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Antegrade Ultrasound-Guided Percutaneous Release of Trigger Thumb

Maxime Rousié, MD,* Soufiane Diaby, MD,*
Virginie Vandenbulcke, PhD,† and Thomas Apard, MD‡§

Abstract: Trigger finger is a common hand condition, with surgical treatment primarily based on the release of the A1 pulley. While open surgery remains the gold standard, ultrasound-guided percutaneous techniques have demonstrated their advantages due to their minimally invasive nature and their positive impact on recovery. However, in the case of trigger thumb, these techniques present specific challenges, particularly due to the proximity of neurovascular structures and constraints related to instrument orientation. The objective of this paper is to describe a novel axial and antegrade ultrasound-guided percutaneous approach for the release of the A1 pulley in trigger thumb, aiming to enhance procedural accuracy while minimizing iatrogenic risks. This technique is based on an antegrade minimally invasive release with an axial orientation under real-time ultrasound guidance, without reliance on theoretical bony landmarks. This approach enables optimized visualization of anatomical structures and precise control of the instrument's trajectory. It could serve as an additional alternative to existing strategies for the treatment of trigger thumb. The axial and antegrade ultrasound-guided percutaneous approach appears to be a promising technique for trigger thumb release. Further studies are required to evaluate its clinical efficacy, feasibility, postoperative recovery, and safety on a larger scale.

Key Words: trigger finger, ultrasound-guided surgery, antegrade percutaneous approach, axial approach

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Trigger finger is a common hand condition, affecting 2 to 3% of the general adult population and up to 10% of diabetic patients, with significant impacts on daily and professional activities.[1–3]

From the *Epicura Hospital, Baudour; †University of Mons, Laboratoire ISIA, Belgium; ‡Ultrasound Guided Hand Center; and §Private Hospital Les Franciscaines, Versailles, France.
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Address correspondence and reprint requests to Maxime Rousié, MD, Epicura Hospital, 136 rue Louis Caty, 7331 Baudour, Belgium. E-mail: maxrousie@gmail.com.

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Although open surgical release remains the gold standard, ultrasound-guided percutaneous techniques have demonstrated their effectiveness due to their minimally invasive nature, enhanced safety, and positive impact on patient recovery.[4,5] Recent studies have shown promising outcomes with ultrasound-guided percutaneous release of trigger finger. A prospective study by Gulabi et al[6] on 61 fingers reported a 90% success rate for ultrasound-guided percutaneous release, with a significantly shorter recovery time compared to open surgery.[7] Ultrasound imaging enables direct visualization of critical anatomical structures, significantly reducing the risk of neurovascular injury compared to blind techniques.[8,9] The integration of ultrasound guidance in percutaneous release has marked a major advancement, enabling direct visualization of anatomical structures and improving surgical precision.[7]

A technique using a modified hypodermic needle as a cutting instrument has demonstrated a 95% success rate in a series of 80 consecutive cases, with no major complications reported.[10] However, the longitudinal ultrasound-guided approach, which is widely used, has limitations in simultaneous visualization of the A1 pulley and adjacent structures, often requiring unreliable external landmarks.[11–13]

The release of trigger thumb presents unique technical challenges due to its anatomical complexity and the proximity of the thumb radial digital nerve, leading to a higher reported complication rate compared to other fingers.[14,15]

In this study, we present a novel axial and antegrade ultrasound-guided percutaneous technique, applied to 32 cases of trigger thumb over the past 18 months. This method provides optimal visualization of the A1 pulley boundaries, precise instrument placement, and safe management of neurovascular structures, while reducing postoperative complications.

