US-guided Percutaneous Release of the Trigger Finger by Using a 21-gauge Needle: A Prospective Study of 60 Cases[1]

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Purpose: To evaluate the efficacy of ultrasonographically (US)-guided percutaneous treatment of the trigger finger by releasing the A1 pulley with a 21-gauge needle.

Materials and Methods: This two-part study was approved by the ethics committee, and written consent was obtained from all patients. The first part consisted of 10 procedures on cadaver digits followed by dissection to analyze the effectiveness of the A1 pulley release and detect any collateral damage to the A2 pulley, interdigital nerves, or underlying flexor tendons. The second part was performed during an 18-month period starting in March 2013. It was a prospective clinical study of 60 procedures performed in 48 patients. Outcomes were evaluated through a clinical examination at day 0 and during a 6-month follow-up visit, where the trigger digit was evaluated clinically and the Quick Disabilities of the Arm, Shoulder and Hand outcome measure, or QuickDASH, and patient satisfaction questionnaires were administered.

Results: No complications were found during the cadaver study. However, the release was considered "partial" in all fingers. In the clinical study, the trigger finger was completely resolved in 81.7% (49 of 60) of cases immediately after the procedure. Moderate trigger finger persisted in 10 cases, and one thumb pulley could not be released. A US-guided corticosteroid injection was subsequently performed in these 11 cases. At 6-month follow-up, only two cases still had moderate trigger finger and there were no late complications. The mean QuickDASH questionnaire score was 4; all patients said they were satisfied.

Conclusion: US-guided treatment of the trigger finger by using a 21-gauge needle is feasible in current practice, with minimal complications.

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Snapping and locking of the fingers are very common clinical findings, related mainly to an imbalance between the size of the flexor tendons and that of the tendon sheath (Fig E1 [online]). The likely cause is thickening of the A1 pulley secondary to repeated microtrauma (1). In the chronic stage, there is histologic evidence of deep fibrocartilaginous metaplasia in this pulley (2–4).

With modern ultrasonographic (US) equipment, the finger pulleys and tendons can be fully analyzed in their normal state (Fig E1 [online]) and the pathologic anatomic structures involved in trigger finger can be clearly seen. The signs of trigger finger have been well described (1): hypoechogenic or even Doppler hyperemic thickening of the A1 pulley with abnormal underlying flexor tendons (tenosynovitis, tendinosis, dark tendon sign [5]).

Typically, trigger finger is first treated conservatively, with the patient wearing a splint and taking nonsteroidal anti-inflammatory drugs (6–8) or undergoing cortisone injections (9). If conservative treatment fails, the A1 pulley can be released surgically; good results have been reported in 60%–97% of cases (6).

Blind percutaneous release by using simple clinical landmarks was first described in 1958 (10). The effectiveness was equal to that of an open procedure (11–14); however, complications such as overly wide release that extends to the A2 pulley or damage to interdigital nerves have been reported. Nevertheless, the complication rate is low (0.02%) (13).

This type of procedure can also be US guided (15–17) and performed with a 2.5–2.6-mm hook (15,16) or a 19-gauge, 1.27-mm needle (17). This has the advantage of providing direct visualization of the vascular and nerve structures during the procedure.

The purpose of our study was to evaluate the efficacy of US-guided percutaneous treatment of trigger finger by releasing the A1 pulley with a 21-gauge needle.

Advances in Knowledge

- US-guided treatment of the trigger finger by using a 21-gauge needle is feasible in current clinical practice.
- Complete resolution of trigger finger was achieved in 96.7% (58 of 60) of cases after 6 months.
- The combined use of US-guided procedure and a small needle (21 gauge) is very safe, making it possible to completely avoid iatrogenic neurovascular or tendinous injuries (zero of 60) and minimizing the occurrence of minor adverse event (four of 60).
- Our microinvasive procedure is painless and requires less than 1 day off work for 100% of our subjects.

