Patellar fracture fixation using cannulated screws and Fiber Wire tension band

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Purpose
This study aims to evaluate the results of patellar fracture fixation using cannulated screws and FiberWire tension band.
Patients and methods
A prospective study was held in Benha University Hospital that included 30 patients with transverse patellar fractures fixed with cannulated screws with FiberWire tension band. All of the patients were followed up for a minimum period of 12 weeks, and the maximum period of follow-up was 24 weeks. Postoperatively, these patients were assessed clinically by the Levack's score. Fracture union was confirmed radiologically. All patients were evaluated and assessed using the questionnaires at 3 and 6 months after surgery. Subjective evaluation consisted of recording pain using (visual analog scale), with categorization of pain into five levels: none, mild, moderate, severe, and unbearable.
Results
The mean age of the studied patients was 32 ± 9 years, and there was a male predominance (70%). More than half of the patients had right-sided affection (56.7%). The mechanisms of injury were direct (30%), falling (46.6%), or road traffic accidents (RTA) (23.3%). The affected side was the right side in 56.7% and the left side in 43.3%. The median time from injury was 3 days, and it ranged from 1 to 6 days. The mean time of surgery was 41 ± 18 min. All patients showed radiological union at 8 weeks, passive range of motion (ROM) at 4 weeks, active ROM at 6 weeks, start of weight-bearing as tolerated within brace at 4 weeks, and start of weight-bearing and ROM without restrictions at 8 weeks. At the final follow-up at 3 months, the median total Levack's score was 12, and it ranged from 9 to 12. At 6 months, the median was 12, and the range significantly increased (11–12) (P<0.001). The reported complications were skin infection (13.3%), stiffness (6.7%), and mild pain (53.3%).
Conclusion
The use of cannulated screws with FiberWire tension band technique is a successful efficient treatment of transverse patellar fractures.

Keywords:
FiberWire tension band, cannulated screws, patellar fractures

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Introduction

Patellar fractures constitute only 1% of all injuries of the human skeleton, and only approximately one-third require surgical interventions. Most fractures occur between the ages of 30 and 60 years. Surgical intervention becomes necessary either when the fracture gap exceeds 2–3 mm or in case of joint incongruence or if failed extensor mechanism [1].

Fractures of the patella may result from either direct or indirect mechanisms [2].

As the patella is an essential component of a fully functional knee. The overall underlying surgical treatment is to anatomically reduce the articulating surfaces while subsequently stabilizing it. Reconstruction of the extensor function and early mobilization also constitute the key objectives in surgical intervention [3–5].

The principle of the tension band technique is to convert the tension forces acting on the anterior surface into compression forces at the articular surface [6,7].

Combining interfragmentary screw fixation with the tension band principle appears to provide improved stability over the modified tension band or screws alone for transverse patella fractures. Cannulated

screws allow simple and reliable addition of a tension band to screw fixation [8].

Symptomatic hardware is a frequent complication following open reduction and often requires reoperation for hardware removal. Loss of reduction and nonunion are also known complications contributing to high reoperation rates. Owing to these historical complications associated with metal wiring, techniques using alternative materials such as braided synthetic suture have been described. In this article, we describe a technique for patella fracture fixation using cannulated compression screws with synthetic high-strength nonabsorbable sutures functioning as the tension band (FiberWire Cerclage System) [1].

Patients and methods

A prospective study was held in Benha University Hospital including 30 patients with transverse patellar fractures fixed with cannulated screws with FiberWire tension band. A written consent was obtained, and the patients were informed about the surgical procedure. All the patients were followed up for a minimum period of 12 weeks, and the maximum period of follow-up was 24 weeks. Postoperatively, these patients were assessed clinically by the Levack's score. Fracture union was confirmed radiologically.

