

## Original Research Article

# Management of displaced patella fracture with modified tension band wiring and percutaneous cannulated screws-a dilemma

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### ABSTRACT

**Background:** Displaced patella fracture has seen various surgical management methods in the past among which tension band wiring (TBW) and less invasive percutaneous cannulated cancellous (CC) screw fixation are mostly preferred and debated on which is better option. The study has been designed to compare the functional outcome and various parameters of both the methods.

**Methods:** The study was conducted as prospective clinical study in 30 skeletally mature patients with x-ray evidence of patella fracture fulfilling inclusion and exclusion criteria, out of which 15 were done tension band wiring and rest percutaneous cancellous screw and outcome graded as excellent, good, fair and poor based on Lysholm knee score.

**Results:** The comparison of the mean values of the Lysholm score in patients operated with patella TBW (92.47) were better than with percutaneous CC screw fixation (88.93). Patella TBW was responsible for all the cases of infection 2 (6.67%) and delayed non-union 1 (3.33%). Whereas stiff was nearly equal in both the techniques. The comparison of the mean values of the knee flexion in patients operated by using percutaneous CC screw (107.27) was better than patella TBW (105.67).

**Conclusions:** Patients managed with CC screw fixation technique achieved better knee function, especially in the early postoperative period. The reported advantages of the percutaneous fixation technique include avoidance of extended incisions, preservation of the blood supply to the patella, and the possibility of a simpler removal of all hardware in the clinical setting. These results suggest that the percutaneous CC screw technique may be a superior alternative to conventional modified tension band wiring.

**Keywords:** CC screw, Lysholm score, Patella fracture, TBW

### INTRODUCTION

Patellar fractures are common and it constitutes about 1% of all skeletal injuries.<sup>1</sup> The patella is a sesamoid bone in quadriceps tendon whose main function is to improve the efficiency of quadriceps muscle by increasing the mechanical leverage of the quadriceps tendon. Most patellar fractures are caused by a combination of direct and indirect forces. A very accurate classification of patella fracture has been presented by Hohl and Larson which differentiates between nondisplaced, transverse longitudinal or vertical, lower or upper pole and

comminuted (stellate) fracture types.<sup>2</sup> The treatment of fracture patella has always been a matter of controversy since the earliest of times. A displaced fracture is generally defined by fracture fragment separation of more than 3 mm or an articular incongruity of 2 mm or more. Open fractures, articular step of 2 mm or greater, and loss of knee extension are indications for surgical intervention.<sup>3</sup> Haxton (1945) believed that complete and accurate reconstruction of patella is likely to give a joint which will tolerate the stresses and strains better than one in which the normally anatomy is disturbed by total excision.<sup>4</sup>

In this study a series of 30 fracture patellae has been studied and the results obtained after treatment by modified tension band wiring and percutaneous cannulated screws have been assessed and critically analysed.

## METHODS

The present study was a prospective comparative study conducted at Dhanwantri Hospital and Research Centre, Jaipur between November 2015 and December 2016. The study was approved in a meeting held by the Ethical Committee of the institute on 13<sup>th</sup> August 2015. A total of 30 cases with patella fractures were studied. Sample size was calculated by considering the 80% of average number of patients presented with patella fracture of knee over the period of last three years treated with modified TBW or CC screw.

### *Inclusion criteria*

Participant giving consent to enroll in the study. Patients with patella fracture. Patients of any sex in the age group of 18 to 65 years. Patients who were fit/unfit for surgery. Open patella fracture.

### *Exclusion criteria*

Patella fracture in children. Pathological fractures of the Patella. Patient not giving consent for study. Comminuted patella fracture

### *Study procedure*

All the patients fulfilling inclusion criteria were clinically and radiologically reassessed by a single surgeon. Detailed informed consent was taken and all the pre-operative investigations were done. After pre anesthetic checkup and clearance, patients were taken to OT. All the patients were positioned supine on the radiolucent table with a pad under buttock of affected limb. Skin preparation done with beta scrub & the limb was properly draped.

