Carpal Tunnel Syndrome: Surgical Landmarks which Increase Safety in Carpal Tunnel Release Procedures

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The carpal tunnel is an osteofibrous canal situated in the volar wrist. It contains the median nerve and nine tendons: the flexor pollicislongus, the four flexor digitorum superficialis and the four flexor digitorum profundus. Patients presenting carpal tunnel syndorome often complain about pain, tingling and numbness in the first 3 fingers and lateral half of the IVth finger. While initial treatment may be medical, patients often require surgical release of the transverse carpal ligament. Even though the surgical procedure is considered to have low difficulty it is accompanied by a significant morbidity and sometimes persistent symptoms post-surgery. In this study we dissected both hands of 9 formalin fixed cadavers and measured fixed landmarks in order to enhance the safety of a surgical decompression of the median nerve.

Keywords: carpal tunnel, median nerve, carpal tunnel syndorome

Carpal tunnel syndrome is the most common compression syndrome, the risk of developing this condition along life is 10%. The prevalence among women is 3% (more common in women over 55 years of age), greater than among men (2%). Among the risk factors statistically significant, the studies include female sex, advanced age, pregnancy, obesity, hypothyroidism, rheumatoid arthritis, chronic renal insufficiency, chronic smoking, alcohol consumption [1-4].

The mechanisms involved in the occurrence of carpal tunnel syndrome include tenosynovitis of finger flexors (favored by repetitive static movements such as *writing on the keyboard*), occupational groups such as the priests, or patients with autoimmune disorders like rheumatoid arthritis [5]. the presence of space-occupying lesions like tumors, local edema installed during pregnancy or thyroid diseases, amyloid deposits, post traumatic fibrosis, excessive fat, abnormal muscles, anatomical variations such as persistent median artery with or without bifid median nerve [6-8].

The carpal tunnel contains nine tendons of flexors with a common synovial sheath, a single nerve (median nerve) immediately under the transverse carpal ligament and flexor pollicislongus, most laterally, the narrowest area being at the level of the hamate bone.

Patients with carpal tunnel syndrome complain about subjective sensations as tingling, numbness and pain in the first three fingers and lateral half of the IVth finger, the nightparesthesiathat wake the patients from sleep, clumsiness and, in later stages, weakness in the hand. The first symptoms are quite frequent in the general population (14.4%), and 1 in 5 syptomatic patients are diagnosed with carpal tunnel syndrome [2].

At physical examination, we can observe a degree of atrophy of thenar eminence.

The most sensitive test used in the diagnosis of carpal tunnel syndrome is the Durkan test. Phalen test, less sensitive than Durkan test, correlates with the severity of the disease, the symptoms appear quickly as the disease is more advanced. The Semmes-Weinstein test is the most sensitive test to detect sensory carpal tunnel syndrome since the early stages. Radiology imaging offers a real help in diagnosis, ultrasound and magnetic resonance being used in most examinationsof compresive syndromes.

Ultrasound shows, in advanced cases, the specific triad:

Arched flexor retinaculum (> 2 mm above the line which unites the pisiform and scaphoid bones);

Distal flattening of the nerve;

Thickening of the median nerve proximal to flexor retinaculum (> 11 mm) (normal diameter = 9-11 mm)-the most sensitive and specific criteria [9,10].

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MRI, in carpal tunnel syndrome, highlighted as well, an arched flexor retinaculum, increase in diameter of the median nerve at the level of pisiform bone and flattening at the level of the hamate bone. Other signs are edema, loss of adipose tissue in the carpal tunnel, thickening of the nerve in fluid-sensitive sequences, hyperintense signal of the nerve

Treatment is initially symptomatic, consisting in avoiding activities that can promote the symptomatology and NSAIDs. Steroid injections are used in carefully selected patients with some positive results, but the females and diabetic patients have a higher risk of reccurence. As a pretty low percentage of patients respond to medical treatment, surgery is necessary in most cases. Regardless of the chosen technique (open or endoscopic), carpal tunnel anatomy knowledges are essential for a successful decompression [11-13].

Even if this surgery is considered a simple procedure, it is accompanied by a significant morbidity. The classic method is accompanied by a higher morbidity, and endoscopic method is accompanied by a higher percentage of nerve damage, due to the lack of direct visibility and relative superficial position of the median nerve.

