

A study to assess the functional outcomes of surgical intervention in patellar fractures and make a comparison between tension band wiring and partial patellectomy

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Abstract

Introduction: Surgical treatment of patellar fractures has evolved over the years. It ranges from partial or total patellectomy to open reduction internal fixation using tension band wiring and constructs. Previous studies have documented conflicting results regarding clinical and functional outcomes after surgical treatment of patellar fractures.

Aim: To assess the functional outcomes of surgical intervention in patellar fractures and make a comparison between tension band wiring and partial patellectomy.

Methods: 46 patients with patellar fractures were included in this prospective longitudinal study. Depending on the fracture type surgical intervention in the form of tension band wiring of the patella in 24 patients and partial patellectomy in 22 patients was done. Postoperatively, the functional outcomes were measured at three months, six months, and the latest follow-up. The outcome variables used were Knee Injury and Osteoarthritis Outcome Score (KOOS), extensor lag, range of knee flexion, thigh circumference, Medical Research Council (MRC) grading of quadriceps and hamstrings strength and complications in treated patients. Levene's test, T test and chi-square test were used to compare the these outcome variables.

Results: KOOS score was significantly better (P value of 0.001) and thigh wasting was less (P value of 0.09 and 0.412) at three and six months in the tension band wiring (TBW) group. Knee flexion (P value of 0.001) and extensor lag (P value of 0.02) had significantly better outcome in the TBW group at three months, but a similar outcome to the partial patellectomy group at six months (P value >0.05). All the patients had regained their full quadriceps/hamstring muscle strength at six months. Fracture union was assessed at six months and showed a significantly better union rate in tension band wiring when compared to partial patellectomy (P value < 0.05).

Conclusions: Operative management of patellar fractures gives good to excellent functional outcomes at short to midterm follow-up with minimal complications, irrespective of the type of procedure. Comparable functional outcomes can be expected following patellar osteosynthesis and salvage procedure. However, future studies with bigger sample size and longer follow-up are needed.

Keywords: Knee flexion, knee injury and osteoarthritis outcome score, partial patellectomy, patellar fracture, tension band wiring.

Introduction

Patellar fracture constitutes 1% of all fractures [1, 2]. Though a common injury, the treatment of the patellar fracture is subject to controversy. Fracture patella was known since Hippocratic times. A unified approach to treatment and outcome assessment of these relatively common injuries remains elusive. Options available are conservative management, open reduction, and internal fixation, partial or total patellectomy depending on fracture personality. Generally accepted indications for surgery are open fractures, articular step off of greater than 2 mm, fracture separation of greater than 3 mm and disruption of active knee extension [1, 3].

Despite advances in surgical treatment, results of patellar fracture treatment have remained unsatisfactory [3-7]. Goals for surgical treatment include anatomic reconstruction of the articular surface, restoration of extensor mechanism and stable fixation that permits early knee motion.

Surgical management ranges from reduction of the fracture and internal fixation to partial or total patellectomy.

Internal fixation using tension band wire fixation developed by the Arbeitsgemeinschaft für Osteosynthesefragen (AO)/Association for the Study of Internal Fixation (ASIF) has been the standard of care for operative fixation of patella fractures [8]. There is a general consensus regarding preservation of patella as biomechanical studies have indicated removal of patella results in 50% loss of quadriceps strength [9]. Partial patellectomy is therefore specifically indicated only in special circumstances when superior or inferior patellar poles are severely comminuted, or significant cartilage loss is there and 60% patella is remaining to avoid horizontal rocking [10].

There is paucity of data comparing internal fixation and partial patellectomy in terms of clinical and functional outcomes. Although predictable union rates have been achieved, little is known regarding how these intra-articular injuries affect health, quality of life, and lower extremity function. Despite advances in the surgical treatment of these fractures, objective functional outcome assessment in the mid- to long-term is sparsely reported [3, 11]. The purpose of the current study was to review the short to midterm functional results of the surgical treatment of patella fractures using standard well-described functional assessment techniques.

Materials & Methods

46 patients with acute, displaced, unilateral patellar fractures who were subjected to surgery as per standard operative indications and completed a minimum of six months follow-up were included in this prospective study. Indications for surgery were an articular step off of greater than 2 mm, fracture separation of greater than 3 mm and disruption of active knee extension. In all the patients, detailed clinical assessment and appropriate hemodynamic stabilization of the patient was done, followed by detailed history and clinical examination. Plain radiographs of the affected knee (anteroposterior and lateral views) were obtained. The patellar fracture was classified based on radiographs and intraoperative fracture configuration as per the AO-OTA classification [12].