Inclusion criteria were failed extensor mechanism (patient not able to lift leg straight), articular displacement more than 2 mm or interfragmentary displacement more than 3 mm [7,8], transverse patellar fractures, intraarticular fractures, closed fractures, and open fractures grades I, II, and III with no contamination. Exclusion criteria included old, neglected fractures with patellofemoral osteoarthritic changes, concomitant knee injuries, delayed union or nonunited fractures, open contaminated fractures, and patients who are medically unfit for operations. All ethical considerations and data analysis were approved by ethical committee in faculty of medicine, benha university, all patients included in this paper were informed about the surgical technique, follow up and their inclusion in this research in a written consent.

The mean age of the studied patients was 32 ± 9 years, and there was a male predominance (70%). More than half of the patients had right-sided affection (56.7%). The mechanisms of injury were direct (30%), falling (46.6%), or RTA (23.3%).

Preoperative assessments

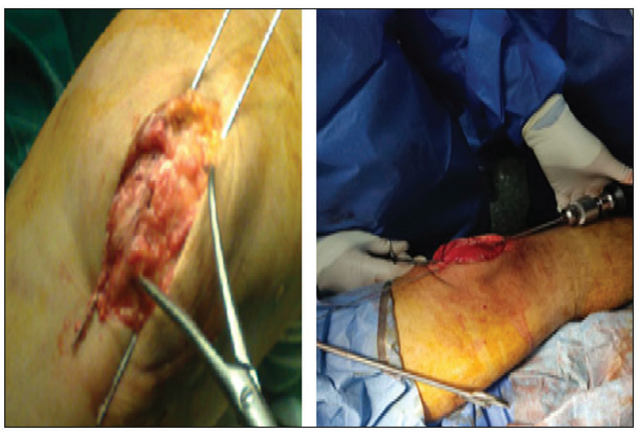
A complete knee assessment, including history and physical examination, was performed in all patients. Patient history included identifying the mechanism of injury. Knee examination was performed as tolerated by pain, which included inspection and testing of the extensor mechanism in the form of straight leg raising. The fractured limb was splinted in an above-knee posterior slab. All patients were admitted in the hospital till time of surgery. Standard radiography in anteroposterior (AP) and lateral views of knee were performed. Moreover, computed tomography scans in axial, coronal, sagittal, and three-dimensional films were taken. One dose of preoperative antibiotics (ceftriaxone) 1 g intravenously was given to all patients within 30 min before induction of anesthesia.

Clinical findings were evaluated using the Levack's score in terms of discomfort, impairment of movement, quadriceps muscle power, and subjective functional evaluation. Radiographic evaluation included true AP and axillary views of the shoulder, and an MRI of the shoulder was done. All patients were evaluated and assessed using the questionnaires at 3 and 6 months after surgery. Subjective evaluation consisted of recording pain using the visual analog scale with categorization of pain to five levels: none, mild, moderate, severe, and unbearable.

Operative technique

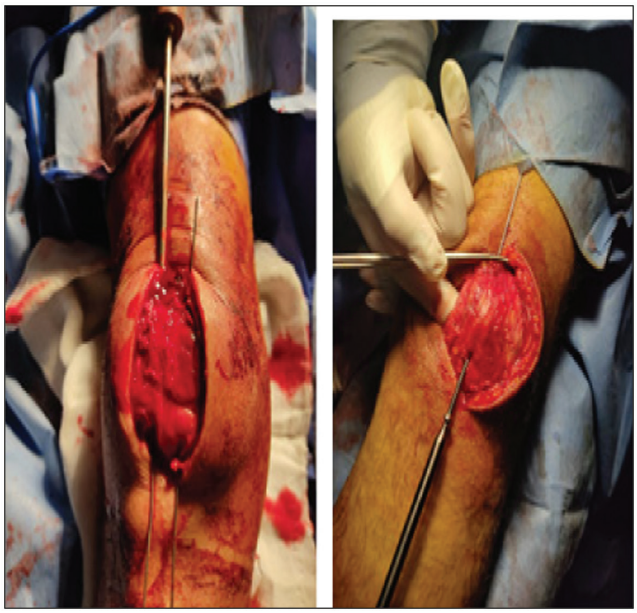
All patients received preoperative antibiotic prophylaxis within 30 min before the beginning of the procedure. Spinal anesthesia was used in all the patients with supine position. A cushion was used under the ipsilateral hip to avoid external rotation of the leg. An anterior longitudinal midline skin incision over the patella was used which can be extended proximally and distally if needed. Evacuation of the fracture hematoma and irrigation of the knee joint were done. Reduction was done using reduction forceps (Fig. 1).

