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# ORIGINAL ARTICLE

## FUNCTIONAL OUTCOME OF PATELLAR FRACTURES TREATED BY INTERNAL FIXATION: A RETROSPECTIVE STUDY

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**ABSTRACT: BACKGROUND AND OBJECTIVES:** Follow-up studies of displaced patellar fractures treated but various accepted contemporary internal fixation techniques have generally shown favorable results. However, reports of modest outcomes are not rare. The aims of this retrospective study were to review a series of patients with closed patellar fractures who a\were treated by internal fixation, and to determine the final functional outcome. **METHODS:** In this study of retrospective design, the hospital records and radiographs of the 43 identified patients with 43 closed patellar fractures, treated by internal fixation between November 2000 and June 2005 were reviewed. These patients were called for a final follow-up evaluation, and the latest functional outcome assessed as per the modified Hospital for Special Surgery knee scores. Results were analyzed and statistical significance determined by Chi-square test. **RESULTS:** Younger patients showed significantly better outcomes. Modified tension band wiring was the most commonly associated with symptomatic hardware requiring removal. Different fixation techniques fared favorably against each other. The final functional outcome assessed using the modified Hospital for Special Surgery scores was encouraging with excellent or good results in 74%. Interpretations and conclusions: Operatively treated closed patellar fracture with accepted fixation techniques eventually result in a satisfactory return of knee function. Complications, particularly symptomatic hardware requiring removal, are not uncommon.

**KEYWORDS:** Patella; fracture; tension band; internal fixation; extensor lag; knee function.

**INTRODUCTION:** Patella – the largest sesamoid bone in the body to an integral part of the extensor mechanism of the knee joint.[1] This mechanism is important to the knee joint in stabilizing it during extension, for adopting the erect posture. By providing an increased lever arm to the extensor mechanism patella offers a greater mechanical advantage to the quadriceps power.[2] When this mechanism is disrupted, as in a situation like fracture patella, it has a destabilizing effect unless restored by a proper internal fixation.

Patellar fractures vary from other fractures because they are subjected to extreme tensile forces acting across the fragments.[3] Neutralizing these forces is a critical aspect of any surgical method of fixation[4]. A chosen procedure should go along with this biomechanical principle to achieve a satisfactory functional outcome.

Excision of patella is no more considered a treatment modality except in the most comminuted and difficult fracture. Patellectomy results in significantly reduced extensor power.[5-7]

This may have a greater implication in the event of a future total knee arthroplasty.

Patellar fractures constitute 1% of all skeletal injuries,[8] and different modalities of internal fixation are being advocated and practiced. Most of these use wiring techniques, such as circlage

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wiring, alone or in combination; tension band wiring alone or modified with longitudinal Kirschner wires or screws.[9]

The functional outcome of patella fractures depends upon such variables as age, severity of communition, treatment modality adopted, accurate and stable restoration of articular congruity, post-operative management including early mobilization, etc.[10-12]

**MATERIALS AND METHODS:** The purpose of our study was to review and analyses the functional outcome of patellar fractures following various methods of internal fixation.

A retrospective review of the medical records of all cases of closed fractures of patella who had undergone open reduction and internal fixation between November 2000 and June 2005, at Father Muller Medical college Hospital, Mangalore was performed. These Patients were operated by different Staff Orthopedic Surgeons assisted by orthopedic residents during the aforementioned period.

A total of 55 consecutive closed patellar fractures treated by internal fixation were identified. Of these, only 43 patients were available and responded to our call for a final follow up evaluation. Hence, 43 cases were considered for this study.

**Exclusion Criteria:** Patients with open patella fractures.

Patellar fractures treated by partial patellectomy.

Patella fractures treated by total patellectomy.

Medical records were studied to obtain demographic data including patient age and gender, mechanism of injury, date of injury, laterality type of fracture, date of surgery. Operative reports were reviewed to determine the specific fixation technique, including loss of fixation as already recorded, were documented.

