SCIENTIFIC ARTICLE

Percutaneous Release of the Finger Joints and Mini-Open Intrinsic Release With Tenolysis: A Cadaveric Study

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Purpose To evaluate the effectiveness and safety of minimally invasive distal intrinsic release and extensor tenolysis combined with percutaneous release of proximal and distal interphalangeal joint collateral ligaments.

Methods The procedures were performed on 5 cadaveric upper extremity specimens, followed by a full anatomical dissection to assess completeness of the targeted releases and any damage to surrounding structures.

Results Complete distal intrinsic release, dorsal capsule release, and distal interphalangeal collateral ligament release was performed on all specimens. We achieved complete release of all proximal interphalangeal joint collateral ligaments in 38 of 40 specimens (95%). We noted damage to nontargeted structures in 2 instances (5%).

Conclusions Minimally invasive and percutaneous techniques can effectively release several structures known to cause finger stiffness with minimal damage to surrounding structures.

Clinical relevance If similar results are seen in clinical trials, this could be a quick and easy way to increase the mobility of a stiff finger with potentially minimal morbidity. *(J Hand Surg Am. 2019;44(11):991.e1-e5. Copyright © 2019 by the American Society for Surgery of the Hand. All rights reserved.)*

Key words Percutaneous, stiff finger, treatment.

Online Exclusive

Active finger motion is critical to the overall function of the hand.[1,2] A stiff finger can have a profoundly negative influence on the range of motion and strength of the surrounding digits.[3] Numerous papers exist outlining evaluation, treatment, outcomes, and complications of the stiff finger.[4–12] A stiff digit can arise from a variety of causes, from autoimmune diseases to trauma, and numerous anatomical structures can be affected and contribute to the lack of motion.

The purpose of this study was to describe a minimally invasive, percutaneous treatment technique for intrinsic muscle tightness and proximal interphalangeal (PIP) joint and distal interphalangeal (DIP) joint extension contractures and to demonstrate whether the targeted tissues can be released without damage to the surrounding structures. This minimally invasive technique eliminates incisions across the joints and on the dorsum of the finger. It could allow for early intensive range of motion without incision complications or dehiscence.

MATERIALS AND METHODS

Five cadaveric upper limb specimens (20 fingers) were utilized in this study. Institutional approval was

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obtained prior to initiation of the study. The frozen limbs were thawed for a minimum of 24 hours.

There were 4 male specimens and 1 female specimen. The procedures were carried out on all fingers; 5 index, 5 middle, 5 ring, and 5 little fingers. Thumbs were excluded from this study. None of the fingers studied had preexisting finger deformities or evidence of prior surgery or injury. All fingers had full passive motion of the metacarpal phalangeal, PIP, and DIP joints.

A single board-certified orthopedic surgeon (J.G.) performed the following procedures: (1) minimally invasive radial and ulnar distal intrinsic release (DIR), (2) minimally invasive extensor tenolysis, (3) minimally invasive PIP dorsal capsule (DC) release, (4) percutaneous PIP radial and ulnar proper collateral ligament (PCL) release, and (5) percutaneous DIP radial and ulnar PCL release. The extensor tenolysis described later was simulated owing to the lack of actual tendon adhesions but was necessary to perform the DC release.

Following the release, a full finger dissection was carried out to assess (1) the extent to which release of the intrinsic muscle contribution to the lateral band had been achieved, (2) the extent to which release of the dorsal PIP capsule had been achieved, (3) the extent to which release of the radial and ulnar PCL of the PIP and DIP had been achieved, and (4) the presence of damage to any untargeted structures (extensor tendon, central slip, lateral band, volar plate, terminal tendon, and neurovascular bundles).

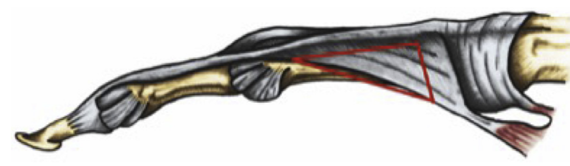

FIGURE 1: Side view of a finger demonstrates the triangular portion of the extensor apparatus including the lateral band and oblique fibers that are resected to perform a DIR.

FIGURE 2: A DIR in a cadaver specimen.

Surgical technique

Distal intrinsic muscle release: The same procedure was carried out on both sides of the digit. A no. 15 blade scalpel was used to create a 1-cm midaxial incision centered over the radial or ulnar sides of the middle one-third of the proximal phalanx. Blunt dissection was then carried down to the extensor mechanism. The oblique fibers of the intrinsic apparatus connecting into the lateral bands were identified. A triangle of tissue was excised starting with a longitudinal incision just palmar to the extensor mechanism and distal to the sagittal band, extending distally through the intrinsic apparatus and back proximally along this tendon. The vertical fibers of the sagittal bands were typically not visualized during the approach, and the length of intrinsic tendon excised varied based on the size of the specimen and finger involved (Figs. 1, 2).

