Outcome of Transverse Patella Fractures Fixed with Cannulated Screws and Stainless Steel Tension Band Wiring

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Abstract

Background
However, it is not without drawbacks. The stainless-streel cable-cannulated screw tension band technique, may shorten healing time, decrease complications and provide an early range of knee motion. Herein, the current study evaluates the clinical and radiological outcomes of this surgical modality.
Patients & Methods
This prospective study was conducted on 21 patients (13 males and 8 females) with transverse fracture patella from June 2017 to April 2021. The fixation consisted of two 4.0-mm parallel partially threaded cannulated cancellous screws with a figure-of-eight stainless steel tension band wiring. Follow-up was at least 10 months. Assessment criteria by Lysholm score for knee function, ROM, VAS for pain, fracture reduction, fracture healing time, and complication rates. After 3 postoperative weeks, the slab was removed and immediate rehabilitation was commenced.
Results
The average Lysholm scores were 82.9 ± 4.4, 87.8 ± 5.3, and 92.7 ± 3.6 after 3, 6, and 10 months, respectively. VAS scores for pain were 2.6 ± 3.0, 1.4 ± 2.6, and 0.5 ± 2.3 at 3, 6, and 10-month, respectively. The patients had gained total ROM after 3, 6, and 10 months. The mean fracture healing time was 2.1 months (range, 1.5 - 3.1 months). Two patients experienced skin irritation by wire tails.
Conclusion
The stainless steel cannulated screws and tension band construct provide a good alternative in the treatment of transverse patellar fractures. It could yield stable fixation, low complication rate while providing early mobilization and accelerated rehabilitation.
Level of evidence: Level III

Keywords
Outcome; transverse patella fractures; cannulated screws; tension band wiring.

Introduction

Patellar Fractures are severe injuries that comprise about 1% of all fractures and are popular within the age group of 20–50 years [1]. Transverse fractures, are the commonest type and usually happen through indirect trauma [2].

Selecting the ideal modality for managing patellar fractures represents a serious task [3,4]. Fractures with displacement more than 2 mm or articular step-off can be treated either closed or open with complementary fixation. It is globally accepted that patellar injuries with translation less than 8 mm are the only indications for closed reduction and fixation [5-7].

A tension band accompanied by K-wires used to be the definitive management technique for fracture patella. However, it is not without drawbacks, such as bad reduction, loosening, and skin irritation [1,3]. So the stainless-streel cable-cannulated screw tension band technique could be an alternative fixation method. Depending on the fact that adding the screws to the tension band techniques provides compression all through the motion of the knee and resists the tensile loading force during full extension. This technique shortens the fracture healing time, decreases complications, provides an early range of knee motion [8,9], and decreases skin irritation and implant failure [10].

Formerly published studies have shown that the cancellous screws alone or in combination with tension band wiring provides rigid fixation as long as the fracture is adequately reduced with less than 1-mm displacement [7]. Additionally, Benjamin et al. have revealed that screw fixation is suitable for transverse patellar fractures with adequate bone stock[11]. Furthermore, series by Dargel et al. and Carpenter et al. have reported that screw fixation is more stable and

firm than the modified tension band wiring system [12,13].

Herein, the current study evaluates the clinical and radiological outcome of the cannulated screws and tension band fixation of transverse patellar fractures. Furthermore, it assesses the described technique while providing early mobilization and accelerated rehabilitation.

Patients and methods

This prospective study was conducted on 25 patients with transverse fracture patella from June 2017 to April 2021. The last case was operated upon in May 2020. The surgical fixation consisted of two 4.0-mm parallel partially threaded cannulated screws with a figure-of-eight tension band made using a 1.25-mm stainless steel wire. Four patients were lost to follow-up. So, we had reviewed 21 patients, with AO/OTA 34-C1 fractures in 15 patients and 34-C2 fractures in six. The study included 13 males and 8 females, aged 20 to 69 years (mean, 44 years). Follow-up was at least 10 (range, 10-19) months.

Mechanism of injury included fall to the ground (18 cases) and road traffic accidents (3 cases). Surgical interference was well-thought-out when separation of the articular surface was more than 2 mm or displacement of the fracture parts increased by 3 mm on radiographs. The mean injury-operation interval appeared to be 2 (range, 1-8) days.