The axial and antegrade ultrasound-guided technique for trigger thumb release offers superior visualization of the proximal and distal pulley margins, ensures precise knife positioning, and allows controlled sectioning of the A1 pulley while avoiding injury to the thumb radial digital nerve as it crosses over the flexor pollicis longus (FPL) tendon. Additionally, it addresses spatial constraints related to probe placement in trigger thumb procedures. This axial and antegrade ultrasound-guided approach allows a more precise identification of the proximal and distal limits of the A1 pulley, significantly reducing the risk of incomplete release, which has been observed in conventional techniques.[16]

ANATOMY

The thumb has a distinct flexor system compared to the long fingers. It consists of a single flexor tendon, the FPL, and four pulley structures: a proximal annular pulley (A1)

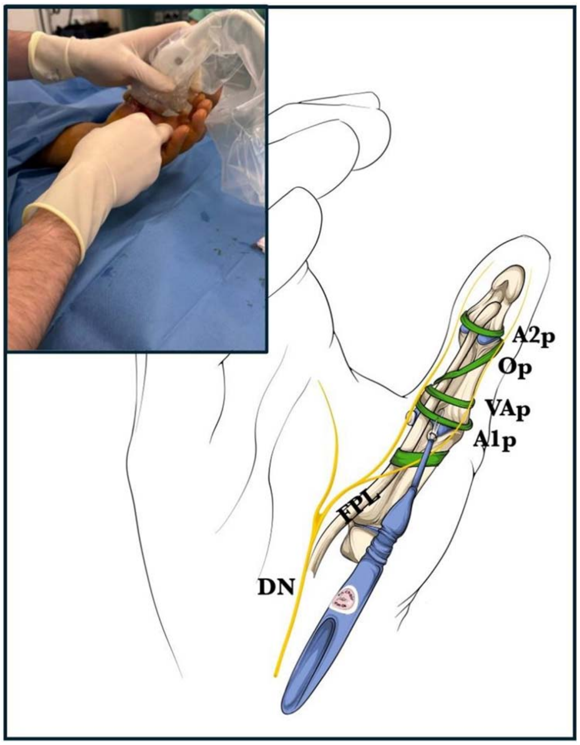

FIGURE 1. Thumb flexor pulley system and collateral digital nerve anatomy. A1p indicates A1 pulley; A2p, A2 pulley; DN, digital Nerve; FPL, flexor pollicis longus tendon; Op, oblique pulley; VAp, variable annular pulley (from "*En chair et en os with permission*").

located at the head of the first metacarpal, a variable annular pulley (Av), an oblique pulley, which is the most crucial for FPL stability and function, and a distal annular pulley (A2)[14,17] (Fig. 1).

The primary anatomical challenge in ultrasound-guided trigger thumb release lies in the proximity of the radial collateral nerve as it crosses over the FPL tendon near the proximal edge of the A1 pulley.[15] This structure can be easily identified intraoperatively through axial ultrasound imaging.[17]

INDICATIONS

The diagnosis of trigger thumb is primarily based on clinical examination. In the early stages, patients may present with only swelling and tenderness upon palpation of the A1 pulley.[18] In more advanced stages, a palpable nodule and an audible clicking sensation during flexion and extension of the affected finger can be observed, with these symptoms being exacerbated by simultaneous compression of the A1 pulley. Ultrasound imaging is only indicated in cases of diagnostic uncertainty.[19]

Among non-surgical treatments, local corticosteroid injections are the most studied and commonly used approach for tendon pathologies, with reported success rates ranging from 60% to 93% depending on the study.[20,21] These injections are typically administered at the level of the A1 pulley, sometimes under ultrasound guidance to enhance precision and efficacy. However, the effectiveness of conservative treatments tends to decrease when symptoms persist beyond 4 to 6 months.[22] If conservative treatment fails or recurrence occurs, surgical intervention is considered.

Absolute indications for surgery include failure of conservative treatment after 3 to 6 months, defined as a lack of or inadequate response to corticosteroid injections (usually after one or two injections), as well as the use of splints and nonsteroidal anti-inflammatory drugs (NSAIDs).[2] Additionally, a fixed flexion deformity (Grade IV) that does not

FIGURE 2. Required equipment for ultrasound-guided trigger thumb surgery: from left to right: ultrasound-guided surgery knife, Adson forceps, Stevens scissors, scalpel with a No. 15 blade, sterile cover, sterile gel, sterile drape.

respond to conservative treatment is a formal indication for surgery, as is severe triggering associated with significant pain that impacts daily activities.[23]

