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Case report

Result of A1 pulley reconstruction after closed rupture of the thumb pulleys during childbirth

Rupture fermée des poulies du pouce pendant un accouchement. Résultat de la reconstruction de la poulie A1

N. Kachouh [a,*], A. Cerlier [a], M. Bouyer [b], R. Legré [a]

[a] *Department of hand and reconstructive surgery, hôpital de la Timone, chirurgie de la main et réparatrice des membres, Aix-Marseille University, Assistance publique–Hôpitaux de Marseille, 264, rue Saint-Pierre, 13385 Marseille cedex 5, France*
[b] *Service de chirurgie de la main et des brûlés, centre hospitalier universitaire de Grenoble, boulevard de la Chantourne, 3870, La Tronche, CS 10217, 38043 Grenoble, France*

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ABSTRACT

Closed rupture of the thumb flexor tendon pulleys is rare. Although anatomical and biomechanical studies have exposed the roles played by the pulleys in flexor pollicis longus (FPL) function, no standardized surgical management has yet been defined, in contrast to situations where pulley reconstruction is required in the fingers. We describe a case of rupture of the three pulleys in the thumb that probably occurred after violent thumb grasp during childbirth in the absence of any other trauma. We reconstructed the A1 pulley only using an extensor retinaculum graft because no remnants of the native pulleys were present.

RÉSUMÉ

La rupture fermée des poulies du flexor pollicis longus (FPL) reste une pathologie rare. Bien que des études anatomiques et biomécaniques aient révélé l'implication de chaque poulie dans la fonction du FPL, il n'existe aucune prise en charge standardisée, contrairement à la reconstruction des poulies des doigts longs. Nous présentons un cas de rupture des trois poulies du pouce pendant un accouchement probablement après une prise violente du pouce sans aucun autre traumatisme. Nous avons procédé à la reconstruction de la seule poulie A1 en utilisant un greffon du rétinaculum des extenseurs en absence des reliquats de la poulie native.

1. Introduction

Closed rupture of the flexor tendon pulleys of the thumb is rare [1]. Pulley rupture is typically observed in rock climbers and usually affects the fingers [2]. Rupture of even one thumb pulley disrupts the function of the flexor pollicis longus (FPL). Reconstruction of finger pulleys is well standardized, and many techniques are available. However, reconstruction of thumb pulleys has not yet been standardized. In the present case, we describe reconstruction of the A1 thumb pulley using an extensor retinaculum graft because there were no remnants of the native pulleys. This reconstruction technique was chosen after reviewing the literature. We report our experience and results at 1 year of follow-up.

2. Case report

A 38-year-old woman complained of pain in her left thumb during flexion for 3 years. Severe pain had initially developed during childbirth without any trauma described by the patient, other than a tight fist being made. She was right-handed, with no

* Corresponding author.
E-mail addresses: najib.kachouh@gmail.com (N. Kachouh), alexandre.cerlier@gmail.com (A. Cerlier), mbouyer@chu-grenoble.fr (M. Bouyer), regis.legre@ap-hm.fr (R. Legré).

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medical or surgical history, and worked as a materials handler in a warehouse. She reported pain during thumb flexion. She had already received several corticosteroid injections and had been treated with splint immobilization, but without any effect. Clinical examination revealed full passive range of motion in the interphalangeal (IP) and metacarpophalangeal (MCP) joints with limited active IP flexion. A bowstringing effect was observed during forced IP flexion.

Ultrasonography revealed bowstringing of the FPL with no sign of the A1, A2 or oblique pulleys. There was a 5-mm gap between the volar aspect of the proximal phalanx and the deep aspect of the FPL. Magnetic resonance imaging of both thumbs in flexion revealed the FPL had ventrally migrated from the shaft and the neck of the proximal phalanx in a bowstring manner leading us to suspect the three pulleys of the left thumb were ruptured (Fig. 1). We decided to reconstruct the A1 pulley.

