Histological assessment of a septum in the first dorsal compartment of the wrist: a fresh cadaver study

（背側第 1 コンパートメント内の隔壁の組織学的評価　新鮮凍結屍体による検討）

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Abstract

Resistance of de Quervain's disease to conservative treatment has been associated with an intertendinous septum in the first compartment; little is known about the histological features of such a septum. This study aimed to examine the intertendinous septum histologically and note its variations. After dissecting the first extensor compartment of 24 hands from 12 fresh frozen cadavers, the presence of any intertendinous septa was determined. The length of the extensor retinaculum and intertendinous septum was measured; histological findings of the first compartment with or without septa were studied and compared with those of the third/fourth compartment. Intertendinous septa were observed in 12 of 24 wrists. Histological assessment of the intertendinous septum revealed tissue similar in composition to the retinaculum observed between the third and fourth compartments.

INTRODUCTION

De Quervain's disease is caused by stenosis of the first extensor compartment at the distal-radial aspect of the wrist (Kay, 2000; Moore, 1997). It has a prevalence of 0.3%–2.1% among industrial workers (Le Manac'h et al., 2011; Tanaka et al., 2001). Women are six to seven times more likely to develop this condition than men (Alemohammad et al., 2009; Vuillemin et al., 2012). Anatomical variations such as an intertendinous septum in the first compartment can lead to symptoms of de Quervain's disease and resistance to conservative treatment (Jackson et al., 1986; Kulthanan and Chareonwat, 2007; Mahakkanukrauh and Mahakkanukrauh, 2000). In a recent systematic review, Lee et al. (2017) reported that a septum was present in 62% of patients with de Quervain's disease versus 44% of normal cadavers.

Although the presence of an intertendinous septum in the first compartment has been well documented (Jackson et al., 1986; Lane et al., 2001; Leslie et al., 1990; Minamikawa et al., 1991; Ta et al., 1999; Weiss et al., 1994; Witt et al., 1991; Yuasa and Kiyoshige, 1998), its incidence rates have varied from 24% to 78% in cadaver studies (Leao, 1958; Mahakkanukrauh and Mahakkanukrauh, 2000). However, the histological features of the intertendinous septum have not been studied and information about it could be useful in the management of de Quervain's disease.

This study aimed to histologically examine the intertendinous septum and its variations.

METHODS

The study protocol was approved by the Institutional Review Board. Upper limbs collected from fresh frozen cadavers donated to the clinical anatomical laboratory were used in the current study. There were 24 hands from 12 cadavers. There were five men and seven women and their mean age was 90 (SD 7.4; range 78-101) years. Upper limbs damaged by injury or surgery were excluded. After removal of the dorsal skin and superficial fascia, the extensor components were dissected.

The following parameters were assessed: sex, presence of an intertendinous septum, length of the extensor retinaculum in the first compartment and length of the septum. An intertendinous septum was defined as allowing the removal of only the extensor pollicis brevis (EPB) tendon from the first extensor compartment whilst retaining the abductor pollicis longus（APL）tendons when the first compartment was cut directly above the EPB tendon (Sugiura et al., 2017).

The length of the extensor retinaculum and intertendinous septum were measured using a digital vernier caliper (Digimatic Caliper; Mitutoyo Corporation, Kawasaki, Japan; measuring range 0-200 mm and precision of 0.01 mm).

The intertendinous septum ratio was determined using the following equation:

$$Intertendinous\ septum\ ratio\ (\%) = \left(\frac{intertendinous\ septum\ (mm)}{extensor\ retinaculum\ (mm)}\right) \times 100$$

A ratio greater than 50% indicated a complete septum, whereas a ratio lower than 50% indicated an incomplete septum. The ratio of men to women and the presence of one-sided or bilateral septum were analysed using the chi-squared test with Yates' correction.

Four representative septal types were used for histological examination; a thick intertendinous septum (*thick-type* septum), defined by the presence of an osseous groove for the EPB tendon on the floor of the first compartment (Figure 1a); a thin intertendinous septum (*thin-type* septum), defined by the absence of an osseous groove for the EPB tendon in the first compartment (Figure 1b); no intertendinous septum in first compartment (*no septum* type); and normal material from the third and fourth compartments. Subsequently, 1 cm segments of each whole compartment (two first dorsal compartments and one of the third and fourth compartments) with a part of the radius and their tendons were obtained for histological examination of their structures. After standard tissue processing, the sections were embedded in paraffin and cut into

four ultrathin sections and stained with the stains haematoxylin–eosin and Azan–Mallory (which is specific for collagen fibres).

