CASE REPORT

Intermittent unspecific osteitis and cortex atrophy of the proximal phalanx after surgical pulley repair

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SUMMARY

Climbing athletes frequently suffer from pulley ruptures, as the shear stress on the finger flexor tendon pulley system is extremely high, especially in the 'crimping position'. Studies showed that surgery only has to be performed in a multiple pulley rupture situation (grade IV injuries). This case describes a complication that appeared after performing a 'bone-encircling' technique recommended for climbers (modified 'one-and-a-half-loop' technique). Simultaneously with resumption of full-strength training after surgery and rehabilitation, the dorsolateral cortex of the proximal phalanx, to which the tendon transplant (palmaris longus tendon surrounding bone and flexor tendon of the finger) is entangled, developed an osteitis and atrophy. We investigated two athletes with the same complaints and symptoms.

BACKGROUND

Traumatic ruptures of finger flexor tendon pulleys presented as a new complex injury in rock climbers in the 1980s, as the shear stress on the pulley system is extremely high, especially in the 'crimping position'.¹ The actual consensus on how to handle multiple pulley rupture situations recommends surgery whereas single pulley ruptures require conservative therapy.² Following these guidelines, we regularly perform surgery in multiple pulley tears. As we usually see few complications or problems in after-treatment following the 'bone-encircling' technique recommended for climbers (modified 'one-and-a-half-loop'—technique),² we investigated two athletes with the same unexpected complaints and symptoms more than 1 year after surgery.

CASE PRESENTATION

On 1 March 2011 we diagnosed a 36-year-old right-hand dominant female rock-climber with a 4-week old complete rupture of the A2 and A3 pulley and a partial-rupture of the A4 pulley of the left ring finger by examination, ultrasound and MRI. At the first appointment, the patient had point tenderness on the palmar side of the finger at the level of the A2 and A3 pulleys, loss of finger strength, 10° extension deficit of proximal interphalangeal joint (PIP) and a flexion deficit of 1 cm in fingertip-palmar distance. Following standard procedure for multiple pulley ruptures, we set the indication for surgical repair. On 25 March, we performed the surgery using a modified 'one-and-a-half-loop' and 'Weilby' technique,² for which a palmaris longus reconstruction of the same arm was used. Subsequent after-treatment was arranged following our standard 'pulley schema',

which provides immobilisation in a splint (intrinsic plus position) for the first 2 weeks, followed by a 4 week mobilisation phase with pulley protection (thermoplastic pulley protection ring). In weeks 7–12, free mobilisation without pulley protection was allowed, including soft strength training with H-taping of the operated finger; H-taping is a taping method that decreases the tendon-bone distance significantly.¹ Careful climbing with increasing force was allowed after 16 weeks with H-taping of the finger until full strength and unlimited climbing was permitted after 6 months with constant H-taping.

One year later, the patient was seen again in our clinic; she reported about constant pain over the metacarpophalangeal (MCP) and PIP-joint of the operated finger; this time at the dorsal aspect of the finger. Ultrasound only showed discreet accumulation of fluid in this area, the pulley repair was intact and the flexor tendons were gliding undisturbed underneath. A radiograph of the finger showed a dorsal accented thickening of the cortex at the distal portion of the proximal phalanx, whereas the proximal portion of the same cortex was thinned out (figure 1). MRI showed the intact pulley repair; the flexor tendons were normal. A bone-marrow oedema with contrast agent accumulation was detected in the proximal phalanx of the left ring finger and the cortex in the area of the reconstruction showed a small defect (figure 2). Immobilisation with a splint was arranged for 2 weeks, combined with oral antiphlogistic therapy (diclofenac); climbing was prohibited for 6 weeks. After this period, control-MRI and radiographs showed unchanged atrophy of the cortex and a discreet peritendosynovitis of the flexor tendons (between the bone and tendons, figure 1). An oral cortisone-therapy over 6 days (dexamethasone: 1–2 day, 16 mg/day, 3–4 day, 8 mg/day, 5–6 day, 4 mg/day) showed no improvement, so we decided to perform a final MRI after six more weeks of climbing-free regeneration. Spot drilling of the bone should have later been performed to induce regeneration of the bone. Unexpectedly, the patient had no more symptoms after this time, and the MRI showed a clear reduction of the oedema and of the unspecific osteitis (figure 2). Smooth climbing training without using the crimping position was allowed and further surgery was cancelled.

Two years later, we re-evaluated the patient, who had no further complaints and had nearly regained her pretraumatic climbing level. Follow-up ultrasound analysis showed correct position of the flexor-tendon, no fluid accumulation and an intact

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Figure 1 Radiograph of the treated fingers of two patients. Dorsal accented thickening of the cortex at the distal portion of the proximal phalanx can be seen, whereas the proximal portion of the same cortex is thinned out (patient I, March/May 2012). Radiographs of the treated fingers in 2014 (patient I/II) show that the cortex, which had been thinned out before, had nearly recovered its full thickness.

graft (figure 3). A new radiograph showed that the cortex, which had been thinned out before, had nearly recovered its full thickness (figure 1).