There were no preset standard post-operative protocol and patients had been seen at various times between first and six months following surgery. The time required for radiological union was noted by reviewing the follow up X-rays. However pre and post-operative X-rays pertaining to 16 medico legal cases were unavailable as they were already submitted to courts of law. In the cases, information was obtained from the documentation in the follow-up records.

The follow-up information also included occurrence of late complication or the need for additional surgery including implant removal. The duration and physiotherapy programme followed was noted.

For this study patients were called for a latest follow up to Orthopedic Out-Patient Department, and clinical and radiological reassessment was done between January 2006 and June 2006.

The minimum period of follow-up was 12 months and maximum period was 56 months with a mean of 34 months.

Patients were assessed as per the modified Hospital for Special Surgery Knee Rating Sheet. Presence of pain was quantified as nil, mild or moderate using the visual analog scale. Ability to perform functions like walking, climbing stairs was noted. The range of motion at the knee joint and fixed deformity and presence of extension lag at the knee were measured using a hand-held goniometer. Quadriceps strength was clinically assessed and any knee joint instability noted.

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Check radiographs consisting of standard anteroposterior, lateral views and Merchant's axial view wherever necessary were made3 and evaluated for fracture union, patello-femoral congruity, articular step-off, state of implants and patello-femoral arthritis.

The final functional outcome was graded as Excellent (Score 90 to 100). Good (Score 800 to 89). Fair (Score 70 to 79) and poor (Score below 70) and documented in the knee rating sheet as per the modified Hospital for Special Surgery (Knee service) scoring system.

Statistical analysis was performed using Chi-square test and a p value of less than 0.05was considered significant.

**RESULTS AND ANALYSIS:** The peak incidence was noted in 20-49 age groups with the mean of 42.

In our study, male patients outnumbered the females by more than double.

The frequency of those engaged in hard manual labor and those performing sedentary work were about the same, with a slight preponderance of the latter.

Right sided patellar fractures were predominant.

Almost 70% of the fractures were of transverse type.

Only 7% of our patients had associated injury.

The mean duration between the time of injury and time of surgery was 2.91 days.

Modification, most frequently with longitudinal K-wires, was preferred tension band wiring technique.

Longitudinal midline skin incisi8on was used in more than ¾ of cases.

In almost 84% of cases, radiological union was evident by 16 weeks with a mean time requirement of 15 weeks.

Pain or discomfort due to implant irritation was the most frequent indication for implant removal. Symptomatic hardware was the commonest of the complication.

More than 75% of our patients had no pain or only mild pain.

Only 10(23.3%) of our patients had significant extensor lag.

Nearly 2/3 or our patients had normal quadriceps strength.

In our study, 97.7% had full range or more than $90^0$ of knee flexion.

In our group, almost 80% were able to walk unlimited and normally.

Gender difference had no influence on outcome.

The fracture geometry had no significant bearing on the outcome.

The fracture geometry had no significant bearing on the outcome.

The fixation technique had no significant influence on range of movements.

The fixation technique did not affect the function of walking.

The operative technique did not influence the ability to do stairs.

The fixation technique had no significant statistical association with outcome.

74% of our patients had excellent or good functional outcome.

**DISCUSSION:** Displaced transverse and comminuted patellar fractures are potentially debilitating injuries resulting in loss of knee function. Restoration of a stable and congruent articular surface is the general goal.[13-14] The majority of displaced patellar fractures thus require precise reduction and internal fixation and we agree with these observations. It is essential to address the biomechanics of a construct when planning for such fracture fixations.

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Currently, a modified tension band technique with or without the use of circlage wire is the standard of care.[12,14-18] However, as noted by Nostman, failure of fixation, device migration, post-operative pain and revision surgery are not uncommon.

We discuss this study of retrospective design, wherein 43 patients with 43 closed patellar fractures who had already undergone open reduction and internal fixation were reviewed and results analyzed, including the final outcome.