Materials and Methods

Our two-part study was approved by our Research Ethics Committee. It consisted of cadaver and clinical studies conducted jointly by a hand surgeon (A.A., 10 years of experience) and an interventional radiologist specializing in musculoskeletal procedures (F.L., 15 years of experience).

Cadaver Study

A feasibility study was performed to confirm that the A1 pulley could be cut in a cadaver by using a 21-gauge needle; the bevel was oriented laterally to act as the cutting edge of a scalpel (Fig 1, Fig E2 [online]). On the basis of these findings, the radiologist performed a US-guided A1 pulley release in 10 digits of a fresh cadaver (80-year-old woman). Subsequently, the surgeon carefully dissected the treated fingers to analyze the condition of the A1 pulley, A2 pulley, underlying flexor tendons, nerves, and collateral vessels.

Implications for Patient Care

- An efficient, quick, safe, and low-cost alternative to surgery is proposed for trigger finger treatment.
- Outpatient care of trigger finger is feasible even in very old patients and those with severe concurrent diseases.

Clinical Study

Study population.—During an 18-month period starting in March 2013, 53 adult patients were enrolled into our prospective study. The inclusion criterion was idiopathic trigger finger present for at least 4 months. The exclusion criteria were a previous history of open release for trigger finger, rheumatoid arthritis, a concomitant pathologic condition in the hand at the time of the first consultation with the surgeon (A.A.), appearance of hand disease not related to the trigger finger during the 6 months following the procedure, absence of the 6-month follow-up visit.

During the first visit, the hand surgeon (A.A.) proposed this procedure to 53 patients; written informed consent was obtained from all subjects. These 53 patients underwent US-guided release of 65 fingers (12 patients had the release performed on two fingers in the same session). Five patients were excluded during the course of our study: two were lost to follow-up at 6 months, one died, and two subsequently developed another hand disease that interfered with analysis of the results (carpal tunnel syndrome, finger wound). As a consequence, 60 fingers in 48 patients (27 women, 21 men) were available for analysis. The average patient age was 61 years. The

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Conflicts of interest are listed at the end of this article.

Figure 1

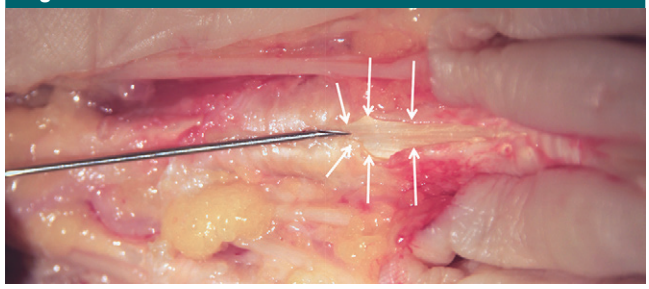


Figure 1: Release of the A1 pulley by using a 21-gauge needle in a cadaver preparation. After the volar side of a fresh cadaver finger in an 80-year-old woman was dissected and the fibrous sheath exposed, the needle was slid longitudinally along the superficial aspect of the A1 pulley. The underlying flexor tendons are visible between the divided edges of the pulley (arrows). The pulley is completely cut after two back and forth movements of the needle.

procedures were distributed among the following fingers: 18 thumbs, six index, 20 middle, 10 ring, and six small fingers; 28 fingers were in the right hand and 32 in the left hand.

Release procedure.—All the procedures were performed by the radiologist (F.L.) using a US unit (model APLIO 500; Toshiba Medical Systems, Tokyo, Japan) with a high-frequency transducer (18 MHz). The patient was positioned supine on a stretcher, with the hand placed flat on a table. A sterile working area was prepared by disinfecting the hand, applying sterile drapes, and using a sterile probe cover and US gel.

First, a local anesthetic was injected with a 25-mm long, 25-gauge needle (orange hub). The needle's entry point was in the proximal third of the proximal phalanx directed toward the distal part of the A1 pulley. Our team places a gel pad (ie, extra gel heaped on the finger) between the transducer and skin, to make it easier to locate the needle and give it the correct trajectory before breaching the patient's skin (Fig 2). Two cubic centimeters of 1% lidocaine HCl (Xylocaine; AstraZeneca, Rueil-Malmaison, France) was injected along the needle's path and into the synovial sheath of the flexor tendons (Movie 1 [online]).

