-femoral ligaments. Extension of the hip is undertaken by the hamstring group of muscles and some of the fibres of gluteus maximus. Flexion of the hip is undertaken by the ilio-psoas and rectus femoris muscles. Hip abduction is undertaken by gluteus medius and minimus and some fibres of gluteus maximus. Hip adduction is carried out by the adductor group of muscles.

A very stable joint with a strong capsule reinforced by ligaments.

### Main Nerves of the Leg




A - Anterior view B - Posterior view

The table lists the fractures of the lower limb most commonly treated with the involvement of Plaster Room staff.

| | |
|---|---|
| **Femur** | Shaft |
| | Supracondylar |
| **Patella** | |
| **Tibia** | Shaft |
| **Ankle** | Malleolus |
| **Foot** | Tarsal bones |
| | Metatarsals |

Fractures of the leg are as likely to develop circulatory and neurological problems as those in the arm. Measures taken should include an early and frequent assessment of pulses in the foot. Feel the dorsalis pedis pulse at the front of the ankle and the tibial pulses at a point half way between the Achilles tendon and the medial malleolus (the bony point on the inside of the ankle). The foot should be elevated.

The leg should be protected in a splint which supports the foot and prevents rotation. Sandbags and a towel will also serve to control the foot. Avoid any pressure behind the knee. When moving the patient, one person should have responsibility for supporting the injured leg.

If it is necessary to remove trousers by cutting them off then give consideration to cutting along the seams rather than along the crease at the front. Trousers cut thus can often be repaired with minimal expense, or tapes attached so they can be fastened over a cast.



# 3.2 Fractures of the Lower Limb

## Fractures of the Femur

### Fractures of the Upper End of the Femur

This is a very common fracture and it is unfortunate that it usually occurs in the most vulnerable members of society, the elderly. Osteoporosis is probably an underlying factor and because of this it is more common in females. All areas of the upper end of the femur may be affected and are described as capital, sub capital, transcervical, inter-trochanteric or subtrochanteric. The treatment prescribed will depend on many factors both physiological and social. A crucial factor will be the estimated state of the blood supply to the femoral head, depending on whether the fracture is intra or extra capsular.

Intracapsular fractures are treated either by replacing the femoral head (a hemi-arthroplasty) or occasionally by total hip replacement. Extracapsular fractures are mostly treated by internal fixation using a dynamic hip screw. For a satisfactory outcome to be achieved an aggressive regime of physiotherapy and a high input from nursing staff is required. An occasional complication is post-operative dislocation of the new joint and this may require the application of a hip brace.

### Fractures of the Femoral Shaft

The femur is the largest bone in the body and takes the longest time to heal. There is always considerable blood loss as a result of the fracture even if closed, and the patient will be in a severe state of shock.

This is an injury mostly associated with fit young men. Initial treatment is usually by traction on a Thomas splint, by skeletal traction or by internal fixation using an intramedullary nail. Occasionally, an external fixator may be required.

When the fracture is showing signs of union, the leg may be placed in a functional cast brace, which might also be used following internal fixation. The brace allows movement at the knee and ankle, and the patient is encouraged to commence weight bearing under supervision. The bodyweight is transferred to the brace via the soft tissues. There is some telescoping of the fracture as the patient walks, which has a beneficial effect on the development of callus. The brace depends for its success on being a perfect fit around the thigh, for compression of the soft tissues around the fracture, and on its shape, for controlling and preventing rotation. The cast takes a major part of the patient's body weight as he walks. Children with this injury may be treated in traction, or in a Thomas splint followed by a hip spica, or may have flexible intermedullary nails inserted.

### Supracondylar Fractures of the Femur

Like supracondylar fractures of the humerus, there is a major risk of arterial damage and compartment syndrome with these injuries. Pulses should be checked frequently in the foot. The leg will be splinted with the knee in a flexed position, to relax the muscles which are displacing the distal fragment backwards.

Treatment options may involve conservative management in an above knee cast with some knee flexion or fixation, using a variety of techniques. A functional brace allows early return to walking.

### Fractures of the Femoral Condyles

Fractures of the femoral condyles are potentially serious as they invariably involve the articular surface of the lower end of the femur within the knee joint. The usual method of treatment is by internal fixation with a T-plate or cancellous screw. A leg cylinder may be prescribed.

## Fractures of the Patella

The kneecap may fracture following a strong contraction of the quadriceps muscle in elderly people, or as a result of direct violence as in hitting the car dashboard in a road traffic accident. The treatment prescribed will depend on the severity of the injury and the amount, if any, of the displacement. If indicated the bone may be excised and the ruptured tendon must be sutured. Alternatively the bone fragments may be wired together. If not repaired knee extension will be permanently impaired.

The direct blow often produces the stellate type of fracture (see diagram page 20). The fragments are usually held together by the enclosing tendon. Treatment may be the application of a cylinder with the knee usually in full extension.

In either fracture exercises to maintain the quadriceps muscle are required.

# 3.2 Fractures of the Lower Limb

### Soft Tissue Injuries in and Around the Knee

Soft tissue injuries involving the knee joint are very common indeed. They may be intracapsular, including tears to cruciate ligaments or semilunar cartilages (menisci) or extracapsular, especially injuries to medial and lateral collateral ligaments.

The anterior cruciate ligament is torn more frequently than the posterior one. Abnormal movement of the femur on top of the tibia will be noted. Although this can be an isolated injury it often accompanies other injuries around the knee joint. Opinion differs on primary treatment, the choices being early surgical repair or a more conservative approach. Surgical intervention is often employed later in order to overcome joint laxity. Following posterior cruciate ligament injuries early treatment is usually conservative, with follow up surgery employed to correct persistent instability which would lead to secondary osteoarthritic changes.

Of the extracapsular ligaments the medial collateral ligament is the more common injury and often follows the so called “bumper injury” whereby the car bumper is in contact with the lateral part of the knee, so forcing open the medial compartment. The rupture may be accompanied by a fracture of the tibial condyle of the opposite side to the ligamentous tear. Treatment depends on the severity of the tear and ranges from support bandaging, a cylinder or surgical repair.

## Fractures of the Tibial Condyles

Fracture of the lateral tibial condyle occurs due to abduction of the tibia while the foot is anchored. The fracture can be comminuted, impacted or oblique. Since the **tibial plateau** (and hence the articular cartilage) is likely to be damaged, secondary osteoarthritic changes may occur later. Initially a haemarthrosis may be present. Treatment involves aspiration of any haemarthrosis and an attempt at restoration of the articular cartilage. This usually involves a period of rest in an above knee or cylinder cast, and then a period of intensive physiotherapy to prevent stiffness of the joint. Open reduction may be carried out to restore the congruity of the articular cartilage. A removable splint may be needed at night to protect the knee joint from movement, which will further damage the soft tissues, and also for comfort. Functional braces are often used after the initial treatment.

### Fractures of the Tibia

The tibia has two anatomical features which give rise to problems with a fracture. It is very close to the skin and therefore the fracture is most likely to be open, and the blood supply to the lower part of the bone enters near the top. Therefore, when the bone is broken, the lower part relies on the blood from the periosteal membrane. These open fractures greatly increase the risk of infection. If the fracture is at all comminuted, the blood supply may be inadequate leading to necrosis of fragments and non-union. Even simple fractures of the tibia can take a long time to unite because of the blood supply problems. The skin may also break down after a few days exposing the bone beneath.

Support the injured leg without moving it, and assess the circulation in the foot. Ask the patient to move the toes.

With undisplaced closed fractures, the common treatment is an above knee cast. The cast may be split along its length if there is any risk of swelling. When the fracture is beginning to unite, a functional brace known as a Sarmiento cast may be applied and the patient encouraged to walk normally. Stiffness of the knee and ankle joints is common after conservative treatment of tibial fractures and may handicap the patient for some time. For this reason displaced or unstable fractures are usually treated with internal fixation.

If the fracture is open, then the cast MUST be split, or better still a back slab applied until the swelling has subsided. External fixators can be used where the fracture is comminuted or compound, where access to a wound is required.

## Fractures Around the Ankle

These are often erroneously called Pott’s fractures. We should more accurately name them in terms of the site of the injury, which affects one or both malleoli, with varying degrees of displacement. Tenderness is usually felt on the side of the fracture. The anatomy around the ankle together with the direction of the forces, dictates the way in which the ankle is injured. The ankle joint is a mortice, holding the tenon formed by the talus. The lateral ligament is weak whilst the lateral malleolus is strong. The medial ligament is strong, whilst the medial malleolus is weak.

Fractures of the ankle must be splinted in a position of the foot at 90° to the leg, in neither inversion nor eversion (plantigrade). Six weeks in cast is usually sufficient.

### Medial Malleolar Fractures

This is commonly the result of the foot being everted. The malleolus is pulled off by the strong medial ligament, producing an avulsion fracture. Treatment is the application of a below knee cast.

When the foot is forced inwards (inversion) the common result is to tear the lateral ligament because of its weakness. The talus may then be displaced medially. If the medial malleolus is then broken, the ankle joint becomes unstable and requires fixation of the malleolar fragment with a screw.



# 3.2 Fractures of the Lower Limb

### Lateral Malleolar Fractures

To break the lateral malleolus requires a lateral shift of the whole foot. The alignment of the ankle joint will be altered and must be restored if function is to be regained.

Instead of fracturing the malleolus the inferior tibio-fibular joint may be separated (a diastasis). In mild separation a below knee plaster cast is applied, with adequate padding over the malleolii, and gentle compression applied by medical staff. This may close the gap, or it may be necessary to operate and insert a diastasis screw.

Less seriously, the tip of the lateral malleolus may be pulled off (avulsed), but given the comparative weakness of the ligament it is more common to sprain the lateral ligament. This may, however, require a below-knee cast, although elevation, strapping and rest are often sufficient.

### Bi-malleolar and Tri-malleolar Fractures

Occasionally both medial and lateral malleoli may be fractured plus the posterior part of the lower end of the tibia, sometimes called the posterior malleolus. The ligaments surrounding the ankle joint may also be damaged. This causes a major disruption of the integrity of the ankle joint.

Treatment is geared towards the restoration of the joint congruity and while this can be achieved by manipulation application of a below knee cast and elevation of the limb for a few days, some will inevitably require open reduction and fixation with plate and screws, or screws alone. A below knee cast may be required, non-weight bearing, for a period of time, and later a walking cast will be applied.

## Foot Fractures

### Calcaneus

The heel bone may be fractured as the result of a fall onto the heel, from a small height. Slipping off a ladder is common. The bone is crushed against the talus and is often comminuted. Swelling is considerable and early treatment is rest and elevation until the swelling has subsided. Wool and crepe bandaging may be replaced by a below-knee cast and the patient will be non-weightbearing for some time before they are allowed to start to take weight. The heel may be painful for some considerable time. Patients with heel fractures must always be examined for other injuries, to hip, pelvis or spine.

Sometimes calcaneal fractures require a manipulation under anaesthetic and internal fixation.

### Talus

Injuries to the talus are rare but disabling. Accurate alignment of fragments is essential if the patient is to walk or stand without discomfort. Early osteoarthritis of the ankle or subtalar joint is a likely outcome. If the fracture is undisplaced a split plaster cast may be utilised, but displaced fractures require open reduction and fixation. The foot is then held in a plantar-flexed position for 3 weeks then recast in a plantigrade position after the wires are removed. The talus is at risk of avascular necrosis after this injury and may ultimately lead to fusion of the ankle joint or joint replacement.

### Metatarsal Fractures

Injured by crushing or twisting, treatment is manipulation and holding in a below knee or slipper cast for some weeks. If swelling is severe then the foot is elevated, and movements encouraged until this has subsided. When the swelling has subsided a cast may be applied and the patient allowed to walk.

Fractures of the 5$^{th}$ metatarsal are amongst the most common metatarsal fractures. A simple avulsion fracture of the tuberosity must be distinguished from the less common Jones’ fracture. This fracture occurs more distal to the tuberosity, in the metaphyseal region at the base of the metatarsal shaft. It extends into the intermetatarsal facet joint not the metatarsal-cuboid joint. This fracture is important to diagnose as it occurs at the junction of 2 separate blood supplies and is prone to delayed healing. Initial treatment for acute fractures is 6-8 weeks non-weight bearing in a cast. Surgical fixation may be required for delayed healing or non-union.

### March Fracture

This is a stress fracture usually affecting the shaft of the 2$^{nd}$, 3$^{rd}$ or 4$^{th}$ metatarsal bone. It arises after unaccustomed walking, e.g. in recruits to the armed services, or police, or during a walking holiday. An X-ray taken soon after the onset of symptoms may not reveal the fracture and it requires a second X-ray some two weeks later when the callus formation is seen.

Treatment is symptomatic and may require the application of a walking cast.

## Fractures of the Toes

These are rarely treated by the application of plaster, the favoured method being to strap the injured toe to its neighbour with a Strappal® rigid zinc oxide strapping tape. If there is an associated injury to metatarsal bones, then a below-knee cast with a toe platform may be applied.

# 3.3 Orthopaedic Conditions

## Congenital Talipes Equinus Varus (CTEV)

A condition present at birth that affects the foot and lower part of the leg. The cause is as yet unknown. About one in 1,000 babies are born with this condition, and it is twice as common in boys than girls. In 50% it is bilateral. The foot is turned inwards (inverted) and, although to a certain extent all babies have slightly inverted feet, the examining midwife will be able to recognise the abnormal.

There are three elements that contribute to the deformity:

1. Inversion at the sub-talar joint
2. Adduction at the forefoot
3. Plantar flexion at the ankle joint

The eventual outcome of treatment depends largely on the age at which treatment begins and the efficiency with which it is carried out. Treatment is mostly conservative and occasionally surgery may be necessary. The aims of treatment are to return the bones to their normal relationship with one another, and to maintain that position until the muscles can maintain the position unaided.

Techniques can vary slightly, however the Ponseti Method is the Gold Standard technique. To undertake the Ponseti technique you should ensure that you receive appropriate training. Usually, medical staff hold the position of the foot and it is essential that the person applying the actual cast is experienced and qualified in casting.

The foot is manipulated and stretched first, then the below knee section is applied first and once this has been moulded and is set, the cast is extended to complete an above knee cast. The serial casts are changed weekly. The pes cavus is corrected first, then the forefoot adduction, the hindfoot and last, the equinus. Often a percutaneous Achilles tenotomy is performed when the equinus is corrected.

After the series of casts the child wears Dennis Brown type boots and bar. The feet are held in 70° of external rotation and 15° of dorsiflexion. They are worn for 23 hours a day for three months, then just at night and day sleeps until 3-4 years old.

Sometimes they do relapse and may need further Ponseti treatment.

Occasionally, even with repeated treatment, the procedure may be unsuccessful and if this is so then operative measures will be required. This will be designed to release the soft tissues on the medial side of the foot and probably the tendo-calcaneus. Once the bones have been returned to their normal position then an above knee cast will be applied. When the cast is removed a night splint may be required and stretching of the soft tissues is continued to prevent a recurrence of the deformity.

Surgery may be required later to overcome problems where the diagnosis has been made late, or if treatment has failed.

## Hallux Valgus

This is a deformity whereby the big toe is deviated away from the mid-line of the body (valgus) and the first metatarsal drifts into varus. It is more common in women than men. The cause is still unknown although it is often familial and it is thought that shoes with pointed toes that are also too tight may be a contributory factor. Thickened skin develops over the prominence and a bursa underneath may become inflamed, causing pain.

Treatment, if required, falls into three categories. Firstly, a first metatarsal corrective osteotomy may be performed, e.g. Scarf, Chevron or Mitchell's. Secondly, an arthrodesis of the metatarso-phalangeal joint in slight dorsi-flexion. In elderly people Keller's Operation (excision of the proximal third of the 1st phalanx with an exostectomy of the 1st metatarsus) may sometimes be performed.

Some surgeons use a below knee cast, slipper or special sandal after surgery.

## Osteochondritis

The term osteochondritis refers to a collection of conditions where there is thought to be a temporary interruption in the blood supply to a part of a bone (avascular necrosis), leading to softening and, in the case of weight bearing bones, to collapse. Rehardening occurs spontaneously over a period of time. There can be damage to the apophyses. In order to maintain the integrity of the bone it will need to be protected during the softened phase. This can be done by the application of casts or splints.

### Vascular Damage

- Perthes affects head of femur (see over)
- Keinbock's affects lunate - treated in a below elbow cast
- Kohler's affects navicular - treated in a below knee cast



3.3 Orthopaedic Conditions

### Damage to the Apophyses

- Osgood Schlatter's affects the tibial tubercle - treated in a cylinder cast
- Sever's affects the calcaneum - treated in a below knee cast

These conditions normally respond to a period of rest in a cast. Scheuermann's Kyphosis may be an osteochondritis of the vertebral body.

### Perthes' Disease

Perthes' disease is an osteochondrotic condition of the head of the femur. The aim of treatment is to hold the head of the femur within the acetabulum during the softened phase. At this stage the cartilage continues to grow and can form a mushroom shaped head if not contained within the acetabulum.

A range of treatments can be applied, depending on the amount of the head of the femur that is affected and could include:

1. Simple rest and follow up
2. Initial rest and then application of broomstick casts or splints to hold the hip in abduction and, with the hip in abduction and a little internal rotation, with knees flexed to 30°
3. A femoral or innominate osteotomy, followed by a hip spica for 6-9 weeks

# 3.4 Casts of the Lower Limb

## Slippers

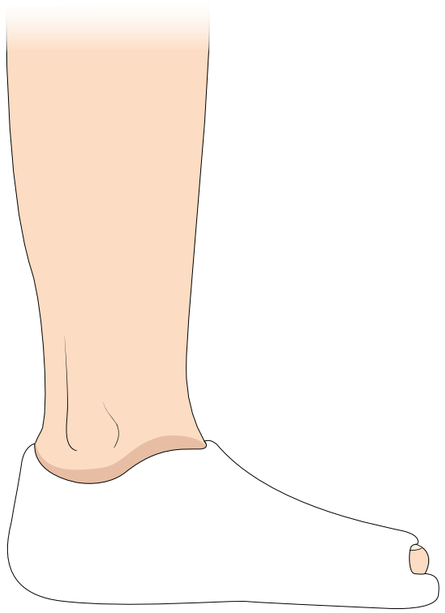
These casts are very difficult to apply satisfactorily. They can be applied following fracture of the metatarsals, operations for hallux valgus and other foot conditions. The diagnosis will affect the way these casts are applied. They may be applied up the tips of the toes, or with a toe piece between the hallux and 2nd toe. Patients with a toe piece are much more comfortable with a platform under all the toes.