Figure 1



Reduction by reduction clamp and inserting two guide wires.

Figure 2



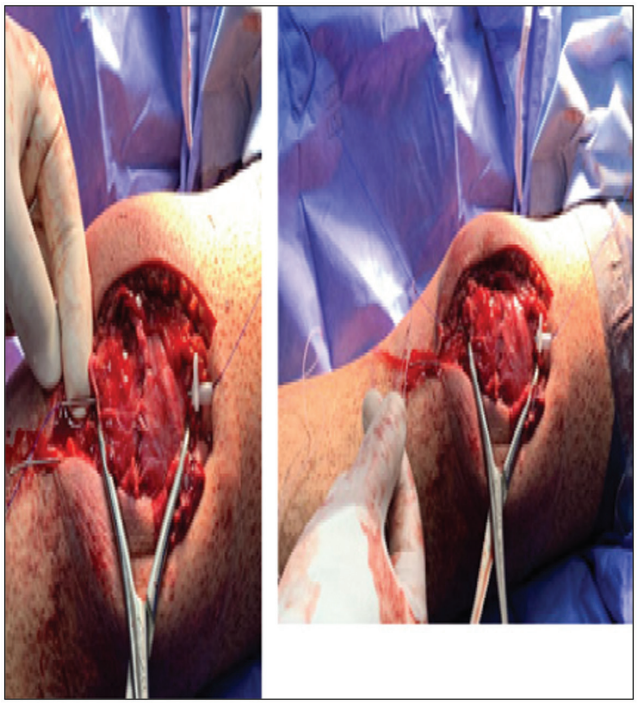
Inserting two partially threaded cannulated screws.

Anatomical reduction of the articular surface was checked by digital palpation of the patellar articular surface inside the knee through arthrotomy incision and rechecked by fluoroscopy. Two parallel threaded guide pins were placed within the patella (Fig. 1). Drilling the fracture fragments over the guide pins was done only for the near cortex. Screws lengths were measured. Two 4.0 mm cannulated partially threaded screws were inserted over the guide pins to achieve interfragmentary compression (Fig. 2). FiberWire 5 mm was passed in a figure of eight through the two screws using a wide-bore cannula, and prolene sutures were passed through the cannulated screws then attached to the FiberWire to guide it through the cannulation of the screws (Fig. 3). All threads of the screws passed the fracture site to achieve lag compression effect but not crossing the far cortex to avoid breakage of the FiberWire over the sharp edge of the screw (Fig. 4). The FiberWire was tensioned in figure of eight and tightened by twisting both limbs of the wire simultaneously, then knotted securely (Fig. 5). Final fluoroscopy image in AP/lateral views of patella was checked. Stability was tested by placing the knee from full extension to 90° flexion and checking the patellar tracking. Repairing of medial and lateral retinacula with 0-vicryl was done. Closure of the wound was performed in layers, with the subcutaneous tissue with 2-0 vicryl, and finally, skin closure with 2-0 vicryl, followed by sterile dressing. All of the patients were put in a knee brace.

Postoperative rehabilitation

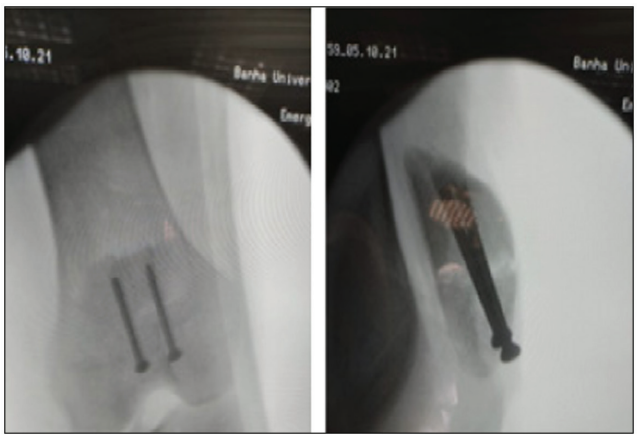
Postoperative dose of the antibiotic (ceftriaxone) was given after 12 h postoperatively. Analgesics and

Figure 3



Passing the prolene suture followed by the FiberWire suture.