Routine investigations like blood counts, serum electrolytes, blood sugar, chest x-ray, and electrocardiogram were done. A pre-anesthetic evaluation was carried out by an anesthetist for the proposed surgery. Limb elevation and active toe movements were encouraged. Analgesics were prescribed for pain and a posterior cylindrical Plaster of Paris slab extending from groin to lateral malleolus was given.

After taking informed consent, the patient was laid in the supine position on the operating table under suitable anesthesia. A single antibiotic dose of ceftriaxone (1 g) and Amikacin (500 mg) was given 30 minutes before starting the surgery. The parts were prepared and draped, the limb was exsanguinated, and a tourniquet was used. Standard surgical approaches and techniques were used for each fracture. The choice of surgical procedure Vis-a-Vis fracture classification was finally decided intraoperatively as per standard operative guideline [13]. A longitudinal straight midline incision was given starting from

a point 5 cm above the superior pole of the patella extending inferiorly till the tibial tuberosity. No internervous plane was made. Medial and lateral flaps were raised in line with skin incision to expose the retinaculae. Treatment modalities used were either internal fixation with tension band wiring (TBW) technique or partial patellectomy by the same group of surgeons.

Tension band wiring

Tension band wiring was the treatment of choice for displaced non-comminuted two-part transverse patellar fractures. If the fracture fragments were large, the reduction was achieved by using a reduction clamp and then drilling the K-wires through reduced fragments (outside-in technique) or by first drilling the wires into an unreduced fragment, followed by reduction and completion of fixation by drilling forward into the opposite main fragment, thus completing the fixation (inside out technique). K-wire was placed approximately 5 mm below the anterior surface of the patella or in the center of the patella. A sufficiently long 1.0 or 1.25 mm thick cerclage wire was pushed manually, as close as possible, to edge between bone and protruding pin tips. Cerclage wire was placed in the form of a figure-of-eight (single loop). It was attempted to keep the wire as close as possible to the bone throughout its whole course. The tips of cerclage were taken out laterally and tightened keeping the knee in extension, reduction confirmed by palpating the retro patellar surface.

Partial patellectomy

Partial patellectomy was indicated when comminution of the distal pole or a fragment of the patella was extensive and could not be stabilized with internal fixation. The articular edge of the proximal fragment was cleared of debris and clots with a curette. Beginning on the fracture surface of the proximal fragment just anterior to the articular cartilage, parallel drill holes were made in a proximal direction using a 2-mm K-wire (one hole in the center and one each in the medial and lateral thirds). Two heavy non-absorbable sutures, preferentially Ethibond (no 5), were woven through the patellar tendon, one through the medial and one through the lateral half of the tendon. A suture passer was used to pass the free proximal ends of the sutures through the holes in the patella. One suture was placed through the medial and lateral holes and two through the central hole. With the knee kept in slight hyperextension, the sutures were tied securely over the superior pole of the patella. Retinacular repair and closure of incision in layers were done. The wound was dressed, knee splinted, and the patient was shifted to the postoperative ward.

All the patients were given antibiotics until suture removal. In fractures amenable to intraoperative stable fixation following tension band wiring, early passive and active-assisted knee mobilization was instituted from 3rd to 5th postoperative day. Knee mobilization was delayed (six weeks) in patients where partial patellectomy had been done.

Postoperatively, the functional outcome was measured immediately, at three month and at six months follow-up. The outcome variables used were Knee Injury and Osteoarthritis Outcome Score (KOOS) (a 42-item self-administered knee specific questionnaire assessing pain, symptoms, activities of daily living, sports and recreation and knee-related quality of life in five different subscales. A score of 100 indicates no symptoms and 0 indicates extreme of scores) ^[14], extensor lag, range of knee flexion, thigh circumference, Medical Research Council (MRC) grading of quadriceps and hamstrings strength and complications in treated patients. Examination of the range of knee flexion at the knee was done with the patient in the supine position. Full knee flexion was approximately 135° (range 120-150°). A goniometer was used to measure the range of knee flexion. The inability to extend the knee against gravity while in the lying position or sitting position compared to the contralateral normal side helped in quantifying the extensor lag with the help of a goniometer. Thigh circumference was measured with a measurement tape 15 cm proximal to the superior pole of the patella and compared to the normal contralateral knee to determine the amount of quadriceps atrophy present. The power of quadriceps was examined by asking the patient to sit on a table and extend the knee against gravity or resistance offered by the examining doctor. It was compared with the contralateral limb to rule out any pre-

existing medical condition which may cause bilateral lower limb weakness.

