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Original Article

# Functional Outcomes of Tension Band Wiring Using Cannulated Screws in Transverse Patellar Fracture

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## Abstract

***Background:*** *The most commonly used surgical intervention for treatment of patellar fractures is open reduction and internal fixation with Kirschner wire (K-wire) tension band. To overcome some disadvantages related to K-wire, a new technique has evolved replacing K-wire with cannulated screw. The aim of this study was to evaluate effectiveness and safety of open reduction and internal fixation of closed transverse patellar fractures with Tension Band Wiring (TBW) using parallel cannulated compression screws.*

***Materials and methods:*** *This prospective study was conducted in the Department of Orthopedic Surgery of Chittagong Medical College Hospital from January 2019 to December 2019. Twenty consecutive patients of closed transverse patellar fractures were enrolled in the study and treated with vertical skin exposure, fracture open reduction and internal fixation by anterior TBW through 4.0 mm Cannulated screws. The patients were followed post-surgery for 6 months to evaluate time required for radiographic bone union, knee joint Range of Motion (ROM) loss of fracture reduction, material failure and the overall functional result of knee using Bostman scoring.*

***Results:*** *The mean age of the patients was 38.91 ±12.01years and 80% were male. At final follow up 15 (75%) patients had full extension and ROM 120 degree and 5 (25%) patients had ROM 90-120 degree. The main postoperative complication was knee stiffness observed in 10% patients. Almost 95% patients had no pain and returned to their original job after 18 weeks of fixation with no significant limitations. The fractures united at a mean of 8.0±2.4 weeks (Range 6 to 10 weeks) and no case of non-union was observed. Evaluation of outcome at 24 weeks after fixation showed that 60% of the patients had excellent outcome (Bostman Score 28-30) and 40% had good outcome (Bostman Score 20-27).*

***Conclusion:*** *TBW with cannulated compression screws is a safe and effective technique for the treatment of closed transverse patellar fractureswith less chance of implant failure and soft tissue irritation.*

**Key words:** Cannulated screws; K-wire tension band fixation; Patella fractures.

## INTRODUCTION

Patellar fractures are uncommon and constitute 1% of all skeletal fractures. However, subcutaneous nature of the patella has made treatment of patella fractures a challenge. Transverse patella fractures (AO 34-C1) account for 23% of all patellar fractures.[1,2] Undisplaced fractures can be managed conservatively by immobilization and plaster splint. Displaced fractures, especially transverse, are associated with complete disruption of the extensor mechanism and operative treatment is generally indicated.Numerous biomechanical studies have assessed fixation using TBW in this fracture pattern, and TBW is widely regarded as the gold standard for this 'simple' fracture pattern.[2,3]

However, some studies indicate the incidence of postoperative complications following K-wire fixation, including wire breakage, migration and subsequently induced skin irritation, infection, pain and reduction loss, may be high (Approximately 21–53%).[4,5] In addition, the long-term function improvement for the knee joint may be also limited.[6] Recently other alternative methods are evaluated in different parts of the world to improve postoperative outcome by reducing complications.[2,3] To overcome the disadvantages of KTB, several alternative approaches have been introduced, including closed reduction and fracture fixation using cannulated screws or inter-fragmentary screws (Cable pin) with or without supplementary tension band wiring through the screw.[7-11] Theoretically, the screws provide stronger fixation strength than K-wires according to the biomechanical testing and thus can protect the implants from breakage, migration, and related complications to improve the reduction and function outcomes. However, the comparative study results seemed to be controversial.[4-7]

Closed transverse patellar fractures are conventionally managed in the study site by open reduction and internal fixation with KTB.So, it was rational to conduct a study to evaluate the effectiveness and safety of internal xation of closed transverse patellar fractures with TBW through parallel cannulated compression screws. If the study would reveal a positive result, then a recommendation can be made to use TBW through parallel cannulated compression screws for management of patella fractures than KTB, which would bring a positive impact in patients with transverse patellar fractures.

## MATERIALS AND METHODS

A prospective study was conducted from January 2019 to December 2019 in the Department of Orthopedics, Chittagong Medical College Hospital, Chattogram, Bangladesh. The Ethical Review Committee of Chittagong Medical College approved the study (Memo No. CMC/PG/2019/620, Dated 26/12/2019) and informed consent was obtained from the patients.

Consecutive admitted patients with closed patellar fractures with a transverse fracture line within three weeks of injury and aged between 18 and 65 years were included in this study. Patients with open patellar fracture, comminuted patellar fracture, polytrauma and unfit for anaesthesia were excluded.

