SCIENTIFIC ARTICLE

Percutaneous Release of the A1 Pulley: A Cadaver Study

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Purpose Percutaneous release of the A1 pulley has been used for treatment of trigger fingers with success. However, lack of direct visualization raises concerns about the completeness of the release and about potential injury to the tendons or neurovascular structures. The purpose of this study was to assess the efficacy and safety of percutaneous release of the A1 pulley in a cadaveric model using a commonly available instrument, a #15 scalpel blade.

Methods Fourteen fresh frozen cadaveric hands (54 fingers, thumbs excluded) were used. Landmarks were established for the A1 pulley based upon cutaneous features. Percutaneous release was performed using a #15 blade. The specimens were then dissected and examined for any tendon or neurovascular injury, and completeness of A1 pulley release was evaluated.

Results There were 39 (72%) complete releases of the A1 pulley with 14 partial and 1 missed (failed) release. There was a 22% incidence of release of the proximal edge of the A2 pulley. However, there was no case of release of more than 25% of the A2 pulley length, nor was bowstringing of flexor tendons seen in these specimens. Eleven digits showed longitudinal scoring of the flexor tendons and 3 had partial tendon lacerations. No neurovascular injuries were noted.

Conclusions Percutaneous release of the A1 pulley using a #15 blade was associated with good efficacy and an acceptable margin of safety in this series.

Clinical relevance Percutaneous release of trigger digits may assume a greater role in the treatment of patients with trigger finger because of cost containment pressures. The data from this study suggest that the technique used in this study is both safe and effective. With use of proper anatomical guidelines, risk to neurovascular structures is low, although longitudinal scoring of the tendon can occur. *(J Hand Surg 2012;37A:2273–2277.*

Key words Percutaneous trigger finger release, stenosing tenosynovitis of the A1 pulley, trigger finger, trigger digit.

Stenosing tenosynovitis at the A1 pulley, or trigger finger, represents one of the most common conditions seen in the practice of hand surgery. Nonoperative management commonly provides satisfactory results, with failures treated with A1 pulley release.[1–4] Release with an open incision centered over the volar aspect of the metacarpophalageal joint is standard, with excellent and reproducible results and a low complication rate.[5,6] Prior cadaver studies have increased interest in percutaneous release of the A1 pulley, with demonstration of safety and efficacy using a variety of tools, including hypodermic needles,[7,8] specially designed surgical blades,[9] or hook blades.[10] Likewise, prior clinical series demonstrated the feasibility of this procedure to be carried out as an office procedure, thereby avoiding use of an operating room, with a potential decrease in health care costs.[8–12] Perceived disadvantages of such percutaneous techniques include

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lack of direct visualization, inability to ascertain complete release, and potential injury to important structures including the digital vessels and nerves and tendons.[8,13]

The aim of the present study was to assess the efficacy and safety of the percutaneous technique when performed using defined surface landmarks and a standard #15 blade.

MATERIALS AND METHODS

Eighteen upper limbs (fingers to midhumerus) were obtained from 14 fresh frozen cadavers through our institution's anatomy bequest program. Appropriate institutional approval was obtained before the study. Arms were thawed for 24 hours before the procedures.

There were 8 male and 6 female cadavers with a mean age of 75 years (range, 38–87 y). Four cadavers had bilateral upper limbs studied. Procedures were performed on 54 digits in total, including 18 index fingers, 11 long fingers, 7 ring fingers, and 18 small fingers. No thumbs were included in this study. Of the 72 fingers (18 upper limbs), 18 were considered inadequate for examination owing to premortem or postmortem changes.

To determine the appropriate site of entry for the blade for trigger release, we first measured and marked anatomical landmarks for the A1 pulley in the digits, using the techniques described by Wilhemi et al[14] and Fiorini et al.[15] The proximal interphalangeal (PIP) joint crease was marked. The palmodigital crease was then marked. The center of PIP joint crease was considered point A and the center of palmar digital crease was considered point B (Fig. 1). The distances from the centers of the 2 creases (distance A–B) were measured and marked using a Vernier digital caliper. This length was then marked out on the palm in line with the digit ray, measured from point B proximally. This new mark was labeled point C. The distance B to C was halved and another point was marked at that spot (point D). This point D represented the entry point for the release instrument.