### Equipment Required

Basic trolley, see page 28 - plus:

**Plaster of Paris**

- Stockinette 7.5cm
- Piece of non-adhesive felt for between the hallux and 2nd toe
- Soffban® Synthetic padding 10cm x 1 roll
- Gypsona® plaster of Paris bandages 10cm x 2 rolls
- Delta-Cast® Conformable 7.5cm x 1 roll
- Tensoplast® Sport cast edge tape 3cm
- Knee rest



### Padding

Apply the stockinette from toes to mid-calf. Apply a covering of undercast padding firmly, smoothly and evenly.

### Application

Apply 1½–2 x 10cm plaster of Paris bandages from just above the malleoli to the tips of the toes. Mould to fit well around the heel and Achilles tendon. When initial set has taken place, trim the cast. Anteriorly, it is trimmed to allow flexion of the ankle, medially and laterally under the malleoli and rising at the back in the form of a Dutch clog. Trim the toe area as required, depending on the diagnosis.

Reinforce for weight bearing using a 3 layer slab to reach from the tip of the toes to just around the heel, cut from a 7.5cm casting tape roll. Hold in position with the remainder of that bandage.

Check and remove any synthetic cast tape which has strayed over the original trimming. Turn back the stockinette over the edges and hold in place with the adhesive tape.

Combination casts are one of the best ways of making a comfortable cast that the patient can walk on within 20 minutes. When applying a build-up, one must be very careful in positioning, and stand the patient up to check that nothing is rubbing and that he is well balanced.

### Toe Piece

The medical officer may wish to have the toe held in position by a piece of plaster. Cut the stockinette between the first and second toe and apply a strip of undercast padding around the toe in a figure of eight down the medial side of the foot. Prepare a 5 layer plaster of Paris slab 5cm x 20cm long.

Apply the slab in the 1st same way as the padding, after applying the bandage to the level of the base of the toes. Commence the second bandage at the toes, incorporating the slab into the rest of the cast before it sets. Reinforce for weightbearing as above.



# 3.4 Casts of the Lower Limb

**Synthetic**

- Stockinette 7.5cm
- Piece of non-adhesive felt for between the hallux and 2nd toe
- Soffban® Synthetic padding 10cm x 1 roll
- Delta-Cast® Conformable 7cm x 1 roll
- Tensoplast® Sport cast edge tape 3cm
- Knee rest

### Padding

1 Apply the stockinette from toes to mid-calf, and apply 2.5cm stockinette to the hallux, and 7.5cm stockinette from toes to calf with a hole for the hallux.

Alternatively cut the stockinette between the first and second toe.

2 Apply a small piece of non-adhesive felt in between and strip of undercast padding around the toe in a figure-of-eight, down the medial side of the foot.

Apply a strip of 2mm adhesive felt around under both malleoli.

3 Apply a covering of undercast padding firmly, smoothly and evenly

### Application

4 Using 1 or 1.5 x 7.5cm casting tape rolls, apply a single layer carefully from the ankle to the toes without making too many layers over the dorsum of the foot.

5 Cut twice to go through between the hallux and the 2nd toe, and around the hallux in a figure of eight.

6 Place a 2 or 3 layer slab to reach from the toes to around the heel, apply and complete with a single layer coverage back up to the ankle.

Trim under the malleolus and to allow movement of the ankle. Leave a platform under the toes for comfort.






# 3.4 Casts of the Lower Limb

## Below Knee Slab

The position of the ankle depends on the injury being held, but it is most commonly held at 90° with the foot in neutral inversion/eversion (plantigrade). If the knee can be held at an angle of 10-15° with the aid of a padded support (e.g knee rest), it is easier to hold and maintain the foot in the correct position. It is all too easy to make ridges around the ankle. It is very important not to let the ankle move during the application.

The slab should extend from just below the knee, but allowing free movement of the knee joint, to the toes.

According to the medical officer's wishes and/or the injury, the toes can be fully exposed or supported by a platform.

A difficult reduction of a fracture may require the patient to be positioned over the edge of the trolley, the foot being supported on the medical officers knee, thereby leaving both hands free to hold the reduction.

There are certain injuries which require different positioning e.g an injury to the Achilles tendon, where the foot and ankle are in plantar flexion. This may be achieved more easily by placing the patient prone on the trolley. Alternatively, the slab can be applied on the anterior aspect of the leg, with strengthening slab/tram lines over the ankle joint.

### Equipment Required

Basic trolley, see page 28 - plus:

- Stockinette 7.5cm
- Adhesive felt 2mm thick
- Soffban® Natural padding 15cm x 2 rolls
- Gypsona® plaster of Paris bandages or slab dispenser 15cm or 20cm
- Gypsona® plaster of Paris bandages or slab dispenser 10cm
- Crepe bandages 15cm
- Knee rest
- Patient trolley

### Padding

**1** Apply stockinette and pad the limb as for a below knee cast.

### Application

**2** Measure a slab, 5-8 layers of 15cm or 20cm plaster of Paris, to go the length of the cast posteriorly, and measure 2 side slabs from the proximal extent, or the cast, to wrap under the foot, allowing for contoring of the limb.

**3** & **4** Pre-wet crepe and wring out thoroughly.

**5** The posterior slab is to be placed from just below the knee to the toes.

**6** One of the side slabs will wrap under the heel or the sole.

**7** The other side slab will wrap around the forefoot (take extra precaution to avoid a gap between this and the posterior slab at the corner of the heel).

**8** Great care must be taken not to allow the slabs to overlap anteriorly.

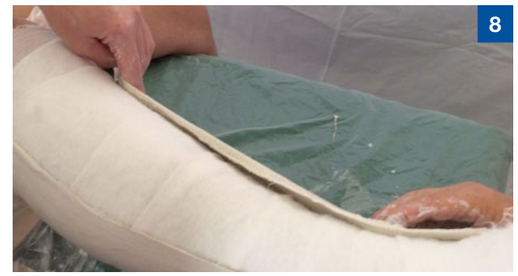
**9** Hold the slabs in place using a pre-wet and squeezed out crepe bandage.

**10** Finish and secure the crepe with another piece of plaster of Paris slab, and ensure that in does not cover the soft area of the back slab.









# 3.4 Casts of the Lower Limb

## Below Knee Cast

The position of the ankle depends on the injury being treated, but is most commonly held at 90° and the foot in neutral inversion/eversion (plantigrade). If the knee can be held at an angle of 10-15º with the aid of a padded support (e.g. knee rest), it is easier to hold and maintain the foot in the correct position. It is very important not to let the ankle be moved during the application, as it is all too easy to make ridges around the ankle.

The complete plaster should extend from just below the knee, but allowing free movement of that joint, to the toes.

According to the medical officer's wishes the toes can be fully exposed or supported by a platform.

A difficult reduction of a fracture may require the patient to be positioned with the knee at a right angle, over the edge of a trolley, the foot being supported on the medical officer's knee or by an assistant, thereby leaving both hands free to hold the reduction.

### Equipment Required

Basic trolley, see page 28 - plus either of the following options:

**Plaster of Paris**

- Stockinette 7.5cm
- Adhesive felt 2mm thick
- Soffban® Synthetic padding 15cm x 2 rolls
- Gypsona® plaster of Paris bandages 15cm x 5 rolls
- Knee rest

### Padding

1 Apply stockinette only if swelling is unlikely. Bony areas, such as the head of the fibula and the malleoli, may need padding with felt. Apply a covering of undercast padding firmly, smoothly and evenly.

### Application

2 Bandaging can commence at either end of the limb and all basic plastering rules must be observed (see pages 30 and 31 for plaster of Paris application).

3 When rolling the plaster of Paris bandage, aim for the middle of the bandage to lay across the flexor surface, and apply evenly without missing anywhere.

4 If any of these casts are to be fully weight bearing then the sole must be levelled and reinforced before an overshoe or walking appliance is added.

5 Synthetic casting material such as Delta-Cast® Conformable can be used to reinforce a plaster of Paris cast to allow the patient to weight bear.

A pair of crutches will have to be issued and instructions given on their usage and how to fit the overshoe.








# 3.4 Casts of the Lower Limb

**Synthetic**

- Stockinette 7.5cm
- Adhesive felt 2mm thick
- Soffban® Synthetic padding 15cm x 2 rolls
- Delta-Cast® Conformable 10cm x 2 rolls
- Tensoplast® Sport cast edge tape 3cm
- Knee rest






### Padding

1 Apply the stockinette. Bony areas, such as the head of the fibula and the malleoli, may need padding with felt.

2 Apply a covering of undercast padding firmly, smoothly and evenly.

### Application

3 Commence at the proximal end of the cast, rolling the bandage away from you. Use 50% coverage to give 2 even layers, finish at the toes or metatarsophalangeal joints.

4 Quickly turn in the proximal edge stockinette and cut a 2 or 3 layer slab from the second roll. This should extend from the toes to just above the Achilles tendon.

5 With the remaining roll catch the stockinette and apply 1 single layer around the calf, reverting back to 50% coverage around the foot and ankle, whilst incorporating the slab.

It may be necessary with different synthetic casting materials, to increase the amount of material used. Trim as necessary. Fit an overshoe and give full instructions to the patient.

6 Completed cast.

# 3.4 Casts of the Lower Limb

## Tibial Bracing Sarmiento

Position the foot with the ankle at 90° and the foot in neutral inversion/eversion (plantigrade). The knee needs to be supported at between 30-40º. A good position is easier to achieve with the leg over the edge of the trolley and held by an assistant sat on a stool at the side. The applicator sits on a stool facing the patient's leg.

The moulding of these casts will depend on the medical officer's wishes, but the method now given may be helpful.

### Equipment Required

Basic trolley, see page 28 - plus either of the following options:

**Plaster of Paris**

- Stockinette 7.5cm
- Soffban® Synthetic padding 10cm x 1-2 rolls
- Gypsona® plaster of Paris slab 15cm x 20cm
- Gypsona® plaster of Paris bandages 15cm x 5 rolls

### Padding

1 Apply 2 layers of stockinette. Strips of 2mm thick adhesive felt can be placed down either side of the leg between the layers of stockinette to aid cast removal. Place a thin strip down the tibial ridge. Place one layer of undercast padding around the leg to protect the fibular head and patella, and one layer from the malleoli to the toes. Remember the padding must be kept to a minimum to allow the cast to support the soft tissues, which in turn support the bone.

### Application

2 Cut a 5 layer slab of 15cm plaster of Paris to fit from the medial femoral condyle around the patella and to the lateral femoral condyle. Apply 2 plaster of Paris bandages as for a below knee cast, but bring one higher around the knee. Place the plaster slab on the patella and around to the femoral condyles.

Complete the cast with a further 1 or 2 plaster of Paris bandages.

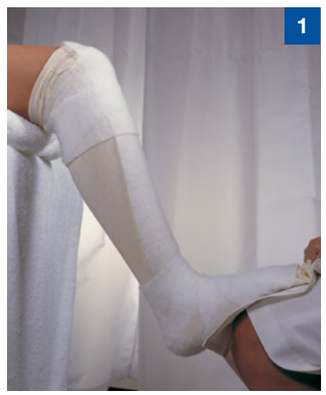
3 With the knee still flexed, mould gently to shape the cast on either side of the patella tendon, supporting behind the cast just below the knee. Do not press laterally over the head of the fibula as you may cause nerve damage. Use the palm of the other hand to gently compress the soft tissue at the posterior aspect of the cast.

**Note:** The cast should extend from mid patella around to the medial and lateral femoral condyles, and posteriorly to allow 90º of flexion of the knee. Do not trim too low posteriorly or the soft tissue support will be lost. Trim the distal end as for below knee cast.

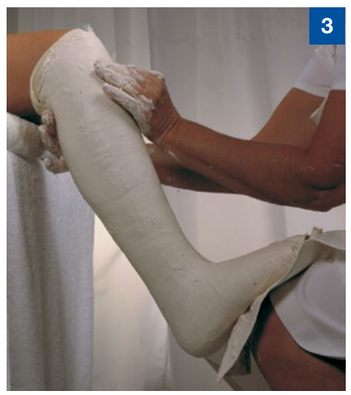
Mark the outside of the cast 'MINIMAL PADDING'. This way the person removing the cast will know to take extra care.

To be fully weight bearing the cast can be reinforced with synthetic casting material such as Delta-Cast® Conformable.

Apply an overshoe.







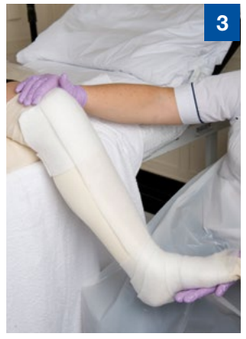



# 3.4 Casts of the Lower Limb

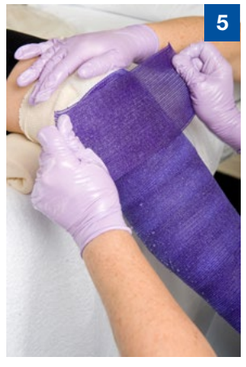
**Synthetic**

- Cast sock or stockinette 7.5cm
- Adhesive felt 2mm thick
- Soffban® Synthetic padding 10cm x 1 roll
- Delta-Cast® Conformable 10cm x 2 rolls
- Delta-Cast® Conformable 7.5cm x 1 roll
- Tensoplast® Sport cast edge tape 3cm













### Padding

1 Apply 1 layer of stockinette. Place strips of 2mm thick adhesive felt down each side of the leg, from the top of the cast to just below the malleoli. This allows easier removal of the cast and pads the bony areas. Apply a second layer of stockinette.

2 2mm adhesive felt or undercast padding can be used to pad the proximal end of the cast.

3 Place 1 layer of 10cm padding down the tibial crest and use one 1 of firmly applied undercast padding around the malleoli and foot.

Remember the padding must be kept to a minimum to allow the cast to support the soft tissues, which in turn support the bone.

### Application

4 Use a 10cm casting tape bandage to create a layer from the proximal edge of the patella to the toes.

5 Quickly, cut a 1 or 2 layer slab 20cm long from the next 10cm bandage. Place on the patella and around the femoral condyles.

6 Use the remainder of the bandage to take 1 turn around to hold the slab in place, and bandage down the leg in a single layer. Mould as discussed on page 74.

7 Use the 7.5cm or 10cm casting bandage to create the 2 layer slab for the sole of the foot, and complete the cast as for a below knee cast (see page 74).

8 Trim and turn back the stockinette and hold in place with cast edge tape.

**Note:** Mark the outside of the cast 'MINIMAL PADDING'. This way the person removing the cast will know to take extra care.

# 3.4 Casts of the Lower Limb

## Cylinder Cast

The knee is usually held in about 5°-10° flexion for comfort. If the patella is fractured, or there is damage/repair to the extensor mechanism, the knee is held in extension. Support the limb fully throughout the application. Hold the foot against the chest and use the hands to support the knee.

The cast should extend from as high up towards the groin as possible, allowing for comfort, and down to 3cm above the malleoli. The cast should be moulded well on the medial and lateral sides of the thigh, just above the femoral conclyles. This helps to prevent the cast from slipping down the leg.

Other methods of preventing the cast slipping are:

- Use 2 layers of stockinette, minimal adhesive felt padding and no undercast padding. Make the cast adjustable by using posterior slabs and minimal cast material anteriorly. Split the cast with a curved cut and holding in place using hook and loop straps
- Attach a webbing strap to the top of the cast at the back, take the strap over the opposite shoulder and down to a buckle from a strap incorporated into the front of the cast. The strap should be padded over the shoulder and can be released if required
- Fit a heel cup or apply an above knee cast

### Equipment Required

Basic trolley, see page 28 - plus either of the following options:

**Plaster of Paris**

- Stockinette 10cm (only if swelling is unlikely)
- Adhesive felt 5mm thick
- Soffban® Synthetic padding 15cm x 2 rolls
- Gypsona® bandages 15cm x 6 rolls
- Strips of Gypsona® plaster of Paris to finish

### Padding

1 Apply stockinette first. Then place a 7.5cm wide strip of 5mm thick adhesive felt around the leg, 3cm above the malleoli. Apply a covering of undercast padding firmly, smoothly and evenly. The patella and head of fibula may require extra padding.

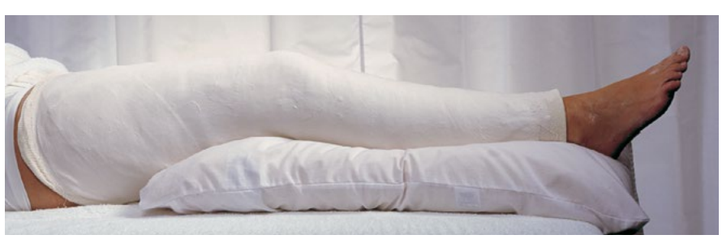
### Application

2 Starting at the distal end of the cast, leave 2.5cm of the adhesive felt showing and apply the plaster of Paris cast following the basic rules of casting.

Before initial setting takes place the cast should be moulded well with the palms of the hands on the medial and lateral sides of the thigh, just above the femoral conclyles.

3 Completed cast.







# 3.4 Casts of the Lower Limb

**Synthetic**

- Stockinette 10cm
- Adhesive felt 5mm thick
- Adhesive felt 2mm thick
- Soffban® Plus padding 15cm x 2 rolls
- Delta-Cast® Conformable 10cm or 12.5cm x 3 rolls
- Tensoplast® Sport cast edge tape 3cm




### Padding

1 Apply stockinette first. Then place a 7.5cm wide strip of 5mm thick adhesive felt around the leg, 3cm above the malleoli. The patella and head of fibula may require extra padding. Pad the proximal end of the cast with the 2mm adhesive felt if required.