Certain situations are considered relative indications, such as recurrence after an initially effective conservative treatment, bilateral or multiple digit involvement, or the presence of tendon nodules that limit the efficacy of non-surgical approaches.[23] Diabetic patients, due to lower success rates with conservative treatments, as well as young and active individuals who require a rapid recovery for professional reasons, may also be candidates for earlier surgical intervention.[1]

ULTRASOUND-GUIDED SURGICAL TECHNIQUE

In this study, selected patients were over 18 years of age (adults) and had experienced failure of conservative treatment, including the use of NSAIDs and corticosteroid injections. A maximum of two corticosteroid injections was administered before considering surgical intervention. Exclusion criteria for the axial and antegrade ultrasound-guided percutaneous approach included known hypersensitivity to local anesthetics, a history of trauma to the metacarpophalangeal joint, burning skin, previous surgery and hyperlaxity.

All procedures were performed by the same experienced surgeon specialized in ultrasound-guided surgery to ensure procedural consistency.

Ultrasound imaging was conducted using a VENUE FIT® ultrasound system (General Electric HealthCare™) equipped with a 4 to 20 MHz probe. The instrumentation used for ultrasound-guided surgery included either a Kemis H1® (Newclip Technics™, Haute-Goulaine, France) or a Mini Keriknife® (KeriMedical™, Archamps, France). The intervention was performed under local anesthesia without a tourniquet, following the Wide Awake Local Anesthesia No Tourniquet (WALANT) technique, as described by Lalonde[24] (see Figs. 2, 3).

The preoperative procedure involves ultrasound mapping, primarily performed in an axial view to accurately identify the proximal and distal limits of the A1 pulley. Doppler mode can be used to visualize the artery in cases of anatomical variations or when it is difficult to detect due to probe pressure or local anesthesia.

This approach enables direct and precise visualization without relying on theoretical skin or bony landmarks.

An initial skin marking is made at the site where the radial collateral nerve crosses the FPL, a region that may be very close to the proximal edge of the pulley. A second marking identifies the proximal origin of the A1 pulley (see Figs. 4, 5).

During the procedure, a 2 mm incision is made using a No. 15 blade, positioned between the two skin markings and aligned with the apex of the tendon. A careful dissection is then performed with Stevens' scissors until contact is made with the FPL.

The knife is introduced directly in contact with the tendon under axial ultrasound guidance, inserting between

FIGURE 3. Illustration of the instrument designed for ultrasound-guided surgery. Its specific design, with a longer lower section compared to the upper section, allows for atraumatic insertion beneath the pulley. The cutting edge is positioned between these two sections, ensuring a controlled and precise release.

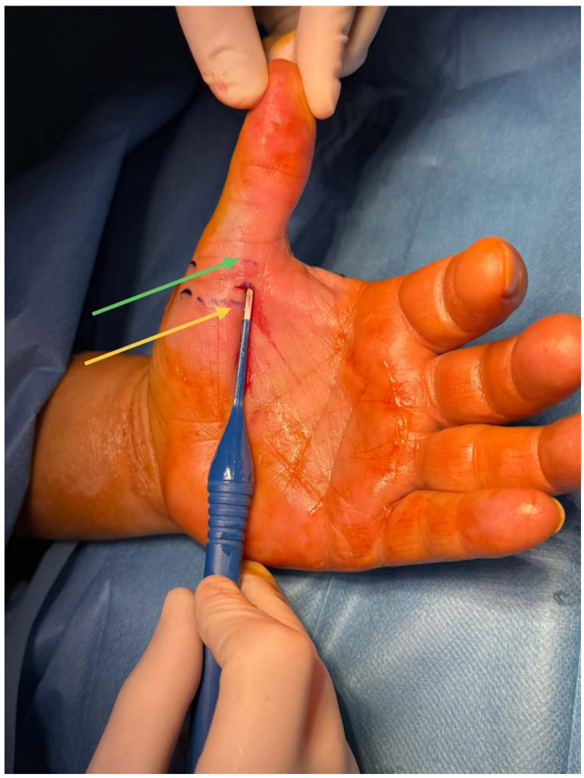

FIGURE 4. Insertion of the knife between the crossing of the radial collateral nerve (yellow arrow) and the proximal edge of the A1 pulley (green arrow).