For percutaneous release of the A1 pulley, a new #15 blade on a scalpel handle was used. This was performed by the 3 study investigators. All 3 were orthopedic surgeons, with 2 board-certified hand surgeons (30 fingers) and 1 hand surgery fellow (24 fingers). The blade was inserted at an angle of 45° at point D until a crunch was felt as the blade encountered the A1 pulley. The blade was then moved in a distal-to-proximal manner to complete the release of the pulley. Completion of the release was assessed by the loss of the crunch or grating sensation. The blade was then withdrawn. During the release, the finger was stabilized in full extension.

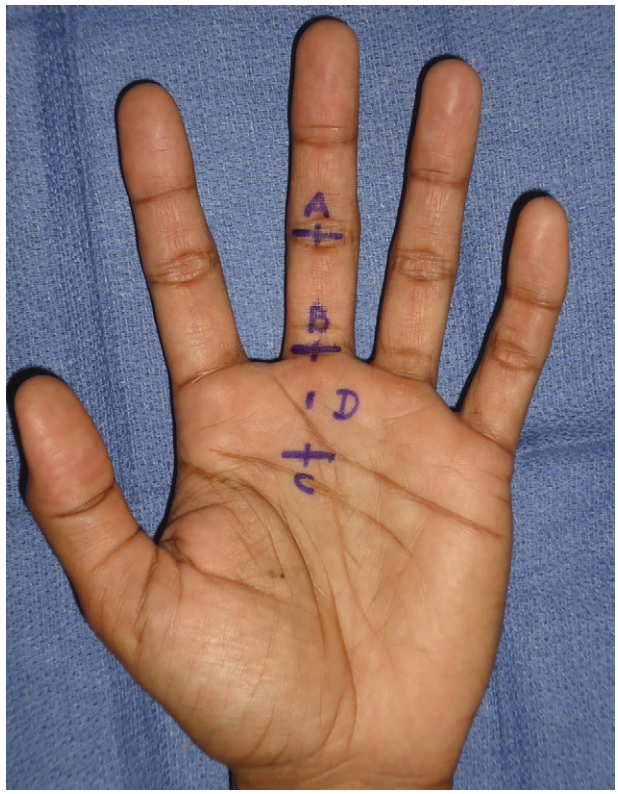

FIGURE 1: Point A represents the proximal interphalangeal joint crease. Point B represents the palmodigital crease. The distance between A and B was measured and used to create point C. Point C was placed a distance equal to distance A/B proximally from B, in line with the digital ray. Point D was created halfway between B and C and represented the entry point for the blade for release.

As the third part of the study, fingers were dissected paying specific attention to adequacy of A1 pulley release and any injury to other structures (A2 pulley, tendon, digital nerve or artery). A longitudinal incision was made extending from the PIP joint to the midpalmar crease in the line with the respective rays, and dissection carefully proceeded down to the tendon sheath (Fig. 2). Each investigator dissected his or her cadaver finger and assessed the above variables. This was done under 3.5 loupe magnification. Measurements were completed using Vernier digital calipers (Pittsburgh by Harbor Freight Tools, Camarillo, CA) with a measurement error of ± 0.01 mm.

We first assessed the status of the pulley release. Release was considered complete if the whole length of the A1 pulley was released. It was deemed partial if a part of the A1 pulley was intact. It was deemed to be a missed release if the blade had not released the pulley at

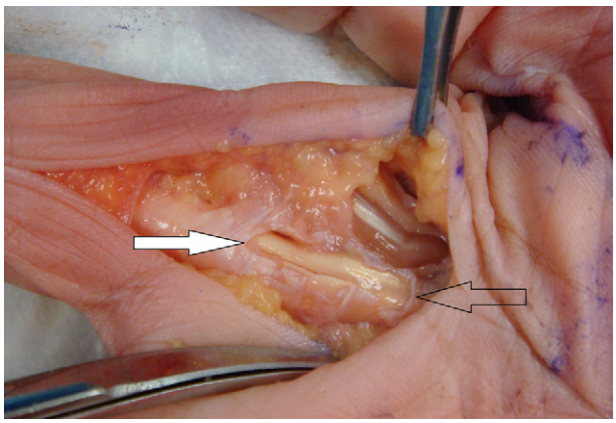

FIGURE 2: This cadaver specimen demonstrates incomplete proximal release of the index finger A1 pulley (*open arrow*) and partial proximal release of the A2 pulley (*solid arrow*).

