Length and Landmark of A1 Pulley in Hand: An Anatomical Study

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Objective: *The purpose of the present study was to identify length and landmark of proximal of A1 pulley in hand.*

Material and Method: *An anatomical study of the length and landmark of A1 pulley in hand was performed in 510 fingers and thumbs from 51 preserved cadavers. There were 25 females and 26 males whose ages at the time of death ranged from 48 to 89 years.*

Results: *The lengths of A1 pulley were 5.30 ± 0.53 mm in average of thumbs and 6.32 ± 0.17, 6.58 ± 0.19, 6.32 ± 0.20, and 5.30 ± 0.49 for the index, middle, ring, and small finger respectively. The average of all fingers were 6.13 ± 0.17 mm. The margin from the proximal edge of A1 pulley related to the perpendicular line from posterior superior prominent of metacarpal head to the volar aspect of its fingers, which was in the same line for 327 (64.1%) fingers and thumbs, and for 464 (91.0%) fingers and thumbs were differences ≤ 1 mm, and for 509 (99.8%) were differences ≤ 2mm to proximal edge of A1 pulley of its finger and thumb.*

Conclusion: *The posterior superior prominent of metacarpal head line in perpendicular to the volar aspect of its finger and thumb may be used as an anatomical landmark to predict of the proximal edge of A1 pulley with reasonable accuracy. The length of A1 pulley can serve as an important guide for the distal termination of A1 pulley release.*

Keywords: *A1 pulley, Landmark, Anatomy, Trigger finger*

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Development surface landmark of A1 pulley is important to identify location for accuracy and reliability of minimal invasive and percutaneous techniques of trigger finger and thumb release[1,2]. Previously described by Dr Jean Lorthioir using palmar crease to locate A1 pulley in hand[2], but it can be misleading because of the variability of the palmar creases or hand size[1,3,4]. Wilhelmi et al found that the distance from the palmar digital crease to the proximal interphalangeal crease corresponded to the distance of the proximal edge of A1 pulley to the palmar digital crease[1,5]. Because of A1 pulley span from the volar plate of metacarpophalangeal joint and the base of proximal phalanx, it start 2 mm proximal to metacarpophalangeal joint[1,6,7].

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The purpose of the present study was to measure the length of A1 pulley and landmark of proximal edge of A1 pulley that relates to the posterior superior prominent of metacarpal headline in perpendicular to the volar aspect of its finger and thumb. In several anatomic studies of the A1 pulley[6-11], none has described the location of the A1 pulley in relation to the posterior superior prominent of metacarpal head.

Material and Method

The author made sliding parallel rulers with one ruler fixed on the edge of the conduit of wood 5 mm depth and 20 mm width and 150 mm long and another could slide parallel to the first for measuring the distance between the line from posterior superior prominent of metacarpal head line in perpendicular to the volar aspect of its finger and thumb and proximal margin of A1 pulley (Fig.1).

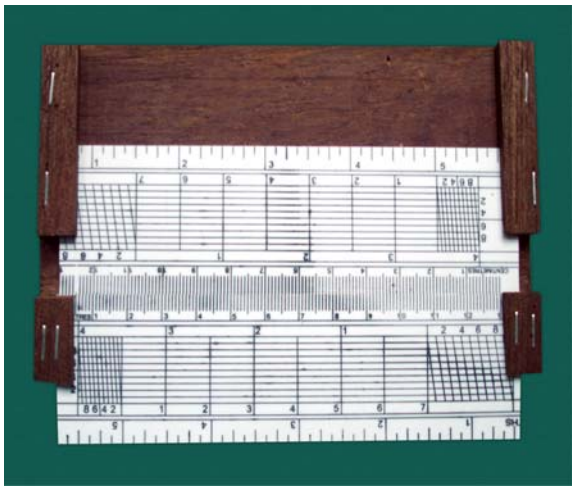

Fig. 1 Sliding parallel rulers which the point number 1-12 of fixed ruler was corresponded to sliding ruler number 12-1 (upper)

The author used each digit only bony part, joint capsule, flexor tendon and flexor tendon pulley in the present study.

