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Original article

Ultrasound-guided surgical treatment for ulnar nerve entrapment: A cadaver study

Traitement chirurgical de la compression du nerf ulnaire au coude sous échographie. Étude cadavérique

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Abstract

Several open and endoscopic techniques for the surgical treatment of ulnar nerve entrapment at the elbow (cubital tunnel syndrome) have been described that provide decompression with or without anterior transposition. Based on our experience with US-guided decompression for carpal tunnel syndrome in our department, we developed a similar surgical technique for the decompression of the ulnar nerve at the elbow. Using sixteen cadaver upper limbs, we performed decompression of all the structures possibly responsible for ulnar nerve compression at the elbow. The structures involved were Struthers' arcade, the cubital tunnel retinaculum, Osborne's fascia and Amadio-Beckenbaugh's arcade. The procedure was followed by anatomical dissection to confirm complete sectioning of the compressive structures, absence of iatrogenic vascular or nervous injuries and absence of nerve dislocation or instability. There were no remaining compressive structures after the release procedure. There was no iatrogenic damage to the nerves and no nerve dislocation was observed during elbow flexion or extension. In 3.4% cases, a thin superficial layer of one or more of the identified structures remained but these did not appear to compress the nerve based on US imaging. Using ultrasonographic visualization of the nerve and compressive structures is easy. Each procedure can be tailored according to the nerve compression sites. Our cadaveric study shows the feasibility of an US-guided percutaneous surgical release for ulnar nerve entrapment.

Keywords: Ulnar nerve; Surgical decompression; Percutaneous technique; Sonography

Résumé

Plusieurs techniques à ciel ouvert ou sous endoscopie sont proposées dans le traitement chirurgical de la compression du nerf ulnaire au coude. Aucune de ces techniques n'a montré sa supériorité. Forts de notre expérience sur la libération du canal carpien sous échographie, nous avons réalisé une étude de faisabilité du traitement chirurgical de la compression du nerf ulnaire au coude sous échographie par voie percutanée. Nous avons effectué la libération de toutes les structures pouvant comprimer le nerf ulnaire dans la région du coude sur seize membres supérieurs cadavériques. Ces structures sont l'arcade de Struthers, la bandelette épitrochléo-olécranienne (ou rétinaculum du tunnel cubital), le fascia d'Osborne et l'arcade d'Amadio et Beckenbaugh. L'intervention sous contrôle échographique a été suivie d'une dissection au laboratoire d'anatomie. Nous avons étudié la section effective des différentes structures, l'absence de lésion vasculo-nerveuse et l'absence de luxation du nerf. Aucune structure ne comprimait le nerf ulnaire après l'intervention sous échographie. Tous les nerfs étaient indemnes de lésion iatrogène et aucun ne se luxait en flexion-extension de coude. Dans 3,4 % des cas, il persistait en continuité la partie superficielle d'une ou plusieurs structures sans compression effective. Notre étude sur cadavre montre la faisabilité du traitement chirurgical de la compression du nerf ulnaire au coude par voie percutanée sous contrôle échographique.

Mots clés : Nerf ulnaire ; Décompression chirurgicale ; Technique percutanée ; Échographie

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1. Introduction

Ulnar nerve entrapment (cubital tunnel syndrome) is the second most common upper limb entrapment syndrome [1–3]. The various anatomical compression sites for the ulnar nerve were redefined in 2004 by Desmoineaux et al. [4]; they are listed below from proximal to distal (Fig. 1):

- Struthers' arcade, taut from the medial head of the triceps brachii muscle to the medial intermuscular septum. It is located 8 cm proximal to the medial epicondyle [5]. Its contribution to ulnar nerve compression is still debated;
- the medial head of the triceps brachii muscle, which can push the nerve against the medial epicondyle [6];
- the cubital tunnel retinaculum, which is the most common cause of compression [7]. It is taut when the elbow is flexed and crushes the nerve against the bottom of the ulnar nerve groove formed by the medial epicondyle of humerus and olecranon;
- Osborne's fascia, which is a thickened part of the antebrachial fascia at the junction of the two heads of the flexor carpi ulnaris muscle. It is an extension of the cubital tunnel retinaculum;
- the common aponeurosis between the humeral head of the flexor carpi ulnaris and the flexor digitorum superficialis, which forms the elliptic tunnel initially described by Amadio and Beckenbaugh [8].