TABLE 1. Incidence of Complete and Incomplete A1 Release With A2 Release in Each Finger

Digit (n)	Complete A1	Partial A1	Missed A1	A2 Release
Index (18)	13	5	0	2
Long (11)	8	3	0	4
Ring (7)	6	1	0	1
Small (18)	12	5	1	5
Total (54)	39	14	1	12

TABLE 2. Incidence of Tendon Complications

Digit (n)	None	Longitudinal Scoring	Partial Laceration	Complete Laceration
Index (18)	13	2	3	0
Long (11)	5	6	0	0
Ring (7)	6	1	0	0
Small (18)	16	2	0	0
Total (54)	40	11	3	0

all. For the partial releases, we evaluated the length and site of the remaining pulley. Actual lengths of the A1 pulleys were also measured with the calipers.

The A2 pulley was assessed as normal (if no cut was made) or incised (if the blade had made a cut). The part of the A2 pulley that may have been incised was also measured with the caliper.

The flexor tendons were then inspected to evaluate for any injury. Tendon injuries were classified as no injury, longitudinal tendon scoring (indentation into the tendon substance), partial laceration (interruption of one edge of the tendon with the tendon continuity maintained), or complete laceration (tendon continuity interrupted).

The digital neurovascular bundles were evaluated carefully for any injury to the vessels or the nerves.

RESULTS

There were 14 (26%) partial releases. There was 1 missed release in a small finger. The results in each finger are provided in Table 1. Of the 14 partial releases, the proximal edge of the A1 pulley was intact in 8 fingers. The distal part was intact in 2 fingers. Both edges were intact in 1 finger. The incomplete part could not be assessed in 3 fingers owing to postmortem changes. The pulley could be identified in these 3 cases, but the remaining length of the pulley could not be measured. Despite the high rate of partial releases, the remaining unreleased portion of the A1 pulley in a partial release measured a mean of 1 mm (range, 1–2 mm).

Twelve (22%) of the 54 digits showed evidence of a partial proximal release of the A2 pulley. The results in each finger are given in Table 1. The mean release of the A2 pulley in these 12 fingers was 2.3 mm (range, 1–5 mm). In each of the 12 fingers, the length of A2 pulley released remained less than 25%.

There were 14 cases of tendon complications. Of these, only 3 had a partial tendon laceration and the rest had a minimal longitudinal indentation (scoring) of the tendon substance without any tendon length interruption. The partial lacerations had oblique involvement interrupting only 1 edge of the tendon. Tendon continuity was maintained in all fingers. The results for each finger are given in Table 2. The flexor digitorum profundus was involved in 1 partial laceration and 4 scorings and the flexor digitorum superficialis was involved in 2 lacerations and 7 scorings.

There were no injuries to the nerves or the vessels.

DISCUSSION

Percutaneous release of A1 pulley as a treatment for trigger finger was reported with the use of a tenotome in 52 digits with no complication.[16] In controlled trials of open versus percutaneous release, some authors have reported shorter recovery time and improved results with the percutaneous technique.[13,17,18] Reported rates and techniques of successful release vary in the literature from 64% to 90% with use of angiocatheters,[7] blades,[9,10,19] or needles.[8,13]

In contrast to the present cadaveric study, these prior clinical studies do not report on completeness of re-

lease. It is possible that some of these patients may have had incomplete releases but had relief of symptoms.[7,8,12] These patients may be prone to recurrence of triggering.[12]

Bain et al,[7] in a cadaveric study of percutaneous trigger digit release with an angiocatheter needle, reported 21 (32%) out of 66 digits with incomplete release. They suggested that percutaneous trigger digit release in a live symptomatic patient may be easier than in a cadaver owing to the presence of a nodule to guide placement of the needle. Our present study had a similar rate of incomplete release (26%), and we concur with their conclusions. We used surface landmarks to locate the position of the A1 pulley, and we believe it would have been easier to identify the appropriate location if a palpable nodule was present. Like Bain et al, we had 1 digit in which the blade missed the A1 pulley in the small finger.

