

## Case Series

# Figure of eight suturing technique with fiber wire for patella fracture: a novel approach

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### ABSTRACT

Modified tension band wiring (TBW) is the most commonly used technique for the management of patella fractures. However, all patella fractures are not-amenable to TBW. Tension band wiring, inter-fragmentary screw fixation, and the combination of cerclage wiring and screw fixation are used for internal fixation of these fractures. Surgical treatment is recommended for fractures that either disrupt the extensor mechanism or have greater than 2 to 3 mm of step-off and greater than 1 to 4 mm of displacement. In this series, we present ten cases managed with open reduction and internal fixation with figure of eight suturing technique using fiber wire. This series included ten patients with fractured patella and managed with open reduction and internal fixation with Tension band wiring with fiber wire. Patient demographics, fracture type, time to union, functional outcome, and complications were recorded. Patients were followed up for minimum of 6 months. All fractures went on to unite with average fracture healing time of 13.8 weeks. Mean Lysholm score and Bostman score were 85 and 27 respectively. Nine patients had excellent to good outcomes. One patient had poor outcome because of knee stiffness. Open reduction and internal fixation with figure of eight suturing technique using fiber wire are an efficient method for the management of severely comminuted and multi-fragmentary patella fractures with minimum complications.

**Keywords:** Patella fracture, Fiber wire, Lysholm score, Bostman score

### INTRODUCTION

Ages 20 to 50 are the most typical range for patella fractures. The quadriceps quickly contracting with a flexed knee or direct impact to the knee can result in patella fractures, which are traumatic knee injuries that can result in the extensor mechanism losing function. Two injury mechanisms are as follows: simple transverse fractures are frequently the result of rapid flexion against tensed quadriceps, and direct blows can cause stellate and vertical fractures, among other fracture types. 20–25% of them are comminuted, and 70–80% of them are transverse fractures. For fractures that either impair the extensor mechanism or have more than 2 to 3 mm of step-off and more than 1 to 4 mm of displacement, surgical treatment is advised. The gold standard surgical treatment for displaced patella

fractures is modified tension band wiring (TBW), which uses longitudinal K-wires and stainless steel wire.<sup>2,3</sup> However, TBW cannot be used to treat all patellar fractures successfully. In order to treat multi-fragmentary lower pole fractures and highly comminuted fractures brought on by high energy trauma, a figure-eight suturing procedure using fiber wire can be used.

### CASE SERIES

This case series included ten patients (seven males and three females) with patella fracture which were managed by open reduction and internal fixation with figure of eight suturing technique with fiber wire after taking informed consent. Patient demographics, fracture type, time to union, functional outcome, and complications were

recorded. Six patients (six male) presented following road traffic accident and four (one male and three females) had fallen on knee. Five patients presented with displaced lower pole fracture and remaining had comminuted fracture. Intra-operatively, the management of these patients was found difficult with TBW with K-wire and stainless steel loop due to severe comminution. Therefore, we opted for fixation with fiber wire sutures.

### Operative procedure

After taking written and informed consents, patient was taken on radiolucent table in a supine position with the knee flexed 30°. All patients were operated under spinal anesthesia with pneumatic tourniquet in situ. A mid-axial longitudinal approach is used. The knee joint and fracture lines irrigated and cleared of blood clot and small debris to allow exact reconstruction. The fracture fragments are reduced using a bone holding forceps. In frontal/coronal (transverse) fractures, reduction is easier with the knee extended. Reduction is held by one or two reduction forceps. Reduction verified by palpation of the retro-patellar surface. Two beath pins are placed at two parallel points on superior and inferior poles respectively. The wire is then similarly threaded around the fractured fragments of the patella i.e. both upper and lower pole in a figure of 8 position and knot is tied.

After assessing adequate tension on the wire, reduction of the two fragments was verified by palpation of retro-patellar surface and stability verified with maintenance of reduction in flexion of 0-70 degrees. A fiber wire which will withstand the tensile forces generated in the cerclage (2.0 mm diameter) is used. The wire is placed as close as possible to the bone throughout its whole course both superiorly and inferiorly. Reduction and fixation were confirmed with intra-operative C-arm image. Irrigation is done with saline and closure done in layers in such a way that there is soft tissue covering over the sutures. Retinacular tears were repaired using the same suture. Tourniquet was released and hemostasis was achieved. Sterile dressing was applied and post operatively above knee below knee brace was given. Patient withstood procedure well and discharge went uneventful.