Demographic characteristics and a complete history regarding the cause and mechanism of injury with duration were taken. Through physical examination was done after that. Patients were managed by open reduction and internal fixation under general anaesthesia with tension band wiring using parallel Cannulated compression screws. Fracture fragments were anatomically reduced and the reduction was held with patellar clamps or with towel clips. Articular surface congruity was checked by palpation with a finger inserted through retinacular defect and confirmed on C-arm image. Two parallel threaded tip guide pins of 1.2 mm diameter were placed in an antegrade or retrograde fashion. Screw lengths were confirmed and the fracture fragments were drilled over guide wires using cannulated drill bit (3.2 mm). Cannulated screws (4.0 mm in diameter) of required length were inserted over the guide wires through the fracture fragments from above downward and the guide wires were then removed. A 18-gauge SS wire was passed through the cannulated screws and crossed over the anterior surface of the patella in a figure-of-eight fashion. A wire twister was used to slowly tension the wire. While tightening the tension band with the knee extended, the articular surface was evaluated by palpating the undersurface of patella through the medial or lateral retinacular defects and by using fluoroscopy (C-arm). The medial and the lateral ends of the figure-of-eight wires were sequentially tightened to apply tension equally across the fracture site, giving even compression across the construct. The final stability of the fracture construct was tested by placing the knee through a ROM. Finally the soft tissues were repaired including the synovium, capsule and extensor mechanism from their outer ends toward the midline of the joint and the wound closed and the knee immobilized in a hinged knee brace in extension.

Isometric quadriceps exercise began from 1st postoperative day. Immediately postoperatively protracted weight bearing with 2 cruches was allowed. Patients were discharged between 2-4 days postoperatively. Stiches were removed on 14th POD. Cast immobilization up to 4th postoperative days. Active ROM exercise were started at 1st POD or immediately after pain subside. Full weight bearing without crutches was allowed after 8th postoperative week. All patients were followed up in the same manner out-patient department as per following schedule from the time of operation. 1st follow-up: At 6 weeks. 2nd follow-up: At 12 weeks. 3rd follow up: At 24 weeks. Clinical follow-up was done to assess the healing status of wound, muscle power and atrophy, ROM achieved in the knee, and complications, if any. Radiological followup was done to check for loss of reduction and time to achieve radiological union. Functional outcome of the knee after surgery was assessed at 6 months (24 weeks)by Bostman scale with a excellent outcome (30-28 points) good (27-20 points) and unsatisfactory (<20 points).[12]

After collection data were entered into Microsoft Excel data sheet to produce a master sheet. Then they were fed into SPSS (Statistical Package for Social Science) for Windows version 23 software for the processing and analyses. Continuous variables were reported as means and standard deviation and categorical variables were reported as count and percentages. Depending on the overall functional outcome patients were grouped as having excellent to fair outcome and poor outcome. To determine the factors associate with poor outcome qualitative variables were analyzed by Chi-square test between groups. p value $<0.05$ was considered as statistically significant.

## RESULTS

Within the study period, 20 patients were found to be eligible

for the study. The age range from 19 to 60 years with a mean age of 38.91 ±12.01 years. The majority of the patients (30%) were in the age group of 31-40 years, followed by 25% in the age group of 21-30 years. Male (80%) patients outnumbered female with a male-to-female ratio of 4:1.Figure 1 shows that mechanism of injury in majority of the cases were either Road Traffic Accident(45%) or accidental fall on slippery ground (45%). The rest 10% were sports injury.Thirteen (65%) patients had right side involvement and 7 (35%) patients had left side involvement.

At 6-month follow-up, majority of the patients (15, 75%) had either full ROM or ROM 1200 of the affected knee joint, 19 (95%) patients had no pain at the affected knee joint, 19 (95%) patients reported to continue their original job, none of the patients had atrophy of >25 mm and four (20%) patients had atrophy of thigh muscles <12 mm, 19 (95%) patients reported that they did not need any assistance while walking, 16 patients (80%) did not have effusion of the knee, 19 (95%) patients did not complain of giving way of the knee and 19 (95%) patients had the average ability to climb the stair (Table I).

