Sonographic Identification of the Intracompartmental Septum in de Quervain's Disease

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Abstract

Background The intracompartmental septum in the first extensor compartment in patients with de Quervain's disease has been associated with disease development and prognosis. However, with the exception of surgical exploration, there is no way of detecting the septum.

Questions/Purposes We evaluated the accuracy of sonography for identifying the intracompartmental septum in the first extensor compartment in patients with de Quervain's disease using surgical findings as the reference standard.

Patients and Methods We performed surgical release of the first extensor compartment in 43 wrists of 40 patients who were unresponsive to nonoperative treatment. In each

case, a sonographic evaluation was performed before surgery by a radiologist and the sonographic and surgical findings were compared.

Results Sonography identified the intracompartmental septum in 19 of the 19 septum-present wrists and absence of the septum in 23 of the 24 septum-absent wrists. The sensitivity of sonography was 100% (95% confidence interval, 80%–100%), its specificity 96% (95% confidence interval, 78%–100%), accuracy 98% (95% confidence interval, 87%–100%), positive predictive value 95% (95% confidence interval, 74%–100%), and negative predictive value 100% (95% confidence interval, 83%–100%). Sonography also identified septum-like structures in 15 of 37 (41%) asymptomatic contralateral wrists.

Conclusions Sonography is useful for detecting the intracompartmental septum in the first extensor compartment in patients with de Quervain's disease.

Level of Evidence Level I, diagnostic study. See Guidelines for Authors for a complete description of levels of evidence.

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Each author certifies that his or her institution has approved the human protocol for this investigation, that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained. This work was performed at Hallym University Sacred Heart Hospital.

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Introduction

de Quervain's disease is a stenosing tenosynovitis of the extensor pollicis brevis (EPB) and the abductor pollicis longus (APL) in the first extensor compartment and was first described by de Quervain in 1895. It has an incidence of approximately 0.94 to 6.3 per 1000 person-years [15, 20] and more frequently affects women, older individuals, and African-Americans [20]. It is associated with pregnancy and lactation [2].

The presence of a septum in the first extensor compartment is another risk factor for de Quervain's disease. The intracompartmental septum reportedly occurs in 44%

to 91% of patients with de Quervain's disease [3, 5, 6, 9, 13, 16, 18, 19] although it is seen in only 20% to 40% of cadavers [3, 4, 6, 8–11, 13]. Two previous studies have directly compared the prevalences of an intracompartmental septum in cadavers and patients with de Quervain's disease, and both reported a higher prevalence of an intracompartmental septum in patients [6, 9]. Furthermore, several studies have suggested those with a separate septum are at higher risk for nonoperative treatment failure [5, 9, 18, 19] and even surgical failure [12, 14].

However, evidence available to date is insufficient to substantiate the hypothesis that the presence of an intracompartmental septum is associated with the development of de Quervain's disease and nonoperative treatment failure because the exclusion of patients who respond well to nonoperative treatment introduces selection bias. The prevalence of an intracompartmental septum among responders to nonoperative treatment is unknown because, in the absence of a way to noninvasively identify the presence of a septum, they can be detected only by surgical exploration.

We therefore evaluated the accuracy of sonography for identifying the intracompartmental septum in the first extensor compartment in a cohort of patients with de Quervain's disease who were unresponsive to nonoperative treatments, using surgical findings as the reference standard.

Patients and Methods

We prospectively followed 40 patients (43 wrists) with a diagnosis of de Quervain's disease in whom surgery was anticipated. Preoperative sonographic studies were performed in all patients. The diagnosis was based on the presence of pain on the first extensor compartment, tenderness to palpation over the first extensor compartment, and a positive Finkelstein test. Patients were enrolled if they did not respond to nonoperative treatments such as steroid injection or splinting with or without NSAIDs. We excluded patients if they were younger than 18 years, pregnant or lactating, had a direct traumatic injury of the radial styloid, or an inflammatory tenosynovitis, such as rheumatoid arthritis or gout. There were 32 women and eight men with an average age of 51 years (range, 18–74 years). Right wrists were involved in 15 patients, left in 22, and both in three. The dominant hand was involved in 17 patients. All the patients received initial nonoperative treatments, that is, one or more steroid injections (31 patients) or splinting with or without NSAIDs when steroid treatment was refused (nine patients). The average symptom duration before surgical treatment was 7.5 months (range, 1–74 months), and the average number of steroid

injections administered per wrist was 2.1 (range, 1–4). Institutional review board approval was obtained before study commencement and all patients provided written informed consent.