Posterior superior prominent of metacarpal head is a point with the highest posterior part. The mid line of metacarpal head is where the fingers and thumb metacarpophalangeal joint flex at 60 degree for the fingers and 45 degrees for the thumbs (Fig. 2).

Placing each digit from distal phalanx to the proximal end of the metacarpal on the side of a digit on the conduit of sliding parallel rulers by having the posterior of the digit attached and parallel to the fixed ruler and sliding the other ruler to attach the volar aspect of digits (Fig. 3).

Five hundred ten cadaveric fingers and thumbs were dissected in 51 preserved cadavers. On dissection, the pulleys were identified, and the A1 pulley lengths of fingers and thumbs were measured with a 4X loupe using a caliper (Fig. 4). In addition, the distance between the line from the posterior superior prominent of metacarpal head line in perpendicular to the volar aspect of its finger and thumb and proximal margin of A1 pulley by placing each digit on the conduit were measured.

Results

In each of these 510 cadaveric fingers and thumbs dissections, the A1 pulley originated from the volar plate of the metacarpophalangeal joint. The line from posterior superior prominent of metacarpal head line in perpendicular to the volar aspect of its finger and thumb and proximal margin of A1 was in the same line for 327 (64.10%) fingers and thumbs, for 464 (91.0%) fingers and thumbs were differences ≤ 1 mm and for 509 (99.80%) were differences ≤ 2 mm. The overall mean difference was 0.37 ± 0.55 mm. The margin from the proximal edge of A1 pulley of thumb, index, middle, ring, and little fingers were 67 (65.70%),

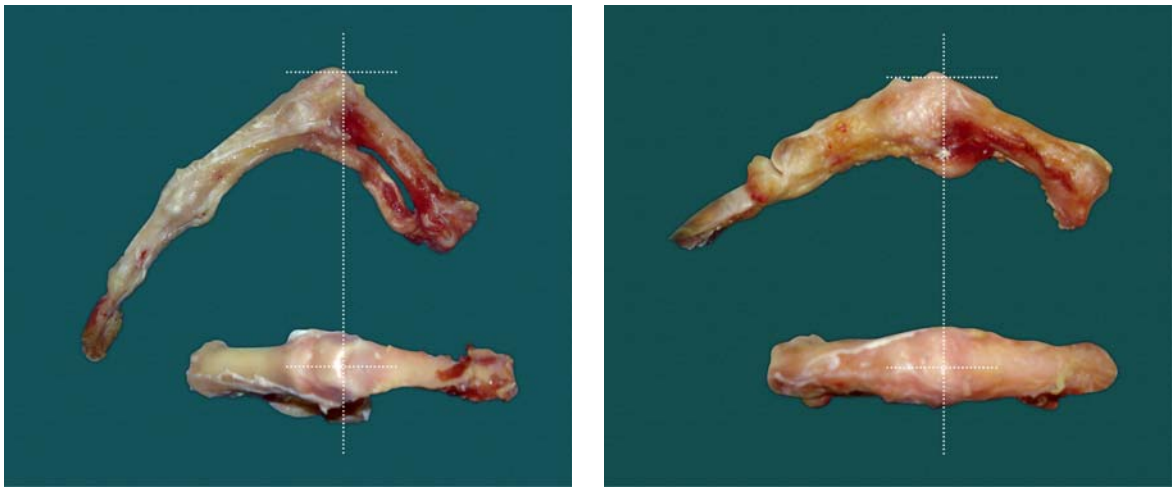

Fig. 2 Mark a point of posterior superior prominent of metacarpal head which is Highest posterior part and mid line of metacarpal head of the ring fingers (Left, lateral and dorsal view) and thumb (Right, lateral and dorsal view) were flexed metacarpophalangeal joint in 80 and 45 degrees of thumb

