

Understanding
**BRACHIAL
PLEXUS
PALSY**

Departments of Physiotherapy,
Occupational Therapy
and Plastic Surgery,
Royal Children's Hospital, Melbourne

ROYAL
CHILDREN'S
HOSPITAL



THIS pamphlet has been prepared to help you learn about brachial plexus injuries.

If you have any further questions specific to your child after reading this pamphlet, please consult your doctor, physiotherapist or occupational therapist.

You can contact the Department of Plastic and Maxillofacial Surgery on the following telephone numbers or email address:

(03) 9345 6636 or (03) 9345 5347

plastic.surgery@rch.org.au

Overview

The brachial plexus is a large network of nerves that extend from the neck into the arm. (Fig. 1) The five large nerves (given the symbols C5, C6, C7, C8 & T1) exit from the spinal cord between the bones in the neck (the vertebrae). (Fig. 2)

These nerves provide movement and feeling to the arm and hand. It is through the nerves of the brachial plexus that the brain sends electrical signals to the individual muscles of the arm and hand. One nerve is made up of thousands of nerve fibres. (Fig. 3) These nerve fibres carry the electrical signals from the brain to the arm. If nerve fibres are injured, the muscle that the nerve serves does not

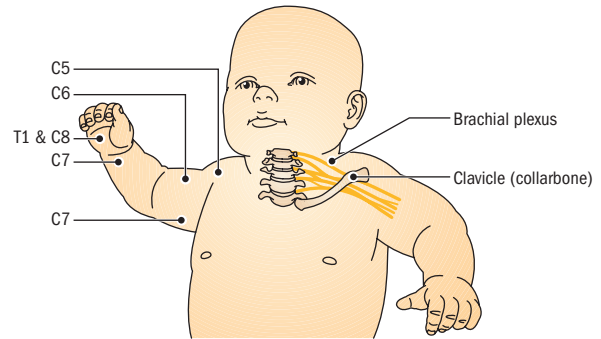


Figure 1. Location of brachial plexus.

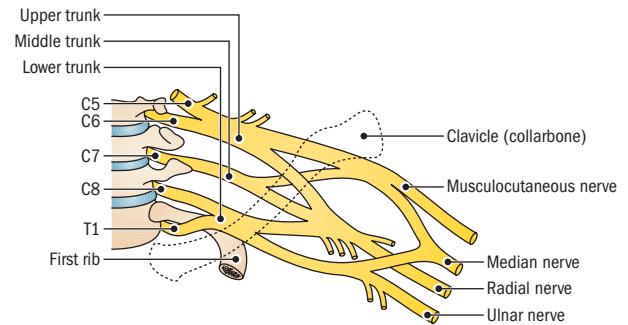


Figure 2. Detail of the nerve network of the brachial plexus.

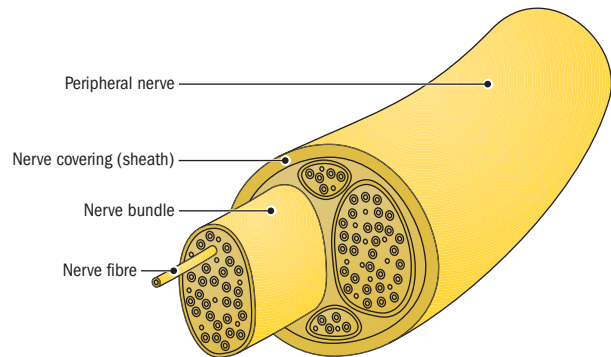


Figure 3. Detail of nerve anatomy.

receive electrical signals from the brain to make it work. Instead, the muscle is inactive and begins to deteriorate. The arm may not grow normally and muscles and joints may tighten. The skin may also have reduced feeling.

Most brachial plexus injuries occur during birth. The brachial plexus is often damaged when it is under tension. Most hospitals report one to two babies being born with a brachial plexus injury per 1000 births.

The nerves of the brachial plexus have some ability to repair themselves. As long as the outer sheath or covering of the nerve is preserved, the damaged nerve fibres can regrow down to a muscle. Nerve fibres regrow at a rate of about 1mm per day, or an inch per month. Therefore it can take many months for regrowing nerve fibres to reach the muscles in the lower arm and hand. If the entire nerve (including the outer sheath) has been

torn, the nerve cannot grow back and the muscle will not work.