Before surgery, sonographic evaluations were performed on symptomatic and asymptomatic wrists by a radiologist (SHK) with a subspecialty in musculoskeletal imaging using a 12- to 5-MHz linear array transducer (HDI 5000; Phillips Ultrasound, Bothell, WA). We examined the asymptomatic wrists to confirm whether the structures characterized as a septum in the symptomatic wrists could be observed in the asymptomatic contralateral wrists by sonographic examination. When present, we called these “septum-like structures” as an actual septum was not surgically verified. The patients sat with the arm on a table in a position of a neutral-positioned forearm and wrist. After applying ultrasonic gel on the radial styloid area, transverse scanning of the first extensor compartment was made. When the tendon was insonated at right angles to its fibers on a transverse scan, it was observed as a round structure, within which tendon fibers formed round arrays of closely packed, dotlike echoes (Fig. 1A), and the intracompartmental septum as a hypoechoic (meaning “dark” in the sonographic image) area between tendons (Fig. 1B) [7, 14]. The EPB tendon was identified easily by asking the patient to gently extend the metacarpophalangeal joint of the thumb. The APL tendon was located just volar to the EPB tendon. The EPB and APL tendons appeared as a single mass when no intracompartmental septum was present (Fig. 1C) and as two separate tendons with an intervening hypoechoic area when the septum was present (Fig. 1B) [14]. However, a hypoechoic area between the two tendons did not necessarily indicate the presence of a septum. If the transverse sonographic scan was made slightly distal to the first extensor compartment, the space between the EPB and APL tendons also was seen as a hypoechoic area (Fig. 2). During sonographic examination, identifying the hyperechoic (meaning “bright” in the sonographic image) distal radius at the base of the tendons was crucial to ensure the sonographic scanning was made exactly on the first extensor compartment. The radiologist determined the presence of a septum by observing the intervening hypoechoic area between the tendons and the hyperechoic area of the distal radius at the base of the tendons simultaneously.

Surgery was performed by one surgeon (BCK) using loupe magnification ($\times 2.5$) under outpatient conditions. Briefly, with local infiltration and tourniquet control, a 1.5- to 2-cm longitudinal incision was made from just distal to the radial styloid to the forearm. Dissection was performed to the plane of the extensor retinaculum, taking care not to injure the radial nerve sensory branches. The composite tendon sheaths of the APL and EPB tendons were opened

◀ **Fig. 1A–C** (A) A schematic cross-sectional image of the distal radius shows the area of sonographic transverse scan images of the first extensor compartment in de Quervain's disease (inset). A tendon appears as a circular structure containing closely packed, dotlike echoes (arrow). (B) The intracompartmental septum is an intervening hypoechoic area between the EPB and APL tendons. (C) In the absence of a septum, the EPB and APL tendons appear as one tendon. Arrowhead = cephalic vein; arrow = EPB tendon; * = APL tendon; ** = a single mass of EPB and APL tendons.

Fig. 2A–B A hypoechoic area just distal to the first extensor compartment incorrectly indicates the presence of a septum. (A) A sonogram of the first extensor compartment reveals one tendon mass, indicating no septum. (B) However, this sonogram taken at a point just distal to the first extensor compartment in a patient without a septum revealed two separate tendons with an intervening hypoechoic area. The hyperechoic distal radius (arrow) just below the tendon is present in (A) but not in (B). This may be used to ensure the correct location of sonographic examinations. Arrow = the cortex of distal radius; ** = a single mass of EPB and APL tendons; arrow-head = EPB tendon; * = APL tendon.

at a point just distal to the extensor retinaculum using a scalpel. The EPB tendon was identified by asking the patient to gently extend his or her thumb. The tendon then was retracted volarward using a tendon sling. The first extensor compartment was opened by incising the extensor

retinaculum at the dorsal margin of the compartment and then explored for the presence of an intracompartmental septum and other anatomic variations. We considered the volar wall of the compartment an intracompartmental septum if it was fibrous or fibroosseous and if the APL

tendon was revealed after incising the volar wall. When only one tendon was seen after opening the first extensor compartment, the decision was straightforward. However, when two tendons were seen, the above criteria were strictly followed so as not to miss the presence of the intracompartmental septum in a rare case such as both tendons being EPB tendons and the volar wall being the intracompartmental septum [6]. After irrigation with normal saline, the skin was closed with 4-0 absorbable suture in a subcuticular fashion. A short-arm, metacarpophalangeal joint-free splint without thumb spica was applied after surgery for 3 weeks to prevent volar subluxation of the tendons in the first extensor compartment.

