

Management of Flexor Pulley Injuries with Proximal Interphalangeal Joint Contracture



Elizabeth Inkellis, MD*, Emily Altman, DPT, CHT,
Scott Wolfe, MD

KEYWORDS

• Flexor pulley injuries • Flexor tendon bowstringing • PIP contractures

KEY POINTS

- Injuries to the flexor pulley system cause bowstringing and increase work of flexion.
- Neglected flexor pulley injuries with proximal interphalangeal (PIP) joint contracture are a difficult challenge.
- This article describes a technique for managing patients with delayed presentation of pulley rupture and fixed PIP flexion contracture with Digit Widget® application followed by splinting without pulley reconstruction.
- This technique allows for correction of the flexion contracture and high patient satisfaction without invasive open surgery.

INTRODUCTION

The flexor pulley system is an elegant, efficient system that converts tendon excursion to angular motion at the joints of the fingers. Injuries to the flexor pulleys cause volar displacement of the flexor tendons by disrupting the balance of the system. Closed pulley injuries may occur from an extension forced applied over a short period of time to a flexed digit, notably in rock climbers.¹ Pulley injuries may also occur postoperatively, most commonly after tendon repairs or exuberant trigger finger releases.² Acute, single-pulley ruptures typically are treated conservatively.³ A statewide database review in New York State found the incidence of operative pulley reconstruction to be 0.27 per 100,000 persons, with an annual frequency of 52 procedures statewide.⁴

Anatomy

The flexor pulley system consists of 5 annular pulleys, 3 cruciate pulleys, and the palmar aponeurosis pulley.⁵ The A1, A3, and A5 pulleys are located over the metacarpophalangeal (MP), proximal interphalangeal (PIP), and distal interphalangeal (DIP) joints, respectively. The critical pulleys are the A2 and A4 pulleys, which overlie the proximal and middle phalanges.

Function and Biomechanics

The purpose of the pulley system is to convert the longitudinal motion of tendon excursion into angular motion across the interphalangeal joints. The pulleys maintain close contact between the flexor tendons and the phalanges, ensuring a short moment arm.⁶ The system permits a 3-cm flexor

Hospital for Special Surgery, Hand and Upper Extremity Service, 535 East 70th Street, New York, NY 10021, USA

* Corresponding author.

E-mail address: liz.inkellis@gmail.com

Hand Clin 34 (2018) 251–266

<https://doi.org/10.1016/j.hcl.2017.12.001>

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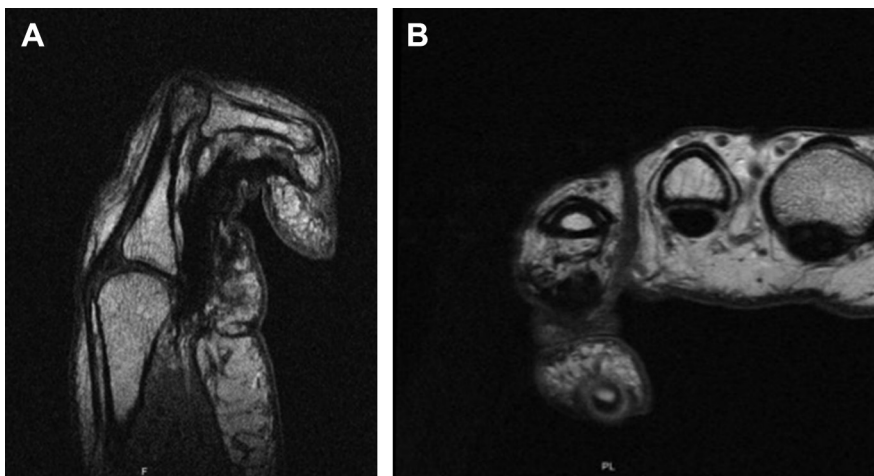


Fig. 1. (A) Sagittal and (B) Axial MRI demonstrating bowstringing in the small finger of Patient 3. Note the distance of the flexor tendon away from the volar surface of the proximal phalanx as well as the PIP flexion contracture. (Courtesy of S. Wolfe, MD, New York, NY.)

tendon excursion to produce a digital arc of motion of 260° .⁷ With injury to the A2 pulley, the flexor tendons bowstring and translate palmarward, increasing the moment arm on the interphalangeal joints (**Fig. 1**). The inability of the relatively weak intrinsic extensor to compensate for the increased moment arm of PIP flexion leads to a flexion contracture.^{7,8} The change in excursion of the flexor muscle-tendon unit that results in an effective lengthening of the tendon leads to a loss of active flexion.¹ It is widely held that the integrity of the A2 and A4 pulleys are the most important for preventing bowstringing.⁹ Biomechanical studies have demonstrated that the sectioning of both the A2 and A4 pulleys leads to a 30% increase in tendon excursion and markedly increased work of flexion as well as decreased range of motion.¹⁰

Management of Pulley Injuries

Patients present clinically with bruising, swelling, and localized tenderness. They may recall a tearing or popping sensation at the time of injury.¹¹ Patients also may present after prior surgery. Bowstringing may not be present immediately and also may not always occur after isolated pulley ruptures. Although radiographs are the initial imaging modality of choice, MRI and dynamic ultrasound can both be useful in confirming pulley injuries and resultant bowstringing (**Table 1**).¹²

Conservative treatment with a ring splint or taping is recommended for isolated pulley injury.¹¹ In a study of 21 rock climbers with complete or

partial isolated pulley ruptures of A2, A3, or A4 treated conservatively, all had excellent clinical outcomes and regained their level of climbing within 1 year.¹³ Another study examining 47 complete pulley ruptures in 45 rock climbers treated with a pulley-protection thermoplastic splint for 2 months found normalization of tendon-phalanx distance on ultrasound as well as return to climbing at their prior level in 38 of 43 patients at an average of 8.8 months.¹⁴

Surgical treatment is indicated for patients with multiple pulley ruptures and impairment of function or those with persistent symptoms after nonoperative treatment.¹¹ Reconstructive techniques are based either on weaving an

Table 1
Management of pulley rupture

Injury	Treatment
Single closed pulley rupture without contracture	Conservative
Multiple pulley ruptures, persistent pain after conservative treatment, good digital range of motion	Pulley reconstruction
Pulley rupture with bowstringing and fixed PIP flexion contracture	Pulley rescue with Digit Widget followed by splinting

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