Rapid return of muscle function is a positive sign. Most nerve regrowth and noticeable muscle function recovery will occur during the first year of life, with some less noticeable improvements in the second year. Most children who spontaneously recover well in the first few months are able to use their affected arm to do almost all activities they want. However, some muscle weakness usually remains. The movements of the affected arm may not look the same as the non-affected arm doing the same movement.

Types of brachial plexus injuries (Fig. 4)

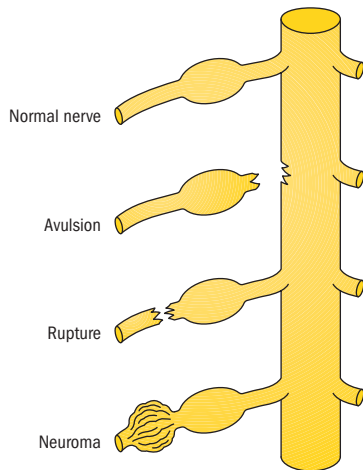


Figure 4. Types of nerve injury.

- An **avulsion** is when the nerve is torn from where it attaches to the spinal cord. No recovery is expected with an avulsion injury. It cannot be repaired with surgery.

- A **rupture** is when the nerve is torn, but not from where it attaches to the spinal cord. This usually occurs beyond the vertebrae in the neck. A rupture requires surgery to reconnect the ends of the nerve.
- A **neuroma** forms when torn nerve fibres have attempted to regrow and heal themselves, but scar tissue has grown in and around the injury. This scar tissue makes it impossible for the nerve to conduct electrical signals to the muscles. Surgery removes the scar tissue around the nerve and between the ends of a completely ruptured nerve.

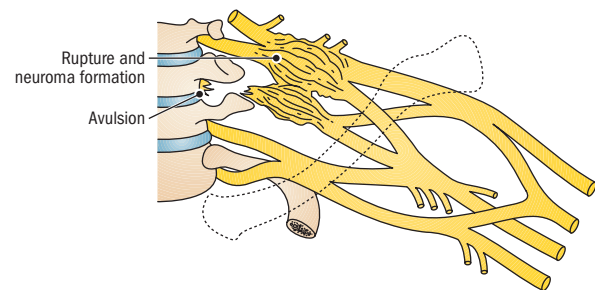


Figure 5. Typical brachial plexus injury.

- **Axonotomesis** occurs when the fibres inside the nerve have been broken but the nerve covering is still intact. Recovery by regrowth of the nerve fibres is often very good but it takes time (1mm per day) for the nerve to regrow from the site of the injury to its paralysed muscle.
- **Neuropraxis** occurs when the nerve has been damaged (e.g. sprained) but not torn. In this case, the nerve fibres can recover on their own. Improvement in movement of the arm should be seen within three months.

A typical brachial plexus injury may have a combination of the above. (Fig. 5)

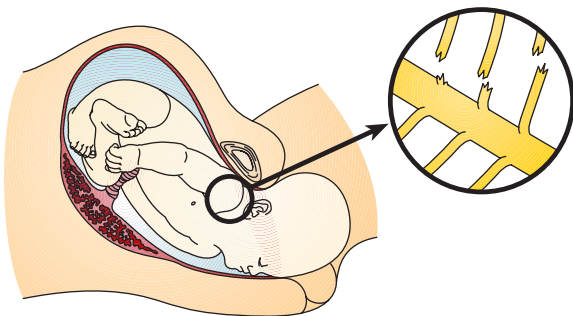


Figure 6. Nerve injury during birth.

How do brachial plexus injuries occur? (Fig. 6)

In many cases the baby is larger than average. However, newborns of all sizes can suffer a brachial plexus injury, and prediction of babies likely to be affected is often extremely difficult. During childbirth, the baby's shoulders can unexpectedly become trapped in the mother's pelvis after delivery of the head. By this stage in labour, it is important that the baby is delivered promptly to avoid brain damage as a consequence of oxygen deprivation. In order to release the shoulders, the head is pulled downward, thereby unavoidably stretching the brachial plexus.

