



Available online at
ScienceDirect
www.sciencedirect.com

Elsevier Masson France
EM|consulte
www.em-consulte.com



Original article

Closed disruption of a single flexor digitorum superficialis tendon slip: 3 cases



Rupture d'une seule bandelette tendineuse du flexor digitorum superficialis : 3 cas

A. Schweizer^{a,*}, T. Bayer^b

^a University Clinic Balgrist, Forchstrasse, 340, 8008 Zurich, Switzerland

^b Radiological Institute, University Clinic Erlangen, Maximilianplatz, 3, 91054 Erlangen, Germany

ARTICLE INFO

Article history:

Received 14 August 2018

Received in revised form 5 January 2019

Accepted 18 January 2019

Available online 30 January 2019

Keywords:

Flexor digitorum superficialis

Closed flexor tendon disruption

Closed distal FDS tendon single slip disruption

Closed flexor tendon injury related to sports

Popping of flexor tendon

Mots clés :

Flexor digitorum superficialis

Rupture du tendon fléchisseur superficiel des doigts

lésion fermée du tendon fléchisseur superficiel

lésion fermée de la partie radiale du tendon fléchisseur superficiel

Lésion fermée du tendon fléchisseur au sport

Claquement tendon fléchisseur

ABSTRACT

Two men and one woman (age 31, 36 and 45 years) felt a painful pop in the left middle, right middle and right index finger during sport-related activities (2 sport climbing and 1 judo). Clinical examination found a painful flexor tendon in zone 2 but no function deficit specific to the flexor digitorum superficialis (FDS) tendon. MRI and ultrasonography revealed a complete disruption of the radial FDS tendon slip only, which was found retracted between the A2 and A3 pulleys. All flexor tendon pulleys remained intact. Conservative and functional treatment resulted in unrestricted normal function and return to sport. Disruption of one FDS tendon slip is a differential diagnosis for a popping incident in the finger, which is typically associated with a closed flexor tendon pulley injury.

© 2019 SFCM. Published by Elsevier Masson SAS. All rights reserved.

R É S U M É

Le présent rapport décrit trois patients (31 ans, 36 ans et 45 ans) chez lesquels une douleur suite à un claquement dans le doigt a été ressentie (deux majeurs, un index) lors d'activités sportives (deux patients pendant l'escalade sportive, un patient pendant le judo). Dans tous les cas, l'examen physique a révélé un tendon fléchisseur douloureux en zone 2, mais aucun déficit fonctionnel particulier pour une lésion du flexor digitorum superficialis (FDS). L'IRM et l'échographie ont indiqué une rupture complète de la partie radiale du tendon FDS avec sa rétraction entre les poulies A2 et A3, alors que toutes les poulies étaient restées intactes. Le traitement conservateur a rétabli la fonction normale sans restriction chez tous les patients et leur a permis de retrouver leur niveau de performance d'avant la blessure. La rupture d'une seule bandelette de l'insertion distale du tendon FDS est un diagnostic rare qu'il faut néanmoins envisager chez les patients présentant une douleur suite à un claquement dans le doigt, habituellement associé à une blessure à une poulie de l'appareil fléchisseur.

© 2019 SFCM. Publié par Elsevier Masson SAS. Tous droits réservés.

1. Introduction

A popping sensation in one of the fingers during resisted flexion particularly in sport/rock climbing without functional loss of the flexor digitorum profundus (FDP) and flexor digitorum superficialis (FDS) tendon is usually associated with a closed flexor tendon pulley disruption. This injury was initially described in rock

climbers [1,2] but has also been observed in other activities [3] and can usually be treated conservatively [3,4]. We describe three cases of a popping sensation in which no bowstringing was found, and no triggering was apparent. Ultrasound or MRI findings showed the flexor tendon pulleys remained intact. Conversely, the radial slip of the FDS tendon was found to be disrupted at its insertion and retracted proximally.

* Corresponding author.

E-mail addresses: andreas.schweizer@balgrist.ch (A. Schweizer), thomas.bayer@uk-erlangen.de (T. Bayer).