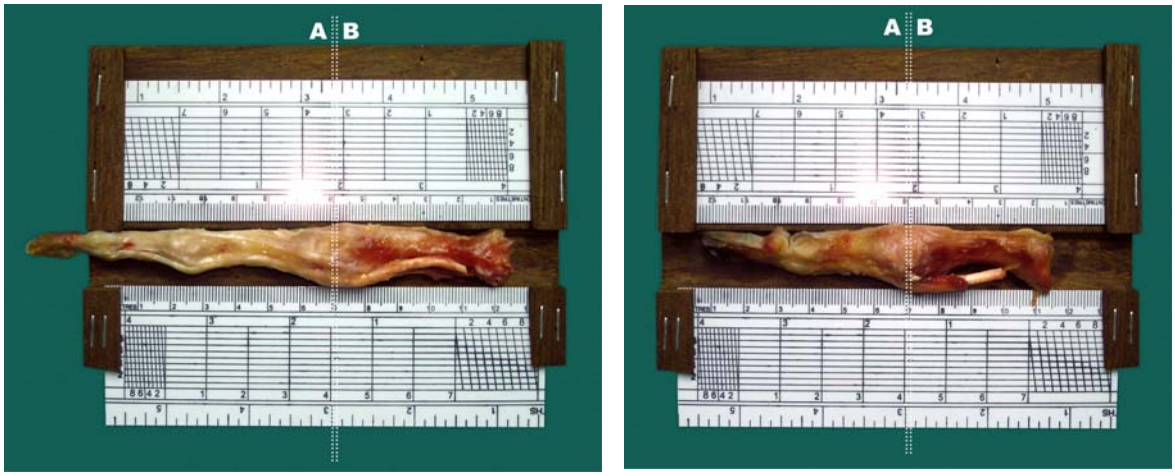

Fig. 3 Placing each digit from distal phalanx to proximal end of metacarpal on side of a digit on the conduit of sliding parallel rulers by posterior of digit attached and parallel to sliding ruler and the other attaches to the A1 pulley of digits. Posterior superior prominent of metacarpal head is a point of number 6 of sliding ruler and A1 pulley point to number 7 of fix ruler (Left is ring finger and right is thumb. Line A is posterior superior prominent of metacarpal head. Line B is different of distance between proximal edge of A1 pulley and line A)

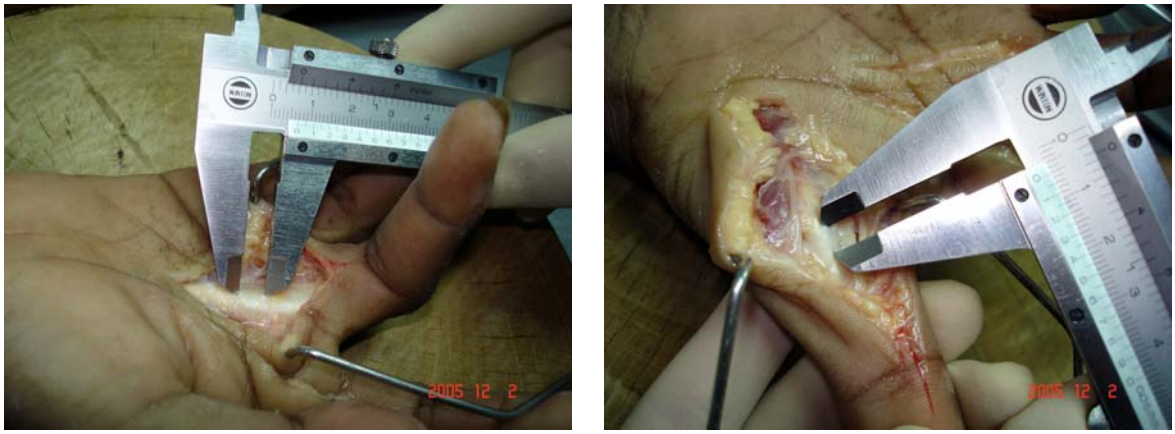

Fig. 4 Demonstration measurement technique using vernier of the A1 pulley of middle finger (left) and thumb (right)

59 (57.80%), 62 (60.80%), 69 (67.60%), and 70 (68.60%) digits respectively to the same line in the perpendicular line from the posterior superior prominent of metacarpal head. The thumb, index, middle, ring, and little fingers were 95 (93.10%), 91 (89.20%), 90 (88.20%), 94 (92.20%), and 94 (92.20%) digits respectively differences $\leq$ 1 mm to the line in the perpendicular line from the posterior superior prominent of metacarpal head (Table 1).