Figure 4



Checking the reduction by fluoroscopy.

antiedematous medications were prescribed also for all patients. Anticoagulant dose (rivaroxaban 10 mg tablet) was given once daily after 12 h postoperatively for 4 weeks. Check radiograph were obtained to assess the reduction postoperatively.

Follow-up program

All patients were followed up at Benha University Hospital outpatient clinic every 2 weeks following hospital discharge. Serial radiographs in two planes (AP and lateral views) were obtained at each visit to ensure maintenance of anatomical reduction and provide basis for the evaluation union.

Figure 5

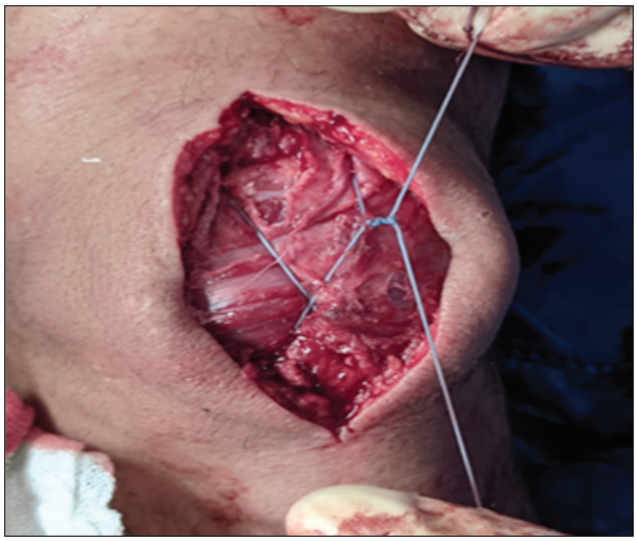


Figure-of-eight tensioning of FiberWire.

The stitches were removed after 2 weeks and the cast was removed after 4 weeks. All patients were advised not to weight bear in the first 4 weeks postoperatively.

At 3 weeks, gentle range-of-motion (ROM) exercises were started gradually and started weight bearing as tolerated in a knee brace locked in extension with crutches if needed.

At 6 weeks, patients were allowed for active ROM and continued weight bearing as tolerated.

At 8 weeks, patients achieved full active ROM and full weight bearing without crutches.

Late follow-up

All patients were evaluated and assessed using the questionnaires at 3 and 6 months after surgery. Subjective evaluation consisted of recording pain using the visual analog scale, with categorization of pain into five levels: none, mild, moderate, severe, and unbearable.

Results

Patient demographic data

The studied group was composed of 21 men and nine women. The mean age at the time of surgery was 32 ± 9 years. More than half of the patients had right-sided affection (56.7%).

Injury characteristics

The mechanisms of injury were direct (30%), falling down (46.6%), or RTA (23.3%).

Time to surgery and surgery duration

The median time from injury was 3 days, and it ranged from 1 to 6 days. The mean time of surgery was 41 ± 18 min.

Outcome

All patients showed radiological union at 8 weeks, passive ROM at 4 weeks, active ROM at 6 weeks, start of weight bearing as tolerated within brace at 4 weeks, and start of weight bearing and ROM without restrictions at 8 weeks

Complications

The reported complications were skin infection (13.3%), stiffness (6.7%), and mild pain (53.3%).

Visual analog score at 6 months

Overall, 46.7% of patients had no residual pain at the sixth month of follow-up, whereas 53.3% had mild pain with functional limitations.

