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Recent advance

Surgical ultrasound-guided carpal tunnel release

Libération du canal carpien sous échographie

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A R T I C L E I N F O

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A B S T R A C T

Ultrasound-guided surgery is a new trend stemming from the introduction of high-frequency linear probes and better quality screens. Surgical treatment of carpal tunnel syndrome is increasingly being performed under ultrasound guidance. Knowledge of musculoskeletal ultrasonography is obviously mandatory. Several types of cutting instruments (miniature knife, Gigli saw or hook) and surgical approaches (wrist or palm) have been described. Ultrasonography allows the wide-awake and local anesthesia with no tourniquet (WALANT) technique to be used in the context of ambulatory patient care. The practitioner must be aware of all the possible intraoperative and postoperative complications, and be able to treat them. The aim of this review is to analyze the literature on the feasibility and outcomes of surgical ultrasound-guided carpal tunnel release, and to compare it to the other validated techniques.

R É S U M É

L'échochirurgie est en plein essor grâce aux progrès des sondes linéaires à haute fréquence et des écrans d'échographie. Ainsi, la chirurgie du canal carpien est de plus en plus pratiquée sous contrôle échographique. La connaissance de l'échographie musculo-squelettique est un prérequis indispensable. Plusieurs types d'instrumentation et de voies d'abord existent : au poignet ou à la paume, avec couteaux, fil ou crochet. L'anesthésie *wide-awake and local anesthesia with no tourniquet* (WALANT) est particulièrement adaptée à cette technique dans le cadre d'un circuit patient « hyperambulatoire » dans un environnement sécurisé pour les patients. L'opérateur doit bien sûr avoir une parfaite maîtrise de l'échographie et de la chirurgie avec ses complications per- ou post-opératoires. Le but de cette revue était d'analyser la littérature rapportant la faisabilité et les résultats de cette technique chirurgicale et de confronter ces données aux autres techniques existantes.

1. Recent advances in ultrasonography (US) for carpal tunnel (CT) anatomy

Ultrasound (US) has emerged as a low-cost, effective, and radiation-free imaging modality. Continuous technological progress has made it possible to perform an increasingly accurate study of the anatomical structures of carpal tunnel, including the median nerve, flexor tendons and transverse carpal ligament (flexor retinaculum) as well as at-risk structures, such as the ulnar artery and the superficial palmar arch [1].

The advent of high-frequency electronic linear transducers (more than 13 MHz) allows superficial structures to be examined comprehensively. This is especially true for the joints of the hands and wrist. This includes scanning the relevant structures in at least two orthogonal planes, with dynamic and Doppler assessments. In the carpal tunnel, anisotropy helps the sonographer distinguish between the flexor tendons and the median nerve. The Doppler mode allows the ulnar and radial arteries to be located.

US can be used to examine the anatomy of the boundaries of the carpal tunnel and its components [1]. The boundaries are the palmar aspect of the proximal and distal carpal rows except under the hook of the hamate. The transverse carpal ligament is always easy to find because of its hyperechoic structure. In a transverse

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view of the carpal tunnel, the median nerve is found just below the transverse carpal ligament, as an ovoid hyperechoic structure (punctiform images of the fascicles). At the wrist, the palmar branch travels towards the flexor carpi radialis. Identification of the palmar branch and possible anatomical variants (given the risk of damage during surgery) requires dynamic maneuvers [1].

The US image shows the nine flexor tendons as fibrillar structures consisting of multiple parallel lines if obtained in the long-axis direction and as multiple hyperechoic punctiform images if obtained in the short-axis direction. Note that the lumbrical muscle (in finger flexion) or the flexor muscle (in finger extension) can be considered as hypoechoic structures of tenosynovitis.

The wrist has numerous anatomical variants involving vascular structures, nerves, tendons and muscles [2]. Some of these are clinically relevant and the US technician should be familiar with them: persistent median artery, bifid median nerve, anatomic variants of the motor branch, Berretini communicating branch, anomalies of the flexor tendons, accessory muscles, occult ganglion, etc. All of these anatomical variants may cause carpal tunnel syndrome or can make carpal tunnel release more difficult [1,3–5].