Weakness of the arm is immediately obvious if significant injury has occurred. Associated complications can include a broken clavicle (collar bone), a broken humerus (upper arm bone), and Horner's Syndrome (characterised by drooping of the eyelid and a slightly smaller pupil).



How can you tell how severe the injury is?

There is no single test which can determine the extent of the brachial plexus injury. Instead, your child's arm movement will be assessed and monitored over a period of time by your doctor and physiotherapist. If your child is being considered for surgery, MRI (magnetic resonance imaging) may be used to diagnose avulsions of the brachial plexus. It has been found that MRI can define the integrity of nerve roots where they leave the spinal cord. It does not show ruptures of the plexus in the neck reliably.

Time is the most important factor in the recovery of brachial plexus injuries. The rate of

recovery of this injury dictates the final outcome.

The faster the return of muscle function, the greater likelihood of complete recovery. Your physiotherapist will rate your child's progress. The majority of children with brachial plexus injuries recover with physiotherapy alone. About 10% require exploration and repair of damaged nerves aiming to achieve a better, but not complete recovery.

Physiotherapy and Occupational Therapy for brachial plexus injuries

Physiotherapy should be started early in the newborn with a brachial plexus injury. You will be given an exercise sheet and be instructed by your physiotherapist how to perform daily exercises. Physiotherapy cannot make the nerve grow faster but it aims to reduce problems with joint stiffness. These “range of movement” exercises aim to keep the muscles and joints flexible and ready to work if and when the nerves and muscle function improve. As your child gets older, weakness of some muscle groups and imbalances between muscle groups with opposite effects can cause tightness of muscles and joints requiring specific exercises or splinting by an Occupational Therapist.

Surgery for brachial plexus injuries

Your child will be regularly monitored by a physiotherapist to record any progress in muscle strength. Surgery may be chosen when adequate muscle function has not been recovered by nine months of age. The decision to operate is often made earlier if there is little recovery by three to four months of age. Primary surgical treatment includes removing scar tissue and nerve grafting. Unimportant sensory nerves are removed from the legs and placed between the nerve ends using microsurgery. (Fig. 7)

Even those children who have a very severe brachial plexus injury will show some recovery by six to nine months. Small fibres of nerve may be intact or small

fibres of nerve may grow through the scar producing some movement in the arm. Children selected for surgery are those who are not expected to continue to improve to a worthwhile extent. Surgery is recommended when it is believed that the chances of achieving further recovery are better with removal of the neuroma and nerve grafting than waiting for spontaneous nerve regrowth.

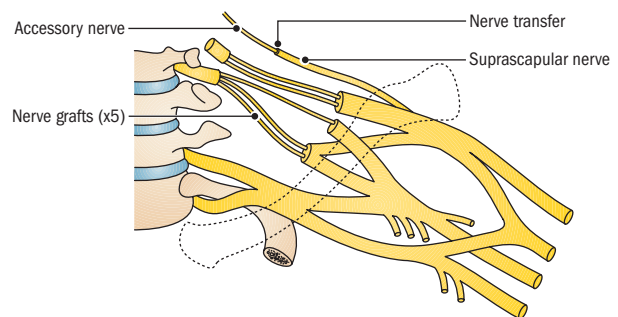


Figure 7. Typical surgical repair of brachial plexus injury.

When older, some children continue to have major movement problems that limit the use of their arm and may benefit from secondary surgery. Secondary surgery involves procedures that are applied directly to the muscles, tendons, joints and bones of the affected arm. There are several procedures for the shoulder, elbow, wrist and hand. Shoulder muscles which have developed tightness may need to be surgically released during the first few years in order to prevent or treat shoulder dislocations and/or abnormal rotation of the arm. Surgical correction of elbow, forearm, wrist and hand deformities are usually carried out in later childhood.

The RCH Brachial Plexus Clinic

The Royal Children's Hospital Brachial Plexus Clinic is run by a multi-disciplinary team. Your child will be seen by a physiotherapist from the clinic on a monthly basis and regularly by the clinic doctor throughout the first year of life. Surgery will be recommended where appropriate. Children who have ongoing problems or have been operated on are followed up by the physiotherapist and occupational therapist until school age and beyond.