### *Group I (modified TBW) patients*

A midaxial incision from 5 cm above superior pole of patella to the tibial tubercle made. The skin and subcutaneous tissue in full thickness proximally and distally reflected to expose the entire anterior surface of the patella and the quadriceps and patellar tendons. The patella was then held with a patellar reduction clamp and reduction confirmed by observing articular surface. A 2 mm k-wire passed along the longitudinal diameter of the patella below anterior cortical surface. Another wire passed 5mm apart the first wire. 18-gauge wire was then passed beneath patellar tendon posterior to K-wires. Limbs of wire crossed over anterior patella. Wire passed through quadriceps tendon posterior to wires and tightened by twisting them simultaneously. K-wires then bent 180° and embedded in quadriceps tendon.

### *Group II (percutaneous cannulated cancellous screws) patients*

Two cannulated screw guide wires passed percutaneously, perpendicular across fracture, which was held in reduction using a patellar clamp, 5 mm below anterior cortical surface drilled with cannulated drill over guide wire. Depth gauge used to measure screw length. And two 4 mm cannulated screws inserted into the patella.



**Figure 1: Percutaneous fixation intra-op imaging.**

### *Postoperative care*

The limb was placed in extension in a posterior plaster splint or removable knee brace, dressing done after 48hrs. The patient was allowed to ambulate while bearing weight as tolerated on the first postoperative day. The patients were encouraged to perform quadriceps-setting exercises and within a few days should be lifting the leg off the bed. At 10 to 14 days, the sutures were removed. The patients were allowed to ambulate using crutches when active muscular control of the leg was obtained.

### *Follow up*

All the patients were followed up at the six weeks, three months and six months duration. The sixth week assessment included clinical assessment to exclude early complications related to the fracture or surgery, and a routine radiograph to evaluate the fracture position. The three months and six months appointment was scheduled for clinical assessment of fracture healing and a routine radiograph to assess union. Radiological union was assessed by the principal investigator at first, third and sixth month. Clinical data of union including fracture mobility, tenderness and pain was also obtained at each follow-up. The functional outcome was evaluated based on Lysholm knee scoring scale.<sup>5</sup> The maximum knee score was 100 points and the maximum functional score was 100 points.

### *Statistical analysis*

Data obtained was coded and entered into Microsoft Excel spreadsheet. The categorical data was expressed as rate,

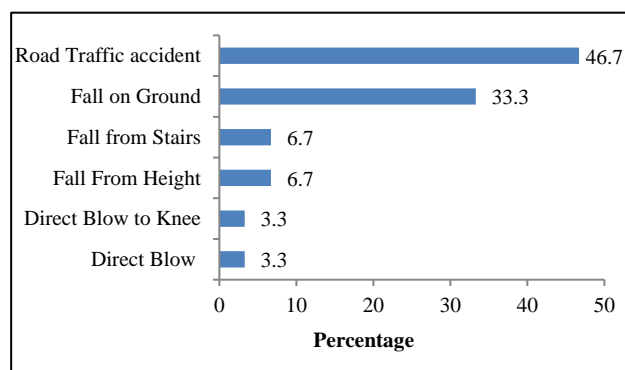
ratio and percentage. The continuous data was expressed as mean±SD. A 'p' value of less than or equal to 0.05 was considered as statistically significant. Type of study was cohort type prospective study.

## RESULTS

The most common people (40%) who sustained patellar fractures were either farmers or non-working class. They were followed by housewives (16.7%), students and drivers. Majority of participants were not having any previous history of illness (about 70%). About 1/3<sup>rd</sup> of total participants were having history of previous illness such as diabetes, hypertension, cardiovascular diseases, COPD and previous surgery.

**Table 1: Age and gender distribution of the study participants.**

Age group (in years)	Gender of the participants		Total (n=30)
	Male N (%)	Female N (%)	
21-40	11 (36.67)	4 (13.33)	15 (50)
41-60	6 (20)	3 (10)	9 (30)
>60	4 (13.33)	2 (6.67)	6 (20)
<b>Total</b>	<b>21 (70)</b>	<b>9 (30)</b>	<b>30</b>



**Figure 2: Distribution of participants on the basis of mode of injury.**

Along with the fracture of the patella, >80% of the participants were not having any associated injuries, while others were having associated forearm fractures, clavicle, metatarsal or head injuries

**Table 2: Distribution of the patients according to the pattern of injuries sustained by them.**

Side of injury	Low transverse N (%)	Transverse N (%)	Total (n=30)
Left	3 (10)	10 (33.3)	13 (43.3)
Right	3 (10)	14 (46.7)	17 (56.7)
<b>Total</b>	<b>6</b>	<b>24</b>	<b>30 (100)</b>

The comparisons of mean values of knee flexion were greater in TBW group when compared with CC screw

group, but this difference was statistically non-significant after using t test (0.08).

