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**Dr. Pawan Kumar**  
Associate Professor, Department  
of Orthopaedics, SB Medical  
College, Hazaribag, Jharkhand,  
India

**Dr. Mritunjay Kumar**  
Senior Resident, Department of  
Orthopaedics, SB Medical  
College, Hazaribag, Jharkhand,  
India

## Fracture patella: Fixation with cancellous screws and anterior cerclage wiring

**Dr. Pawan Kumar and Dr. Mritunjay Kumar**

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### Abstract

Patella is the largest sesamoid bone. It is a triangular bone that lies within quadriceps tendon. Fractures of patella constitute approximately 1% of all skeletal injuries and occur in all age groups. There is always a need to salvage the fracture as it is an important functional structure in extensor mechanism of knee. Its report to evaluate the effectiveness and safety of anterior cerclage wire/tension band wiring technique using two or more cannulated cancellous screws in patients with transverse or transverse with comminuted patellar fractures.

**Material and Methods:** This is a prospective study of 28 patients with transverse or transverse with comminuted fractures. All patients were treated with open reduction and internal fixation using multiple cancellous screws (more than two) and 18G stainless steel wire except two cases with TBW with k wire as per tension band principle. Result-There were 28 patients, 24(85.71%) males and 4(14.28%) females. The age group ranged from 22-60 years with mean age 38 years. The mode of injury was either direct or indirect trauma, fall (74%) followed by RTA (18%) and violent quadriceps contraction (8%). Transverse fractures were present in 60% patients and transverse fracture with comminution in 40% patients. Mean time to achieve union was 10.7 weeks (Range 8-12 weeks). Cases were followed up for 3 months, then at 6 months, thereafter 6 monthly and assessed for recovery of knee function. Study continued up to 12 months to 18 months. Mean ROM at the end of 3 months was 113.8° (90-130) and at final follow up this movement improved up to 125.4° (ROM 100-150). There was loss of reduction in one case, one case of infection and one case of nonunion. No case of implant failure was observed. The study was conducted in Department of Orthopaedics, Hi Tech Medical College, Rourkela and SB Medical College, Hazaribag. The results were graded according to the criteria given by Gaur *et al.* IJO May 1997.

**Conclusion:** The criteria for surgery, open reduction and internal fixation with multiple cannulated cancellous screws with anterior cerclage was if > 3mm displacement and > 2mm articular step off was present. The screws provide rotation control of fragment and anchorage of cerclage wire. It provides additional compression across the fracture site. Open reduction and internal fixation with cannulated cancellous screws with anterior cerclage /TBW is a safe, reliable and reproducible method in the management of transverse or transverse with comminuted fractures, with less chances of implant failure and less soft tissue irritation.

**Keywords:** Transverse, comminuted fractures, patella, ORIF, cannulated screws, anterior cerclage wires

### Introduction

Patella is the largest sesamoid bone. It is a triangular bone that lies within quadriceps tendon. Patellar fractures occur in all age groups of 20-60 years comprising 1% of all skeletal injuries<sup>[1]</sup>. There is always a need to salvage the fracture as it is an important functional structure in extensor mechanism of knee. To preserve the range of knee motion adequate management followed by aggressive post-operative rehabilitation is mandatory. Patellar fractures may be undisplaced or displaced. Un-displaced fractures are usually managed by immobilization in a cylinder cast and allow immobilization as tolerated by the patient with intact extensor mechanism<sup>[2]</sup>. However displaced patellar fractures are usually managed surgically to minimize the risk of developing arthritis, necessitating open reduction and internal fixation<sup>[3]</sup>. The surgical management of patellar fractures has evolved over the years from simple cerclage wiring to tension band wiring (TBW), further modified to increase its strength. Multiple cannulated cancellous screws<sup>[4]</sup> have also been used in the management of transverse or transverse with comminuted patellar fracture with low failure rate compared to modified tension band wiring.

**Corresponding Author:**  
**Dr. Pawan Kumar**  
Associate Professor, Department  
of Orthopaedics, SB Medical  
College, Hazaribag, Jharkhand,  
India

The addition of anterior cerclage/TBW has added strength to the construct.

Its surgical management is evolving constantly with mini screw fragment fixation system<sup>[5]</sup> and fixed angle plate fixation<sup>[6]</sup> for various patellar fracture. Configurations. The revolution in the management of patellar fractures was brought on with the introduction of tension band wiring in 1959<sup>[7]</sup>. It was further modified by adding kirschner wires to the construct to increase its strength allowing early mobilization and rehabilitation. Wires may protrude at times leading to soft tissue irritation, hindering ROM of knee joint. The sharp ends of K wires distally may hinder kneeling, thus hampering certain religious activities. To overcome these shortcomings, a new technique has evolved replacing K Wires with multiple cannulated cancellous screws<sup>[8]</sup>. The screws act as lag screws providing rotation control of fragment and anchorage of cerclage wire. It provides additional compression across the fracture throughout the range of motion and by resisting the tensile loading during the terminal extension. The tension forces of extensor mechanism are converted to compressive force by another tension band cerclage wire. The force dynamically closes fracture line during knee flexion. The construct has been proved to be mechanically stronger than modified tension band in various biomechanical studies pioneered by Burvant *et al.*<sup>[9]</sup> and followed by Carpenter *et al.*<sup>[10]</sup>.

