International Journal of Research in Orthopaedics
Khemkar SM et al. Int J Res Orthop. 2023 Nov;9(6):1261-1266
http://www.ijoro.org

DOI: https://dx.doi.org/10.18203/issn.2455-4510.IntJResOrthop20233274

Case Series

Inter-fragmentary compression using cannulated cancellous screws augmented with modified tension band wiring in transverse patella fractures

Sachin M. Khemkar[1]*, Eknath D. Pawar[2], Sandeep V. Gavhale[2], Mrinal M. Kambli[2], Vivek Chavan[2], Nihar Modi[2]

[1]Department of Orthopaedics, Seth GSMC and KEM Hospital, Mumbai, Maharashtra, India
[2]Department of Orthopaedics, Grant Government Medical College and Sir JJ Group of Hospitals Mumbai, Maharashtra, India

Received: 21 September 2023
Revised: 10 October 2023
Accepted: 18 October 2023

***Correspondence:**
Dr. Sachin M. Khemkar,
E-mail: sachinkhemkar@gmail.com

ABSTRACT

The classical Kirschner wires and tension band wiring technique, described by the AO foundation, has been the most widely used method for transverse patella fractures. In this study, we have adopted what we perceive to be an improved technique, the cannulated cancellous screws with modified tension band wiring. 20 patients with transverse patella fractures were included in our prospective single-blinded randomized control study with a duration of 3 years. All patients were operated on with modified tension band wiring with a 4 mm cannulated cancellous screw. Functional evaluation was made using the Tegner lysholm knee scoring scale. Roentgenograms were taken in AP and Lateral views to look for signs of radiological union and interfragmentary gap. The post-operative interfragmentary gap between fracture fragments with 65% of patients having a 0 mm gap, 25% of patients having a 1 mm gap, 5% of patients having a 2 mm gap, and 5% of patients having a 3 mm gap. The mean duration for the radiological union was 10 weeks. Mean Tegner lysholm score at 6 months was 88±4.7. We concluded that modified tension band wiring with cannulated cancellous screw is a safe, reliable, and better alternative method of fixation for transverse patella fractures with excellent union rate, range of motion, and functional outcome.

Keywords: Transverse patella fractures, Tension band wiring, Cannulated cancellous screw, Tegner lysholm score

INTRODUCTION

Fractures of the patella constitute only 1% of all skeletal fractures.[1] About 50-80% of patellar fractures are transverse (Arbeitsgemeinschaft für Osteosynthesefragen classification: 34-C1) and are likely to disrupt the extensor mechanism of the knee, making operative management necessary.[2]

When the extensor retinaculum is torn, the quadriceps muscle displaces the superior fragment proximally, making adequate reduction of the patella fragments impossible by closed means and necessitating operative treatment.[3] In addition, fractures with articular incongruity of greater than 2-3 mm are at increased risk to develop post traumatic osteoarthritis.

Since the patella is subjected to strong tensile forces, patella fractures require rigid fixation with anatomical reduction.[4] Fixation can be achieved in different ways. The classical Kirschner (K) wires and tension band wiring (TBW) technique, described by the AO foundation, have been the most widely used: two parallel Kirschner wires (K-wires) are combined with figure of eight metallic

TBW.[5] The principle behind tension band wiring of patellar fractures is to resist bending loads across the fracture as the knee is flexed. But during extension, the tension band does not resist displacement at the articular side of the fracture site as effectively as it can in flexion.[6] The TBW technique is associated with failure from prominent hardware and postoperative discomfort.[7] Metal implants have to be removed as a result of local tissue irritation produced by the K-wires, which can also migrate.[8,9] Fixation can be also achieved using TBW through cannulated screws which aids in interfragmentary compression and also resists the displacement of articular side of the fracture during extension of knee.[10]

We have adopted what we perceive to be an improved technique, the cannulated cancellous screws with tension band wiring. Functional outcome depends on the ability to achieve early, pain-free, and stable range of motion. The purpose of this study was to assess the interfragmentary compression achieved by the cannulated cancellous screw and its functional outcome.

