Transverse anatomic landmarks for the A1 pulley of the thumb

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Abstract

Background Triggering of the thumb is a common entity resulting in pain and disability. Operative management requires accurate knowledge of the pulley system for proper release of the A1 pulley. The purpose of this study was to predict the location of the A1 pulley with surface anatomic landmarks while avoiding injury to the neurovascular bundles and the critical oblique pulley.

Methods Thirteen fresh cadaveric thumbs were dissected while the volar digital creases of the thumb served as our potential anatomic landmarks for the A1 pulley. These included the distal crease and the two identifiable proximal creases. Measurements from the proximal edge of the A1 pulley to the surface landmarks were obtained. The pulley system was also inspected for variability, and the length of the A1 pulley was measured.

Results Of the three volar creases in the thumb, the proximal–proximal crease (PPC) corresponded anatomically to the A1 pulley and demonstrated minimal variability compared to the other landmarks. It measured 0.10 ± 0.15 cm distal to the proximal edge of the A1 pulley. The average length of the thumb A1 pulley measured 0.61 ± 0.17 cm. Therefore, the distal edge of the A1 pulley is predicted to be located 0.51 cm distal to the PPC.

Conclusions Hand surface landmarks can be used reliably to predict the location of the thumb A1 pulley, thus avoiding injury to adjacent structures such as the critical oblique pulley.

Keywords Trigger thumb · A1 pulley · Percutaneous release · Bowstring · Open release · Anatomic landmarks

Introduction

Trigger thumb is a common cause of pain, discomfort, and disability. It is about ten times more common than trigger finger [7]. There are multiple described treatments for trigger thumb consisting of nonoperative and surgical modalities. Those include corticosteroid injections, splint immobilization, percutaneous release, and open incision release [2, 6, 8, 11]. When patients fail conservative treatment, complete sectioning of the A1 pulley surrounding the flexor pollicis longus (FPL) tendon is necessary. Inadequate or excessive release of the flexor tendon sheath can lead to secondary complications such as persistent triggering or “bowstringing,” respectively [7]. Although a relatively simple procedure, success and efficacy may depend on the knowledge of reliable anatomic landmarks for the A1 pulley of the thumb.

A previous attempt to describe landmarks for the A1 pulley relied on dorsal structures such as the dorsum of the metacarpophalangeal (MCP) joint [5]. Volar anatomic landmarks may provide an easier and more reliable approach to the release of the volarly located A1 pulley. We prefer the use of the palmar digital creases as previously described by Wilhelmi [10]. Although a detailed description of longitudinal anatomic landmarks for the thumb A1 pulley has been reported [4], the transverse landmarks have not yet been described. The digital creases of the thumb were used as our anatomic landmarks for predicting the location of the A1 pulley.

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Fig. 1 Proposed anatomic landmarks for the thumb A1 pulley. *DC* distal crease, *DPC* distal-proximal crease, *PPC* proximal-proximal crease

Methods

Thirteen fresh cadaveric hands were dissected with the aid of loupe magnification. In order to facilitate better exposure of the anatomic landmarks, the thumb was placed in a fully abducted position. We identified three distinct palmar digital creases in our specimens corresponding to the interphalangeal (IP) and the MCP joints. Only one crease corresponded to the IP joint, while in 84.6% of our specimens (11/13), at least two proximal creases were identified at the MCP joint level. In two hands, only one crease was over the MCP joint. We labeled the creases as the proximal-proximal crease (PPC), the distal-proximal

crease (DPC), and the distal crease (DC). These digital creases served as our transverse anatomic landmarks for the A1 pulley (Fig. 1).

A longitudinal incision was created to expose the thumb flexor sheath. The pulley system was examined for its content and variability. Needles were inserted at different points along the length of the flexor tendon sheath corresponding to the thumb volar creases as described earlier. Measurements (mean $\pm$ standard deviation) were taken from the proximal edge of the A1 pulley to our proposed landmarks (Fig. 2). In addition, the length of the A1 pulley was recorded for each specimen.

Results

The proximal edge of the A1 pulley was 0.10 ± 0.15 cm proximal to the PPC, 1.23 ± 0.32 cm proximal to the DPC, and 3.50 ± 0.25 cm proximal to the DC. Of the three digital creases of the thumb, the PPC corresponded anatomically to the proximal edge of the A1 pulley and demonstrated minimal variability as compared with the other landmarks. The average length of the thumb A1 pulley measured 0.61 ± 0.17 cm.

Therefore, we can predict that the proximal edge of the A1 pulley is approximately 0.10 cm proximal to the PPC. Since the average length of the thumb A1 pulley measured 0.61 ± 0.17 cm, the distal edge of the A1 pulley is approximately 0.5 cm distal to the PPC.