**History:** Prior to 1820, Patellar fractures were treated nonoperatively in extension. In 1877, Sir Hector Cameron<sup>[11]</sup>, Glasgow Scotland for the first time did ORIF with silver wires threaded through drill holes. It is the first bone to undergo ORIF. In 1909, Heineck<sup>[12]</sup> performed total patellectomy for severely comminuted fractures. In 1942, Thomson<sup>[13]</sup> did reconstruction of entire patella. Stimson<sup>[14]</sup> in 1898, reported that open reduction reduced the period of rehabilitation and gave an improved result. During early 1950, Pauwels<sup>[15]</sup> did anterior tension band wiring. McKeever<sup>[16]</sup> used a patellar prosthesis for acute fractures. Later AO<sup>4</sup> advocated for the stabilization of majority of patellar fractures.

**Material and Methods:** This is a prospective study of 28 patients, being studied in Hi-Tech Medical College, Rourkela and SB Medical College, Hazaribag since April 2016. Of 28 patients, 24(85.71%) patient were males and 4(14.28%) were females. The age group ranged from 22-60 years with mean age 38 years. The left knee (72%) was involved more frequently than the right (28%). The mode of injury was either direct or indirect trauma, fall (74%) followed by RTA (18%) and violent quadriceps contraction (8%). Transverse fractures without comminution were present in 16 patients (57.14%) and transverse fractures with mild comminution were present in 12 patients. Severely comminuted fractures

are not amenable to screw fixation and were not included in the study. Criteria for surgery was that ORIF performed if > 3mm displacement and >2 mm articular step off. Principle- The screws provide rotation control of the fragment and anchorage of cerclage wire. It provides additional compression across the fracture site. The tension forces of extensor mechanism are converted to compressive force by anterior tension band cerclage wire. The force dynamically closes the fracture line during knee flexion.

Routine investigations and X-ray done (Fig. 1 and 6). Under tourniquet control, a straight longitudinal midline incision was used to expose the fracture site. The retinacular tears were identified and the knee joint was inspected for loose fragments and cartilage damage (osteochondral fractures). The joint was irrigated and debrided of irreparable bone fragments. The fracture fragments were anatomically reduced and held using reduction clamp. Articular congruity was assessed by digital palpation through the retinacular tear and confirmed on fluoroscopy. Two parallel guide wires were passed and their position checked under image intensification. After confirming the screw size, 2/3 cannulated cancellous screws were passed over the guide wires either in antegrade or retrograde direction after drilling the fracture fragments. The guide wires were removed and 18G stainless steel wire was passed through the cannulated screws and crossed over the anterior aspect of the patella (Fig.7). The wire ends were tightened with the knee in full extension. To compress the fracture sites, the wires were sequentially tightened both medially and laterally. Final stability of the construct fixation was tested in OT (Fig. 2 and 7). Full range of motion tested and fracture fragments observed for motion or inadequate fixation followed by quadriceps repair with a nonabsorbable suture. Knee immobilized in a hinged knee brace in extension or cylinder slab. Active rehabilitation (quadriceps strengthening) started on the 2<sup>nd</sup> postoperative day. Splint worn for 3 weeks with active assisted range of motion exercises. Splint discontinued and partial weight recommended, as tolerated with knee in full extension. Full weight bearing achieved at 6 weeks from stabilization with x ray showing progressive fracture healing (Fig. 3 and 9). Gradually the ROM was increased up to 90 degrees and extended as tolerated by the patient. Radiological union was established when the bony trabeculae crossed the fracture line (Fig 9 and 10).

**Results:** The results were graded according to the criteria given by Gaur *et al.*<sup>[17]</sup> IJO May 1997. Mean time to achieve union was 10.7 weeks (Range 8-12 weeks). Cases were followed up for 3 months, then at 6 months, thereafter 6 monthly and assessed for recovery of knee function. Study continued up to 12 months to 18 months (Fig 11). Mean ROM at the end of 3 months was 113.8° (90-130) and at final follow up this movement improved up to 125.4° (ROM 100-150).