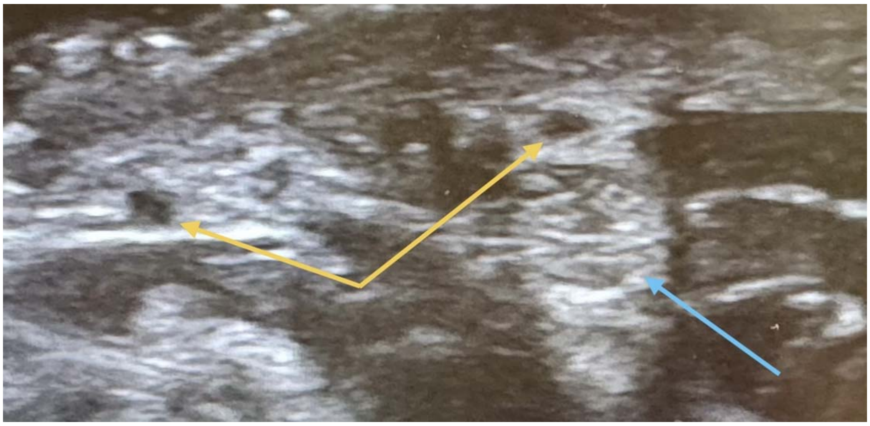

FIGURE 5. Axial ultrasound illustration of the collateral nerves (yellow arrow) at the crossing between the radial collateral branch and the flexor tendon (blue arrow).

the pulley and the tendon to ensure optimal positioning. It is essential to verify that the distal end of the knife is correctly positioned between the pulley and the tendon, while the proximal portion remains superficial (see Fig. 6).

Particular attention is given to preserving the integrity of the synovial sheath and the tendon to prevent postoperative inflammation that could lead to tenosynovitis. The position of the vascular pedicles on either side of the tendon is also carefully assessed to minimize the risk of complications (see Fig. 7).

Once the complete sectioning of the pulley is performed, the release is verified by passing the non-cutting portion of the knife from deep to superficial through the A1 pulley.

Skin closure is achieved using ¼-inch steri-strips.

Immediate mobilization is encouraged from postoperative day 0, with passive extension exercises of the operated finger. The wound can be washed after 24 hours, and the Steri-Strips are removed after 4 days, leaving the wound exposed to air (see Fig. 8).

EXPECTED OUTCOMES

This study, carried out between 2024 and 2025 by the same experienced surgeon, examines a series of 32 trigger finger cases treated with ultrasound-guided percutaneous release. Of these cases, 17 affected the right hand and 15 the left hand.

Postoperative recovery was rapid, allowing patients to resume daily activities the day after the procedure. The range of motion achieved was satisfactory, and the scar appearance was minimal. No patient required specific nursing care, and wound washing was permitted as early as the day after surgery, facilitating postoperative management.

However, this study does not report objective functional scores or comparisons with other surgical techniques, limiting the ability to assess the outcomes comparatively.

Additionally, no cases of recurrence were reported in this series, suggesting a durable effectiveness of the employed technique. However, the absence of complications and recurrences should be interpreted with caution due to the sample size and limited follow-up. The mean postoperative follow-up was 7.6 months, which remains relatively short to draw definitive conclusions. A larger-scale study with extended follow-up would be necessary to confirm these results and better assess the long-term stability of the benefits.

Nevertheless, this technique presents a theoretical limitation: if the distance between the crossing of the thumb radial digital nerve and the proximal edge of the pulley is insufficient to ensure an adequate safety margin, the introduction of the knife may pose a risk. However, we did not encounter any such anatomical configuration in our series that prevented the procedure from being performed.

