

A Comparative Study of Surgical Techniques in the Management of Patellar Fractures

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Abstract

Background: The largest sesamoid bone in the body, the patella, is essential to the stability and functionality of the knee. It functions as a fulcrum to adhere to the patellar ligament and quadriceps tendon, increasing the quadriceps effectiveness. Fractures with minimal displacement and intact extensor mechanism are managed conservatively. However, patellar fractures with disrupted extensor mechanism, displacement of more than 1 to 4 mm and articular step-off of more than 2 to 3 mm are managed surgically. We reviewed the three fixation strategies for management of patellar fractures which included metal fixation, suture fixation or a hybrid method combining the two.

Aims and Objectives: To study the clinico-radiological outcomes of the various surgical techniques used in the management of patellar fractures.

Methods and Materials: Thirty-six eligible patients underwent patella fracture fixation over a two year period from January 2023 to December 2024. As determined by fracture configuration, patients received (1) suture fixation (Transosseous sutures and figure-of-eight tension banding with FiberWire), (2) Hybrid fixation (transosseous FiberWire sutures and metal tension banding), or (3) metal fixation. Primary outcome measures included re-operation rates and soft tissue irritation. Secondary outcomes included surgical complications, radiological, and functional parameters.

Result: Re-operation rate was the highest for metal fixation (7/12, 58 %) and lowest for suture fixation (0/11, 0 %). There was an increase in patella baja (8/36, 22 %) and reduction in Insall-Salvati ratio (0.742; 95% confidence interval: 0.682-0.802) following suture fixation as compared to the other two fixation methods ($P < 0.05$). **Conclusion:** Patients should be counselled regarding the expected sequelae of their fixation method. Suture fixation is the favoured means to fix distal pole fractures of the patella. An additional metal tension band loop may confer additional stability but should be applied with caution.

Keywords: Patellar Fracture, Suture Fixation, Metal Tension Band Loop.

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Introduction

Patellar fractures are common, accounting for 1% of all the skeletal injuries [1]. In the presence of significant fracture displacement and articular incongruity, open reduction and internal fixation is the standard of care to restore quadriceps function and prevent the development of post traumatic arthritis [2]. Classically, the AO-technique for patellar fixation utilizes axial K-wires in combination with anterior tension banding [3]. Screw fixation, both with and without tension banding for reinforcement, is another option [4]. As a result of utilizing metallic implants, patients commonly complain of soft tissue irritation over the knee. More than one-third of patients subsequently require secondary procedures for implant removal to provide symptomatic relief [5].

An alternative to metallic implants is to utilize suture-based fixation methods, or a hybrid method combining suture fixation with metal tension banding [6,7]. Extra osseous suture fixation via circumferential cerclage in combination with anterior tension banding has also been described [8]. Under controlled conditions, these studies demonstrate a reduction in implant-related sequelae and similar functional outcomes as compared to traditional fixation methods. Here, we compare the results of 3 fixation techniques viz (1) suture fixation (Transosseous sutures and figure-of-eight tension banding with FiberWire), (2) hybrid fixation (Transosseous FiberWire sutures and metal tension banding), or (3) metal fixation, operated over a 2 year period. Our primary

objective was to evaluate the re-operation rates for the 3 fixation methods due to symptomatic hardware and otherwise. We also evaluated for surgical complications and radiological and functional outcomes after a minimum of 6 months of follow-up.

Aims and Objective

To study the clinico-radiological outcomes of the various surgical techniques used in the management of patellar fractures.

Material and Methods

Inclusion and Exclusion Criteria: This prospective study was carried out in the Department of Orthopaedics, Government Medical College, Srinagar over a period of two years, spanning from January 2023 to December 2024. An institutional ethical clearance was sought before the study. Informed written consent was taken from all the patients before participation in the study. All the patients with patellar fractures with disrupted extensor mechanism, displacement of more than 1 to 4 mm and articular step-off of more than 2 to 3 mm were included in the study. Patients with open fractures, polytrauma patients, patients with inflammatory arthropathy, pre-existing limb deformity or delayed presentation were excluded from the study. A total of 45 patients were identified, out of which 09 patients were excluded. Hence, a total of 36 patients were included in the study. After admission in the hospital, the patients were thoroughly examined and evaluated. Standard antero-posterior radiographic views of the knee were taken. After appropriate anaesthesia clearance, the patients were taken up for surgical fixation.

Patient Demographics: Of the 36 included patients, there were 22 males and 14 females with an average age of 60.0 ± 15.4 years (14-70 years).