Examination of the pulley system configuration demonstrated the presence of four pulleys in all of our specimens. A fourth pulley was found consistently between the A1 and oblique pulleys. This pulley, namely the variable annular pulley, has been described in a previous study [1] and is quite distinct from the A1 and oblique pulleys (Fig. 3).

Fig. 2 Exposure of the flexor tendon sheath demonstrating the location of the proximal edge of the A1 pulley. Needles are placed at the various volar creases of the thumb. *DC* distal crease, *DPC* distal-proximal crease, *PPC* proximal-proximal crease

Fig. 3 Dissection of the flexor tendon sheath demonstrates the presence of the variable and oblique pulleys distal to the A1 pulley. A *red arrow* represents the proximal edge of each pulley, and a *black arrow* represents the distal edge

Discussion

Stenosing tenosynovitis is a painful, disabling condition and one of the most frequent conditions of the hand that causes a patient to consult his family physician. The movement of a tendon within its sheath may become restricted by an enlargement of the tendon itself, by a swelling and thickening of the normally thin synovial covering of the tendon, or by a thickening of the fibrous sheath through which the tendon glides. As the diameter of the sheath decreases and the diameter of the tendon increases, the resultant discrepancy between the size of a tendon and the sheath causes a “locking” and the tendon is

unable to pass through the sheath without extrinsic assistance [9]. Initially, patients experience intermittent pain, swelling, and triggering of the involved digit. In the early stages of triggering, the finger may merely be “slow” to function. In the most severe state, the digit becomes locked in the flexed position. Clinically, the tendon nodule and triggering is often palpable [10]. Most commonly affected digit is the thumb, followed by the ring finger [3].

Knowledge of the pulley system is critical for the treatment of trigger thumb. Pulleys are fibrous bands of variable width, thickness, and configuration that overlie the synovial sheath. They provide biomechanical efficiency for flexor tendon excursion [11]. Traditional description of the thumb pulley system consists of three distinct pulleys [12]. These include two annular pulleys and a single oblique pulley. Bayat et al. [1] reported the presence of a fourth pulley, the variable annular (Av) pulley, between the A1 and the oblique pulleys. In their study, the Av pulley was found in 90% of patients and appeared to play a role in bowstringing if sectioned during A1 pulley release. We confirmed the presence of such entity as seen in all of our specimens and were able to identify the distal edge of the A1 pulley as distinct from the proximal edge of the Av pulley. No biomechanical measurements were taken in our study to measure bowstringing of the FPL tendon after sectioning of this pulley.

Identification of transverse surface landmarks for the thumb A1 pulley can assist clinicians in predicting its location prior to the surgical management of trigger thumb. According to our findings, a useful landmark is the PPC (Fig. 4). In an analysis of all specimens with at least three thumb creases (11/13), the PPC appears to be the most reliable landmark measuring 0.1 cm distal to the A1 pulley. In one cadaveric hand, three proximal creases were

Fig. 4 Predicted location of the A1 pulley based on measurements from the proximal–proximal crease (PPC)

Fig. 5 A case demonstrating the percutaneous release of the A1 pulley in a 47-year-old male with intermittent locking of the right thumb. *Left* the thumb A1 pulley is marked based on the proximal-proximal crease as a

surface anatomic landmark. *Center* the pulley is released with an 18-gauge needle. *Right* the patient is demonstrating release of the A1 pulley with no bowstringing of the flexor pollicis longus

identified. Nonetheless, the most proximal crease was still 0.1 cm distal to the A1 pulley as in the other specimens.

Predicting the length of the A1 pulley can assist in preparing for a complete release that does not extend to other critical elements of the pulley system. This measurement is essential when performing an open or a percutaneous release. Our measurements of the A1 pulley length as 0.61 cm concur with previous studies as ranging from 0.53 to 0.60 cm [1, 5]. In the operating room, we recommend that the patient would be instructed to flex and extend the thumb in order to ascertain the adequacy of the A1 pulley release along its entire length.

In conclusion, surface anatomic landmarks can be used to predict the location the A1 pulley of the thumb, thus facilitating a complete A1 pulley release by either open or minimally invasive technique. Identification of the A1 pulley distal edge can also reduce the risk of bowstringing with inadvertent release of the critical oblique pulley (Fig. 5). We identified the PPC of the thumb as the most reliable anatomic landmark for the A1 pulley. The proximal edge of the A1 pulley is 0.1 cm proximal to PPC, while the distal edge is approximately 0.5 cm distal to this landmark.

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