RESULTS

Intertendinous septa were present in 12 wrists (seven men and five women) of which nine were complete and three were incomplete. No significant difference was noted between men and women, The mean lengths of the extensor retinaculum and intertendinous septum were 14 (SD 1.7) mm and 10 (SD 4.5) mm, respectively, and the intertendinous septum ratio was 74%. The presence of bilateral septa was noted in five cases and a unilateral septum in two of 12 cases; no significant difference was noted between the bilateral and unilateral cases.

Histological assessment of the extensor retinaculum between the third and fourth compartments (Figure 2)

Retinacular tissue was observed between the third and fourth compartments. This retinaculum consisted of the extensor retinaculum from the dorsal side and the periosteum of the radius on the deep side. The retinaculum was wider than the septum in the first compartment and contained collagen fibres.

Histological assessment of a thick-type septum unit in the first compartment (Figure 3)

Morphological analysis of the axial septum histology section revealed a predominantly retinacular tissue that was similar in composition to the extensor retinaculum in the first compartment. The septum passed to the radius between the APL and EPB tendons. In addition, the osseous groove for the EPB tendon was clearly observed on the floor. Collagen fibres were identified in this septum using by staining.

Histological assessment of a thin-type septum unit in the first compartment (Figure 4)

A thin-type septum was observed between the APL and EPB tendons. This septum consisted of an extensor retinaculum, similar to the thick-type septum, and it passed to the radius between the APL and EPB tendons. The septum was thinner than the thick-type septum (Figure 3) and it did not have an osseous groove for the EPB tendon. Collagen fibres were also identified in this septum.

Histological assessment of the first compartment without an intertendinous septum (Figure 5)

No septum was observed in the first compartment; the EPB and APL tendons were observed to lie adjacent to each other.

DISCUSSION

Studies have reported that approximately 30%–80% of fixed cadavers have an intertendinous septum in the first dorsal compartment (Giles, 1960; Gonzalez et al., 1995; Leslie et al., 1990; Mahakkanukrauh and Mahakkanukrauh, 2000) (Table1). Although there are few reports about the presence of a septum in fresh cadavers, in one study 40% of fresh cadaver hands contained a septum (Rousset et al., 2010), whereas the present study found that 50% of fresh cadaver hands contained a septum.

Regarding septum size, Motoura et al. (2010) reported that 79 of 246 wrists obtained from cadavers contained a septum and 28% were found to be incomplete. Jackson et al. (1986) also reported a 36% prevalence rate for incomplete septa. However, these studies estimated the septum size macroscopically. The current study included measurements of the septum–retinaculum ratio; nine of 12 cases had a >50% ratio with the mean ratio also being high (74%).

There is limited information about the ratio of men to women with a septum and the occurrence by side. Sugiura et al. (2017) reported that the occurrence of septa was not a significantly different between men and women in a fixed cadaver study. In the present study with fresh cadavers, no significance difference was also noted.

The presence of a septum blocks the diffusion of locally injected steroids (Harvey et al., 1990; Leslie et al., 1990; Mahakkanukrauh and Mahakkanukrauh, 2000; Witt et al., 1991); it is a well-known cause for unsuccessful blind steroid injections (Harvey et al., 1990; Ilyas, 2009; Leslie et al., 1990; Sawaizumi et al., 2007; Zingas et al., 1998). Some have suggested the need to inject both sub-compartments (Leslie et al., 1990; Sawaizumi et al., 2007). Our histological findings showed that the intertendinous septum consisted of retinacular tissue which would certainly prevent the diffusion of injected steroid within the first compartment.

This study has several limitations. The sample size was small and studies involving larger sample sizes are warranted to confirm the histological findings. The history of de Quervain's disease among the included cadavers was unknown. The specimens were elderly, the sample was not representative of the demographics of patients with de Quervain's disease and the anatomical variations may not be characteristic of patients with de Quervain's disease.

The septum in first compartment consisted of retinacular tissue similar to the extensor retinaculum found between the third and fourth compartments. Therefore, the presence

of a septum in the first compartment could be characterized as sub-compartmentalization rather than true septation.

Ethical standards

The study protocol was approved by the institutional review board of our University.