Under regional anesthesia with pneumatic tourniquet inflated at 250 mmHg, we used the Brunner approach and found considerable fibrosis. The FPL was not in close contact with the ventral aspect of the proximal phalanx, creating a bowstring effect. No competent pulleys or pulley remnants were found (Fig. 2). The fibrosis had created adhesions around the FPL tendon, explaining the thumb's flexed position. Tenolysis was performed and full extension was obtained. We harvested an extensor retinaculum strip via a transverse incision on the dorsum of the wrist at the level of the fourth extensor compartment. The graft was inserted in the proximal third of the proximal phalanx and, due to the lack of remnants of the native pulleys; the graft was fixed with two Mitek® 2/0 anchors positioned at both edges (Figs. 3 and 4). The bowstring effect disappeared. We checked normal tendon gliding at the end of the procedure by proximal traction on the tendon. The thumb was immobilized in extension with a splint. Passive and active rehabilitation was initiated at 3 weeks and regular follow-up was scheduled. At 6 months, the result was satisfactory: pain had disappeared, active and passive thumb motion was complete. Grip strength on the operated side evaluated with a Jamar® dynamometer improved from 15 kg preoperatively to 26 kg postoperatively versus 32 kg for the right hand. Thumb mobility evaluated with the Kapandji score improved from 8/10 to 10/10 and the QuickDASH score improved from 25/100 to 15.4/100. At 1 year postoperative, ultrasonography showed the bowstring effect was no longer present. The A1 pulley was visible, and the FPL and the proximal phalanx were less than 2 mm apart.

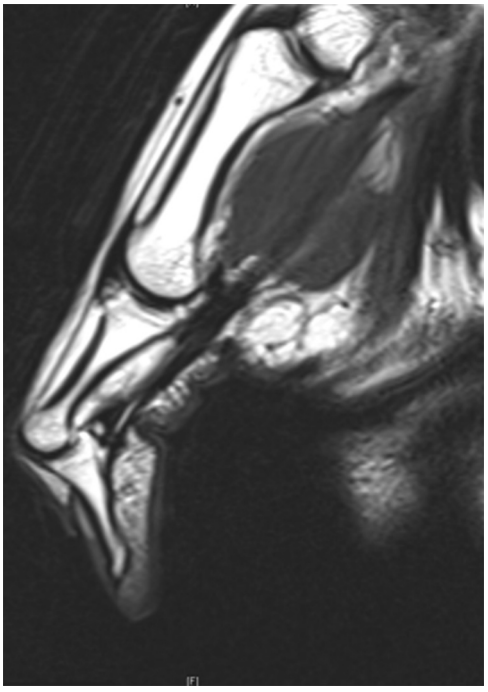

Fig. 1. Preoperative magnetic resonance imaging. Bowstringing is apparent during interphalangeal joint flexion, with disruption/absence of the oblique, A1 and A2 pulleys.

Fig. 2. Intraoperative view after excision of fibrous tissue showing complete rupture of the A1 and oblique pulleys, without any remnants.

3. Discussion

Only a few cases of closed rupture of the thumb flexor tendon pulleys have been reported in the literature. The patients are usually middle-aged females with chronic tendinitis who had received recent corticosteroid injections, with or without trauma [3]. During childbirth, our patient experienced sudden thumb pain followed by progressive flexion deformity of the thumb. The reported cases often feature rupture of all thumb pulleys [3,4]. The rupture mechanism is unknown [4]. In climbers, the fingers can transfer very significant forces to pulleys when the hand is in the crimped position, leading to pulley rupture [4]. Guidelines for conservative or surgical management of closed ruptures of finger pulleys are available, but not for thumb pulleys [4]. Thus, we searched the literature to determine which pulley(s) we should reconstruct. Several studies on the anatomy of thumb pulleys, biomechanics, and effects on FPL function have been published.