2 Apply a covering of undercast padding firmly, smoothly and evenly.

### Application

3 Starting at the distal end of the cast, leave 2.5cm of the adhesive felt showing and apply the casting tape bandage, rolling away from the applicator, covering approximately 50% of the previous turn, progressing up the leg.

4 Do not turn in the top stockinette until the cast is set, as this is inclined to roll down the casting material. Start again with a single layer of casting material going up the leg, creating 3 layers over muscles but 50% coverage over the knee, to give 4-5 layers around the joint.

5 Before initial setting takes place the cast should be moulded well with the palms of the hands on the medial and lateral sides of the thigh, just above the femoral conclyles.


# 3.4 Casts of the Lower Limb

## Above Knee or Long Leg Cast

Position the ankle at 90° and the foot in neutral inversion/ eversion (plantigrade). Never attempt to plaster the 2 joints of the leg in one application, as a static position of the whole limb cannot possibly be maintained.

The completed plaster should extend from as high up on the thigh as is conducive to comfort and down to the toes.

### Equipment Required

Basic trolley, see page 28 - plus either of the following options:

**Plaster of Paris**

- Stockinette 7.5cm for below knee if used
- Stockinette 10cm or 15cm for thigh if used
- Soffban® padding 15cm x 4 rolls
- Gypsona® plaster of Paris bandages 15cm x 10 rolls
- Strips of plaster to finish
- Knee rest
- Patient trolley

### Padding

1 First apply the stockinette only if swelling is unlikely. Apply a covering of undercast padding firmly, smoothly and evenly, using a double layer at the area of the join and over the patella.

### Application

2 Provided the injury is mid or lower half of tibia apply the first half as for a below knee cast, but keeping it 5cm lower at the knee.

3 When that part has set, the cast is then completed with the knee in 15-20º flexion.

4 If the injury is elsewhere then apply as for a cylinder cast, but not taking it quite as low towards the ankle, and then complete, with the foot in the desired position.

5 Finally, to ensure that the two parts of the cast bond well together, 1 or 2 bandages should be applied down the whole length to include both joints.









# 3.4 Casts of the Lower Limb

**Synthetic**

- Stockinette 7.5cm for below knee
- Stockinette 10cm or 15cm for thigh
- Adhesive felt 2mm thick
- Soffban® Synthetic padding 15cm x 4 rolls
- Delta-Cast® Conformable 10cm x 3 rolls
- Delta-Cast® Conformable 12.5cm x 1 roll)
- Tensoplast® Sport cast edge tape 3cm
- Knee rest
- Patient trolley

### Padding

1 First apply the stockinette in 2 pieces overlapping below the knee. A circle of 2mm felt can be used at the proximal edge and at the area of the join. Pad the malleoli as necessary.

Apply a covering of undercast padding firmly, smoothly and evenly, using a double layer at the area of the join and over the patella.

### Application

2 Provided the injury is mid or lower half of tibia apply 2 x 10cm casting bandages as for the below knee, but keeping it 5cm lower at the knee.

3 When that part has set the cast is then completed with the knee in 15-20º flexion.

4 Apply the upper section padding, using the 12.5cm and remaining 10cm casting bandage to complete the upper part.

5 Continue down well over the area of the join to ensure union of the two parts. If the injury is elsewhere then apply as for a cylinder cast but not taking it quite as low towards the ankle and then complete, with the foot in the desired position.

6 Completed cast.






# 3.4 Casts of the Lower Limb

## Broomstick Casts

These are bilateral leg cylinders applied with the limb position maintained by means of two wooden or metal bars, plastered into position just below the knee areas, one bar anteriorly and one posteriorly. These bars must run parallel to each other. The position of the limbs is determined by the condition for which the cast is applied, and can be used in any age group (photo1). Often, the hips are abducted and internally rotated and the knees flexed.

Sometimes the bars are adjustable so that the legs may be further abducted if required (photo 2).


1


2



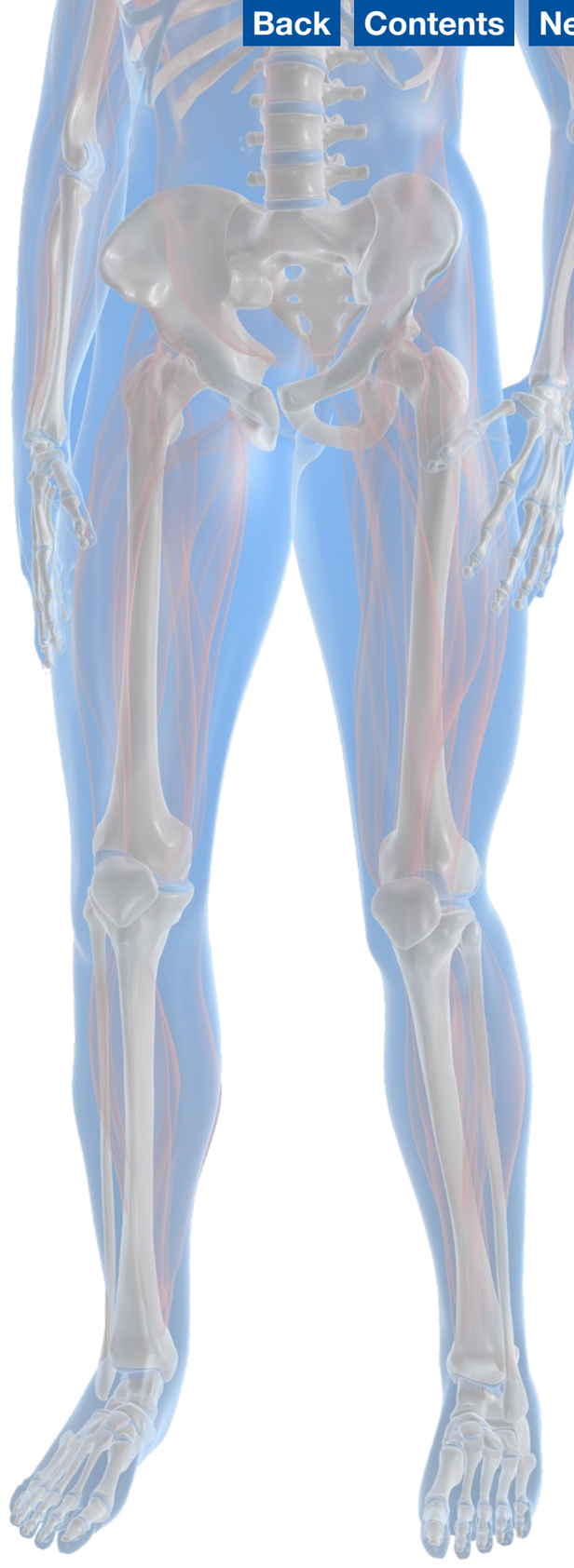


# A Practical Guide to Casting

## Focused Rigidity Casting (FRC)

Contents





Brands suggested for each technique covered are an example of what brands can be used. Other brands are available.

# Focused Rigidity Casting (FRC)

**Before applying any FRC cast, you must have a good understanding of anatomy, physiology and the injury, to determine where the cast should be rigid and where it can safely be flexible. You should practice this technique before undertaking it on a patient and discuss its use with the Orthopaedic Surgeon.**

Focused Rigidity Casting (FRC) was developed by Axel A Wierzimok.

These casts are constructed using only polyester cast materials and vary in the number of layers. The polyester material used must be flexible enough. 2 or 3 layers allow the cast to be flexible and by adding layers in the form of slabs or extra turns of the bandage, this area becomes more rigid. The cast is constructed with only those areas stable where the fracture, and/or any joints, require to be rigid. The remainder of the cast is kept flexible by using only 2 or 3 layers of material.

The FRC cast can be kept as a complete cast or can be adjustable by cutting through on one side and the join held together with hook and loop straps, or a cohesive bandage.

Axel states on his Mokcast website that:

The philosophy of focused rigidity poses 2 questions of prominence which have to be asked and answered for each patient anew:

- What has to be stabilised to support the fracture healing process?
- What can stay flexible to minimise the consequences of the immobilisation?

http://www.mokcast.com/index_e.html

Anne Petty & Chris Wardman undertook the first research on FRC in the UK in 1998.

Anne C Petty RGN, RIM, PTechCert., Sister, Casting and Appliances. Chris Wardman RGN, PD DipHe, PTechCert., Staff Nurse, Bradford Hospitals NHS Trust, Bradford BD9 6RJ

## Further Reading:

COHEN, A.P. & SHAW, D.L., 2001, Focused Rigidity Casting: a prospective randomised study, J R Coll Surg Edinb, 46 (5), pp.265-270

KHANDUJA V., LIM C.B., VEMULAPALLI K.K., LEE C.M., BANAN H., 2006. Detachable functional focused rigidity cast for metatarsal fractures, British Journal of Nursing, 15(5) pp.282-284 PubMed [citation] PM ID: 16607259

LARGE, P., 2001. A 'new focus' in casting – an introduction to the concepts of focus rigidity casting, Journal of Orthopaedic Nursing, 5 (4), pp.176

LEVY, J., EMAT, SONG, D., COOK, J., JUDD, D. & SHAHA, S., 2015. Outcomes of Long-arm casting versus double-Sugar-Tong splinting of acute, pediatric distal forearm fractures, Journal of Pediatric Orthopaedics, 35(1) pp.11-17

MUSHI, P., NEALE, G., & MACLELLAN, G., 2000. Detachable functional forearm focused rigidity cast A 'one-off' definitive for stable forearm greenstick fractures, Injury, 31 (4), pp.239-242

PETTY, A. & WARDMAN, C., 2011. Focused Rigidity Casting (FRC) part 1, Orthopaedic & Trauma Times, no. 14 pp.13-16

PETTY, A. & WARDMAN, C., 1998. A randomised controlled comparison of adjustable focus rigidity primary casting technique with standard plaster of Paris/synthetic casting technique in the management of fractures and other injuries, Journal of Orthopaedic Nursing, 2, pp. 95-102

WIERZIMOK, A.A., HOUBEN, F. & WILMAN, H.R., 1996. Definitive primary care of fractures, Dialog, 1, pp.26-28

# 4.1 Below Knee FRC

## Below Knee

The position of the cast will depend on the injury being treated, but is most commonly applied with 90° flexion of the ankle with the foot in neutral inversion/eversion (plantigrade). The knee should be held at an angle of 10-15° with the aid of a padded support (e.g knee rest). This makes it easier to hold and maintain the foot in the correct position. It is very important not to let the ankle move during the application, it is all too easy make ridges around the ankle.

Proximally, the completed cast should extend from just below the knee allowing flexion there.

Distally, it should extend to either the metatarsal heads or to the tips of the toes. Trim as necessary to make sure the toes are free anteriorly.

### Equipment Required

Basic trolley, see page 28 - plus:

- 2mm adhesive felt
- Stockinette 7.5cm, depending on the size of the leg
- Delta® Terry-Net Stockinette 7.5cm
- Delta-Cast® Conformable 7.5cm x 1 roll (have 2 rolls available)
- Delta-Cast® Conformable 10cm x 1 roll (have 2 rolls available)
- Knee rest

### Padding

**1** These casts require 2 layers of stockinette. Protection for cutting should be placed between these 2 layers; protection for bony prominences should be placed on top of the 2nd layer of stockinette. It is preferable for the second layer to be Terry stockinette

Apply 1 layer of 7.5 cm stockinette.

Place a strip of 2mm adhesive felt to protect, where the cast will be cut.

Apply 1 layer of Delta® Terry-Net Stockinette.

**2** Both malleoli must be padded with circles of 2mm adhesive felt. The head of the fibula and any other bony areas should be assessed and padded with felt, as necessary.

### Application

**3** Measure a 3 layer ,10cm Slab from the metatarsal heads to 5cm below the edge of the cast at the knee. Taper the proximal ends to prevent a ridge in the cast.

Measure a 2 layer 7.5cm U-stirrup from the midcalf on the medial side, down under the heel; and up to midcalf on the lateral side.

Pre-cut the slabs quickly from the polyester material rolls.

**4** Apply the 10cm slab and commence bandaging with the remainder of the 10cm bandage, from the proximal end, with a 50/50 overlap, for 2 turns.

**5** Before you reach the mid-calf area halt and apply the 7.5cm U stirrup, and then continue the 10cm roll down the leg.

**6** Finish the 10cm roll behind the ankle and avoid going over the flexor surface with excess material.

**7** Take the rest of the 7.5cm roll and apply with a 50/50 overlap starting behind the ankle, being very careful not to exceed the correct layers over the flexor surface, as this may make the cast more difficult to remove.

Mould to make the cast fit and have no airgaps. Maintain the position of the ankle and foot throughout until the cast is set. The cast can be left as a full cast.

**8** If the cast is to be adjustable/removable, use a lazy 'S' down the front of the cast.

If appropriate to do so, leave the cast intact around the heads of the metatarsals helps to keep the cast's integrity.

**9** Use hook and loop straps or a cohesive bandage to hold the cast together securely.









# 4.2 Below Elbow FRC

## Below Elbow

The position will depend on the injury and could be applied in slight dorsiflexion and mid ulnar/radial deviation of the wrist. For a true Colles fracture, it will usually be in slight palmar flexion and ulnar deviation of the wrist.

Proximally, the completed cast should extend from just below the elbow to allow full flexion there.

Distally, the palmar crease should be fully visible to allow full flexion of the metacarpophalangeal joints, and dorsally the cast should extend to the top of the knuckles of the hand. Trim around the thumb for comfort as the thumb should be completely free.

### Equipment Required

Basic trolley, see page 28 - plus:

- Elbow rest
- Stockinette 5cm or 7.5cm
- Delta® Terry-Net Stockinette 5cm or 7.5cm
- Adhesive felt 2mm thick
- Delta-Cast® Conformable 5cm or 7.5cm x 1 roll (have 2 rolls available)


### Padding

1 These casts require 2 layers of stockinette, with protection for cutting placed between these 2 layers, i.e. a strip of 2mm adhesive felt.

2 Protection for bony prominences should be placed on top of the 2nd layer of stockinette (preferably Delta® Terry-Net).

### Application

3 The position of the slab will depend on the nature of the injury.

Commence by applying a 2 layer slab, cut from the roll of polyester material, and place over the area of the cast that needs the rigidity (usually the injury site and/or joint).

4 Complete the cast with a careful 50/50 coverage, creating 2 layers.

5 Commence at the proximal end, rolling from within out so that the bandage is brought up through the grip, thereby spreading the heads of the metacarpals.

6 Pass through the grip twice and cut off any excess bandage. The cast can be left as a full cast.

**7 If the cast is to be adjustable/removable, the split should be as far away from the injury as possible. If it is suitable to split to the thumb hole only then do so.**

**8 & 9** Create a tongue of thin felt and insert into the split, then line the other cast edges where/if required.

10 Use hook and loop straps, or a cohesive bandage, to hold the cast together securely.










# 4.3 Cylinder FRC

## Cylinder

The knee is usually held in about 5°-10° flexion for comfort. If the patella is fractured or there is damage/repair to the extensor mechanism, the knee is held in extension. Support the limb fully throughout the application. Hold the foot against the chest and use the hands to support the knee.

Proximally, the cast should extend from as high up towards the groin as possible, allowing for comfort.

Distally, it should be extended down to 3cm above the malleoli (see below).

### Equipment Required

Basic trolley, see page 28 - plus:

- Stockinette 10cm
- Delta® Terry-Net Stockinette 10cm
- Adhesive felt 5mm
- Adhesive felt 2mm
- Delta-Cast® Conformable 10cm or 12.5 cm x 3 rolls

### Padding

1 These casts require 2 layers of stockinette. Protection for cutting should be placed between these 2 layers; protection for bony prominences should be placed on top of the 2nd layer of stockinette (preferably Delta® Terry-Net).

2 Place a strip 2mm adhesive felt between the layers to protect, where the cast will be cut.

A 7.5cm strip of 5mm adhesive felt should be placed around the leg, 3cm above the malleoli. A circle of 2mm adhesive felt will be needed to protect the patella and, if required, the head of fibula.

### Application

Measure for the 12.5cm slab (10cm if small leg/child) from the middle of the distal adhesive felt to two thirds of the way up the thigh posteriorly.

Pre-cut the 2 layer, 12.5cm slab quickly from the rolls of polyester material.

3 Apply a single layer of polyester material distally to proximally.

4 Then position the posterior slab and commence bandaging the second layer, with edge to edge coverage from the distal end.

5 Change to 50/50 coverage from mid-calf to mid-thigh, for extra support of the knee joint.

6 Return to single layer coverage once past this point.

7 Mould medially and laterally above the femoral condyles, to help prevent the cast from slipping. Laminate to eliminate air gaps. Maintain the position of the knee throughout until the cast is set. The cast can be left as a full cast.

**8 If the cast is to be adjustable/removable, cut through all layers using a lazy 'S'; avoid cutting over the patella.**

**9 If the cast is to be split, use hook and loop straps, or a cohesive bandage, to hold it together securely.**









# 4.4 Sugar Tong FRC

## Sugar Tong

The position is usually with the elbow at 90° of flexion, mid pronation-supination of the forearm and no deviation of the wrist.

Proximally, the completed cast should extend from just above the epicondyles of the humerus posteriorly and covering the superior radio-ulnar joint anteriorly, whilst still allowing some flexion of the elbow (see below).

Distally, the palmar crease should be fully visible to allow full flexion of the metacarpophalangeal joints and dorsally, the cast should extend to the top of the knuckles of the hand. Trim around the thumb for comfort, as the thumb should be completely free.

### Equipment Required

Basic trolley see page 28 - plus:

- Stockinette 5cm or 7.5cm
- Stockinette or Delta® Terry-net Stockinette 5cm or 7.5cm
- Adhesive felt 2mm thick
- Delta-Cast® Conformable 7.5cm or 10cm x 1 roll (have 2 rolls available)
- Cast edge liner

### Padding

1 These casts require 2 layers of stockinette. Protection for cutting should be placed between these 2 layers, i.e a strip of 2mm adhesive felt.

2 Protection for bony prominences should be placed on top of the 2nd layer of stockinette, (Terry towelling stockinette should only be used if it very close fitting around the epicondyles of the humerus, otherwise opt for a 2nd layer of stockinette). 2mm adhesive felt is placed around the elbow posteriorly, covering both the medial and lateral epicondyles of the humerus and the olecranon process of the ulna. Place another strip of 2mm adhesive felt across the flexor surface of the elbow, and as usual, a circle on the ulna styloid.