CASE SERIES

A prospective single blinded randomized control study to evaluate functional outcome of patella fractures treated with modified tension band wiring with cannulated cancellous screw was conducted from December 2020 and January 2022. 20 patients with displaced transverse patella fractures who are willing to participate and give informed written consent were included in our study.

Figure 1: Pre-operative X-ray knee (AP and lateral).

Figure 2: Midline approach.

Preoperative knee anteroposterior and lateral X-rays were done (Figure 1). All surgeries were performed under regional anesthesia. Surgery was performed on simple table in supine position using tourniquet. Using mid axial longitudinal approach to patella, incision was taken from 5cm above the superior pole of patella to the tibial tubercle (Figure 2). Full thickness flaps were developed medially and laterally to expose the anterior surface of patella. The knee joint was inspected for loose fragments and intraarticular damage to the cartilage and the retinacular tears were identified. Fracture surfaces were cleaned of blood clot and small fragments. Fracture fragments were reduced anatomically with pointed bone holding forceps (Figure 3).

Figure 3: Guide wires passed, and reduction held with pointed bone holding forceps.

Articular surface congruity was checked by palpation with a finger inserted through retinacular defect and confirmed on C-arm image on lateral views. First two K wires were inserted in the mid coronal plane perpendicular to fracture site under fluoroscopic guidance then replaced with two cannulated screw guide pins along the same tract to prevent inadvertent bending of this guide wire.

Then we drilled along the guide wire with an appropriate cannulated drill bit and, after measuring its depth, a partially threaded 4.0 mm cannulated cancellous screw was inserted along the guide wire making sure threaded part of screw that has crossed the fracture site either from superior or inferior pole of the patella based on the level of the fracture. The screw head remained proud of the patella cortex, and the threaded end of the screw should be close to, or embedded within, the patella.

For second screw same procedure was followed and an 18-gauge SS wire was negotiated along the guide wire tract in order to pass the SS wire inside screw. Second SS wire also passed in same manner. Inferior ends of SS wires were crossed over and knotted to superior ends of opposite SS wire anteriorly in figure of eight manner and tensioned simultaneously on both the sides to achieve equal compression medially and laterally, knots were buried in the soft tissue (Figure 4). The reduction was further confirmed with the help of C-arm, the retinacular repair was done if present (Figure 5). Knee flexion and extension

was checked on table for the stability of the fracture reduction. Wound wash given thoroughly. Drain kept when necessary. Wound closed in layers. Sterile dressing done. Limb was placed in extension in a long knee brace.

Figure 4: Modified TBW with CC screw.

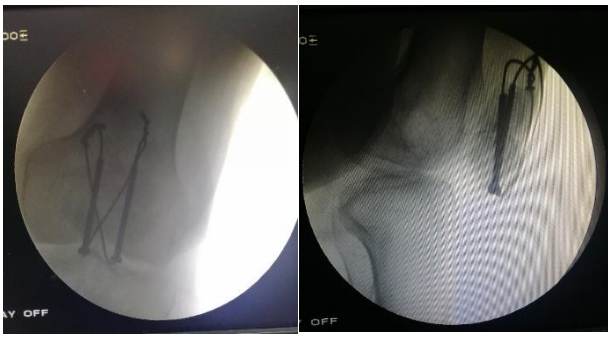

Figure 5: C arm image of modified TBW with CC screw (AP and lateral).

Figure 6: Immediate post-operative X-ray knee (AP and lateral).

Post operatively, compression bandage was applied. Check X-ray in AP and lateral views were done (Figure 6). Parenteral antibiotics were given for a period of 3 days. Wound was inspected on the 3rd and 5th post-operative day. Isometric quadriceps and hamstring exercises were started from post-operative day one. Passive ROM from 0 to 30 degrees was started in the first week and active ROM from 0 to 30 degrees was started in the second week. Sutures were removed between the 12th and 15th post-operative days.

Figure 7: Clinical images showing functional outcome of knee.

Partial weight bearing walk with walker was started from second week. Range of motion was gradually increased to 0-90 degrees in the 3rd and 4th week. At the end of 6 weeks full weight bearing and ROM of up to 120 degrees was achieved. Radiological outcome was assessed by postoperative interfragmentary gap and union at the fracture site (Figure 7). The functional outcome was assessed using Tegner-Lyshlom score, and knee range of motion at 6 weeks, 3 months, and 6 months follow-up (Figure 7).