In 1977, Doyle and Blythe [5] described three ubiquitous thumb pulleys: the A1 pulley in front of the MCP; an oblique pulley extending from the ulnar side to the radial side of the proximal phalanx (from proximal to distal) and, finally, an A2 pulley in front of the IP joint. They concluded the oblique pulley prevents bowstringing and that its reconstruction should be prioritized when rebuilding the FPL sheath.

In 1994, Zissimos et al. [6] found the bowstring effect arose with simultaneous rupture of the A1 and oblique pulleys and concluded that repair of only one of the two pulleys would restore normal thumb function. The A2 pulley appeared to be less important in this context.

The biomechanical study by Esplin et al. [7] in 1996 showed that at least two pulleys must be ruptured to produce bowstringing. Restoring normal flexor function of the thumb required repairing the oblique pulley and one of the two annular pulleys.

In 1999, Schmidt et al. [8] reviewed the anatomy of the thumb pulleys and found that the FPL sheath is more complicated than the description given initially. The cadaver study by Bayat et al. [9] in 2002 furthered our knowledge of thumb pulley anatomy. They described a variable pulley (termed "Av"), similar to the A1 pulley in thickness and length, covering mostly the proximal half of the shaft of proximal phalanx and extending from the ulnar side at the level of musculotendinous junction of the adductor pollicis muscle

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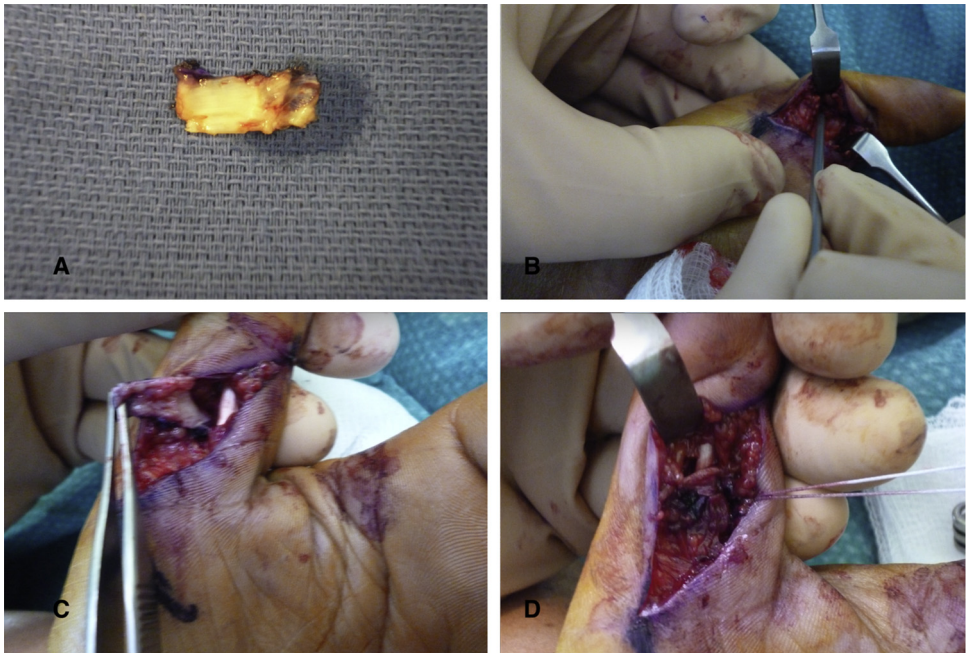

Fig. 3. Surgical technique. A strip of the extensor retinaculum is harvested from the fourth compartment (A). The first Mitek® anchor is introduced on the lateral side of the proximal phalanx (B). One extremity of the graft is fixed by the anchor; the synovial layer of the graft lies against the flexor pollicis longus (C). The second extremity of the graft is then anchored (D).

