



Brachial Plexus Injury Awareness

GENERAL BRACHIAL PLEXUS INJURY INFORMATION

WHAT IS THE BRACHIAL PLEXUS?

The brachial plexus is a network of nerves that conduct signals from the spine to the shoulder, arm, and hand. It is composed of the four lower cervical roots (C5-C8) and the first thoracic root (T1). The roots exit through the anterior vertebral foramen and divide first to the upper, middle and lower trunk, and then to the lateral, posterior and medial cord in the axilla. They then split into the final nerve branches.

The anatomy of the brachial plexus is very complicated. The axons inside every nerve root are used to innervate many different muscles. One muscle can be innervated from 1-5 segments (nerve roots). Put simply, one can say that the upper roots innervate the upper part of the arm and the lower roots innervate the lower parts of the arm and hand.

Each nerve root has its own sensory segment (dermatome) in the skin. Because these partly overlap each other, damage to one or two roots of the brachial plexus usually doesn't affect the sensory functions of the skin to a great degree. Extensive loss of sensory function is usually a sign of injury to the entire plexus.

WHAT IS A BRACHIAL PLEXUS INJURY?

Brachial plexus injuries are nerve injuries in which the nerves and/or the nerve roots of the brachial plexus are damaged. This injury affects the motor and sometimes also sensory functions in the patient's arm and/or hand. Depending on the severity and extent of the injury the first symptoms may vary individually:

- Some patients have good or moderate use of their fingers, but little or no control over the muscles of shoulder and elbow.
- Some patients can use their arm, but have little or no control of the fingers.
- Some patients have a completely flaccid limb with no sensory or motor functions.

The injury can be bilateral in which case both arms are affected.

CLASSIFICATION OF THE BRACHIAL PLEXUS INJURIES

The injury is usually caused by stretching, tearing or other trauma to the nerves of the brachial plexus.

Injuries to the Brachial Plexus can be divided into three clinical types based on the anatomical location of the injury.^(4,6)

- Upper plexus palsy (Erb's palsy in the OBPI cases) involves C5-C6 +/- C7 roots.
- Lower plexus palsy (Klumpke's palsy) involves C8-T1 roots (and sometimes also C7)
- Total plexus lesions involve all nerve roots C5-T1
- Some authors have included a fourth type,^(1,9) an intermediate type that primarily involves the C7 root.

CLASSIFICATION OF THE NERVE INJURIES

The classification of the nerve injuries can aid in the prognosis and treatment.⁽³⁾ The two most commonly used classifications are that of Seddon (1943) and of Sunderland (1951).⁽³⁾ The Seddon classification system is presented here. Seddon classified nerve injuries into three types:

Neurapraxia: This is the least severe injury - a localized conduction block of the nerve. It can be caused by stretching or compression of the nerve. The axons inside the nerve remain intact, but there may be segmental demyelination of the nerve.⁽³⁾ Because there is no terminal structural damage to the nerve, this type of injury usually recovers quite quickly.⁽⁹⁾

Axonotmesis: The sheath of the nerve remains intact, but there is axonal disruption.^(3,9) The axons can regenerate, and near to complete recovery can be expected in the injuries where the motor targets are close enough. (Not more than 12"-24" away.)⁽³⁾

Neurotmesis: This is an injury where the nerve has been ruptured. There will be no or very little recovery without surgical intervention. Even with surgical intervention, the recovery is not usually complete.

In some cases, the nerve has begun to rupture, but the rupture is incomplete. In such cases, the nerve can develop a neuroma, a disorganized collection of fibrous tissue and nerve endings.⁽⁹⁾ Sometimes the axons can not regenerate through this scar tissue and surgical intervention is required.

The most severe type of injury is an avulsion, in which the nerve root has been torn out of the spinal cord.

A brachial plexus injury can be anatomically located in any part of the brachial plexus. In obstetric cases the most common site is the Erb's point, where the roots C5 and C6 unite.

DIAGNOSTIC ASSESSEMENT

Often multiple diagnostic techniques are used to assess the extent and severity of the nerve injury. They can be used as aids to confirm the clinical assessment of the injury. Clinical assessment is

very important when treating a brachial plexus injury, but the clinician can use different tools to gain more information about the extent of the injury and the sequelae deformities.