For exact evaluation, we investigated different indicators: for the clinical outcome, we used the Buck-Gramcko score, which

Figure 2 Bone-marrow oedema with contrast agent accumulation in the proximal phalanx of the left ring finger 1 year after surgery (May 2012). Twelve weeks later, and after 6-day oral cortisone-therapy, MRI shows a clear reduction of the oedema and of the unspecific osteitis (June 2012).

Figure 3 Ultrasound analyses of the treated finger 3 years after surgery-pulley repair and 2 years after the intermittent unspecific osteitis and cortex atrophy of the proximal phalanx. Correct position of the flexor-tendon (1) close to the bone (2), with no fluid accumulation (3) and with an intact graft (4).

showed an excellent result²; the functional outcome was good,² as there was a minor extension deficit in the PIP joint, subjective loss of strength only in the crimping position and normal motion pattern.² The sport-specific outcome was also good,² as the patient had a full-load capacity of the former injured finger in the hanging position, a minor loss of strength in the crimping position and a nearly full climbing ability without any pain (general reduction of climbing intensity due to new professional position).

To confirm these results, we performed several tests. Flexibility of the treated finger compared to the others was analysed with a finger-goniometer (SAEHAN, Korea); an extension deficit of nearly 20° was measured. Strength measurement with a hand dynamometer (SAEHAN, Korea) showed no severe loss of force while clenching the fist; there was no significant difference between the 'dominant' and 'stronger' right hand and the left hand with the treated finger (figure 4). Results of the 'full power flexion of the PIP joints' overlapped with the results of the 'full power flexion in the distal interphalangeal joints (DIP)'. In a secondary finger-specific strength test, we analysed each finger separately with a pinch-gauge (SAEHAN, Korea) (figure 4). Also, in these analyses, no loss of strength was present in the finger on which surgery was performed. The left ring finger showed no significant decrease of strength compared with the other fingers of the same hand and the ring finger of the healthy hand.

For measurement of the sport-specific relative finger strength, we used a protocol, first described by Köstermeyer and Weineck, using a wooden edge placed over a door frame. The patient was made to stand on the force platform pulling as hard as possible on the hold over a period of 5 s. The platform measured the relative release (body weight minus applied finger strength). We tested the index, middle and ring fingers of both hands, first isolated and then (D=digitus) DII/DIV, respectively, DII/DIII/DIV together in crimping and hanging position. The data were then processed further as described by Schöffl *et al*³ in 2006. Testing showed that the treated left ring finger was 29.3% stronger than the healthy right ring finger (20.04% relative release versus 14.7% relative release) in the 'hanging position'. However, results of the 'crimping-position' tests showed a 58.9% weaker left (treated) ring finger compared with the other side (figure 5).

In the meantime, we diagnosed a second patient with the same complication. Similar to the first female rock climbing athlete, a 31-year-old male rock-climber initially presented with tenderness on the palmar side of the finger (A2, A3 and A4

Figure 4 (A) Strength measurement with a hand dynamometer (SAEHAN, Korea), (B) finger-specific strength test with a pinch-gauge (SAEHAN, Korea).

pulley). Loss of finger strength was reported and a flexion deficit of 0.5 cm in fingertip-palmar distance without extension deficit was detected during clinical examination. MRI and ultrasound examination confirmed the diagnosis of a multiple pulley rupture (A2/A3/A4). Surgical repair was performed with the same technique as previously described and after-treatment following our standard protocol was started. Fourteen months after surgery, this patient presented with the same symptoms as the first patient (constant pain over the MCP and PIP-joint), which appeared simultaneously with an increase in training load. Radiographs showed a similar appearance as seen in the female athlete (figure 1). Immobilisation of the affected finger was started and a break from training was prescribed. Further details or data of the second patient cannot currently be given, as the patient just began his climbing-free regeneration.