A total of 11, 13, and 12 patients received fixation by means of suture, hybrid, and metal fixation, respectively. Slip and fall injury on level ground was the most common mechanism of injury, accounting for 55 % of the cases (n=20), followed by dashboard injury in 36 % patients (n=13). Average operation time was approximately 60 minutes and did not demonstrate statistically significant differences between groups (P value 0.414). A follow-up period of 12 months or more was attained in 34 patients (94.44%), while for the rest a follow up of 6-12 months was attained.

Determination of Fixation: The decision regarding the fixation method of the fractured patella was determined intra-operatively by the senior two surgeons based on the fracture morphology and the degree of comminution. Distal pole fractures were managed with pure suture fixation using trans-osseous sutures supplemented by a figure-of-eight anterior tension band suture, while those considered to require further stability received hybrid fixation with rigid metal tension banding to prevent anterior displacement of fracture fragments in addition to trans-osseous sutures. Transverse and comminuted intraarticular fractures were treated by metal fixation. For the former, we utilized the AO-technique of axial K-wires in combination with anterior tension banding. Implant configuration in the latter often necessitated additional augmentation to achieve stability.

Surgical Technique: All the cases were operated upon by the two senior authors. An anterior midline approach to the patella was adopted with exposure from the superior pole down to the patellar tendon. Reduction was achieved with the aid of bone clamps, and temporary intra-osseous K-wires.

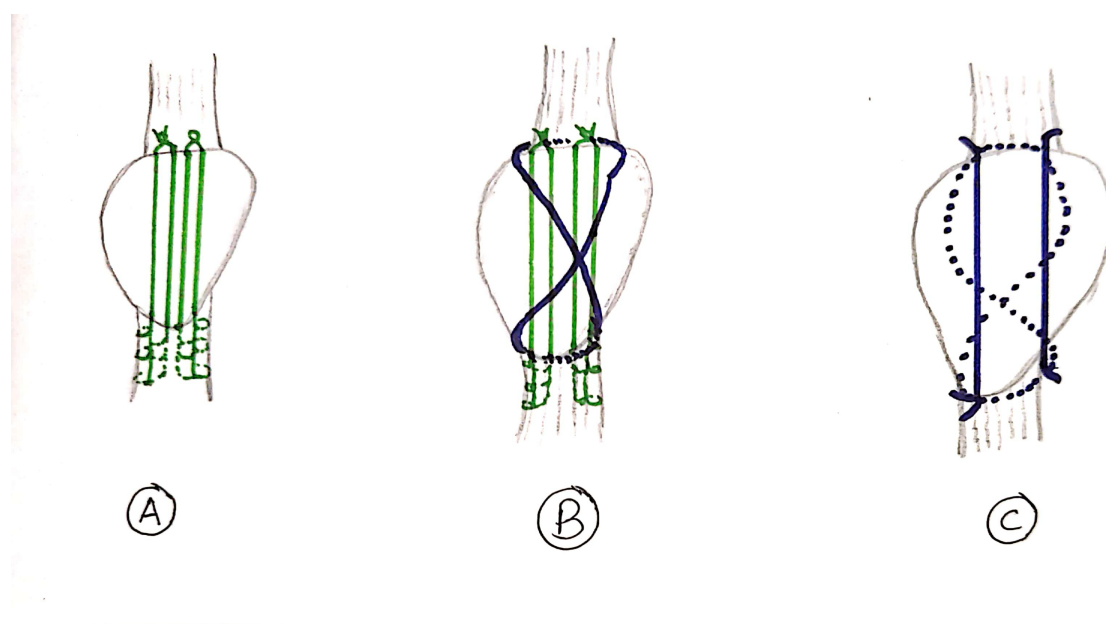


Figure 1

For suture-based fixation (Figure 1A), two loops of 2-FiberWire were anchored to the patella tendon substance distally in the krackow configuration, resulting in 4 suture limbs. Three axial transosseous tunnels spanning the proximal fracture fragment were created using 1.6-mm K-wires. A needle passer was inserted through the tunnels from proximal to distal to retrieve the suture limbs; central sutures from both loops were passed through the middle tunnel. After fracture reduction, sutures were tied over the proximal pole of the patella. An anterior FiberWire figure-of-eight tension band provided further reinforcement.

For the hybrid fixation method (Figure 1B), Transosseous Fibre wires were reinforced by a 1.25 mm metal figure-of-eight anterior tension banding. For the metal fixation (Figure 1C), two 1.6 mm axial K-wires were reinforced with 1.25 mm metal figure-of-eight anterior tension banding. Complex fracture patterns necessitated additional intraosseous K-wires together with circumferential metal cerclage to ensure stability.

Subsequent to fracture fixation, stability was noted throughout the passive range of motion of the knee. Torn extensor retinaculum was repaired, followed by closure of the subcutaneous and skin layers.