The study population here were most frequently (69.8%) in the 20-49 age group (range 20-69) with an average age of 42.4 years. Both Smith[19] and Bostrom[8] mention the mean age as 48 years in their respective series.

Male patients were doubly predominant, accounting for 30(69.8) while females were 13 (30.2%). Similarly, Nummi[20] reported the incidence to be nearly twice in males compared to females.

In this study, 46.5% of patients were engaged in hard manual work (eg. agriculture, building construction) compared to 53.3% with sedentary occupation (e.g., domestic, clerical, students).

With respect to mode of injury, out of 43 cases, accidental falls, fall from height were the most frequent (58.1% - 25 cases) followed by road traffic accidents (39.5% - 17 cases). Direct blow due to assault was seen in 1 case. The mechanism of injury as noted by Smith[19] were almost identical with falls (3 cases) and gunshot injury (3 cases). Similarly, Aglietti and Buzzi[21] in their study not subjected to peer review, noted falls (59.1%) followed by traffic accidents as the more frequent causes. Road traffic accidents were not the most frequent cause as observed by other workers.

Patellar fractures occurred on right side in 60.5% of our cases while 39.5% occurred on left side. There were no bilateral cases. On the contrary, Nummi[20] recorded no predominance of the side but noted that bilateral fractures were rare.

We noted transverse fracture of the patella to be the most frequent fracture type (69.8%) followed by polar fractures (16.3% - all of lower). Comminuted fractures made up for the remaining 14%. Nummi also found transverse fractures to be the most common constituting 50-80% of patellar fractures with comminuted/ stearate oatterbs accounting for 30 to 35% and displaced apical fractures of 11.5%.

The duration between the time of injury and surgery was 2.91 days (range 1-8 days). It was noted in our study that the delay in 7 cases was due to patients reporting late to the hospital.

In our series an associated injury was recorded in only 3(7%) out of a total of 43 cases. Associated injuries were ipsilateral tibial condyle fracture in 1, head injury in 1 and ipsilateral undisplaced tibial shaft fracture in one patient.

In contrast, Schimitsch[22] reported 25(52%) of their 50 patients as having suffered concomitant injuries. However, this did not affect the outcome at their final follow up. Our study is limited by the small number with associated injuries to draw any conclusion of statistical significance.

Modified tension band wiring (AO) was the most frequent technique of internal fixation (30 cases – 69.7%). Out of these, tension band wiring modified with K-wires was used in 27 and that modified with cannulated cancellous screws in 3 patients. In one case of comminuted fracture a circlage wire was added to the modified tension band. Smith[19] et al, in their series of 51 patients used modified tension band wiring in 49 patients, whereas 2 fractures were treated with tension band wires threaded through cannulated cancellous screws. Currently, the modified tension band wiring technique with or without use of a circlage wire is the standard care.

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In contrast to the above, Levack[23] used modified tension band in only 46.2% while Hung et al used 6 different techniques and only 7% were treated with modified tension band wiring.

Only cancellous screws were used in 13.9% of our cases, cancellous screws (not longitudinal) with tension band wiring in 9.3% of our cases and circlage wire alone in 7%. It is observed by several authors that modified tension band wiring allowed for earlier knees mobilization compared to other techniques, which is the goal in operative treatment of patella fractures. We agree with this observation.

The average time taken for radiological evidence of fracture union after fixation in our study was 15 weeks (range 12-16 weeks) with a standard deviation of 2.8. In comparison, Berg observed that radiological union occurred at mean of 13 weeks (range 8-24 weeks). However, Aglietti and Buzzi[21] reported a much shorter time for radiographic union of 6.4 weeks to 8.5 weeks (45-60 days).