The length of A1 pulley averaged 5.30 $\pm$ 0.53 mm for thumb, 6.32 $\pm$ 0.17 mm for index, 6.58 $\pm$ 0.19 mm for middle, 6.32 $\pm$ 0.19 mm for ring, and 5.30 $\pm$ 0.49 mm for small finger whereas the A1 pulley of small fingers were not significantly shorter ($p > 0.05$) than the length of the A1 pulley for the index, middle, and ring fingers with a 95 percent confidence interval (Table 2).

Discussion

Pulleys are a fibrous band of variable length, thickness, configuration, and lining with synovial sheath[7,12,13]. They provide flexor tendon excursion in the hand. The location of A1 pulley plays a role in the treatment of many hand conditions and injuries, such as trigger fingers and thumbs that encountered steroid

Table1. Measuring the distance between the line from posterior superior prominent of metacarpal head (Line A) line in perpendicular to the volar aspect of its finger and thumb and proximal margin of A1 pulley (Line B) in 510 digits

Digit	Same line A and B (digit)	%	≤ 1 mm (digit)	%	≤ 2 mm (digit)	%
Thumb	67	65.70	95	93.10	102	100
Index	59	57.80	91	89.20	102	100
Middle	62	60.80	90	88.20	102	100
Ring	69	67.60	94	92.20	102	100
Little	70	68.60	94	92.20	101	99.00
Average of all digits	327	64.10	464	91.00	509	99.80

Table 2. The length of A1 pulleys of 51 cadaveric digits

Digit	Length of A1 pulley (mm)	Maximum	Minimum	Mean SD
Thumb	4.4	6.50	5.30	0.53
Index	6.0	6.75	6.32	0.17
Middle	6.0	7.00	6.58	0.19
Ring	6.0	6.80	6.32	0.20
Little	4.1	6.40	5.30	0.49
Average of all digits	5.8	6.46	6.13	0.17

injection, release of A1 pulley, and repairing flexor tendon at the digital level[1,4,14-23].

Wilhelmi et al reported the proximal edge of the C0 fibers or the distal A1 surface landmark can be predicted to be approximately 5 mm proximal to the palmar digital crease, creating a C0 line, a guide for concluding trigger release[1,5]. In releasing the A1 pulley to treat trigger finger, it is essential to avoid injury to the A2 pulley, because the A2 and A4 pulleys have been determined to be the critical pulleys[4,6,11,25,26]. Loss of one of these critical pulleys increases the moment arm, which decrease flexion with flexor tendon excursion and bowstring effect[6]. The flexor system will tolerate loss of 25% of the length of either of the A2 or A4 pulley without flexion effect[27]. Therefore, use of the distal A1 surface landmark line or the C0 pulley cruciate fibers as the guide for terminating pulley release can ensure preservation of the A2 pulley and optimal finger flexion[1,6]. In the present anatomic study, the length of A1 pulley averaged 5.30 ± 0.53 mm for thumb, 6.32 ± 0.17 mm for index, 6.58 ± 0.19 mm for middle, 6.32 ± 0.19 mm for ring, and 5.30 ± 0.49 mm for small finger. These lengths of A1 pulley can serve as an important guide for the distal termination of A1 pulley release.