Cutaneous incision must not affect the wrist flexion crease, to avoid any scars that reduce mobility at the level of the radiocarpal joint.After the skin incision is made, the cutting of the palmar aponeurosis and the transverse carpal ligament. In this phase of intervention, a special attention must be paid to the superficial palmar arch, whose lesion must be avoided [14]. This frees the content of carpal tunnel and realize the decompression of median nerve, which is found between the tendons of Palmaris longus and Flexor carpi radialis. The most common cause of failure in the intervention of decompression is incomplete cutting of the ligament or injury of the median nerve [22-27]. Persistent symptoms may be due to scar tissue formation and/or adhesions around the median nerve(Fig.1, Fig.2).

Fig.1, Fig.2, Clinical aspects of carpal tunel

In one study,which included 87 patients with persistent symptoms after surgery, 48% had incomplete cut of the ligament, 34% had nerve lesions, while 88% had scars and adhesions. Even if the compressive symptoms are relinquished, the patient may present sensory disturbances due to the lesion of the palmar branch during superficial dissection, or disorders of biomechanics at the radiocarpal or intercarpal joints, caused by the loss of the capacity of flexor retinaculum to maintain the position of the tendons and the concave shape of the carpal groove [15].

In the study of MacDonald et al [16]., the percentage of complications is 12%. In the study of Kluge et al [17]., 50% of patients har a reduced grip strength, 19 % had scars, 18% complain of incomplete relief of primary symptoms.

During endoscopic approach, Murphy et al [18]. Reported a case with median nerve and superficial palmar arch lesions, followed by the formation of a pseudo-aneurysm. Iatrogenic damage of the superficial palmar arch is a complication also in the open approach.

Experimental part

Material and methods

We disected both hands of 9 formalin fixed cadavers in the Anatomy Department of Carol Davila University of Medicine and Pharmacy Bucharest. The careful dissection emphasized and preserved the flexor retinaculum, the superficial palmar arch, the content of the carpal tunnel(Fig.3, Fig.4, Fig.5).

We also measured, using a digital caliper, some distances which can be used as landmarks for a safe surgical decompression of the median nerve:

-Distance from the distal border of the transverse carpal ligament to the superficial palmar arch, measured at the lateral border of the ring finger;

-Width of the transverse carpal ligament measured at the level of the lateral border of the ring finger;

-Distance from the proximal end of transverse carpal ligament to the palmar branch of median nerve.

Fig. 3. Flexor retinaculum

Fig.4. Carpal tunnel

Fig.5. Superficial palmar arch

Results and discussions

The mean distance from distal border of transverse carpal ligament to superficial palmar arch was 17.21 mm (range 7.31-22.8 mm).

The mean distance from the proximal end of transverse carpal ligament to the palmar branch of median nerve was 9.53 mm (range 4.26-14.78 mm).

The width of the transverse carpal ligament was 27.79 mm (range 20.4-35.27).

In the study of Samarakoon et al [2], the reported values of the same variables were 11.48 mm (range 4-18.25 mm), 8.16 mm (range 2.45-14.80), 27 mm (range 20.6-34.25 mm).

In the study of Sacks [19], the same distances were 18.8±0.6 mm, 6.9±0.4 mm, 28.5±0.8 mm.

Watchmaker et al [20] studied the course of the palmar branch related to the incision used for median nerve decompression. They described an incision which begins at 5mm medial to the interthenar depression and is oriented towards the third interosseous spaceș using this incision, the damage of the palmar branch would decrease.

Xu X et al [21] reported that the distance between the flexion crease of the wrist and the origin of the palmar branch was 2.09±0.31 mm. In the same study, the authors described an area where the incision line is safe: 5 mm medial or 6 mm lateral to the intersection between the axis of the third finger and the flexion crease.

Regarding the study of Samarakoon [2], if the incison extends more than 8 mm proximally to the distal border of transverse carpal ligament, the risk of damaging the palmar branch of the median nerve increases. In the same study, the authors described an avascular area free of thenar and hypothenar attachments on the transverse carpal ligament. Performing an incision for median nerve decompression in this area along the lateral border of the ring finger, also decreases the risk of iatrogenic lesions.

Conclusions

A throughout knowledge of the anatomy of the carpal tunnel is mandatory for a safer surgical technique during decompression of the median nerve in patients with carpal tunnel syndrome.

The anatomical landmarks are also very useful to minimize the damage of the superficial palmar arch, the median nerve or its palmar branch. Extending the incision more than 8-9 mm proximally from the distal border of the transverse carpal ligament shoul be avoided in order to preserve the palmar branch of the median nerve. The mean width of the ligament varies between 27 and 29 mm, so the length of the incisoon must not exceed this values.

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