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COMPARATIVE STUDY OFARTICLES ON DIFFERENT SURGICAL APPROACHESBY DIVERSE AUTHORS IN TREATMENT OF CUBITAL TUNNEL SYNDORME

КОМПАРАТИВНА СТУДИЈАНАНАУЧНИ ТРУДОВИ НА РАЗЛИЧНИ ХИРУРШКИ ПРИСТАПИ ОД РАЗЛИЧНИ АВТОРИ ВО ТРЕТМАНОТ НА СИНДРОМОТ НА КУБИТАЛНИОТ КАНАЛ

Boro Dzonov and Blagoja Srbov

University Clinic for Plastic and Reconstructive Surgery, Medical Faculty, Ss Cyril and Methodius University of Skopje, Republic of North Macedonia

Abstract

Introduction. Cubital tunnel syndrome is the second most common compressive neuropathy in the upper limb. The diagnosis of cubital tunnel syndrome is primarily clinical. A thorough history should include the onset of symptoms, presence of grip or pinch weakness, numbness and the chronicity of the condition.
Methods. Depending on symptoms and clinical signs, the surgical methods of choice include *in situ* open decompression, submuscular transposition, intramuscular transposition, subcutaneous transposition and medial epicondylectomy. APubMed search was conducted and published articles were comparedusing predetermined criteria. Data collected showed the follow-up of patients' surgical treatment with different surgical approaches. The percentage results are shown as combined good and excellent outcomes.
Results. Despite the different scoring scales used and difficulty comparing studies directly, the bulk of single technique outcomes studies and multi-technique comparative studies demonstrate that all surgical techniques discussed are effective treatment methods for cubital tunnel syndrome, but fail to demonstrate one technique to be uniformly superior to another.
Conclusion. The literature, articles and casereports, state that all of the techniques are generally effective. Comparative studies show no statistical difference in outcomes with any presentedtechnique. One conclusion is obvious that transposition should be performed only when subluxation of the nerve is present. In conclusion, there is no superior technique and no gold standard in treatment ofcubital tunnel syndrome.

Keywords: cubital tunnel, ulnar nerve, decompression, transposition, ulnar neuropathy

Апстракт

Вовед. Синдромот на кубиталниот канал е втора најчеста компресивна невропатија на горниот екстремитет. Дијагнозата на овој синдром е примарно клиничка. Целосната историја на болеста вклучува појава на симптомите, присуство на слабост при зграпчување или штипењесо шаката, отрпнатост и самата хроничност на состојбата.
Методи. Во зависност од тоа какви се симптомите, хируршките третмани на избор се декомпресија на самото место, субмускуларна транспозиција, интрамускуларна транспозиција, поткожна транспозиција и медијална епикодилектомија. Според критериумите за овој синдром се бараа и споредуваа трудови кои се објавени на PubMed. Информациите од опоравокот на пациентите после различни хируршки третмани на овој синдром се групираа и анализираа. Се разгледуваше процентот на добар и одличен исход од оперативниот третман.
Резултати. Без разлика на начинот на оценување кај различни студии и неможноста да се споредат директно, се приметува дека исходот кај разлчните начини на оперативен третман сите имаат задоволително ниво на опоравување. Не може да се издвои еден пристап кој би бил подобар од другите.
Заклучок. Литературата, трудовите и приказите на случаеви, ни покажуваат дека сите пристапи се генерално ефективни. Не постои статистичка разлика во резултатот од различните хируршки техники. Еден заклучок може да се издвои, а тоа е дека транспозиција треба да се направи кај нерв кој луксира од лежиштето. Не постои златен стандард при третман на Синдромот на кубиталниот канал.

Клучни зборови: кубитален канал, улнарен нерв, декомпресија, транспозиција, улнарна невропатија

Introduction

Cubital tunnel syndrome is the second most common

Correspondence to: Boro Dzonov, University Clinic for Plastic and Reconstructive Surgery, Medical Faculty, Ss Cyril and Methodius University of Skopje, R. N. Macedonia; E-mail: bdzonov@yahoo.com

compressive neuropathy in the upper limb. Its history dates back to the 1807 when a 14-year-old girl presented to Dr. Henry Earle with a 3-year history of hypersensitivity and pain in the ulnar nerve distribution that prevented sleep. At one point, her pain was so severe that Mr. Earle (1816) transected her ulnar nerve above the medial epicondyle of the humerus. Intraoperatively, he noted that the epineurium of the ulnar nerve behind the medial condyle was firmer and thicker than normal. After surgery, the patient had permanent ulnar nerve deficit but was cured of her pain [1].

