International Journal of Orthopaedics Sciences

E-ISSN: 2395-1958
P-ISSN: 2706-6630
IJOS 2021; 7(4): 331-334

www.orthopaper.com
Received: 19-08-2021
Accepted: 21-09-2021

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Evaluation of patella fractures managed by augmented cannulated cancellous screw fixation: A prospective study

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DOI: https://doi.org/10.22271/ortho.2021.v7.i4e.2903

Abstract
Patella is an important part of the extensor mechanism of the knee hence proper management of patellar fractures is necessary to prevent any complications. We conducted this study to evaluate cannulated cancellous screws as a modality of fixation for transverse fractures of patella. 63 patients of patella fracture were admitted, operated and followed who were managed by the above mentioned technique and based on our observation and results we recommend augmented cannulated cancellous screw as a better implant as compared to other contemporary implants for patella fracture fixation.

Keywords: Patella fractures, augmented cannulated cancellous screw fixation, sesamoid bone

Introduction
The patella is the largest sesamoid bone in the body and is located within the tendon of the quadriceps. The patella is triangular in shape with apex which is directed distally. The patella has a superficial location therefore is more prone for injury. Fractures of the patella account for approximately 1% of all skeletal fractures. Comminuted fracture patterns are often the result of high-energy direct injuries. Indirect injuries occur secondary to the large forces that are generated through the extensor mechanism, and typically result from forceful contraction of the quadriceps.

Material and Methods
Our prospective randomized clinical trial entitled was conducted in the Department of Orthopaedics, Shri Mahant Indiresh Hospital, Dehradun, from 1st June 2018 to July 2020.
The study subjects were chosen as per the inclusion and exclusion criteria:
Inclusion criteria were patients aged above 16 years, transverse fracture pattern, compound fracture type 1 (wound size <1 cm) and the exclusion criteria were Ipsilateral osteoarthritic changes in patellofemoral compartment, fractures in adults >60years, fracture in neurovascular compromised patient, comminuted fractures, associated ligamentous injury, compound fracture type $\geq$ 2 (wound size $\geq$ 2cms) and any operative procedure done in the ipsilateral extremity.

Surgical technique
- Under tourniquet control a longitudinal midline incision was used to expose the fracture site. The retinacular tears were identified and the knee joint inspected for loose fragments and cartilage damage (osteochondral fractures) and retinacular tears were identified. The fracture fragments were anatomically reduced and held using patellar reduction clamps. Articular congruity was assessed by digital palpation through the retinacular tear in cases it was present or by doing a medial arthrotomy through the retinaculum and was confirmed on fluoroscopy. Two parallel guide wires of 1.2 mm diameter were passed approximately 5-10 mm from the articular surface in the anterior third of patella and having 2 cm distance between the wires in the coronal plane and their position checked under image intensification.

- Screw lengths were confirmed, and the fracture fragments were drilled over guidewires using cannulated drill bit (3.2 mm). Cannulated screws (4.0 mm in diameter) of required length were inserted over the guidewires through the fracture fragments from above downward. An 18G stainless steel wire was passed through the cannulated screws and crossed over the anterior aspect of the patella in figure of 8 pattern. The wire ends were then tightened with the knee in full extension. 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. Final stability of the construct was tested by taking the knee through the range of motion. Finally, the soft tissues were repaired including the extensor retinaculum and the wound closed and the knee immobilized in a hinged knee brace in extension.
- Immediate post operatively from day 1 full weight bearing, quadriceps strengthening exercises and knee ROM exercises was started as per the pain tolerance of the patient with ROM brace. Patient was discharged after first dressing on 3rd post op day and stitch removal was done on 12th post op day. Patients were reviewed and evaluated in the OPD with serial x -rays and knee range of motion on 4th, 8th, 12th and 24 weeks based on VAS/NRS, Lysholm Score and Bostman Score. The functional outcome in the follow up was assessed by the VAS/NRS, Lysholm Score and Bostman Score while the Radiological follow-up was done to check for loss of reduction and time to achieve the radiological union.

Observation and Results

We carried out a study entitled "Analysis of functional outcome of patients with transverse fracture patella treated by cannulated screws with tension band wiring" in the Department of Orthopaedics, Shri Mahant Indiresh Hospital, Dehradun, from 1st June 2018 to July 2020 with 63 patients out of which none were lost to follow up.

Table 1: Distribution of study population according to gender

Gender	Frequency	Percent
Male	37	58.7%
Female	26	41.3%
Total	63	100.0%

The study population consisted of 37 (58.7%) males and 26 (41.3%) females.