The vertical midline skin incision was most frequently used (77% of cases). Transverse and medial parapatellar were the other skin incisions accounting for just 19% and 4% of cases respectively. It is noteworthy that recent literature[4, 17, 26, 27,] advocates the vertical midline approaches it provides excellent exposure, rarely offers problems with wound healing and does not compromise a future knee surgery including total knee arthroplasty.

As our study was of retrospective design, no preset standard post-operative rehabilitation protocol was followed. The post-operative programme was the discretion of the operating Staff orthopedic surgeon. Patients were rehabilitated under the guidance of a physiotherapist. In general, static quadriceps drill and straight leg raises was started the day after surgery and patient made ambulate partial weight bearing with crutches on the second day and progressed to complete weight bearing depending upon tolerance.

The wounds were inspected on third day with a dressing and range of motion exercises started on the same day. Suture removal was performed between tenth and twelfth day. No patient was put on CPM machine. Fractures with insecure fixation, communition, elderly and those with expected non-compliance were given a removable knee extension brace at discharge (average 12$^{th}$ day) and advised to use the same during ambulation for the following 4 weeks. Check X rays were taken on the day of surgery, at discharge and generally at 4 to 6 weekly intervals. Physiotherapy programme was continued on out-patient basis till satisfactory return of knee function

Early motion is the goal in operative treatment of patella fractures but the definition of “early” verifies by author, Hung[28, 29] initiated knee motion within the first week whereas Lotke[15] immobilized fractures for three weeks before initiating motion. Bostman immobilized his patients for an average of 38 days, and no associating was found between the length of immobilization and final result.[3] In the absence of a preset standard protocol, we were unable to compare our series in this aspect. According to available literature[8, 15, 23, 30] the early complication from operative treatment with tension band wiring is low, ranging from 0% to 15%.

Post-operative loss of fixation of more than 2mm was recorded in 5(11.6%) of our cases - all treated by modified tension band wiring techniques. The displacement could be attributed to faulty technique in 2 cases, due to improper reduction in 1 case and poor compliance with post-operative restriction in two others. Smith[19]in their retrospective review noted displacement of more than 2mm (range 2-6mm) in 13.7% of the cases. Like in our study, 6 of their 7 fractures were treated with tension band wiring modified with K-wires. Similarly, Nummi[20] noted 11% incidence of loss of fixation.

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In our study 9% (4 cases) developed infection. One of them was a diabetic who developed in abscess within three weeks after surgery which was drained. But he continued to have a discharging sinus. However, he proceeded to by union and implants were removed at 10 weeks with healing of sinus. Three other patients had skin break down with infection between 6 months to 1 year-all attributable to implant irritation. Hardware removal resulted in prompt wound healing and good results. Schemitch[22] and Smith[19] documented an almost identical incidence of wound infection (4%) in the respective retrospective studies.

17 (40%) of our patients required hardware removal within 1 year. Out of 17 cases, 3 required implant removal before fracture union. Of these, one patient underwent refixation with good result, one bad to undergo partial patellectomy, regarded as a salvage procedure due to poor functional outcome. The third patient was happy with a good return of knee function despite non-union and did not opt for additional procedures. In our series, pain (10 cases) due to hardware irritation followed by infection (4 cases) were indication for implant removal.

Broken implants were noted in 4 cases. Implant removal in three asymptomatic patients were don on their request. Hong[28] in their series reported that 37% of patients had broken implants and 15% required revision surgery. Literature abundantly indicates that post-operative pain secondary to irritation from implanted hardware was a significant issue.[8, 19, 28] Revision surgery with implant removal is necessary in up to 65% of cases. We concur with these observations. The reason for irritation is attributed to migration of circlage wire as the interposed soft tissue sinks. But, Gardner[26] recently report a series of 12 cases fixed with a new arthrotomy technique wherein none required symptomatic implant removal.

In contrast, Smith[19] argue that the incidence of symptomatic hardware being although high, it is difficult to ascertain this fact from the literature because it is rarely reported. A solution to symptomatic metallic hardware may lie in the use of biodegradable implants or synthetic cables[31-33]. In addition these metallic substitutes do not require a second surgery for removal.

