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# Cubital Tunnel Syndrome- Modern Treatment Options

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**Abstract**

**Introduction:** Cubital Tunnel Syndrome (CuTS) is the second most prevalent compression neuropathy affecting the upper extremity. Patients typically present with symptoms of paresthesia in the fourth and fifth digits, accompanied by hand weakness and pain. Most patients respond well to conservative treatments, but some of them require surgical intervention.

**Aim of the study:** The aim of this study is to assess and compare both surgical and conservative treatment methods. Conservative treatment for CuTS is typically pursued before surgical intervention, but there are no universally agreed-upon diagnostic and treatment algorithms for the condition.

**State of knowledge:** Symptoms of Cubital Tunnel Syndrome manifest in approximately 5% of the general population. Etiological factors include repetitive pressure, stretching, flexion, or trauma to the elbow joint. If not appropriately managed, advanced stages of the disease may lead to irreversible muscle atrophy and hand contractures.

**Summary:** Early diagnosis and intervention are the key factors in managing Cubital Tunnel Syndrome. The condition is frequently underdiagnosed, primarily due to patients' reluctance to seek treatment for their symptoms. No studies have definitively proven that one treatment approach is more effective than another. The choice of treatment should be based on the severity of the condition and the individual needs of the patient.

**Keywords:** Cubital Tunnel Syndrome, Ulnar Nerve Entrapment, Cell-Phone Elbow Conservative Therapy, Surgical Management, Elbow Anatomy.

**Introduction:**

**Definitions**:

Cubital Tunnel Syndrome (CuTS) is the second most prevalent compression mononeuropathy affecting the upper extremity, following carpal tunnel syndrome (Osei et al, 2017). Even though it is widespread, CuTS can be challenging for physicians to diagnose and treat due to the lack of widely accepted diagnostic and treatment guidelines. CuTS is defined as compression of the ulnar nerve in the cubital tunnel- a space in the dorsal medial elbow. Common causes include frequent elbow flexion, external pressure due to arm positioning during rest or work, abnormal musculature around the medial elbow (such as the anconeus epitrochlearis muscle), or post - traumatic adhesions and scarring from previous injuries or surgeries (Baron & Strohl, 2020). Ulnar nerve injuries are relatively common because this nerve is not protected by muscle or bone. In the natural progression of the syndrome, muscle atrophy (mainly dorsal interossei muscles of the hand) develops, if not treated. It is crucial to recognize that CuTS is a syndrome - a collection of signs and symptoms that occur together but may have different underlying causes, courses, and treatment approaches. This pathology is also known by other names, including ulnar nerve entrapment and more recently, as Cell - Phone Elbow.

**Epidemiology**:

According to various sources, the prevalence of cubital tunnel syndrome in the general population ranges from 1.8% to 5.9%, depending on the criteria used in the study (An et al., 2017). Despite its prevalence, it is difficult to determine exact statistics for several probable reasons. High - quality research is hard to conduct due to the lack of precise criteria and the need to include a large number of patients in the study. Cubital tunnel syndrome may be more prevalent than previously estimated in research. Some individuals experiencing symptoms of CuTS may be unwilling or unable to see a doctor for various reasons and may choose to self-manage their symptoms by using non-steroidal anti-inflammatory drugs (NSAIDs), avoiding strenuous activities, or even ignoring their problems entirely. When a patient does seek medical attention from a physician or another healthcare professional, they may not always receive an accurate diagnosis, or the diagnostic process may be prolonged. In some cases, it is difficult to differentiate this problem from other ulnar nerve neuropathies due to anatomical differences and the wide spectrum of symptoms. In the case of idiopathic CuTS, a specific morphological cause cannot be identified, which makes an accurate diagnosis challenging even with the use of MRI and other imaging techniques.

Since there is no clear anatomical abnormality or underlying pathology, diagnosing idiopathic CuTS often relies on excluding other potential causes of ulnar nerve compression.