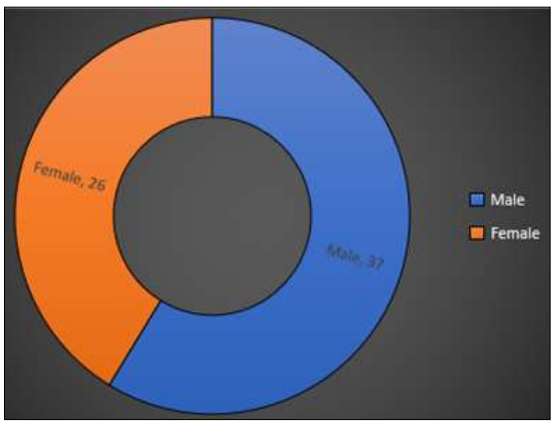

Fig 1: Distribution of study population according to Mode of injury

Table 1: Fall from stairs was reported by 20 (31.8%), Fall on ground by 16 (25.4%) and RTA among 27 (42.8%)

Mode of injury	Frequency	Percent
Fall from stairs	20	31.8%
Fall on ground	16	25.4%
RTA	27	42.8%
Total	63	100.0%

Fall from stairs was reported by 20 (31.8%), Fall on ground by 16 (25.4%) and RTA among 27 (42.8%).

Table 2: Distribution of study population according to Type of injury

Type of injury	Frequency	Percent
Compound	7	11.1%
Simple	56	88.9%
Total	63	100.0%

The injuries reported were Compound among 9 (14.3%) and Simple among 54 (85.7%) subjects.

Table 3: Comparison of Lysholm score at different time intervals

Lysholm score	Mean	Std. Deviation	F-value	p-value
4 weeks	80.00	2.42	34.047	< 0.001*
8 weeks	85.94	3.85		
12 weeks	90.17	3.71		
24 weeks	93.63	3.03		

The mean Lysholm score was compared between 4 weeks, 8 weeks, 12 weeks and 24 weeks using the repeated measures ANOVA test. There was a significant difference in mean Lysholm score between 4 weeks, 8 weeks, 12 weeks and 24weeks.

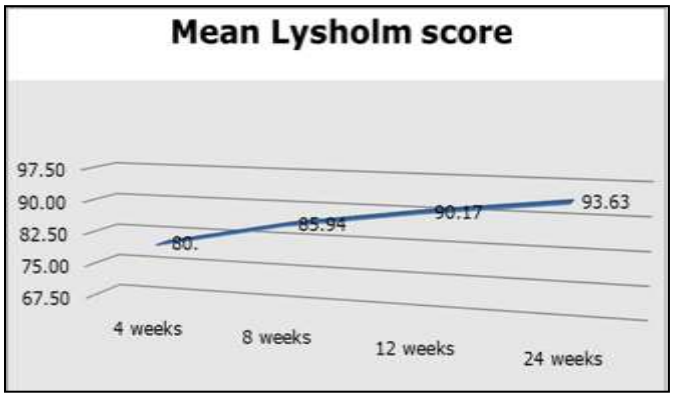

Fig 2: Mean Lysholm score

Table 4: Comparison of NRS score at different time intervals

Knee range of motion	Mean	Std. Deviation	F-value	p-value
4 weeks	82.90	9.74	10.919	< 0.001*
8 weeks	107.45	10.02		
12 weeks	122.90	7.28		
24 weeks	131.74	5.86		

Table 5: Comparison of Knee range of motion score at different time intervals

Knee range of motion	Mean	Std. Deviation	F-value	p-value
4 weeks	82.90	9.74	10.919	< 0.001*
8 weeks	107.45	10.02		
12 weeks	122.90	7.28		
24 weeks	131.74	5.86		

Fig 3: Mean Knee range of motion

Table 6: Comparison of Bostman score at different time intervals

Bostman Score	Mean	Std. Deviation	F-value	p-value
4 weeks	17.49	2.46	6.591	< 0.001*
8 weeks	23.73	2.84		
12 weeks	27.40	1.33		
24 weeks	28.97	1.08		

Table 7: Distribution of Bostman score at different time intervals

Bostman Score	4 weeks		8 weeks		12 weeks		24 weeks	
	N	%	N	%	N	%	N	%
Excellent	0	0.0%	4	6.3%	32	50.8%	56	88.9%
Good	15	23.8%	51	81.0%	31	49.2%	7	11.1%
Unsatisfactory	48	76.2%	8	12.7%	0	0.0%	0	0.0%
Total	63	100.0%	63	100.0%	63	100.0%	63	100.0%

$\chi 2$ value = 187.335, p-value < 0.001*

The comparison of Bostman Score was compared between 4 weeks, 8 weeks, 12 weeks and 24 weeks using the chi-square test. Bostman Score improved significantly from 4 weeks to 24 weeks.

Table 8: Distribution of Radiological Union at different time intervals

Radiological Union	Frequency	Percent
8 weeks	14	22.2%
12 weeks	39	61.9%
16 weeks	10	15.9%
Total	63	100.0%

Radiological Union took 8 weeks among 14 (22.2%), 12 weeks among 39 (61.9%) and 16 weeks among 10 (15.9%).

