The Relationship Between the Intercrease Line and the A1 Digital Pulley: A Cadaveric Study

Colyn J. Watkins¹, Nikola Zivaljevic¹, Kyle R. Eberlin¹,
Michael Rivlin¹, and Chaitanya S. Mudgal¹

Abstract

Background: Accurate identification of surface anatomy is critical to identify the location of the A1 pulley. The intercrease line (ICL) describes a transverse line between the radial edge of the proximal palmar crease and the ulnar edge of the distal palmar crease. We hypothesize that this easily identifiable surface landmark approximates the location of the A1 pulley. **Methods:** The ICL was marked on 7 cadaver hands. We marked a point proximal to the proximal digital crease (PDC) equal to the distance between each digit's proximal interphalangeal crease (PIC) and PDC (the PIC/PDC point). We calculated the distance between PIC/PDC points and proximal edge of the A1 pulleys. **Results:** The ICL was proximal to A1 in all digits. The PIC/PDC point was distal to A1 in the ring finger, and proximal to A1 in the index, middle, and small fingers. The PIC/PDC point was closer to the A1 pulley than the ICL in the middle and ring fingers. **Conclusions:** Despite less accuracy than the PIC/PDC point at approximating the location of the A1 pulley, the ICL is reliably proximal to the A1 pulley.

Keywords: A1 pulley, tendon, intercrease line, trigger finger, palmar crease

Introduction

Accurate identification of the A1 pulley is critical in many aspects of hand surgery. Understanding the anatomy of the A1 pulley and the surrounding neurovascular structures allows the hand surgeon to efficiently and safely treat a variety of common hand conditions. Most commonly, the A1 pulley is identified in the treatment of stenosing tenosynovitis, commonly known as trigger finger.^{7,17} However, a variety of hand conditions, including retrieval of flexor tendons during zone 2 repair and infectious flexor tenosynovitis, require clear identification of the A1 pulley and the intimately associated neurovascular structures.^{8,18}

Both transverse and longitudinal surface anatomy landmarks have been described to help identify the location of the A1 pulley.^{6,9,10,18} Wilhelmi et al^{18,19} demonstrated that the distance between the proximal digital palmar crease and proximal interphalangeal creases (PICs) corresponds to the distance of the proximal edge of the A1 flexor pulley from the proximal digital crease (PDC) in nonthumb digits. This finding was reproduced in 2011 by Fiorini et al.⁶ The use of surface landmarks to identify the A1 pulley is critical when operating near the A1 pulley as multiple studies describe its proximity to the neurovascular bundle, vascular arches, and the A2 pulley.^{1,3,8,11,19}

The intercrease line (ICL) represents a transverse line between the radial edge of the proximal palmar crease and the ulnar edge of the distal palmar crease. The utility of this surface landmark was first described by Graham Lister in 1977.¹² We hypothesize that this easily identifiable surface landmark approximates the location of the A1 pulley. This is an alternative to the PIC to PDC distance method by Wilhelmi et al^{18,19} to identify the location of the A1 pulley. Unlike previously described methods that require accurate caliper measurements, the ICL is defined with visual inspection alone. This cadaveric study evaluates both the PIC to PDC distance described by Wilhelmi et al^{18,19} and the ICL and their spatial relationships to the proximal extent of the A1 pulley.

Methods

We marked the ICL on 7 cadaveric hands by connecting a straight line between the volar radial edge of the proximal palmar crease and the volar ulnar edge of the distal palmar

¹Harvard Medical School, Boston, MA, USA

Corresponding Author:

Chaitanya S. Mudgal, Associate Professor in Orthopaedic Surgery, Harvard Medical School, Massachusetts General Hospital, Hand Service, Yawkey Center, Suite 2C, MA 02114, USA.
Email: cmudgal@partners.org

Figure 1. The intercrease line (ICL). The ICL is demonstrated in blue ink as a transverse line between the radial edge of the proximal palmar crease and the ulnar edge of the distal palmar crease.

crease (Figure 1). In total, we dissected 28 digits, 4 on each hand. All of the cadavers had both a proximal and distal palmar crease; none had a single, “simian” crease. Using a 27-gauge needle, we injected a single point of methylene blue (the amount of methylene blue at the very tip of the needle) perpendicular to the long axis of the palm at the ICL at index, middle, ring, and small fingers to mark the subcutaneous tissues and palmar fascia.

Using the method described by Wilhelmi et al^{18,19}, we measured the distance from the PDC to the PIC with a digital caliper under $2.5 \times$ loupe magnification. We used the proximal edge of these creases. On each digit, we subsequently marked a point proximal to the PDC the distance between each digit’s PIC and PDC (PIC/PDC point; Figure 2).

We then dissected and identified the A1 pulley in each finger. The distance between the ICL, as marked by methylene blue, and the midpoint (in the lateromedial plane) of the proximal edge of the A1 pulley was measured with a digital caliper under loupe magnification (Figure 3). We measured the distance between the PIC/PDC point and the ICL. From this, we calculated the distance between the PIC/PDC point and the proximal A1 pulley.

Figure 2. The proximal interphalangeal crease (PIC)/proximal digital crease (PDC) line. The PIC/PDC points are marked with digital caliper on palm.

