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Surgical and anatomical studies on De Quervain's tenosynovitis syndrome: Variations in the first extensor compartment

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ABSTRACT

Purpose: Anomalies of the first extensor compartment are widely present in patients presenting with De Quervain's tenosynovitis (DQT) and require surgical release of the wrist tendons. The aim of this study was to test the hypothesis that such patients exhibit significantly more anatomical alterations in the first extensor compartment, the abductor pollicis longus (APL) tendons and the extensor pollicis brevis (EPB) tendons in comparison with the general population using cadavers.

Methods: A cross-sectional study was conducted during the period January 2013 to May 2014 in which anatomical variations identified in the first extensor compartments of the wrists of 101 DQT patients who had undergone tenolysis were compared with those detected in the wrists of 65 cadavers without DQT determination.

Results: The occurrence of septation in the first extensor compartment was observed in 62.4% of the DQT group (64/101). Supernumerary APL tendons were present in 86.1% of DQT patients (87/101), whereas double EPB tendons occurred in seven patients. In one patient, the EPB tendon was absent. In the cadaveric group, 21.5% (14/65) of the anatomical specimens exhibited double tunnel in the first extensor compartment, while supernumerary APL tendons occurred in 52.3% (34/65) of the wrists. No anatomical variations in the EPB tendon were observed in the cadaveric group.

Conclusion: The predominance of the septated first extensor compartment and the presence of supernumerary APL tendons observed in the DQT group indicated that these anatomical variations may be associated with the syndrome. Such anomalies tend to be less common in the general population and are, presumably, asymptomatic.

Clinical relevance: As septation of the first extensor compartment and multiple APL tendons appears to represent risk factors for the development of DQT, prior knowledge of the frequency of such anomalies may assist surgeons in pre-operative evaluation and perioperative procedures.

Key words: *De Quervain disease, tenosynovitis, anatomic variation, wrist*

Introduction

De Quervain's tenosynovitis (DQT) is a painful condition involving inflammation of the sheath around the abductor pollicis longus (APL) and the extensor pollicis brevis (EPB) tendons involved in movement of the thumb. This ailment can affect anyone independent of age and sex, [1-3] most particularly when provocative overuse mechanisms are present like, for example, in the case of volleyball players [4]. However, the condition appears to be significantly more frequent

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in women in their fifth and sixth decades of life and in pregnant or lactating women. Furthermore, race constitutes a risk factor for DQT since African Americans are more affected (ratio of 1.3:1000) than Caucasians (ratio of 0.8:1000) [1,3].

The causative factors for DQT are repetitive stress through thumb abduction and ulnar deviation of the wrist, acute angle to the extension of the tendons, increased anatomical angle of tendons in women, anatomical variations,including aberrant tendons or subdivision of the first extensor compartment, and secondary lymphedema. Various theories attempt to explain the etiology of the disease in terms of increased frictional force or biomechanical compression, repetitive microtrauma, inflammatory conditions, the presence of anatomical variations and physiologically increased volume caused by pregnancy [1].

The purpose of this investigation was to test the hypothesis that DQT patients undergoing surgical release of the tendons present significantly more anomalies in the first extensor compartment than the general population. For this purpose, the frequencies of occurrence of septated first extensor compartments and multiple APL and EPB tendons in DQT patients submitted to tenolysis with those established in the general population represented by a sample of human cadaveric wrists were compared. Important novel features of this study including the size of the DQT group being significant and that the cadaveric wrists were derived from a Brazilian population presenting mixed ethnic-racial characteristics.

Materials and Methods

Details of the project were submitted to and approved by the Ethical Committee (protocol no. 08554713.2.0000.5149), and the study was conducted according to the principles of the Declaration of Helsinki. The aims and objectives of the investigation were explained carefully to all potential participants, and those interested in taking part in the study were invited to read and sign the informed consent documents.

