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ORIGINAL RESEARCH

# Pulley Ruptures in Rock Climbers: Outcome of Conservative Treatment With the Pulley-Protection Splint—A Series of 47 Cases

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**Objective.**—To evaluate the effectiveness of conservative treatment of finger flexor tendon pulley rupture with a pulley-protection splint (PPS) with regard to reduction in tendon-phalanx distance (TPD) and functional and sport-specific outcomes in a retrospective case series.

**Methods.**—Tendon-phalanx distance in active forced flexion was measured before and after treatment in ultrasound records. Functional and sport-specific outcomes were evaluated by means of a questionnaire, which also contained instructions for self-measurement of finger range of motion and finger strength.

**Results.**—Forty-seven complete pulley ruptures in 45 rock climbers (mean age, 33.4 years; range, 21.8–56.2 years) were included in the study. In the 39 patients who had follow-up ultrasound examination, PPS treatment decreased mean $\pm$ SD TPD from 4.4 $\pm$ 1.0 mm to 2.3 $\pm$ 0.6 mm after A2 pulley rupture and from 2.9 $\pm$ 0.7 mm to 2.1 $\pm$ 0.5 mm after A4 pulley rupture. Tendon-phalanx distance was reduced in all patients. Finger range of motion ($n = 42$) and finger strength ($n = 22$) did not differ significantly between treated and contralateral sides. Of the 43 climbers who completed questionnaires, 38 had regained their previous climbing level a mean 8.8 months after pulley rupture; 1 reported reduced finger dexterity; 39 assessed their treatment results to be good, and 4 to be very good.

**Conclusions.**—The PPS is an effective conservative treatment modality for pulley ruptures, which reduces TPD and enables the patient to regain previous finger function.

*Key words:* bowstringing, finger injury, flexor tendon, pulley rupture, rock climbing

## Introduction

Pulleys arch over the flexor tendon sheath, keeping the tendons close to the skeletal structures and allowing functionally optimal finger flexion (Figure 1). The most important pulleys with regard to function are the A2 and A4.[1–3] Pulley ruptures are among the most frequent injuries in sport climbing.[4,5] Vice versa, sport climbing accounts for the bulk of pulley ruptures; however, they also occur in nonclimbing activities, such as lifting or carrying heavy objects.[6,7] The injury mechanisms seem to be uniform[7]: Heavy loads on the pulley system occur when tendon deflection at the edge of the pulley is large, as is the case with the crimp grip (proximal interphalangeal [PIP] joint flexed, distal interphalangeal [DIP] joint hyperextended).[8] In addition, friction between tendon and pulley, which increases with PIP joint flexion, can make the pulley more susceptible to injury when this holding technique is used.[9,10] Finally,

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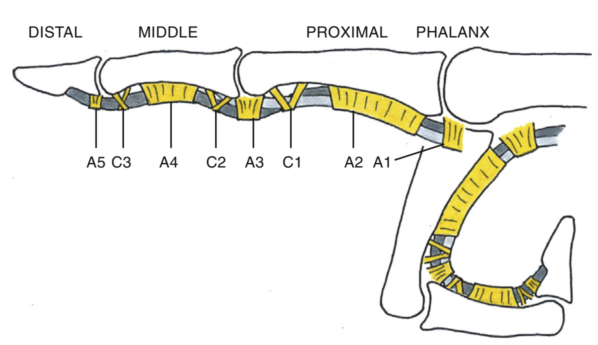


**Figure 1.** The finger flexor tendons glide in a sheath reinforced by annular (A1–A5) and cruciform (C1–C3) pulleys. The tendons are kept close to the phalanges also during finger flexion.

peak loads on the pulley system, such as those occurring during dynamic climbing moves or after slipping off a foothold, often trigger a rupture.[4,5,11–18]

The loss of anatomic pulley integrity results in a palpable protrusion caused by the dehiscence of flexor tendons and phalanges, especially in forced finger flexion,[5,11–14,16–24] and is equivalent to functional deficiency; the diminished tendon amplitude causes a deficit in both strength[25] and range of motion (ROM) of the affected finger. Depending on the number of pulleys ruptured, the increased tendon-phalanx distance (TPD) can be visible as so-called bowstringing.[4,17,26] Suspected pulley rupture can be reliably confirmed by ultrasound measurement of TPD,[20,23] which is recommended for routine diagnosis.[4,21,23]