DISCUSSION

'Weilby's repair', described by Kleinert and Bennett, has been reported as having the best functional outcome after multiple pulley ruptures.¹ However, sport climbers need a higher tearing force, especially in the crimping position. Therefore the 'loop-and-a-half' technique is preferred for these patients.² It is already described in detail that this procedure can cause problems at the PIP as the loop might irritate the extensor tendon and lead to an extension block.^{1 4-6} The intermittent osteitis and atrophy of the cortex after the described surgical pulley repair technique has not yet been observed. We assume that the rising stress the loop carries on the cortex leads to a critical undersupply of this area; blood circulation around the bone is reduced and the perfusion of the periosteum is compromised. On radiographs, it is clearly visible that the thinning of the

Figure 5 Results of strength tests in 'hanging position' show that the treated left ring finger (DIV left hand) is stronger than the healthy right ring finger (DIV right hand) (20.04% relative release vs 14.7% relative release). Results of 'crimping-position' tests shows a 58.9% weaker left (treated) ring finger compared with the other side. D, digitus.

cortex appears only in those regions where the 'one-and-a-half-loop' is in close contact with the cortical bone, whereas the flexion side of the proximal phalanx is intact. This can be clarified as the symptoms on both athletes started simultaneously after returning to accelerated training, especially in the crimping position of the fingers, leading to a higher compacting pressure of the loop on the periosteum. Overall, this complication is an unfavourable situation that requires full stress reduction over a relatively long period, at least 6–10 weeks, to reduce pain, provide adequate blood circulation and prohibit further damage such as necrosis or bone fracture. In fact, it is not yet clear to what degree the regional atrophy of the cortex raises the risk of bone fracture, but it must be assumed that it is increased.

However, as the symptoms of patient 1 abated, results of the strength measurement tests showed no finger strength deficit but actually indicated increased finger strength in the treated finger, at least in the hanging position. Nevertheless, there was a clear weakening measurable in the treated finger in the crimping position, which was consistent with the subjective loss of finger power. There was no difference in the hanging position. This is remarkable, as there was no observable reason for this weakening, and previous studies had shown constant strength conditions of fingers after surgery, in general.² We suggest that the patient avoided strength training in the crimping position consequently leading to the reduction of power in this finger position during climbing. Furthermore, the patient indicated that she was afraid of a new rupture while pulling with the maximal strength (in the crimping position).

Nevertheless, we still believe that the recommended 'bone-encircling' technique (modified 'one-and-a-half-loop' technique²), as performed on our two described patients, still provides the best outcome for rock climbers and should preferably be performed. Against the background of possible intermittent cortex atrophy and osteitis, multiple alternative techniques should not be disclaimed, especially in patients with a pre-existing reduction of circulation, bone oedema or cortex atrophy.^{5–10}

CONCLUSION

In a multiple pulley rupture situation (grade IV injury), studies have proven that surgery should be performed.¹ The long-term

postoperative complications of an unspecific osteitis and cortex atrophy arising out of resumption of full-strength training appears to be a significant problem that needs to be considered in cases of postoperative unspecific pain and bone-oedema after performance of a surgically encircling technique. These findings demand further evaluations of non-encircling techniques.

Learning points

- Unspecific osteitis and cortex atrophy must be considered after surgical treatment of multiple pulley ruptures.
- Further evaluations of non-encircling surgical techniques should be considered.

Competing interests None declared.

Patient consent Obtained.

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REFERENCES

- 1 Schöffl VR, Schöffl I. Injuries to the finger flexor pulley system in rock climbers: current concepts. *J Hand Surg Am* 2006;31:647–54.
- 2 Schöffl V, Küpper T, Hartmann J, et al. Surgical repair of multiple pulley injuries—evaluation of a new combined pulley repair. *J Hand Surg Am* 2012;37:224–30.
- 3 Schöffl VR, Einwag F, Strecker W, et al. Strength measurement and clinical outcome after pulley ruptures in climbers. *Med Sci Sports Exerc* 2006;38:637–43.
- 4 Schöffl V, Hochholzer T, Winkelmann HP, et al. Pulley injuries in rock climbers. *Wilderness Environ Med* 2003;14:94–100.
- 5 Widstrom CJ, Doyle JR, Johnson G, et al. A mechanical study of six digital pulley reconstruction techniques: part II. Strength of individual reconstructions. *J Hand Surg Am* 1989;14:826–9.
- 6 Arora R, Fritz D, Zimmermann R, et al. Reconstruction of the digital flexor pulley system: a retrospective comparison of two methods of treatment. *J Hand Surg Eur Vol* 2007;32:60–6.
- 7 Widstrom CJ, Johnson G, Doyle JR, et al. A mechanical study of six digital pulley reconstruction techniques: part I. Mechanical effectiveness. *J Hand Surg Am* 1989;14:821–5.
- 8 Lin GT, Amadio PC, An KN, et al. Biomechanical analysis of finger flexor pulley reconstruction. *J Hand Surg Br* 1989;14:278–82.
- 9 Seiler JG, III, Leversedge FJ. Digital flexor sheath: repair and reconstruction of the annular pulleys and membranous sheath. *J Southern Orthop Assoc* 2000;9:81–90.
- 10 Peterson WW, Manske PR, Bollinger BA, et al. Effect of pulley excision on flexor tendon biomechanics. *J Orthop Res* 1986;4:96–101.

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