**Table 3: long term follow-up in the study participants (n=30).**

	Frequency	Percentage (%)
Uneventful	26	86.7
Debridement and implant removal	1	3.3
Implant removal	1	3.3
Lost to follow up	2	6.7

**Table 4: Knee flexion in participants in post-operative period (n=30).**

Knee flexion	Frequency	Percentage	Mean value =106.47, SD=19.488
<90 degree	4	13.33	
90-120 degree	22	73.33	
>120 degree	4	13.33	

**Table 5: Comparison of the knee flexion in participants in post-operative period according to the type of surgery.**

	Group 1 (TBW)	Group 2 (CC screw)
Mean	105.67	107.27
N	15	15
Std. deviation	18.325	21.201

In more than 70 % patients Lysholm score was found to be more than 90, while in only about 7% cases it was found to be less than 60. Minimum Lysholm score was found to be 45 and maximum score was 100.

**Table 6: Comparison of the Lysholm score in participants in post-operative period according to the type of surgery.**

	Group 1 (TBW)	Group 2 (CC screw)
Mean	92.47	88.93
N	15	15
Std. deviation	13.637	14.675

**Table 7: Association of the operative procedure and the outcome in the study participants.**

Procedure	Excellent (%)	Fair (%)	Good (%)	Poor (%)
CC screw fixation	12 (40)	0 (00)	2 (6.67)	1 (3.3)
Patella TBW	11 (36.67)	2 (6.67)	0 (00)	2 (6.67)

Majority of the participants were having excellent outcome in both CC screw fixation (40%) as well as patella TBW (36.67%). Poor outcome was found in about 10% of the participants which was more in TBW group.

Main post-operative complications that were reported included stiffness of the joint (about 16.7 %) infection of the wound (6.7%) or its delayed union (3.3%). About 2/3<sup>rd</sup>

of the participants were having excellent post-operative outcome, only 10% participants were having poor post-operative outcome.

**Table 8: Association of the post-operative complications with the operative procedures followed in the study participants.**

Post-operative complication		Procedure		Total N (%)	
		CC screw fixation	Patella TBW		
Infection	Yes	0	2 (6.67)	2 (6.67)	Chi-square=2.143, df=1, p value=0.143 (non-significant)
	No	15 (50)	13 (43.33)	28 (93.33)	
Delayed union	Yes	0	1 (3.33)	1 (3.33)	Chi-square=1.034, df=1, p value=0.309 non-significant
	No	15 (50)	14 (46.67)	29 (96.67)	
Stiffness	Yes	2 (6.67)	3 (10)	5 (16.67)	Chi-square=0.240, df=1, p value=0.624 non-significant
	No	13 (43.3)	12 (40)	25 (83.33)	

The association of the post-operative complications with the operative procedures were that patella TBW was responsible for all the cases of infection 2 (6.67%) and delayed non-union 1 (3.33%). Whereas stiffness was nearly equal in both the techniques. These associations were statistically non-significant after using chi-square analysis.

## DISCUSSION

In our study, road traffic accidents were responsible for majority (46.7%) of the patellar fractures. Jabshetty, reported that in 60% of cases, the mechanism of injury was fall on the knee and in other 40% cases it was RTA.<sup>6</sup> Shobat and Mann reported fall accounted for 82% of cases.<sup>15</sup> In our study, the most common fracture types included transverse, middle third patellar fracture which is consistent with other previous studies.

Carpenter et al in their study presented that open surgical techniques are the standard method for reduction and fixation of displaced patellar fractures, many reports describe the disadvantages and complications associated with traditional surgical treatments of patella fractures.<sup>7</sup> The common complications of these techniques are infection, loss of fixation, knee stiffness, posttraumatic osteoarthritis, non-union, irritation of the anterior knee caused by internal fixation devices, and cosmetic problems. Because the patella is a subcutaneous bone, fixation devices that have been used for fracture fixation are frequently irritating. Wires and wire knots seem to be particularly irritating to the soft tissues of the anterior knee area. In a report Hung et al which was a large series of patella fractures, the incidence of complications related to wire circlage materials was 47%.<sup>8</sup> These complications resulted in a delay for patients in returning to their activities of daily living and a need for additional surgery. For this reason, new treatment modalities are being researched to minimize these disadvantages. In our study patella TBW was responsible for all the cases of infection 2 (6.67%) and delayed non-union 1 (3.33%). Whereas

knee stiffness was nearly equal in percutaneous technique as well.