**Table 1:** The results were graded according to the criteria given by Gaur *et al.*<sup>[17]</sup>. I.J.O. May 1997

Parameters	Results			
	Excellent	Good	Fair	Poor
<b>Quadriceps</b>				
Wasting	Nil	< 1.5 cm	Up to 2.5 cm	> 2.5 cm
Power loss	Nil	< 10%	Up to 25%	> 25%
Extension lag	Absent		< 10°	> 10°
Range of knee movement	Full	0°-110°	Up to 90°	Grossly restricted
Pain	Absent	Minimum	Moderate	Severe
Function	Normal	Normal	Particularly restricted (No change occupation)	Incapacitated from normal work (change of occupation)



**Fig 1: Pre op X -Ray**



**Fig 5: Follow up**



**Fig 2: Immediate Post OP Day**



**Fig 6: Pre op X ray**



**Fig 3: After 6 weeks**



**Fig 7: Per operative**



**Fig 4: After 6 months**



Fig 8: Immediate Post-operative



Fig 9: After 1 month



Fig 10: After 3 months



Fig 11: Follow up

**Complications:** There was one case of loss of reduction in one case, one case of superficial wound infection and one case of nonunion. No case of implant failure or soft tissue irritation was observed.

Complication	Screws/K-wire
Loss of reduction	1
Infection	1
Giving way	--
Non-Union	1
Ossification of quadriceps	--
Change of work	--

**Discussion:** The open reduction and internal fixation with multiple cannulated cancellous screws and anterior cerclage wiring is a relatively new technique in the management of transverse patella fractures. In 1877, Sir Hector Cameron [11], Glasgow Scotland for the first time did ORIF with silver wires threaded through drill holes. It is the first bone to undergo ORIF. The first biomechanical study was done by Burvant *et al.* [9], who compared five methods of fixation of patella fractures including modified TBW, anterior tension band with supplemental cerclage wire (Lyford technique), anterior tension band with multiple cannulated screws, Pyrford technique with cancellous screws and cancellous screws alone. The technique of tension band with screws performed significantly better than the modified tension band. The second biomechanical study done by Carpenter *et al.* [10] compared the mechanical effectiveness of three different techniques for stabilization of transverse fractures of the patella (a)modified tension band (AO technique), (b)two parallel 4.5 mm interfragmentary lag screws, or(c)a new technique using 4 mm cannulated cancellous screws with a tension band wired through the screws. Fractures stabilized with a modified tension band were found to displace significantly more than those fixed with screws alone or screws plus tension band in simulated knee extensions. The fracture fixed with cannulated screws plus tension band failed at higher loads compared to those stabilized with screws alone or those with a modified tension band. The study concluded that combining interfragmentary screw fixation with tension band principle appeared to provide stability over the modified tension band or screws alone for transverse patellar fractures. The first clinical study done by Berg EE [18] included 10 patients and followed by Chang [19] which also included 10 patients. In this study no patient had loss of fracture reduction, implant migration and implant breakage. The study concludes that anterior tension band wiring through cannulated cancellous screws for displaced inferior pole patella fractures is a safe, simple and relatively effective alternative

management with minimal soft tissue irritation. Chiang <sup>[20]</sup> performed this technique arthroscopically and concluded that this was a safe and reproducible method for transverse patellar fractures. Jin <sup>[21]</sup> performed this technique percutaneously and concluded that this technique provided stable fixation, allowing early motion exercise by minimizing injury to the extensor mechanism and reduce cosmetic scar problems. The first comparative study, retrospective one concluded that the titanium cable -cannulated screw tension band group showed improved fracture reduction, reduced healing time compared the modified tension band group. In the modified tension band group, eight patients experienced wire migration, three of those requiring a second operation. There were no complications in the titanium cable-cannulated screw tension band group. Berg EE <sup>[18]</sup> evaluated the midterm functional outcomes of patients with isolated operatively treated patella fractures.

Our series present the open technique, relevant in the Indian setup. In this study the males outnumbered the females, consistent with the literature. The most common mode of injury was simple fall and the most common side involved was the left. Majority of the fractures (60%) were simple fractures. Mean time to achieve union was 10.7 weeks (Range 8-12 weeks). Mean ROM at the end of 3 months was 113.8° (90-130) and at final follow up this movement improved up to 125.4° (ROM 100-150). There was one case of loss of reduction in one case, one case of infection and one case of nonunion. No case of implant failure was observed. One patient developed knee stiffness which improved over 6 months with useful quadriceps exercises.

This study is a good alternative to modified tension band wiring. The construct being biomechanically stronger allows early regaining of full or useful range of motion, with less chances of implant failure and soft tissue irritation, thus minimizing need for second surgery.

Type of operation	Excellent		Good		Fair		Poor	
	No.	%	No.	%	No.	%	No.	%
Fixation with screws	15	83.33	2	11.11	1	5.55	--	--

**Conclusion:** The criteria for surgery, open reduction and internal fixation with multiple cannulated cancellous screws with anterior cerclage was if > 3mm displacement and > 2mm articular step off was present. The screws provide rotation control of fragment and anchorage of cerclage wire. It provides additional compression across the fracture site. ORIF with cannulated cancellous screws with anterior cerclage /TBW is a safe, reliable and reproducible method in the management of transverse or transverse with comminuted fractures, with less chances of implant failure and less soft tissue irritation.

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