

Multiple flexor tendon pulley ruptures in a division 1 collegiate football player

Kelly Scott,¹ Donald Dulle,¹
Genaro Garcia,² Jonathan A. Flug,³
Anikar Chhabra¹

¹Department of Orthopedic Surgery,
Mayo Clinic Arizona, Phoenix, AZ;

²Arizona State University Athletic
Department, Tempe, AZ; ³Department
of Radiology, Mayo Clinic Arizona,
Phoenix, AZ, USA

Abstract

Injuries to the hand and digits are common in football players. To our knowledge, there have been no reports on multiple flexor pulley ruptures in football players treated non-operatively through splinting and taping techniques. A 22-year old collegiate defensive lineman sustained an injury resulting in complete disruption of the annular 2, 3, 4, and cruciate 1 and 2 pulleys. The patient was successfully treated with serial custom splints for 12 weeks. Our splinting and taping techniques and timing of these have not been previously described. This case illustrates a successful treatment option in football players with multiple flexor pulley ruptures.

Introduction

Upper extremity injuries in football are common due to the full contact nature of the sport. Specifically, injuries to the hand and digits are a significant source of morbidity for players of all levels.¹ The flexor pulley system is a complex structure made up of five annular (A1-A5) and three cruciate (C1-C3) pulleys in the index, long, ring, and small fingers, through which the flexor digitorum profundus (FDP) and flexor digitorum superficialis (FDS) run;² the anatomy of the thumb pulley system is slightly different and beyond the scope of this case report.³ The location of the pulley dictates its function and the pulleys located in between the joints (A2, A4) are most critical to prevent bowstringing and often considered the most biomechanically important.⁴

Classically, flexor pulley injuries have been reported in rock climbers.⁵⁻⁷ Recent literature has also described this injury in baseball players,^{8,9} Kendo players,¹⁰ and people performing activities of daily living.¹¹ To our knowledge, multiple flexor

pulley ruptures have not been described in football players and we present our encounter with this unique injury and our nonoperative management through novel splinting and taping techniques.

Case Report

A 22-year old right hand-dominant male, Division 1 collegiate football defensive lineman, presented with pain localized to his left ring finger metacarpophalangeal (MCP) joint. The patient was playing in a game and grabbed a jersey in the midst of tackling another player, when his flexed left ring finger was suddenly jerked into extension. He had immediate pain and swelling but was able to continue playing. Upon completion of the game, he presented to the athletic training staff.

The patient's chief complaint was pain. He denied numbness, tingling, and prior injuries to the left ring finger. Past medical and surgical histories were noncontributory. The patient had no allergies and did not take any daily medication (prescription or non-prescription). Examination of the left ring finger revealed diffuse swelling with no visible or palpable deformity. The volar aspect of the ring finger MCP and proximal interphalangeal distal interphalangeal (PIP) joints were tender to palpation. The patient was able to flex at both the PIP and distal interphalangeal (DIP) joints and full extension was actively maintained with no obvious bowstringing. On the day of injury, fluoroscopy was negative for fracture or acute osseous abnormalities. Prior to advanced imaging, differential diagnosis included flexor tendon injury/strain and/or flexor tendon pulley injury. Diagnostic magnetic resonance imaging (MRI) revealed complete disruption of left ring finger A2, A3, A4, C1 and C2 pulleys with associated surrounding soft tissue edema (Figure 1). There was also clinical evidence of bowstringing of the flexor tendon over the proximal and middle phalanges. The patient was diagnosed with ruptures of the left ring finger A2, A3, A4, C1, C2 pulleys.

After a discussion of nonoperative and operative modalities the patient elected to be managed non-operatively due to timing of his final collegiate season. On the day of presentation, the patient was given two options for bracing. One option was a custom molded clamshell orthosis, with convexities over the volar mid-portions of the proximal and middle phalanges to put pressure on the flexor tendon towards the phalanges. Tape straps were fashioned to make snug as possible. The second option was a

Correspondence: Anikar Chhabra, Department of Orthopedic Surgery, Mayo Clinic Arizona, 5777 E. Mayo Blvd., Phoenix, AZ 85054, USA.

Tel.: +1.480-432-6367 - Fax: +1.480-342-2782.
E-mail: chhabra.anikar@mayo.edu

Key words: Flexor digitorum, annular, cruciate, splint.

Contributions: KS: analysis of data, drafting and revision of manuscript, literature review, final manuscript approval. DD: acquisition of data collection, revision of manuscript, final manuscript approval. GG: conception of work, acquisition of data collection, revision of manuscript, final manuscript approval. JAF: interpretation of data, revision of manuscript, final manuscript approval, selection of magnetic resonance images, image preparation. AC: interpretation of data, revision of manuscript, final manuscript approval.