The ulnar nerve (C7, C8, Th1) is formed directly from the medial branch of brachial plexus. The nerve is medial to the axillary and brachial artery and medial to the brachial vein until it reaches the medial part of the humerus. The arcade of Struthers is a deep brachial fascial band that joins the intermuscular septum and invests the ulnar nerve approximately 8 cm proximal to the medial epicondyle. About 4 cm distal to the medial epicondyle, the nerve gives a motor branch for the*flexor carpi ulnaris* muscle, and few centimeters distally it innervates the ulnar part of *flexor digitorum profundus* muscle. The ulnar nerve travels posterior to the medial epicondyle and medial to the olecranon to enter the cubital tunnel. The tunnel roof comprises a tight fascial layer that extends from the *flexor carpi ulnaris* muscle (FCU) to the arcuate ligament of Osborne, while the floor is defined by the ulnar collateral ligament. Upon exiting the cubital tunnel, the ulnar nerve travels into the forearm between the ulnar and humeral FCU heads, then deep to the deep *flexor pronator aponeurosis* [2].

The diagnosis of cubital tunnel syndrome is primarily clinical, as electrodiagnostic tests can often be negative despite significant symptoms and exam findings. A thorough history should include the onset of symptoms, presence of grip or pinch weakness, numbness, aggravating and alleviating activities, comorbidities (i.e., diabetes, peripheral neuropathies), and previous elbow trauma. Perhaps the single most important feature of history, however, is the chronicity of the symptoms. Intermittent symptoms elicited by elbow flexion are likely due to transient ischemia of the nerve and will respond well to treatment. Constant numbness or weakness responds less predictably to surgery. Numbness and paresthesias are the most common presenting features in early cubital tunnel syndrome, with pain developing later in the condition. Patient complaints of loss of dexterity suggest intrinsic muscle weakness. There are many diagnostic tests that can determine this nerve entrapmentsyndrome. Usually electromyography is useful because it demonstrates block or slower motor conduction of the nerve at the region of the elbow. Other diagnostic methods are X-ray of the elbow, computer tomography (CT) scan, MRI or ultrasonography. A scale used by McGowan can be used to classify the pain and the dysfunction caused by the ulnar nerve compression, where grade I dysfunction is characterized by transient paresthesias and subjective weakness. Grade II dysfunction presents with intermittent paresthesias and objective weakness. Grade III is defined by constant paresthesias and measurable weakness. There are few clinical signs of unlar nerve palsy. Duchenne's sign or claw or intrinsicminus deformity, is hyperextension of proximal phalanx with flexion of middle and distal phalanges caused by paralysis of lumbricals and interossei muscles. Masse's sign is flattening of the dorsal transverse metacarpal arch caused by hypothenar paralysis and loss of the fifth metacarpal supination. Wartenberg's sign is ulnar deviation and weak adduction of the small finger caused by unopposed pull of *extensor digiti minimi*. Froment's sign is hyperflexion of thumb distal phalanx and supination of index during attempted key pinch caused by atrophy of *adductor pollicis* and first dorsal interosseous muscles. Jeanne's sign is hyperextension deformity of thumb metacarpophalangeal joint caused by compensatory instability [3]. The treatment of this condition depends on the clinical presentation of the patient. If the symptoms are mild or intermittent, patients can be treated non-surgically, such as activity modification, splinting, and physiotherapy, and the outcome is highly satisfactory. Once the symptoms begin to be permanent, surgical treatment should be considered. There are few surgical methods we use when treating this condition. Depending on the symptoms and the clinical signs, the methods of choice include *in situ* open decompression, submuscular transposition, intramuscular transposition, subcutaneous transposition and medial epicondylectomy.

Material and methods

The methods of choice for surgical treatment of cubital tunnel syndrome are described in brief. Approaches for treatment include *in situ* open decompression, submuscular transposition, intramuscular transposition, subcutaneous transposition and medial epicondylectomy.

In situ open (simple) decompression

The first described approach is open *in situ* (simple) decompression. A 6-10-cm incision is made along the course of the ulnar nerve between the olecranon and medial epicondyle. This procedure is using the wide-awake approach (local infiltration without sedation or tourniquet). Field infiltration of local lidocanie and epinephrine is performed beginning 8–10 cm proximal to the medial epicondyle to ensure anesthesia in the medial antebrachial cutaneous nerve distribution. Care should be taken to avoid branches of this nerve during subsequent dissection. Beginning proximally, the arcade of Struthers is released, followed by Osborne's ligament and the FCU fascia. The ulnar nerve is left undisturbed in its bed. The elbow is placed through a range of motion to check for any residual compression sites or subluxation of the nerve [4].