Levack's score

At 3 months, the median total Levack's score was 12, and it ranged from 9 to 12. At 6 months, the median was 12, and the range significantly increased (11–12) (P<0.001).

Discussion

Patellar fractures are relatively uncommon, accounting for 1% of all skeletal injuries. Many patellar fractures, especially transverse fractures, are associated with complete disruption of the extensor mechanism. The objectives of operative treatment are anatomic reduction of the articular surface and restoration of the extensor mechanism while preserving the patella. Internal fixation is used to maintain reduction until the fracture is healed. Early ROM of the knee will reduce the incidence of postoperative knee stiffness and shorten the disability after patellar fractures. Several different techniques of internal fixation have been employed. Cerclage wiring or wires placed through drill holes were the most commonly used techniques until the introduction of the tension band wiring method by the AO group.

Clinically, it can be difficult to secure the tension band wire directly down against the patella, allowing the fragments to slip apart with quadriceps contraction. In addition, patient reports of skin irritation from prominent hardware are very common postoperatively [2]. Some surgeons have used interfragmentary screws to prevent the fracture from sliding apart and to decrease the frequency of hardware irritation to the surrounding soft tissues. Others have recommended using a tension band in combination with interfragmentary cannulated screws.

This prospective randomized study reviewed the results of treatment of 30 patients with transverse patellar fractures at Benha University Hospitals by two cannulated screws with FiberWire tension band. Several comparative studies had been done to evaluate different methods of the treatment of patellar fractures with the same results of this study.

Regarding fixation of patella using cannulated screws with tension band wiring, Berg [9] managed 10 patients with displaced transverse patellar fractures with a tensioned anterior figure-of-eight wires placed through parallel cannulated screws. They used the modified hospital specialized surgery knee scoring system. Seven (70%) patients had excellent and good results, whereas three (30%) patients had fair results.

Hatab *et al.* [10] included 20 patients treated by open reduction and internal fixation with figure-of-eight tension band wire through cannulated screws. They used the modified hospital specialized surgery knee scoring system. The final results of the study showed 14 (70%) patients had excellent results, five (25%) good result, one (5%) fair result, and no patient had a poor result. There were high-outcome final results, which support what was concluded in this study.

Chengxue *et al*. [11] included 72 patients who were retrospectively reviewed. Among them, 37 patients were fixed by the modified tension band technique and 35 patients were fixed by the titanium cannulated lag screws. The results were better in the titanium cannulated lag screw group [excellent in 32 (91.4%) patients, good in three (8.6%), and fair and poor in none) than in the modified tension band group [excellent in 21 (56.6%) patients, good in nine (24.5%), fair in six (16.2%), and poor in one (2.7%)]. The previous series were almost similar to this study, which showed higher mean scores (modified hospital specialized surgery knee score) in cannulated screws with tension band wiring than Kirschner wires with tension band wiring.

Regarding fixation of fractured patella using FiberWire tension band, Camarda *et al.* [12] in 2016 performed a retrospective study of 20 patients, where 17 were available for clinical and radiological follow-up (12 men and five women) who were fixed by FiberWire nonabsorbable suture, and a peripatellar circumferential cerclage was performed in a purse-string fashion close to the bone. Average Bostman scores at 3 months postoperatively and final follow-up were 25.2 ± 2 (range: 20–30) and 28.3 ± 1.6 (range: 26–30), respectively. Further, the mean Lysholm score at the final follow-up was 91 ± 5.7 points (range: 83–100 points). All fractures healed (time to union 9.2 ± 2 weeks), and no fixation failure was observed in the group studied. Slight losses of reduction (4 mm) were noted in two patients at 4 weeks postoperatively.

Tian *et al.* [6] retrospectively reviewed 101 patients, where 52 patients were fixed by the modified tension band group and 49 were fixed by the titanium cable-cannulated Screw tension band group. The results were better (P=0.01) in the titanium cable-cannulated screw tension band group [excellent in 45 (91.8%) patients, good in four (8.2%), and fair and poor in none] than in the modified K-wire tension band group [excellent in 36 (69.3%) patients, good in nine (17.3%), fair in four (7.7%), and poor in three (5.7%)].

