An anatomical study for safer carpal tunnel decompression

Mamatha Hosapatna, Anne D Souza, Sachendra Mittal, Antony Sylvan D Souza, Vrinda Hari Ankolekar

ABSTRACT

Objective: To calculate the dimensions of flexor retinaculum and to measure its distance from important anatomical landmarks.

Methods: The present study was carried out using 10 formalin-fixed cadavers (7 male and 3 female). Both hands were dissected using a midline incision to expose the flexor retinaculum (FR), superficial palmar arch (SPA), palmar cutaneous branch of the median nerve (PCMN) and the recurrent branch of the median nerve (RMN). Width of the FR was noted and the distances were measured using these landmarks.

Results: The width of the FR ranged from 13 mm to 26 mm and the average was 20.08±4.05 mm on the right side and 22.5±2.12 mm on the left side. An unpaired t test was applied to compare the means between the right and left sides. The distance of origin of PCMN from FR was more on the left side and the difference was statistically significant.

Conclusion: Careful attention to anatomical landmarks can minimize inadvertent damage to the palmar and thenar branches of the median nerve, as well as the superficial palmar arch, in carpal tunnel decompression.

Key words: Carpal tunnel, flexor retinaculum, median nerve, superficial palmar arch

Introduction

Carpal tunnel syndrome (CTS) is a common peripheral neuropathy. Median nerve entrapment in the carpal tunnel is considered one of the most common entrapment neuropathies [1,2]. Increased pressure in the carpal tunnel results in median nerve compression, leading to discomfort and paresthesia in the affected hand. This can be the result of repetitive strain, wrist fracture, rheumatoid arthritis, a space-occupying lesion, diabetes mellitus or idiopathic [3,4]. CTS could be caused by thickening or fibrosis, the evidence of which was found to be thickening of the synovium in most of the operative cases [5].

Pseudo-aneurysm is one of the main complications that occurs during open and endoscopic decompression of the median nerve and superficial palmar arch [6]. Palmar cutaneous branches of the median nerve can also get damaged during decompression of the carpal tunnel [7].

Surgical treatment for CTS is performed on symptomatic patients that are unresponsive to conservative management. The aim of surgical intervention is to decompress the median nerve by sectioning the flexor retinaculum (FR). A thorough knowledge of anatomy of the median nerve in the wrist and superficial palmar arch is fundamental to avoiding complications during
Successful diagnosis and treatment of CTS requires awareness of the possible involved sites and a detailed knowledge of the related anatomy [12].

The present study aims to provide a thorough knowledge of FR in relation to important anatomical landmarks. This knowledge will be very useful for surgeons who incise the FR for decompression of the median nerve. A thorough knowledge of the anatomy and variations of the neurovascular structures at the wrist is required for surgical techniques with open and endoscopic procedures.

**Material and Methods**

The present cadaveric observational study was carried out using 10 formalin-fixed cadavers (7 male and 3 female) of unknown age. Both hands were dissected using a midline incision to expose the flexor retinaculum (FR), superficial palmar arch (SPA), palmar cutaneous branch of median nerve (PCMN) and the recurrent branch of the median nerve (RMN). The specimens with anatomical variations were excluded from the study.

Keeping the hands in the anatomical position, the distances were measured in millimeters using Vernier calipers. A vertical line was drawn from the radial border of the ring finger up to the proximal border of the FR, taken as a reference point for measurements and is called the incision site. The origins of the PCMN and the RMN, and the highest point of the SPA, were noted.

The following distances were measured.
1. Width of the FL at the point corresponding to the radial side of the ring finger;
2. Distance between the incision site at the proximal border of the FR and the origin of the PCMN;
3. Distance between the incision site at the distal border of the FR and the origin of the RMN;
4. Distance between the incision site at the distal border of the FR and the highest point of the SPA.

The measured parameters are shown in Figure 1.

The mean and standard deviations were calculated using SPSS 15.0 (SPSS Inc., Chicago, Ill., USA).

**Results**

The width of the FR ranged from 13 mm to 26 mm and the average was 20.08±4.05 mm on the right side and 22.5±2.12 mm on the left side. The mean and standard deviations of the distances measured are shown in Table 1.

An unpaired t test was applied to compare the means between the right and left sides. The distance of origin of the PCMN from the FR was more on the left side and the difference is statistically significant (p<0.05).

**Discussion**

CTS can be secondary in some patients, vascular anomalies (usually a persistent median artery), median nerve variations, or both are among the etiologic factors [13]. Inadequate release of the FR results in persistent carpal tunnel syndrome and ultimately requires re-exploration and revision carpal tunnel release. Scar formation can occur in an incompletely healed FR as well as can an increase in pressure on the median nerve, possibly bringing out recurrent symptoms. Surgical
exploration release of the reconstituted FR and freeing of the median nerve from a constricting scar usually results in symptom relief [14-17]. For this reason, mini-open and endoscopic surgical techniques performed through a smaller incision have been recommended. Mini-incision procedures were carried out using a longitudinal palmar incision or a transverse wrist incision for this purpose, as the anatomy of the FR and median nerve are important [11,14].

A study by Samarakoon et al. observed that the palmar cutaneous branch originated at a distance of 8.16 mm from the proximal border of the FR. The recurrent branch of the median nerve originated at a distance of 7.75 mm and the SPA was located 11.48 mm from the distal border of the FR. Mean length of the FR was 27.00 mm [18]. In a study conducted by Sacks, it was noted that the average distance from the distal FR to the superficial palmar arch was 18.8±0.6 mm, and that to the thenar branch of the median nerve, it was 6.9±0.4 mm. The average length of the FR was 28.5±0.8 mm [19].

Xu et al. demonstrated the mean distance to the emergence of the palmar cutaneous branch was measured from the distal palmar crease at 2.09±0.31 cm. It was concluded that a longitudinal palmar incision could avoid injuries to the recurrent branch and palmar cutaneous branch of the median nerve [20]. In the present study, the width of the FR was 20.08-4.05 and 22.50-2.12 mm on right and left sides, respectively. The distance between FR to SPA was 15.77-3.96 and 15.28-3.05 mm, FR to PCMN was 37-6.74 and 45-13.91 mm.

In another study, it was noted that an incision placed approximately 5 mm ulnar to the thenar depression, directed to the third web space, will decrease the incidence of injury to the palmar cutaneous branch of the median nerve [7]. It also revealed that the incision extending proximally more than 8.16 mm from the proximal border of the FR may put the palmar cutaneous branch at risk [7]. A thorough knowledge of the morphometry of the FR and its relationship to anatomical landmarks are fundamental in avoiding complications during carpal tunnel release.

Conclusion
The present anatomical study may provide the guidelines for a safer approach to carpal tunnel syndrome treatment and prevent iatrogenic injury to important neurovascular structures.

Conflict of interest statement
The authors have no conflicts of interest to declare.

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