The cross-sectional study was conducted during the period from January 2013 to May 2014 and involved 101 DQT patients that had been unresponsive to conservative treatment, subsequently submitted to surgical release of the tendons. The diagnoses were clinical via the Filkenstein test, Eichoff test and entrapment APL test.

Initially, all patients in the test group were provided with conservative treatment, which consisted of avoiding misuse during ulnar activities for a period of 30 to 60 days to attempt to resolve the symptoms associated with the immobilization of the wrist and thumb. No patients were given steroid injections. All patients in the test group signed an informed consent. There was no exclusion in this study.

The same surgical team carried out analogous procedures on all patients from the DQT group (Figures 1A and 1B) and recorded the first extensor compartment anomalies and tendon multiplicities detected during surgery. The data obtained were compared with those associated with a general population represented by 65 cadaveric wrists, supposedly without DQT, provided by the Laboratory of Anatomy of the School of Medicine during the period from March to May 2014. A single examiner was responsible for dissecting the cadavers (Figure 1C) and for determining the numbers of APL and EPB tendons as well as the presence of septation in the first extensor compartment.

In order to study the relationship between EPB, APL and number of tunnels in the control and DQT groups, a statistical test type comparative cross-sectional cohort analysis was performed. To compare the variables in the healthy and diseased groups, the Mann-Whitney non-parametric test was conducted based on the discrete nature of the data. The software R (Foundation for Statistical Computing, Vienna, Austria) was used to carry out the test.

The recommended sample size formula [5] considers α as the value that corresponds to the Type I error in the standard normal table, β corresponds to the Type II error in the standard normal table, σ^2 the variable variance and d the sample error. The Type I error was defined as 0,05 and the Type II error was defined as 0,10. Both are conservative values from the literature. The variance was calculated in the pre-test data as well as the sampling error, defined by the difference between the means of the DQT and control groups for a variable.

