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Efficacy of Simple Decompression Versus Anterior Transposition in Cubital Tunnel Syndrome: Evidence-Based Perspectives

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ABSTRACT

Background: Cubital tunnel syndrome is the second most common peripheral nerve entrapment neuropathy of the upper extremity, characterized by compression of the ulnar nerve at the elbow. Surgical management is indicated for patients with persistent symptoms or progressive neurological deficits. Among various surgical interventions, simple decompression and anterior transposition of the ulnar nerve are the most widely performed techniques. However, the optimal surgical approach remains a topic of debate. This review aims to evaluate the efficacy, outcomes, and risks associated with simple decompression versus anterior transposition in the management of cubital tunnel syndrome, drawing upon recent evidence and comparative studies. Simple decompression is a less invasive procedure involving the release of compressive structures without disturbing the ulnar nerve's anatomical pathway. In contrast, anterior transposition entails repositioning the nerve anteriorly, away from the cubital tunnel, which can be performed subcutaneously, intramuscularly, or submuscularly. While both techniques are effective in relieving symptoms, controversies persist regarding their comparative benefits, risks, and indications. Recent randomized controlled trials and meta-analyses have provided mixed results, with some suggesting equivalent outcomes and others indicating specific advantages for each technique based on patient factors such as severity, occupational demands, and anatomical considerations. This article synthesizes current literature to compare the efficacy of simple decompression and anterior transposition, with a focus on functional outcomes, complication rates, and patient-reported satisfaction. It also discusses the underlying anatomy, pathophysiology, diagnostic challenges, and surgical decision-making. Despite the wealth of available studies, gaps remain regarding optimal patient selection and long-term outcomes. By critically evaluating the existing evidence, this review seeks to inform clinical decision-making and highlight directions for future research in the surgical management of cubital tunnel syndrome.

Keywords: Simple Decompression, Anterior Transposition, Cubital Tunnel Syndrome

INTRODUCTION

Anatomy and Pathophysiology of Cubital Tunnel Syndrome

The ulnar nerve originates from the medial cord of the brachial plexus and traverses a complex anatomical course, most notably passing through the cubital tunnel at the elbow. The cubital tunnel is a fibro-osseous canal bounded by the medial epicondyle, olecranon, and the Osborne ligament.

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Dynamic factors such as elbow flexion can decrease the tunnel's volume, increasing pressure on the ulnar nerve and predisposing it to compression [6]. Repetitive elbow flexion and external pressure are common precipitating factors [7].

Histopathologically, chronic compression leads to demyelination and, in advanced cases, axonal degeneration of the ulnar nerve. The sequence of pathophysiological events begins with local ischemia, inflammation, and subsequent fibrosis, ultimately resulting in compromised nerve conduction and clinical symptoms. Variations in tunnel anatomy and individual susceptibility further influence the development and severity of cubital tunnel syndrome [8].

Anatomic anomalies such as an accessory anconeus epitrochlearis muscle or hypertrophy of surrounding tissues may predispose individuals to entrapment. Furthermore, congenital or acquired instability of the ulnar nerve, where it subluxes over the medial epicondyle during flexion, can exacerbate compression and alter the mechanical environment of the nerve, influencing the choice of surgical technique [9].

Clinical Presentation and Diagnosis

Patients with cubital tunnel syndrome most commonly present with numbness, tingling, and paresthesias in the ring and small fingers, often exacerbated by elbow flexion. In advanced cases, there may be weakness or atrophy of the intrinsic hand muscles, especially the first dorsal interosseous and hypothenar muscles, leading to diminished grip and pinch strength [10]. Clawing of the ring and little fingers may be evident in severe cases.

Diagnosis is primarily clinical but is often supplemented by electrophysiological studies. Nerve conduction velocity (NCV) testing remains the gold standard, revealing conduction slowing across the elbow segment. Electromyography (EMG) may demonstrate denervation changes in the ulnar-innervated muscles, further supporting the diagnosis [11]. Advanced imaging, such as ultrasound or MRI, can aid in detecting space-occupying lesions, structural anomalies, or nerve subluxation, thereby influencing surgical planning [12].