Additionally, diagnostic methods like nerve conduction studies may not always reveal conclusive results, further complicating the diagnostic process. A comprehensive clinical assessment, including the patient’s medical history, symptoms, and physical examination, is crucial for diagnosis. The mean age of patients diagnosed with cubital tunnel syndrome is 46 years, with a standard deviation of 15.7 years (An et al., 2017). Several studies suggest that males are more likely to develop ulnar nerve compression at the elbow (Mondelli et al., 2005). Individuals with lower levels of education who work in more physically demanding jobs are at greater risk of developing ulnar nerve compression at the elbow, due to an increased likelihood of injury that may lead to CuTS (Bartels & Verbeek, 2007). Other lifestyle-related risk factors include diabetes, smoking, heavy alcohol consumption, and obesity (Palmer & Hughes, 2010).

**Anatomy and Pathophysiology:**

The ulnar nerve is composed of nerve fibers originating from the C8 and T1 spinal roots. These fibers form the medial part of the brachial plexus (plexus brachialis), which is responsible for the innervation of the upper limb. It originates from the medial cord of the brachial plexus and travels through the medial bicipital groove, alongside the inner side of the brachial artery. From there, it moves to the posterior part of the upper arm, reaching the ulnar groove above the medial epicondyle of the humerus. The nerve then descends along the inner side of the forearm, running with the ulnar artery and positioned between the ulnar and deep flexor muscles of the fingers, continuing down to the wrist (Polatsch et al., 2007).

This study focuses on the cubital tunnel, a space situated on the inner side of the elbow that serves as a pathway for the ulnar nerve around the joint. The anterior wall of the tunnel is formed by the medial epicondyle, the lateral wall is created by the ulnar brachial ligament on the medial side of the elbow joint. The fascia that forms the medial wall lies between the olecranon and the medial epicondyle of the humerus, with fibrous connections at the ends of the flexor carpi ulnaris. The ulnar nerve moves through the cubital tunnel, traveling from the medial side of the upper arm to the posterior side of the forearm. Its position within the ulnar groove is superficial, allowing the nerve to be palpated in this area. Posner identified and described five potential sites of compression for the ulnar nerve at the elbow level. These include: the epicondylar groove, the cubital tunnel, the area around the medial epicondyle, the intermuscular septum and the point where the ulnar nerve exits from the flexor carpi ulnaris muscle. Compression usually occurs at the cubital tunnel and at the epicondylar groove (Posner, 1998).

Anatomical variations can influence the cubital tunnel's structure and function, potentially causing ulnar nerve compression and contributing to cubital tunnel syndrome. The anconeus epitrochlearis muscle, a relatively common anatomical variant at the medial side of the elbow, forms part of the roof of the cubital tunnel. While it may help protect the ulnar nerve, its presence can also be a cause of nerve compression. Recent cadaver studies determined the prevalence of this variation in a Central European population to be 4.3%, with 95% confidence intervals (Dolensek, 2024).

The cubital tunnel retinaculum also known as the Osborne ligament typically forms the top part of the cubital tunnel and stretches between the medial epicondyle and the olecranon process. The ligament is a fibrous connective structure formed by the fusion of the antebrachial fascia and the deep fascia of the flexor carpi ulnaris (Lee et al., 2020).

A study by James et al. found that the average thickness of the ligament is 0.14 mm, and its average length is 2.2 cm (James et al., 2011). A notably thick Osborne ligament occurring in some individuals can lead to ulnar nerve compression. The risk of thickening is heightened when the elbow is frequently flexed or the flexor carpi ulnaris muscle contracts, as these movements increase tension in the ligament (Schuind et al., 1995). While multiple factors may play a role in cubital tunnel syndrome development, the structure forming the roof of the tunnel is the most common cause of the syndrome. There is no consensus on the role of the anconeus epitrochlearis muscle in CuTS. Some researchers believe that AE hypertrophy is a primary cause of CuTS (Zhang et al., 2017), while others argue that the AE protects against CuTS due to its lower rigidity compared to the cubital tunnel retinaculum (Maslow et al., 2018). Additionally during elbow flexion, the ulnar nerve can stretch between 4.7 and 8mm due to its anatomical path behind the medial epicondyle, which acts as a hinge. Repeated stretching of the nerve, as it moves proximally and distally to the medial epicondyle, can lead to nerve damage and result in symptoms of cubital tunnel syndrome (Bozentka, 1998).The ulnar nerve may be compressed as it passes under the arcade of Struthers, an aponeurotic band that connects the medial intermuscular septum to the medial head of the triceps, located about 8 cm proximal to the medial epicondyle, where it pierces the intermuscular septum and enters the posterior compartment (Folberg et al., 1994). As stated in the introduction, repeated pressure on the elbow or a history of elbow joint trauma are also recognized causes. These factors contribute to increased joint laxity due to a weakened ulnar collateral ligament, which in turn puts additional strain on the ulnar nerve (Mihata et al., 2019).

