Location of the Cut Flexor Tendons in the Palm Using Surface Anatomy: A Simple Guide for Minimal Incision Surgery

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ABSTRACT

BACKGROUND
Hand Zone 2 flexor injuries are among the most important tendon lesions and its prognosis is poorer than the other hand zones. Limited incisions prevent multiple skin flaps. The present study aimed to determine the location of palmar flexor tendons using surface anatomical markers to provide a simple and easy guide for hand surgeons assisting them in minimal incisions.

METHODS
Patients with hand injuries in Zone 2 were taken to the operating room for surgery. The skin and subcutaneous tissue over the flexor tendons sheath were incised. After finding the flexor tendons in the palm, their exact position was located with a blue needle (23G) over the palm crease and marked relative to the finger borders.

RESULTS
Thirty-eight patients with the mean age of 27±3.6 years were operated. Totally, 57 fingers and 38 palms were dissected. The flexor tendons were located under the proximal and distal palm creases between two parallel lines extended from finger borders and mid-axial axis of the fingers. The average distance from finger print to distal palmar crease was 25, 32 and 24 mm for little, ring and long finger, respectively and 32 mm from index finger print to mid palmar crease.

CONCLUSION
The precise position of flexor tendons can be easily determined in the palm according to surface anatomical markers and plan for limited incisions.

KEYWORDS
Flexor tendon; Tendon injury; Surface anatomy; Palm; Surgery

INTRODUCTION
Hand Zone 2 flexor injuries are among the most important tendon lesions. Exploration of this zone can lead to further damage to its components, such as pulleys, and increase the risk of postoperative complications. Adhesion at the repair site is the most common complication.1,2 On the other hand, the cut tendons in Zone 2 lack...
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the proximal end, which is retracted towards the palm, requiring further steps to pull it back to the cut site. In this regard, Zone 2 is referred to as the “no man’s land”.3 Some authors have proposed different methods to access the injury site. In 1944, Bunnell introduced the midaxial incision of flexor tendons;4 the midlateral incision by Varden,5 and in 1967, Bruner explained the zigzag volar-digital incision.6 Despite the simplicity and appropriate exposure of the Bruner method, the risk of iatrogenic damages is high due to the large dissection required, when the palm undergoes exploration. In general, the prognosis of Zone 2 injuries is poorer than the other hand zones.3

Limited incisions prevent multiple skin flaps. However, these methods require knowledge of finger and hand surface markers to determine the exact location and anatomy of the tendons. The location of finger flexor tendons and pulleys was already described.7 The present study aimed to determine the location of palmar flexor tendons using surface anatomical markers to provide a simple and easy guide for hand surgeons assisting them in minimal incisions.

MATERIALS AND METHODS

Patients with hand injuries in Zone 2 who referred to our emergency department from December 10, 2017 to March 3, 2019 were enrolled in this study. Informed consent was received and the rights of the patients were protected. After transferring them to operating room, the patients were prepared through nerve blocking and sedation or general anesthesia and, using a tourniquet if necessary. Flexor tendons and pulleys were explored through the Bruner method with zigzag incision up to the distal or middle palm to find the proximal ends of tendons. After finding the flexor tendons in the palm, their exact position was located with a blue needle (23G) over the palm crease and marked relative to the finger borders. Then, the proximal end of the cut tendon was attached to a small tube (G8) or a straightened silk needle 2-0, which was already passed from the cut site beneath the $A_1$ and $A_2$ pulleys up to the palm, and was slowly pulled back distally beneath the pulleys with a proper maneuver. After repairing the tendon using the Kessler method, the skin flaps were sutured in the correct positions. Then, in order to identify the exact location of flexor tendons in the palm, the designated areas on the palm and its creases, as well as the distance between the tendons relative to the radial, ulnar, and midaxial edges of each finger were measured.

RESULTS

In this study, 57 fingers and 38 palms underwent an operation in 38 patients, 29 men (76%) and 9 women (24%) with a mean age of 27±3.6 years. The causes of injuries were cutting with a knife or glass in the kitchen, sharp object at the workshop, motor vehicle accident and during the conflict. Thirty-four (89.47%) patients were male ($p<0.0001$). The mean footprint of four fingers and the mean distance between the proximal finger creases to the palm creases were presented in Table 1.

To determine the cut tendon end in the palm, the following criteria were used for the little to the index fingers: Two lines were drawn from the radial and finger midaxial edges towards the palm for the little and middle fingers. The interval between the two lines on the palm distal crease would be the location of the proximal flexor tendon end. In the middle finger, the intersection of the finger midaxial line on the distal palmar crease would be the location of the proximal tendon end. In the index finger, the intersection of the finger midaxial line on the distal palmar crease would be the location of the proximal tendon end. In the index finger,

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<th>Table 1: Surface markers of fingers and palm</th>
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<td><strong>Surface marker</strong></td>
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<tr>
<td>Finger foot print</td>
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<td>MAD**</td>
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*SD: Standard Deviation, **MAD: Mid-axial distance, the distance between mid-point of finger print to distal palmar crease; ***UBD: Ulnar border distance, the distance between ulnar border of finger print to palmar crease; ****RBD: Radial border distance. For Index finger the distances are from mid-palmar crease.
the ulnar edge and the finger midaxial line were drawn towards the mid palmar crease, and the interval between these two lines at the intersection with the middle crease will be the proximal tendon end (Figures 1-3).

DISCUSSION

Zone 2 was introduced as the “no man’s land” for the first time in the Bunnell’s Surgery Textbook, with its anatomical location between
the distal palmar crease and the middle finger crease. The zone includes the area between the A1, A2, and A3 pulleys, which form palmar plates in the distal interphalangeal (DIP), proximal interphalangeal (PIP), and metacarpophalangeal (MCP) joints, respectively.

The FDS tendon is branched in pulley A1 forming the chiasm of Camper at the depth of the FDP tendon. The FDS junction is between the first and the mid one-third of the middle phalanx, while the flexor digitorum profundus (FDP) is at the beginning of the last phalanx. In Gordon’s study, the structure of pulleys was determined based on the surface markers of the fingers. In this study, performed on 12 hands-on cadavers, the flexor zones and subzones were precisely determined. Gordon intended to precisely locate the pulley system using the fingers’ surface markers so that hand surgeons can access the injured pulley with limited incisions in the specified areas, but quick and easy remembering of a large amount of palm and hand anatomical details is difficult for surgeons during the operation. In addition, this classification cannot be of much assistance in locating the proximal end of the tendon when the proximal end is pulled back towards the palm.

Nickle studied the junction of FDS tendon to the proximal interphalangeal crease in six pairs of hands-on cadavers. He reported its location at about 3.22 mm more proximal than the proximal interphalangeal crease, but this study only addressed the FDS junction with no description of the Zone 2 injuries and the position of flexor tendons in the palm. The present study examines the position of deep tendons in relation to the surface markers of the palm rather than the previously identified bone markers.

CONCLUSION

The precise position of flexor tendons can be easily determined in the palm according to palm creases and finger sides. Muscle contraction may retract cut FDP tendons proximally towards the origin of lumbrical muscles in the palm (palmar arc). It is sometimes hard to find the proximal end with the available instruments and to pull it back distally from under the pulleys. On the other hand, damaging the neurovascular bundle and other structures is also a concern. Therefore, this study can help hand surgeons to directly reach the proximal end of the cut tendon through a limited transverse incision in the palm. This guide is very easy to learn, prevents large and extra incisions, and accelerates the surgeons’ performance.

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CONFLICTS OF INTEREST

The author has no conflicts of interest to declare.

REFERENCES