Several provocative tests, including Tinel's sign at the elbow and the elbow flexion test, are commonly employed but lack high specificity. Careful differentiation from other causes of ulnar neuropathy, such as cervical radiculopathy or Guyon's canal syndrome, is essential for appropriate management. Early diagnosis is crucial as prolonged compression may lead to irreversible nerve damage [13].

Surgical Indications

Surgical intervention is indicated for patients with persistent symptoms despite adequate conservative management, or in those presenting with progressive motor weakness, atrophy, or severe sensory loss.

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Conservative treatments, such as activity modification, splinting, and anti-inflammatory medications, may benefit patients with mild or intermittent symptoms, but often fail in cases with significant or longstanding nerve compression [14].

The decision to operate is influenced by the severity and duration of symptoms, degree of nerve dysfunction, patient comorbidities, and occupational requirements. Advanced cases, marked by muscle wasting or marked conduction block on NCV testing, generally warrant prompt surgical decompression to prevent permanent neurological deficits [15]. Moreover, patients whose symptoms significantly impair daily function or quality of life should also be considered for surgical intervention [16].

There is growing recognition of the importance of early surgical intervention in patients with moderate to severe disease, as prolonged denervation can limit the potential for functional recovery even after successful nerve decompression. Patient selection should therefore be individualized, considering both clinical and electrophysiological findings [17].

Surgical Techniques

Simple Decompression

Simple decompression involves releasing compressive structures over the ulnar nerve at the elbow without altering its anatomical position. This can be achieved through open or minimally invasive (endoscopic) approaches. The rationale behind simple decompression is that most cases of cubital tunnel syndrome result from external compression rather than intrinsic instability of the nerve [18].

Surgical exposure allows for the release of the Osborne ligament, fascia of the flexor carpi ulnaris, and any fibrous bands constricting the nerve. The technique is relatively straightforward, associated with shorter operative times, lower morbidity, and rapid postoperative recovery compared to transposition procedures. Studies have demonstrated favorable outcomes in patients without evidence of nerve subluxation or significant deformity [19]. Endoscopic simple decompression is gaining popularity for its minimally invasive nature and reduced postoperative pain [20].

Despite its advantages, simple decompression may be less effective in patients with ulnar nerve instability or structural anomalies. Careful intraoperative assessment is essential to ensure that the nerve remains stable throughout the elbow's range of motion. In cases of persistent subluxation or instability observed intraoperatively, conversion to anterior transposition may be required [21].

Anterior Transposition (Subcutaneous, Intramuscular, Submuscular)

Anterior transposition involves relocating the ulnar nerve from its position in the cubital tunnel to an anterior location, thereby relieving tension and minimizing the risk of recurrent compression. This can

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be achieved through subcutaneous, intramuscular, or submuscular techniques, each with unique technical considerations and indications [22].

Subcutaneous transposition places the nerve just beneath the skin and superficial fascia, providing effective decompression while maintaining a relatively simple dissection. Intramuscular and submuscular transpositions position the nerve within or beneath the flexor-pronator muscle mass, offering greater protection but at the cost of increased surgical complexity, potential for muscle ischemia, and prolonged rehabilitation [23].

Anterior transposition is traditionally indicated in patients with nerve instability, significant cubitus valgus deformity, or failed prior decompression. It is also favored in cases where intraoperative assessment reveals persistent compression or kinking of the nerve despite decompression. Recent studies have sought to determine the optimal transposition plane, but no consensus has been reached regarding superiority, and the choice is often dictated by surgeon preference and intraoperative findings [24].

While anterior transposition provides robust decompression in appropriately selected patients, it is associated with a higher risk of peri-neural scarring, vascular injury, and iatrogenic nerve trauma. Thus, careful patient selection and meticulous surgical technique are critical to optimizing outcomes [25].

Comparative Efficacy: Simple Decompression vs. Anterior Transposition

Multiple randomized controlled trials and meta-analyses have compared the outcomes of simple decompression versus anterior transposition in patients with cubital tunnel syndrome. Overall, the evidence suggests that both techniques provide comparable symptomatic relief, with no significant difference in long-term functional outcomes for the majority of patients [26]. However, nuanced differences exist based on patient selection, anatomical considerations, and presence of nerve instability.