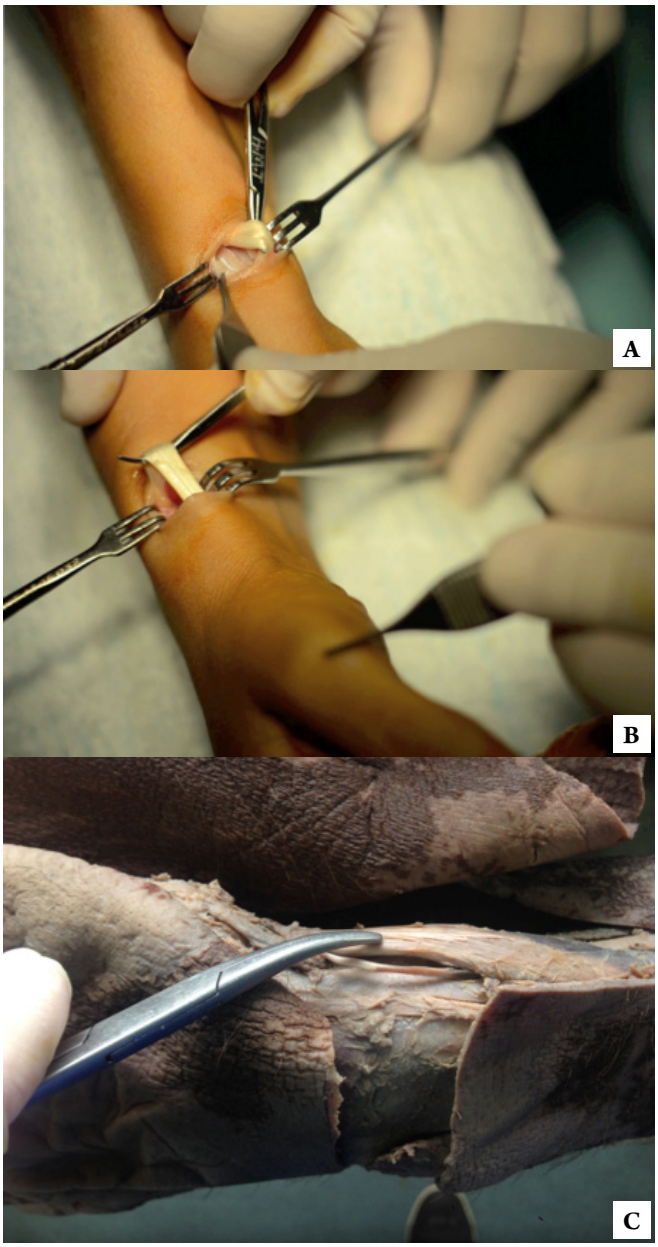

Figure 1. (A) Surgical procedures performed on the wrists of patients presenting with DQT. **(B)** Surgical procedures performed on the wrists of patients presenting with DQT. **(C)** Dissection of cadaveric wrists.

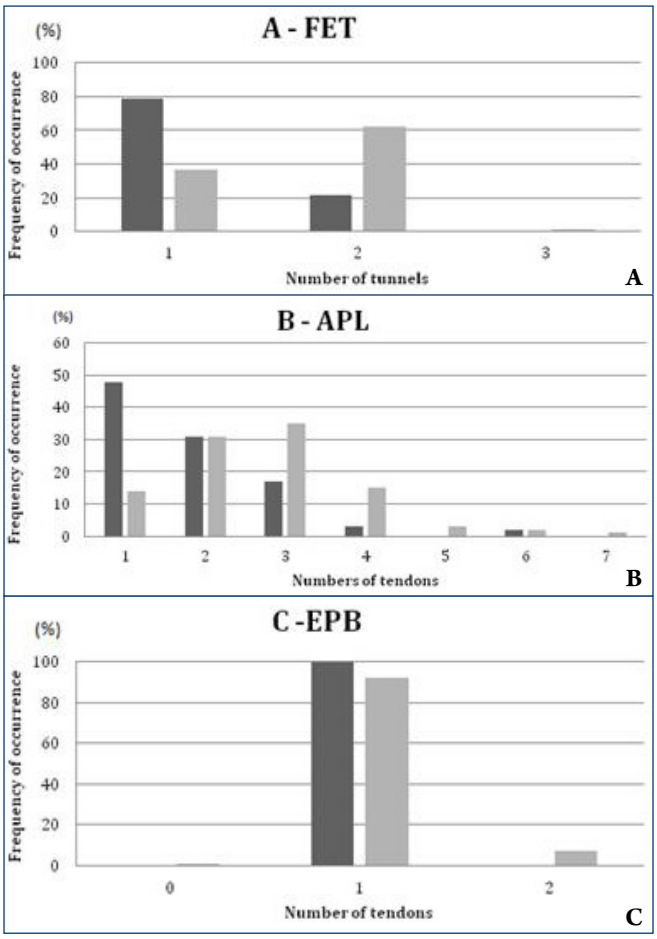

Figure 2. Percentage distributions of: **(A)** Single and multiple first extensor tunnels (FET); **(B)** Single and multiple abductor pollicis longus (APL) tendons; and **(C)** Missing, single or double extensor pollicis brevis (EPB) tendons among the left wrists of patients presenting with DQT and the right wrists of cadavers.

Results

The DQT group comprised 82 females (81.2%) and 19 males (18.8%), while the cadaveric wrists originated from 13 female (20%) and 32 male (49.2%) cadavers. This gender difference was a result of the availability of cadavers in the institution. The ages of the DQT group ranged between 26 and 88 years with a median of 54 years and a mean of 53.63 years (± 13.84 years standard deviation).

The sample size was calculated for each of the variables in this study, and only the largest was considered to guarantee statistical significance. The sample size that had 95% confidence was 63.

