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Mini Review

An orthopaedic surgeon's approach to adult brachial plexus injuries

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Abstract

Adult patients with brachial plexus injuries are frequently seen by orthopaedic surgeons because they are frequently associated with other musculoskeletal injuries. The management of these complex injuries appears difficult, but many such injuries can be managed appropriately with a proper systematic approach. This article discusses the anatomy, injury characteristics, diagnostic procedures, and management guidelines for brachial plexus injuries in adults.

Keywords: Assistive technology, amputation, hemicorporectomy, rehabilitation, prosthesis, case report

INTRODUCTION

Adult brachial plexus injuries are uncommon but can be fatal if not treated promptly. Because these injuries are frequently (but not always) associated with other bony injuries such as clavicle fracture, humerus fracture, and cervical spine fractures, an orthopaedic surgeon is usually the first person to whom the patient presents. Approximately 75% of traumatic brachial plexus injuries are associated with head injury, thoracic trauma, and cervical spine or ipsilateral upper extremity fractures or dislocations (or both); 20% of patients have associated vascular trauma. Orthopaedic surgeons in general are not well trained in diagnosing and surgically managing these injuries because many procedures require microsurgical skills that are not taught in Indian Orthopaedics programmes. These injuries are gradually being managed by plastic and neurosurgeons. However, upon closer inspection, the approach and management are not exceptional and can be easily understood and managed very well by a general Orthopaedic surgeon if certain basic principles are followed. The goal of this review article is to help an orthopaedic surgeon approach, manage, and, if necessary, refer a patient to an appropriate specialist [1].

ANATOMY OF THE BRACHIAL PLEXUS

The brachial plexus is made up of five cervical nerves, which are usually C5, C6, C7, C8, and T1, and is divided into five anatomic sections: nerves, trunks, divisions, cords, and terminal branches. As the ventral and dorsal nerve rootlets pass through the spinal foramen, they combine to form the spinal nerves. Each spinal nerve communicates with the paraspinal musculature via a small dorsal ramus. As the first section of the brachial plexus, the remaining large ventral rami of the lower four cervical (C5-C8) and T1 spinal nerves emerge from the foramina. Trunks-The C5 and C6 nerves, as well as the C8 and T1 nerves, join to form the upper and lower trunks, respectively. C7 continues distally as the middle trunk, with no clear demarcation point for this nomenclature change. The suprascapular nerve emerges at the point of convergence of the C5 and C6 nerves, known as the Erb point. The supraclavicular plexus is a collection of nerves and trunks located above the clavicle. Each trunk then divides into anterior and posterior divisions beneath the clavicle (the retro clavicular plexus). The posterior divisions of all trunks form the posterior cord, and the anterior divisions of the upper and middle trunks form the lateral cord. The anterior division of the lower trunk continues as the medial cord distal to the clavicle. The lateral cord divides into two terminal branches: the musculocutaneous nerve and the contribution of the lateral cord to the median nerve. The posterior cord gives rise to the axillary nerve and the radial nerve, while the medial cord gives rise to the median nerve and the ulnar nerve. The infraclavicular plexus is made up of cords and terminal branches that arise from them. At the proximal nerve level, clinically significant branches include a C5 contribution to the phrenic nerve, the dorsal scapular nerve (C5), and the formation of the long thoracic nerve from C5, C6, and C7. The upper trunk contains the only trunk branches, the suprascapular nerve and the nerve to the subclavius muscle. The retroclavicular plexus has no muscular branches. The lateral pectoral nerve arises from the retroclavicular plexus at the division level. The lateral pectoral nerve emerges from the posterior cord infraclavicularly. The posterior cord divides into branches that include the upper subscapular nerve, the thoracodorsal nerve, and the lower subscapular nerve (from proximal to distal). The medial cord is the origin of the medial pectoral nerve, medial antebrachial cutaneous nerve, and medial brachial cutaneous nerve[2-5].