Surgical treatment of ulnar nerve entrapment at the elbow is still controversial [9,10]. None of the standard surgical procedures (neurolysis, medial epicondylectomy, subcutaneous, intramuscular or submuscular transposition) have demonstrated long-term superiority [9,11–13]. There is also no consensus on whether to choose an open or endoscopic procedure. A recent symposium of the Société d'orthopédie de l'Ouest (2013) [14] confirmed meta-analysis data by concluding that subcutaneous transposition led to similar results as in situ neurolysis through open or endoscopic procedures.

Recent publications use diagnostic ultrasound (US) for ulnar nerve entrapment [15,16]. Therapeutic ultrasonography is limited to guiding corticosteroid injections in certain pathologies [17]. Based on an US surgical technique developed to treat carpal tunnel syndrome [18,19], we developed a percutaneous US-guided technique to release compressive structures in cases of ulnar nerve entrapment at the elbow.

We decided to try to release all the structures previously described (Fig. 1) even if their role in compression had not been proven [20,21]. We wanted to demonstrate the feasibility of an US-guided percutaneous procedure that would be as effective as an open procedure. This study consisted of an US-guided procedure performed on cadaver specimens that were then dissected to look for the release of compressive structures and absence of anatomical damage.

2. Material and method

2.1. Material

Eighteen cadaver upper limbs were used (9 left and 9 right). We used an ultrasonography machine (Esaote, Technos) with a 13 MHz probe, a No. 11 scalpel blade, dissection forceps, Stevens scissors, and a BD Beaver™ blade holder prototype with retractable blade (Figs. 3 and 4). We used two types of BD blades: initially Banana 4 mm and then Rosette type (Fig. 2). These tools are similar to the ones used in US-guided carpal tunnel release.

2.2. Method

2.2.1. US-guided ulnar nerve release

The upper limb was set on a table. Elbow flexion varied depending on the surgical phase. We first performed US imaging of the nerve from Struthers' arcade to Amadio-

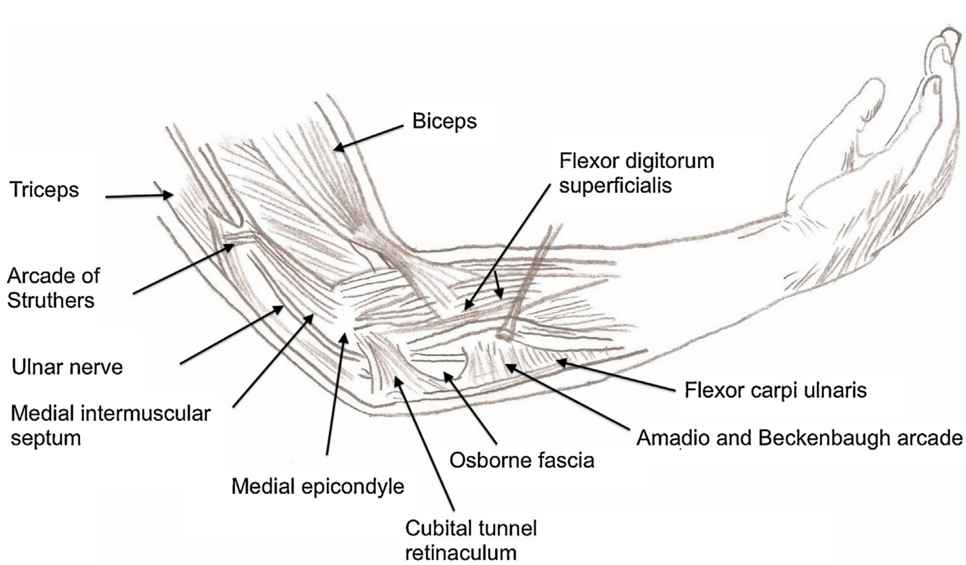

Fig. 1. Ulnar nerve compression sites at the elbow.