Conflict of interest: The authors declare no potential conflict of interest.

Funding: None.

Received for publication: 20 September 2019.
Accepted for publication: 27 October 2019.

This work is licensed under a Creative Commons Attribution NonCommercial 4.0 License (CC BY-NC 4.0).

©Copyright: the Author(s), 2019
Licensee PAGEPress, Italy
Orthopedic Reviews 2019;11:8316
doi:10.4081/or.2019.8316

thermoplastic splint molded in slight flexion with pressure points at the proximal and middle phalanx (Figure 2). Due to comfort both during and outside of football he chose the thermoplastic molded splint. The patient wore this full time for six weeks. He was instructed to only remove the splint to let the digit air out, but was instructed to maintain his finger in full extension during this time. During games and practice, this splint was over-wrapped with athletic tape to hold it to the hand in order to avoid inadvertent removal. He did undergo repeat MRI three weeks later with brace on (Figure 3A) and off (Figure 3B), with improvement of flexor tendon bowstringing and decreased edema noted. At six weeks, the patient was instructed to wear this splint only during practice, games, and sleep. During the daytime, the patient was instructed to wear pulley ring splint to allow active flexion and extension (Figure 4). At 12 weeks, the patient was instructed to continue wearing the pulley ring splint only while playing football. Patient was re-examined eight weeks after date of injury. The patient was

noted to have a 5-10° extensor lag at the left ring finger PIP joint. A new extension splint was made to ensure full PIP extension; again, focused molding over the volar midportions of the proximal and middle phalanges was performed to keep the tendon reduced against the phalanges. In addition, a narrower, more rigid pulley ring splint was fabricated to allow full flexion of the digit. At 12 weeks, the patient was noted to have a 5° extensor lag at the PIP joint, which was passively correctable. There was full flexion with no evidence of bowstringing-

ing and the patient had excellent grip strength. At this point, the patient had played in 11 football games with no issues noted. The patient was instructed to continue wearing the pulley ring splint while playing football and to follow up as needed.

Discussion

Flexor pulley ruptures in football players have not been reported previously. The

classic presentation of flexor pulley ruptures has been described in rock climbers.⁵⁻⁷ Rock climbing has been described as a biomechanically unique activity that defies human anatomy, structured to support body weight through upper limbs rather than lower limbs; specifically, only the distal phalanges are responsible for supporting the majority of the weight at small ledges.¹² The position of the digit that leads to pulley rupture has been described as a “crimp” position, where the PIP joints are flexed to 90-100° and the DIP joints are hyperextended.⁶

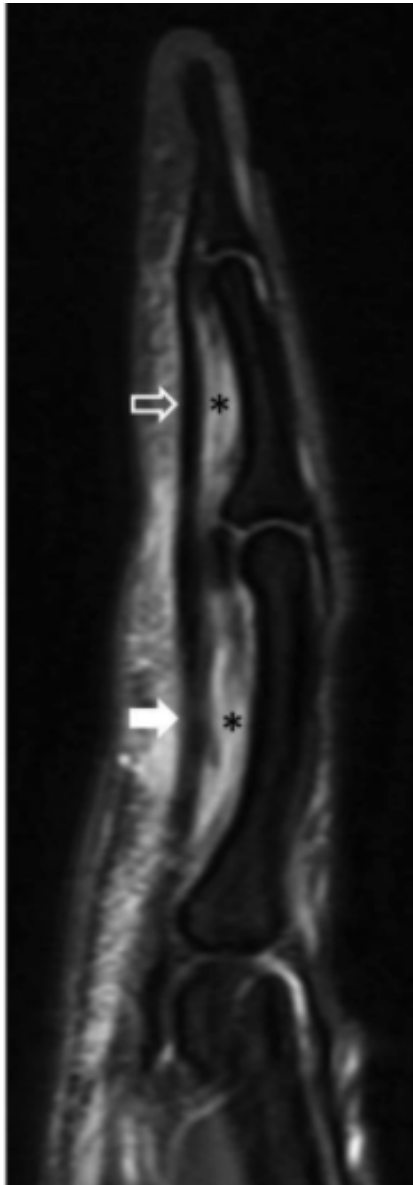


Figure 1. Sagittal T2 weighted MR image with fat saturation of the ring finger shows bowstringing of the flexor tendon at the proximal phalanx (solid arrow) and middle phalanx (open arrow) with edema (asterisk) between the tendon and the bone consistent with rupture of the A2, A3, A4, C1, and C2 pulleys.



Figure 2. Thermoplastic splint molded in slight flexion with pressure points at the proximal and middle phalanx.