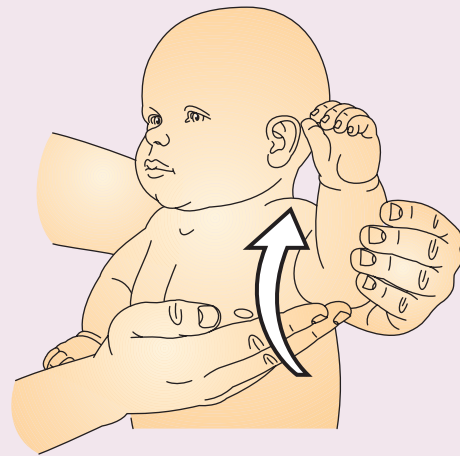
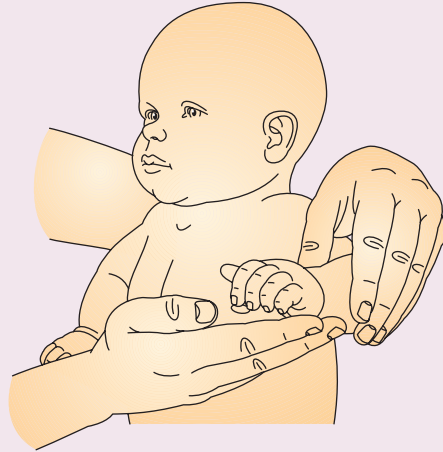
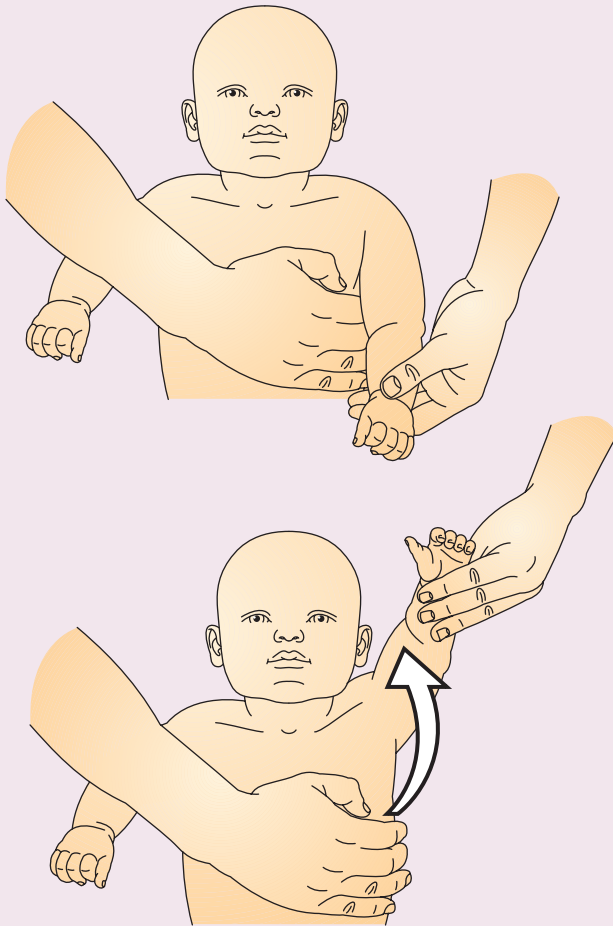


Range of motion exercises for infants with obstetric brachial plexus palsy

Range of motion exercises are movements done with your child's arm to ensure that the joints maintain full movement. They should be performed slowly and held at the end of the range for at least ten seconds. The exercises should be done at least **three times a day** with each exercise being repeated three times unless otherwise directed by your therapist. There will be many more opportunities to do these stretching exercises such as during baths and times when your baby is being nursed, held or changed.