Next, the base of a 50-mm long, 21-gauge needle (green hub) was manually curved to a 140° angle so that its bevel faced laterally (Fig 3). This curvature had two effects: it placed the needle in a completely horizontal position and made it possible to determine the bevel's orientation even when it was hidden beneath the patient's skin.

Once the 21-gauge needle was in the desired location, the radiologist slid it back and forth horizontally, parallel to the long axis of flexor tendons, four or five times along the trajectory of the A1 pulley (Fig 4a, Movie 2 [online]). While doing so, the hand of an experienced radiologist feels the typical slight resistance of the structure being cut. During the release, continuous US verification was performed in the longitudinal plane (Fig 4b), while making sure that the tip of the needle was visible. The position of the needle was also verified in the short axis of the tendon before the release. In general, a centrally located needle near the vertex of the pulley ensures there will be no complications in the long fingers; the interdigital pedicles remaining in this position are as far away as possible from the needle (Fig 4c).

Once these four or five back and forth movements were completed, the needle was removed and the patient was asked to flex the treated finger. If the triggering was gone, the procedure was considered complete. If moderate triggering remained, the 21-gauge needle was reintroduced for another four or five back and forth movements; this second set of needling was required in 42% of cases (25 of 60). If the triggering still persisted after these two release attempts, a few drops of Cortivazol (Altim; Sanofi-Aventis, Paris, France) were injected around the distal part of A1 pulley and in the tendon sheath when not contraindicated. This additional injection was required in 11 cases.

Performance of US-guided release in the thumb is technically more difficult than in the long fingers. Since the thumb cannot be laid completely flat (Fig E4a [online]) on its dorsal side while keeping the flexor tendon pointed at 12 o'clock, the needle must be inserted while taking into account two bends (Fig E4b [online]). Anatomic variations in the position of the palmar interdigital nerves can also make the procedure more challenging (Fig E4c [online]). After the procedure, we advised patients to avoid using their treated hand for 6 hours.

Assessment of clinical outcomes.—On the day of the procedure (day 0), the radiologist also performed a clinical examination; a video of the finger's movement before and after the procedure was created with a camera (Movies 3 and 4 [online]).

The triger finger cases were classified by using the following semiquantitative scale and McNemar test was used for statistical testing. Grade 0 indicated no triggering; grade 1, intermittent, moderate triggering; grade 2, continuous triggering that is eliminated with active extension; grade 3, triggering with flexion contracture that requires the patient to use the other hand to unlock the involved finger; and grade 4, active flexion of finger is impossible.

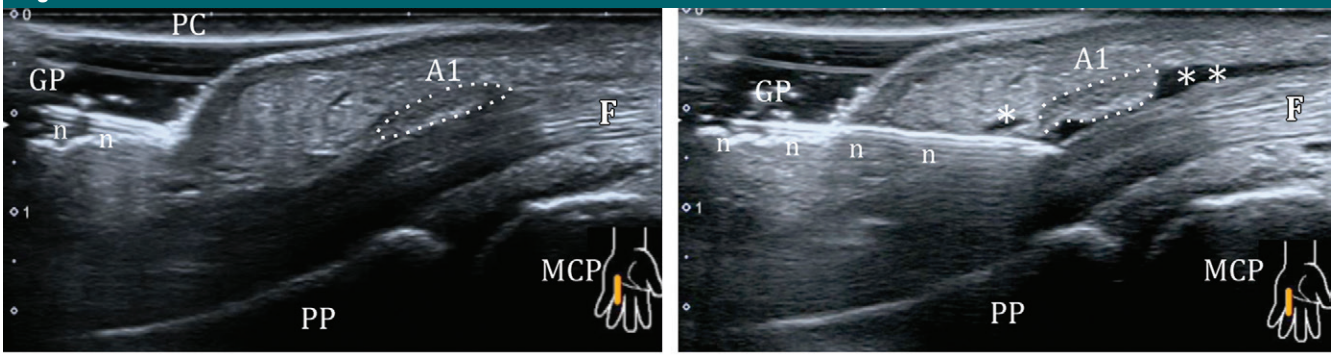
Patients had a follow-up consultation with the surgeon after 6 months. The clinical outcome of the trigger finger was estimated based on the above scale, and a QuickDASH (Quick Disabilities of the Arm, Shoulder and Hand outcome measure) questionnaire was completed. The patient was also asked to state he or she was "very satisfied," "satisfied," "barely satisfied," or "not satisfied" with the care of their trigger finger.