A recent study by Leung et al observed fragment displacement of 2 mm in 22%-30% of the patients with early mobilization after tension band wiring.<sup>9</sup> Secondary postoperative pain due to skin irritation caused by the K-wires or the stainless steel wire can be a common problem which may require an extra surgery for fixation removal. Moreover, the “figure of 8” tension band configuration was proved not the most stable construct for fixation of transverse patella fractures. In the present study, we found that the cannulated screw fixation technique was associated with less pain, and facilitated early knee motion and avoided complications due to immobilization. It has also been demonstrated that early motion has some advantages for joint cartilage perfusion and nutrition. The cannulated screws has the advantages of causing less destruction of the soft tissues and less implant irritation to the soft tissues, reducing the risk of postoperative wound complications and encouraging early rehabilitation.

In our study, the mean range of movements of knee in all the patients was recorded as 106.47+19.48 degrees. By the end of 6 weeks, 26 patients i.e., 86.66 % have gained knee movements and only 4 patients reported stiffness. In study by Dudani et al, 73% of cases had more than 120° of flexion, whereas in Srinivaslu et al series, all (100%) cases had full range of movements.<sup>10,11</sup> In Srinivaslu et al series, normal power was in 93% of patients.<sup>11</sup> In the study of Jakobsen et al and Edwards et al reduction in quadriceps strength was seen in 33% and 44% cases respectively.<sup>12,16</sup> The mean Lysholm score observed was 90.70±14.03.

Present study group consists of 30 cases, 15 cases each from both groups. Union was seen in all the cases except one, but the union was faster in cases of cannulated cancellous screw. The average period of union was 12-14 weeks in cases treated with modified tension band wire. In cases of, Cannulated cancellous screw the average time of union was 10-12 weeks.



The results of cases treated with tension band wiring are excellent in 73.3% of cases, fair in 13.3% of cases and poor in 13.3% of cases. In cases of, Cannulated cancellous screw excellent results were found in 80.0% of cases, good in 13.3% and poor in 6.7% of cases. Jabshetty reported that cases treated with tension band wiring are excellent in 50% of cases, good in 40% of cases and poor in 10% of cases.<sup>6</sup> In cases of, cannulated cancellous screw excellent results were found in 40% of cases, good in 40% and poor in 20% of cases.

In our study, the mean range of movements of knee in patients treated with modified tension band wiring was  $107.27 \pm 21.20$  degrees, whereas it was  $105.67 \pm 18.32$  in the other group. This difference was statistically non-significant ( $p$  value=0.05). In patients treated with cannulated cancellous screws on applying t test this difference was found to be statistically significant ( $p$  value <0.05). By the end of 6 weeks, 4 patients i.e., 13.33% have gained knee movements of more than  $120^\circ$ . More number was contributed from the CC screw group as compared to the other one.

In modified tension band wiring, 50% of cases showed full range of movement, 40% showed more than  $120^\circ$  of flexion and 10% showed flexion between  $90-120^\circ$ . In Cannulated cancellous screw 40% of cases showed full movement, 40% above  $120^\circ$  flexion and 20% showed flexion between  $90-120^\circ$ . Gaining range of movements was faster in cases treated with tension band wiring because of better fixation and start of knee mobilization after 2 weeks compared to 4 weeks in cases of Cannulated cancellous screw. Quadriceps atrophy may also have occurred because of this longer period of immobilization in Cannulated cancellous screw. Extensor lag was seen in 20% of cases treated with Cannulated cancellous screw and 10% of cases treated with modified tension band wiring.

Patients managed using the CC screw fixation technique achieved better knee function, especially in the early postoperative period. The reported advantages of the percutaneous fixation technique include avoidance of extended incisions, preservation of the blood supply to the patella<sup>13</sup>, and the possibility of a simpler removal of all hardware in the clinical setting.

