Cureus
Part of SPRINGER NATURE

Open Access Technical Report

A Baseball Suture Technique With Single Bone Tunnel and Button Fixation for Flexor Digitorum Profundus Avulsion Repair

Review began 05/25/2026
Review ended 06/14/2026
Published 06/16/2026

© **Copyright** 2026
Papadopoulou et al. This is an open access article distributed under the terms of the Creative Commons Attribution License CC-BY 4.0., which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

DOI: 10.7759/cureus.110953

Zoe K. Papadopoulou [1], Vasilios Raoulis [1], Konstantinos N. Malizos [1], Alexis T. Kermanidis [2], Aristidis H. Zibis [1]

1. Department of Anatomy, Faculty of Medicine, University of Thessaly, Larissa, GRC 2. Department of Mechanical Engineering, School of Engineering, University of Thessaly, Volos, GRC

Corresponding author: Zoe K. Papadopoulou, zoetsa.papadopoulou@gmail.com

Abstract

Flexor digitorum profundus (FDP) avulsion injuries require secure tendon fixation within the limited footprint of the distal phalanx to achieve strong tendon purchase while minimizing tendon trauma, while osseous compromise remains a surgical challenge. We propose a novel surgical technique for FDP avulsion repair using a baseball suture configuration, a single transosseous bone tunnel, and dorsal pullout button fixation. The tendon is secured with a multi-pass baseball suture technique and advanced through a single bone tunnel in the distal phalanx, thereby providing stable fixation while minimizing osseous disruption. A protective interface is interposed beneath the dorsal button to reduce pressure-related complications at the nail apparatus. This approach is designed to improve tendon purchase while reducing tendon penetrations and minimizing osseous disruption. The accompanying images are derived from a cadaveric specimen to enhance visualization of the described technique. This method represents a simple and reproducible option for FDP avulsion repair, offering potential mechanical and practical advantages. Further biomechanical and clinical studies are required to validate its effectiveness.

Categories: Trauma, Anatomy, Orthopedics
Keywords: baseball suture, distal phalanx, fdp avulsion, flexor digitorum profundus, flexor tendon repair, hand surgery, jersey finger, looped suture, pullout button fixation, transosseous tunnel

Introduction

Flexor digitorum profundus (FDP) avulsion injuries are uncommon but functionally significant lesions that require stable reinsertion to restore distal interphalangeal joint flexion [1,2]. Flexor digitorum profundus avulsion injuries, commonly referred to as “jersey finger” injuries, typically occur following forced extension of a flexed distal interphalangeal joint, resulting in avulsion of the tendon from its insertion on the distal phalanx. Because the FDP tendon is the sole flexor of the distal interphalangeal joint, untreated injuries may result in substantial impairment of finger flexion and hand function [1,2]. Several repair methods have been described, including pullout sutures tied over a dorsal button, suture anchors, and transosseous fixation techniques [2-5]. Each method presents specific advantages and limitations related to fixation strength, technical complexity, implant cost, and potential complications involving the nail unit or distal phalanx [4-6].

Secure tendon purchase is a critical determinant of repair reliability, especially in distal tendon avulsion patterns with limited residual tendon length or compromised tissue quality [7]. Looped suture constructs, originally developed for ligament reconstruction, have demonstrated favorable tensile properties and load distribution characteristics. These features may be advantageous in FDP avulsion repair, where secure tendon purchase and resistance to suture pull-through are critical considerations. However, their use in FDP avulsion repair has not been widely emphasized.

We describe a technical modification for FDP avulsion repair using a baseball suture configuration combined with a single transosseous bone tunnel and dorsal pullout button fixation. The tendon is secured with a multi-pass baseball suture construct and advanced through a single tunnel in the distal phalanx, allowing secure fixation while minimizing osseous disruption. A protective interface is interposed beneath the dorsal button to reduce pressure-related trauma to the nail apparatus. This technical report outlines the surgical steps, underlying rationale, and key practical and biomechanical aspects of the described technique.

Technical Report

Surgical technique

The patient is positioned supine with the affected upper limb placed on a hand table in supination. A pneumatic tourniquet is applied to the upper arm and inflated to an appropriate pressure, typically around 250 mmHg in our practice, to provide a bloodless field. Tourniquet pressure should be adjusted according to

patient-specific factors and limb occlusion pressure.

A standard volar approach to the distal phalanx is performed, allowing identification of the FDP tendon and its insertion site. The avulsed tendon is isolated and prepared by debriding nonviable tissue to obtain an appropriate tendon end for repair.

A nonabsorbable No. 2 looped polyester suture mounted on a 75-mm straight needle (Wilsuture®, Péters Surgical, Bobigny, France) is used to secure the tendon with a multi-pass baseball suture configuration (Figure *1*).

