Nerve compression syndromes at the elbow

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Abstract

All three major peripheral nerves to the forearm and hand traverse the elbow joint. Each nerve has a complex pathway intertwining between and around the other soft tissue structures around the joint that allow stability and mobility. Each nerve glides freely in a pulleyed tunnel that allows both efficiency of motion and provides soft tissue protection.

The symptoms of nerve entrapment and compression vary with each nerve depending on the degree of compression and the nature of the nerve fascicles involved: altered sensation; tingling; weakness; pain.

This article discusses entrapment syndromes of the median, ulnar and radial nerves at the elbow including cubital tunnel syndrome, radial tunnel syndrome, posterior interosseous nerve compression, anterior interosseous nerve compression and pronator syndrome. The anatomical course, clinical features, investigations and treatment strategies for management are all considered.

Keywords cubital; elbow joint; entrapment syndrome; nerve compression; pronator syndrome

Introduction

In order for the major peripheral nerves to the forearm and hand to glide effectively at the elbow they are positioned adjacent to the elbow joint in arrangements of pulleys and sheaths. It is this anatomical and biological system which predisposes each nerve to its unique risk of compression and the resulting effects at this mobile site.

The musculo-tendinous units that attach around the elbow joint and form this pulley system are involved in movements of the arm, forearm and hand. Thus, nerve compression about the elbow can be caused by dynamic or static activities depending on the relative positions of the arm, elbow, forearm and hand. The motor and sensory effects of nerve compression are distal to the elbow in the hand and forearm. Knowledge of nerve anatomy and function is key to locating the site of compression and producing an effective treatment plan.

These macroscopic effects are compounded by microanatomical changes within and surrounding the nerve fibres, which also contribute to alteration in local blood flow and bring about changes to the surrounding connective tissues by inducing fibrosis. This ultimately results in disruption of axonal transport and nerve conduction.

Fascicular anatomy and physiology

The microanatomy of any nerve is complex and provides built-in protective mechanisms to prevent disruption of nerve function following compression. Individual neurons may be surrounded by a myelin sheath or not, but either way all nerves have myelin and Schwann cells within their immediate environment: the endoneural sheath. These fibres are then grouped into fascicles surrounded by connective tissue called perineurium. Epineurium surrounds these fascicles in turn and provides the external coat, promoting the gliding function within the surrounding connective tissue sheath. The connective tissue and fascicular elements of each nerve differ in ratio and overall cross sectional area depending on the location of the nerve. The elasticity of the nerve is a property of the fascicular pattern while the connective tissue elements resist the effects of compression.[1]

Nerves glide both an extraneurally and intraneurally, allowing movement of the nerves during joint motion. This is particularly important for those nerves traversing the elbow joint, as the range of motion at the joint is quite extensive. The ulnar nerve may glide 9.8 mm during full flexion and extension of the elbow joint, whilst during the same range of motion the median nerve glides 7.3 mm. Nerve excursion is greater in the distal forearm; 14.5 and 13.8 mm respectively.[2,3]

The vascular supply to each nerve is segmental, being supplied by adjacent vessels that lie along the nerve pathway. The longitudinal epineural and perineural vessels connect via multiple channels and these in turn connect in an oblique fashion with the endoneurial capillaries to prevent vessel occlusion during excursion of the nerve. Due to the absence of a lymphatic network in the endoneural system any increase in oedema can cause an increase in the neuronal pressure and thus potentially disrupt the vascular supply. Any mechanism that alters the fluid dynamics of the nerve can interfere with nerve function and if persistent may result in changes that are slow to reverse.[3,4]

Pathophysiology

As each peripheral nerve is made up of a combination of elongated neurones it is the effects of compression on intraneural transport to and from the periphery, intermittently or constantly, which leads to the alternation in nerve function.[5] Increases in the extraneural pressure can effect changes in neurons on the transport of intracellular components both to and from the cell body, and also the periphery. These changes are proportional to the duration and degree of pressure applied. Prolonged pressure effects also alter the connective tissues surrounding the neurones resulting in fibrosis and disruption of blood flow. These effects are important around the elbow joint, as fibrosis may also restrict the excursion and gliding capabilities of the nerve resulting in a traction effect on the fascicles.[3,5]

The double crush phenomenon was first described in 1973. It hypothesises that neurons may be compressed at one location along the nerve pathway such that this site of compression alone is insufficient to alter axoplasmic flow and produce symptoms. However, this leaves the nerve susceptible to compression at a second site, proximal or distal, from a lesser force than would

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otherwise have any effect, resulting in the onset of symptoms.[6] Each nerve crossing the elbow joint; radial, ulnar and median, may thus have a secondary site of synchronous compression along the nerve pathway e.g. proximally at the cervical root level or distally at the wrist or distal forearm. This may also explain the location of proximal pain that the patient can experience, in the arm or shoulder, when they present with distal nerve compression.

