RESEARCH ARTICLE

A Novel Transosseous Suture Repair Technique for Inferior Pole Patella Fractures Using a Suture Anchor: A Case Series and Technical Note

Duy Nguyen Anh Tran, MD, MSc; Yen-Wei Huang, MD, PhD; Yi-Jie Kuo, MD, PhD; Tan Thanh Nguyen, MD, PhD; Shun-Jen Cheng, BSN; Yu-Pin Chen, MD, PhD

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Abstract

Objectives: Fractures located at the inferior pole of the patella pose challenges in terms of fracture fixation, primarily due to inadequate bone quality at the lower pole and typically limited options for secure fixation. This study introduces a novel approach that involves employing the Krackow suture technique on the patellar tendon, followed by a longitudinal transosseous and upside-down fixation at the superior aspect of the patella using a suture anchor to address this challenge.

Methods: A retrospective cohort case series was conducted at a single center, involving ten patients with fractures at the lower pole of the patella. Follow-up assessments were performed for a minimum of six months to observe postoperative gap formation and evaluate bony union. Knee motion, pain, function, and any intra- and postoperative complications were documented throughout the follow-up periods.

Results: All patients exhibited complete bone union without gap formation six months postoperatively, accompanied by a regained full range of motion without any functional limitations. No instances of postoperative anterior knee pain, refracture of the inferior patellar pole, or other complications were reported during the follow-up period.

Conclusion: The innovative technique involving longitudinal transosseous and upside-down suture anchor repair for the management of inferior patellar pole fractures is a straightforward and easily executable surgical procedure. This method offers stable fixation and yields favorable functional outcomes.

Level of evidence: IV

Keywords: Anchor suture, Fixation, Krackow suture technique, Patellar inferior pole fracture, Transosseous suture

Introduction

The patella, a small, flat, triangular bone situated in front of the knee joint, serves a crucial role in knee function by safeguarding the joint and aiding thigh muscle leverage. Patellar fractures account for about 1% of all human bone fractures, with 15.0–17.4% categorized as inferior pole fractures.[1-3]

Fractures of the inferior pole of the patella are uncommon and can result from various causes, such as direct knee trauma or sudden forceful contractions of the quadriceps muscle. Due to the majority of fractures occurring at the lower part of the patella being fragmented, achieving accurate anatomical alignment and secure fixation poses a significant challenge. Presently, two primary surgical techniques exist for addressing inferior pole fractures.[4] The first method involves removing the fragmented lower section of the patella and reconstructing the connection point of the patellar ligament using a suture anchor (SA) or drilled hole. However, fragment removal and reduction in patella length lead to increased patellofemoral pressure[5] and unfavorable functional outcomes.[6] The second method commonly preserves fragmented fractures through various means, including patella plates,[7-9] concentrators,[10] tension band wiring,[11] SA,[12] and transosseous reattachment.[13,14] Flexible immobilization methods utilizing sutures often result in post-surgery fracture displacement, necessitating prolonged patient immobilization. On the other hand, rigid

Corresponding Author: Yu-Pin Chen, Department of Orthopedics, Wan Fang Hospital, Taipei Medical University, Taipei, Taiwan/ Department of Orthopedics, School of Medicine, College of Medicine, Taipei Medical University, Taipei, Taiwan

Email: 99231@w.tmu.edu.tw

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fixation methods, while stable and aiding early patient mobilization, can lead to complications such as implant failure, fragment displacement, or soft-tissue irritation due to prominent hardware, often requiring reoperation for implant removal.[4]

The use of the SA method has gained prominence within orthopedic practice over the last decade, especially in managing fractures located at the lower pole of the kneecap. While this method has shown effectiveness, instances of failure due to suture-anchor interface breakage or anchor dislodgment have been reported.[15-17] Furthermore, the rising prevalence of osteoporosis complicates the selection of suitable bone fixation techniques.[15,18,19]

To address these concerns, we propose a modified technique involving utilizing the Krackow suture technique on the patellar tendon, followed by a longitudinal transosseous and upside-down fixation at the superior aspect of the patella using a suture anchor to address this challenge [Figure 1]. The study aims to evaluate postoperative gap formation in fractures and bone healing outcomes after six months.