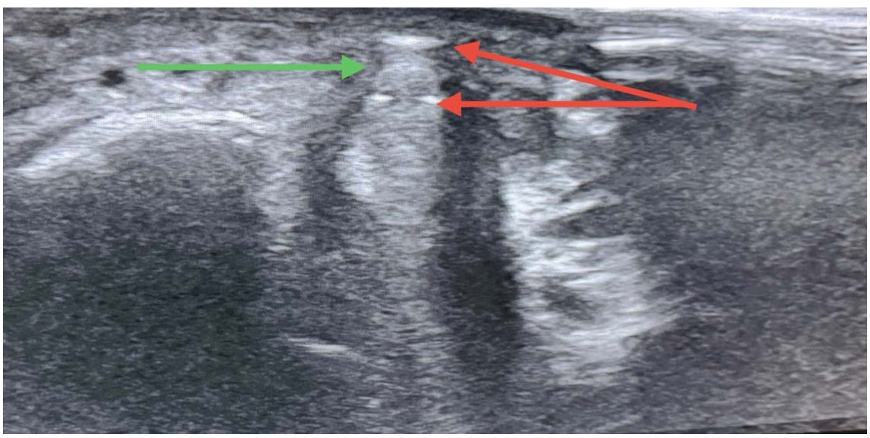

FIGURE 6. Axial ultrasound illustration of the A1 pulley (green arrow) positioned between the lower and upper portions of the knife (red arrow).

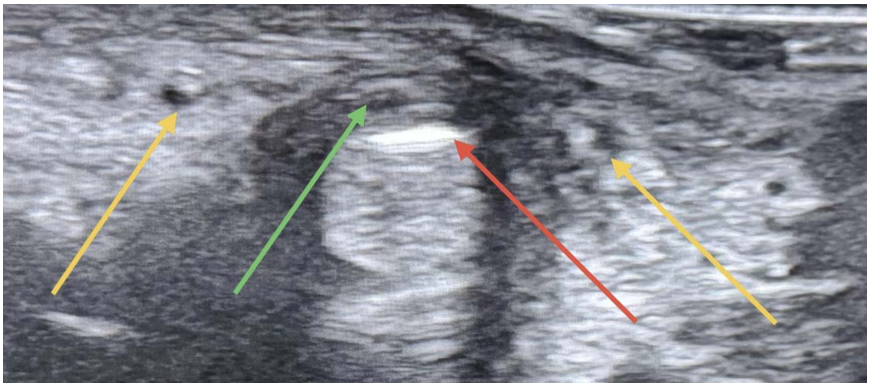

FIGURE 7. Axial ultrasound illustration of the lower portion of the knife (red arrow) inserted beneath the A1 pulley (green arrow) and its relationship with the collateral nerves (yellow arrow).

COMPLICATIONS

No major complications were observed in this series of 32 trigger thumb releases using the antegrade ultrasound-guided technique. Specifically, there were no cases of neurovascular injury, infection, tendon damage, or loss of range of motion related to the procedure.

However, this technique presents potential risks, including incomplete release of the A1 pulley if the instrument is not correctly positioned, or accidental injury to the thumb radial digital nerve if the anatomical landmarks are not precisely identified during ultrasound mapping.

Additionally, this technique should not be performed if the crossing of the radial collateral nerve branch is too close to the proximal edge of the A1 pulley, as this may increase the risk of nerve injury.

DISCUSSION

Open trigger thumb release is a well-established and reassuring technique due to direct visualization of the A1 pulley release, ensuring controlled dissection and optimal safety. However, ultrasound-guided percutaneous release is emerging as a minimally invasive alternative, offering faster recovery, reduced postoperative pain, lower adhesion formation, and decreased recurrence rates.[25]

Both open and percutaneous techniques can be performed under WALANT anesthesia, facilitating outpatient management with improved patient comfort.[26]

Ultrasound-guided trigger thumb release has demonstrated superior outcomes compared to conservative management and equivalent results to open surgery, with a lower complication rate.[27] Additionally, this technique allows for the simultaneous treatment of multiple trigger fingers without increasing scarring or postoperative stiffness, making it a viable option for patients with multiple affected digits.[28]

However, trigger thumb release presents a higher risk of nerve injury compared to long fingers, as the radial collateral nerve crosses the FPL at the proximal edge of the A1 pulley, making it particularly vulnerable during open incisions.[12,15,25]