Discussion

FDP avulsion injuries remain challenging to manage due to the need for secure tendon fixation within the limited footprint of the distal phalanx [1,2]. Multiple techniques have been described, including pullout button fixation, suture anchors, and transosseous repairs, each with distinct advantages and limitations related to fixation strength, technical complexity, implant cost, and complication profile [2-5].

The technique presented herein combines a baseball suture configuration with a looped, nonabsorbable suture and single transosseous tunnel fixation, aiming to optimize tendon purchase while minimizing local tissue trauma and osseous compromise. The biomechanical rationale presented in this discussion is based on the design characteristics of the construct and established principles of tendon repair. While these concepts were not directly evaluated in the present study, they may help explain the potential behavior of the repair construct and merit further biomechanical investigation.

A key feature of this construct is the use of a looped suture, which allows effective tendon grasp with fewer individual passes through the tendon. By reducing the number of needle penetrations, this approach may reduce cumulative tendon trauma and the risk of suture pull-through, particularly in cases with a short or attenuated distal tendon stump [6,7]. Similarly, fewer tendon penetrations may help preserve tendon integrity and local vascularity while limiting excessive suture bulk within the repair site. Furthermore, the looped configuration may facilitate more uniform load distribution along the repair construct, potentially reducing focal stress concentration and excessive tendon strangulation [6,7,12].

The multi-pass baseball suture configuration provides broad circumferential engagement of tendon fibers and may improve load sharing across the repair construct by distributing forces over a larger tendon surface area. Consequently, this configuration may improve resistance to gap formation while maintaining a balance between secure fixation and avoidance of excessive focal compression of the tendon tissue, which has been associated with compromised vascularity and weakening of tendon tissue [7,12]. However, these proposed biomechanical advantages were not directly evaluated in the present study and require further biomechanical investigation.

The use of a nonabsorbable suture may contribute to construct robustness, as larger-caliber sutures have generally been associated with increased tensile strength and improved resistance to failure. In addition, looped suture constructs have been utilized in procedures requiring high fixation strength, indirectly supporting their potential applicability in tendon repair settings where secure tendon fixation is desired [12].

From an osseous standpoint, the use of a single transosseous tunnel may represent an advantage over techniques requiring multiple drill holes or implant insertion. By limiting bone violation to a single tunnel, the risk of iatrogenic weakening or fracture of the distal phalanx may be reduced, particularly in small or osteopenic bones [3,13]. However, this potential benefit was not specifically evaluated in the present study.

Compared with suture anchor-based techniques, the described method may also offer practical advantages in terms of cost and accessibility, as it relies on commonly available suture material and avoids the need for implants [4,14]. These characteristics may be particularly relevant in resource-limited settings or in situations where implant use is not feasible.

The use of a dorsal pullout button remains a simple and widely used method for distal fixation but carries a known risk of complications involving the nail unit, particularly when the dorsal exit point is improperly positioned relative to the germinal matrix [5]. In the present technique, the transosseous tunnel exits through the nail plate distal to the lunula in an effort to avoid injury to the germinal matrix. In addition, a petrolatum-gauze interface is interposed beneath the button to reduce direct pressure on the dorsal soft tissues and nail apparatus. Although the protective effect of these measures was not formally evaluated, they represent practical modifications intended to minimize nail-related and pressure-related complications.

Limitations

This study has several limitations. As a technical report, the manuscript is intended to describe the surgical

technique and does not include clinical or functional outcome data. In addition, no biomechanical testing was performed to quantify fixation strength, assess gap formation, evaluate cyclic loading performance, or compare the construct with established repair techniques. Tendon gliding characteristics and potential effects on tendon excursion were not evaluated. Furthermore, no assessment of nail-unit complications or other procedure-related clinical outcomes was possible within the scope of this report. The proposed biomechanical and clinical advantages of the technique, therefore, remain to be confirmed. Future studies, including comparative biomechanical testing, cyclic loading analysis, and prospective clinical evaluation, are necessary to further validate the effectiveness and safety of this approach [15,16].

Despite these limitations, the described technique represents a simple and reproducible option for FDP avulsion repair. Its design aims to maximize tendon purchase while minimizing tendon and osseous disruption; however, the proposed biomechanical and clinical advantages of the construct require confirmation through future comparative biomechanical and clinical studies.

Conclusions

The described technique represents a technically feasible and reproducible option for FDP avulsion repair, combining a baseball suture configuration with a looped nonabsorbable suture and single transosseous tunnel fixation. Its design aims to optimize tendon purchase while minimizing tendon and osseous disruption.