For a significance level equivalent to 5%, the null-hypothesis should be rejected for a p-value greater than 0,05. According to the Mann-Whitney test for independent samples, individuals from the DQT and cadaveric groups were significantly different with regards to the variables associated with the first extensor compartment and APL ($P < 0.01$), but similar with respect to the variable EPB ($P = 0.08$). Therefore, it can be concluded that individuals differed in the operated and control groups for the tunnel and abductor variables. For the extensor variable, no evidence was found to discern the behavior of the variable in either of the groups.

Anatomical variations were observed in all 101 members of the DQT group. The first extensor compartment of the majority of patients (63.4%) contained two (63/101) or three (1/101) tunnels, while only 37 (36.6%) patients exhibited single tunnel in the first ex-

tensor compartment (Figure 2A). Supernumerary APL tendons were observed in 87 (86.1%) members of the DQT group, of which the numbers of patients exhibiting two, three, four, five, six and seven APL tendons were 31, 35, 15, 3, 2 and 1, respectively (Figure 2B).

The 14 (13.9%) DQT patients remaining had single APL tendons besides other anatomical alterations, mainly double tunnel in the first extensor compartment (one compartment for APL and another for EPB). Anatomical variations in EPB tendons were less common and occurred in only eight (7.9%) patients, of which seven had two tendons, while in one patient, the EPB was absent (Figure 2C). Anomalous muscles passing through the carpal tunnel were observed in just 10 patients (10.1%).

Single tunnel in the first extensor compartment was observed in most of the wrists (51/65; 78.5%) of the cadaveric group, while the remaining anatomical specimens (14/65; 21.5%) presented double tunnel. Supernumerary APL tendons were observed in 34 (52.3%) of the cadaveric wrists, of which the numbers of anatomical specimens exhibiting two, three, four and six APL tendons were 20, 11, 2 and 1, respectively (Figure 2B). The remaining 31 (47.7%) cadaveric wrists had single APL tendons. No anatomical abnormalities were observed in the EPB tendons of the cadaveric group, only in the operated group.

Discussion

The literature describes the first extensor compartment of the wrist as encompassing the first extensor compartment together with the APL and EPB tendons, within which diverse anatomical variations, such as irregular numbers of tendons and distinct first extensor compartment structures, may occur. The frequency of anomalies in the first extensor compartment was established for the general population through studies of cadaveric specimens, and appears to range between 50 and 80%, [1,6-9] although a rate of approximately 100% has also been reported [10]. In vivo studies relating to anatomical variations in the first extensor compartment are scarce, and investigations comparing wrists of DQT patients with those from cadavers have considered insufficient numbers of cases. For this reason, more extensive information concerning anomalies observed during the performance of surgical procedures would be extremely valuable [11].

The study described herein was impelled by the research question "Are the frequencies of occurrence of abnormalities in first extensor compartment, APL and EPB in DQT patients submitted to tenolysis significantly higher than those observed in the general population?"

The number of APL tendons can vary quite considerably and it is sometimes difficult to distinguish these tendons from EPB tendons. In the present study, for example, supernumerary APL tendons and extra tunnels in the first extensor compartment could not be readily identified because the EPB tendon in the second tunnel was deeper and often emulated the distal radius. Similar issues have been reported previously by Shiraishi and Matsumura [7]. These sorts of problems were not encountered, however, in this investigation of cadaveric wrists, probably because of the atrophy of the muscles of the forearm and the absence of adipose tissue in the specimens.

In the present study, multiple tunnel in the first extensor compartment was found in 21.5% of the cadaveric group, a frequency that is similar to the figure of 20% reported by Wolfe, [3] though slightly lower than the values determined by Leslie et al., [9] where 34% of wrists derived from 50 cadavers exhibited a septated first extensor compartment, and Jackson et al. [12] that observed 40% of 300 cadaveric wrists showed partial or complete first extensor compartment septation. In comparison with the cadaveric group, the frequency of multiple tunnels in the first extensor compartment of this work's DQT group was considerably higher, with 62.4% of patients presenting two tunnels and 1% presenting three tunnels. This finding is in agreement with that of Kulthanan et al., [6] who described septated first extensor compartment in wrists of 58% of the 66 DQT patients studied and in 37% of 82 cadavers, a difference that was statistically significant. In contrast, however, Minamikawa et al. [13] observed multiple first extensor subcompartments in 47% of DQT patients and in 75% of cadaveric wrists. The presence of accessory tunnels is considered one of the major causes of failure of conservative treatment by corticosteroid injection because,

in the case of septation, it is imperative to release the tendons in order to improve the symptoms [14-16].