Phieffer,[10] Nummi[20,34] report a high incidence of patellofemoral osteoarthritis as a complication of fractured patella. We noted at final follow up 4 cases of early patella femoral osteoarthritis. These were percent pre-operatively. In only one of these cases was the outcome significantly affected while the other tree patients were able to cope up despite the problem. We agree with Nummi that a longer duration follow-up is necessary for a valid conclusion on this aspect.

**Functional outcome of our study:** Expression of the results of our surgically treated patellar fractures was done using Hospital for Special Surgery (HSS) knee score with its modified point categories. The most popular and accepted rating system for assessing results of total knee arthroplasty is the HSS knee score,[18] which is simple and easy to understand. Although not primarily designed for evaluation of results following patellar fracture fixation, it provides a common or a sound communication platform for comparison with other similar studies in literature.

Assessment of knee pain was done using the visual analog scale. In our study, 74% had no or only mild pain at final evaluation. Presence of moderate knee pain in 10 cases (23.3%) did not seem to affect their activities of daily living except in two who had pre-existing early patellofemoral osteoarthritis. There was no significant correlation between the fixation technique and pain ($p = <0.303$). However it is to be pointed out that 17 (40%) of our cases had already had their symptomatic hardware removed. Aglitti and Buzzi[21] reported a similar pattern of absent or slight

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pain in 79% of cases and moderate pain in 21%. Hung et al reviewed a series of 69 patients and only 72% was subjectively happy with the result.

Extensor lag of 5 or more degrees was recorded (with goniometer) in 10 (23%) of our cases. In contrast, Aglietti[21] noted extensor lag in only 3 of their 76 cases. Higher incidence of extensor lag in our series could be attributed to poor patient's effort and co-operation.

A quadriceps strength (clinical evaluation) was noted by us to be normal in 65.1% of our cases (could not break quadriceps), and fair in 34.9% of cases (could break quadriceps). This compares favorably with the Alglietti and Buzzi[21] series who observed normal strengths in 72%.

Only one of our patients had range of knee motion of less than 90 degrees and was associated with a poor outcome. Multiple factors like age (60 years), poor motivation, weak quadriceps strength and pre-existing patellofemoral arthritis could be attributed to the poor outcome. There were no clinically documented cases of flexion contracture or instability of the knee.

As noted by Muller et al[4] stable fixation by tension band wiring principle allows for early knee mobilization and optimum return of knee flexion. In contrast, Phieffer et al opined that despite appropriate surgical management, there is usually some lass of knee flexion.

Of our patients 79.1% and 67.4% were able to walk unlimited and use stairs normally respectively. 29.1% were able to walk a limited distance compared to the pre-injury status while 32.6% required support to use stairs.

At our final follow up, statistical analysis using Chi-square test revealed that gender, fracture type and operative procedure had no significant influences on the outcome. Fractures due to falls were associated with a slightly better outcome.

In contrast, older age was associated with a significantly poorer outcome. This could be attributed to delayed mobilization, lack of patient motivation and pre-existent patello-femoral arthritis. Another explanation for this could be found in the observation made by Insall.[35] He took a serious objection the HSS rating system for the fact that aging or deterioration in patients general health lowers score, although the knee itself remains unaffected.

We also noted at final follow-up that the method of fixation had not significant bearing on duration required for fracture healing, pain, knee movements, ability to walk and use stairs and on the final outcome. Schimitsch[22] et al observed that open reduction and internal fixation of patella fractures restores excellent limb and health status.

At final assessment, the functional outcome in our series were graded according to the modified Hospital for Special Surgery Knee Score as Excellent in 58% (25 cases), Good in 16% (7 cases) Fair in 18.6 (8 cases) and Poor in 4.7% (2 cases), Schimitsch[22] et al in their discussion mention that good results of operatively fixed patellar fractures have been reported to literature, but lack outcome measures with proven validity. However, Gardner et al[26] differ in their perception and state that long term outcomes from different clinical series have been modest.