Incomplete releases were commonly reported at the distal edge of the A1 pulleys in a series by Pope et al.[8] In the present study, however, incomplete releases were more commonly related to proximal incomplete release than to distal release. This may have been due to a more distal starting point of the blade or, alternatively, a more distal arc of the release. It is important to note that incomplete release of the A1 pulley was common in this series (26%); however, the portion that was unreleased was minimal (1–2 mm) and may not be clinically relevant.

Tendon lacerations have been reported in several previous studies. Bain et al[7] had a rate of 88% tendon injuries including tendon scoring. Calleja et al[12] reported tendon scoring in 15 (60%) of 25 digits studied. However, in clinical studies, no patients had symptoms of tendon impairment.[20] Pope et al[8] reported tendon scoring in most of their cadaveric digits as well as in patients. The present study had a 26% incidence of tendon scoring. Our lower incidence may have been due to use of defined landmarks for the A1 pulley.[14,15]

A concern with percutaneous A1 pulley release is injury to the neurovascular bundles, because direct visualization and protection is not possible. However, previous studies have suggested that the nerve or vessel injury is unlikely except for in the thumb or little finger.[7,20] Because we did not include thumbs in our study, we cannot comment on the risk in thumbs. In the remaining digits, no digital nerve or vessel injury occurred. Thus, digital nerve and vessel injury is technically possible but unlikely.

Another concern regarding percutaneous trigger digit release is potential injury to the A2 pulley. Few prior series have addressed the status of the A2 pulley. Pope et al[8] reported no A2 releases in the cadaveric portion of 1 study. However, they did not report on the status of the A2 pulley in the clinical portion of this study. In our series, we had a 22% incidence of partial release of the A2 pulley. This partial release included a mean 2.3 mm of the proximal part of the A2 pulley. This discrepancy between our study and the previous one could be that our starting point for the insertion of the blade or the arc of motion might have been too far distally. Alternatively, the status of the A2 pulley might not have been reported by earlier studies because release of the proximal edge of the A2 pulley is probably inconsequential and insufficient to result in any functional deficits. Complete A2 pulley release causes bowstringing of the flexor tendons. However, we did not notice any bowstringing with passive motion of the digits and with proximal pull on the tendon. This could be because most of the A2 pulley remained intact.

Percutaneous release of the A1 pulley has been investigated with cadaver[7,12,14,15] as well as clinical[13,16–18] studies. The current study used established landmarks to determine surface anatomy of the A1 pulley and released the A1 pulley with a standard #15 blade. This allowed us to minimize the risks of aberrant entry point that may have altered the path of the release instrument. Needles including angiocatheters have been studied and have been found to be successful. However, because the needle gauge is narrow, multiple passes may be required before complete release is achieved. Others have studied specifically designed blades including hook blades[9,10] for this procedure with success. However, these designed blades require special manufacturing process and may not be readily available. We decided to use a commonly available and inexpensive instrument for this process.

The major limitation of the present study is that it was a cadaver series without a clinical comparative arm, which makes extrapolation of clinical results difficult. In patients with complete release of the A1 pulley, it would be likely that triggering would cease. In patients with incomplete release of the A1 pulley, symptoms might be ameliorated but perhaps not abolished, as suggested by some clinical studies.[7,12] In addition, technical differences exist. Cadavers might have altered landmarks and tissue turgor owing to soft tissue shrinkage or fluid shifts postmortem. Also, the presence of a nodule over the A1 pulley, a thickened pulley, or a history of triggering was not a requisite inclusion in this study. However, a nodule or a thickened pulley, which is typically present in the clinical setting, may allow easier identification of the A1 pul-

ley.[8] Further study is required to determine the usefulness of percutaneous release in the thumb.

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