Of the cadaveric wrists dissected in the present study, 47.7% (31) had only one APL tendon, while 52.3% (34) displayed between two and six supernumerary tendons. In the DQT group, however, 86.1% (87) of the patients presented between two and seven supernumerary APL tendons. In contrast, Kulthanan et al. [6] reported that supernumerary APL tendons occurred in 49% (32/66) of DQT patients and in 89% (73/82) of cadavers, a difference that was statistically significant. In this context, Shiraishi and Matsumura [7] evaluated 60 wrists from 30 cadavers and determined that the number of APL tendons ranged from one to seven, with 85% of the pieces presenting three or more supernumerary tendons, while Minamikawa et al. [13] reported that 94% of cadaveric wrists displayed between two and four APL tendons. Moreover, accessory tendons were observed in most of the 246 cadaveric wrists examined by Motoura et al. [10] and in 75% of the 300 cadaveric wrists studied by Jackson [12]. It would appear, therefore, that the frequency of supernumerary APL tendons observed in this study's cadaveric group was somewhat lower than the values reported previously.

Here, all of the cadaveric wrists exhibited just one EPB tendon. In earlier studies, Minamikawa et al. [13] observed that just 2.8% of cadaveric wrists displayed multiple EPB tendons, while Shiraishi and Matsumura [7] evaluated 60 wrists from 30 cadavers and found that 85% had only one EPB tendon, the remainder presenting double or triple tendons. A similar result was reported by Nayak et al. [8] dissecting 156 wrists from cadavers of south Indian origin and identified single EPB tendons in 85.3% of the pieces, double tendons in 10.9% and triple tendons in 3.8%. Additionally, Wolfe [3] had stated that the EPB tendon may be absent in 5 - 7% of the general population. In comparison with cadaveric wrists, anomalies relating to the EPB tendon were more frequent in the wrists of this study's DQT group and were seen in 7.9% of the patients, including one individual in which the tendon was not present. This finding is in line with that of Kulthanan et al. [6] having reported that single EPB tendons were more common in cadavers (98%) than in DQT patients (94%).

According to Motoura et al. [10], the number of accessory tendons demonstrated no association with inflammation and thickening of the tendon sheath. However, in the present study, a link between anatomical variations and inflammation with increased synovial fluid was observed in the perioperative period in 100% of the DQT patients (n = 101).

Based on the results presented herein, it is possible to infer that, in comparison with the general population, anatomical variations in the first extensor compartment and the APL tendon are more frequent in DQT patients submitted to tenolysis. Thus, it is possible to deduce a direct relationship between DQT and the frequency of anatomical abnormalities in the first extensor compartment and the APL tendon, but not in the EPB tendon.

The limitations of this study include that the female gender was connected to development of DQT and there was no control for this distribution in the cadaveric group.

Conclusion

In conclusion, the original hypothesis here was only partially supported by the results of this evaluation because the significant anatomical variations observed in the DQT group were associated with the first extensor compartment and the APL tendon. In the cadaveric specimens, abnormalities in the first extensor compartment were observed at a lower frequency from which it may be concluded that these anomalies are common, though likely asymptomatic among the general population.

More studies are necessary to explain DQT in the general population with more specific exams (e.g. MRI) as in cadaveric specimens, DQT cannot be evaluated and compared to conservative or surgical treatment.

Conflict of interest statement

The authors have no conflicts of interest to declare.

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