Declaration of conflicting interests

The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Figures

Figure1

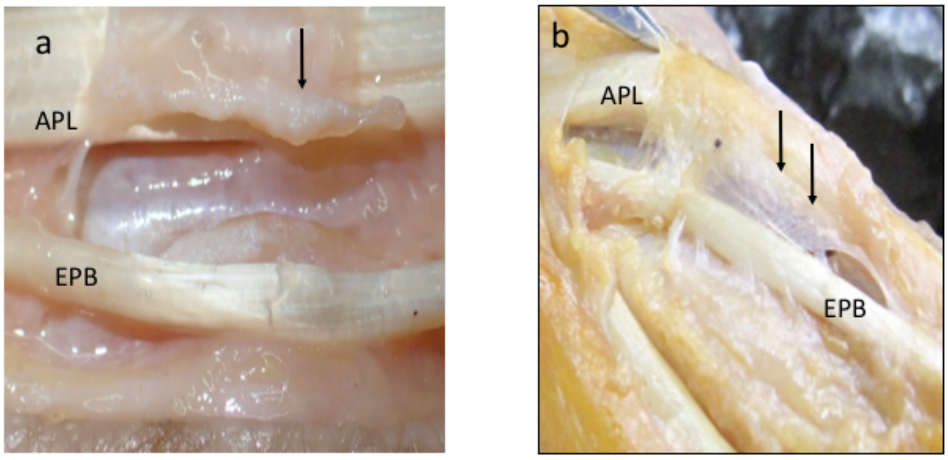

Figure 1. Radial aspect of the first compartment of the wrist. a: intertendinous septum (thick-type).b: intertendinous septum (thin-type).single arrow: intertendinous septum (thick-type). double arrow: intertendinous septum (thin-type)

Figure 2

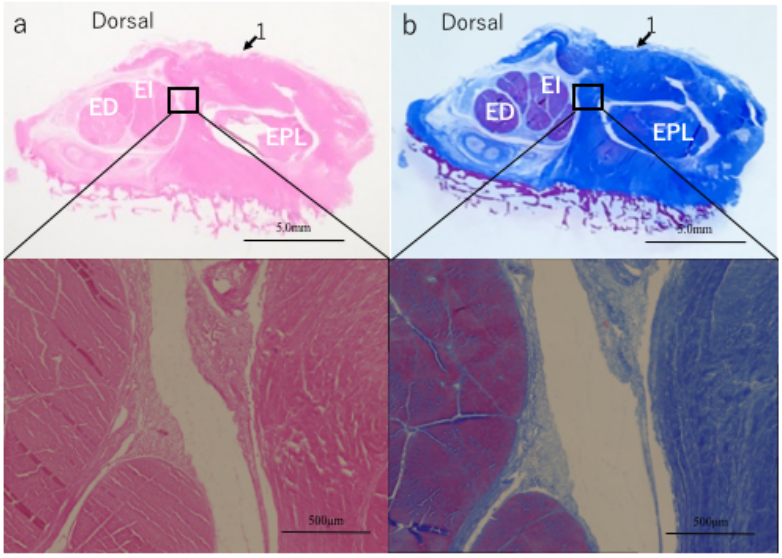

Figure 2. Histological assessment of the third and fourth compartments. a: Hematoxylin–eosin staining.b: Azan–Mallory staining. Collagen fibres comprising the retinaculum could be identified between the third and fourth compartments.1: extensor retinaculum. ED: extensor digitorum. EI: extensor indicis. EPL: extensor pollicis longus.

Figure 3

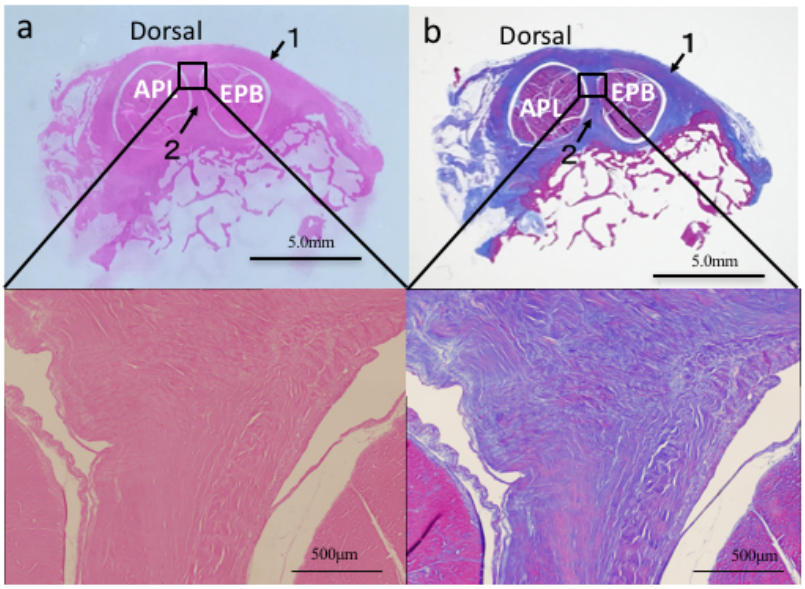

Figure 3. Histological assessment of an intertendinous thick-type septum unit in the first compartment. a: Hematoxylin–eosin staining. b: Azan–Mallory staining. Thick collagen fibres comprising the retinaculum could be identified between the EPB and APL tendons.