The potential biomechanical and clinical advantages of this construct were not directly evaluated in the present study. Further biomechanical and clinical investigations are warranted to validate its effectiveness, safety, and potential role in the management of FDP avulsion injuries.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

Concept and design: Zoe K. Papadopoulou, Vasilios Raoulis, Aristidis H. Zibis

Acquisition, analysis, or interpretation of data: Zoe K. Papadopoulou, Vasilios Raoulis, Konstantinos N. Malizos, Alexis T. Kermanidis, Aristidis H. Zibis

Drafting of the manuscript: Zoe K. Papadopoulou, Aristidis H. Zibis

Critical review of the manuscript for important intellectual content: Vasilios Raoulis, Konstantinos N. Malizos, Alexis T. Kermanidis, Aristidis H. Zibis

Supervision: Aristidis H. Zibis

Disclosures

Human subjects: All authors have confirmed that this study did not involve human participants or tissue. **Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Intellectual property info:** The authors are evaluating potential intellectual property protection related to the described surgical technique. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

References

1. Leddy JP, Packer JW: Avulsion of the profundus tendon insertion in athletes. J Hand Surg Am. 1977, 2:66-69. 10.1016/S0363-5023(77)80012-9
2. Bachoura A, Ferikes AJ, Lubahn JD: A review of mallet finger and jersey finger injuries in the athlete . Curr Rev Musculoskelet Med. 2017, 10:1-9. 10.1007/s12178-017-9395-6
3. McCallister WV, Ambrose HC, Katolik LI, Trumble TE: Comparison of pullout button versus suture anchor for zone I flexor tendon repair. J Hand Surg Am. 2006, 31:246-51. 10.1016/j.jhsa.2005.10.020
4. Tang JB: Flexor tendon injuries. Clin Plast Surg. 2019, 46:295-306. 10.1016/j.cps.2019.02.003
5. Keller N, Guidi M, Tobler-Ammann B, et al.: Pull-out vs. suture in zone Ia-Ib flexor tendon injuries: clinical results from a multicentre cohort study. Handchir Mikrochir Plast Chir. 2024, 56:342-9. 10.1055/a-2217-7944
6. Wu YF, Tang JB: Recent developments in flexor tendon repair techniques and factors influencing strength

of the tendon repair. J Hand Surg Eur Vol. 2014, 39:6-19. 10.1177/1753193413492914

7. Takeuchi N, Mitsuyasu H, Kikuchi K, et al.: The biomechanical assessment of gap formation after flexor tendon repair using partial interlocking cross-stitch peripheral sutures. J Hand Surg Eur Vol. 2011, 36:584-9. 10.1177/1753193411406632
8. Weston M, Henning S, David M: Management of acute open flexor tendon injuries of the hand and wrist: basic sciences, surgical factors and rehabilitation pertinent to optimizing outcome. Orthopaedics and Trauma. 2023, 37:125-133. 10.1016/j.mporth.2023.01.006
9. Lalonde DH, Martin AL: Wide-awake flexor tendon repair and early tendon mobilization in zones 1 and 2 . Hand Clin. 2013, 29:207-13. 10.1016/j.hcl.2013.02.009
10. Strickland JW: Development of flexor tendon surgery: twenty-five years of progress . J Hand Surg Am. 2000, 25:214-35. 10.1053/jhsu.2000.jhsu25a0214
11. Starr HM, Snoddy M, Hammond KE, Seiler JG 3rd: Flexor tendon repair rehabilitation protocols: a systematic review. J Hand Surg Am. 2013, 38:1712-7.e1-14. 10.1016/j.jhsa.2013.06.025
12. Osei DA, Stepan JG, Calfee RP, et al.: The effect of suture caliber and number of core suture strands on zone II flexor tendon repair: a study in human cadavers. J Hand Surg Am. 2014, 39:262-8. 10.1016/j.jhsa.2013.11.001
13. Boyer MI, Ditsios K, Gelberman RH, et al.: Repair of flexor digitorum profundus tendon avulsions from bone: an ex vivo biomechanical analysis. J Hand Surg Am. 2002, 27:594-8. 10.1053/jhsu.2002.33708
14. Dy CJ, Hernandez-Soria A, Ma Y, et al.: Complications after flexor tendon repair: a systematic review and meta-analysis. J Hand Surg Am. 2012, 37:543-551.e1. 10.1016/j.jhsa.2011.11.006
15. Higgins A, Lalonde DH, Bell M, et al.: Avoiding flexor tendon repair rupture with intraoperative total active movement examination. Plast Reconstr Surg. 2010, 126:941-5. 10.1097/PRS.0b013e3181e60489
16. Thomopoulos S, Parks WC, Rifkin DB, Derwin KA: Mechanisms of tendon injury and repair . J Orthop Res. 2015, 33:832-9. 10.1002/jor.22806