1. Shoulder exercises

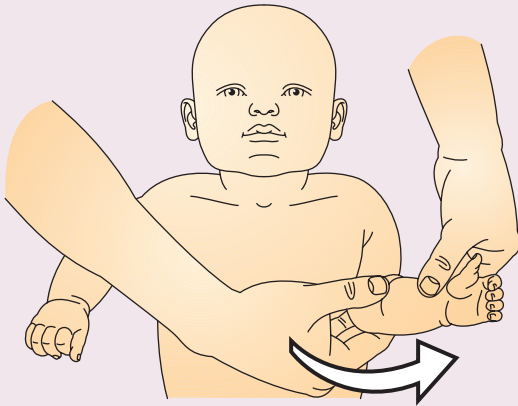
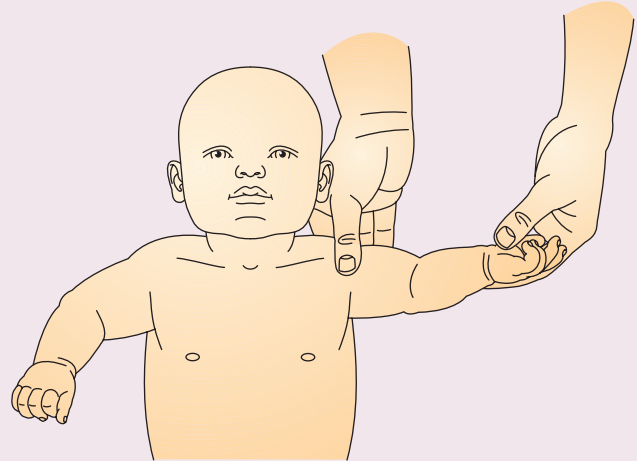
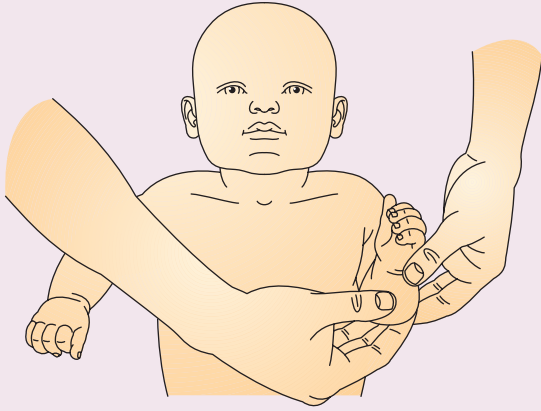
A. Gently grasp the child's forearm and raise the arm slowly over the head, keeping the arm close to the ear and hold.



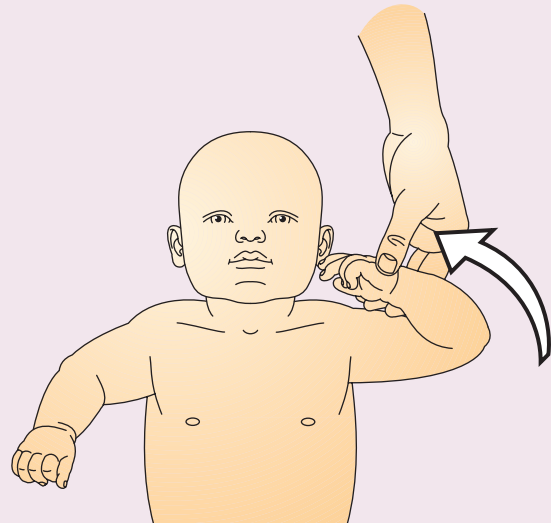
B. This exercise resembles a “high five”. Raise the shoulder out half way and bend the elbow 90°. Maintaining this position, rotate the arm back so that the arm touches the bed and hold.

2. Elbow exercises

A. Keeping the palm turned up, straighten the elbow and hold. Then bend the elbow and hold.

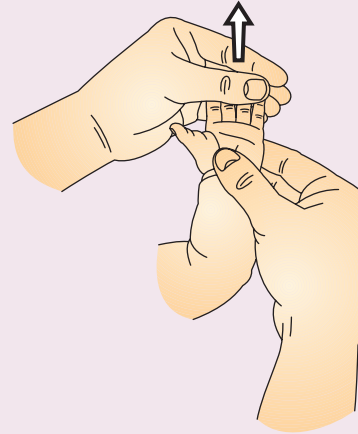
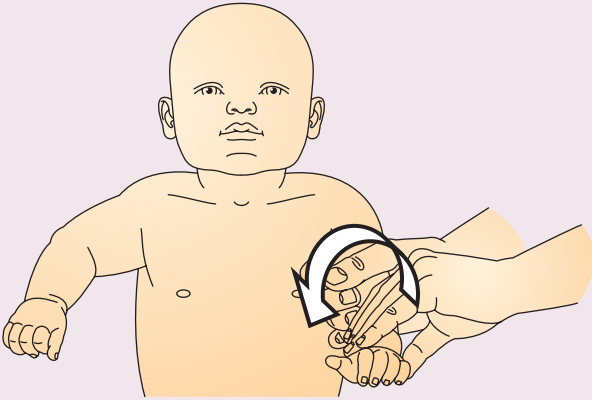