**Symptoms:**

Patients typically report both sensory and motor issues, starting with tingling or numbness in the fourth and fifth fingers, which can progress to muscle weakness and atrophy if not treated (Stewart, 2006). Pain and tenderness in the elbow are often a result of inflammation caused by repeated elbow flexion, especially during activities like phone use or sleeping with the elbow bent. Sleeping with the elbow flexed may cause nighttime symptoms that are severe enough to disrupt sleep. As the condition advances, symptoms may worsen, leading to hand weakness, difficulty performing daily tasks, and a claw hand deformity. McGowan classified cubital tunnel syndrome into three stages based on symptom severity: stage 1 involves intermittent sensory symptoms, stage 2 includes noticeable sensory loss and weakness in the hand's intrinsic muscles, and stage 3 is characterised by severe sensorimotor deficits and muscle atrophy (McGowan, 1950). Patients with different characteristics and comorbidities may present with distinct symptoms of varying severity. Diabetic patients often experience fewer sensory symptoms and more motor symptoms, such as weakness and muscle wasting, at the same time, this group tends to experience less improvement following surgery (Stirling, 2023). A study by Naran et al. compared CuTS presentations between older and younger patients, finding that older individuals typically show motor symptoms with a slow onset.

This gradual progression delays early diagnosis in older patients, whereas younger patients often present with acute sensory symptoms, leading to quicker identification. The study also suggested that the chronic onset of symptoms in older patients may be due to increased fibrosis around the nerve over time, while younger patients' early symptoms are likely linked to higher levels of elbow activity (Naran et al., 2010).

**Diagnostics:**
Paresthesia and hand pain can have many different reasons, so it is essential to correctly diagnose Cubital Tunnel Syndrome and choose the most appropriate treatment option. The diagnostic process should always start with a detailed patient history and physical examination. Physicians should begin the examination by carefully inspecting and palpating the affected extremity to identify any muscular atrophy, clawing of the ring and small fingers, or ulnar nerve subluxation over the medial epicondyle as the elbow moves through its full range of motion. Sensation should be tested mainly on the ulnar side of the hand and in the fourth and fifth digits. Clinicians can look for an ulnar claw hand deformity, an advanced symptom of ulnar nerve entrapment below the elbow. This deformity typically causes flexion and clawing of the fourth and fifth fingers due to a deficit in the third and fourth lumbricals, allowing the flexor digitorum profundus muscles to overpower hand function. The inability to properly flex the metacarpophalangeal joints or extend the interphalangeal joints results in the characteristic claw deformity. Several clinical tests can be performed to evaluate the ulnar nerve by analysing its motor function. The first muscle innervated by the ulnar nerve - the flexor carpi ulnaris, should be tested by having the wrist flexed against resistance in an ulnar direction. The flexor digitorum profundus should be evaluated by instructing the patient to flex the distal interphalangeal joint against resistance to detect any weakness. Similarly, the intrinsic hand muscles need to be examined by testing their strength and function through abduction against resistance (Beekman et al., 2017). Ulnar nerve impingement weakens the adductor pollicis muscle preventing proper thumb adduction. To test for this, the patient needs to pinch a piece of paper between their thumb and index finger. If the thumb's interphalangeal joint flexes instead of adducting, this indicates APM weakness, known as Froment's sign. This occurs due to the compensatory action of the flexor pollicis longus muscle, which is innervated by the median nerve. Wartenberg's sign, a sign of advanced ulnar nerve impairment, results from weakness in the third palmar interosseous and small finger lumbrical muscles. It is considered positive when the patient is asked to keep all fingers adducted, but the fifth finger starts to move away from the other digits (Goldman et al., 2009). A positive motor Tinel sign is present when tapping or manipulating a peripheral nerve causes a visible muscle twitch, sometimes accompanied by detectable electromyographic activity. For ulnar nerve testing, Tinel's sign is performed by tapping on the nerve at the cubital tunnel, which can trigger sensations such as an electric shock, tingling, or numbness in the areas innervated by the ulnar nerve (Montagna & Liguori, 2000). The elbow flexion test requires the patient to fully bend the elbow while the shoulder is slightly abducted. This position compresses the nerve in the cubital tunnel. Keeping the elbow flexed can lead to tingling or numbness in the ulnar nerve distribution in the forearm or hand (Cicotti et al., 2004). Studies have shown that clinical exams and provocative tests alone are not sufficient (Beekman et al., 2009), which is why various imaging methods should be used when diagnosing CuTS.
Magnetic resonance imaging with neurography sequences can demonstrate pathological changes within or around the nerve, nerve swelling with increased signal intensity and decreased muscle mass in atrophied muscles. However, studies have shown that ultrasonography is more sensitive than MRI and can better identify multifocal lesions (Burahee, 2021), MRI may offer additional benefits, such as better tissue detail and imaging of deeper or bone-surrounded structures. Ultrasound is a cost-effective, bedside tool recommended for initial nerve evaluation alongside clinical and electrodiagnostic tests.