Statistical analysis was done using statistical package for social sciences (SPSS 22.0 software. Variables were presented as mean with standard deviation or median with interquartile range and we also calculated frequencies with percentages.

Out of 20 patients, 14 (70%) were male and 6 (30%) were female. Patient age ranged from 22 years to 59 years with a mean age of 31.2±11.9 years. 60% of the patients had right sided involvement while in rest 40% left side was affected. 13 (65%) patients had road traffic accident as mode of injury (most common mode of injury), 7 (35%) patients had fall from height as mode of injury. Mean delay in surgery was 2.9 days. The mean duration of surgery was 77.25 min with standard deviation of 9.79. Post-operative interfragmentary gap was assessed between fracture fragments with 13 (65%) patients having 0 mm gap, 5 (25%) patients having 1 mm gap, 1 (5%) patient having 2 mm gap and 1 (5%) patient having 3 mm gap (Figure 1). Mean duration till radiological union was 10 weeks. Mean

tegner-lysholm score was 71.7±2.9, 79.9±3.9 and 88±4.7 at 6 weeks, 3 months, and 6 months respectively (Figure 2).

Range of motion of knee at the end of 6 months, out of 20 patients 10 (50%) patients had ROM of 0-135 degrees, 7 (35%) patients had ROM of 0-130 degrees, 1 (5%) patient had ROM of 0-120 degrees, 1 (5%) patient had ROM of 10-120 degrees and 1 (5%) patient had ROM of 10-90 degrees. 2 patients showed extensor lag of 10 degrees. 1 patient developed superficial infection who was managed with systemic antibiotics. None of the patients developed painful hardware, non-union or required revision surgery.

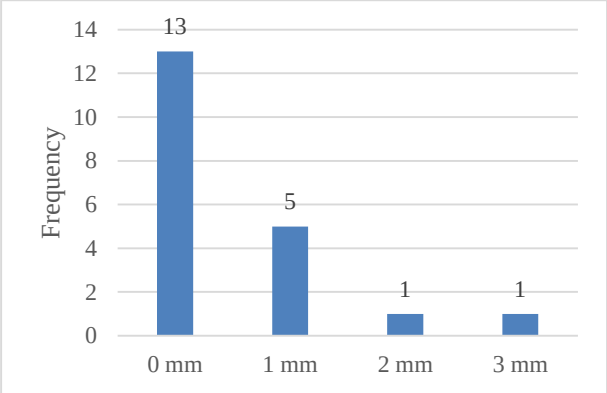

Figure 8: Post-operative inter-fragmentary gap.

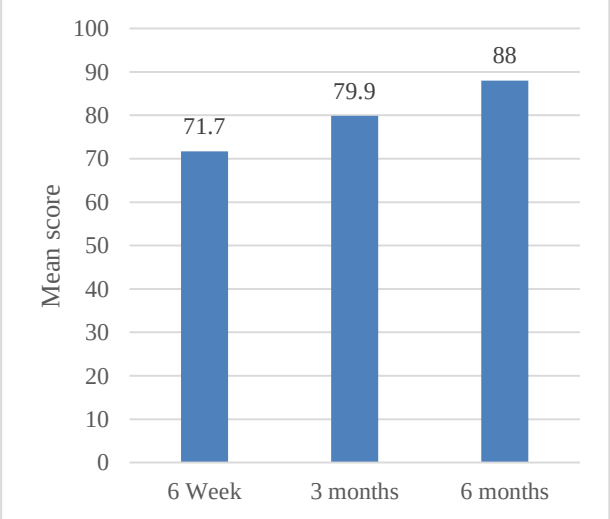

Figure 9: Tegner Lysholm score.

DISCUSSION

Patella fractures are one of the rarest fractures which accounts for only 1% of all adult fractures. Patellar fractures are prevalent within age group of 20-50 years old, and males are twice more affected than females. The injury mechanism may be either direct (most common) or indirect.