Results

The mean age of the patients was 37.3 years (range 20-60 years). Of the 46 patients, 44 had an isolated, unilateral, closed fracture of the patella and two had an open knee injury with the patellar fracture. 24 patients (52.2%) underwent patellar osteosynthesis (tension band wiring) and 22 patients (47.8%) underwent patella salvage procedure (partial patellectomy).

Mean KOOS scores at three months and six months were 56.6 and 82.4 respectively. The average mean scores in group 1 (partial patellectomy) at three months and six months were 49.8 and 80.3 respectively. Average mean scores in group 2 (tension band wiring) at three months and six months were 62.8 and 85.9 respectively. There was a significant association of KOOS score to treatment modality. Better KOOS scores were present in the TBW group compared to the partial patellectomy group at three-and six-month follow up. (Table 1).

The range of knee flexion was categorized into three categories- good, fair, and poor. There was a significant association of KOOS score (P-value of 0.001) to treatment modality. The TBW group had a better range of knee flexion than partial patellectomy at three months but this difference was insignificant at six months. (Table 2).

Extensor lag was measured in degrees and was categorized into four categories. There was a significant association between treatment modality and extensor lag (P-value of 0.02). The TBW group had better knee extension than the partial patellectomy group at the three-month follow-up but this difference was insignificant at six months. (Table 3).

Mid-thigh circumference wasting (MTC) was divided into three categories. Both modalities showed similar outcome in terms of muscle wasting post intervention. (Table 4).

Medical research council (MRC) grading analysis of quadriceps/hamstring strength was done. Both treatment modalities had insignificant effect on MRC grading of quadriceps/hamstring strength at 3 months follow up. At six-month follow-up, all the patients were observed to have regained their MRC 5 quadriceps/hamstring muscle strength (Table 5).

Fracture union was analyzed at the end of six months (Table 6). Union was achieved in a total of 32 patients; 22 patients had a union in the TBW group and 10 in the partial patellectomy group. Non-union of the polar fragment was seen in 14 patients, 12 patients were of the partial patellectomy group and two belonged to the TBW group. A statistically significant ($P < 0.05$) association was seen in fracture union to treatment modality with a higher incidence of union in patients subjected to TBW.

The average KOOS score in patients with union of the fracture was 85.10 and in that of non-union was 78.97 at six months. When Levene's test for equality of variance and T-test for equality of means was applied, they showed a P-value of 0.001 ($P < 0.05$) which was significant, thus showing better KOOS score in fractures which have united.

The complications following surgery were assessed. There was implant prominence in two patients, K-wire migration in one patient, tension band failure in three patients, and surgical site infection in one patient and Ethibond knot prominence in one patient (Table 7).

Table I: KOOS scores three and six months postoperatively

	Treatment Modality	Number of Patients	Mean (SD)	P value (chi square)
KOOS at 3 months	PP	22	49.86 (7.05)	.001
	TBW	24	62.79 (11.24)	
KOOS at 6 months	PP	22	80.30 (4.81)	.001
	TBW	24	85.92 (5.98)	

KOOS: Knee Injury and Osteoarthritis Outcome Score; PP: partial patellectomy; TBW: tension band wiring; SD: standard deviation.

Table 2: Range of knee flexion at three and six months postoperatively

Range of knee flexion					P-value (chi square)
Period	Procedure	>120°	90° to 120°	<90°	
Three months	PP	1	20	1	.001
	TBW	13	10	1	
	Total	14	30	2	
Six months	PP	22	0	0	.522
	TBW	23	0	1	
	Total	45	0	1	

PP: partial patellectomy; TBW: tension band wiring.

Table 3: Extensor lag at three and six months postoperatively

Extensor lag						
Period	Procedure	0°-5°	6°-10°	11°-15°	>15°	P value (chi square)
3 months	PP	1	14	5	2	.02
	TBW	13	5	3	3	
	Total	14	19	8	5	
6 months	PP	18	4	0	0	.291
	TBW	22	2	0	0	
	Total	40	6	0	0	

PP: partial patellectomy; TBW: tension band wiring.