Figure 3. The distance from A1 pulley to the intercrease line (ICL). A digital caliper measures the distance from the proximal extent of A1 pulley to the deep methylene blue marker at the ICL.

Table 1. Mean Distance and Standard Deviation Data in Millimeters.

	Index finger	Middle finger	Ring finger	Small finger
Mean difference A1 to ICL	-3.4 (3.3)	-7.8 (1.8)	-5.8 (3.4)	-3.9 (4.0)
Mean difference A1 to PIC/PDC point	-2.4 (5.9)	-0.8 (3.2)	0.8 (4.8)	-1.8 (6.6)

Note. Negative values denote a landmark proximal to A1. ICL = intercrease line; PIC = proximal interphalangeal crease; PDC = proximal digital crease.

Results

The ICL was consistently proximal to the A1 pulley in all digits. The PIC/PDC point was consistently proximal to the proximal edge of the A1 pulley in the index, middle, and small fingers and distal to the A1 pulley in the ring finger. Table 1 demonstrates numeric values for the distances from the A1 pulley to ICL and the A1 pulley to PIC/PDC point.

The mean PIC/PDC point was closer to the A1 pulley than the mean ICL in the middle and ring fingers ($P < .05$). The mean distances from the A1 pulley to the ICL and PIC/PDC point were not significantly different in the index and small fingers. However, the standard deviations were smaller for the ICL to A1 distances than the PIC/PDC point to A1 distance in all digits.

Discussion

Proper identification of the location of the A1 pulley is critical for hand surgeons. Treatment of trigger finger, both with open techniques and injection, is based on accurate identification of the structures in this area. In addition, retrieval of lacerated flexor tendons in the palm and treatment of purulent flexor tenosynovitis rely on locating the A1 pulley. Injury to the neurovascular bundle is a known complication when operating near the A1 pulley.^{4,5,16} Furthermore, errant release of the A2 pulley will decrease efficiency of flexor tendon excursion and can lead to tendon bowstringing.¹⁵

The purpose of this study was to compare an easily identifiable surface landmark, the ICL, to the known anatomic location of the A1 pulley based on the established method of Wilhelmi et al.^{18,19} Superficial fixed landmarks such as the distal and proximal palmar creases and metacarpophalangeal joints have been described as means to locate the pulley.^{2,3,14} Wilhelmi et al^{18,19} and Fiorini et al⁶ described landmarks that use ratios that account for individual and population-based differences in hand size. The concept that the pulley location will vary between individuals by a constant ratio, rather than fixed lengths, is described in the literature.^{11,13}

Our study demonstrates that the ICL is a surface landmark that is reliably proximal to the location of the A1 pulley. The PIC/PDC point was proximal to the A1 pulley in the index, middle, and small fingers but distal in the

ring finger. However, we found that the PIC/PDC point described by Wilhelmi et al^{18,19} was closer to the actual location of the A1 pulley in the ring and middle fingers. In the index and small fingers, there was no statistical significance in the difference in distance from A1 pulley to the ICL or PIC/PDC point.

Interestingly, our data demonstrate that the A1 pulley is, on average, farther from the ICL than the PIC/PDC point in the ring and middle fingers. However, the standard deviation was greater across all digits for the PIC/PDC point than for the ICL. This suggests that the PIC/PDC point, although more accurate, is less precise than the ICL in its relationship to the A1 pulley. It should be understood then that the ICL is not an accurate representation of the location of the A1 pulley but perhaps a more precise, and therefore reliable, landmark proximal to the A1 pulley. This reproducible relationship between the ICL and A1 pulley renders it a useful landmark to the hand surgeon.

One primary benefit of the ICL is its simplicity of identification. Unlike the PIC/PDC point, the ICL requires no measurements. The possibility of user or instrument error is minimized with a surface landmark such as the ICL. It simply requires creation of a straight line between 2 points. The PIC/PDC point, however, requires accurate caliper measurement. We believe that the ICL is useful in day-to-day clinical practice and can serve as a guide for the location of needle insertion, directed distally, during corticosteroid injection for treatment of trigger finger.

This study is limited in that it was performed on 7 cadaveric hands and the gender, age, and ethnicity of them were unknown. In addition, an a priori power analysis was not performed to determine the number of cadavers needed to identify a statistically significant result. Therefore, the results from our study should be interpreted with judicious caution. Clearly, a larger number of hands analyzed would add statistical power to the study, and this could be addressed in future studies. In addition, it would also be useful to measure the width of the palm, the size of the hand and then perform these same measurements across a range of hand sizes across both genders.

The ICL is a surface landmark that can help guide the clinician to the A1 pulley in the office or the operating room. The ICL is consistently proximal to the proximal extent of the A1 pulley in all nonthumb digits. Despite being less accurate than the PIC/PDC distance at

approximating the location of the A1 pulley in the ring and long fingers, the ICL does have a lower standard deviation across all digits and may have a more consistent proximal relationship to the A1 pulley.

Ethical Approval

This study was approved by our institutional review board.

Statement of Human and Animal Rights

This article does not contain any studies with human or animal subjects.

Statement of Informed Consent

There are no human subjects in this article and informed consent is not applicable.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

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