C. Keep the elbow bent at 90° with the upper arm against the body. Turn the forearm out to the side and hold. **This is probably the most important exercise.**

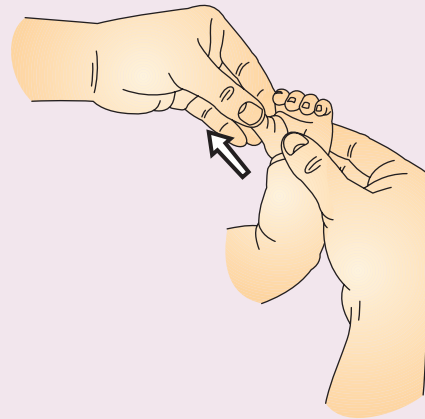
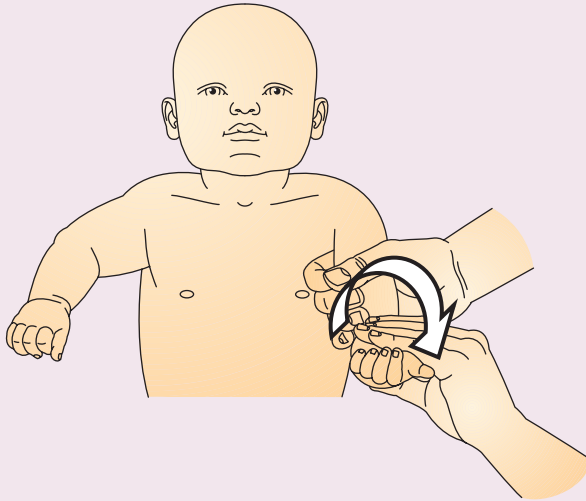


3. Wrist and fingers exercises

A. Gently bend the wrist backwards and hold, then straighten the fingers and hold.



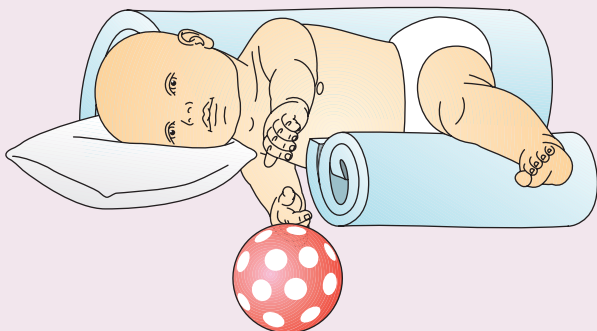
B. Use the same wrist position as above. Straighten the thumb and hold.



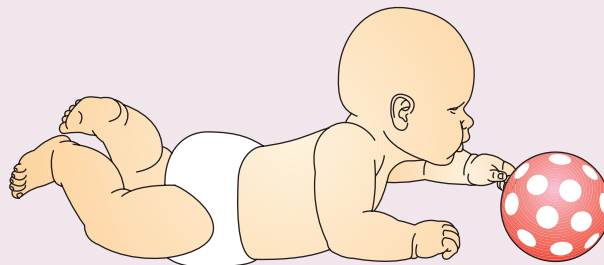
B. Keep the elbow bent at 90° with the upper arm against the body. Start with the palm down. Turn the forearm until the palm is up and hold. Then, turn the forearm until the palm is down and hold.