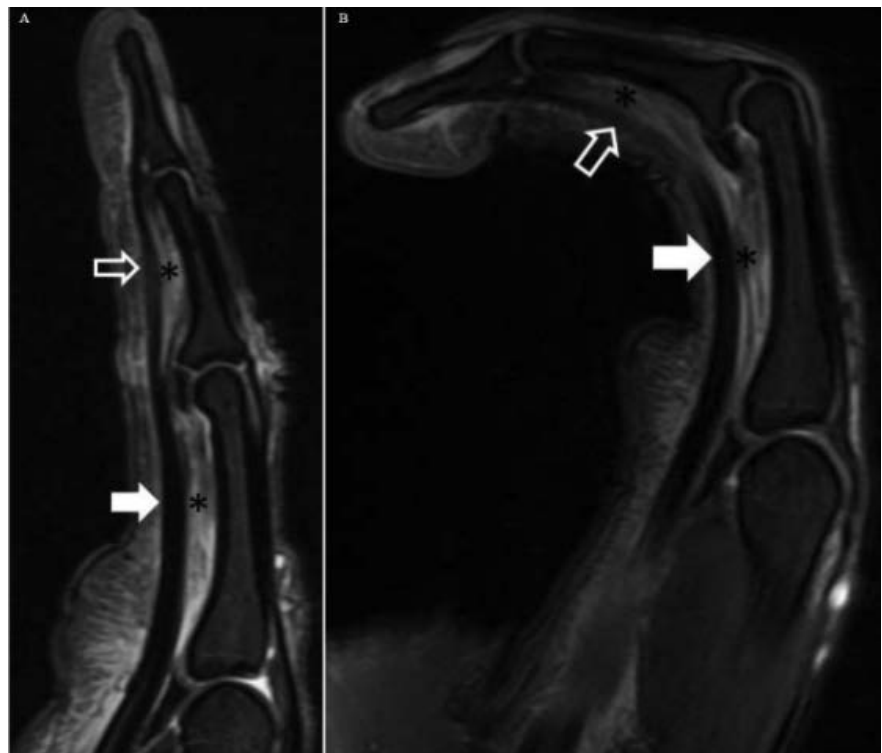


Figure 3. Sagittal T2 weighted MR images with fat saturation of the ring finger obtained three weeks later with the hand splint in extension (A) and flexion (B) shows decreased bowstringing of the flexor tendon at the proximal phalanx (solid arrow) and middle phalanx (open arrow) and decreased edema (asterisk) from the multiple pulley injuries.

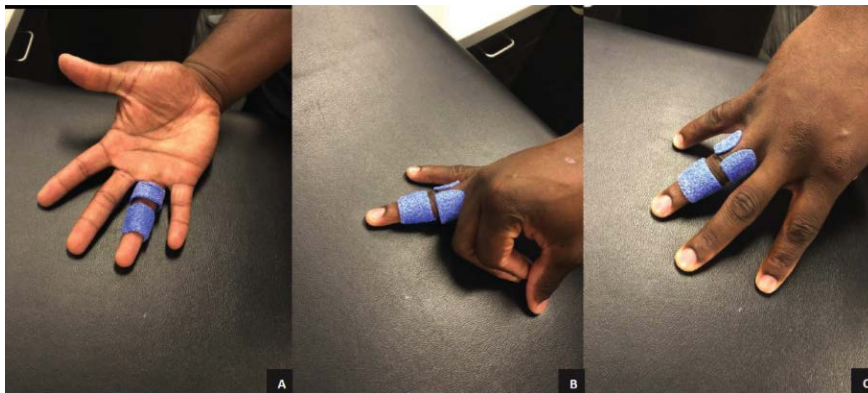


Figure 4. Thermoplastic splint worn during the daytime to allow active range of motion.

In this position, bowstringing of the flexor tendons applies very high forces to the flexor tendon pulleys. In our case, the mechanism of injury was forced hyperextension of the digit. Although this may be considered a more sudden, traumatic mechanism, the flexor tendons still apply a high force to the pulleys, consistent with the “crimp” position described in rock climbers. A grading system of flexor pulley injuries has been described to help guide treatment and includes four grades.⁵ Grade I are strains, grade II are complete A4 rupture or partial A2 or A3 rupture, grade III are complete A2 or A3 rupture, and grade IV are multiple pulley ruptures or a single rupture of A2 or A3 with associated lumbrical muscle or collateral ligament injury. Treatment can often times be dictated by grade of injury and nonsurgical management is typically selected for grade I-III injuries.¹³⁻¹⁵ Based on this grading system, our case would be considered grade IV, which literature has suggested should be treated surgically.^{5,16}