Submuscular transposition

With elbow flexion, the ulnar nerve is placed under tension and compression as the cubital tunnel volume decreases. The goal of transposition is to move the nerve anterior to the axis of elbow flexion, thereby decreasing tension on the nerve. Critics of this technique thinkthat dissection of the nerve from its bed compromises the segmental blood supply of the nerve. Transposition may also lead to more local numbness and discomfort than simple decompression due to the sacrifice of a greater number of local cutaneous and articular sensory branches. As in simple *in situ* decompression, the proximal nerve is identified and traced distally following release of the arcade of Struthers. To prevent the formation of a new compression site proximally, a segment of the intramuscular septum is excised; care must be taken to avoid injury to the venous plexus associated with the septum. The nerve is then unroofed to the level of the deep *flexor pronator aponeurosis*. A vessel loop is placed around the nerve to provide gentle traction while the nerve is dissected free from its bed and transposed anterior to the medial epicondyle. The motor branches to the FCU and the FDP are preserved. The *flexor pronator* muscle mass is divided 1–2 cm distal to the medial epicondyle. The median nerve must be identified and preserved. The *flexor pronator* mass is repaired over the transposed nerve with a stepwise lengthening technique to avoid causing a new compression site .

Intramuscular transposition

Intramuscular transposition is another technique used in combination with anterior transposition. Instead of elevating the entirety of the *flexor pronator* muscle mass to maintain the ulnar nerve anterior to the medial epicondyle, the intramuscular technique involves making a groove in the *flexor pronator* mass. Opponents tothis-technique thinkthat the absence of a natural tissue plane results in a scarred bed around the nerve that can itself lead to nerve compression.

Subcutaneous transposition

After anterior transposition, many surgeons prefer to leave the nerve in a subcutaneous position. Instead of elevating the *flexor pronator* mass, the ulnar nerve is maintained in its transposed position by suturing the loose epineurium to the forearm fascia. Alternatively, a small sling can be created by suturing the subcutaneous tissue from the anterolateral skin flap to the fascia overlying the medial epicondyle, or by suturing a strip of elevated muscle fascia to the overlying dermis. To prevent subluxation of the nerve back into its native bed, the roof of the cubital tunnel may be reapproximated [5].

Medial epicondylectomy

In the medial epicondylectomy technique, the nerve is dissected as in a simple *in situ*decompression. The medial epicondyle is exposed in a subperiosteal plane, maintaining the origin of the *flexor pronator* mass with the periosteum. The anteromedial edge of the epicondyle is scored with an osteotome. The epicondylectomy is performed along a plane midway between the sagittal and coronal planes of the humerus, all the while preserving the attachments of the ulnar collateral ligament. The flexor pronator origin is then reattached over the epicondylectomy site.
Many different scoring scales are used across these studies, however most studies group outcomes into Excellent, Good, Fair, Satisfactory, and Poor. Some of the scales used in determination of the condition are the McGowan improvement scale, Bishop score, Lsu (Louisiana State University) grade, Wilson and Krout, Gabel Amadio, MacDermid, Messina classification and of course the subjective assessment and the patient satisfaction. A PubMed search was conducted and published articles were comparedusing predetermined criteria. Data collected showed the follow-up of the surgical treatment of patients with different surgical approaches. The percentage results are shown as combined good and excellent outcomes.

Results

In situ open (simple) decompression

The poorest outcome wasdescribed by Barterls *et al.* with 65.3% of combined good and excellent percentage [6]. Those with the best combined good and excellent percentages outcomes, both limited by notably small sample sizes, were Cho *et al*. and Keiner *et al.* with 100% and 94.1%, respectively [7, 8]. Most of the other studies presentedfrom 78 to 91% of combined good and excellent percentage outcomes.
Complication rates, while not uniformly reported, are generally low with this technique. Most frequent were incisional tenderness, as well as numbness in the distribution of the median antebrachial cutaneous nerve (MACN), followed by the less common superficial infections and wound dehiscence. Incisional length varied widely, but often as long as 8-10 cmor more, which poses a substantial threat of injury to the MACN, as well as increased postoperative pain and healing time, which are established consequences of open surgery and large incisions [9].

Submuscular transposition

Both Gervasio and Gambardella with a combined good and excellent percentage of 87% [10] and Davis and Bulluss with 82.5% of patients improving at least one Louisiana State University grade, [11] have demonstrated good results with this technique, with only one complication of MACN distribution numbness between the two studies. The main advantage of this technique compared tothe other transposition techniques is the protection offered by the overlying muscle, but there have beenno studies that demonstrate any degree of superiority over any of the techniques discussed. Submuscular placement may be preferable when the patient has little subcutaneous tissue to protect the nerve but transposition is necessary due to subluxation of the nerve.