Sonographic findings in the symptomatic wrists were compared with those at surgery to calculate sensitivity, specificity, accuracy, positive predictive value, and negative predictive value of sonography. The 95% confidence intervals (CIs) were calculated using the plus four method [1]. The prevalence of septum-like structures on the contralateral asymptomatic wrists was calculated.

Results

Intraoperatively, an intracompartmental septum was present in 19 of 43 wrists. Sonographic examinations identified an intracompartmental septum in all 19 of these wrists and determined there was no septum in 23 of the 24 septum-absent wrists. Accordingly, the sensitivity of sonography was 100% (95% CI, 80%–100%), its specificity was 96% (95% CI, 78%–100%), accuracy was 98% (95% CI, 87%–100%), positive predictive value was 95% (95% CI, 74%–100%), and negative predictive value was 100% (95% CI, 83%–100%). In one wrist, sonography revealed an ovoid hypoechoic area between the tendons in the first extensor compartment. This lesion was interpreted as an intracompartmental septum by the examiner, which was not consistent with the surgical finding (Fig. 3). Of the 37 patients with unilateral disease, a septum-like structure in the asymptomatic contralateral wrist was found by sonographic examination in 12 of 17 (71%) patients who had a septum in the symptomatic wrist and three of 20 (15%) patients who did not have a septum in the symptomatic wrist.

Discussion

The literature suggests patients with an intracompartmental septum in the first extensor compartment are more likely to have de Quervain's disease develop and to be resistant to nonoperative management. These arguments are based on observations that the septum is more prevalent in patients

Fig. 3 An atypical hypoechoic area between tendons in the first extensor compartment in this case contained dotlike echoes (arrow), which appeared like tendon fibers and did not completely separate the tendons. These findings were suggestive of intratendinous degeneration rather than a septum.

than in cadavers. However, these observations do not allow evidence-based conclusions because no direct comparisons were made between patients with de Quervain's disease and the healthy population regarding the prevalence of the septum or between patients with and without a septum concerning nonoperative treatment outcomes. The actual prevalence of the intracompartmental septum in patients with de Quervain's disease has not been determined, as there was no noninvasive means of determining the presence of a septum in patients who were responsive to nonoperative treatment. In the current study, we explored the use of sonography to identify the presence of an intracompartmental septum in patients with de Quervain's disease by evaluating its accuracy using surgical findings as the gold standard.

We acknowledge several limitations. The first is that sonography does not visualize the intracompartmental septum directly. Accordingly, other lesions likely to be seen as a hypoechoic lesion between the tendons, such as intratendinous degeneration, fluid collection, or synovial proliferation, should be carefully differentiated. Longitudinal tracing, or anisotropy of a lesion, which signifies changing appearance of a lesion with changing direction of examination and is considered a characteristic of a tendon, and provocative maneuvers would be helpful for differential diagnosis. Second, our findings should be applied with caution to patients without symptoms or with mild symptoms. It is possible the intracompartmental septum in those groups is difficult to distinguish from the adjacent tendons. However, we believe sonography can identify the septum in most patients with de Quervain's disease because sonography was able to show septum-like structures in asymptomatic wrists in this study.

Our observations suggest sonography accurately identifies the intracompartmental septum in the first extensor compartment in patients with de Quervain's disease who were unresponsive to nonoperative treatment. This finding concurs with that of Nagaoka et al. [14]. In their retrospective study, sonography positively identified the septum in 26 of 27 wrists with a surgically proven septum (sensitivity, 96%) and negatively identified the septum in five of five wrists without the septum. They failed to identify a septum in one wrist, in which the septum was thin and incomplete. In contrast, we did not encounter a septum that was too thin or incomplete to be detected by sonography, which we attribute to the use of a more accurate transducer. Furthermore, caution should be exercised when interpreting hypoechoic lesions between the tendons in the radial styloid area. One wrist was deemed to have a septum by sonography, but no septum was found during surgery. On reviewing the sonographic images in this case, we observed small, dotlike structures in the hypoechoic area, which are believed to have represented tendon fibers. Furthermore, the hypoechoic area was contained in tendons (Fig. 3). We speculate the observed hypoechoic area represented a degenerated area in the tendon. Additional longitudinal scan or provocative maneuvers to assess tendon gliding along a fixed septation or to assess lateral displacement of the tendons by the pressure of the transducer over the first dorsal compartment may have more accurately localized this lesion in a specific tendon, being able to distinguish it from a septum. In addition, a hypoechoic area between the tendons does not necessarily indicate the presence of a septum because it could be a space between the tendons if the transducer is placed distal to the first extensor compartment. Thus, to ensure sonographic examinations are performed on the first extensor compartment, it is important to note the hyperechogenicity of the bone of the distal radius just below the tendons.