The deforming forces of quadriceps muscle and patellar tendon is the reason for the displacement of the fragments which is the reason for delayed or non-union. Hence the displaced transverse patella fractures necessitate fixation. Anatomical alignment and prevention of displacement is required for the fracture to unite. The widely accepted surgical technique for patella fracture management is open reduction and the modified tension band technique.

The application of cannulated cancellous screws with anterior tension band wiring is a relatively new technique in the management of transverse displaced patella fractures. The first biomechanical study was done by Burvant et al who compared five methods of fixation of patella fractures including modified TBW, anterior tension band with supplemental cerclage wiring (Pyrford technique), anterior tension band with cannulated cancellous screws, Pyrford technique with cancellous screws and cancellous screws alone.[13]

The technique of tension band with screws performed significantly better than the modified tension band. The second biomechanical study done by Carpenter et a1 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 four-millimetre cannulated lag screws with a tension band wired through the screws.[14] Fractures stabilized with a modified tension band were found to displace significantly more than those fixed with screws alone or screws plus a tension band in simulated knee extensions ($p<0.05$). Modified tension band wiring with K wire has some common like implant irritation, migration of k wires which leads to pain and poor functional outcome.

The K wires in tension band wiring technique does not by itself generate compression force at fracture site, rather the compression effects are provided by anterior tension band wire leading to maximum compression occurring at the anterior half of patellar surface than on the articular surface. The compression forces are not uniform throughout the fracture site. Due to smooth geometry of K wires, loosening of K wire with time is more common ad further requiring reoperation to remove hardware. The cannulated cancellous screw is more rigid and primary compression can be achieved by screws alone. Anterior tension band gives additional protection. As screw length is matched to patellar height, prominence of hardware with lesser incidence of soft tissue irritation pain and necessity for implant removal.

The fracture healing time in our study was 10 weeks. Statistical analysis was also performed to see the effect of age, gender, side of injury and associated comorbidities on rate of healing (time taken for radiological union).

Table 1: Comparison of our study with other similar studies.

Study	N	Mean radiological union in weeks	Functional outcome at final follow up (lysholm score)	Percentage of patients with	
				Superficial infection	Soft irritation that necessitated hardware removal
Our study	20	10	88±4.7	5	0
Abdel-Moneim et al[11]	21	9	87.8±5.3	9.5	4.7
Vij et al[12]	63	11	93.63±3.03	3.2	0
Revs et al[15]	24	Not clear	IOWA criteria (excellent)	8.3	0
Khan et al[16]	25	12.4	Bostman score (26.4)	0	0

It was found out that age, gender, and side of injury does not have any effect of rate of healing. But time taken for radiological union was higher in patients with at least one associated medical comorbidity (diabetes, hypertension, IHD etc) as compared to those without any associated medical comorbidities. Studies conducted by Abdel-Moneim et al, Vij et al, Revs et al and Khan et al showed similar results with radiological union (Table 1). [11,12,15,16]

Significant compression was achieved at the fracture site with 90% patients having less than 1 mm interfragmentary gap. 1 patient developed superficial infection who was managed with systemic antibiotics and recovered completely. 2 patients developed extensor lag of 10 degrees at the end of 6 months.

Abdel-Moneim et al in their study had complications rate of 2/21 (9.5 %).[11] Two patients experienced skin irritation from wire tails, one of them required implant removal at 9 months postoperatively. No cases of implant failure, implant migration or soft tissue irritation were observed in our study and these findings were comparable to the above-mentioned studies.

CONCLUSION

Cannulated cancellous screw achieves significant inter-fragmentary compression at the fracture site, and it is further augmented with modified tension band wiring which provides a secure and superior initial fixation strength and decrease the chances of loss of reduction, and we conclude that this construct being biomechanically stronger allows early useful range of motion, with less chances of implant failure and soft tissue irritation, thus minimizing the need for a second surgery.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: Not required

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Cite this article as: Khemkar SM, Pawar ED, Gavhale SV, Kambli MM, Chavan V, Modi N. Inter-fragmentary compression using cannulated cancellous screws augmented with modified tension band wiring in transverse patella fractures Int J Res Orthop 2023;9:1261-6.