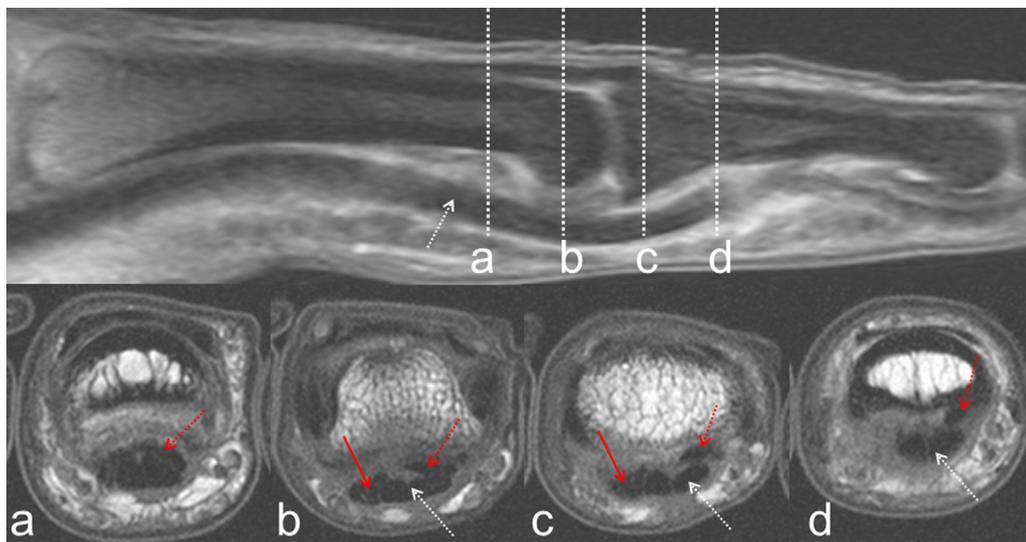


Fig. 1. Proton density weighted MRI showing sagittal and cross sections in the transverse (axial) direction (a–d). Disrupted and crimped up radial FDS slip (red continuous arrow), intact ulnar FDS slip (red dotted arrow), FDP tendon (white dotted arrow), cross section (d) showing a void where the radial FDS tendon slip is disrupted and missing.

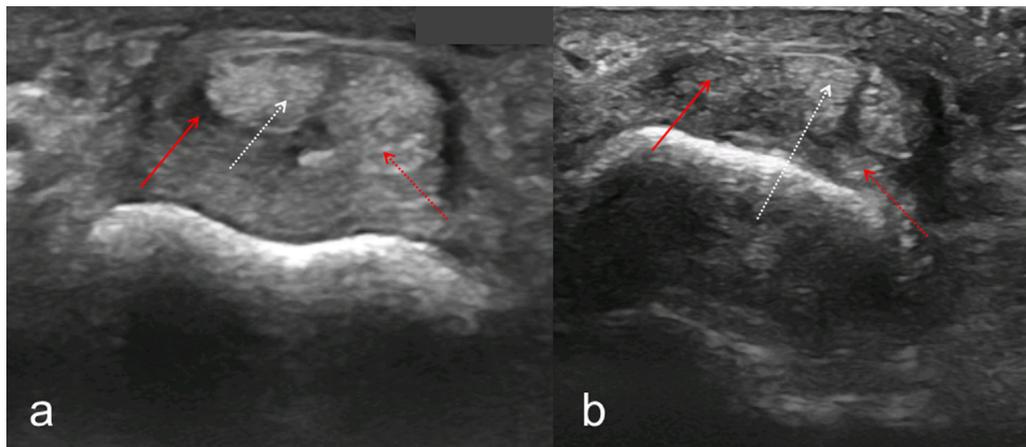


Fig. 2. Ultrasound cross-sectional view at the PIP joint volar plate (a) and between the A3 and A2 pulleys (b). Red dotted arrow depicts the remaining ulnar FDS slip, red continuous arrow shows the tendon missing (a) and crimped up (b), white dotted arrow indicates the FDP tendon.

2. Case reports

2.1. Case 1

A 31-year-old male recreational rock climber performed a difficult dynamic move on a small hold while he felt a “pop” in his left middle finger, followed by mild pain and swelling on the volar side of his middle phalanx. Two weeks later, he was seen in the clinic with mild swelling and a palpable mass but no functional loss, full range of motion and no triggering. MRI of the finger revealed an avulsion of the radial-sided FDS tendon slip, which was retracted between the A2 and A3 pulleys (Fig. 1). Functional treatment with reduction of maximum load to the finger flexors for 10 weeks led to symptom-free return to sport at the pre-injury level.