Multiple studies have found ultrasound to be highly sensitive in detecting ulnar nerve disorders at the elbow (Ellegaard et al., 2015). It can identify ulnar nerve compression by assessing the nerve's cross-sectional area and diameter (Simon et al., 2015). The combination of ultrasound and electrodiagnostic testing boosts diagnostic sensitivity to 98% (Beekman et al., 2004). Nerve conduction studies and electromyography (EMG) are useful for pinpointing the location, confirming the diagnosis, and evaluating the severity of neuropathy. If surgery is needed, these electrodiagnostic tests can assist the surgeon in determining the exact site of nerve compression (Raeissadat et al., 2019). They can also help distinguish between ulnar neuropathy, C8 radiculopathy, plexopathies, and other forms of mononeuropathy. EMG should not be performed in patients with severe bleeding disorders, active infections or damaged skin at the needle insertion site, to avoid the risk of bleeding and spreading infection (Tavee, 2019).

There are no universally agreed-upon diagnostic algorithms due to test inaccuracies and positive results in asymptomatic individuals. Correct diagnosis requires a combination of clinical evaluation, physical exam, and additional testing.

## Treatment Options

### Conservative Management:

Conservative treatment is recommended for patients with mild manifestations of Cubital Tunnel syndrome. The main objectives are to reduce or eliminate symptoms and prevent the condition from worsening. Due to its nature, successful nonoperative treatment is less common in pediatric patients, but it should still be considered before surgery (Stutz et al., 2012).

A thorough patient history helps with identifying activities that worsen the symptoms. Educating the patient about the pathophysiology of the condition and suggesting modifications to avoid placing mechanical stress on the ulnar nerve can lead to significant improvement, depending on the extent of elbow degeneration (Nakamichi et al., 2009). Patients' compliance with instructions is often limited, as most jobs and daily activities require the use of the hands and elbows.

Elbow splints and braces can help patients avoid prolonged elbow flexion, providing support and relief. They can be used during daily activities as well as overnight. When combined with activity modifications, rigid night splinting has proven to be an effective, well-tolerated, and long-lasting treatment option for managing cubital tunnel syndrome (Shah et al., 2013). There are no well-established protocols for degrees of flexion or duration of treatment. Both in clinical practice and clinical studies, a flexion angle of 30-45° is typically used, with a treatment duration of around 3 months (Boone et al., 2015). However, the lack of high-quality scientific research prevents firm conclusions from being drawn.

Nonsteroidal anti-inflammatory drugs (NSAIDs) can help reduce inflammation in entrapment lesions, decrease swelling, and relieve symptoms. For pain that is well-localized, corticosteroid injections may be considered (Trehan et al., 2012). However, some studies suggest that the benefits of these treatments are typically short-lived, especially in patients with severe CuTS (Svernlöv et al., 2009).