### Application

3 Quickly prepare and cut a 2 layer slab of the polyester material, reaching from just proximal to the palmar crease to cover the epicondyles of the humerus. The slab will need to be fanned out at the proximal end to achieve this.

4 Commence by applying this 2 layer slab, along the ulna side of the forearm (as described above). Using the remainder of the casting bandage, create a further 2 layer slab and apply it posteriorly from the lateral epicondyle to the medial epicondyle, taking a further turn of the bandage around the distal humerus to ensure the slab is firmly held.

5 Complete the cast with a careful 50/50 coverage, rolling from within out, creating 2 layers.

6 The bandage is brought up through the grip, thereby spreading the heads of the metacarpals. Pass through the grip twice and cut off any excess bandage.

7 **It is essential to do a firm interosseous mould, as well as moulding into the palm and around the distal humerus, above the epicondyles. These are key to preventing supination and pronation of the forearm within the cast and must be held until the cast material has completely set. These moulds, along with the close fitting nature of the cast, are what makes it so efficient at stopping pronation and supination.**

Trim the cast as described above and secure the stockinette.

In the unlikely event of this cast being used as an adjustable/ removable cast, the split should be along the radius from the flexor surface of the elbow to the thumb hole.

Create a tongue of thin felt and insert into the split, then line the other cast edges where/if required.

Use hook and loop straps, or a cohesive bandage, to hold the cast together securely.





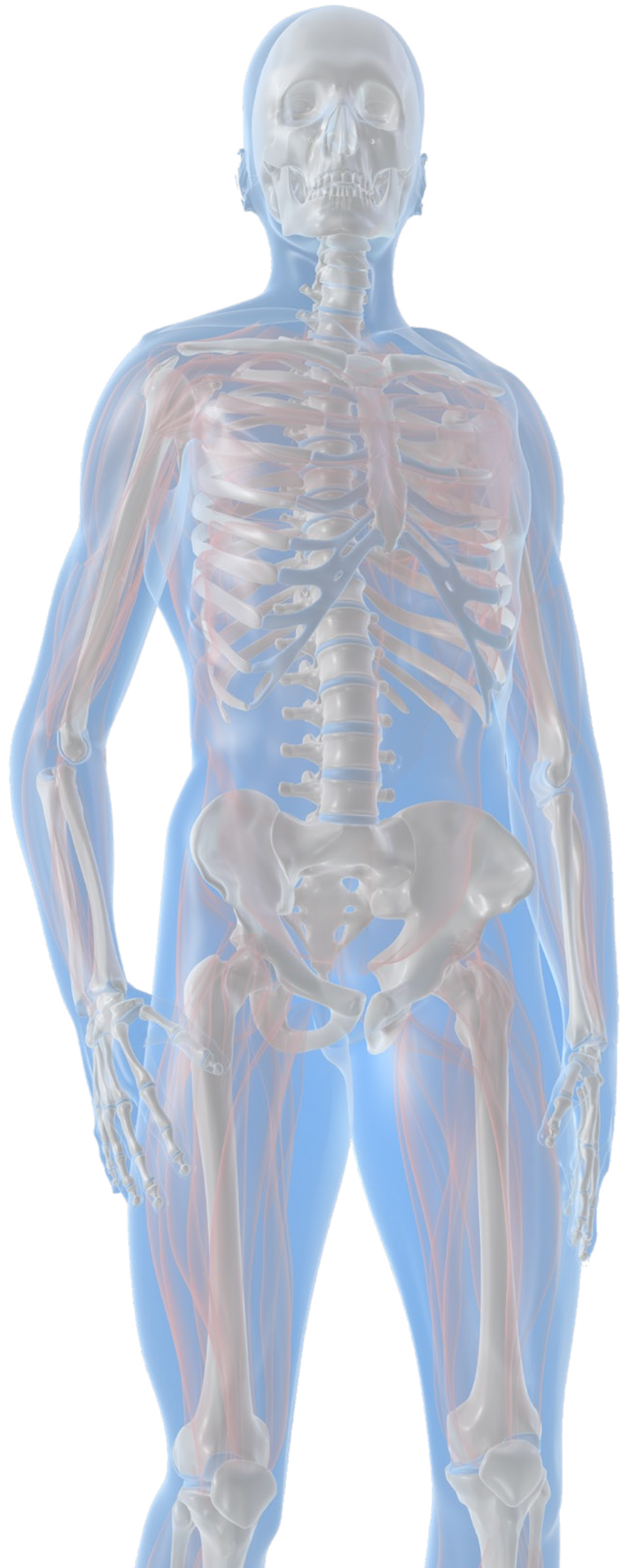


# A Practical Guide to Casting

## Soft Combination Casting

Contents





Brands suggested for each technique covered are an example of what brands can be used. Other brands are available.

# Soft Combination Casting

**Before applying a soft combination cast, you must have a good understanding of anatomy, physiology and the injury, to determine where the cast should be rigid and where it can safely be flexible. You should practice this technique before undertaking it on a patient and discuss its use with the Orthopaedic Surgeon.**

This technique was developed by Jan Schuren, in early nineties, in the Netherlands, using a soft casting product combined with slabs of fibreglass, strategically placed where the cast requires rigidity and offloading. This allows the remainder of the cast to be very flexible. The slabs should create the two points of the 3-point fixation and the remainder of the close fitting cast creates the 3rd. Because the material is softer, the cast can be lined only with stockinette, and any bony areas minimally padded. This results in a close fitting, comfortable cast, which allows some muscle movement, and may reduce muscle atrophy and improve venous return.

The cast saw should **NEVER** be used on these casts. The material should be removed with a pair of bandage scissors, or unwound. There is a great benefit in using this type of cast on children, as removal avoids the use of the cast saw, which for many children is traumatic.

## Further Reading:

KATZ, K., FOGELMAN, R., ATTIAS, J., BARON, E. & SOUDRY, M., 2000. Anxiety reaction in children during removal of their plaster cast with a saw, Journal of Bone & Joint Surgery – British, vol.83-B, no. 3, pp.388-390

KHAN, K.S., GRUFFERTY, A., GALLAGHER, O., MOORE, D.P., FOGARTY, E. & DOWLING, F., 2007. A randomised trial of 'soft cast' for distal radius buckle fractures in children, Acta Orthopaedica Belgica,73(5), pp.594-597

PARIKH, S., SHARMA, N., ADJEI, M., PATEL, A. & SYMONS, S., 2016. Paediatric distal radius (buckle) fractures – improving compliance to the 'soft cast' guideline, British Journal of Surgery, 103, Suppl 6, pp.14-14

SILVA, M., SADIK, G., AVOIAN, T. & EBRAMZADEH, E., 2016. A Removable Long-arm Soft Cast to Treat Nondisplaced Pediatric Elbow Fractures: A Randomized, Controlled Trial

WHITE, R., SCHUREN, J. & KONN, D.R., 2003. Semi-rigid vs rigid glass fibre casting: a biomechanical assessment, Clinical Biomechanics, 18, pp. 19–27

# 5.1 Below Knee Soft Combination Cast

## Below Knee

The position of the cast will depend on the injury being treated, but is most commonly applied at 90° flexion of the ankle, with the foot in neutral inversion/eversion (plantigrade). The knee should be held at an angle of 10-15° with the aid of a padded support (e.g. knee rest). This makes it easier to hold and maintain the foot in the correct position. It is very important not to let the ankle move during the application; it is all too easy make ridges around the ankle.

The cast should extend from just below the knee, but allowing free movement of the knee joint, to the toes (see below).

**Special Points**

This cast, with a U stirrup of fibreglass, will only support an ankle injury. If the foot requires offloading, a second fibreglass slab should extend from the metatarsal heads/tips of toes to either the heel or just above the Achilles tendon.

If the cast is to be waterproof/water repellent polyester stockinette must be used, and the only padding should be Delta-Dry® if/where needed. Normal felt can be used in a non-waterproof cast.

## Equipment Required

Basic trolley, see page 28 - plus:

- Stockinette 7.5cm
- Adhesive felt 2mm thick
- Delta-Cast® Soft 10cm x 2 rolls
- Delta-Lite® Plus 7.5cm x 1 roll for the splint
- Knee rest

## Padding

1 These casts require 2 layers of stockinette.

2 Protection for cutting should be placed between these 2 layers; protection for bony prominences should be placed on top of the 2nd layer of stockinette.

Both malleoli and the head of fibula may require circles of adhesive felt or water-resistant alternative.

## Application

When combining types of casting material use products from the same manufacturer.

Measure the slab. The position of the slab should be a U stirrup of 7.5cm fibreglass (if a large adult this might be 10cm wide). It should reach from at least 20cm proximally above the lateral malleoli, down around the heel, and up to at least 20cm proximally above the medial malleoli.

Pre-cut the 4 layer slab quickly from the fibreglass material and place aside. The number of layers in the slab may be increased if needed; this will be dependent on assessment of the patient.

3 Apply a 50/50 overlap of Delta-Cast® Soft casting material, creating 2 layers. Then place the pre-cut 4 layer slab, ensuring it is positioned to cover the heel strike area.

4 Follow this with other 50/50 overlap of the Delta-Cast® Soft casting material. Commence both bandages at the proximal end, and roll from lateral to medial, to prevent tension and to encourage the foot not to invert.

Mould the arches of the foot and around the Achilles tendon, and hold until the cast material is set, laminating throughout to smooth the cast and avoid any air gaps between the layers. The cast can be left as a full cast.

5 **If the cast is to be adjustable/removable, the split should be done where the removal strip has been placed, which may alter according to the injury and/ or slab positions. If it is appropriate to do so, leaving the cast intact over the metatarsal heads will help maintain the cast's integrity.**

If the cast is to be adjustable/removable, cut through all layers using a lazy 'S' with scissors.

Use hook and loop straps or a cohesive bandage, to hold the cast together securely.

6 If the cast is being removed it may be easier to unwind the top layer, then cut with scissors.

The cast saw should never be used on any soft material.






# 5.2 Below Elbow Soft Combination Cast

## Below Elbow

The position of the cast will depend on the injury and could be applied in slight dorsiflexion and neutral ulna/radial deviation of the wrist. For a true Colles fracture it will usually be applied in slight palmar flexion and ulna deviation of the wrist. The position of the wrist may affect where the best position for the slab is.

Proximally, the completed cast should extend from just below the elbow to allow full flexion there.

Distally, the palmar crease should be fully visible to allow full flexion of the metacarpophalangeal joints and dorsally, the cast should extend to the top of the knuckles. Trim around the thumb for comfort, as the thumb should be completely free.

**Special Points**

If the cast is to be waterproof/water repellent, polyester stockinette (e.g. Delta-Dry®) must be used, and where padding is needed it must be waterproof.

## Equipment Required

Basic trolley, see page 28 - plus:

- Stockinette 5cm or 7.5cm
- Adhesive felt 2mm thick (or waterproof alternative)
- Delta-Cast® Soft 5cm or 7.5cm x1 have a spare roll available
- Delta-Lite® Plus 5cm or 7.5cm x 1 for the ridged splint
- Elbow rest


## Padding

1 These casts require 2 layers of stockinette. Protection for cutting should be placed between these 2 layers, away from where the splint will be placed. Protection for bony prominences should be placed on top of the 2nd layer of stockinette.

## Application

**The positioning of the slab will depend on the injury.**

When combining types of cast material use products from the same manufacturer.

Measure the slab and pre-cut a 3 layer slab quickly from the fibreglass material, and place aside. The number of layers in the slab may be increased if needed; this will be dependent on assessment of the patient.

2 Apply a 50/50 overlap layer of soft casting material, creating 2 layers.

3 Then position the pre-cut, 3 layer, fibreglass slab, ensuring that in does not reach the edges of the cast, as these should be kept soft.

4 Follow this by another 50/50 overlap of the soft casting material.

Commence both bandages at the proximal end, rolling from within out so that the bandage is brought up through the grip, thereby spreading the heads of the metacarpals. Pass through the grip 3 times in total. Cut of any excess bandage.

5 Mould into the palm and hold until the cast material is set, laminating throughout to smooth the cast and avoid any air gaps between the layers. The cast can be left as a full cast.

**If the cast is to be adjustable/removable, the split should be as far away from the injury as possible. If it is suitable to split to the thumb hole only then do so.**

Use hook and loop straps, or cohesive bandage, to hold the cast together securely.





# 5.3 Cylinder Soft Combintion Cast

## Cylinder

The knee is usually held in about 5°-10° flexion for comfort. If the patella is fractured, or there is damage/repair to the extensor mechanism, the knee is held in extension. Support the limb fully throughout the application. Hold the foot against the chest and use the hands to support the knee.

Proximally, the cast should extend from as high up towards the groin as possible, allowing for comfort.

Distally, the cast should extend down to 3cm above the malleoli (see below).

**Special Points**

If the cast is to be waterproof/water repellent, polyester stockinette (e.g. Delta-Dry®) must be used, and where padding is needed it must be waterproof.

## Equipment Required

Basic trolley, see page 26 - plus:

- Stockinette 10cm (polyester)
- Thick adhesive felt 2mm & 5mm
- Delta-Cast® Soft10cm or 12.5cm x 3 or 4 rolls
- Delta-Lite® Plus 10cm or 12.5cm x 1 or 2 rolls (for the splint)


## Padding

1 These casts require 2 layers of stockinette. Protection for cutting should be placed between these 2 layers; protection for bony prominences should be placed on top of the 2nd layer of stockinette.

A 7.5cm strip of 5mm adhesive felt should be placed 3cm above the malleoli. A circle of adhesive felt may be needed to protect the patella and/or the head of fibula. A water-resistant padding alternative can be used.

## Application

When combining types of cast material use products from the same manufacturer.

The position of the 2 fibreglass slabs should be down the medial and lateral sides, from mid-calf to mid-thigh.

Measure and pre-cut the 4 layer slabs quickly from the 10cm or 12.5cm fibreglass material and place aside. The number of layers in the slab may be increased if needed, this will be dependent on assessment of the patient.

2 Apply a 50/50 overlap of soft casting material, creating 2 layers. Commence at the distal end of the cast, leaving 2.5cm of the felt showing, and rolling from lateral to medial to prevent tension.

3 Then position the two pre-cut 4 layer fibreglass slabs, followed by another 50/50 overlap of soft material.

4 Before initial setting takes place, the cast should be moulded well with the palms of the hands on the medial and lateral sides of the thigh, above the femoral condyles.

This helps to prevent the cast from slipping down the leg. Laminate to smooth the inside of the cast and avoid any air gaps. Maintain the position of the knee throughout until the cast is set. The cast can be left as a full cast.

5 **If the cast is to be adjustable/removable, cut through all layers with scissors using a lazy 'S'. Avoid cutting over the patella.**

Use hook and loop straps, or a cohesive bandage, to hold it together securely.

If the cast is being removed it may be easier to unwind the top layer, then cut with scissors.

The cast saw should never be used on any soft material.





# A Practical Guide to Casting

## Casting the Trunk

### Contents



Casts most commonly used to treat fractures and orthopaedic conditions of the trunk. Each is discussed in more detail.

- Plaster Jacket
- Plaster Corset
- Minerva Jacket
- Shoulder Spica
- Hip Spica
- Frog Type Cast

Brands suggested for each technique covered are an example of what brands can be used. Other brands are available.

# 6.1 Anatomy of the Trunk

**The trunk, comprising the thoracic cavity, the abdominal cavity and the pelvic cavity, contains most of the vital organs (e.g. the lungs, heart, digestive system), the internal organs of reproduction, and the spinal cord.**

The skeletal framework of the trunk is therefore constructed to:

1. Protect the vital structures
2. Give stability and maintain the upright position
3. Allow flexibility and movement

The skeleton of the trunk consists of the **vertebral column,** which protects the spinal cord; the **rib cage** and **sternum,** which protect the lungs and heart and contribute to the process of respiration; the **shoulder girdle (clavicles and scapulae)**, by which the upper limb is attached to the trunk; the **pelvic girdle** which protects the bladder, rectum and internal sex organs, and also attaches the lower limbs to the trunk.

## The Skeleton of the Trunk




## The Vertebral Column

Thirty three bones form a column, rather like a tower of children's toy bricks. However, the column is capable of moving without falling down. The bones all have the same characteristic/basic structure but each bone has variations, which adapt to its structure, so that no two bones are quite alike.




### Structure of a Vertebra

All vertebrae have a roughly box shaped mass of bone - the **vertebral body**. Piled one on top of the other, the largest towards the base of the spine, these vertebrae give stability and carry the body's weight. Between each lies a cartilagineous **inter-vertebral disc**, which acts as a shock absorber, and allows each vertebrae to move slightly in relation to its neighbours.

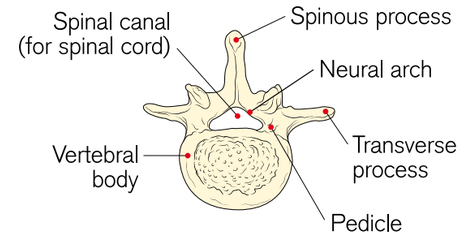
The disc is made up of two parts; an outer ring of white fibro-cartilage called the annulus fibrosus, and an inner, softer, highly elastic structure called the nucleus pulposus. The discs allow for limited movement and act as shock absorbers. They are vulnerable to damage from misuse.

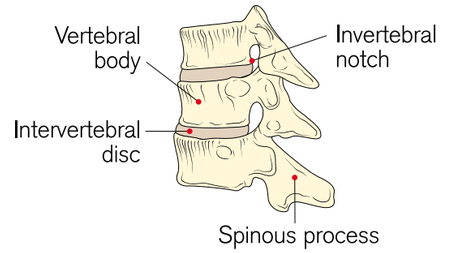
The **neural arch** is attached to the posterior surface of the vertebral body. Situated in a vertical line, they form a tube - the neural canal - which contains and protects the spinal cord and spinal nerve roots.

The spinal nerves originate at the spinal cord and then branch off, passing through the intervertebral notch, one on either side of each vertebrae.