In this study, one patient lost 10° of terminal flexion of the knee and two patients lost 20° of terminal flexion of the knee but this did not affect patient satisfaction. No patients developed any flexion contracture or extensor lag. Hatab *et al.* [10] reported that no patient had a flexion contracture or an extensor lag. Three patients had loss of terminal flexion, one patient lost 30°, another lost 20°, whereas the last lost 10°. Camarda *et al.* [12] reported that no patient had significant flexion contracture. Average ROM was 131.1 for flexion (range: 120–140) and 0.5 for extension (range: 0–3). No significant ROM differences were noted with the uninjured contralateral knee. Because of noncompliance with the postoperative rehabilitation protocol, one patient presented knee stiffness at 2 months postoperatively that required gentle manipulation under anesthesia.

The previous series were almost similar to this study, which showed no patients had developed any flexion contracture or extensor lag, but patients had loss of terminal flexion of the knee, which improved after condensed physiotherapy sessions.

In this study, the mean age of patients was 32 ± 9 years, which was less than the mean age in Hatab *et al.* [10] (39.25 years), Tian *et al.* [6] (56.6 years), and Berg [9] (63 years). Camarda *et al.* [12] reported that the average patient age at injury was 46.6 years (range: 20–75), and there was no statistically significant relation between age and the final score.

In this study, 21 (70.0%) males and nine (30.0%) females were included. In most studies, males were more than females, as males are more active so they are more liable to trauma. There was no statistically significant relation between sex and final score.

In this study, the mechanisms of injury were direct (30%), falling (46.6%), or RTA (23.3%). Berg [9] had reported three (30%) fractures that occurred from

severe trauma, four (40%) had moderate trauma, and three (30%) had mild trauma. In this study, patients were younger than in the study by Berg [13], where males were more than female and osteoporotic patients were not included, so high-energy trauma was the main mechanism of trauma. Camarda *et al*. [12] reported that the main mechanisms of injury were fall from height on hard ground in 10 (59%) cases and road traffic accidents in the remaining seven (41%).

In this study, none of patients had pain due to irritative symptoms related to hardware. Tian *et al*. [6] reported a large series of 53 patients who were in the modified tension band group, where five patients experienced skin irritation, and 49 were in the titanium cable-cannulated screw tension band group, with no patients had skin irritation. In Chengxue *et al*. [11], five patients treated by tension band wiring were affected by skin irritation due to Kirschner wires prominence and no patients treated by cannulated lag screws had skin irritation. The previous series showed higher irritation with Kirschner wires more than cannulated screws.

In this study, four patients had superficial infection, which improved later on with antibiotics and dressing. Berg [9] and Hatab *et al*. [10] included no infection patients. In this study, the patients who developed just superficial infection were usually old, and all patients were effectively treated by parenteral empirical antibiotic. Camarda *et al*. [12] reported that only one patients in the study required elective FiberWire removal 24 months after surgery. This was performed secondary to a superficial infection, which did not affect the final clinical outcome (ROM: 0–125). Another patient underwent knee arthroscopy in another Institution because of anterior knee pain. No patients referred localized pain deriving from prominent suture knots.

Limitation of the current study include the relative small numbers of patients, the lack of a control group, the short follow-up time, and the wide exclusion criteria. It is recommended that these potential limitations should be taken into account in larger prospective studies that may be conducted in the future with more inclusion criteria.

Conclusion

The cannulated screws with FiberWire tension band technique is a successful efficient treatment of transverse patellar fractures due to the following reasons:

(1) Strong fixation combining the lag effect of the screws and the tension band of FiberWire reforming distractive forces into compressive forces.
(2) No hardware irritation.
(3) No need for secondary operation to remove the hardware unlike other traditional methods that necessitate removal due to irritation of the hardware.
(4) Reproducible.

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Nil.

Conflicts of interest
There are no conflicts of interest.

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