Physical therapy is an effective way to avoid surgical treatment in some patients. The most commonly used and clinically studied method is neuromobilization. Neurodynamic mobilization works by reducing intraneural swelling through specific exercises that change the pressure in and around the nerves (Rozmaryn et al., 1998).

There are two main techniques used in neurodynamic mobilization: sliding and tensioning. Sliding involves increasing tension on the peripheral nerve by changing the joint position at one end while releasing tension at the opposite end. With the ulnar nerve, this can be done by flexing the elbow while simultaneously abducting the shoulder, or vice versa. Tensioning, on the other hand, increases the tension on the nerve at both ends simultaneously. Cadaveric biomechanical studies suggest that the sliding technique is less aggressive and is often better suited for acute injuries, postoperative care, and conditions causing nerve irritation or entrapment, such as bleeding and inflammation (Coppieters & Butler, 2008). Different physiotherapy techniques can also be implemented, and their effectiveness, like that of neuromobilization, largely depends on the knowledge and experience of the physician or physiotherapist, as well as the progression of the patient's condition. Manual techniques such as soft tissue release, especially of the fascia and relaxation of the forearm muscles are commonly used alongside neuromobilization. Physical therapy methods based on various physical stimuli are widely used in rehabilitation. However, their effectiveness in treating cubital tunnel syndrome has not been thoroughly studied, and there are no specific guidelines available. Transcutaneous electrical nerve stimulation (TENS) is a non-invasive pain relief treatment that uses low-frequency pulse currents to stimulate nerves, activating peripheral nerve fibers. This process helps expand blood vessels, improving circulation and nutrient flow to both the nerves and surrounding tissues. As a result, it enhances neuromuscular activity and excitability, which supports nerve regeneration. Shock wave therapy, laser therapy and ultrasound therapy also provide pain relief and possess anti-inflammatory properties. A study by Ozkan et al. demonstrated that ultrasound and low-level laser therapy led to improvements in clinical and electrophysiological measures, with both treatments demonstrating effective short-term results in managing ulnar nerve entrapment (Ozkan et al., 2015). Studies on the effectiveness of physiotherapy in treating CuTS have shown some benefits, but no clear conclusions can be made due to the small number of randomized clinical trials and differences in study methods, diagnoses, and treatment protocols. High-quality randomized controlled trials are needed to evaluate the effectiveness of physiotherapy for CuTS. Although physiotherapy may have a positive impact, most studies so far have questionable quality, making it impossible to recommend the best approach, duration, or frequency of treatment at this time. Therefore more research is needed (Wolny et al., 2022).

**Surgical Management:**

Surgery is recommended for advanced cases of CuTS or when conservative treatments have not been effective. Current treatment approaches are generally divided into two types: in situ decompression or transposition, with various technical variations in each. However, there is no scientific evidence suggesting that one technique is more effective than the other (Gervasio et al., 2005). A definitive "gold standard" for surgical treatment of CuTS has not yet been established (Palmer & Hughes, 2010). Usually, the choice of technique depends on the specific clinical situation and the surgeon's clinical experience and preference (Adkinson et al., 2015).

Simple in situ decompression is a commonly used technique, especially effective when nerve entrapment is the direct cause of Cubital Tunnel Syndrome. It is simple to perform and usually free of complications. Both open and endoscopic procedures are employed for decompression. The surgery aims to relieve nerve compression by cutting the superficial fascia of the flexor carpi ulnaris muscle and the retroepicondylar groove retinaculum.