# 6.1 Anatomy of the Trunk




### The Processes and Facets

Attached to each neural arch posteriorly, are the two **transverse processes,** situated to either side, and the **spinous process** which is situated centrally and posteriorly. The spinous process can be felt in the cervical and thoracic regions. Also attached to the neural arch are the **superior and inferior articulating facets**. These form gliding synovial joints between the facets of each vertebrae and those above and below it. The facet joints also contribute to the vertebral column's flexibility.

### Regions of the Vertebral Column

The **cervical region** - the upper seven bones, situated in the neck, and identified as C1 to C7. C1 and C2 are also known as the atlas and the axis respectively; their bodies are adapted to form the pivot joint which allows the head to turn from side to side.

The **thoracic regions** - identified as T1 to T12. The ribs are also attached to these vertebrae at the costovertebral joints.

The **lumbar region** - L1 to L5.

The **sacrum** - S1 to S5 are fused together to form one bone. The neural canal continues through the sacrum, but the processes are very small or non-existent.

The **coccyx** - 4 very rudimentary bones which are fused and tilted forwards, so that they cannot be felt on the surface.

### Curves of the Vertebral Column

When looked at from behind, the vertebral column should appear to be vertical. However, when a person is viewed from the side, you should be able to see that the vertebral column is curved anteriorly or posteriorly in the different regions. The cervical region is convex forwards, the thoracic region convex backwards, the lumbar region convex forwards and the sacrum and coccyx convex backwards.

### Ligaments

Long ligaments which lie along the length of the vertebral column, and short ones which connect the processes of one vertebrae with those of its neighbours, are very important for maintaining the position of the vertebrae. Torn ligaments can allow the intervertebral joints to dislocate, thus allowing the neural canal to become distorted and the spinal cord to become compressed.

### Movements of the Spine

Movements of the spine are:

- Flexion: a forward movement brought about by the rectus abdominis which is attached to the 5$^{th}$, 6$^{th}$ and 7$^{th}$ ribs superiorly and the crest of the pubis inferiorly
- Extension: a backwards movement of the spine is brought about by erector spinae, a complex muscle with many attachments from the occiput superiorly to the iliac crest and sacrum inferiorly
- Lateral flexion, or side flexion, is mainly brought about by the internal and external oblique muscles which are attached to the rib cage posteriorly, and the iliac crest and the fascia or rectus abdominis. Quadratus lumborum is attached to the iliac crest inferiorly and the 12$^{th}$ rib superiorly, and also helps with lateral flexion
- Rotation of the spine is brought about by the combined action of quadratus lumborum and the internal and external oblique muscles

## The Rib Cage (Ribs and Sternum)

The ribs are comprised of 12 pairs of long bones which articulate with the thoracic vertebrae, and which curve around the chest wall. Anteriorly, costal cartilages attach the upper 10 pairs to the sternum. The 11$^{th}$ and 12$^{th}$ ribs are short and articulate only with the lower thoracic vertebrae. They are therefore known as 'floating ribs'.

Sheets of intercostal muscles lie between and attach to each pair of ribs. It is these muscles that bring about the rise and fall of the chest wall with each breath.

### The Sternum

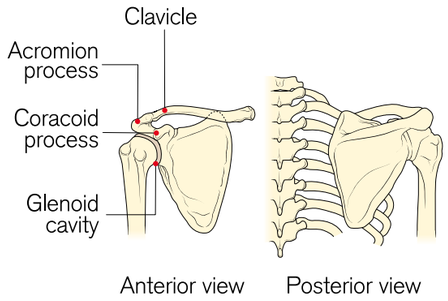
The sternum, or the breast bone, is a flat bone that forms part of the shoulder girdle.

It can be felt under the skin of the chest. The sternal notch of its upper border is easy to see and feel.

# 6.1 Anatomy of the Trunk

## The Shoulder Girdle

The shoulder girdle consists of 2 clavicles and 2 scapulae, as well as the sternum.




### The Clavicles

The clavicles (collar bones) are 2 long bones with S-shaped curves. Easily felt under the skin, they extend from cartilagineous joints with the sternum to synovial gliding joints with the acromion processes of the scapulae.

### The Scapulae

The shoulder blades are 2 triangular flat bones that overlay, but are not attached to, the posterior surface of the rib cage. They can be felt to glide over the rib cage as the shoulder girdle moves.

The upper lateral angle is the glenoid cavity.

A ridge - the spine - lies on the posterior surface. It can be felt to extend from the joint with the clavicle towards the medial border of the scapula.

## The Pelvic Girdle

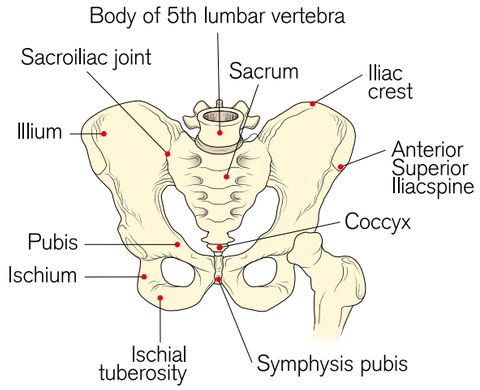
The pelvic girdle is formed of 3 bones - the sacrum and 2 innominate bones. The innominate bones articulate with the sacrum at the sacro-iliac joint - a synovial plane joint. Sacro-iliac strain is a frequent source of back pain. The pelvic girdle protects the bladder, rectum and internal sex organs.

## The Innominate Bones

Each is formed of 3 separate bones in infancy - the ilium, the ischium and the pubis - which fuse to form each innominate bone by adulthood.

Easily identified landmarks are:

- The iliac crest and the anterior superior iliac spine - the bony projections which can be felt on either side of the abdomen
- The ischial tuberosities, which carry the body weight when sitting upright
- The symphysis pubis, where the two pubic bones meet to from the arch of bone at the base of the abdomen




## Muscles of the Trunk

Some have been referred to elsewhere when referring to movements of the limbs.

Other important muscles:

- The sternocleidomastoid is attached to the sternum and clavicle, and extends to the mastoid bone behind the ear, on each side of the neck. It is involved in head turning
- The trapezius is attached to the occiput of the skull and the cervical and thoracic vertebrae. It extends to the spine of the scapulae and lateral part of the clavicle. Involved in pulling the head backwards, and elevating the shoulder girdle. Together the two triangular muscles have a diamond shape, which gives them their name

The erector spinae muscles, which lie on either side of the vertebral column, extend from the sacrum to the back of the skull, and participate in extension of the trunk. Muscles of the abdominal wall flex the trunk forwards.

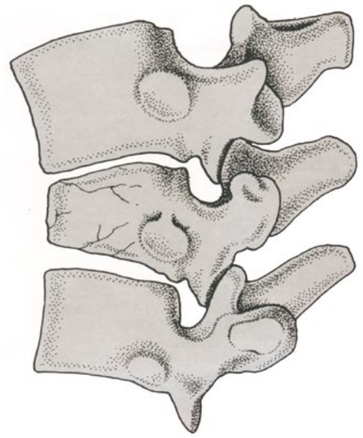


# 6.2 Fractures of the Spine

Patients with acute spinal injury are unlikely to appear in the plaster department until the fracture is well on the way to healing. At this stage the Plaster Room staff may be involved in the application of a jacket to stabilise the area. The level of the fracture dictates the type of jacket applied. For example, in the case of cervical or high thoracic injury, a Minerva jacket, or a plaster vest for a Halo splint may be used.

The main problem with spinal injuries is the risk of damage to nerves or the spinal cord itself. This damage may arise as a result of mishandling the patient. Before any cast is applied we must ensure that there are sufficient staff to assist, who must all be adequately briefed as to their roles. The patient may be able to sit or stand for the application, or there must be adequate support for the patient. In addition, the cast may be applied with the patient lying down and fully supported on a frame. The surgeon ought to take personal responsibility for the positioning of the patient and maintaining of the desired position.

If the patient has altered skin sensation, special care must be taken to prevent skin breakdown under the cast, with adequate padding and fit of the jacket. Sometimes the Plaster Room staff will be asked to manufacture resting splints to maintain the position of paralysed limbs. Special care must be taken to ensure that these splints do not cause skin breakdown.



Crush fracture of the vertebrae

Lateral view of spine showing fracture of the vertebra

# 6.3 Orthopaedic Conditions

## Scoliosis

Scoliosis is a lateral curvature of the vertebral column. The problem can be postural, sciatic or structural. Postural curves can be caused by limb inequality or muscle spasm and will disappear when the patient bends forward. Sciatic curves are secondary to a prolapsed intervertebral disc or maybe spondylolisthesis, and resolve when the condition is treated.

In structural scoliosis there is a curvature of the spine accompanied by a rotational abnormality of the vertebrae. When the patient bends forward the rib hump is accentuated. The causes of structural scoliosis are many. It can be due to, for example, a congenital abnormality of the vertebrae, or to a neuro-muscular imbalance, but most are idiopathic (unknown cause). Idiopathic scoliosis is further described according to age at which it presents either infantile (0-3 years), juvenile (4-10 years) or adolescent (10-maturity).

The disease may affect any part of the vertebral column, though the thoracic and lumber regions are affected more frequently. The first sign is usually a primary curve and then a secondary or compensatory curve develops.

The treatment objectives are firstly to prevent the regression of the curve and, if indicated, to stabilise the spine. Conservative management involves the application of serial casts/jackets, and/or the use of various types of orthoses such as the Boston brace.

Surgical treatment comprises correction of the deformity, usually done at the time of surgery, plus the fusion of the vertebrae by internal fixation. In the post-operative period an orthosis, or occasionally a synthetic jacket, will be needed. The casts applied in the management of scoliosis require a high level of skill on behalf of the Plaster Room staff.


## Low Back Pain

Pain in the lumbar region is probably the most common symptom requiring General Practitioner consultation. It is often referred to as lumbago (pain in the lumbar region) or sciatica (pain along the course and distribution of the sciatic nerve).

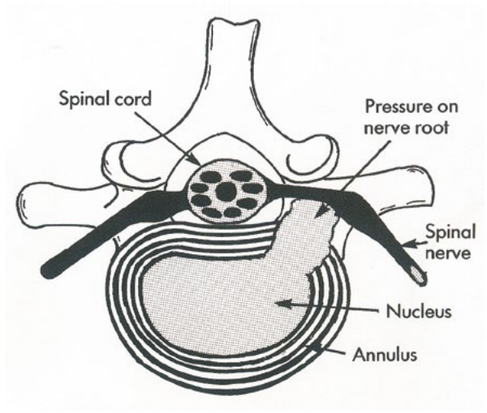
The source of the pain, and hence the cause, can be widespread in the area from the inferior angle of the scapula to the natal cleft.

The origin of the pain can be the bones, muscles, nerves, internal organs and skin.

The treatment usually involves physiotheraphy or sometimes a short period of rest. The patient will usually require analgesia and a muscle relaxant. The patient should commence a series of exercises to strengthen and improve mobility.

The pain may be as a result of a prolapse of an intervertebral disc. The disc is made up of two parts, an outer ring of fibrocartilage called the annulus fibrosus, and an inner, soft mass called the nucleus pulposus. When the disc ‘slips’ the nucleus pulposus herniates through what is probably an already weakened annulus fibrosus.

If the problem does not resolve with rest and support then surgery will need to be considered. This involves the decompression of the nerve root that has been compressed and is thus causing the pain.






# 6.3 Orthopaedic Conditions

## Developmental Dysplasia of the Hip (DDH)

(Previously called Congenital Dislocation of the Hip joint)

A condition in which 1-5 per 1,000 newly born babies have hips that are either dislocated or are dislocatable.

Factors associated with this condition are familial tendency, breech delivery or presence of other congenital abnormalities. Girls are affected more than boys, and a third of these have bilateral hip involvement.

The condition is treatable and you will encounter patients from birth through to early adulthood requiring skilled application of splints.

The earlier that treatment begins the better will be the outcome. The aims of treatment will be to relocate the femur in the acetabulum of the innominate bone and maintain that position for a sufficient time to allow moulding of the acetabulum to take place, and to encourage a normal development of surrounding soft tissues.

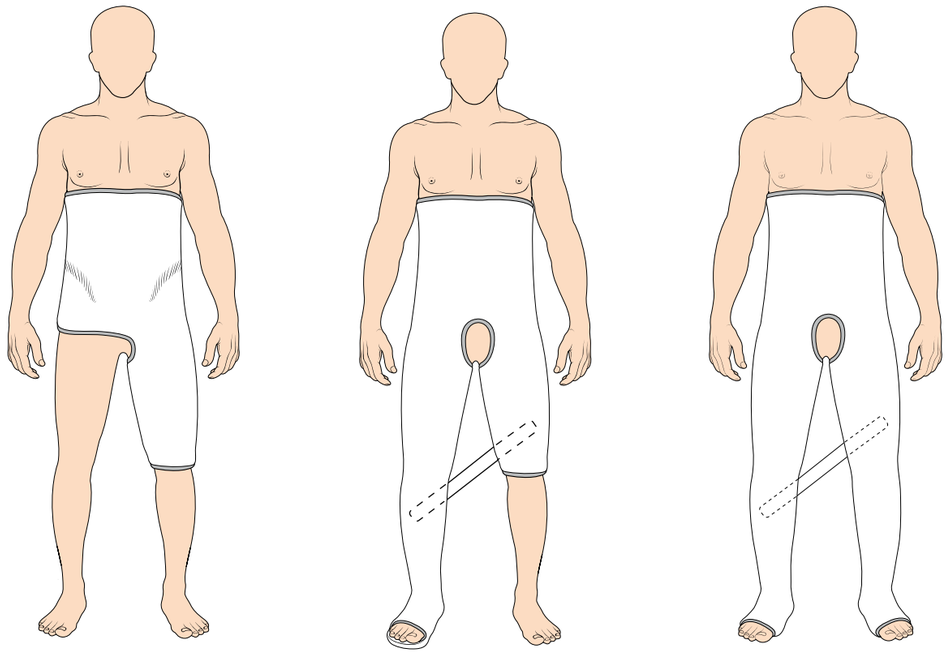
Initially this will require splinting in the reduced position, with the hip flexed to approximately 100-110° and in 40–60° abduction, for approximately three months. Some surgeons prefer the use of one of the abduction harnesses available commercially, such as the Pavlik harness. If the child is older, splinting may be by the use of a 'frog' type cast applied in the humane position.

Cases that fail to respond to early treatment, or those that are diagnosed later in life, may require operative reduction in order to achieve a stable position. An open reduction ,and sometimes a femoral or innominate osteotomy, may be needed. Following surgery, the patient may require the application of a hip spica.

# 6.4 Casts of the Trunk

## Paediatric Hip Spica

**(Single, One and a Half, and Double)**



**Single Hip Spica** **One and a Half Hip Spica** **Double Hip Spica**

These casts can be applied in resin based materials or plaster of Paris only, or in a combination of plaster of Paris covered with resin based materials. Consideration of the absorbent nature of materials used should be made before applying casts post-operatively, particularly as blood loss will not stain through or absorb into resin based materials.

The position will depend on the injury and/or surgeons instructions. It is worth noting that the hips and knees are most comfortable in the slightly flexed position. For one and a half or double hip spicas abduct the good leg to facilitate toileting and nursing care.

### The cast extends from

**Anteriorly** - just below the nipple line to the symphasis pubis.

**Posteriorly** - below the tips of the scapula to the coccyx.

It continues down the legs to the knees, ankles or to include the foot (depending on surgeon's instructions).

### Equipment Required

Hip spica frame, or equivalent, for casts applied with the patient lying supine.

Electric hoist for transfer, if required (please refer to local Handling and Moving policy).

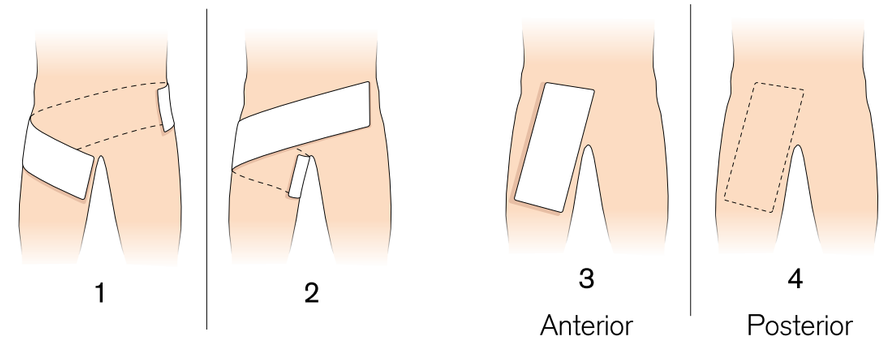


# 6.4 Casts of the Trunk

## Single Hip Spica

These are generally applied with the patient lying on a hip spica table with hip and knees slightly flexed. The hip is abducted according to the medical officer's wishes. Single hip spicas can be applied whilst the patient is standing, if their condition allows.

The cast extends from just below the nipple line to the pubis anteriorly, and from the lower edges of the scapulae to the coccyx posteriorly. It continues down the affected leg only, to end at either the knee, ankle or to the toes.




### Equipment Required

Basic trolley, see page 28 plus:

**Plaster of Paris**

- Stockinette 15cm or 10cm depending on the trunk size
- Stockinette 7.5cm
- Non-adhesive felt 5mm thick
- Adhesive felt 2mm thick
- Gamgee™
- Soffban® Synthetic padding 15 cm x 2 rolls
- Soffban® Synthetic padding 10 cm x 2 rolls
- Gypsona® plaster of Paris bandages 15cm or 10cm depending on size of child
- Gypsona® plaster of Paris Slab 15cm or 10cm depending on size of child
- Soffcrepe® bandage 7.5cm x 1 roll
- Tensoplast® Sport cast edge tape 3cm

### Padding

Stockinette is applied to the body, with armholes cut like a vest. The circle of Gamgee™ is placed over the diaphragm, and non-adhesive felt squares are placed over each iliac crest, and one down the spine over the sacral area. Apply a layer of undercast padding, in a figure-of-8, firmly around the hip and down the leg – beware of the beginner's triangle on the posterior aspect of the hip. Use an extra layer around the supra-condylar area of the femur.

Note: 'Beginners triangle' is the area over the posterior aspect of the hip joint.