4. Activity exercises

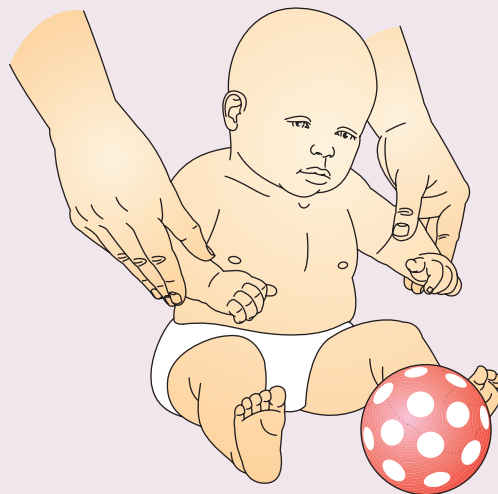
A. Place the child on their side with the affected arm highest. Place a large rolled up towel snugly at the child's back and another at their front. Put toys in front to encourage activity of the uppermost affected arm. This position makes reaching easier because the child does not have to lift against gravity.



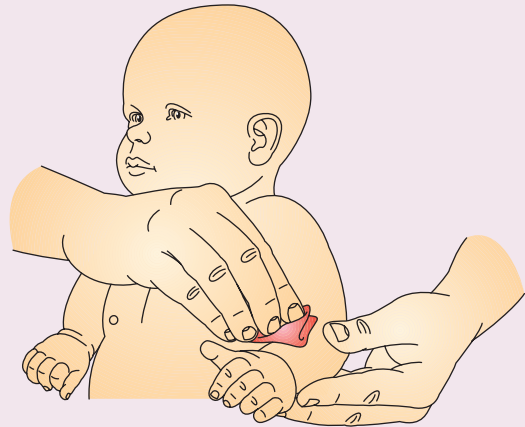
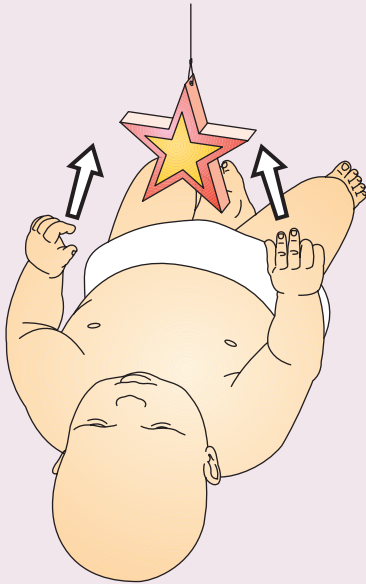
B. Place the child on the floor on their tummy with their arms forward. Encourage them to lean on the affected arm and reach for a toy with the opposite arm. Then reverse the exercise so they are reaching the toy with the affected arm. This allows practise of both supporting and reaching with the affected arm.



C. Place your hands on the child's arms or elbows and assist them in a two handed activity such as reaching for a toy or clapping. This encourages co-ordination between the unaffected and affected arms.



D. Place the child on the floor and then suspend or hold a toy above them. Encourage reaching upwards, particularly with the affected arm. The child must be able to reach the toy and you may need to gently hold back the unaffected arm at times. This encourages reaching skills.



E. Increase body awareness by rubbing a variety of textures against the child's skin; velvet for soft sensations and coarser material like a bath towel for rough ones. This may not be tolerated by some children because of sensitivity, but in others it will increase awareness of the affected arm.