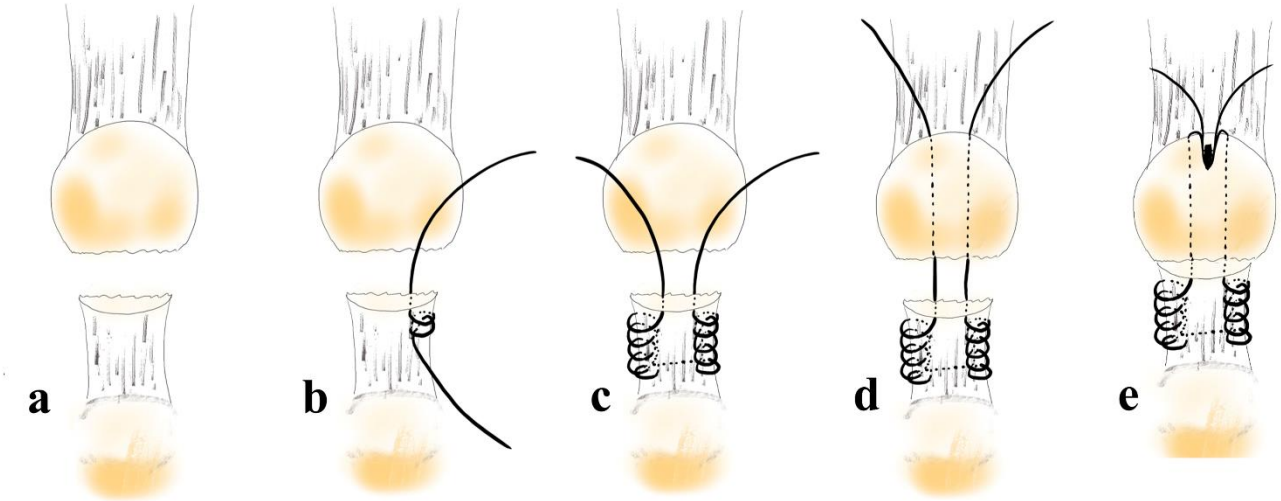

Figure 1. Illustration of our novel method for treating infrapatellar pole fractures (a). The Krackow suture method will be applied to the patella's tendon (b, c), followed by threading the sutures through two pre-created longitudinal transosseous tunnels of the body patella (d) and fixing by an anchor at the top of the patella (e)

Materials and Methods

A single-center prospective case series at a single medical center was performed from February 2021 until July 2023. In this research, all participants diagnosed with unilateral patellar fractures classified as AO/OTA type 34A1 were enrolled,[20] ensuring a follow-up duration of a minimum of 6 months. The exclusion criteria were strictly defined, specifically: (i) exclusion of cases involving an open fracture and (ii) individuals with a history of previous patellar surgery.

The study focused on monitoring gap formation by radiography, range of motion (ROM), and functional assessment using Bostman's scoring after employing a modified anchor suture technique for treating inferior pole patella fractures. Additionally, bone union was evaluated six months post-surgery. Bostman's score was applied to assess knee function across eight aspects: ROM (patient's total flexion), pain, work, atrophy, giving way, walking, and stair-climbing. Results were classified as excellent (30-28), good (27-20), or unsatisfactory (poor) if the total score was below 20.[21] Data were collected from a single institution and analyzed by descriptive statistics.

The study complied with the code of ethics of the World Medical Association (Declaration of Helsinki) and was approved by the Ethics Committee.

Surgical technique

We follow the technique described by author Gao Z, employing the Krackow suture method at the patellar tendon and threading the sutures through two pre-created longitudinal transosseous tunnels of the patella.[13] However, unlike Gao's technique, after passing the sutures to the superior aspect of the patella, we secured the sutures using an anchor (SwiveLock®) placed between the two tunnels [Figure 1].

In the course of the operation, the patient was positioned in a supine posture and administered anesthesia. Following meticulous sterilization and draping procedures, a povidone-iodine film was applied. Subsequently, a sterile longitudinal incision was made at the midpoint of the patella, extending seamlessly from the superior pole to the patellar tendon [Figure 2a]. We employed the suture technique outlined by Krackow in 1986[22] for the patellar tendon, placing the two suture ends on the lower pole fracture surface as depicted in [Figure 2b-d]. Subsequently, we fashioned two longitudinal patellar tunnels using 1.8 mm K-wires aligned with the suture tips [Figure 2e-f]. Bone retainers were employed to secure the fracture temporarily.

Following this, the two thread ends were affixed to the anchor, generating maximum tension and securing the anchor to the upper pole between the two tunnels [Figure 2g-h]. Ultimately, additional stitches were introduced to fortify the fracture [Figure 2i].