### Application

One layer of plaster of Paris bandage is followed by 2 plaster of Paris slabs, each 0.5 metres long by 15cm wide, placed figure-of-eight wise around the hip, (diagrams 1 & 2). Two reinforcing slabs, 30 cm long x 10cm wide, are placed, 1 anteriorly and 1 posteriorly, to the hip joint, (diagrams 3 & 4). A further layer of bandages holds these slabs in place. Mould well over the top of the iliac crests. If the spica is to be a long single hip spica, position the knee, and pad and plaster to the ankle, then position and complete down to the foot.

Remove the Gamgee™ circle to create a space for breathing and eating. Trim the nursing area anteriorly to above the symphysis pubis around the legs, and posteriorly make sure you trim to just above the coccyx. Turn back the stockinette and hold in place with 2 layer strips of plaster of Paris.

# 6.4 Casts of the Trunk

## Synthetic Single Hip Spica

### Equipment Required

Basic trolley see page 28 plus:

- Stockinette 15cm or 10cm depending on the trunk size
- Stockinette 7.5cm
- Non-adhesive felt 5mm thick
- Adhesive felt 2mm thick
- Gamgee™
- Soffban® Synthetic padding 15 cm x 2 rolls
- Soffban® Synthetic padding 10 cm x 2 rolls
- Delta-Cast® Conformable 10cm, 7.5cm and 5cm depending on size of child
- Soffcrepe bandage 7.5cm x 1 roll
- Tensoplast® Sport cast edge tape 3cm

### Padding

Stockinette is applied to the body, with armholes cut like a vest. The circle of Gamgee™ is placed over the diaphragm, and non-adhesive felt squares are placed over each iliac crest, and one down the spine over the sacral area. Apply a layer of undercast padding around the body and in a figure-of-eight around the hip, and down the leg. Beware of the beginner's triangle on the posterior aspect of the hip. Use an extra layer of padding or 2mm adhesive felt around the supra-condylar area of the femur, to protect the skin at the join. It can be helpful to place a layer of thin felt on the medial aspect of the proximal thigh. This is an area where synthetic casting materials may end up being pulled tight.

### Application

Apply the casting bandages round the body and in a figure-of-eight around the hip, and down the leg to the knee. It is useful to cut 2 slabs of 10cm wide x 20cm long, 3 layer cast material and apply as the slabs in diagrams 3 & 4 on page 111.

Sandwich the slab between the layers of casting material. This slab will strengthen the beginner's triangle at the back of the hip. Continue down the legs as required. Finally take a bandage over the joins and up and around the hip area. To bond the layers well, apply a pre-wet and squeezed out crepe bandage firmly for a 2-3 minutes.

Remove the Gamgee™ circle to create a space for breathing and eating. Trim the nursing area anteriorly to above the symphysis pubis around the legs, and posteriorly make sure you trim to just above the coccyx. Turn back the stockinette and hold in place with stretchy, adhesive tape.

## One and a Half or Double Spica

For a one and a half or a double spica the patient is positioned on the hip spica table as before, and the unaffected hip abducted to facilitate toilet care.

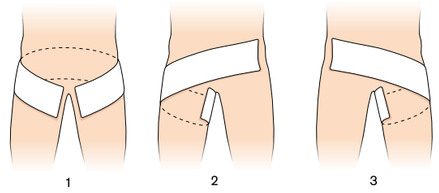
### Padding

Pad as a single spica, continuing the undercast padding down both legs.

### Plaster of Paris

Apply the bandages as for a single hip spica but using a figure-of-eight technique around both hips.

The three plaster of Paris slabs required are slightly different - one slab being taken across the sacral area and anteriorly over both hips, (diagram 1 below). The 2nd and 3rd slabs are reversed, across the pubic area and round each hip, forming a figure-of-eight round the hips, (diagrams 2 & 3 below). Great care must be taken to ensure that the cast is strong over the beginners triangle.



1 2 3

### Synthetic

Apply the bandages, starting at the base of the sternum thus incorporating the lower ribs, using a 50/50 coverage over the body, then a figure-of-eight pattern around the body and the hips, extending down to the knee. Then cut 2 slabs of 7.5 cm wide material x 2 layers, to extend from mid-thigh to mid-sacrum on the posterior aspect. These should cover and reinforce the beginner's triangle to prevent weakness in that area. Sandwich the slabs between the layers by applying another figure-of-eight bandage over the top.

The cast must be moulded just above the iliac crests.

Once the hips are secure, apply a strip of 5mm felt, approximately 3cms wide, above the malleolus on the affected leg. Starting at the join above the knee, continue the material down the affected leg, to the middle of the felt above the malleolus. With the final bandage, lock the bandage, from the bottom of the affected leg, up and around the hips and body, with a single turn.

A wet crepe bandage can be applied temporarily to help bond the layers.

Remove the Gamgee™.

Apply 2mm felt to the edges of the cast around the top and the unaffected leg.

Trim the nursing area anteriorly to above the symphysis pubis, around the legs and posteriorly make sure you trim to just above the coccyx. Trim the wool so it is flush with the edge of the cast, hold all stockinette down firmly.



# 6.4 Casts of the Trunk

Pictures for the application of a one and a half synthetic hip spica are on page 115, showing use of the Delta-Dry® Pantaloons.

A metal bar, or strut made of twisted casting material, should be placed between the legs of one and a half or double hip spicas, and plastered on to the outside of the cast once it has set. Pads of plaster of Paris should be positioned under and over the bar ends before plastering into position. This bar adds strength to the cast and facilitates moving the patient, but must not be used for such until the cast has finally set.

### Care

All patients who have large body casts applied must, of course, receive full cast instructions prior to return home. Comprehensive guidance on coping with daily living whilst in such casts must also be given, and additional information for parents.

### Nappies

Use a smaller size nappy, with a nappy liner if possible, tucked inside the nursing area of the cast. Cover with a second larger size nappy applied over the cast. The inside nappy needs to be changed more frequently than normal to prevent the cast from becoming soiled.

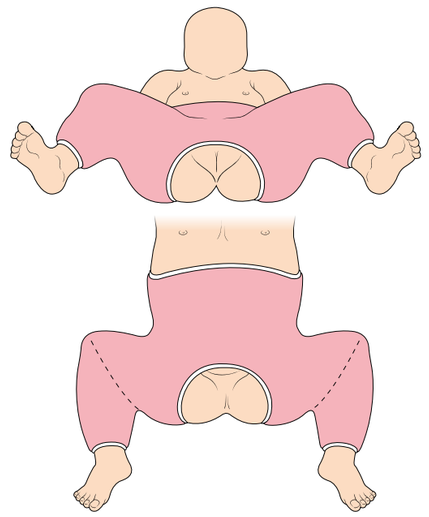
### Toileting

Whilst on a bedpan the upper part of the child should be raised on pillows to keep it higher than the legs to prevent soiling the cast.

### Skin Care

Do not wet the cast but daily, wash all the skin you can reach and dry well. Check the skin at the edges and under the cast for redness. Contact the doctor if there are any problems.

Beginners Triangle:- this is the area over the posterior aspect of the hips missed when applying these casts.



## 'Frog' Type Cast in the Humane Position

### Equipment Required

Basic trolley, see page 28 plus:

- Stockinette 10cm
- Stockinette 5cm or 7.5cm
- Non-adhesive felt 5mm thick
- Soffban® Synthetic padding 10cm x 3-5 rolls
- Gypsona® plaster of Paris bandages 10cm x 4 rolls, plus 4 if to include below the knee
- Delta-Cast® Conformable 5cm x 2, 7.5cm x 1 rolls, plus 2 if to include below the knee
- Tensoplast® Sport cast edge tape 3cm
- Small hip spica table

### Padding

Apply 10cm stockinette to the body, cutting laterally at the hips, and 5cm or 7.5cm stockinette for the legs.

It is essential that the medical officer positions the legs for this cast. With the anaesthetised child on a small hip spica frame and the medical officer holding the legs in the humane position, place a non-adhesive felt pad to the sacral area and small felt strips to the flexed area of the hips. Apply a firm layer of undercast padding.

### Application

Apply 4 rolls of 10cm plaster of Paris bandages around the body and the thighs, and in a figure-of-eight across the hips. Make sure to check at the back as it is easy to miss the corners of the sacral area. It must then be moulded well, helping it to laminate. Once the bandages have initially set apply the synthetic cast tape bandages to strengthen the cast, using the same technique as the plaster of Paris bandages. Check the cover behind the hips again. Conform using a wet crepe bandage; remove as soon as the casting material has set.

The cast extends from just below the nipple line and can finish either above the knees, or is taken down to the ankle.

If the legs are to be included, place strips of felt around the legs 2.5cm above the malleoli and pad below the knee. Extend the cast down to the ankle, taking care around the flexor surfaces of the knees.

Trim the nursing area anteriorly to above the symphysis pubis around the legs, and posteriorly to just above the coccyx.

Use 2mm adhesive felt to line the edges of the cast as necessary and turn back the stockinette. Hold in place with the 3cm cast edge tape.

As well as the usual cast instructions, parents/guardians need full explanation of the extra care required. Use a smaller size nappy, with a nappy liner if possible, tucked inside the nursing area of the cast. Cover with a second larger size nappy applied over the cast. The inside nappy needs to be changed more frequently than normal to prevent the cast becoming soiled. See page 115.

# 6.4 Casts of the Trunk

## Use of Waterproof Delta-Dry® Pantaloons for a Paediatric Hip Spica

Before choosing to use this product (or informing the parents/carers about the cast being waterproof), ensure that the surgeon is fully aware of the product and how to use it, and has agreed to the use prior to application.

### Equipment Required

Basic trolley, see page 28 plus:

- Delta-Dry® Pantaloon in appropriate size for child
- Gamgee™
- 2 x 7.5cm Delta-Cast®
- 1 x 5cm Delta-Cast®
- Water permeable tape
- Hip spica table
- Roll of Delta-Dry® for extra padding areas if needed (most cases it will not be required)


Great care must be taken when applying the Delta-Dry® Pantaloons, as the legs must be brought together to fit through the body section. Folding the body section down reduces the need to pull on the product to get it over the body.

The legs must be put into the leg sections, which can be made easier by putting your hand up through the leg section of the pantaloons and holding the leg of the child securely, before pulling the pantaloons on. Again ensure this is safe to do so with the surgeon before commencing.

Do not apply any felt as this will stop the cast being able to get wet. If extra padding is needed, cut a section of Delta-Dry® from a roll and place where needed. This will not be necessary in most circumstances.

**1** Place a piece of Gamgee™ under the pantaloons, against the skin over the stomach and diaphragm area. This must be removed once the cast is finished to allow room for feeding.

After trimming the nursing area, you must ensure that the tape used to hold the edges of the Delta-Dry® Pantaloon back is water permeable, so it will not compromise the cast in any way. There are several tapes available which will allow this, or alternatively, use some resin material but ensure this does not make the cast too bulky and occlusive or impinge on the baby's skin. Fully waterproof tapes are not advisable as they may cause mould to occur in the cast.

Position the child on the hip spica table safely and securely, ensuring that the table rest is between the pantaloon and the skin.

## Application of Synthetic Material

**2 - 6** Apply the bandages, starting at the base of the sternum thus incorporating the lower ribs, using a 50/50 coverage over the body, then a figure-of-eight pattern around the body and the hips extending down to the knees.

**7 - 10** Turn in the trimmed top edge if suitable, then cut 2 slabs of 7.5cm wide material x 2 layers, to extend from mid-thigh to mid-sacrum on the posterior aspect.

These should cover and reinforce the beginner's triangle to prevent weakness in that area. Sandwich the slabs between the layers by applying another figure of eight bandage over the top.

**11 & 12** The cast must be moulded just above the iliac crests.

**13** Once the hips are secure, trim the pantaloon on the affected leg.

**14** Starting at the join above the knee continue the material down the affected leg, to just above the malleolus.

**15** With the final bandage lock the bandage, from the bottom of the affected leg, up and around the hips and body with a single turn, catching the trimmed pantaloon on the other leg.

(A wet crepe bandage can be applied temporarily to help bond the layers).

**16 & 17** Remove the Gamgee™. Mark nursing area for trimming.

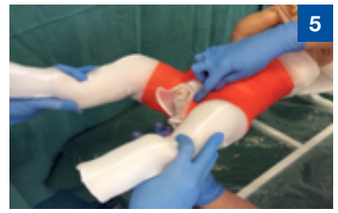
**18 - 20** Trim area anteriorly to above the symphysis pubis, around the legs and posteriorly make sure you trim to just above the coccyx. Turn back the pantaloon and hold in place. Apply double nappy (see 'Nappies' page 113).

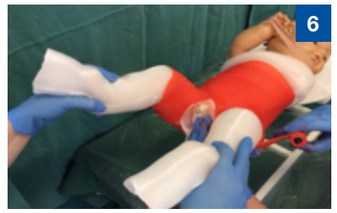


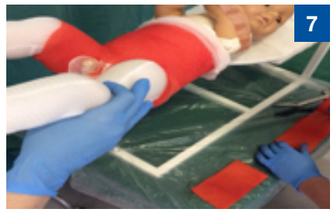
# 6.4 Casts of the Trunk

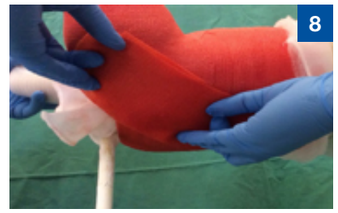


















# 6.4 Casts of the Trunk

## Plaster Jacket

As stated previously, the actual position of the patient will be decided by the medical officer, but for clarity of application we will presume that the jacket is applied with the patient standing upright.

The cast extends from the top of the sternum to the symphysis pubis anteriorly, and from the lower edge of the scapula to the coccyx posteriorly. It should be trimmed at the lower edge to allow the patient to sit comfortably, and also under the axilla to allow full movement of the arms. An abdominal window can be cut and the Gamgee™ removed to create space over the diaphragm and the stomach area.

### Equipment Required

Basic trolley, see page 28 - plus either of the following options:

**Plaster of Paris**

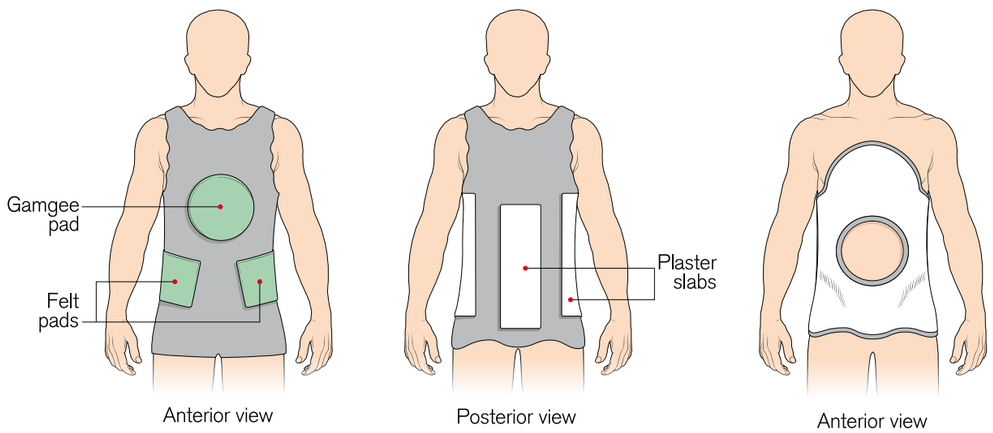
- Stockinette 30cm
- Soffban® padding 15cm x 3 rolls
- Circle of Gamgee™
- Non-adhesive felt
- Leukopor® Tape (non-woven tape for gentle fixation)
- Paper pants
- Gypsona® plaster of Paris bandages 15cm x 6 rolls
- Gypsona® plaster of Paris slab dispenser 20cm
- Stool
- Standing frame if available

### Padding

Stockinette is applied and taped over the shoulders. The circle of Gamgee™ is placed over the diaphragm, and felt squares placed over each iliac crest, and one down the spine over the sacral area. Non-adhesive felt is preferable as it can be adjusted more easily and gives no risk of an allergy. These are all held in place by a single layer of undercast padding.

### Application

Following basic rules, casting is then commenced from top or bottom, and 2 or 3 15cm plaster of Paris bandages applied. Two plaster of Paris slabs, 20cm wide by 35cm long, are then positioned down each side and one slab, 20cm wide by 40cm long, down the central back. A further 2 or 3 bandages are then applied. A further slab, 20cm wide x 30cm long, may be required across the top front of the chest, particularly in tall patients. Before the cast has set, it is moulded well over the top of the iliac crests, as this area will take the weight of the jacket.






# 6.4 Casts of the Trunk

**Synthetic**

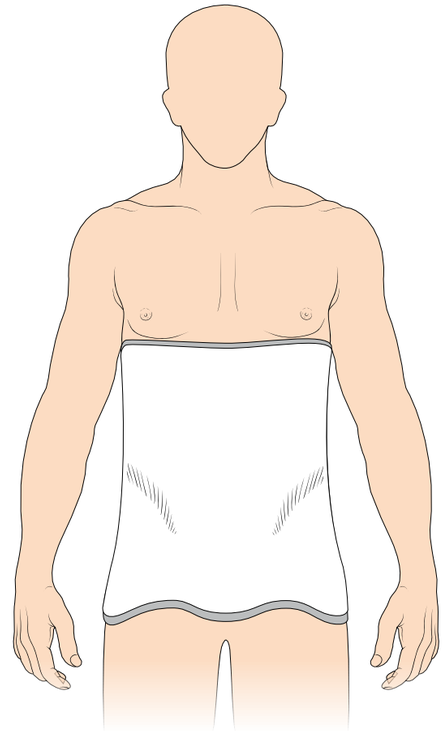
- Stockinette 30cm
- Leukopor® Tape (non-woven tape for gentle fixation)
- Circle of Gamgee™
- Adhesive felt 2mm thick
- Non-adhesive felt
- Soffban® Synthetic padding 15cm x 3 rolls
- Delta-Cast® Conformable 4-5 x 10cm or 12.5cm rolls
- Tensoplast® Sport cast edge tape 3cm
- Paper pants
- Standing frame if available

### Padding

Stockinette is applied and taped over the shoulders. The circle of Gamgee™ is placed over the diaphragm, and felt squares placed over each iliac crest, and one down the spine over the sacral area. Non-adhesive felt is preferable as it can be adjusted more easily and gives no risk of an allergy. These are all held in place by a single layer of Soffban® undercast padding.