MECHANISM OF INJURY

The majority of traumatic brachial plexus injuries are caused by traction or stretch and result in injuries ranging from mild stretch to rupture or avulsion.Low-energy traction trauma that is not severe enough to cause rupture or avulsion usually results in injuries with the potential for spontaneous regeneration, such as neurapraxia or mild axonotmesis. Low-energy injuries disrupt brachial plexus microcirculation, resulting in ischemic injury. High-energy injuries are associated with more severe plexus damage, which may include plexal element rupture or avulsion of nerve roots from the spinal cord. When an incomplete rupture and avulsions occur, some spontaneous recovery may occur. Damage is first imparted to the upper nerves (C5 and C6)/upper trunk and/or C7/middle trunk if the shoulder-neck angle is forcibly widened by downward traction on the arm; if the scapulohumeral angle is forcibly widened, damage is first imparted to the lower nerves (C8 and T1) and the lower trunk. If the impact is severe, all levels may be damaged.According to anatomic studies, the supporting tissue that anchors the upper nerves (C5 and C6) to the vertebral foramina is significantly stronger than the supporting tissue that anchors the lower nerves (C8 and T1). According to this anatomic arrangement, the more caudal brachial plexus structures (i.e., the C8-T1 nerves) are more likely to be avulsed from the spinal cord, whereas the more cranial structures (C5-C6) are more likely to stretch or rupture after exiting the neural foramina. Approximately two-thirds of traction injuries occur in the supraclavicular region; the other third occur in the retroclavicular or infraclavicular regions and involve the divisions, cords, or terminal nerves. A double-level (supraclavicular and infraclavicular) injury can occur in some patients and should be considered. Individual patients may suffer varying degrees of injury at various nerve levels; for example, the C8 and T1 roots may be avulsed, the C7 nerve or middle trunk may be ruptured, and the upper trunk may be intact but with varying degrees of internal damage. Individual axons and fascicles within a brachial plexus element may also be injured to varying degrees. This variation in the degree of injury affecting each plexus explains why spontaneous recovery may occur in some plexuses but not in others. Other injuries may result from the same high-energy traction injury that damages the brachial plexus. Fractures, dislocations, and vascular injuries can all cause further damage to the plexus. Other mechanisms of injury include gunshot wounds and penetrating wounds from glass, knives, and other sharp objects. In these cases, the extent of damage is determined by the type of missile and its velocity. In these cases, associated vascular injuries may necessitate simultaneous exploration and repair, complicating neural status [6].

COMMON PATTERNS OF BRACHIAL PLEXUS INJURY

Stretch, rupture, and avulsion can all occur in brachial plexus injuries. Certain patterns, however, are more common. Injury to the C5 and C6 nerves or the junction where they form the upper trunk occurs in approximately 15% of patients (Erb point). These patients have problems with shoulder stability, abduction, external and internal rotation (supraspinatus and infraspinatus, deltoid, subscapularis), and forearm supination (biceps, brachialis, and brachioradialis) (biceps, supinator). The C5 and C6 distributions will have a sensory deficit. Elbow extension, as well as wrist and hand function, is normal. Erb-Duchenne palsy is the medical term for this type of injury. C5-C7 Injury: As previously described, weakness of muscles innervated by C5 and C6 is often accompanied by a partial or complete C7 or middle trunk injury in 20% to 35% of patients. These patients will have varying degrees of elbow, wrist, and finger extensor weakness. This is known as an Erb-plus pattern at times. Supraclavicular lesions isolated to the C8 and T1 nerves affect approximately 10% of patients. Depending on the C7 contribution to these territories, these patients will have weakness of the hand intrinsic muscles as well as variable weakness of the hand extrinsic muscles and finger extensors. Sensory loss may be present in the ulnar digits, medial aspect of the forearm, and distal part of the arm. Horner syndrome is caused by involvement of the lower roots and is characterised on examination by meiosis (constricted pupil), ptosis of the upper eyelid, anhidrosis, and enophthalmos. Klumpke palsy is a term used to describe this uncommon pattern of injury. Traumatic injury to the entire brachial plexus (C5-T1) occurs in 50% to 75% of patients with supraclavicular brachial plexus injuries. The majority of these patients have a completely flail arm and an insensate hand. Certain elements may be partially injured on occasion. Even in complete pan-plexus injuries, postganglionic injury (especially of C5) is common, with preganglionic lesions affecting other nerves [7].

INFRACLAVICULAR AND TERMINAL BRANCH INJURY

Infraclavicular or retroclavicular brachial plexus injuries may involve division or cord level injuries. Clavicular fracture is common in these cases. Injury to the posterior cord (radial and axillary nerve

distributions), as well as isolated axillary or suprascapular nerve injuries, are the most common patterns [8].

APPROACH TO THE PATIENT

To determine the location and severity of the brachial plexus injury and appropriate management, a comprehensive preoperative evaluation that includes a detailed history, physical examination, imaging, and electro diagnostic evaluation is required. The first goal is to determine whether there is a possibility of spontaneous and functionally significant recovery that warrants further investigation. If no improvement is seen within the first 2 to 3 months, surgery is recommended. If surgery is recommended, determining whether the injury is preganglionic or postganglionic will aid in planning the surgical approach and possible reconstructive options. The nerve root is avulsed from the spinal cord in preganglionic injuries and cannot be repaired or grafted [9,10].

CONCLUSION

Other skeletal, vascular, and soft tissue injuries are frequently associated with brachial plexus injuries. The distinction between upper plexus (C5, C6), lower plexus (C8, T1), and pan plexus injuries aids in determining the prognosis for spontaneous recovery and planning the timing of surgical procedures. Post-ganglionic injuries should not be treated before 3 months because there is a high likelihood of spontaneous recovery. Nerve transfers are becoming more popular than traditional nerve exploration and reconstruction. In a pan plexus injury, the first priority is to regain elbow flexion, followed by shoulder stabilisation with abduction.

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