2.2. Case 2

A 36-year-old male judoka felt a painful pop in his right middle finger during a fight while pulling on his opponent’s kimono. Because he is also a rock climber, he was aware of possible finger injuries and suspected a finger flexor pulley disruption; he showed up at our outpatient clinic 2 days later. Clinical examination found mild painful

swelling and a palpable mass between the A3 and A2 pulleys on the radial side. There was no functional loss, full range of motion and no triggering. Ultrasound investigation showed an intact pulley system but a disruption of the radial slip of the FDS tendon which was retracted between the A3 and A2 pulleys (Fig. 2). Functional treatment with reduction of maximum load to the finger flexors for 10 weeks led to symptoms-free return to sport at the pre-injury level.

2.3. Case 3

A 45-year-old female recreational rock climber complained of pain and swelling on the volar side of the proximal interphalangeal joint (PIP) on her right index. She reported an acute onset with popping sensation in the finger like in the first two patients. In the clinical examination, she had painful swelling that was the greatest on the volar side of the PIP joint, but no functional loss, triggering or reduced range of motion. MRI revealed a disruption of the radial slip of the FDS tendon (Fig. 3). The proximal stump of the disrupted FDS portion was not seen in the MRI due to palmar retraction, which was outside the MRI’s field of view and therefore not visible. Due to initial pain and soreness, the patient wore a splint for 2 weeks followed by functional therapy with avoidance of

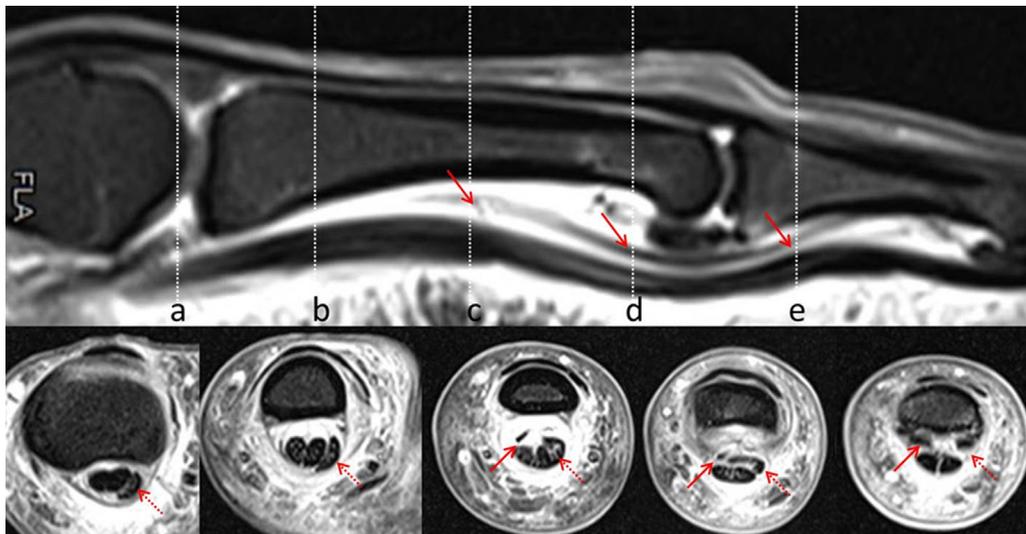


Fig. 3. T1-weighted fat-saturated MRI cross sections after intravenous contrast agent injection with five axial images (a–e) and one sagittal image. MRI shows disruption of the radial FDS slip visible at level of the A3 and A2 pulleys (continuous arrows: axial images c, d, e and sagittal image). The undamaged ulnar FDS portion was misaligned inside the tendon sheath with relocation in an ulnar direction at level of the proximal phalanx (all axial images, dotted arrows).

Table 1

Published cases of isolated closed FDS tendon disruption.

Author/year	Cases/anatomy	Symptoms	Treatment	Outcome
Boyes 1960	8 complete FDS tendon disruption (5 at distal insertion): 1 index, 3 middle, 3 ring, 1 little finger	1 with PIP joint extension deficit	7 conservative, 1 resection of FDS tendon stump	Good
Ferraro 1998	1 complete FDS tendon avulsion with bony fragment: right ring finger	60° extension deficit of PIP joint	Excision of fragment	Good
Drapé 1998	2 complete FDS tendon disruption: right little finger, left middle finger	No info	Reinsertion	No info
Tos 2011	1 complete FDS tendon disruption: right ring finger	Flexion deficit PIP joint, pain at A1 pulley	Conservative	Good
Netscher 2001	1 bony avulsion of radial FDS tendon slip: right little finger	Extension block PIP joint	Excision of bony fragment and FDS tendon slip	Good
Bhardwaj 2014	1 ulnar FDS tendon slip disruption: left middle finger	Trigger phenomenon	Resection of tendon slip	Good
Our study	3 radial FDS tendon slip disruption: left middle, right middle, right index finger	Painful lump at PIP joint, full range motion	Conservative	Good

extensive loading of the finger for another 10 weeks. This patient had good outcomes without any symptoms or complaints in the follow-up visit in our outpatient department 4 months after the initiation of hand therapy.