Results

Cadaver Study

The following observations were made after dissecting the 10 cadaver fingers

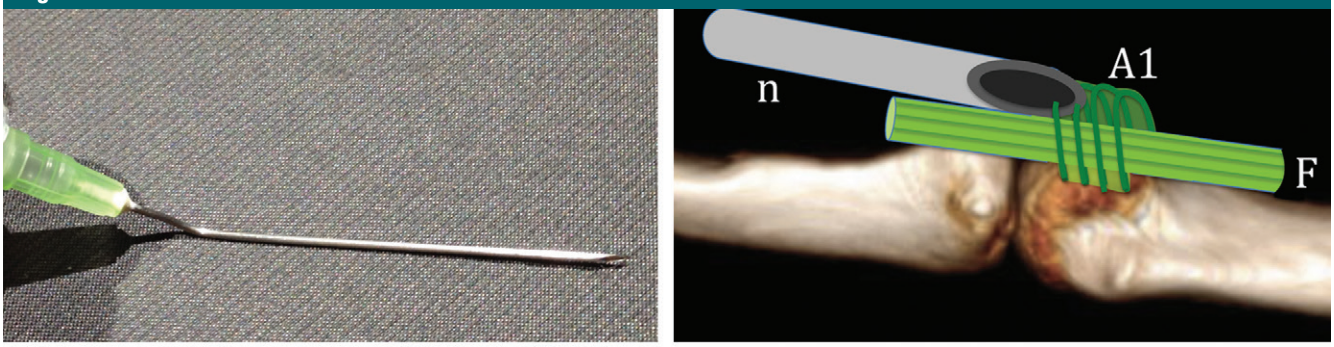
Figure 2



a. b.

Figure 2: Anesthesia performed over the release trajectory of the pulley by using the gel pad technique. Longitudinal US views in a 71-year-old woman. **(a)** A sterile gel pad *(GP)* made of extra gel heaped on the finger is placed between the transducer and its cover (*PC* = probe cover, superficial hyperechogenic line) and the finger. The needle *(n)* is precisely positioned before it enters the patient's skin. The needle points at the distal part of the hypertrophied A1 pulley (dotted line) in a patient with trigger finger. **(b)** The needle *(n)* is advanced to the targeted site and the anesthetic is injected into the flexor tendon sheath (**), around the A1 pulley (*) and along the needle's entire trajectory. The pulley is easier to discern as it is "molded" by the anechoic material. *F* = flexor tendons, *MCP* = metacarpal, *PP* = proximal phalanx.

Figure 3



a. b.

Figure 3: Preparation of the needle used to release the pulley. **(a)** The base of a 50-mm-long, 21-gauge needle (green hub) is curved to about 140° so that its bevel points to the side. **(b)** Drawing of the volar side of the flexor mechanism at the metacarpophalangeal joint shows why the needle's bevel *(n)* must face laterally. By it facing laterally, it can cut the fibers of the A1 pulley that are perpendicular to the long axis of the finger and will cause minimal damage to the longitudinally oriented fibers of the underlying flexor tendons *(F)*.

that underwent US-guided pulley release: *(a)* all 10 A1 pulleys were not fully released (Fig E5 [online]), superficial or deep grooves were visible or the pulley was partially divided, (b) none of the A2 pulleys were damaged, *(c)* the underlying flexor tendons were not damaged, and *(d)* the nerves and collateral blood vessels (palmar interdigital neurovascular bundles) were not damaged.