A large meta-analysis by Mowlavi et al. included over 500 patients and found no statistically significant difference in overall success rates, complication rates, or recurrence between the two procedures. Notably, patients without ulnar nerve instability or anatomical deformity achieved similar outcomes with the less invasive simple decompression [27]. Subsequent systematic reviews have supported these findings, though some report a slight trend toward improved strength recovery with transposition in severe or unstable cases [28].

Recent randomized studies have emphasized the importance of intraoperative assessment of nerve stability. Intraoperative subluxation is a strong predictor of poor outcomes following simple decompression, and such patients may benefit from anterior transposition. Conversely, in the absence

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of subluxation, simple decompression is generally sufficient and spares patients the added morbidity of transposition [29].

Despite these general trends, surgeon preference, training, and local practice patterns continue to influence the choice of procedure. Ongoing research is needed to refine indications and better stratify patients based on preoperative and intraoperative risk factors [30].

Functional and Patient-Reported Outcomes

Assessment of surgical outcomes in cubital tunnel syndrome relies on both objective measures (muscle strength, two-point discrimination, nerve conduction studies) and subjective patient-reported metrics (pain scores, disability indices, satisfaction). Multiple studies have reported high rates of symptom resolution and patient satisfaction with both simple decompression and anterior transposition, with over 80% of patients experiencing significant functional improvement postoperatively [31].

Patient-reported outcome measures, such as the Disabilities of the Arm, Shoulder and Hand (DASH) score and the Michigan Hand Outcomes Questionnaire (MHQ), are commonly utilized in comparative studies. Recent data suggest no significant difference in long-term DASH or MHQ scores between the two procedures when patients are appropriately selected based on nerve stability and severity of compression [32]. Early postoperative pain may be lower with simple decompression, owing to its less invasive nature and minimal tissue dissection [33].

Return to work and resumption of daily activities are important considerations for patient counseling. Simple decompression is generally associated with shorter rehabilitation and faster return to function, especially in patients with mild to moderate disease. However, in cases with marked nerve instability or recurrent compression, anterior transposition may provide superior long-term relief and functional gains [34].

Complications and Risks

Both simple decompression and anterior transposition are considered safe procedures with low overall complication rates, but each carries specific risks. The most common complications of simple decompression include incomplete symptom relief, persistent nerve instability, and, rarely, iatrogenic nerve injury. Recurrence rates are low but may be higher in patients with unrecognized nerve subluxation [35].

Anterior transposition is associated with a broader range of potential complications, including perineural fibrosis, vascular injury, wound complications, and delayed return of function due to muscle dissection. Submuscular and intramuscular transpositions, while offering protection from trauma, are linked to increased postoperative pain, longer rehabilitation, and higher risk of muscle weakness or

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ischemia [36]. Overall complication rates in comparative studies range from 5% to 15%, with no significant difference in serious adverse events between the two approaches [37].

Nerve instability, subluxation, and scarring are important factors influencing long-term outcomes and risk of recurrence. Appropriate intraoperative assessment and meticulous technique can mitigate many of these risks. Infection, hematoma, and complex regional pain syndrome are rare but recognized complications that must be discussed with patients preoperatively [38].

Conclusion

Simple decompression and anterior transposition represent the cornerstone surgical interventions for cubital tunnel syndrome, each offering distinct advantages and limitations. Current evidence supports the efficacy of both techniques in alleviating symptoms and restoring function, with outcomes largely dictated by patient selection, anatomical factors, and intraoperative findings. Simple decompression is sufficient for most patients without nerve instability or deformity, providing rapid recovery and minimal morbidity. Anterior transposition remains the procedure of choice in cases of nerve instability, failed prior decompression, or significant anatomical abnormalities. Surgeons must individualize treatment decisions, guided by clinical and electrophysiological assessment, to optimize outcomes for patients with this common and disabling condition [39,40].

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