Inclusion criteria included; (1) AO/OTA 34-C1 fractures, (2) AO/OTA 34-C2 fractures, (3) either gender and (4) older than 18 years. Exclusion criteria included; (1) associated lower limb fractures, (2) open fractures, and (3) previous or neglected patellar fracture. Assessment criteria included Lysholm score for knee function, ROM, pain score using VAS, fracture reduction, fracture healing time, and complication rates.

Surgical technique

The surgical approach included an anterior longitudinal incision. Then routine dissection and reduction of the fracture were carried out. With a large towel clamp or Spanish clamp and with the aid of image intensifier, two parallel 2.0-mm K-wires 2-cm apart and 5- to 10-mm from the articular surface, were introduced from the inferior to the upper pole of the patella. K-wires penetrated the superior cortex, with their position detected using the image intensifier. The first K-wire was replaced by a guide pin. Drilling with a cannulated bit, followed by measuring the length was carried out. Then a 4.0-mm stainless steel cannulated screw was introduced while compressing the fracture site. The screw head just stopped at the lower patellar cortex, and the tip of the screw was close to or deep-seated within the upper patellar pole. The same technique was applied to the second screw. After removal of the guidewire, a 1.3-mm-diameter stainless steel cable was delivered through the cannulated screws in a figure-of-8 manner. The cable was then tightened anterior to the patella and the extra part was cut off (Fig. 1, 2).

Postoperative protocol

All cases were put in a high above knee slab for 3 weeks with quadriceps femoris exercises soon after the operation but without weight-bearing. After 3 weeks slab was removed, and passive joint flexion and extension exercises were commenced. Then, active joint flexion and extension exercises were started 3 days later. Five weeks after the operation, partial weight-bearing was allowed, and AP and lateral x-rays were gained. At seven postoperative weeks, complete weight-bearing was commenced. The clinical and radiological evaluations were carried out at 1, 2, 3, 6, and 10 postoperative months.

Statistical analysis

Results were analyzed by SPSS® statistical software (SPSS Inc, Chicago, IL, USA). Logistic regression had been applied to detect whether age, sex, fracture type, and mode of trauma had affected the postoperative general results, clinical improvement, implant evaluation, and radiographic outcome. The impact of age, gender, fracture type, the interval between injury and surgery, and health status on Lysholm scores and complications had been studied. The differences were considered to be statistically significant when p values were less than 0.05.

Results

Follow-up

The mean follow-up was 13 (range, 10-17) months. Patients were followed up as follows; at immediate postoperative hospital stay, weekly during the first postoperative month, every two weeks till the end of 3rd month, then every month till the last follow-up.

General results

The mean period between injury and operation was 16 (range, 5-72) hours. The mean operative time was 70 (range, 45-100) min, mean fluoroscopy time was 0.5 (range, 0.25-1) min, and the mean hospital stay was 2 (range, 1-3) days. Tourniquet was applied during surgery, and no patient required blood transfusion postoperatively. No intraoperative complications had occurred.