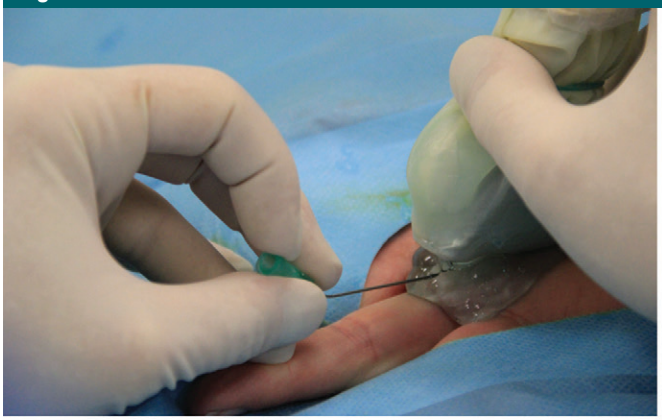
Clinical Study

Detailed results by trigger finger grades are given in the Table and Table E1 (online). At day 0, immediately after the procedure, 81.7% (49 of 60) of the procedures ($P < .001$) resulted in complete mechanical release. One thumb (grade 4) could not be released, and 10 of 60 fingers (16.7%) still had minor intermittent catching that was not bothersome (grade 1). These 11 of 60 fingers (18.3%) were subsequently injected with cortisone.

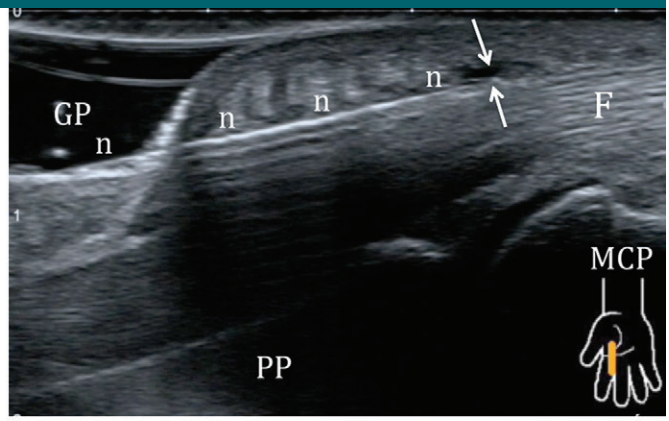
At the 6-month follow-up, only two of 60 fingers still had a grade of 1 (3.3%). The failed thumb release procedure was eventually successful 3 weeks after the cortisone injection. The initial trigger finger was completely resolved in 58 of the 60 cases (96.7%) ($P < .001$). No recurrence was observed in the treated digits.

The QuickDASH results at 6 months were as follows: *(a)* Thirty-two patients scored 0 (0 is the best possible score; it implies that there was no impact on activities of daily living), nine patients scored between 2 and 10, six patients scored between 10 and 21 (no significant impact), and one patient scored 38 (moderate aftereffects; this patient had concurrent shoulder problems that could modify the QuickDASH); note that 100 is the worse score possible;

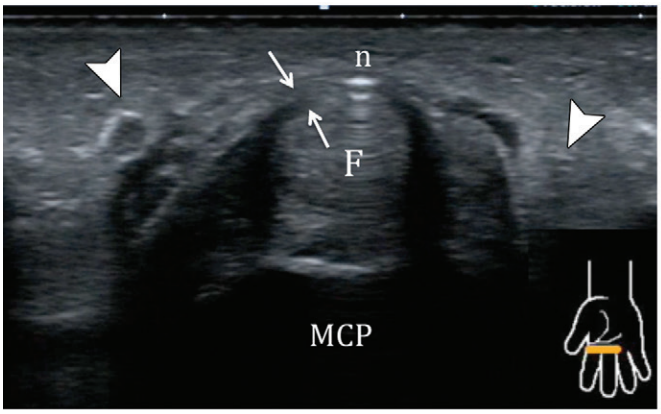
Figure 4



a.



b.



c.