Postoperative Care and Follow-Up:

Postoperative radiographs were taken the day after surgery. Patients were given a hinged knee brace as protection post-operatively and allowed to weight

bear as tolerated. In general, 0 to 90 of flexion brace was allowed for the first 2 weeks postoperatively. Subsequently further flexion was achieved. Patients were discharged after attaining sufficient independence in ambulation and toileting and given their first follow-up appointment at 2 weeks postoperatively for wound inspection. Patients were followed up every 4 weeks to monitor for functional return and clinical/radiological fracture union and thereafter assessed at 3 to 6 month intervals.

Outcomes Measures: The primary outcomes of this study were the re-operation rates for the 3 fixation methods and the prevalence of symptomatic hardware causing soft tissue irritation. Secondary outcomes included surgical complications including hardware failure including breakage, dislodgement, non-union, infection, radiological parameters (union, patella baja, Insall-Salvati ratio), and knee function (return to pre-morbid walking status, knee range of motion). Fracture displacement was defined as an opening up of the fracture gap 3 mm compared to immediate postoperative radiographs. Non-union was defined as failure to achieve radiological bony union at 6 months' time. Re-operation for elective implant removal included patients scheduled for but yet to receive their surgery. Patellar height was calculated by measuring the Insall-Salvati ratio of most recent lateral knee X-rays, with a value < 0.0167 for subgroup analysis following the Bonferroni correction.

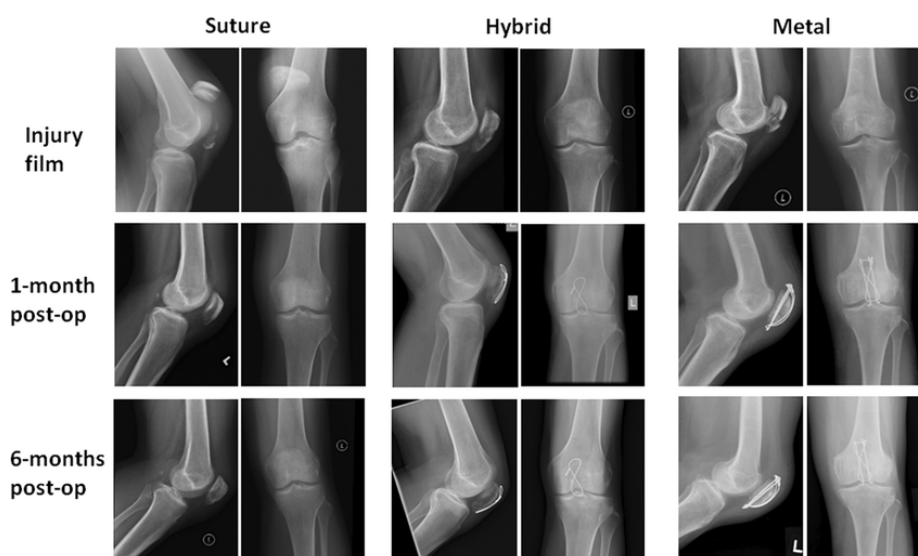


Figure 2:

Ethical Considerations: This study was approved by the Ethical committee of the college. Prior samples and data collection, the study objective was clarified to them. Informed written consent was obtained to participate in this study.

Statistical Analysis: The statistics package used to analyse the data was the Statistical Package for the Social Sciences (SPSS) version 16.0 and the statistics tests used for each analysis is detailed along with the results.

Results

We used the Speck and Regazzoni classification for classifying the patellar fractures and tailoring the fixation method. Simple distal pole fractures (B1) accounted for 4 of 11 and 8 of 13 of fractures receiving suture and hybrid fixation, respectively, while comminuted distal pole fractures (C3) accounted for 2 of 11 and 2 of 13 among the two groups. Comminuted intraarticular fractures (C3; 6/36) and simple transverse fractures (B2; 12/ 36) accounted for the majority of fractures receiving metal fixation.

For cases receiving suture fixation, we observed that none required an elective removal procedure, while as 3/13 patients with hybrid fixation required an elective implant removal procedure. Reoperation rate for implant removal was the highest for metal implant 58 % (7/12). Statistical analysis failed to demonstrate a significant correlation between fracture configuration and reoperation rate. Soft tissue irritation was the highest in metal group (8/12), while the least in suture group (1/11). Fixation failure in the form of suture breakage occurred in 1/11 suture group patients. However, none of the patients with hybrid or metal implants has implant breakage.