2. Procedures for carpal tunnel release (CTR)

Four options are available for surgical treatment of carpal tunnel syndrome: open carpal tunnel release (OCTR), endoscopic carpal tunnel release (ECTR), mini-open carpal tunnel release (mini-OCTR) and reconstruction of the transverse carpal ligament (RTCL). Because of the recent technical advances in ultrasonography, the authors regularly perform US-guided carpal tunnel release (UCTR). The first authors to describe their experience with UCTR were Nakamichi and Tashibana in 1997 [6]. Some authors have described percutaneous UCTR (PCTR) [7–11]. Ohuchi et al. have even described a combined ECTR–UCTR technique [12].

3. Surgical US-guided CTR (UCTR)

3.1. Experience of the sonographer

The sonographer (US technician) must have appropriate experience to successfully perform US-guided procedures; the clinician must be familiar with the basics of US imaging [6,8,13,14].

The Ravnic et al. study [15] showed that a surgeon with no formal US training can reliably diagnose and localize flexor tendon lacerations in cadavers using US (which can happen in CTR). US is a useful diagnostic tool in hand surgery but is also useful in therapeutic procedures [16]. In a survey on the use of US, 43% of upper extremity surgeons answered that they have an US machine in their office [17].

According to Chern et al. [14], UCTR is technically demanding and requires significant training before proficiency is attained. Hence, US-guided CTR requires both US and surgical experience.

3.2. Cutting instruments

Nakamishi and Tachibana in 1998 [18] defined the safe zone in which the cut must be performed. The entry point of the instrument is marked on the palm, distal to the critical pillar rectangle, at the intersection of the superficial palmar arch and a line midway between the ulnar margin of the median nerve and radial margin of the ulnar artery (safe line). Every author agrees on the safe line concept for UCTR [4,6–8,10,14,19–21]. The cutting instruments and their use are exposed in Table 1.

3.3. Type of anesthesia

3.3.1. Local anesthesia

Many authors use local anesthesia to perform CTR. Unfortunately, we usually do not have any details on the type or quantity of anesthetic solution used. We also do not have any information about the possibility of anticoagulant or aspirin use during the treatment. PCTR requires only local anesthesia.

3.3.2. WALANT technique

The WALANT technique was first described by Lalonde et al. [22]. Using a 27-gauge needle, 10–15 cc of a premixed 1% lidocaine with 1:100,000 epinephrine and 1 cc of 8.4% bicarbonate solution is injected slowly. It generates an area of palpable local anesthetic swelling at least 5 mm ahead of the needle tip. The patient will not feel any further local anesthetic injection pain if the solution is buffered.

For OCTR, the solution is injected throughout the entire palmar aspect of the wrist to bathe all areas that will be dissected. The goal is to stay within the safe limits of 7 mg/kg of lidocaine and

Table 1
Key elements of published US-guided carpal tunnel release studies.

Year	Authors	US system	Probe (MHz)	Technique	Instrument used	Study design	Number of hands	Location of procedure	Type of anesthesia
1997	Nakamichi and Tachibana	Aloka™	10	Retrograde/ palmar approach	Cutting device with a basket punch	Prospective clinical study	103	Operating room	Local
2010	Nakamichi et al.	Unknown	Unknown	Retrograde/ palmar approach	Cutting edge	Comparative study	35 PCTR and 39 mini-OCTR	Unknown	Local
2013	Markinson	Sonosite™	6–13	Retrograde/ wrist approach	Manos device	Technical note	3 cases	Operating room	Lidocaine with epinephrine
2014	Capa-Grasa et al.	GE™	5–11	Retrograde/ wrist approach	Hook knife	Comparative study	20 mini-OCTR and 20 PCTR	Operating room	Unknown
2014	Apard et al.	Sonosite™	6–15	Anterograde/ wrist approach	Kemis knife	Prospective clinical study	350	Operating room	WALANT
2015	Chern et al.	Sonosite™	5–10	Anterograde/ wrist approach	Hook knife	Consecutive case series	91	Operating room	Local anesthesia
2015	Guo et al.	GE™	12	Retrograde/ wrist approach	Gigli saw	Clinical serie	34	Operating room	LA + conscious sedation
2015	Lecoq et al.	Esaote™	13	Retrograde/ wrist approach	Scalpel blade	Prospective study	39	Interventional radiology room	Local
2016	Petrover et al.	Hitashi™	18	Retrograde/ wrist approach	Acufex hook knife	Prospective study	129	Interventional radiology room	Local
2016	Candelier et al.	Sonosite™	6–15	Anterograde/ wrist approach	Kemis knife	Prospective study	100	Operating room	WALANT

OCTR: open carpal tunnel release; PCTR: percutaneous carpal tunnel release; WALANT: wide-awake local anesthesia and no tourniquet.

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