Figure 4: US-guided release of the A1 pulley in a long finger. **(a)** Photo obtained during the procedure: The 140° curved needle is held between the radiologist's thumb and index finger; the patient's treated finger is extended. **(b)** Longitudinal US view in a 55-year-old woman. The 21-gauge needle *(n)* is inserted by using the gel pad *(GP)* method, with the transducer aligned in the finger's longitudinal plane. The needle's curved base allows it to be tilted to achieve a horizontal trajectory and to make four or five back and forth movements over the trajectory of the thickened A1 pulley (arrows). The radiologist must make sure that the tip of the needle does not damage the underlying flexor tendons *(F)*. *PP* = proximal phalanx, *MCP* = head of metacarpal. **(c)** Transverse axial US view in the same patient as in *b*. Inspection in the short axis of the finger at the start of the procedure to identify the palmar interdigital neurovascular bundles (arrowheads). Here the needle *(n)* is in the ideal position at the most superficial portion of the thickened A1 pulley (arrows), away from the bundles. *MCP* = head of metacarpal.

Type of Trigger Finger before the Procedure, Immediately after the Procedure, and 6 Months Later

Grade and Type of Trigger Finger	No. of Each Type of Trigger Finger (n = 60)		
	Before Procedure	Day 0 after Procedure	6 Months after Procedure
Grade 0, no triggering	0 (0)	49 (81.7)	58 (96.7)
Grade 1, intermittent, moderate triggering	7 (11.7)	10 (16.7)	2 (3.3)
Grade 2, continuous triggering that is eliminated with active extension	23 (38.3)	0 (0)	0 (0)
Grade 3, triggering with flexion contracture that requires the patient to use the other hand to unlock the involved finger	12 (20.0)	0 (0)	0 (0)
Grade 4, active flexion of finger is impossible	18 (30.0)	1 (1.6)	0 (0)

Note.—Data in parentheses are percentages.

(b) The mean QuickDASH score was 4, with a median of 0 and standard deviation of 8.5.

At the 6-month follow-up, 39 of 48 patients were very satisfied (81.2%) and nine of 48 were satisfied (18.8%). The following complaints were noted at the 6-month follow-up: seven of 60 fingers had slight, intermittent pain (1 of 10 in the numeric rating scale for pain) without triggering; two fingers had minimal residual triggering (grade 1); and trigger finger developed in one finger that had been initially asymptomatic.

Procedure Tolerance and Early Complications

The mean procedure time (including patient set-up) was 15 minutes (standard deviation, 2.2 minutes); once local anesthetic had been injected into the finger, the patients no longer complained of pain during the procedure. Only one complication, a hematoma, was observed in four patients; it appeared a few hours after the procedure and became less noticeable 1 week later. Two of the patients were taking

platelet inhibitors and two patients had resumed use of their hands within an hour of the procedure. These four minor adverse events led us to add a compressive dressing after the procedure and to recommend a half day of rest. There were no other complications and no clinical signs of damage to the interdigital nerves, flexor tendons, or A2 pulleys and no bowstringing.

The costs of a standard release procedure were compared with those of a US-guided procedure in France (Table E2 [online]). The standard surgical treatment requires a doctor's visit, potentially a diagnostic US, anesthetic nerve block, surgical release of the pulley, at least 10 days off work, and nursing care at home. Our percutaneous treatment consists of diagnostic US, US-guided release, with or without cortisone injection, and a half day off work.

Discussion

The results of our clinical study were good immediately after the procedure, with 81.7% of trigger finger cases (49 of 60) completely resolved at day 0. Although these results appear contradictory with our cadaver study findings, in which the pulley division was incomplete in 100% of cases, it suggests that even partial release of the A1 pulley can be mechanically effective.