Conservative treatment of pulley ruptures involves first immobilization, then a gradual increase in the intensity of finger exercise, including easy climbing, always under pulley protection.[4,12–15,17] This is conventionally done with a simple inelastic tape or with a thermoplastic ring.[4,5,13–17] Good clinical results,[4,11,13,24,25] albeit with TPD remaining increased,[4,11,14,17,25] have been reported. Surgical reconstruction, recommended as second-line treatment,[12,13,24,25,27] has been noted to reduce TPD[6,14,19,27] but involves risks associated with invasive procedures.

We developed a novel device, the pulley-protection splint (PPS), which we have used for conservative treatment of pulley ruptures since 2007. In contrast with conventional taping, the splint's shape allows firm fixation on the finger with inelastic tape, but without compression of blood vessels or nerves (Figure 2). The flexor tendons are thus forced back into a nearly anatomic position, and the pulley can heal at a functionally effective length, close to its original state, which is equivalent to TPD reduction.

In the present case series, we evaluated the effectiveness of conservative treatment of pulley rupture with the PPS by quantifying TPD reduction and investigating functional and sport-specific outcomes.

## Methods

The present study is a systematic retrospective analysis of pulley ruptures seen in our clinic during a period of several years. Concerning diagnosis, treatment, and follow-up, the procedure subsequently described represents our clinic's standard algorithm for pulley ruptures receiving conservative treatment and was not designed for or influenced by the study.

Subjects eligible for the present study were rock climbers older than 18 years who experienced closed complete pulley rupture a minimum of 6 months before the survey and were treated conservatively with a PPS (start of therapy between December 2007 and May 2013).

All patients provided written informed consent to participate in the study. The responsible ethics committee approved the study.

### DIAGNOSIS AND TREATMENT

Patients were clinically examined and diagnosed in our clinic. Mean interval between pulley rupture and first consultation was 18.0 days (range, 1–83 days). Ultrasound was used to quantify the amount of bowstringing over the disrupted pulley. Tendon-phalanx distance was

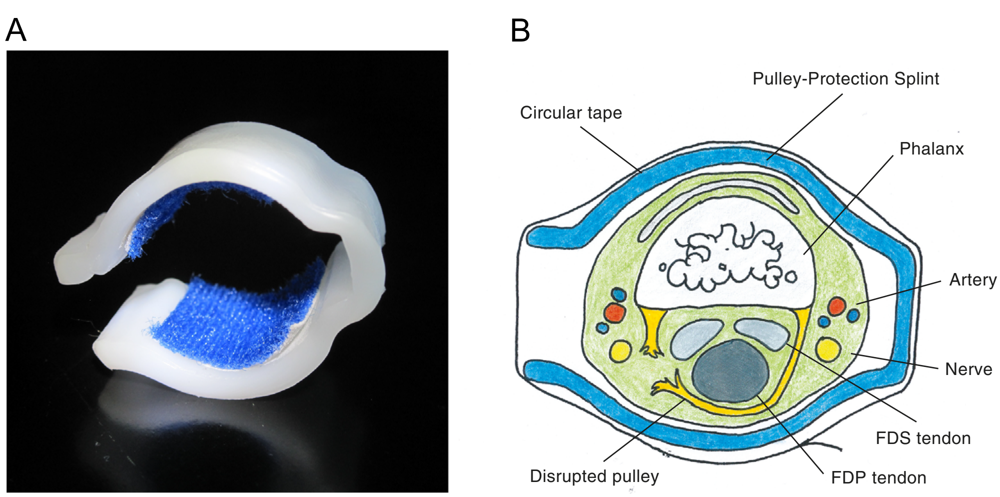


**Figure 2.** A, Pulley-protection splint with padding on the contact zones to provide a comfortable fit. B, The splint's lateral convexities prevent compression of blood vessels and nerves running along both sides of the finger. FDP, flexor digitorum profundus tendon; FDS, flexor digitorum superficialis tendon.