According to Baydar et al, cannulated screws are more durable against distraction forces than the modified tension band technique to treat transverse patellar fractures.<sup>14</sup> Similar studies have reported that fractures stabilized with a modified tension band displace significantly more than those fixed with screws alone or screws plus a tension band in simulated knee extensions ( $p < 0.05$ ). An advantage of cannulated screws is the potential for percutaneous application.

Two separate studies have demonstrated through biomechanical evaluation that among the 2 methods for patella fixation (modified tension band, cannulated screws

with a tension band wired through the screws), the cannulated screws plus the tension band provided the most efficient stabilization, indicating that combining inter-fragmentary screw fixation with the tension band principle seems to provide improved stability over the modified tension band or screws alone for transverse patella fractures.

Tian et al also showed that the cannulated screw tension band was better than the modified K-wire tension band technique.<sup>3</sup> Thus this technique should be an effective device for fixation of transverse patella fractures.

## CONCLUSION

Patients managed using the CC screw fixation technique achieved better knee function, especially in the early postoperative period. The reported advantages of the percutaneous fixation technique include avoidance of extended incisions, minimal soft tissue dissection, preservation of the blood supply to the patella, and the possibility of easy hardware removal later. These results suggest that the CRCF technique may be a superior alternative to conventional Modified tension band wiring in simple and transverse patellar fracture.

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*Ethical approval: The study was approved by the institutional ethics committee*

## REFERENCES

1. Bostrom A. Fracture of the patella: a study of 422 patients. *Acta Orthop Scand.* 1972;143:1-80.
2. Hohl M, Johnson EE, Wiss DA. Fractures of the knee. In: Rockwood CA Jr, Green DP, Buchholz RW, eds. *Fractures in adults.* 3rd edn. Vol. 2. Philadelphia: Lippincott; 1991:1765.
3. Tian Y, Zhou F, Ji H, Zhang Z, Guo Y. Cannulated screw and cable are superior to modified tension band in the treatment of transverse patella fractures. *Clin Orthop Relat Res.* 2011;469(12):3429-35.
4. Haxton H. The function of the patella and the effects of its excision. *Surg Gynecol Obstet.* 1945;80(4):389-95.
5. Lysholm J, Gillquist J. Evaluation of knee ligament surgery results with special emphasis on use of a scoring scale. *Am J Sports Med.* 1982;10:150-4.
6. Jabshetty AB. A comparative study of modified tension band wiring and cannulated cancellous screw fixation in management of transverse fractures of patella. *Nat J Integrat Res Med.* 2015;6(4).
7. Carpenter JE, Kasman RA, Patel N, Lee ML, Goldstein SA. Biomechanical evaluation of current patella fracture fixation techniques. *J Orthop Trauma.* 1997;11:351-6.
8. Hung LK, Chan KM, Chow YN, Leung PC. Fractured patella: operative treatment using the tension band principle. *Injury.* 1985;16:343-7.

9. Leung PC, Mak KH, Lee SY. Percutaneous tension band wiring: a new method of internal fixation for mildly displaced patella fracture. *J Trauma.* 1983;23:62-4.
10. Dudani B, Sancheti KH. Management of fracture patella by tension band wiring. *Indian J Orthop.* 1981;15(1):43-8.
11. Srinivaslu K, Sanjiv K, Marya S, Surya Bhan, Dave PK. Results of surgical treatment of patellar fractures. *Indian J Orthop.* 1986;20(2):158-61.
12. Jakobsen J, Christensen KS, Rasmussen OS. Patellar fracture treatment. *Orthop Scand.* 1985;56:430-2.
13. Gardner MJ, Griffith MH, Lawrence BD, Lorich DG. Complete exposure of the articular surface for fixation of patellar fractures. *J Orthop Trauma.* 2005;19(2):118-23.
14. Baydar ML, Atay T, Gurbuz O. Compressive screwing of transverse patella fractures provides better resistance to traction than tension band. *Eur J Orthop Surg Trauma.* 2011;21(2):105-10.
15. Shobat S, Mann G. Functional results after patellar fractures. *Arch. Gerontol. Geriatr.* 2003; 37(1): 93-98.
16. Edwards SB, Johnell O and Redlund-Johnell I. Patella fractures— a 30 years follow-up. *Acta Orthop.Scand.* 1989;60:712-4.

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