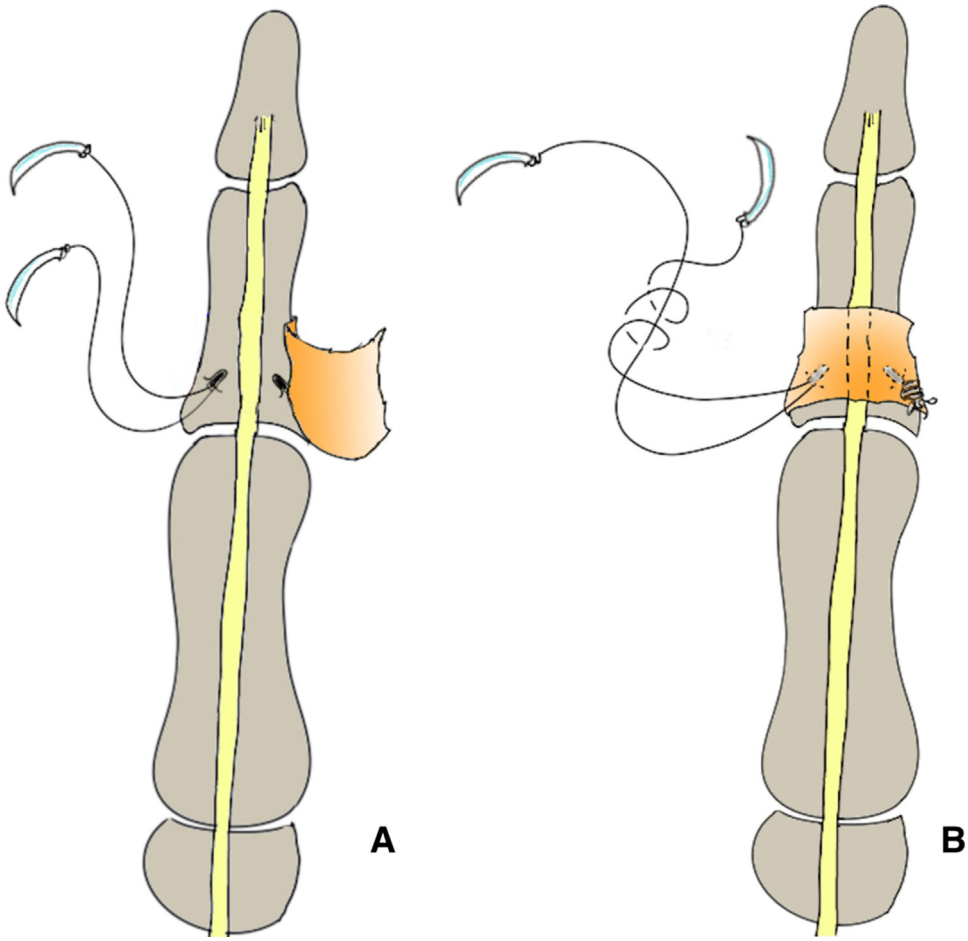

Fig. 4. Details of the graft reconstruction for the new A1-Av pulley. The graft is placed beside the proximal third of the proximal phalanx. One extremity is fixed by an anchor introduced on a lateral side of the proximal phalanx (A). The other extremity is fixed by another anchor introduced on the other lateral side of the proximal phalanx (B).

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to the radial side of the proximal phalanx. Because of the different appearances of the Av pulley and the distinct anatomic arrangements, they presented an anatomical classification of three types of thumb pulleys. They claimed that restoring the oblique pulley only would not prevent bowstringing if the A1 and Av were also ruptured [9]. The oblique pulley prevented IP hyperextension and reconstruction of A1 or Av alone ensured good thumb mobility [9]. Their findings were confirmed by Meyer zu Reckendorf et al. [10] in 2006, in a prospective study of patients with trigger thumbs to determine the limits of permissible pulley-splitting. The same findings were confirmed by Schubert et al. [11] in 2012 and by Zafonte et al. [12] in 2014.

Thus, we decided to reconstruct only the A1-Av pulley complex; however, the exact location of the reconstructed pulley was not clear.