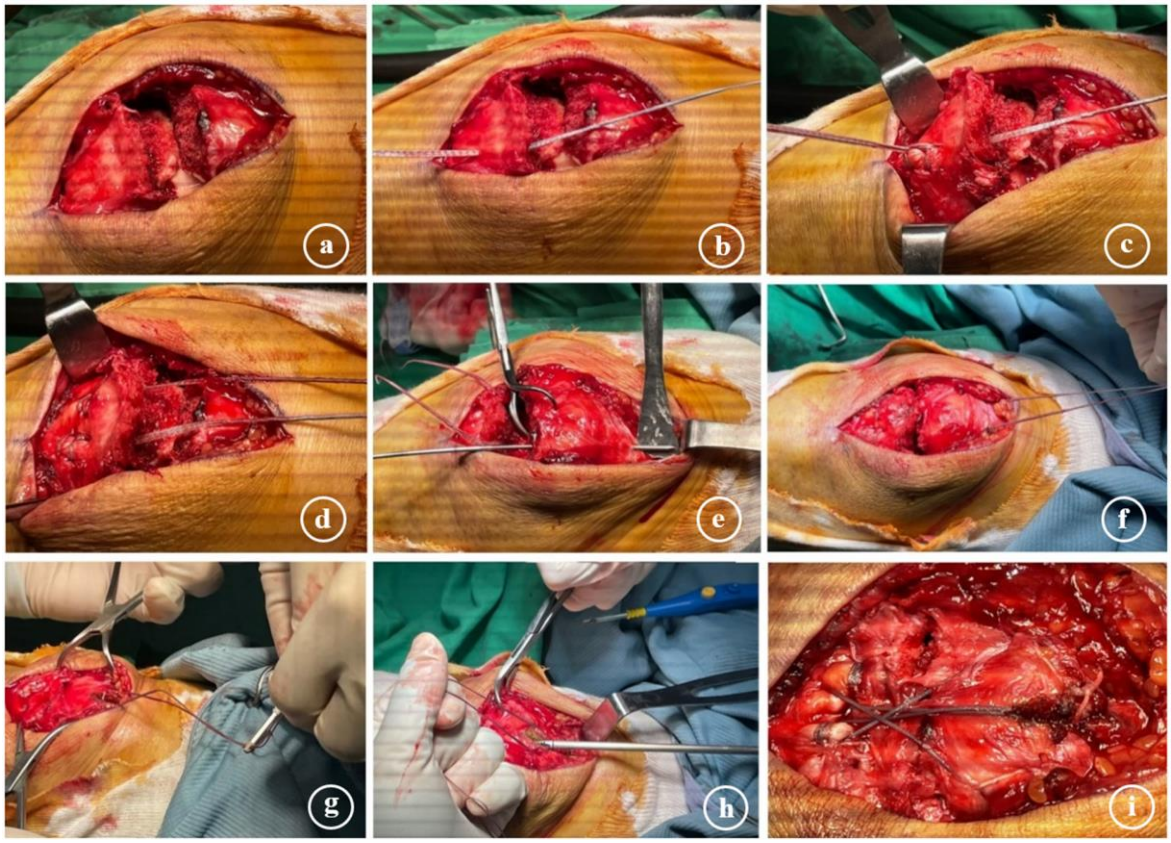

Figure 2. Distal patella pole fracture (a); The Krackow suture technique at patella tendon (b-d); Using K wire to create two longitudinal transosseous tunnels (e); Threading the two sutures through the tunnels (f); Tying down the sutures by an anchor at the superior aspect of the patella (g-h); Reinforcing sutures (i)

Post-operation

Following the recommendations from AO and other authors, we have developed a program for post-operative care and rehabilitation for patients.[4,23-25] After the surgery, a hinged knee brace was utilized to immobilize the knee for a duration of 6 weeks. Subsequent to the surgical procedure, patients were given the approval to commence muscle-strengthening exercises. Partial weight-bearing was initiated 2–3 weeks post-surgery, gradually progressing to full weight-bearing between 4–6 weeks. The range of knee flexion motion was systematically expanded, with active knee flexion stages commencing at 30° two weeks postoperatively, advancing to 60° in 3 weeks, followed by 90° in 4 weeks, and ultimately reaching 120° in 5 weeks. Following the establishment of post-operative weight-bearing, the knee brace could be removed, and patients were actively encouraged to achieve a complete range of motion for the knee. All the patients received regular follow up. X-rays are scheduled at specific intervals immediately after the operation (day 0), as well as at the 1-month, 3-month, and 6-month marks [Figure 3].