**Table I** Condition of the patients at final follow-up (6-months)

| Knee functonal paramters | Frequency | Percentage (%) |
|---|---|---|
| Range of motion | | |
| Full extension and ROM ≥120$^0$ | 15 | 75.0 |
| ROM 90-120$^0$ | 5 | 25.0 |
| Pain status of the knee | | |
| No pain | 19 | 95.0 |
| Moderate pain on exertion | 1 | 5.0 |
| Vocational status | | |
| Continue the original job | 19 | 95.0 |
| Engaged in different job | 1 | 5.0 |
| Atrophy of thigh muscle | | |
| 12-25 mm | 4 | 20.0 |
| <12 mm | 16 | 80.0 |
| Assistance in walking | | |
| No need of any assistance | 19 | 95.0 |
| Use occasional cane | 1 | 5.0 |
| Knee effusion | | |
| None | 16 | 80.0 |
| Reported to be present | 4 | 20.0 |
| Giving way knee | | |
| No | 19 | 95.0 |
| Occasional giving way | 1 | 5.0 |
| Ability to climb stair | | |
| Normal ability | 19 | 95.0 |
| Disturbing stair climbing | 1 | 5.0 |

Majority of the patients (16, 80%) had no complication in the 6 month follow-up period. Most common complication was knee stiffness observed in 2 (10%) patients. One (5%) patient had superficial surgical site infection and other had symptomatic hardware (Figure 1).

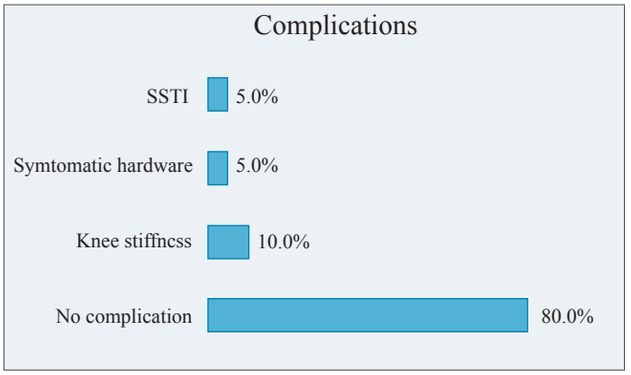


**Figure 1** Bar diagram showing complications of the patients (n=20)

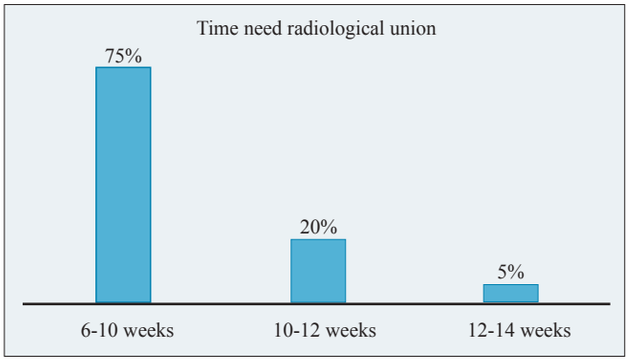


**Figure 2** Duration of radiological union in the studied patients (n=20)

Within 6 months follow-up the entire group had radiological union and most of them (15, 75%) had radiological union between 6-10 weeks. Mean duration of radiological union in the present study was 8±2.4 weeks (Figure 2).

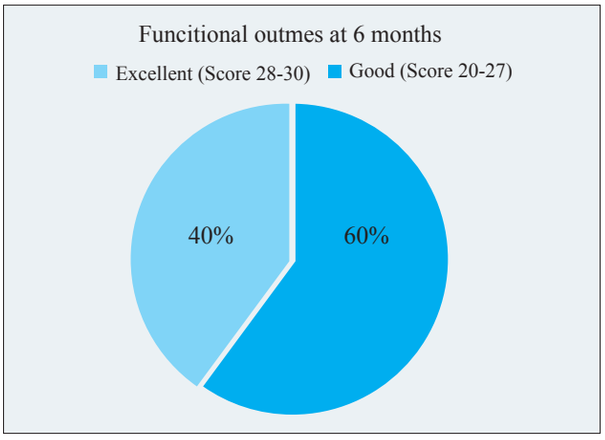


**Figure 3** Functional result assessment by Bostman Knee scoring (n=20) at 6-months

In the study out of 20 patients evaluated at 6 months of surgery none of them had unsatisfactory outcome. 12 (60%) patients had Bostman Knee Score 28-30 indicating excellent outcome and rest of the 8 (40%) patients had score between 20 and 27 indicating good outcome.

Table II shows that excellent outcome was more frequent among patients ≥40 years and among male than their counterpart. However, the differences failed to reach statistical significant (p>0.05).