In 1983, Meyer zu Reckendorf et al. concluded (in an unpublished biomechanical work [13]) that it was important to reconstruct a neo-pulley in front of the proximal third of the proximal phalanx. Their conclusions were similar to the biomechanical conclusions made by Roloff et al. [14], who described the perfect positions for new pulley reconstruction in the fingers. It was concluded that a new A2 pulley had to be placed at a distance from the proximal interphalangeal (PIP) joint center of rotation equal to 37% of the proximal phalanx length. The A4 pulley had to be placed at a distance from the proximal interphalangeal (PIP) joint center of rotation equal to 34% of the middle phalanx length. If we apply these results to a thumb with one tendon, the new pulley should be placed in front of the proximal third of the proximal phalanx.

What type of graft should be chosen and what technique should be used? Several thumb pulley reconstruction techniques have been published. There is no consensus on surgical indications or techniques. Fazilleau et al. [1] described a novel approach to reconstruction of the complex thumb annular region (the oblique-Av-A1 region) using a palmaris longus graft as described for A2 pulley reconstruction in the fingers. This requires tendon sacrifice, can lead to adhesion with the extensor apparatus and requires remnants of the A1 pulley. Wilson et al. [3] described two cases of closed thumb pulley rupture in which the oblique and A1 pulleys were reconstructed. In the first case, the oblique pulley was reconstructed using the palmaris longus according to the Okutsu technique for A2 pulley reconstruction of the fingers [15], and the A1 was reconstructed using a flap from the thumb adductor, according to Le Viet and Ebelin [16]. In the second case, the oblique pulley was reconstructed using a Le Viet and Ebelin flap, and the A1 was reconstructed using the Z-wound method of Kapandji using A1 remnants [17]. In a case of closed rupture of the three pulleys, Kosiyatrakul et al. [4] reconstructed the oblique pulley using the plantaris tendon graft according to the Okutsu technique.

In 1997, Guelmi et al. [18] described a case of rupture of the three thumb pulleys following repeated tenolysis. The A1-oblique complex was reconstructed by suturing an extensor retinaculum graft to the fibrous residues of the native pulleys using a modified Lister technique [19], described initially for reconstruction of the A2 and A4 finger pulleys. The sutures were reinforced proximally on the thenar muscles; additional sutures were placed medially on the insertion of the adductor pollicis, and radially on the insertion of the abductor pollicis brevis. Lister described ten cases of A2 and A4 finger pulley reconstruction using free extensor retinaculum grafts; the results were good, and no donor site complications were noted. The author wrote that, "the extensor retinaculum is literally made for the job of pulley reconstruction" [19]. Moutet considered that use of a synovialized tissue such as the extensor retinaculum was better than that of a tissue without any synovial layer [2]. Bouyer et al. reported on 38 rock climbers who underwent pulley reconstructions using the extensor retinaculum to treat closed ruptures that occurred during climbing and showed that most patients regained their pre-rupture climbing skills [20].

Thus, we chose an extensor retinaculum graft. Since there were no pulley remnants, we fixed the graft using Mitek® anchors; this is effectively the Lister approach. The graft was 2 cm long by 1 cm wide as described previously by Guelmi et al. [18]. The tension was set in a way to remove the bowstringing effect. Three weeks of immobilization seemed prudent. The A1 graft remained in place as confirmed ultrasonographically 1 year after surgery, and the motion recovery was very good in our patient. This technique is simple and provides satisfactory results with a low risk of adhesion. The thumb muscles remain intact and the donor site had only minimal comorbidity. Wrist motion is preserved, extensor bowstringing is absent, and no tendon was sacrificed.

4. Conclusion

This is an additional case of thumb pulley reconstruction; all previous reconstructions differed. Such reconstruction is not standardized, in contrast to finger pulley reconstructions. Surgery is essential when the goal is to restore thumb mobility and eliminate bowstringing. Reconstruction of a single A1-Av pulley is sufficient; remnants of the native pulleys do not seem to be necessary and the extensor retinaculum remains the graft of choice.

Disclosure of interest

The authors declare that they have no competing interest.

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