Results

Ten patients with a median age of 59.4 ± 10.6 years (range 39-72) were enrolled in this study, and the median follow-up period was 10 ± 2.3 months. We noted the average operative time was 44.8 ± 4.7 minutes. All patients demonstrated bone union at the final follow-up, confirmed both clinically and radiographically. By radiography, no gap formation at the fracture site was observed in any patient during follow-up assessments. Furthermore, by the end of the follow-up period, all patients had regained full ROM of the knee joint without any functional limitations. At the latest follow-up, the patients achieved a mean knee ROM of 131.0° ± 6.1° (range: 120°–140°) and a mean Bostman score of 27.9 ± 1.5 (range: 25–30), with seven patients receiving an excellent score and three patients receiving a good score. No complications were observed in any patient at the latest follow-up. A summary of the characteristics of patient information is presented in [Table 1].

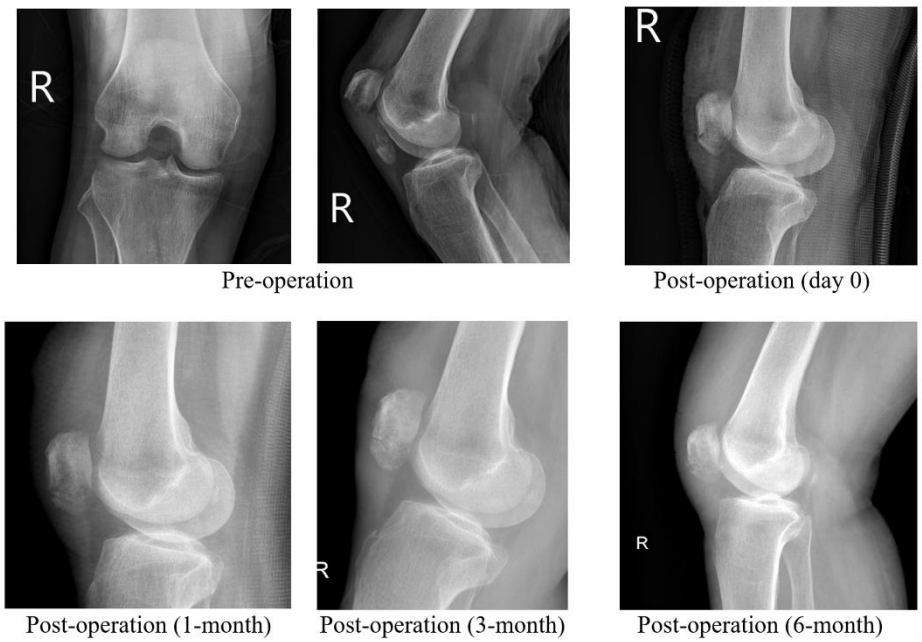

Figure 3. A 68-year-old female patient received a diagnosis of an inferior pole patellar fracture and was slated for surgery involving our modified anchor suture technique. The follow-up radiographs after the operation revealed no gap formation at the fracture site and bone union after six months

Table 1. Clinical and demographic characteristics of patients

Case	Age (years)	Gender	Surgical time (minutes)	Follow-up (months)	Bostman score	Knee ROM (°)	Fracture gap formation	Union
1	39	Female	45	12	29	135	No	Yes
2	57	Female	50	10	27	125	No	Yes
3	58	Female	43	12	28	140	No	Yes
4	65	Male	39	9	30	130	No	Yes
5	68	Female	46	12	29	135	No	Yes
6	72	Female	53	7	26	125	No	Yes
7	70	Female	41	13	28	135	No	Yes
8	59	Male	49	10	28	130	No	Yes
9	61	Female	42	9	29	135	No	Yes
10	45	Female	40	6	25	120	No	Yes

Discussion

The management of distal pole patella fractures presents a considerable challenge in the realm of treatment. Various methods and implants have been employed to achieve optimal outcomes thanks to advancements in science and technology. A recent systemic review study of 42 studies focusing on the distal pole patella fractures revealed that the majority of approaches, including plates, suture anchors, and transosseous reattachment, consistently yielded favorable postoperative functional results with minimal complications, except the patellotibial wire. Moreover, the authors highlighted several noteworthy observations, including more than half of the patients necessitated additional surgical interventions for implant removal, fragments should not removed, and the contemporary trend involves combining multiple surgical techniques.[4]