Our study also showed a septum-like structure between the tendons in the first extensor compartment could be observed in the asymptomatic wrists by sonographic examination. We observed this structure in 71% of asymptomatic contralateral wrists of the patients with the septum and in 15% of those without the septum. The bilaterality of the septum based on sonographic examination was similar to results in a previous anatomic study using cadavers [6], which suggested sonography may detect the septum in the asymptomatic individuals. However, the accuracy of sonographic examination in this population has not been determined because no gold standard measure such as surgery could be used for comparison.

The presence of an intracompartmental septum generally is believed to be associated with the development of de Quervain's disease. Investigations of cadaveric wrists have revealed the presence of an intracompartmental septum in

the first extensor compartment in 47% (range, 20%–78%) of wrists on average, and this prevalence is greater (average, 59%; range, 44%–91%) in the wrists of patients with de Quervain's disease [3, 5, 6, 9, 13, 16–19, 21]. When we combined data from previous studies to calculate the relative risk conferred by an intracompartmental septum to the development of de Quervain's disease, we found a relative risk of 1.40 (95% CI, 1.19–1.65) (Tables 1, 2). Therefore, it seems plausible the presence of an intracompartmental septum is a risk factor for de Quervain's disease development. However, this calculated relative risk is likely to be affected by selection bias. The patients included in the above studies likely had an intracompartmental septum because treatment with local steroids or other nonoperative measures had failed, and the intracompartmental septum might have been a major reason why these measures failed [5, 18, 19]. To validate the association between the intracompartmental septum and the occurrence of de Quervain's disease, data for patients, not yet reported, who were treated successfully with local steroid injection or other nonoperative measures should be included. Sonography will be useful for identifying the septum in these patients without surgical exploration.

Similar bias could be found in the studies that suggested an association between the presence of the septum and the poor outcome after local steroid injection in de Quervain's disease. Witt et al. [19] indicated the intracompartmental septum could be a possible cause of steroid injection failure in patients with de Quervain's disease, based on the observation that 22 of 30 patients (73%) unresponsive to steroid injections had an intracompartmental septum, which was greater than numbers reported in cadaveric studies. Other authors shared this view, reporting a higher

Table 1. Summary of previous investigations

Septum	Patients	Cadavers	Sum
Present	255	467	722
Absent	174	518	692
Sum	429	985	1414

Table 2. Calculation of relative risk and 95% confidence interval

Event	Patients	Normal	Sum
Exposed	a	b	a + b
Nonexposed	c	d	c + d

Relative risk (RR) = number of patients in the exposed group/number of patients in the unexposed group = $(a/a + b)/(c/c + d) = (a \times (c + d))/(c \times (a + b))$; 95% confidence interval of RR = $e^{-1.96 \times SE \ln RR} \sim e^{1.96 \times SE \ln RR}$, where SE ln RR = standard error of

$$\ln RR = \sqrt{\frac{1}{a} - \frac{1}{a+b} + \frac{1}{c} - \frac{1}{c+d}}$$

prevalence of the intracompartmental septum in patients who experienced steroid treatment failure [5, 18]. However, these studies inadequately support the association between the presence of an intracompartmental septum and steroid treatment failure because responders to nonoperative treatment were not used as control subjects. This type of comparative study has been difficult to conduct for ethical reasons as the information for those who responded to nonoperative treatment could be obtained only by surgical exploration. We believe sonography provides an effective diagnostic tool for this purpose.

An accurate injection of steroid into both compartments reportedly improves the outcomes in patients with de Quervain's disease. Zingas et al. [22] reported a higher rate of symptom relief was attained in patients with successful steroid injections into the APL and EPB compartments than that with a steroid injection only into the APL or none of the compartments. Exact delivery of steroids into both compartments under the guidance of sonography may lead to improved outcomes.

Sonography is useful to identify the intracompartmental septum in the first extensor compartment in patients with de Quervain's disease. Sonographic examinations may be used to verify whether the intracompartmental septum is a risk factor for steroid injection failure and disease development and to accurately deliver steroids into both compartments in patients with de Quervain's disease.

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