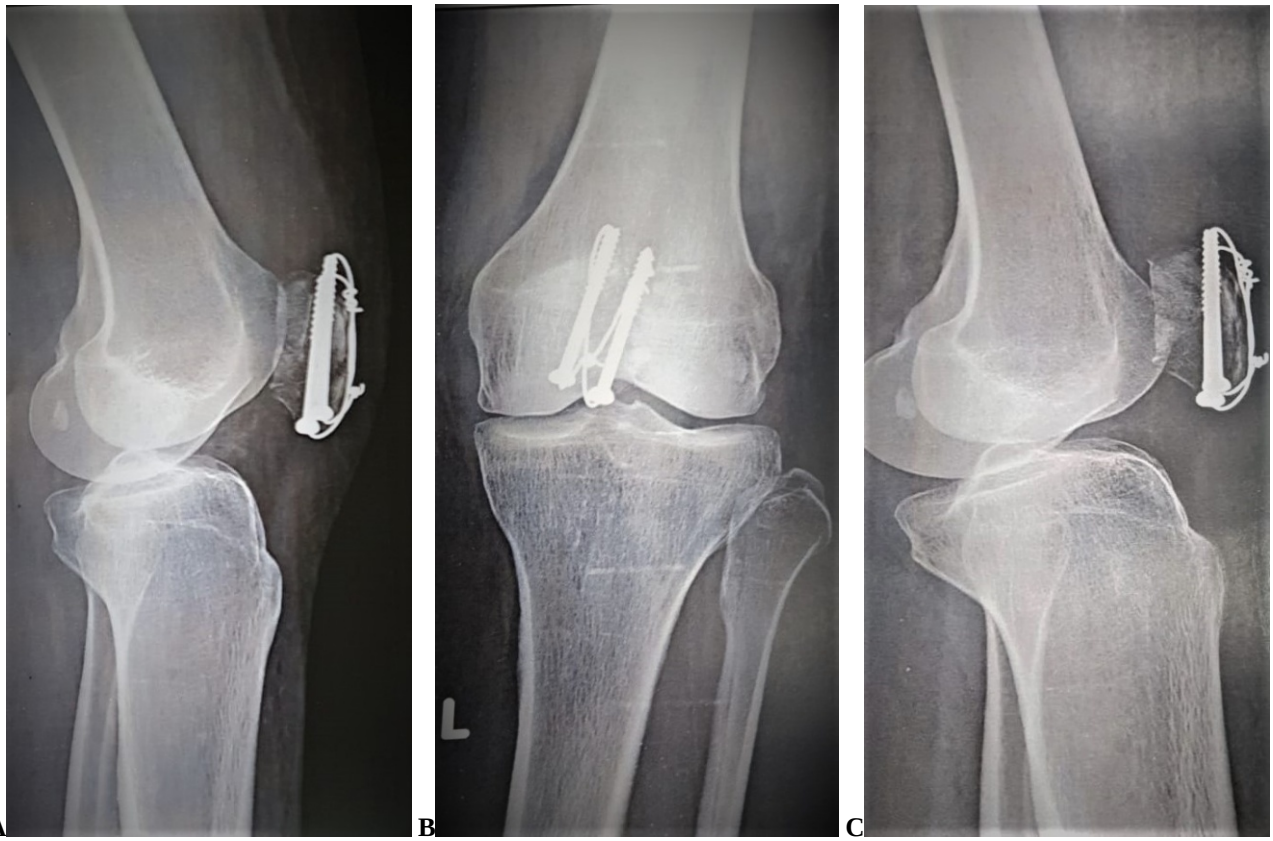

Fig. 1A: One-month postoperative lateral radiograph for a female patient 41 years old (case no. one), with a transverse fracture patella fixed with the technique described. **B:** One-month postoperative AP radiograph of case no. one. **C:** Six-month postoperative lateral radiograph of case no. one.