### Application

Use 10cm or 12.5cm Delta-Cast® Conformable casting tape, depending on the size of the patient. Apply from top or bottom edge, covering at least 50% of the previous turn. Use a Delta-Cast® Conformable slab (10cm x 30cm long slab of 3 layers) across the posterior lower edge, sandwiched between the cast layers. Using strategically placed slabs allows you to cut down on the total material used and strengthen selected areas. Mould and trim as described for plaster of Paris. The edges may need padding with 2mm adhesive felt.



## Plaster Corset

If a corset is asked for it is applied in the same way, but extends from just below the bust to the symphysis pubis.

All casts are finished off by turning back the stockinette and holding it in place with strips of plaster or adhesive, stretchy tape.

# 6.4 Casts of the Trunk

## Minerva Jacket

First you need to organise a team to apply this cast. The position of the patient will, of course, be dependent on the type of injury and the medical officer's instructions. A better fitting cast can be applied with the patient standing or sitting, with or without some form of cervical traction. Therefore, an overhead hook may be required. If the patient has to be supine, then a frame, table or hip spica table can be adjusted to accommodate them.

Whichever position is chosen, the medical officer ought to take personal responsibility for placement and maintaining the desired position.

If the patient wears glasses or dentures, make sure that these are in situ before commencing application. The jacket extends from the symphysis pubis to the chin anteriorly, and from the coccyx to the upper border of the occiput posteriorly, with a band of plaster carried from the occipital portion across the forehead anteriorly, and the ears left free.

### Equipment Required

Basic trolley, see page 28 - plus either of the following options:

**Plaster of Paris**

- Stockinette 10cm
- Stockinette 30cm
- Non-adhesive felt
- Soffban® Synthetic padding 15cm x 4 rolls
- Soffban® Synthetic padding 10cm x 2 rolls
- Gamgee™
- Leukopor® tape
- Paper pants
- Stool
- Gypsona® plaster of Paris Slab 15cm width
- Gypsona® plaster of Paris Slab 20cm width
- Gypsona® plaster of Paris bandages 15cm x 10 rolls
- Gypsona® plaster of Paris bandages 10cm x 6 rolls

### Padding

Apply stockinette, fixing the body part to the head part with non-allergenic tape and also fix across the shoulders. Pad the iliac crests and sacral area with non-adhesive felt squares. Place the circle of Gamgee™ over the diaphragm and 2 small circles over the ears, under the stockinette. The Gamgee™ can then be removed through abdominal and ear windows during trimming. Apply a layer of undercast padding overall.

### Application

Apply the body part as for the plaster jacket, moulding well over the iliac rests.

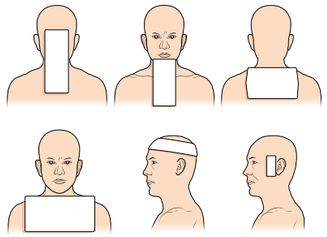
Once this has set, apply plaster of Paris bandages as follows;

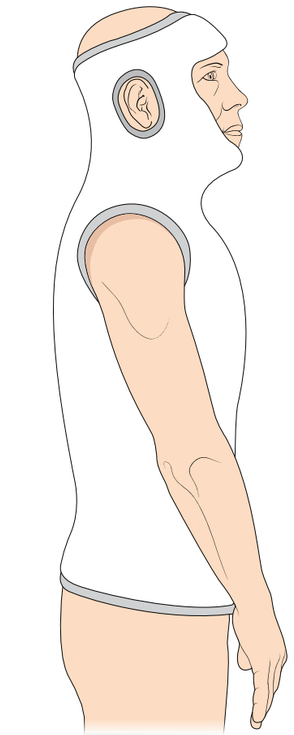
- A 10cm bandage round the head and neck
- A 15cm bandage over the shoulders in a figure-of-eight

The following plaster of Paris slabs are applied and held in position by 2 or 3 further bandages:

- 2 x 35cm long and 20cm wide, one for chin and top of chest, and one for occipital area and back of neck
- 2 x 25cm long and 20cm wide, across the front and back of shoulders
- 1 x 55cm long and 10cm wide, for circumference of head
- 2 x 10cm long and 5cm wide, for temporal area and front of ears

The cast should be well moulded round chin and occiput, but should not put pressure on the throat.



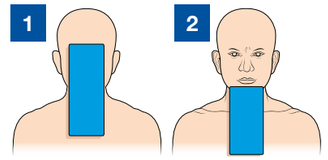


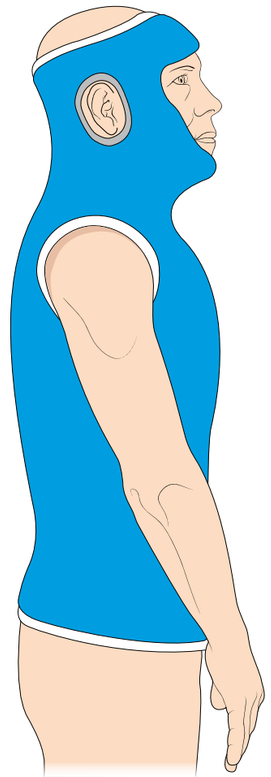


# 6.4 Casts of the Trunk

**Synthetic**

- Stockinette 10cm
- Stockinette 30cm
- Non-adhesive felt 5mm thick
- Gamgee™
- Leukopor® tape
- Paper pants
- Stool
- Soffban® Synthetic padding 15cm x 4 rolls
- Soffban® Synthetic padding 10cm x 2 rolls
- Delta-Cast® Conformable 10cm or 12.5cm x 7 rolls
- Delta-Cast® Conformable 7.5cm x 3 rolls
- Pre-wet Soffcrepe® 1 x 10cm plus 1 x 15cm
- Adhesive felt 2mm thick
- Tensoplast® Sport cast edge tape 3cm



### Padding for the Body

Apply stockinette, fixing the body part to the head part with non-allergenic tape, and also fix across the shoulders. Pad the iliac crests and sacral area with non-adhesive felt squares. Place the circle of Gamgee™ over the diaphragm and 2 small circles over the ears, under the stockinette. The Gamgee™ can then be removed through abdominal and ear windows during trimming. Apply a layer of undercast padding overall.

### Application for the Body

Apply the body part as for a jacket, moulding well over the iliac crests, except use 1 less bandage at this stage.

### Padding for the Head

Pad the upper part. Place a piece of thin, non-adhesive felt from the top of the occiput to the T2 area of the spine, and a 2nd piece from the tip of the chin down the neck to the top of the sternum. Hold in place with a layer of padding.

### Application for the Head

Apply a 7.5cm cast bandage around the head and neck, and a 10cm over the shoulders and under the axilla in a figure-of-eight. Cut and apply a slab of 3 layers of 7.5cm cast tape to the front and back of the head and neck, as diagram 1 & 2 Apply a further 1 x 7.5cm cast tape around the head and neck and 1 x 10cm cast tape over shoulders, as before. Check the area in front of the ear for strength. Complete the cast, taking a 10cm cast tape over the join of the upper and body part, right down to the iliac crest area. Apply this bandage firmly and cover all with firmly applied, wet, crepe bandages. This should assist bonding of the 2 pieces.

**Do take extreme care if using an electric oscillating saw to trim or remove this jacket. The noise and vibration is most unpleasant for the patient, and remember the blade can cut through the skull.**

# 6.4 Casts of the Trunk

## Shoulder Spica

A better fitting, more comfortable, cast can be applied if the patient can sit or stand. If the cast is to be applied following a shoulder operation, the trunk and lower two thirds of the upper limb can be plastered 24-48 hours before the operation. These 2 parts are then joined following the operation while the patient is still anaesthetised. If the patient is a buxom female, it is advisable to suggest that a brassiere be worn to prevent excoriation of the skin beneath the breasts.

The cast should extend from just below the iliac crests to axilla on the unaffected side and on the affected side should enclose the shoulder and the upper limb down to the palmar crease and metacarpal heads.

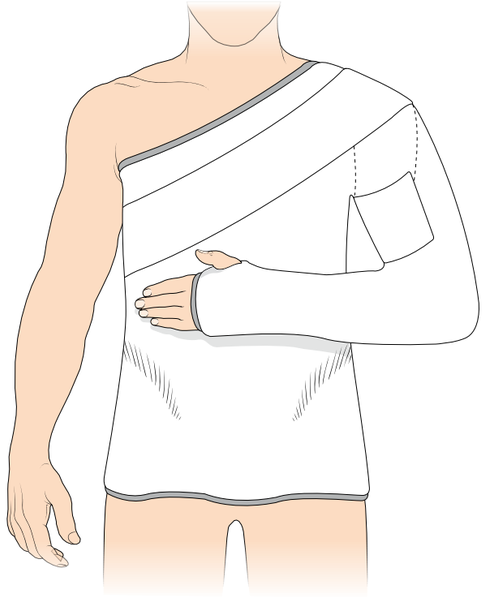
As for plaster of Paris jackets these casts must be well moulded over the iliac crests so that no weight is taken on the shoulder.

### Equipment Required

Basic trolley, see page 28 - plus either of the following options:

**Plaster of Paris**

- Stockinette 7.5cm
- Stockinette 10cm
- Stockinette 30cm
- Soffban® Synthetic padding 10cm x 3 rolls
- Soffban® Synthetic padding 15cm x 4 rolls
- Circle of Gamgee™
- Non-adhesive felt
- Leukopor® (non-woven tape for gentle fixation)
- Gypsona® plaster of Paris bandages 10cm x 5 rolls
- Gypsona® plaster of Paris bandages 15cm x 8 rolls
- Gypsona® plaster of Paris Slab 15cm width
- Gypsona® plaster of Paris Slab 20cm width



### Padding

As for plaster of Paris jacket and above elbow cast. Use an extra layer of padding at the areas of the joins. A half roll of undercast padding is placed in the axilla to prevent pressure. Pad the shoulder, the olecranon and the medial epicondyle with non-adhesive felt. Cover with a layer of undercast padding.

### Application

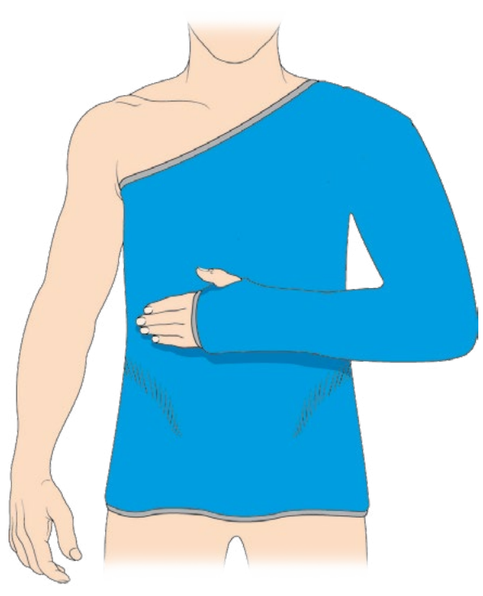
The body part is applied as for a plaster of Paris jacket, but trimmed low under the axilla on the affected side. An above elbow plaster to mid-humerus is then applied. These 2 parts of the cast are joined by using 15cm plaster of Paris bandages and 2 plaster of Paris slabs, 15cm wide x 65cm long, in a figure-of-eight around the arm and shoulder, and on to the body part. A 15cm wide plaster of Paris slab is brought from the iliac crest, through the axilla, and down the arm to just above the elbow. This eliminates the need for a plaster bar from the iliac crest to the forearm. Cover the slabs with a further layer of 15cm plaster of Paris bandages.



# 6.4 Casts of the Trunk

**Synthetic**

- Stockinette 7.5cm
- Stockinette 10cm
- Stockinette 30cm
- Soffban® Synthetic padding 10cm x 3 rolls
- Soffban® Synthetic padding 15cm x 4 rolls
- Circle of Gamgee™
- Non-adhesive felt
- Leukopor® (non-woven tape for gentle fixation)
- Adhesive felt 2mm thick
- Delta-Cast® Conformable 10cm or 12.5cm x 8-10 rolls
- Delta-Cast® Conformable 7.5cm x 1-3 rolls
- Delta-Cast® Conformable 5cm x 1 roll
- Tensoplast® Sport cast edge tape 3cm



### Padding

Apply stockinette, fixing the body part to the head part with non-allergic tape and also fix across the shoulders. Pad the iliac crests and sacral area. Place the circle of Gamgee™ over the diaphragm. The Gamgee™ can then be removed through the abdominal window during trimming. Pad the shoulder, the olecranon and the medial epicondyle with non-adhesive felt. Apply a layer of undercast padding overall.

The 2mm adhesive felt could be used at the areas of the joins for extra protection. A half roll of undercast padding is placed in the axilla to prevent pressure there.

### Application

Apply following the instructions for a plaster of Paris jacket and the above elbow cast finishing. The 2 parts are joined by using 10cm casting material in a figure-of-eight around the arm and shoulder, and onto the body part. Make a slab of 3 layers, 10cm x 50cm long, from a 10cm casting bandage, placing it from the iliac crest through the axilla and down the arm to just above the elbow and incorporate it between layers. Complete the cast taking a 10cm casting bandage over the join of the upper and body part right down to the iliac crest area. Apply this bandage firmly and cover all with firmly applied, wet, crepe bandages. This should assist bonding of the 2 pieces.

# Acknowledgements


## The authors would like to acknowledge the following contributors to the 1st edition

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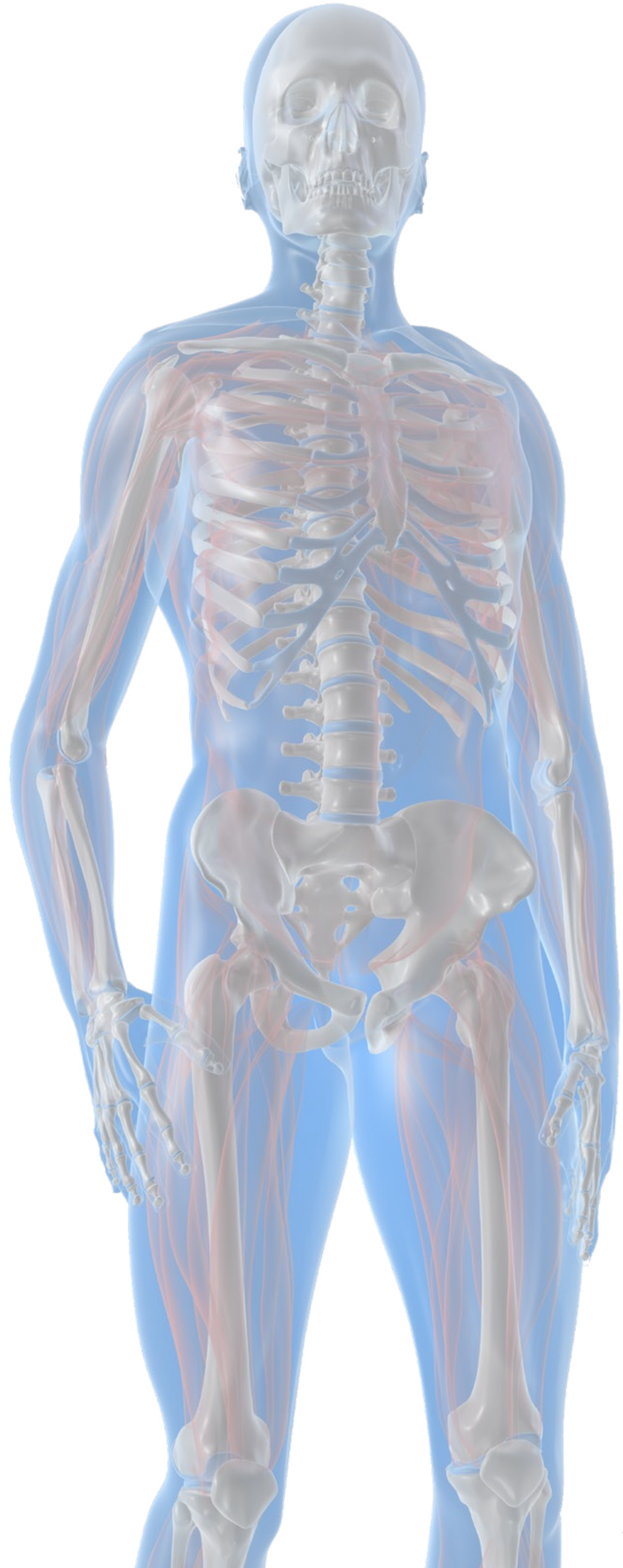
# A Practical Guide to Casting

## Glossary

This is not intended to be a comprehensive glossary of all terminology used in this book.

Refer to a standard medical dictionary for further explanation.