It is essential to examine the nerve proximally to check for any compression by the arcade of Struthers or the septum and distally to the proximal forearm to identify and release any compression within the FCU caused by thicker intermuscular connective tissue. Open decompression, the first surgical technique for managing cubital tunnel syndrome, involves a longitudinal incision of 4-8 cm over the cubital tunnel to expose the medial elbow. Endoscopic decompression, on the other hand, uses a smaller 2-3 cm incision between the medial epicondyle and the olecranon (Balogh et al., 2018). Through this incision, an endoscope and retractors are used to locate the compression point and alleviate pressure on the nerve by cutting the overlying tissue. The endoscopic technique tends to result in less scar tenderness and elbow pain (Byvaltsev et al., 2020). However, it is suitable only for specific cases without nerve subluxation, traumatic causes of cubital tunnel syndrome, or significant structural issues. Simple decompression is generally successful, with a short-term complication rate of about 3.6% and a revision surgery rate of 1.8% (n = 225). Persistent symptoms may result from incomplete release, scar tethering, or ulnar nerve subluxation (Zhang et al., 2016).

Medial epicondylectomy is sometimes performed in combination with simple decompression. It involves removing varying amounts of the medial epicondyle bone-total, partial, or minimal, based on the specific clinical findings. This procedure allows for controlled anterior subluxation of the nerve, preventing abnormal movement during elbow flexion. It's recommended to remove less than 4 mm of the medial epicondyle's width to avoid damaging the anterior part of the medial collateral ligament, which can lead to elbow instability or medial elbow pain (Kim et al., 2012). Common complications include pain at the osteotomy site, elbow flexion contracture, and elbow instability.

Anterior transposition involves moving the ulnar nerve to a position in front of the elbow's axis of rotation. This can be done using subcutaneous, intramuscular, or submuscular techniques. This surgery allows for the release of the nerve from the cubital tunnel, the arcade of Struthers, and any other restrictive tissues over the medial epicondyle. It treats both the compression and traction components of the disease resulting in reducing tension on the nerve. In subcutaneous transposition, a sling made of muscular fascia is created to hold the ulnar nerve just below the skin.

Intramuscular and submuscular transpositions place the nerve within or beneath the pronator teres and flexor carpi ulnaris muscles, respectively (Anderson et al., 2022). Anterior transposition is often used in revision surgeries after a failed primary decompression. Meta-analyses conducted in recent years have found no difference in outcomes or revision rates between simple decompression and anterior transpositions for cubital tunnel syndrome (Said et al., 2019).

For severe or recurrent CuTS, nerve transfers have been proposed as a method to "supercharge" the ulnar nerve, promoting faster and more complete recovery with minimal complications. Axon regeneration is unlikely due to intraneural fibrosis and the apoptosis of chronically compressed axons. Supercharging involves transferring an intact, expendable motor nerve from a nearby area to the chronically denervated distal motor nerve, aiming to restore the axon population in the affected nerve. Studies have shown that the terminal branch of the anterior interosseous nerve that innervates pronator quadratus muscle can be transferred to the motor component of the ulnar nerve by creating an epineural window (Davidge et al., 2015). Improvement in function is related to remyelination and axonal regeneration.

**Conclusions:**

Cubital Tunnel Syndrome (CuTS) is a common condition affecting up to 6% of the general population, hence, knowing how to manage it is important for healthcare providers. It presents with a variety of symptoms, including paresthesia, hand weakness and clumsiness, muscle atrophy, and pain in the upper extremity. CuTS is notable for its impact on a wide and diverse population. Despite this, there are few definitive epidemiological or risk factors linked to the development of CuTS, with repetitive elbow movements, such as those performed at work, being the most significant. The condition often goes undiagnosed due to a lack of precise diagnostic algorithms and patients not seeking treatment for their symptoms. Correct diagnosis requires a combination of clinical evaluation, physical examination, and testing. If diagnosed promptly and accurately, the treatment outcomes for CuTS can be very promising. In the treatment of ulnar nerve entrapment, conservative methods are employed, including lifestyle changes to reduce mechanical stress on the elbow, nonsteroidal anti-inflammatory drugs, use of a splint or brace and physiotherapy with a focus on neuromodulation. In cases of severe Cubital Tunnel Syndrome, patients can be qualified for one of the surgical methods such as open or endoscopic decompression with or without medial epicondylectomy, anterior transposition and nerve transfer. Due to the lack of consensus regarding the single best treatment modality, treatment plan should be personalized considering the patient's predispositions, financial resources and physical activity level. There is a need for high-quality randomized controlled trials to assess the effectiveness of various treatment methods for CuTS.

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