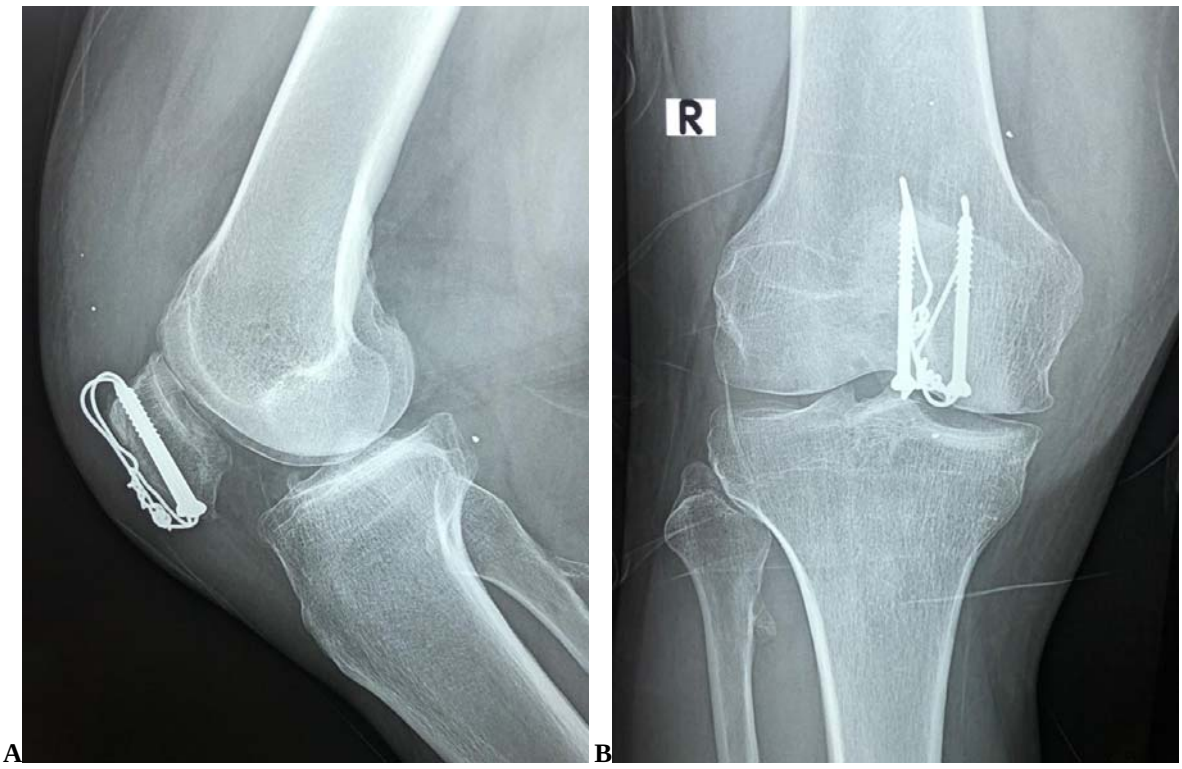

Fig. 2A: Two-month postoperative lateral radiograph for a female patient 50 years old (case no. two), with a transverse fracture patella fixed with the technique described. **B:** Two-month postoperative AP radiograph of case no. two.

Clinical results

The average Lysholm scores were 82.9 ± 4.4, 87.8 ± 5.3, and 92.7 ± 3.6 after 3, 6, and 10 months, respectively. Assessment of Lysholm score subgroups demonstrated that a lower mean difference of pain (25 points) and a lower mean difference of squatting scores (5 points) didn't affect Lysholm scores. Furthermore, there were no differences in Lysholm scores as regards the fracture classification, mechanism of injury, age, or gender (Tables 1, 2).

Table 1: Subgroup analysis showing correlations between different factors and the results.

Factors	*P-value (Variables)*			
	General Results	**Clinical Improvement**	**Implant Evaluation**	**Radiographic Improvement**
Age	0.74**	0.29**	0.44**	0.08**
Gender	0.67**	0.58**	0.48**	0.62**
Fracture type	0.11**	0.24**	0.39**	0.27**
Mechanism of injury	0.34**	0.59**	0.26**	0.54**

* Significant effect. ** Nonsignificant effect

Table 2: The functional outcomes among the study group were measured as regards Lysholm scores and complications, using univariate analysis.

Factors	*P-value (Variables)*	
	Lysholm scores	**Complications**
Age	0.26**	0.07**
Gender	0.06**	0.54**
Fracture Type	0.04**	0.09**
Interval Between Injury and Surgery	0.91**	0.85**
Health Status	0.11**	0.04**

* Significant effect ** Nonsignificant effect

VAS scores for pain were 2.6 ± 3.0, 1.4 ± 2.6, and 0.5 ± 2.3 at 3, 6 , and 10-month, respectively. Most patients had experienced a full flexion and normal range of motion after 3, 6, and 10 months. The average flexion degrees were 109.0 ± 10.5°, 138.3 ± 10.9°, and 140.4 ± 10.3°, after 3, 6 and 10 months respectively. The average total ROM values were 105.0 ± 11.8°, 135.9 ± 10.4°, and 139.1 ± 10.6°, after 3, 6 and 10 months respectively.

The wounds had healed nicely in all patients at a mean time of 4±2 (range, 2-6) weeks. Moreover, there was an improvement of symptoms and signs gradually during the regular follow-up. The knee pain and edema subsided gradually.

Radiological results

The mean fracture healing time was 2.1 months (range, 1.5 - 3.1 months) with adequate fracture reduction. All fractures had healed well, and the mean postoperative articular surface displacement was 0.3 (range, 0–2) mm.

Implants evaluation

Fixation with proper rigidity was accomplished and confirmed with an image intensifier. The two partially threaded cannulated screws with the tension band used for fixation were rigid enough throughout the bone union process in all patients, with no failure had occurred.

Complications

The complications rate was 2/21 (9.5 %). Two patients experienced skin irritation from wire tails, one of the required implant removal at 9 months postoperatively. There was no quadriceps atrophy, loss of ROM, loss of fixation, or patient dissatisfaction with daily activities at the final follow-up.