# Glossary

**Abduction:** movement away from the mid-line of the body

**Adduction:** movement towards the mid-line of the body

**Anaemia:** refers to a large group of problems involving the blood. Literally the word means without haem, this being the red pigment of red blood cells, the function of which is to carry oxygen around the bloodstream

**Ankylosis:** the elimination of a joint as a result of either fusion across a joint space by bony tissue or fibrous tissue

**Anterior:** the front, for example, anterior view in X-ray terminology

**Aponeurosis:** a sheet of fibrous tissue that replaces a tendon for attachment to bone, when the muscle is wide and flat

**Arthrodesis:** fusion of bones across a space by surgical means

**Articulate:** (in anatomy) to join together as in skeletal joints or articulations

**Ataxia:** the brain's inability to co-ordinate the movements produced by different muscles

**Atheroma:** degeneration of the walls of arteries due to formation in them of fatty plaques and scar tissue

**Atonia:** without tone, referring to muscles

**Atrophy:** wasting of a normally developed tissue due to degeneration of cells

**Avulsion:** the tearing away of a structure (tendon, ligament or nerve) from its point of insertion

**Bursa:** a small sac of synovial fluid which acts as a protector where parts move over one another, for example ligaments or tendons sliding over bones

**Cellulitis:** an inflammatory disorder affecting the connective tissue between adjacent tissues and organs

**Circumduction:** movement whereby a limb moves in a circular motion from a fixed point

**Chondrocyte:** a cartilage cell

**Collateral:** has two common usages. (1) in the circulatory system it means an alternative circulation that develops to bypass an obstruction and (2) in the musculoskeletal system a collateral ligament is one that is secondary and intended to reinforce others

**Compartment syndrome:** a condition where there is increasing pressure within a muscle compartment, which eventually leads to the death of the muscle tissue

**Condyle:** a rounded projection at the bone ends, for example the condyles at the upper end of the tibia

**Congenital:** a word to describe a condition that is present at birth

**Crest:** a ridge of bone as at the top of the innominate bone (iliac crest) or in the intertrochanteric region at the upper end of the femur

**Deformity:** an alteration of the normal contour of the body

**Digit:** finger, thumb or toe

**Dislocation:** complete loss of the normal relationship between joint surfaces

**Distal:** that part of the bone that is furthest from the centre of the body

**Dorsiflexion:** movement of the hand or foot in an upwards direction

**Embolism:** the blocking of an artery by an embolus

**Embolus:** a substance circulating in the blood of sufficient size to cause a blockage of a vessel. It may be blood, fat or a large quantity of air

**Epicondyle:** above the condyle, the best example are the small protuberances just above the condyles of the humerus always referred to as the epicondyles

**Epidural (extradural):** outside the dura. The term is mostly used to describe a type of anaesthetic procedure whereby a local anaesthetic can be injected into this space to suppress sensation in the part of the body served by the affected nerve roots

**Eversion:** turning the sole of the foot outwards

**Extension:** the opposite of flexion, an increase in the angle between two bones

**Facet:** a flat, articulating surface, the best example is to be found forming the facetal joints of the vertebral column

**Flexion:** a decrease in the angle between two bones

**Foramen:** a hole in a bone (plural is foramina)

**Fossa:** a depression or hollow

**Fovea:** a small depression

**Fracture:** an interruption in the normal continuity of a bone

**Fusion:** a term used in surgery to describe the joining together of 2 structures for example 2 vertebrae

**Gangrene:** death of part of the body due to deficiency or destruction of the blood supply

**Gas gangrene:** death of deep tissue caused by infection with the anaerobic organism Clostridium perfringens. The toxins produced as a result of the infection produce the typical gas

**Gibbus:** a deformity of the spine that produces a hump. It is usually associated with tuberculosis

**Gout:** a condition occasionally seen in orthopaedic settings whereby a joint or digit, usually the big toe, is painful and swollen due to a build up of uric acid in the tissues as a result of faulty metabolism

**Haemarthrosis:** bleeding into the joint cavity

**Haematoma:** a collection of blood in the tissues

**Hallux:** the big toe

**Head:** a rounded or disc like part of a bone. Look for the head of the radius at the elbow joint and the head of the femur



# Glossary

**Iatrogenic:** a condition caused by the treatment

**Inversion:** turning the sole of the foot inwards

**Lamina:** a thin plate of bone (plural is laminae)

**Lateral rotation:** rotation away from the mid-line of the body (external rotation)

**Medial rotation:** rotation towards the midline of the body (internal rotation)

**Meniscus:** the semilunar cartilages of the knee joint are called the menisci. They are crescent shaped pieces of white fibro cartilage which improve the articulating surface of the tibia for articulation with condyles of the femur

**Metabolism:** the sum of all the changes that take place within the body usually at the chemical level

**Metacarpals:** the bones of the hand

**Metatarsals:** the bones of the forefoot

**Motor movement:** a motor nerve is one where impulses travel from the central part of the nervous system to the periphery, usually a muscle fibre, where it stimulates the muscles into action

**Myofibril:** a muscle fibre

**Neck:** a constricted part of a bone

**Neoplasm:** an abnormal tissue growth, it may be benign or malignant

**Neurapraxia:** bruising a nerve causing a temporary alteration of sensation, for example pins and needles

**Neuroma:** a tumour of nerve tissue

**Neurone:** a nerve cell, the basic functional unit of nerve tissue

**Notch:** an indentation of bone. Identify the greater sciatic notch of the innominate bone

**Oedema:** an excessive amount of fluid in the tissues

**Osteo-arthritis:** a painful disease of joint cartilage caused by degenerative changes

**Osteomalacia:** a disease of bone due to a reduction in the amount of calcium resulting from reduced intake or uptake of calcium. It may be due to deficiency of vitamin D which is necessary for the absorption of calcium

**Osteophytes:** outgrowths of bone at joint margins. A feature of osteo-arthritis

**Osteoporosis:** a disease of bone whereby the density of bone is reduced. The reduction is in the bone matrix as well as the mineral content

**Osteotomy:** cutting a bone as at surgery

**Palmar flexion:** flexion at the wrist joint resulting in the hand pointing forwards

**Paraesthesia:** an abnormal sensation, for example numbness and tingling

**Parenteral:** administration of drugs, or food, other than through the mouth

**Phalanges:** the name applied to the bones of both the fingers and the toes

**Plantarflexion:** movement of the foot in downwards direction, sometimes called equinus

**Plantigrade:** position of the foot which is at 90° to the leg and neutral in relation to inversion and eversion

**Pollex:** the thumb

**Posterior:** situated at the back of the body

**Process:** a local projection of bone. Identify the odontoid process or peg of the 2nd cervical vertebra (axis) or the spinous processes of the vertebrae below C7

**Pronation:** turning the palms of the hands backward in the anatomical position

**Prophylaxis:** prevention used particularly in primary health e.g. vaccination against poliomyelitis

**Proximal:** that part of a bone that is nearest to the centre of the body

**Ramus:** a straight piece of bone usually used to describe the inferior and superior rami (plural) of the pubis of the innominate bone

**Sciatica:** pain along the course and distribution of the sciatic nerve

**Scoliosis:** a lateral curvature of the spine

**Septic:** produced by, or due to, decomposition by microorganisms

**Spine:** a sharp process of bone as in the spine of the scapula. The word is often used to describe the vertebral column

**Sprain:** injury to a ligament caused by over stretching

**Supination:** turning the palms of the hands forward in the anatomical position

**Synovitis:** inflammation of the synovial lining of a joint or tendon sheath

**Systemic:** affecting the whole body

**Tenotomy:** cutting a tendon

**Thrombosis:** the development of a blood clot in a blood vessel

**Traction:** the act of pulling on a limb or other part of the body

**Trochlea:** an anatomical part of the body whereby it has the function of a pulley, e.g. the trochlea of the humerus around which the trochlear surface of the ulna revolves

**Tubercle:** a small rounded protuberance on a bone, look for the infra and supra glenoid tubercles in the shoulder joint

**Tuberosity or Trochanter:** a roughened and enlarged area of bone to which muscles are usually attached. The greater trochanter of the lateral aspect of the femur gives attachment to gluteal muscles

**Tumour:** the term is now used to describe an abnormal growth of tissue which may be benign or malignant

**Valgus:** the distal part of a bone or limb is bent or twisted away from the mid-line

**Varus:** the distal part of a bone or limb is bent or twisted towards the mid-line

**Vasculitis:** an inflammatory condition of the walls of blood vessels, it may also be called angiitis

# A Practical Guide to Casting

## Appendices

- Instructions to Patients in a Cast
- Instructions for Use of Crutches/Sticks
- Shoulder, Elbow and Hand Exercise
- Shoulder and Hand Exercise
- Exercises for Lower Limbs
  - For patients in below knee casts
  - For patients in a leg cylinder cast
- Further Reading

# Appendix I

Hospital Trust _____ Department _____

## Instructions to Patients in a Cast

**Please read the following instructions carefully**

Report to the above hospital, or your nearest hospital with an A&E Department, immediately if you experience any of the following:

- Your toes or fingers become blue or swollen, or you are unable to move the limb
- Your limb becomes painful
- You have pain in the calf
- You have pain in the chest or shortness of breath
- You feel 'pins and needles' or numbness
- Any 'blister-like pain' or rubbing under the cast
- You have any discharge, wetness or smell under the cast
- If you drop any object in the cast

## Care

- Exercise the joints not held in the cast as much as possible
- Do not let the limb hang down unless it is being used; elevate the limb, especially during the first few days
- Allow the cast to dry naturally and if it is plaster of Paris leave it uncovered for 48 hours after application
- Do not sit close to the fire, as your cast may become hot and burn you
- Do not wet the cast, it may disintegrate or cause skin problems
- Do not cut, heat or otherwise interfere with your cast
- If the cast becomes cracked, soft, loose or tight, or if you are worried, return to the hospital

**The contact number is:**
**Or between 17:00hrs and 09:00hrs contact:**

I confirm that I have received a copy of 'Instructions to Patients in a Cast'.

---

Name (capital letters please)_____

Date of birth_____ Signed_____ Date_____



# Appendix II

## Instructions for Use of Crutches/Sticks

**You have been issued with elbow crutches/sticks to aid your mobilisation.**
**Please read the following carefully:**

### Walking

- Move both crutches forward a short distance - if non-weight bearing holding, injured leg off the floor
- Lean on the crutches - taking weight through your arms and hands
- Step through with the good leg. Continue thus - keeping steps short and equal

### Stairs

- The safest way up and down is on your bottom. If there is a handrail, use it!
  Ascending: place good leg up the step first, followed by crutches and bad leg
  Descending: bad leg and crutches down first, good leg follows. Can be a dangerous procedure!
  NOTE: Good leg to heaven! Bad leg to hell

### Sitting Down

- Stand on the good leg, close to the chair
- Hold both crutches in one hand
- Feel for chair with other hand
- Sit down

### Standing up

- Hold crutches in one hand, push on arm or seat of chair
- Stand up on to good leg
- Place crutches in position

### Maintenance

- Ensure the crutches are adjusted to the corrected height
- Check crutches daily
- Look for wear or dirt on ferrules (rubber ends)
- Make sure adjustable clips/buttons are functioning and metal around them is not damaged
- If you have a problem contact the department that issued your crutches
- When they are no longer required, please return your crutches promptly

---

I confirm that I have received a copy of "Instructions for Use of Crutches/Sticks" and that I have been supplied with crutches, sticks etc, which I have/have not been taught to use.

(Cross through where not applicable)

Name (capital letters please)_____ Patient No._____

Date of birth_____ Signed_____ Date_____

# Appendix III

## Shoulder, Elbow and Hand Exercise

### For patients with a below elbow cast

When wearing a below elbow slab/cast it is important that you do not allow the joints that are not in the cast to become stiff. Exercise is important to prevent this. Unless you are advised otherwise, this exercise should be gentle and not to a degree that causes you pain.

These exercises should be done at least 6 times every morning, noon and evening to prevent shoulder and elbow stiffness:

1. **Raise your arm above your head (if necessary help it with the other hand)**
2. **Touch the back of your neck with your hand**
3. **Touch the small of your back with your hand**
4. **Straighten and bend your elbow**

## Hand Exercise

These exercises should be done at least 10 times an hour during the day and evening to prevent stiffness:

1. **Make a fist with your fingers and thumb, relax it and then make a fist again**
2. **Spread your fingers and thumb wide apart, relax and then spread them again**

Do not allow your hand to hang down for any length of time, as it may become swollen and painful. Elevate your hand to heart level when you are sitting or lying. If you have been given a sling, wear it for 24-48 hours following cast application, unless you have been instructed otherwise. However, do not forget to remove the sling to do the above exercises.

If you are worried or have problems, contact the hospital where you had your slab/cast applied, or go to your nearest hospital.



# Appendix IV

## Shoulder and Hand Exercise

### For patients with an above elbow cast

When wearing an above elbow slab/cast it is important that you do not allow the joints that are not in the cast to become stiff. Exercise is important to prevent this. Unless you are advised otherwise, this exercise should be gentle and not to a degree that causes you pain.

These exercises should be done at least 6 times every morning, noon and evening to prevent shoulder stiffness:

1. **Raise your arm above your head (if necessary help it with the other hand)**
2. **Touch the back of your neck with your hand**
3. **Touch the small of your back with your hand**

You may not be able to do 2 and 3.

## Hand Exercise

These exercises should be done at least 10 times an hour during the day and evening to prevent stiffness:

1. **Make a fist with your fingers and thumb, relax it and then make a fist again**
2. **Spread your fingers and thumb wide apart, relax and then spread them again**

Do not allow your hand to hang down for any length of time, as it may become swollen and painful. Elevate your hand to heart level when you are sitting or lying. If you have been given a sling, wear it for 24-48 hours following cast application, unless you have been instructed otherwise. However, do not forget to remove the sling to do the above exercises.

If you are worried or have problems, contact the hospital where you had your slab/cast applied, or go to your nearest hospital.

# Appendix V

## Exercises for Lower Limbs

### For patients in below knee casts

When wearing a below knee cast, it is important that you do not allow the joints that are not in the cast to become stiff. Exercise is important in order to prevent this. Unless you are advised otherwise, this exercise should be gentle and not to a degree that causes you pain.

These exercises should be done at least 6 times every morning, noon and evening to prevent stiffness:

(Depending upon the extent of your cast, you may not be able to exercise all of your leg joints)

1. **Bend your toes and then straighten them**
2. **Move your leg out to the side and back, to keep your hip mobile**
3. **Bend and straighten your knee**
4. **Press your knee into a pillow and feel your thigh muscle tighten**

Do not allow your leg to hang down for any length of time, as it may become swollen and painful. Elevate it to heart level when you are sitting.

If you are worried or have problems, contact the hospital where you had your cast applied, or go to your nearest hospital.



# Appendix VI

## Exercises for Lower Limbs

### For patients in a leg cylinder cast

When wearing a leg cylinder cast, it is important that you do not allow the joints that are not in the cast to become stiff. Exercise is important in order to prevent this. Unless you are advised otherwise, this exercise should be gentle and not to a degree that causes you pain.

These exercises should be done at least 6 times every morning, noon and evening to prevent stiffness:

1. **Bend your toes and then straighten them**
2. **Move your leg out to the side and back, to keep your hip mobile**
3. **Exercise your ankle by pointing your toes away from you and then pulling your foot towards you**
4. **Rotate your ankle, drawing a circle with your foot**

CHECK with medical staff or physiotherapist that you are allowed to do the next exercise.

If guided to do so, press your knee into the back of the cast and feel your thigh muscle tighten, pull your toes towards you at the same time (static quadriceps contraction).

Do not allow your leg to hang down for any length of time, as it may become swollen and painful. Elevate it to heart level when you are sitting.

If you are worried or have problems, contact the hospital where you had your cast applied, or go to your nearest hospital.

# Appendix

## Further Reading

Recommended reading for Plaster Room staff

### Anatomy and Physiology

Gunn, C., (2012) Bones and Joints: A Guide for Students, 6th edition, Churchill, Livingstone, Elsevier

Jarmey, C., Myers, T.W., (2012) The Concise Book of the Moving Body, Lotus publishing

Rowett, H.G.Q., (2003) Basic Anatomy and Physiology, John Murray

Tortora & Grabowski, (2015) Introduction to Human Body - essentials of anatomy and physiology. 10th edition. Wiley

Waugh, A., Grant, A.W., (2010) Ross & Wilson Anatomy and Physiology in Health and Illness, 11th edition. Elsevier

### Management of Fractures and Orthopaedic Conditions

Clarke, S., Santy-Tomlinson, J., (2014) Orthopaedic and Trauma Nursing: An Evidence-based Approach to Musculoskeletal Care, Wiley

Dandy, D.J., Edwards, D.J., (2009) Essential Orthopaedics and Trauma, 5th edition, Churchill Livingstone

Luqmani, R., Robb, J., Porter, D., Joseph, B., (2013) Textbook of Orthopaedics, Trauma & Rheumatology, 2nd edition, Mosby Limited

White, T.O., Mackenzie, S.P., Gray, A., (2015) McRae's Orthopaedic Trauma and Emergency Fracture Management, 3rd Edition, Elsevier

### Pharmacology

British National Formulary (twice yearly) BMA & Royal Pharmaceutical Society GB

### Casting Standards

Miles, S., Williams, M., (2015) Casting Standards, online, available from:
http://www.boa.ac.uk/training-education/casting-standards/



# British Casting Certificate

## Courses and Examinations

**The British Casting Certificate qualification and courses have been running since 1982 and are the only qualification for casting in the UK. They are held under the auspices of the Casting Techniques Committee of the British Orthopaedic Association.**

The British Casting Certificate courses and examinations are validated by the British Orthopaedic Association (BOA) and the Association of Orthopaedic Practitioners (AOP), and supported by the Royal College of Nursing (Society of Orthopaedic and Trauma Nursing). Since 2011, this has been a joint award with Glasgow Caledonian University (GCU).

**These validated courses currently run at:-**

### Stanmore

5.5 week course that runs 3 times a year

### Bradford

day release over 6 months

### Glasgow

day release over 6 months

### Newport

day release over 6 months

The courses are all followed by an external Objectively Structured Clinical Examination (OSCE) held at Stanmore. Students then undertake a 3,000 word assignment to complete the module "The Theory and Practice of Musculoskeletal Casting and Splinting".

If successful in both, students receive a Joint Award from the BOA, AOP and GCU, the British Casting Certificate and 60 credits either at:

- Diploma Level 8 SCQF equivalent to Level 5 NQF, or
- Degree Level 9 SCF equivalent to Level 6 NQF

### Top-Up Degree Award

All Registered Nurses, who complete the course and who are not already graduates, will be eligible to graduate from GCU with BSc Professional Studies in Nursing in addition to the British Casting Certificate.

Nurses, who hold a Degree, are now eligible for a Graduate Certificate Professional Studies in Nursing. These options do not incur any additional cost or study.

### For further information or enquiries about the course and examination please go to

http://www.boa.ac.uk/training-education/casting-course/

### or contact:

Conference and Committee Administrator

British Orthopaedic Association, 35-43 Lincoln's Inn Fields, London WC2A 3PE

Email: casting@boa.ac.uk

Further information can be obtained from Essity.
Essity UK Ltd
Southfields Road, Dunstable, Bedfordshire, LU6 3EJ
Tel: 01482 670100 · Fax: 01482 670111
https://medical.essity.co.uk

essity

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