Our technique combines methods including Krackow suture on the patellar tendon, longitudinal transosseous, and fixation by an anchor on the top of the patella. This technique is a modification of the SA method with two anchors attached to the fracture surface in the body of the patella. Several clinical studies have demonstrated the effectiveness of the SA method compared to other methods in distal pole patellar fractures. In comparison with wiring, Part YG et al. (2022) and Xie J et al. (2021) concluded that SA has better clinical results and fewer complications than tension band wiring.[25,26] Another clinical study comparing SA and transosseous sutures showed similarly satisfactory clinical outcomes, but SA had a shorter operation time and a smaller incision length.[24] Furthermore, biomechanical studies have shown that SA yields significantly better biomechanical

results than repair with commonly applied transosseous sutures.[16,17,27] Nevertheless, these above studies pointed out that SA has the risks of suture failure at the anchor eyelet or pulling the anchors out of the bone,[16,17,27,28] especially in cases of osteoporosis.[15] To overcome this drawback, we relocated the anchor to the superior patellar pole. In addition, unlike the traditional method, we found that just one anchor can ensure an excellent fixation effect. Consequently, we are able to minimize surgery time and decrease patient treatment costs, addressing another drawback of the traditional SA technique.[24]

Several recent studies have reported significant advancements in rigid implants for distal pole patella fractures. Four studies were conducted by Gu H, Du B, Li M, and Ma XY in 2022 and 2023, respectively, with patient sample sizes ranging from 16 to 49, demonstrating positive outcomes in terms of function and bone healing.[8,9,29,30] However, these studies had longer average surgical times than ours, ranging from 62.2 to 76.2 minutes. Regarding postoperative complications, B. Du documented a single case of soft-tissue irritation caused by an implant needing removal within one year.[30] Ma's study reported one instance of poor incision healing in an 86-year-old male with diabetes mellitus,[8] while Gu's study revealed that one Gustillo I open fracture patient developed acute cellulitis.[9] Additionally, another author conducted a study involving concentrators on a sample size of 94 patients and showed favorable outcomes with an average operation time of around 48 minutes.[10] However, this study reported several complications, including one case of internal fixation loss, one case of marginal wound necrosis, and two cases of established hematoma. A retrospective study by Shea GK in 2019 on surgically treated inferior pole patellar fractures found that suture repair had lower rates of soft tissue irritation and reoperation than metal fixation.[31] Other authors noted a reoperation rate for the removal of metal implants at approximately 50%.[4,32]

To address the issue of soft tissue irritation associated with implants during surgery for distal pole patella fractures more effectively while minimizing device-related complications requiring additional surgery for implant removals, we have implemented a technique involving passing the sutures through through the transosseous tunnel and fixing it with a single anchor. This technique limits the contact area and force of the implant on surrounding soft tissue and is expected to reduce the incidence of soft tissue irritation. In our initial cases, we opted for larger incisions; however, as we become more proficient in this technique, we intend to adopt a minimally invasive approach to minimize treatment complications and enhance patient aesthetic outcomes.

Our study is subject to certain limitations, including small sample sizes, absence of comparisons with other techniques, and short-term follow-up. Moreover, there has been a lack of biomechanical research conducted on this novel fixation technology. We acknowledge these deficiencies and anticipate addressing them through comprehensive follow-up research in the future.

Conclusion

In summary, preliminary findings indicate that this technique offers excellent fixation and ensures optimal functional recovery and bone healing outcomes with no complications. Despite the limitations, this technique appears to be a promising option for distal pole patellar fractures. Our commitment lies in conducting a more comprehensive study to evaluate the efficacy and potential of this technique thoroughly.

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Declaration of Informed Consent: All participants consented to their inclusion in the study and the publication of data in an unidentifiable form. The publication of identifiable images or information is not applicable.

Duy Nguyen Anh Tran MD, MSc [1,2]
Yen-Wei Huang MD, PhD [3]
Yi-Jie Kuo MD, PhD [3,4]
Tan Thanh Nguyen MD, PhD [2]
Shun-Jen Cheng , BSN [3]
Yu-Pin Chen MD, PhD [3,4]

1 The International Ph.D. Program in Medicine, College of Medicine, Taipei Medical University, Taipei, Taiwan
2 Department of Orthopedics, Faculty of Medicine, Can Tho University of Medicine and Pharmacy, Can Tho, Vietnam
3 Department of Orthopedics, Wan Fang Hospital, Taipei Medical University, Taipei, Taiwan
4 Department of Orthopedics, School of Medicine, College of Medicine, Taipei Medical University, Taipei, Taiwan

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