Table 4: Mid-thigh circumference wasting at three and six months postoperatively

Mid-thigh circumference wasting					P value (chi square)
Period	Procedure	>2.5cms	1.5 to 2.5cms	0 to 1.5	
3months N=46	PP	15	7	0	.09
	TBW	10	11	3	
	Total	25	18	3	
6months N=46	PP	3	8	11	.412
	TBW	6	5	13	
	Total	9	13	24	

PP: partial patellectomy; TBW: tension band wiring.

Table 5: MRC grading of quadriceps/hamstring at three and six months postoperatively

MRC Grading of quadriceps/hamstring				
Period	Procedure	MRC 4	MRC5	P value (chi square)
3 months N=46	PP	11	11	.148
	TBW	7	17	
	Total	18	28	
6 months N=46	PP	0	22	=46
	TBW	0	24	
	Total	0	46	

MRC: Medical Research Council; PP: partial patellectomy; TBW: tension band wiring.

Table 6: Fracture union at six months postoperatively

Treatment modality	Fracture union status		Total patients
	Union	Non union	
PP	10(45.5%)	12(54.5%)	22
TBW	22(91.7%)	2(8.3%)	24
Total patients	32	14	46

PP: partial patellectomy; TBW: tension band wiring.

Table 7: Postoperative complications

Complications	Number of patients	Percent
Implant prominence	2	4.34%
K wire migration	1	2.17%
TBW failure	3	6.52%
Ethibond knot prominence	1	2.17%
Post-operative SSI	1	2.17%
Total	46	

TBW: tension band wiring; SSI: surgical site infection.

Discussion

The objective functional outcome assessment following surgical intervention in patellar fractures is not well documented and the methods assessing outcome have been inconsistent [7]. Further, objective assessment of postoperative functional outcomes of these fractures is sparsely reported in the Indian context [12, 13]. This assumes significance due to the need for floor level activities of our patients as per their socio-cultural habits. Hence, the current study was envisaged to evaluate the outcome and complications seen in patients treated surgically for displaced intraarticular fracture of the patella.

The objective functional assessment in our study was done by using the KOOS score. It showed that the tension band wiring group had very good mean KOOS scores at three months and six months which were significantly better than the partial patellectomy group, implying that functional outcome was better in tension band wiring. It implies operative management of patella fractures gives good to excellent short to midterm functional outcomes. Lebrun *et al.*, on the contrary, had shown in their study of 40 patients who had been surgically intervened for patellar fracture, all KOOS subscale scores were significantly lower than published normalized population values [7].

At three months, in the tension band wiring group, more patients had better knee flexion, whereas, in the partial patellectomy group, there was only one patient with more than 120 degrees knee flexion. This might be due to the six-week-long splintage given in partial patellectomy group patients. This was in conformation with an earlier study done by Pailo *et al.* which concluded that early mobilization provided a wider range of motion at the knee joint [14]. However, we found that at six months, there was no significant difference between the range of knee flexion in the two groups. This was similar to the finding of a study conducted by Egol *et al.* [15].

At three months, tension band wiring patients had minimal extensor lag compared to the partial patellectomy group. This can be related to delayed knee mobilization protocol followed in the partial patellectomy group. However, similar to the range of knee flexion, there was no significant association of procedure to extensor lag at the six-month follow-up. This was in conformation with the previous study done by Srinivas *et al.* [13].

There was more wasting noted at three and six months in the partial patellectomy group as the patients' knee was splinted for a period of six weeks with only static quadriceps exercise being taught to them. This might be due to early mobilization at 2nd to 3rd postoperative day done in a group of patients who had undergone tension band wiring.

MRC grading analysis of quadriceps/hamstring function showed that at three months, patients operated with tension band wiring had better strength. At six months and later follow-up, all patients had MRC 5 grading in their quadriceps/hamstring strength. This study of MRC grading assessment of quadriceps/hamstring strength analysis was primitive and subjective as it provided no real information about the actual strength of muscle. Objective strength testing was not done in our study.

Fracture union was assessed at six months and showed a significantly better union rate in tension band wiring when compared to partial patellectomy. There were significantly better KOOS scores in fractures that had united. However, there was no significant association of mean KOOS score to fracture union at the latest follow-up.

We concluded that operative management of displaced, intra-articular patellar fractures gives good to excellent functional outcomes at short to midterm follow-up with minimal complications, irrespective of the type of procedure. Further, our study reveals that comparable functional outcomes can be expected following patellar osteosynthesis and salvage procedure. However, future studies with bigger sample size and longer follow-up are needed.

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