Discussion

Furthermost patellar fractures are usually managed operatively. The tension band technique accompanied by K-wires used to be the core way for the manage-

ment of such injuries [1,3,4,8]. Numerous investigations have shown that the cancellous screws supplemented with tension band wiring yield constant fixation so long as the fracture is properly reduced [7,15].

Cannulated screw tension band technique was applied for patellar fractures in some studies, to provide proper reduction, direct fracture compression, and earlier ROM [1]. No loss of fixation had occurred among their patients [1]. Similarly, no hardware loosening, nor loss of fixation had been reported in the current study. The possibility of cable-cannulated screw failure is trivial due to the compact cancellous nature of the patellar bone, and the threaded end of the screws used. Furthermore, the cable is firmly tightened adherent to the bone surface to prevent displacement of the patellar fragments acting a tension technique [1].

In the present series, patients were put in a postoperative high above knee slab for 3 weeks, with quadriceps contraction exercises commenced soon after operation without weight-bearing. After 3 weeks, the slab was removed and immediate passive ROM was encouraged to decrease muscular atrophy and intra-articular adhesions. Besides, it may improve the articular cartilage nourishment and fracture healing process.

Tian et al. permitted active range of knee motion a week after the intervention. They allowed partial weight-bearing after 30 days, and their patients were permitted to perform full ambulation after 8 weeks [1].

Bhati et al. encouraged patients to perform isometric knee extension and straight leg raising exercises. Complete weight-bearing was allowed after the removal of the sutures. Knee flexion was permitted to less than 45 degrees in the first week and gradually increased to 90 degrees in the 2nd week. The cases were provided with an exercise chart [16].

Posner et al. patients were put in a 24-hour hinged knee brace which was locked at full extension. Early weight-bearing as endured with the support was started. At the 2-week postoperative visit, traditional physiotherapy consisted of progressive and controlled active knee flexion exercises were commenced. At an 8-week postoperative visit, full ROM and active knee flexion were allowed [17].

Lin et al. didn't apply any external immobilizers to any of their cases. Patients started quadriceps contraction exercises immediately after surgery. Free passive ROM was commenced early after the operation, according to the patient's pain acceptance. Active ROM was permitted at 3-postoperative weeks, and complete weight-bearing was allowed by 8 weeks in their study [7].

Skin irritation remains the foremost drawback of the K-wire tension system. In a few investigations, this had led to hardware removal in nearly 15% of the patients [18,19]. In our study, two patients (9.5 %) experienced skin irritation generated by wire tails and one of the required implant removal at 9 months postoperatively. As regards the cable-cannulated screw system, the cannulated screw tip is firmly close to the patellar cortex, with the screw threads embedded within the bone. Furthermore, the cable is only 1.3 mm in diameter and is tightened onto the patellar surface decreasing the incidence of skin irritation and activity limitation [2].

An article reported that painful hardware was the most common complication which developed in 30.1 % of cases, and tension band loosening and migration was the second main drawback, achieved in 11.5 % of cases [7]. Although painful wire irritation is not a major hazard, it delays rehabilitation and potentially leads to stiffness that may require a second intervention with additional hospitalization and cost [7].

As stated by Baydar et al. [20], cannulated screws are more resistant to distraction forces than tension band techniques to manage patellar injuries. Additionally, the elasticity of K-wires may neutralize a portion of the load that usually acts on the fracture site leading to reduced compressive forces, unlike cannulated screw's tension band fixation [21,22].

A shortcoming of the screws tension band technique involves its technical difficulty [21]. As, it is difficult to properly locate the K-wires with a minimally invasive technique, and it may consume a considerable learning curve [7].

Regrettably, the present series had some limitations, as the small number of patients, the short follow-up duration, and the absence of comparison to the classic technique of tension band system. Another limitation is the stainless steel material used in the study. Although it is cheaper, it is weaker in comparison to the titanium screw's tension band system and interferes with MRI.

Conclusion

The stainless steel cannulated screws and tension band construct provide a good alternative in the treatment of transverse patellar fractures. It could yield stable fixation, proper reduction and fracture healing, low complication rate while providing early mobilization and accelerated rehabilitation. A ran-

domized, controlled trial with a larger number and longer follow-up is recommended.

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