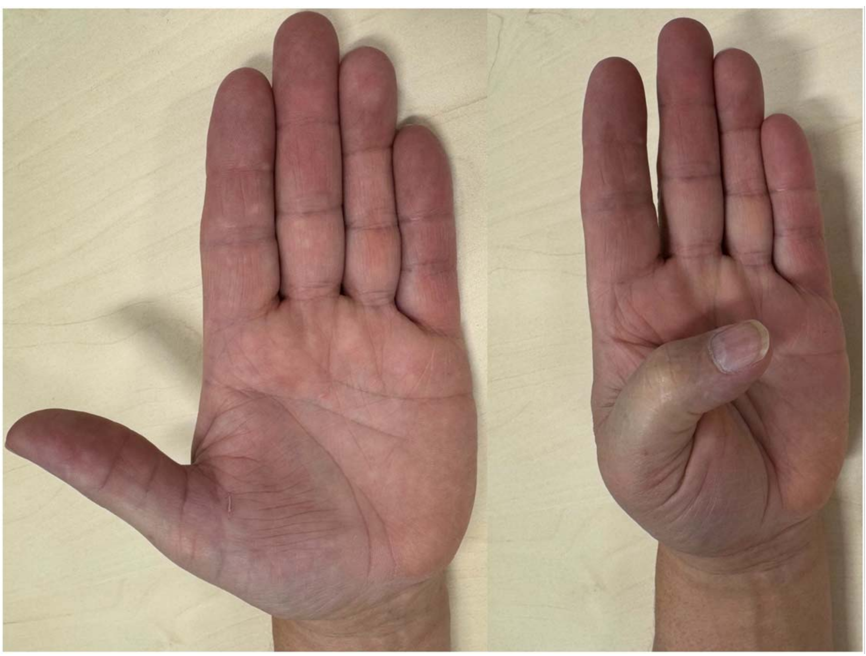

FIGURE 8. Follow-up at 10 days after percutaneous release of a trigger finger, demonstrating full recovery of the range of motion.

A retrospective study of 42 patients using a retrograde ultrasound-guided knife design reported no cases of nerve injury or recurrence, reinforcing the safety and efficacy of this method. This antegrade technique enables direct visualization of the radial collateral nerve in a sagittal plane during the A1 pulley sectioning, ensuring precise and controlled release.[26]

Other studies have described alternative retrograde techniques using different ultrasound-guided knife designs, such as those employing oscillating hooking movements in the long-axis plane. While these methods provide effective release, particular caution is required due to the anteposed position of the thumb and the dynamic movement of the radial collateral nerve under the ultrasound probe, posing additional technical challenges.[28]

A systematic review and meta-analysis of 10 studies involving 648 patients reported an overall success rate of 97% (95% CI, 95%-99%), a complication rate of 1% (95% CI, 0%-2%), and a recurrence rate of 1% (95% CI, 0%-3%) for ultrasound-guided needle-knife trigger thumb release.[29]

Despite its promising complication rate, ultrasound-guided trigger thumb release remains technically demanding due to the anatomical complexity and anteposed position of the thumb. These factors necessitate progressive learning and advanced proficiency in ultrasound-guided surgery to avoid iatrogenic nerve injury.

To enhance procedural safety and technical feasibility, we propose a modified percutaneous approach by placing the incision distally relative to the radial collateral nerve crossing to maintain a safe margin. Combining this with an antegrade incision of the A1 pulley to improve precision and reduce nerve proximity risk.

Our proposed antegrade percutaneous ultrasound-guided technique aims to optimize procedural safety while maintaining the advantages of a minimally invasive approach. Further prospective comparative studies are required to validate long-term clinical outcomes and reproducibility in various patient populations.

We conclude that the antegrade ultrasound-guided approach for trigger thumb release is a precise and minimally invasive technique. By utilizing a small percutaneous entry point rather than a traditional incision, it enables controlled sectioning of the A1 pulley while maintaining a safe margin from the radial collateral nerve. This approach minimizes postoperative pain and scarring, promotes faster functional recovery, and provides excellent cosmetic outcomes with minimal tissue trauma.

However, ultrasound-guided trigger thumb release requires a high level of expertise in ultrasound-guided surgery to ensure optimal outcomes and minimize the risk of complications. Further clinical studies and long-term follow-ups are necessary to confirm its reproducibility and to compare its efficacy with other surgical techniques.

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