3. Discussion

Closed FDS tendon disruption is a rare injury. Since this type of injury is not clinically obvious and usually just minimally disturbing [5], patients are less likely to seek medical attention compared to closed FDP tendon disruption. The largest series of closed flexor tendon injuries was published in 1960 by Boyes et al. [5]. They described 80 subcutaneous disruptions of finger flexor tendons in 79 patients over a 13-year period. There were only five cases of selective distal FDS tendon disruption (Table 1). All were treated conservatively with good results. One patient needed a secondary excision of the FDS stump because of a PIP joint extension deficit. Since then, only case reports [6,7] or small series [8] of closed FDS tendon ruptures have been published Fig. 4.

Partial laceration of the FDS tendon after open injury has been described several times in case reports [9–13] and was correlated with a trigger event as a leading clinical sign. Disruption of one FDS slip after closed injury is quite rare. Netscher et al. [14] described

one case with bony avulsion of the radial FDS slip in a little finger leading to an extension block at the PIP joint, while Bhardwaj et al. [15] reported one case with closed disruption of the ulnar-sided FDS slip of a middle finger. The tendon slip was found to be rolled up proximal to the A1 pulley and was resected due to a trigger phenomenon at the PIP joint.

We described the cases of three patients with a popping sensation after forced flexion against resistance without bowstringing or functional loss of FDS/FDP tendon. None of the patients had a trigger phenomenon. Selective disruption of one FDS tendon slip was found on either MRI or ultrasound investigation (Fig. 1–3). One of the reasons for late detection of this kind of injury might be related to unavailability of high-resolution MRI/ultrasound equipment at the time. In all cases, the radial slip was affected suggesting that either the radial FDS slip was weaker or that a larger force was applied to it. In rock climbing, the force applied to the flexor tendons happens in a rather static-eccentric way. The often-used crimp grip [16] may lead to acute deviation of the FDS tendon at the distal edge of the A2 pulley and may play a role in the pathophysiology of this injury [17]. A similar injury mechanism may occur in judo during a sudden eccentric movement. Furthermore, a well-coordinated movement may favor sudden unloading of the finger after the popping sensation before the entire tendon is disrupted.

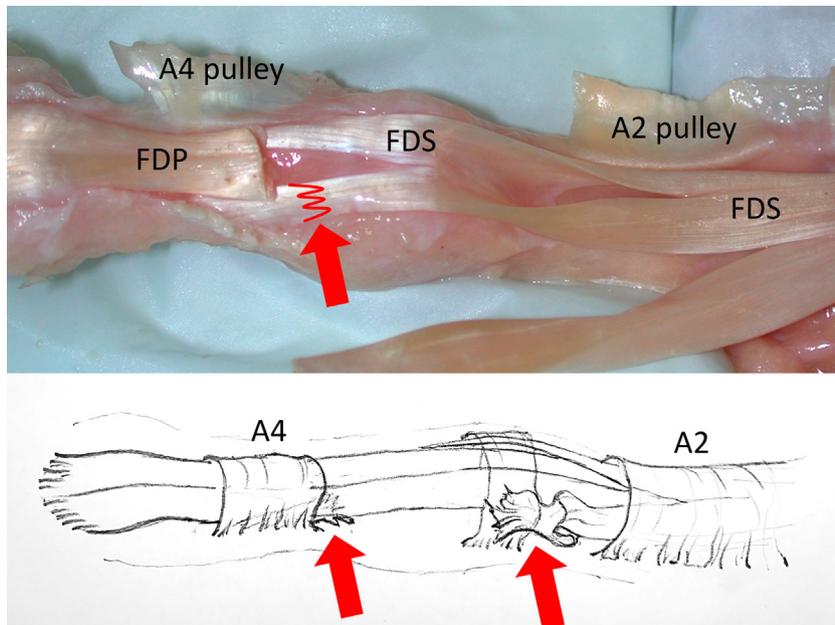


Fig. 4. Cadaver dissection showing the human finger flexor tendon system; the FDP tendon is transected and retracted proximally to show both FDS tendon slips. Wavy line and arrows show the area of disruption, the proximal and distal stumps of the disrupted FDS tendon slip on the drawing.