Other Surgical Outcomes: Non-union was demonstrated in 1 of 11 (9%), 1 of 13 (7.6 %), and

1 of 12 (8.3 %) patients receiving suture, hybrid, and metal fixation, respectively. No statistical significance could be demonstrated between the non-union rate and the method of fixation. The cases of non-union among suture and hybrid subgroups resulted from a failure to maintain anatomical reduction. Implant breakage and dislodgement was encountered in 1 of 11 (9%), 0 of 13, and 0 of 12 patients receiving suture, hybrid, and metal fixation, respectively. For the suture subgroup, this occurred as a result of FiberWire rupture during sitting to standing transfer. Differences between the 3 treatment subgroups failed to reach statistical significance (P value = .348). There were no cases of infection among our patient population.

Radiological and Functional Outcomes: A total of 5 of 11 (45%), 2 of 13 (15 %), and 1 of 12 (8%) patients receiving suture, hybrid, and metal fixation, respectively demonstrated patella baja, with statistical significance demonstrable between groups. Subgroup analysis specifically revealed a significant increase in the number of cases with patella baja following suture fixation as compared to hybrid fixation. Functional outcome was assessed by means of walking status and knee range of motion at final follow-up. Return to pre-morbid walking status was achieved in 11 (100%) of 11, 8 (61%) of 13, and 10 (83 %) of 12 of patients receiving suture, hybrid, and metal fixation, respectively. There was no difference in the number of patients with extension lag between the 3 groups, nor in the average angular deficit from full extension. Similarly, differences between treatment groups were insignificant with regard to patient's knee flexion range.

Discussion

This study describes the patients receiving operative intervention for patella fractures as well

as suture-based fixation methods [6, 7]. Implant-related soft tissue irritation resulting in anterior knee pain and subsequent need for implant removal is the most common complication following metal fixation. The prevalence of such sequelae should be discussed with patients in order to temper expectations. Meta-analysis with regard to surgical management of transverse patella fractures demonstrates that in general, 23% to 38% of patients receiving metal fixation experienced suboptimal results and postoperative pain/irritation. Following on, counts of hardware removal were reported to range from 5% to 100%. The study with the lowest reported rate of irritation and subsequent implant removal utilized a cannulated screw and cable construct, which was demonstrated to be superior to the traditional modified tension band technique [4]. Alternatively, utilization of suture-based techniques also results in a marked reduction in soft tissue irritation [10] and lessens the need for reoperation [7]. Fixation with biodegradable materials is another approach, but not as widely available or feasible [11]. The reduced incidence of soft tissue irritation was apparent in this work upon comparison of suture and metal fixation groups. Surprisingly, incidence of soft tissue irritation in the hybrid subgroup approached that of the metal subgroup and was around 4-fold that observed in patients receiving suture fixation alone. From our observation, the source of irritation in patients with metal hardware is often from the prominent terminal wire loop originating from the anterior tension band, which we fail to avoid when utilizing the hybrid fixation technique. Our overall incidence of non-union at 6 months among patients receiving metal fixation (1/12; 8.3 %) was elevated as compared to rates reported in existing literature [12]. Likely contributory factors in our cohort included the significant number of comminuted fractures, together with our criterion of achieving radiological bony union at 6 months despite many cases being asymptomatic with good function likely resultant from fibrous union having been achieved within this period of time. Incidence of non-union and fixation failure among patients receiving suture and hybrid-based fixation was statistically insignificant as compared to patients receiving metal fixation. Biomechanically, FiberWire has been demonstrated to have a higher load to failure than stainless steel [13,14]. Concerning fractures of the distal pole, suture-based techniques avoid the complications associated with partial patellectomy in relation to affecting patella height and impairing knee biomechanics [7]. However, we found a significant decrease in patella height following suture fixation. We hypothesize that a reduction in patella tendon length and excursion resulting from the use of locking sutures over the tendon substance, cause elongation and weakening, served to unbalance the

extensor mechanism. Following metal fixation, intra-osseous axial K-wires may impede progressive anterior translation of the tension band wire but are absent in the hybrid fixation construct. An obvious limitation of our study is in the heterogeneity of fracture configurations. Results should not be interpreted as a direct comparison between 3 different surgical options, as we have predominantly utilized suture-based techniques for tackling distal pole fractures and metal fixation for intraarticular fractures. The comparatively small numbers of fractures receiving suture and hybrid fixation likely contributed to the study being underpowered.

Conclusion

All means of fixation achieved acceptable outcomes. Our results allow us to counsel patients and manage their expectations on the prevalence of soft tissue irritation and reoperation with respect to the fixation method. Concerning clinical decision-making, our study encourages pure suture as opposed to hybrid fixation for patella fractures involving the distal pole. Although a supporting metal tension band loop in addition to trans-osseous sutures may confer additional stability, this technique should be utilized with caution as incidence of soft tissue impingement and reoperation is elevated. Further assessment and follow-up is required to determine whether the significant reduction in patella height consequent to suture fixation results in functional impairment and early osteoarthritis.

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