Plain radiographs

Plain radiographs of upper extremity, chest and spine are used to determine additional injuries. Fractures, subluxations and dislocation of the bones of upper extremity, injury to the spine and diaphragm can be indicated using plain radio-graphs.

MRI and Myelography

Magnetic resonance imaging and myelography with or without CT scan are used to find root avulsions. Myelography is an invasive procedure and therefore there seems to be a significant trend in the literature advocating the use of MRI over CT myelography.⁽⁴⁾ Some authors prefer the CT-myelography because they have found it to be more sensitive and therefore more accurate.^(6, 5, 4) Both techniques can produce false positive and negative findings.

Electrodiagnosis

Electrodiagnosis is used pre-operatively to examine the extent and severity of the lesion. EMG (electroneuromyography) results can help the assessment of prognosis in some cases. This test is not always reliable when predicting damage.^(9, 4) EMG is sometimes used for postoperative follow-up.⁽⁴⁾ SEP (Sensory Evoked Potentials) is sometimes used intraoperatively to help with diagnosis of root avulsions.

BRACHIAL PLEXUS SURGERY

Primary surgery

The surgery is conducted under general anesthesia using the standard microsurgical operating techniques. The purpose of primary surgery is to correct the injury in the plexus and help the reinnervation of muscles. The techniques used depend on the severity of the lesion. ⁽⁹⁾

1. **Neurolisis:** Removal of the constrictive scar tissue surrounding the nerve.
2. **Neuroma excision:** When the neuroma is large, it must be excised and the nerve reattached either with end-to-end technique or with nerve grafts.
3. **Nerve grafting:** When the gap between the nerve ends is so large that it is not possible to have a tension free repair using end-to-end technique, nerve grafting is used. The most popular harvesting sites for autogenous nonvascularised nerve grafts are: the sural nerve, the lateral and medial antebrachial cutaneous nerves and the terminal sensory branch of the posterior interosseus nerve. ⁽³⁾
4. **Neurotization:** Neurotization of the nerves of the brachial plexus is used generally in those cases where there is an avulsion of the nerve root from the spinal cord. The nerves that can be used as a donor nerve include: the hypoglossal nerve, spinal accessory nerve, phrenic nerve, intercostal nerve, long thoracic nerve and ipsilateral C7 nerve. ⁽²⁾ In addition, intraplexual neurotization can be used. The parts of the roots still attached to the spinal cord can be used as donors for avulsed nerves.

Secondary surgery

The aim of secondary surgery is to improve overall function of the affected limb. Depending on which nerves are affected, functional deficit can vary from minor clumsiness to a totally flail and anesthetic arm. ⁽⁸⁾ Secondary surgical procedures may include: tendon transfers, pedicled muscle transfers, free muscle transfers, joint fusions and rotational, wedge or sliding osteotomies. ⁽¹⁰⁾ Operations to restore sensory functions can also be done.

CONCLUSION

Brachial plexus injuries are perhaps one the most difficult management problems faced by neurologists, rehabilitation specialists and reconstructive surgeons. The anatomy of the brachial plexus is extremely complicated and most injuries affect the entire plexus to some degree. Current management is primarily based on the fact that muscle which loses its nerve supply (as in brachial plexus injury) will become completely wasted after about 15 to 18 months in children and cannot be recovered after that time. ⁽⁷⁾

There are two basic approaches to treating brachial plexus injuries: (1) occupational or physical therapy exercises and (2) surgery plus therapy exercises.

Regardless of the need for surgical intervention, patients with brachial plexus injuries are recommended to follow a routine of daily range of motion exercises to help keep the muscles and joints moving normally and to help prevent contractures.

It is essential to seek evaluation by practitioners experienced in brachial plexus injury treatment to optimize the overall outcome. Brachial plexus injuries are significant functional injuries that are often permanently disabling, and can affect employment, health, and future socio-economic status. Because brachial plexus injuries are so diverse, and because experience dictates specific management for each patient, consultation with a specialist is critical to maximize outcome.

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