Obstetrical brachial plexus injuries: glossary of terms

Abduction	A movement of the shoulder where the arm moves out to the side, away from the body.
Adduction	A movement of the shoulder where the arm moves in towards the body.
Avulsion	When a nerve is disconnected from the spinal cord; no recovery is expected. At present it is not possible to surgically repair the nerve back into the spinal cord.
Brachial Plexus	Brachial refers to the arm; plexus means network. The brachial plexus is the name given to the network of nerves that provide movement and feeling to the arm. It is made up of five nerve roots (C5, C6, C7, C8 & T1) that exit the spinal cord and travel between the bones (vertebrae) of the spine. The nerves are called C5, C6, C7, C8 and T1. 'C' stands for cervical (neck), 'T' stands for thoracic (chest) and the number tells you which spinal cord segment the nerve comes from.
Clavicle	Also called the collarbone; an elongated, slender bone running horizontally at the root of the neck, in the upper part of the chest.
Contracture	Shortening of muscles, tendons and ligaments about joints causing stiffness and limitation of movement.
Dislocation	Displacement of a bone from a joint, eg. shoulder dislocation occurs when the upper arm bone (humerus) comes out of the shoulder joint.
Dystocia	Pathologic or difficult labour, which can be caused by an obstruction or constriction of the birth passage or an abnormal size, shape, position or condition of the foetus.
Erb's Palsy	This is the name given to the injury when only the first 2 or 3 (C5, C6 +/- C7) of the five nerves that make up the brachial plexus are injured. This usually results in paralysis of the shoulder and elbow muscles. This is the most common type of brachial plexus injury at birth.
Extension	In the upper limb, the shoulder, elbow, wrist and small joints of the fingers all move into extension. Extension is the straightening out of a joint.
External Rotation	A movement of the shoulder which turns the arm out away from the body. It is this movement which is the most difficult for a baby with a brachial plexus injury. This movement is required when bringing your hand to your mouth, for example.
Flexion	In the upper limb, the shoulder, elbow, wrist and small joints in the fingers all move into flexion. Flexion is the opposite of extension, ie. bending the joint.
Horner's Syndrome	Caused when the T1 nerve root of the brachial plexus is injured. It is characterised by drooping of the eyelid and a slightly smaller pupil on the same side as the brachial plexus injury.
Humerus	The bone of the upper arm, between the shoulder and elbow.
Internal Rotation	A movement of the shoulder which turns the arm in towards the body. This movement is used when bringing your hand behind your back or when bringing your hand towards your opposite shoulder, for example. It is the muscles that produce the movement of internal rotation, which are most at risk of tightening up and forming contractures. Therefore these muscles need to be stretched regularly and these range of movement exercises will be taught to you by your physiotherapist.

Klumpke's Palsy	This is the name given when only the last 2 (C8 and T1) of the five nerves of the brachial plexus are injured. This usually results in paralysis of the hand. Klumpke's Palsy is rarely seen in newborns.
MRI	MRI (Magnetic Resonance Imaging) is used to diagnose avulsions of the brachial plexus from the spinal cord. It is reported as being very accurate. This is a technique which requires a general anaesthetic. The patient is put into a machine which creates a very detailed picture of the inside of their body.
Nerve Graft	This is a length of nerve taken from elsewhere in the body and microsurgically attached to both ends of a torn nerve after it has been trimmed back to healthy nerve fibres (ie. neuroma = scar tissue needs to be removed). Usually the sural nerve from the leg is used. Apart from the long scar on the back of the leg, the only side effect of removing it is an area of numbness on the outer aspect of the foot.
Neuroma	The nerve has attempted to heal itself, but instead scar tissue has developed around and within the injured nerve forming a neuroma. This scar tissue prevents electrical signals passing through this part of the nerve. Surgery is required to remove the scar tissue. When scar tissue has replaced the interior of the nerve, this section of the nerve must be cut out and replaced by nerve grafts.
Neuropraxia	The nerve has been damaged but not torn. A neuropraxia heals itself.
Pronation	Pronation is a movement which occurs in the forearm. You pronate your forearm when you turn your palm away from your face or downwards. For example, when you pick a pen up off the table you need to pronate your forearm.
Radius	The bone on the thumb side of the forearm.
ROM	Range of motion exercises (ROM) are designed to keep the affected muscles and joints flexible and to prevent any stiffness. An exercise sheet will be given to you by your physiotherapist and it is recommended that these exercises are repeated three times a day.
Rupture	When a nerve is completely torn in the neck. All ruptured nerves develop neuromas on the ends. This can be repaired. The surgical procedure involves bypassing the torn area of nerve with a nerve graft taken from another part of the body. As the nerve is still attached to the spinal cord (not an avulsion) there is some hope of nerve regeneration.
Scapula	Also called the shoulder blade; the flat, triangular bone in the back of the shoulder.
Subluxation	Partial dislocation.
Supination	Supination is a movement which occurs in the forearm and it is the opposite movement of pronation. Supination is the movement which turns your palm upwards. For example you supinate your forearm when you bring a biscuit to your mouth.



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Masonic Centre of Victoria
300 Albert Street,
East Melbourne, Victoria, Australia 3002
Telephone (03) 9419 8687