The 10 cases of minor residual triggering are probably due to partial insufficient release of the A1 pulley. The single case of failed release of the A1 pulley in the thumb can be explained by the fact that the A1 pulley was very thick in this patient (2 mm) and that the procedure is technically much more difficult at the thumb than in the long fingers. The thumb can easily move during the procedure and cannot be laid completely flat on its dorsal side.

Six months after the procedure, 96.7% (58 of 60 procedures) of cases had an excellent outcome, with the initial trigger finger completely resolved. The additional cortisone injection performed at day 0 in the cases with residual triggering likely explains these excellent results at 6 months.

The objective improvement in the trigger finger grade is consistent with patients' feelings after 6 months: The QuickDASH score was less than 21 in 98% (47 of 48 patients) of cases with little to no impact on activities of daily living. The patient with the worst score (score of 38) had concurrent shoulder problems that interfered with the QuickDASH and was not excluded from the study. Lastly, the procedure is safe: No significant complications were observed in the anatomic or clinical studies.

Beyond the cost of the procedure itself, recovery differs substantially between the standard surgical procedure and percutaneous release. A patient can return to work the day of or the day after a US-guided percutaneous procedure, with no need for nursing care because the needle's entry point is less than 1 mm long.

Our study used a smaller caliber needle (21 gauge, 0.8 mm) than the one used in similar published studies of pulley release (13,16–18), which makes the procedure less traumatic for the patient, but may also explain why the A1 pulley was not completely divided. In their cadaver study, Smith et al (18) used larger devices and obtained better results: Complete release of A1 pulley was achieved in 32% (eight of 25) of cases with a 19-gauge (1.27-mm) needle and in 88% (22 of 25) of cases with a commercially available hook (HAKI knife; BK Meditech, Seoul, Korea).

Conversely, our clinical outcomes compare well with other recent published studies of US-guided A1 pulley release. In a recent meta-analysis (13) reviewing 2114 procedures with (n = 209) and without (n = 1798) US guidance, the overall success rate was 94% (2004 of 2114). Rajeswaran et al (17) performed a very similar procedure to ours, but with a larger needle (19 gauge, 1.27 mm); with a follow-up of 6 months in 35 cases, the trigger finger was completely resolved in 91% (32 of 35) of cases and no complications were observed. Jou et al (16) conducted a larger study (104 fingers) where a specially designed hook (2.5 mm) was used during the US-guided release; patients were seen again 9 to 15 months later; the mechanical problem had resolved in 100% of cases and the pain had disappeared in 97% (101 of 104) of cases. The persistence of isolated, nonspecific, nondisabling pain in 3% (three of 104) of fingers in the Jou study (16) was also observed in our study (seven of 60 cases).

Possible causes of this moderate residual pain are yet to be determined. However, this residual pain is not limited to this type of procedure, as it has been reported after cortisone injections (19) and after open surgery (20) as well. A concomitant cortisone injection during the release procedure was expected to improve our results as had been demonstrated in one study (21), but this was not confirmed in a meta-analysis (13).

There are limitations to our study. First, a single, experienced radiologist performed all of the US-guided procedures; the operator-dependent nature of the procedure was not evaluated—we know this is not an insignificant factor in interventional US. Second, our clinical study did not compare cases treated with standard open surgery, which remains the standard or reference, and the follow-up was only 6 months.

In conclusion, US-guided release of the A1 pulley responsible for trigger finger is feasible with a 21-gauge (0.8-mm) needle. The procedure is quick, painless, risk-free, and low cost, requires almost no time off work, and can be performed on at-risk patients. The trigger digit was resolved immediately and at 6 months in the majority of cases, providing satisfactory results for all patients. If residual triggering is present immediately after the procedure, corticosteroid injection improves symptoms, with complete resolution of triggering after 6 months in nearly all patients.

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disclosed no relevant relationships. **M.F.** disclosed no relevant relationships.

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