Introduction
Successful treatment of trigger thumb may involve a corticosteroid injection into the tendon sheath or surgery to release the A1 pulley by open or percutaneous techniques. Both approaches to treatment necessitate familiarity with the location and structural anatomy of the tendon sheath and neurovascular structures. The radial border of the index finger, the ulnar border of the thumb, and the flexion creases of the thumb are easily identified topographical landmarks in the uninjured hand.

We performed a cadaveric study to assess hand surface landmarks as potential reference points in localizing the thumb A1 pulley. In addition, we measured relevant portions of the thumb flexor tendon sheath, and we determined the positions of the volar digital neurovascular structures in relationship to the surface landmarks and A1 pulley.

Methods & Materials
Twenty fresh frozen hand specimens from 17 cadavers (11 men and 6 women) were obtained for this study. The mean age of the specimens was 75 years (range, 50 to 92 years). There were 1 to 3 IP joint flexion creases, spanning a distance of 2.4 to 8.6 mm, and 1 to 2 more widely spaced MP joint flexion creases, spanning a distance of 5.4 to 11.1 mm.

The radial artery of each specimen was injected proximal to the wrist flexion crease with red latex and the liquid was allowed to harden. The hand was placed supina on a flat surface with the thumb and fingers in full extension and the hand in approximately 90 degrees of radial abduction relative to the index finger (Fig 1).

A straight line was drawn from the tip of the thumb pulp to the hook of the hamate, bisecting the IP and MP joint flexion creases. Four surface landmarks were marked with a pen:
1) the radial border of the index finger,
2) the ulnar border of the thumb,
3) the midpoint of the IP joint flexion creases,
4) the separate MP joint flexion creases.

A longitudinal skin incision was made from the tip of the thumb pulp to the hook of the hamate along the depicted line. Skin flaps were elevated medially and laterally with the aid of loupe magnification and the FPL tendon and tendon sheath were exposed. All measurements are shown in Table 1.

Table 1: Hand Surface and Internal Measurements

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Width, Diameter (mm)</th>
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</thead>
<tbody>
<tr>
<td>A1 pulley (longitudinal width)</td>
<td>9.2 ± 0.9 (5.4 - 7.8)</td>
<td>A1 pulley to UD</td>
<td>0.4 ± 0.6 (0.0 - 1.8)</td>
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<tr>
<td>A1 pulley (transverse width)</td>
<td>9.7 ± 0.9 (5.4 - 7.8)</td>
<td>A1 pulley to UD</td>
<td>7.1 ± 1.5 (0.0 - 6.2)</td>
</tr>
<tr>
<td>Variable annular pulley (longitudinal width)</td>
<td>1.5 ± 0.1 (0.5 - 1.8)</td>
<td>Volar margin A1 pulley to proximal crossing of UD over FPL tendon</td>
<td>5.8 ± 2.0 (0.5 - 9.9)</td>
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<tr>
<td>UDN width</td>
<td>0.4 ± 0.2 (0.0 - 0.8)</td>
<td>UDN to A1 pulley</td>
<td>0.7 ± 0.5 (0.0 - 1.5)</td>
</tr>
<tr>
<td>UDN length</td>
<td>9.7 ± 1.8 (7.5 - 13.2)</td>
<td>Proximal margin UD to distal crossing of UD over FPL tendon</td>
<td>2.7 ± 0.7 (1.0 - 19.0)</td>
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</table>

Results
The measurements are tabulated in Table 1. There was a distinct demarcation between the A1 pulley and the variable annular pulley. The variable annular pulley exhibited both transverse (12 specimens) and oblique (8 specimens) configurations as recognized by others.

The ratio of measurements from the tip of the thumb to the midpoint of the IP joint flexion creases, and from this point to the proximal margin of the A1 pulley averaged 1.1:1 (range, 0.8:1 to 1.3:1).

The RDN passed over the FPL tendon proximal to the A1 pulley at an oblique angle in a proximal-ulnar to distal-radial direction. Both digital nerves were positioned nearly parallel with the A1 pulley and the digital arteries tracked dorsal to the digital nerves at this level.

Discussion
Incomplete and excessive release of the A1 pulley, and injury to the digital neurovascular structures by percutaneous or open techniques, are recognized complications of trigger thumb release surgery. Variable numbers of thumb MP joint flexion creases have been recognized, and the dorsal prominence of the 1st metacarpal head can be difficult to localize. The proximal border of the A1 pulley was located 0.3 ± 1.3 mm of the most proximal MP joint flexion crease in our specimens. Relative to the radial border of the index finger, the proximal margin of the A1 pulley was positioned between 0 and 13.5 mm proximally. Using the midpoint of the thumb IP joint flexion creases, we measured an average ratio of 1.1:1 in the distances between this point and the thumb tip and the proximal margin of the A1 pulley. The UDN was situated almost immediately below intersecting lines drawn along the radial border of the index finger and the ulnar border of the thumb. Based on the findings from our study, skin surface landmarks may be helpful in the treatment of trigger thumb. Knowledge of flexor tendon sheath anatomy, and the relationships between the surface landmarks, the volar neurovascular structures, and the A1 pulley may help to circumvent iatrogenic injuries with injection or surgery.