Tenolysis and DC release: To perform the extensor tenolysis and DC release, the same midaxial incisions created during the intrinsic release are utilized. First, a plane was created between the extensor tendon and the skin. A Freer elevator was then passed distally and proximally from the PIP joint to the metacarpophalangeal joint, to release any adhesions to the skin. Next, a plane was created between the extensor tendon and the dorsal cortex of the proximal phalanx. The elevator was again inserted. Using the sharper end of the elevator curved toward the bone and away from the extensor tendon, it was passed proximally to the metacarpophalangeal joint and distally to the central slip. Increased resistance was commonly felt as the DC was encountered and released. Care was taken not to damage the central slip. We used direct palpation and visualization of the proximal middle phalanx to determine that the elevator had reached the central slip.

PIP and DIP collateral release: A 1.5-inch, 18-gauge needle was used to perform the ligament release. The midaxial portion of the radial or ulnar PIP or DIP joint was first identified, and the joint line was palpated. The needle was inserted perpendicular to the skin into the palmar portion of the PCL. We then repeatedly levered the needle to a more vertical position using a sawing motion with the bevel and tip of the needle to incise the collateral ligament and any remaining DC (Figs. 3, 4). A similar technique was previously described for the release of the A1 pulley and for needle aponeurotomy in Dupuytren disease.[13,14] There was an audible and tactile tearing sensation

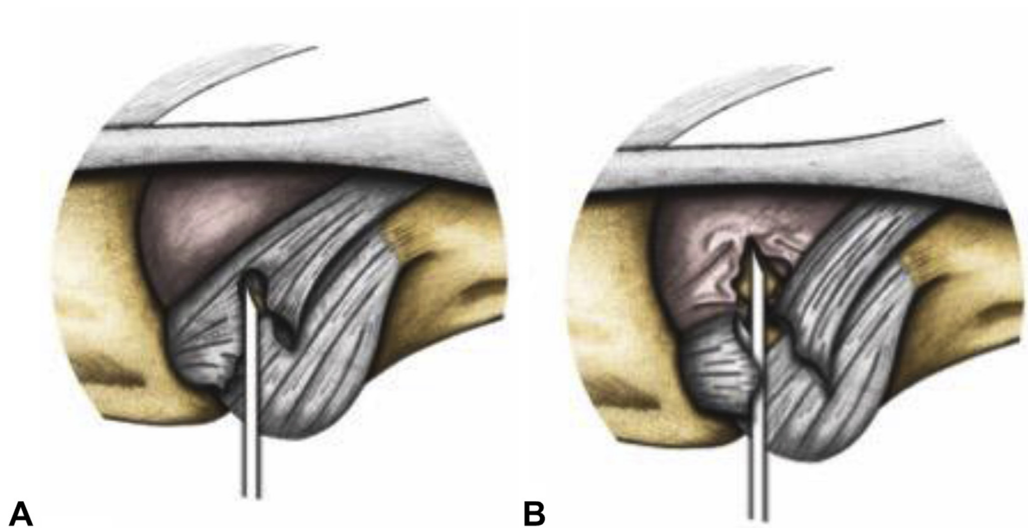

FIGURE 3: **A** Schematic illustration of percutaneous release of the dorsal half of the collateral ligament complex. **B** Schematic illustration of percutaneous release of the DC.

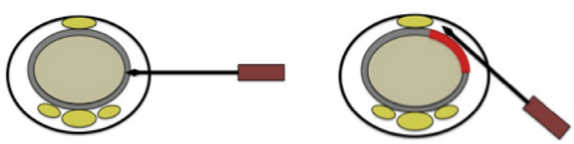

FIGURE 4: The 2 images demonstrate the starting point and end point for release of half of the DC. The red line represents the release portion of the DC.

as the ligament and capsule were released. This procedure was carried out on both sides of the PIP and DIP joints. Caution was taken not to insert the needle into the joint because this may result in damage to the articular cartilage, central slip, or terminal tendon. Starting too dorsal may also result in damage to the lateral bands at the PIP joint level.

Following the percutaneous release, a joint manipulation was performed to release any remaining ligament that was not released. The manipulation involved a repetitive radial and ulnar force to the PIP or DIP joint while moving from extension to flexion (Figs. 3, 4).

RESULTS

Of the 20 fingers used (40 DIRs, 40 PIP PCLs, 40 DIP PCLs, and 20 DCs), there were 2 (5%) incomplete PCL releases and 1 (2.5%) partial lateral band injury. The incomplete PCL releases occurred once in a middle finger radial PIP PCL and once in a ring finger ulnar PIP PCL. Less than 25% of the PCLs remained intact following the release and both were located at the dorsal-most aspect of the ligaments.