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**SKIN INCISSION USED**

MIDLINE LONGITUDINAL

AN ISOLATED CASE OF MEDIAL PARAPATELLAR

TRANSVERSE

TRANSVERSE- NOTE THE SKIN PROMINENET DUE TO UNDERLYING IMPLANT AT (12 'O' CLOCK POSITION)

**MRS. M - TREATED WITH MTBW**

LATEST X-RAYS AP AND LATERAL VIEW NOTE THE BROKEN STAINLESS STEEL WIRE

MERCHANT'S VIEW

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**X-RAYS AFTER IMPLANT REMOVAL**

**ROM – RESTRICTED TERMINAL 20$^0$ OF FLEXTION**

**NO EXTENSION LAG**

**X-RAY TAKEN AT 10 WEEKS POST –OP. COMMUNITED FRACTURE TREATED MTBW, NOTE THE INTER-FRAGMENTARY CANCELOUS SCREW FIXATION AND 2MM STEP – OFF OF PATELLA.**

**HEALED FRACTURE AT 16 WEEKS, WITH THE ARTICULARSTEP-OFF APPEARS TO BE LESS PRONOUNCED**

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COMPLETE RETURN OF ROM KNEE

NO EXTENSOR LAG, EXCELLENT OUTCOME

**Case of Polar Fracture Patella**

Inferior polar fracture treated with cerclage wiring. Implant failure noted on immediate post-op x-rays.

However, despite implant failure fracture united because of additional stability provided by meticulous retinacular repair.

Clinical photograph showing full knee flexion

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**A case of transverse fracture patella**

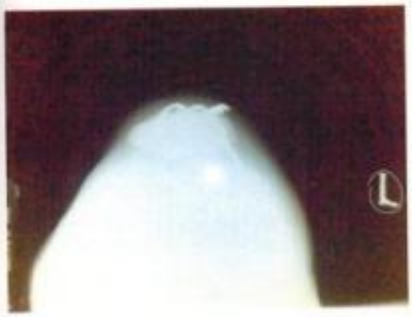
X-rays AP and lateral.
MTBW with circumferential wiring

Clinical photograph showing extensor lag, measured with the goniometer

**A case of transverse fracture patella**

X-ray showing MTBW hardware in situ

Healed fracture with hardware



Skyline view of patella femoral joint
This patient eventually required hardware removal

**Another case of transverse # patella**

Note the gross fracture displacement

Patient required removal of implants due to severe pain with loss of knee motion. Salvaged with partial patellectomy

Knee flexion after hardware removal & partial patellectomy.

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**A case with broken implants**

Elderly gentlemen with chronic discharging sinus & hardware ware in-situ.
Note the sinus and skin discoloration due to implant irritation & infection.

Photograph showing broken implants removed.
9 pieces of metal could be counted !

X-ray of the same patient with broken implants

X-ray after implant removal.
Well healed fracture with good outcome

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**A case of infected implants**

Photograph showing chronic sinus

Almost normal knee extension

Healed fracture. Sinus promptly healed after implant removal

**Transverse # patella with comminution**



Fixed with TBW modified with longitudinal screws. Note the transverse interfragmentary screw


Fractured healed with excellent return of knee function

**CONCLUSION:** Displaced closed patellar fractures treated by accepted contemporary methods of internal fixation, including the most frequently employed modified tension band wiring technique, eventually results in a favorable outcome in terms of satisfactory return of knee function.

Symptomatic hardware, requiring a second surgery for removal in a high percentage of cases was the main drawback of wiring techniques. However, the study was limited by its retrospective nature, and a longer duration of follow-up may be necessary to determine the true incidence and impact of patello-femoral arthritis.

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