The decision was made to treat the patient non-operatively for several reasons. As a senior, with aspirations of a National Football League (NFL) career, showcasing his talent was both important and time-sensitive; surgical treatment would have set his timeline back, required more recovery time, and possibly hindered his ability to return to pre-injury level. In addition, as a defensive lineman, less hand and finger dexterity are required as compared to a catching/passing position; this allows for more taping and splinting options with nonoperative management. Taking these factors into consideration as well as his clinical picture, we employed a new method of nonsurgical management including a custom-molded thermoplastic splint with pressure points. Two methods of taping for nonsurgical management of flexor pulley ruptures have been reported in the literature. The first, more common method described is circumferential taping around the distal end of the

proximal phalanx to reduce bowstringing and limit PIP flexion.^{13,15,17} The second method is the “H-tape” that centers the tape over the PIPJ with the proximal straps at the distal end of the proximal phalanx and the distal straps at the proximal end of the middle phalanx.^{18,19} In contrast to the taping methods, Schneeberger *et al.*²⁰ described the pulley-protection splint, a thermoplastic material that allows for firm fixation on the finger while preventing obstruction of the neurovascular bundles; this method has been met with success. To our knowledge, our method has not been previously described in the literature and proved successful in the nonoperative management of a grade IV pulley injury.

Conclusions

Our case report details a unique injury involving multiple flexor pulley ruptures in a Division I collegiate football player. A high index of clinical suspicion and understanding of this injury are paramount to its identification and ultimate treatment goals. We hope that our successful outcome with nonoperative management through splinting and taping techniques will enhance the existing literature and raise awareness of varying treatment options.

References

1. Mall NA, Carlisle JC, Matava MJ, et al. Upper extremity injuries in the National Football League: part I: hand and digital injuries. *Am J Sports Med* 2008;36:1938-44.
2. Doyle JR. Anatomy of the finger flexor tendon sheath and pulley system. *J Hand Surg Am* 1988;13:473-84.
3. Schubert MF, Shah VS, Craig CL, Zeller JL. Varied anatomy of the thumb pulley

- system: implications for successful trigger thumb release. *J Hand Surg Am* 2012;37:2278-85.
4. Doyle JR. Anatomy of the flexor tendon sheath and pulley system: a current review. *J Hand Surg Am* 1989;14:349-51.
5. Schöffl V, Hochholzer T, Winkelmann HP, Strecker W. Pulley injuries in rock climbers. *Wilderness Environ Med* 2003;14:94-100.
6. Schweizer A. Biomechanical properties of the crimp grip position in rock climbers. *J Biomech* 2001;34:217-23.
7. King EA, Lien JR. Flexor Tendon Pulley Injuries in Rock Climbers. *Hand Clin* 2017;33:141-8.
8. Marino JT, Lourie GM. Boutonnière and pulley rupture in elite athletes. *Hand Clin* 2012;28:437-45.
9. Lourie GM, Hamby Z, Raasch WG, et al. Annular flexor pulley injuries in professional baseball pitchers: a case series. *Am J Sports Med* 2011;39:421-4.
10. Lee JH, Kim HS, Joo SH. Isolated A1 Pulley Rupture of Left Fourth Finger in Kendo Players: Two Case Reports. *Ann Rehabil Med* 2015;39:838-43.
11. Schöffl VR, Jüngert J. Closed flexor pulley injuries in nonclimbing activities. *J Hand Surg Am* 2006;31:806-10.
12. Crowley TP. The flexor tendon pulley system and rock climbing. *J Hand Microsurg* 2012;4:25-9.
13. Bollen SR. Upper limb injuries in elite rock climbers. *J R Coll Surg Edinb* 1990;35:S18-20.
14. Logan AJ, Makwana N, Mason G, Dias J. Acute hand and wrist injuries in experienced rock climbers. *Br J Sports Med* 2004;38:545-8.
15. Schweizer A. Biomechanical effectiveness of taping the A2 pulley in rock climbers. *J Hand Surg Br* 2000;25:102-7.
16. Gabl M. The use of a graft from the second extensor compartment to reconstruct the A2 flexor pulley in the long finger. *J Hand Surg Br* 2000;25:98-101.
17. Warme WJ, Brooks D. The effect of circumferential taping on flexor tendon pulley failure in rock climbers. *Am J Sports Med* 2000;28:674-8.
18. Schöffl I, Einwag F, Strecker W, et al. Impact of taping after finger flexor tendon pulley ruptures in rock climbers. *J Appl Biomech* 2007;23:52-62.
19. Schöffl VR, Schöffl I. Injuries to the finger flexor pulley system in rock climbers: current concepts. *J Hand Surg Am* 2006;31:647-54.
20. 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.