All patients regained normal function of their finger after conservative functional treatment with active and passive range of motion exercises. They were advised to not load the injured finger maximally for 3 months to allow remodeling and adaptation of the remaining ulnar slip of the FDS tendon, since it is well known that in rock climbing, the loads applied to the finger flexor tendons and pulleys are exceptionally high [16]. This has been shown by an up to 50% increase in the thickness of the cortical bone and the A2 and A4 pulleys, which is not observed in other sports or occupational activities [18,19].

4. Conclusion

Disruption of a single slip of an FDS tendon should be considered as a differential diagnosis following the popping sensation in a finger as an alternative to a closed flexor tendon pulley injury and may occur also without trigger phenomenon. The prognosis is good with conservative treatment; normal function can be expected after 10 or so weeks.

Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

Disclosure of interest

The authors declare that they have no competing interest.

Acknowledgments

None

References

- [1] Bollen SR. Injury to the A2 pulley in rock climbers. *J Hand Surg Br* 1990;15:268–70.

- [2] Tropet Y, Menez D, Balmat P, Pem R, Vichard P. Closed traumatic rupture of the ring finger flexor tendon pulley. *J Hand Surg Am* 1990;15:745–7.
- [3] Schoffl VR, Schoffl I. Injuries to the finger flexor pulley system in rock climbers: current concepts. *J Hand Surg Am* 2006;31:647–54.
- [4] Schneeberger M, Schweizer A. Pulley ruptures in rock climbers: Outcome of conservative treatment with the pulley-protection splint – a series of 47 cases. *Wilderness Environ Med* 2016;27:211–8.
- [5] Boyes JH, Wilson JN, Smith JW. Flexor-tendon ruptures in the forearm and hand. *J Bone Joint Surg Am* 1960;42:637–46.
- [6] Ferraro Jr, Schenck RR. Isolated closed rupture of the bony insertion of the flexor digitorum superficialis tendon: an unusual case. *J Hand Surg Am* 1998;235:837–9.
- [7] Tos P, Catalano F. Spontaneous rupture of the flexor superficialis tendon of ring finger: a case report and review of literature. *Musculoskelet Surg* 2011;95:245–6.
- [8] Drapé JL, Tardif-Chastenot de Gery S, Silbermann-Hoffman O, Chevrot A, Houvet P, Alnot JY, Benacerraf R. Closed ruptures of the flexor digitorum tendons: MRI evaluation. *Skeletal Radiol* 1998;27:617–24.
- [9] Janecki Jr. Triggering of the finger caused by flexor-tendon laceration. *J Bone Joint Surg Am* 1976;58:1174–5.
- [10] Bilos ZJ, Hui PW, Stamelos S. Trigger finger following partial flexor tendon laceration. *Hand* 1977;9:232–3.
- [11] Gordon SL. Late rupture of one slip on the floor digitorum superficialis: an unusual cause of triggering. *Clin Orthop Relat Res* 1981;158:142–3.
- [12] Schlenker JD, Lister GD, Kleinert HE. Three complications of untreated partial laceration of flexor tendon-entrapment, rupture, and triggering. *J Hand Surg Am* 1981;6:392–8.
- [13] Fujiwara M. A case of trigger finger following partial laceration of flexor digitorum superficialis and review of the literature. *Arch Orthop Trauma Surg* 2005;125:430–2.
- [14] Netscher DT, Eladoumikdachi F, Schneider A. A case study of a patient with closed avulsion rupture of a single slip of the flexor digitorum superficialis tendon. *Ann Plast Surg* 2001;47:431–4.
- [15] Bhardwaj P, Chandrasekar V, Sabapathy RS. Spontaneous rupture of one slip of flexor digitorum superficialis causing triggering. *Indian J Plast Surg* 2014;47:272–3.
- [16] Schweizer A. Biomechanical properties of the crimp grip position in rock climbers. *J Biomech* 2001;34:217–23.
- [17] Schweizer A, Moor BK, Nagy L, Snedeker JG. Static and dynamic human flexor tendon-pulley interaction. *J Biomech* 2009;42:1856–61.
- [18] Hahn F, Erschbaumer M, Allenspach P, Ruffibach K, Schweizer A. Physiological bone responses in the fingers after more than 10 years of high-level sport climbing: analysis of cortical parameters. *Wilderness Environ Med* 2012;23:31–6.
- [19] Schreiber T, Allenspach P, Seifert B, Schweizer A. Connective tissue adaptations in the fingers of performance sport climbers. *Eur J Sport Sci* 2015;15:696–702.