Wilhelmi et al found that the distance from the palmar digital crease to the proximal interphalangeal crease corresponded to the distance of the proximal edge of A1 pulley to the palmar digital crease in absolute differences of ≤ 2 mm 89.8%[1]. Doyle described the A1 pulley span from the volar plate of the metacarpophalangeal joint and base of the proximal phalanx[6,9,10]. Berish Strauch found that annular proximal pulley starts 2 mm proximal to the metacarpophalangeal joint[7]. And Gau-Tyan Lin found that the joint center was intersected at the center line of adjacent phalanges and the axis of motion of metacarpophalangeal joint was in the metacarpal head[8]. This present study has shown that the distance between the line from posterior superior prominent of metacarpal head line in perpendicular to the volar aspect of its finger and thumb and proximal margin of A1 pulley was in the same line for 327 (64.1%) fingers and thumbs, and for 464 (90.1%) fingers and thumbs were differences ≤ 1 mm and for 509(99.8%) were differences ≤ 2 mm. In the hand surface, the posterior superior prominent of metacarpal head line in perpendicular to the palm of its finger and thumb may be used to predict the proximal edge of A1 pulley with reasonable accuracy.

Traditionally, trigger finger and thumb have been approached operatively through skin incisions. Recently, minimally invasive and percutaneous techniques have gained popularity[14-22]. Knowledge from the present study about length and landmark of proximal edge of A1 pulley is useful to improve the accuracy of percutaneous trigger finger and thumb release and avoid injuries to the A2 pulley. In surgical approach, the surgeon can place an incision directly over the proximal edge of the A1 pulley. This can be better exposure to distal edge of the A1 with minimal dissection and soft tissue injury.

The present study involving 510 cadaveric fingers and thumbs dissection demonstrated that the length of A1 pulley and the distance between the line from posterior superior prominent of metacarpal head line in perpendicular to the volar aspect of its finger and thumb and proximal margin of A1 pulley can be correlated and can serve to locate the proximal edge of A1 pulley. This facilitates trigger finger and thumb release by either minimal invasive or percutaneous technique.

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ความยาวและตำแหน่งปลอกหุ้มเอ็นเอ 1 ของนิ้วและนิ้วหัวแม่มือ: การศึกษาทางกายวิภาค

ยลชัย จงจิระศิริ

วัตถุประสงค์*: ต้องการศึกษาความยาวและตำแหน่งปลอกหุ้มเอ็นเอ 1 ส่วนต้นที่สัมพันธ์กับปุ่มกระดูกหลังมือ*
วัสดุและวิธีการ*: ผู้รายงานได้สร้างเครื่องมือในการหาตำแหน่งของปลอกหุ้มเอ็นเอ 1 ส่วนต้นที่สัมพันธ์กับปุ่มกระดูกหลังมือจากนิ้วมือจำนวน 510 นิ้ว และวัดความยาวของปลอกหุ้มเอ็นเอ1*
ผลการศึกษา*: พบว่าตำแหน่งของปลอกหุ้มเอ็นเอ1ส่วนต้น อยู่ตำแหน่งเดียวกับปุ่มกระดูกหลังมือที่ลากมาตั้งฉากมาที่ฝ่ามือ จำนวน 327 นิ้ว (ร้อยละ 64.1) ที่ความผิดพลาดไม่เกินหรือเท่ากับ 1 และ 2 มิลลิเมตรจำนวน 464 นิ้ว (ร้อยละ 91.0) และจำนวน 509 นิ้ว (ร้อยละ 99.8) ตามลำดับ และความยาวของปลอกหุ้มเอ็นเอ1 เฉลี่ย นิ้วหัวแม่มือ นิ้วชี้ นิ้วกลาง นิ้วนาง และนิ้วก้อย เท่ากับ 5.30, 6.32, 6.58, 6.32 และ 5.30 มิลลิเมตรตามลำดับ*
สรุป*: ผู้รายงานแนะนำให้ใช้วิธีนี้คาดคะเนตำแหน่งปลอกหุ้มเอ็นเอ 1ส่วนต้นที่สัมพันธ์กับปุ่มกระดูกหลังมือ*