Table 9: Distribution of complications at different time intervals

Complication	Frequency	Percent
No	58	92.1%
Joint stiffness	3	4.8%
Superficial infection	2	3.2%
Total	63	100.0%

Joint stiffness was reported among 3 (4.8%) and Superficial infection among 2 (3.2%) subjects.

Discussion

The widely accepted surgical technique for patella fracture management is open reduction and the modified tension band technique [1, 2]. The application of cannulated cancellous screws with anterior tension band wiring is a relatively new technique in the management of transverse patella fractures.

The first biomechanical study was done by *Burvant et al.* who compared the methods of fixation of patella fractures [3] including modified TBW, anterior tension band with supplemental cerclage wiring (Pyrford technique) and anterior tension band with cannulated cancellous screws. Pyrford technique used cancellous screws and cancellous screws alone. The technique of tension band with screws performed significantly better than the modified tension band [4, 5, 6]. The second biomechanical study done by *Carpenter et al.* compared the mechanical effectiveness of three different techniques for stabilization of transverse fractures of the patella [7] (a) modified tension band (AO technique); (b) two parallel 4.5-millimeter interfragmentary lag screws; and (c) a new technique using four-millimetre cannulated lag screws with a tension band wired through the screws. The study concluded that combining interfragmentary screw fixation with the tension band principle appeared to provide improved stability over the modified tension band or screws alone for transverse patellar fractures [1].

Qi used bioabsorbable cannulated lag screws and braided polyester suture tension bands and concluded that this new double fixation technique resulted in satisfactory outcomes for patellar fractures [7]. The first comparative study was done by *Tian*, and concluded that the titanium cable-cannulated screw tension band group showed improved fracture reduction, reduced healing time and better Iowa score compared with the modified tension band group [8].

Hoshino compared the incidence of complications after tension-band fixation of the patella with Kirschner wires as compared with cannulated screws and observed symptomatic implants, as the most common complication and were twice as frequent in patients treated with Kirschner wires [9].

In our study, the study population consisted of 58.7% males and 41.3% females. This was in concordance with the literature. The mean age of the study population observed in my study was 37.60±13.73 (16-58) years.

In the mode of trauma, fall from stairs was reported by 31.8%, fall on ground by 25.4% and road traffic accidents (RTA) among 42.9% in our study.

The most common injury reported in our study was 34C1.1 (76.2%) with simple fractures accounting to 88.9% and 11.1% were compound fractures.

In our study, the LYSHOLM Knee Scoring Scale improved significantly from 4 weeks to 24 weeks (80.0 to 93.63). The mean Knee range of motion score in our study increased significantly from 4 weeks (82.90) to 8 weeks (107.45) to 24 weeks (131.74).

The BOSTMAN SCORE on successive follow ups improved significantly from 4 weeks to 24 weeks (17.49 to 28.97). Excellent and Good score was significantly more at 24 weeks accounting to 88 % of the patients.

The mean time to achieve radiological union in the current study was 11.75±2.48 weeks. The complications were reported in 5 (8.0%) patients with 3 patients (4.8%) having joint stiffness and 2 patients (3.2%) reporting superficial infection that healed. There were no cases of implant migration, painful hardware or loosening of the construct.

An advantage of cannulated screws is the potential for percutaneous application. Currently, several treatment options have been introduced for displaced transverse patellar fractures, including cannulated screws as well as cannulated screws with a tension band wire or a titanium cable placed through a screw [10, 11].

This relatively new technique 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 the need for a

second surgery.

The findings of present study provide and insight of evaluation of use of cannulated screws with tension band wiring for transverse patella fractures in adult age group patients. The present study was an exhaustive account of patient evaluation and provided some insights regarding the fracture and its management and follow up periods. However, on comparison of similar studies at 12 and 24 weeks, the results of present study were better in some criteria and similar to others in some. Hence it could be said that at final follow up overall results were not significantly altered. The limitation of our study is that there is no direct comparison between modified TBW (conventional treatment) and this technique.

Fig 4: Pre-operative x-ray

Fig 5: Post-operative X-ray at 4 weeks

Fig 6: Post-operative X-ray at 8 weeks

Fig 7: Post-OP X-ray at 12 weeks showing union

Conclusion

The observations and experiences during the course of this study helped us to conclude that treatment of transverse patella fracture with cannulated screws provides rigid inter fragmentary compression by the screws itself which can be further augmented by the tension band, thus, providing a secure and superior initial fixation strength and help in decreasing the chances of reduction loss through the compression of two bony fragments.

Tension band wiring with K-wires is the most common management option for transverse fractures of the patella; but problems commonly associated with the use of K wires (hardware related issues like migration, bending and breakage of k wires and irritation to skin, soft tissue; adventitious bursa formation) are not encountered with the use of cannulated cancellous screws. Early and continuous physiotherapy following the cannulated screws with tension band wiring technique is of paramount importance in determining the end results.

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