Intramuscular transposition

Kleinman *et al*. retrospectively analyzed 52 procedures in 48 patients, finding a combined good and excellent percentage of 87%. They noted that many detractors of the technique previously were concerned about scarring within the muscle bed or traction forces on the nerve, but these concerns have yet to be proven and no complications were noted in this study [12]. Only one comparative study, was found, that of Emamhadi *etal*., presenting intramuscular transposition to have better motor outcomes than subcutaneous transposition, but equivalent pain and sensory outcomes between the two groups [13]. It was posited by Kleinman that adequate release of the fibrous aponeurosis and intermuscular septum, between the flexor and pronator muscles, in addition to the creation of a 5 mm trough fashioned into the musculature, allows free movement of the ulnar nerve in a well-vascularized bed providing a better environment for healing and protection than the subcutaneous location.

Subcutaneous transposition

In 2015, Lima *et al.* demonstrated 77.7% of combined good and excellent percentage with complications of scar pain, paresthesia and early superficial infection. A recent meta-analysis by Chen *etal*. concluded that outcomes were equivalent between subcutaneous transposition and *in situ* decompression; however, subcutaneous transposition had a significantly higher complication rate [14].
Overall, there is no evidence to suggest subcutaneous transposition to besuperior to *in situ* decompression, and that outcomes are likely comparable between the two techniques. Except in the case of a nerve subluxation on exam, which over time may cause chronic irritation which is relieved by transposition, it may be preferable to perform *in situ* decompression as the *de facto* procedure in order to preserve the vascular supply which is disrupted by transposition. However, many proponents of the procedure argue that the anastomoses between proximal and distal vascular supply to the nerve negates this point. The nerve is more exposed to potential trauma in its post-transposition location, with only the skin and small amount of subcutaneous tissue protecting it from external forces as compared to being protected by the bony structures of the elbow and several layers of overlying tissue in its native position.

Medial epicondylectomy

Twenty-one case series reported on 886 medial epicondylectomies. The mean percentage of patients obtaining improvement of one or more McGowan grade was 79%. The mean percentage obtaining a good and excellent Wilson Krout grade of outcome was 83%. Of six comparative studies, two showed no significant differences in outcomes between medial epicondylectomy and transposition procedures, and three reported better outcomes with medial epicondylectomy. One reported similar outcomes with medial epicondylectomy and simple decompression [15].

Discussion

Despite the different scoring scales used and difficulty comparing studies directly, the bulk of single technique outcomes studies and multi-technique comparative studies demonstrate that all surgical techniques discussed are effective treatment methods for cubital tunnel syndrome, but fail to demonstrate any technique to be uniformly superior to another, except in the case of ulnar nerve subluxation in which transposition is generally preferred. While anterior transposition is widely accepted as the preferred method for treating cubital tunnel syndrome where ulnar nerve subluxation is present, it seems there are no studies specifically comparing *in situ* decompression against anterior transposition in this specific subset of patients. Studies that compared simple decompression against anterior transposition showed that specific group of patients with subluxation of the nerve experienced distinctly better results when treated with anterior transposition rather than with simple decompression, but that overall there was no significant difference between the two groups. Except for these two studies,it seems there is no evidence supporting the widely held belief that transposition is superior for this subset of patients.
Simple decompression has been shown to be effective in treating cubital tunnel syndrome, with results equivalent to those of anterior transposition. Similarly, a retrospective study comparing medial epicondylectomy alone with medial epicondylectomy and anterior subcutaneous transposition showed no differences. Two meta-analyses compared the outcomes of simple decom-

pression and anterior transposition techniques, butfailed to find a significant difference between surgical techniques, although one of the studies did observe a trend toward improved outcomes with anterior transposition. The major limitation of the meta-analyses in cubital tunnel syndrome remains a lack of reliable, reproducible, and valid outcome measures. The posterior branch of the medial antebrachial cutaneous nerve (MACN) is at potential risk of injury during both simple decompression and anterior transposition. Injury to the nerve can result in a painful neuroma and hyperesthesia. Ulnar nerve subluxation following simple decompression can lead to a persistent pain and is addressed by anterior transposition. Medial epicondylectomy is complicated by a persistent elbow pain in up to 45% of patients. Incomplete decompression is effectively addressed through a thorough reassessment for points of persistent compression followed by an anterior transposition. If there is a significant amount of perineural scarring associated with symptoms, the addition of soft-tissue coverage in the form of a muscle flap, fat flap, or vein wrapping may be considered.

Conclusion

The literature, articles and casesreported state that all of the techniques are generally effective.When considering the various techniques with roughly equal efficacy, many authors suggest choosing techniques that will minimize incision size and degree of tissue dissection, operating time, post-operative complication rates. The predominant role has the surgeon, who has to decide which approach to choose. Some surgical approaches are more invasive than others. Less invasive techniques lead to shorter healing times, less pain and decreased operative times. The rates of infection are decreasing. Comparative studies show no statistical difference in outcomes with any technique. One conclusion is obvious that transposition should be performed only when subluxation of the nerve is present. In conclusion, there is no superior technique and no gold standard in treatment ofcubital tunnel syndrome.

Conflict of interest statement. None declared.

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