**Table II** Association between demographic characteristics and 6-months functional outcome

| Variable | Functional outcomes | | p value* |
|---|---|---|---|
| | Excellent (n=12) | Good (n=8) | |
| **Age group** | | | |
| <40 years | 7 (58.3) | 5 (62.5) | 0.852 |
| ≥40 years | 5 (41.7) | 3 (37.5) | |
| **Sex** | | | |
| Male | 3 (25.0) | 1 (12.5) | 0.494 |
| Female | 9 (75.0) | 7 (87.5) | |

Data were expressed as frequency (%).*Chi-square test.

## DISCUSSION

In order to avoid these problems associated with the MKTB technique, in this study a comparatively newer technique-tension band wiring using cannulated screws were used to treat transverse patellar fractures. Twenty patients with closed transverse patellar fractures were managed by this technique and evaluated for 6 months duration. The present study demonstrated that, the entire group had satisfactory (Excellent or good) outcome as assessed by Bostman Knee Score.

The average time of fracture union was 11.20±2.78 weeks in the present study, which agreed with the study of Shrestha et al. (11.20±2.78 weeks) study of Berg (13 weeks) study of Khan et al. (10.7 weeks).[13,14,15] In the study by Tan et al. which compared the MTBW and TBW with CCS, they had union me of about 10 weeks in average in both groups. Regarding ROM of the knee joint after 6 months of surgery, majority of the patients (75%) had either full ROM or ROM $120^0$ of the affected knee joint. Five (25%) patients had ROM $90^0$-$120^0$ at final follow-up.[8] Khan et al reported that average ROM at three months was 113.8 degree and it was improved to 125.4 degree at one year follow up.[15] Shrestha et al. reported that out of 20 patients 12 had full ROM and other 8 had >$120^0$ ROM at 24 weeks follow-up.[13]

In the present study, after 6 months of surgery none of them had unsatisfactory outcome and 12 (60%) and 8 (40%) patients had excellent and good outcome, respectively. Berg first reported this technique in a clinical study of 10 cases, 7 of whom (70%) obtained excellent or good results.[14] Their clinical results were similar to modified TBW, with advantages of less soft tissue irritation and early ROM in this fixation. Qi et al.evaluated the effectiveness and safety of a fixation technique for displaced patellar fractures using bioabsorbable cannulated lag screws and braided polyester suture tension bands in a prospective study of 15 patients.[16] They found that this technique resulted in satisfactory outcomes for patellar fractures without any obvious complications. Other studies reported good to excellent outcomes in 90% to 100% of the patients.[8,13,15]

In the current study only four complications were observed. One case of superficial wound infection subsided with meticulous wound care and prolonged antibiotic administration. In different studies, the rate of infection after surgical treatment in patella fractures is 3-10% and studies describing the technique of cannulated screw reported comparatively lower rate of infection.[9,12,13,15] The other two cases had knee stiffness. One of these two patients had an attack of acute pancreatitis for which she was hospitalized for a prolonged duration. This patient also gained useful ROM over a period of six months. There were no complications in the form of loss of reduction, material failure or implant migration. Rate of hardware removal is relatively less in this technique as compared with modified TBW.[4,13,14,17] Implant loosening and migration can lead to skin irritation, which are the main reasons for the removal of hardware, besides tension band wires whose knots may also cause irritation. Loosening and migration were not seen in the present study. Only one patient had skin irritation due to tension wires and larger screws, and required hardware removal in our series. Two complications noted in our series were managed effectively and were insignificant as far as the actual results of surgical technique are concerned.

The outcome of the cannulated screws with anterior tension band wiring for transverse patellar fracture was excellent and very similar to the international study. However, caution should be exercised in generalizing this study's findings due to the limitations, including the small sample size and the absence of a direct comparison between modified TBW (Conventional treatment) and this technique. Therefore, further comparative studies are needed to establish that this relatively new technique of patellar fracture fixation is superior to modified TBW.

## CONCLUSION

In light of the study's findings, cannulated screws with anterior tension band wiring are a safe and effective method in the management of transverse patellar fractures, with less chance of implant failure and soft tissue irritation. This procedure is thus a good alternative to modified tension band wiring.

## RECOMMENDATIONS

Tension band wiring through cannulated screws in closed transverse patella fractures can be used as a better alternative to the traditional modified tension band wiring whenever possible. However, further prospective comparative studies are needed with a randomized design and longer follow-up follow-up to establish the conclusion.

## DISCLOSURE

All the authors declared no competing interest.

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