The lateral band injury occurred in a little finger ulnar lateral band at the level of the PIP joint and involved less than 25% of the tendon.

All DIRs, DIPs, and DCs releases were complete and there was no damage noted to any central slip, common extensor tendon, or neurovascular bundle (Table 1).

DISCUSSION

Traditional treatment for extension contractures has involved an open dorsal incision through which the structures are sequentially released.[4,6–8,12] This may include release of the intrinsic muscle contribution to the lateral band, extensor tenolysis, DC release, and collateral ligament release. Early motion is a key component to optimizing postoperative functional recovery; however, this open approach can lead to wound complications because it puts newly sutured skin under tension during grip.

Previous authors have proposed using a minimally invasive approach to extension contracture release utilizing a small incision and a scalpel or hemostat.[9,10] Whereas adequate release is possible, and motion does improve, these techniques utilized fluoroscopy for localization. We propose a percutaneous approach to PIP and DIP joint extension contracture release combined with a minimally invasive intrinsic muscle release and tenolysis. This technique utilized surface anatomy for instrument placement and results in no incision along the dorsal aspect of the finger.

When performing a PCL release for PIP joint extension contracture, the targeted area is the dorsal

TABLE 1. Results of Attempts to Release Those Structures Typically Involved in Finger Stiffness

Specimen	Finger	Intrinsic Release	PIP Release	DC	DIP Release	Damage
1	2 R:U	Full:full	Full:full	Yes	Full:full	None
	3 R:U	Full:full	Full:full	Yes	Full:full	None
	4 R:U	Full:full	Full:full	Yes	Full:full	None
	5 R:U	Full:full	Full:full	Yes	Full:full	None
2	2 R:U	Full:full	Full:full	Yes	Full:full	None
	3 R:U	Full:full	Three-fourths:full	Yes	Full:full	None
	4 R:U	Full:full	Full/full	Yes	Full:full	None
	5 R:U	Full:full	Full/full	Yes	Full:full	None
3	2 R:U	Full:full	Full/full	Yes	Full:full	None
	3 R:U	Full:full	Full/full	Yes	Full:full	None
	4 R:U	Full:full	Full/full	Yes	Full:full	None
	5 R:U	Full:full	Full/full	Yes	Full:full	None
4	2 R:U	Full:full	Full/full	Yes	Full:full	None
	3 R:U	Full:full	Full:full	Yes	Full:full	None
	4 R:U	Full:full	Full:three-fourths	Yes	Full:full	None
	5 R:U	Full:full	Full:full	Yes	Full:full	**U lateral band < one-fourth**
5	2 R:U	Full:full	Full:full	Yes	Full:full	None
	3 R:U	Full:full	Full:full	Yes	Full:full	None
	4 R:U	Full:full	Full:full	Yes	Full:full	None
	5 R:U	Full:full	Full:full	Yes	Full:full	None

R, radial; U, ulnar.

aspect of the ligament.[12] When this does not adequately increase the motion, the remaining volar PCL is released. Therefore, we aimed to see whether the entire PCL release was possible through a percutaneous approach. Caravaggi et al[15] published a cadaveric study showing the effects of various releases on the kinematics and stability of the PIP joint. Their results showed that complete release of PCL alone was unlikely to result in instability; however, clinical correlation was not addressed.

Espiritu et al[16] examined the effect of dorsal hood excision on PIP joint motion when performing DIR. They concluded that 59%, 26%, and 33% release for index, ring, and little fingers, respectively, was adequate for improvement in PIP joint motion. They estimated that 65% release for the middle finger was adequate.[16] Extensive radial- and ulnar-sided DIR does carry the risk of development of an intrinsic-minus finger; however, this does not appear to correlate with clinical outcomes.[6]

The major limitation to this study is that it was carried out in normal cadaver digits. In this model, the digits did not have joint contractures, extensor tendon adhesions, or intrinsic tightness. In a stiff finger, the joint capsule and ligaments become thickened and fibrotic. We recognize that the release of these structures in a diseased finger may be more difficult than this study suggests. The aim of this study, however, was to assess whether the targeted structures could be released without damage to surrounding structures. Additional studies are needed to investigate the clinical implications.

The results demonstrate that specific target structures can safely and adequately be released through a minimally invasive and percutaneous approach. We believe this procedure is easily learned and reproducible. If this technique is performed with wide-awake surgical techniques, patient participation may add information regarding the adequacy of tissue release and potential need for additional procedures. Studies are needed to assess clinical outcomes compared with traditional open or other minimally invasive techniques.

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