1: extensor retinaculum. 2: intertendinous septum (thick-type). APL: abductor pollicis longus. EPB: extensor pollicis brevis.

Figure 4

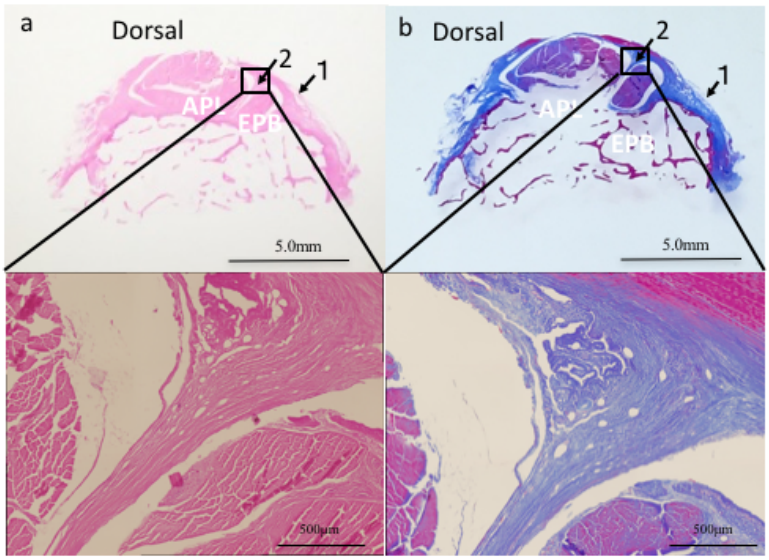

Figure 4. Histological assessment of an intertendinous thin-type septum unit in the first compartment.a: Hematoxylin–eosin staining. b: Azan–Mallory staining. Thin collagen fibres comprising the retinaculum could be identified between the EPB and APL tendons.

1: extensor retinaculum. 2: intertendinous septum (thin-type). APL: abductor pollicis longus. EPB: extensor pollicis brevis.

Figure 5

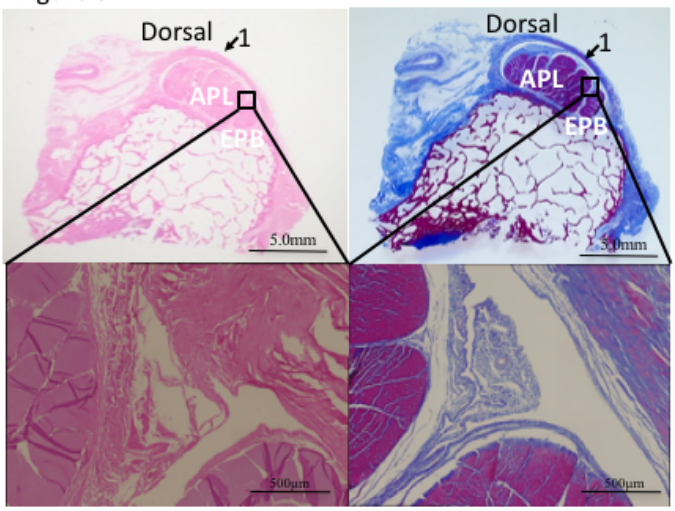

Figure 5. Histological assessment of the first compartment without a septum.

a: Hematoxylin–eosin staining. b: Azan–Mallory staining. No collagen fibres suggesting a retinaculum could be seen between the EPB and APL tendons.1: extensor retinaculum. APL: abductor pollicis longus. EPB: extensor pollicis brevis.

Table 1

Incidence of septa in fixed cadaver studies.

Study	Septa/cadavers	Septum incidence rate (%)
Giles (1960)	27/50	54
Gonzalez et al. (1995)	31/66	47
Leslie et al. (1990)	34/100	34
Mahakkanukrauh and Mahakkanukrauh (2000)	155/200	78
Total	247/416	59
Mean (SD) (95% CI)		53 (18) (95% CI: 17 to 89)

SD: standard deviation, CI: confidence interval

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