Epidemiology/Demographics

Cubital Tunnel syndrome is the most common nerve compression syndrome at the elbow. It is actually the second most common peripheral nerve compression syndrome of the upper limb.[7] In a 5-year retrospective study, Mondelli et al reported a mean incidence of ulnar neuropathy at the elbow of 20.9 cases per 100 000 person-years. Over a 5-year period they also showed a higher incidence of cubital tunnel in males.[8]

Posterior interosseous nerve compression syndrome is rare, with an incidence of 0.03%. This is however the most common radial nerve compression syndrome. Symptoms related to compression of the superficial radial nerve in the distal forearm occur in 0.003%. Posterior interosseous nerve compression is commoner in women and in the age range 30–50 years.[9]

Entrapments of the median nerve at the elbow – pronator syndrome and anterior interosseous nerve compression – account for less than 1% of nerve compression syndromes of the upper limb. This is rare when compared with more distal compression of the median nerve at the wrist.[10]

In 2006, Hughes et al reviewed the epidemiology of compressive neuropathies on the UK. This study assessed data from 253 general practices; 1.83 million patient years. The age annualized standard rates per 100 000 of new presentations in primary care were 25.2 male: 18.9 female for ulnar neuropathy and 2.97male: 1.42 female for radial neuropathy.[11]

Ulnar nerve anatomy and compression sites

The ulnar nerve is formed from spinal nerve roots C8-T1 and is the largest terminal branch of the medial cord of the brachial plexus. In the arm, the ulnar nerve descends postero-medial to the brachial artery, pierces the medial intermuscular septum and then courses along the border of the medial head of triceps brachii.[12] It is crossed by a musculofascial band known as the arcade of Struthers, located approximately 8 cm proximal to the medial epicondyle and extending between the intermuscular septum and the medial head of triceps brachii[13] (Figure 1). The nerve then travels through the epicondylar groove on the posterior aspect of the humerus. In a cadaveric study of 30 upper extremities, the arcade of Struthers was present in 87% of specimens.[14] It must not be confused with the much less common ligament of Struthers associated with the median nerve.[15]

The medial intermuscular septum, the arcade of Struthers and the epicondylar groove are all sites of potential compression of the ulnar nerve around the elbow.[13] The nerve enters the anterior compartment of the forearm via the cubital tunnel.[16] The roof of the cubital tunnel, also known as the arcuate ligament of Osbourne, runs transversely from the medial epicondyle to the olecranon and is around 4 mm wide[17] (Figure 2). The nerve is

Figure 1 The Ulnar nerve is crossed by a musculofascial band known as the arcade of Struthers, located approximately 8 cm proximal to the medial epicondyle and extending between the intermuscular septum and the medial head of triceps brachii.

most commonly compressed in this region, causing cubital tunnel syndrome (CUTS). The ulnar nerve leaves the cubital tunnel and passes between the humeral and ulnar heads of flexor carpi ulnaris. It can be compressed here by the deep flexor-pronator aponeurosis (Figure 3).[15]

Predisposing conditions for ulnar neuropathy

Systemic conditions such as diabetes and hypothyroidism are associated with an increased incidence of nerve compression in general. In ulnar neuropathy at the elbow, cigarette smoking is a definite risk factor. However, it is not correlated with the dominant smoking arm i.e. repetitive elbow motion, nor is there a dose response relationship. It may be related to the effects of smoking on the microcirculation.[18]

Trauma at the elbow joint does not necessarily predispose to ulnar nerve compression but there may be an association.[18]

The combination of changes seen on electrophysiology and ultrasound would suggest that the location and aetiology of ulnar nerve symptoms may be related to either retroepicondylar compression or compression in the humeroulnar aponeurotic arcade. The former is more common in young administrative workers with external compression being the underlying compression force. The later is seen following manual labour or heavy work.[19]