### Post-operative protocol

Quadriceps strengthening exercises were started from day 1. Sutures were removed at post-operative day 14. Knee was mobilized with range of movements (ROM) allowed till 30 degree till post-operative day 3. From post-operative day 5 knee bending was allowed till 70 degree. Partial weight bearing with above knee-below knee brace was started from day 5. Full weight bearing mobilization was started at 4 weeks. All patients were followed up regularly with clinical and radiological assessment at 2 weeks, 6 weeks, 10 weeks and continued till 6 months. Fracture union and ROM were assessed. Lysholm and Bostman scoring were used for assessment of functional outcome.<sup>7,8</sup>

### Results

Patients were followed up regularly in our out-patient department for 6 months. All fractures went on to unite well in 12–16 weeks. One patient with comminuted lower pole fracture developed knee stiffness (ROM: 10–50°) due to lack of physiotherapy. Another patient with the lower pole fracture developed anterior knee pain. The average range of knee flexion was 110° (range 90–120°). Lysholm score ranged from 81±15 and Bostman score ranged from 27±3. Six patients had excellent outcome, three patients had good outcome. One patient had poor outcome because of knee stiffness due to lack of physiotherapy.

**Table 1: Results.**

Outcome (Lysholm score and Bostman score)	No. of cases	Percentage
Excellent	6	60
Good	3	30
Poor	1	10
Total	10	100



**Figure 1: Clinical picture of 45 years female with fracture of patella showing ecchymosis over anterior aspect of the knee.**



**Figure 2: Radiographs showing comminuted displaced patella fracture.**



**Figure 3: Immediate post-operative radiographs showing satisfactory reduction using fiber-wire.**

## DISCUSSION

Patella is the largest sesamoid bone in the body embedded in the quadriceps tendon. Patella fractures can lead to severe restriction of the knee movements and in turn affect the knee function as it plays very important role in the extensor mechanism and biomechanical function of the knee. It primarily acts as an anatomical pulley for the quadriceps muscle. Patellar fractures account for a considerable portion of traumatic musculoskeletal injuries, and despite a multitude of proposed treatment options, there exists a lack of evidence-based investigations proposing which method of fixation is superior. Plate and screw devices, tension band wiring, cannulated screw tension band wiring, inter-fragmentary screw fixation, and partial patellectomy and tendon repair are currently the most commonly conducted fixation methods for patellar fractures, with no established consensus on best practices for these patients.<sup>1</sup> Our report demonstrates a unique way of tension band wiring with a strong and tensile fiber wire. Additionally, we demonstrate a significant decrease in implant removal following utilization of fiber wire treatment. Historically, comminuted patella fractures were managed with total patellectomy. With a better understanding of the importance of this bone and a growing emphasis on maintaining as much patella as possible, this procedure is rarely utilized today despite reported satisfactory outcomes. Several surgical fixation strategies have been developed to help manage these fractures and are now frequently employed. Tension band wiring was among the first employed surgical treatments, which allows for the conversion of tension force at the anterior surface of the patella to a compression force at the articular surface. Poor biomechanical strength in vivo led to the exploration of augmenting this tension band wire technique with that of cannulated screws. Since, tension band wiring positioned through cannulated lag screws has gained in popularity, as it was demonstrated to have superior biomechanical performance compared with anterior tension band wiring with Kirschner wire fixation alone. Additionally, inter-fragmentary screw fixation has also demonstrated successful outcome. The fracture characteristic frequently dictates treatment. Generally,

fractures that are at either the superior or inferior poles of the patella, or those not amendable to tension band wiring or inter-fragmentary screw fixation, have been treated with partial patellectomy with variable success. Classically, transverse fractures without comminution are commonly treated with Kirschner wire fixation with or without cannulated screw utilization. Several small case series have demonstrated significant rates of tension band failures after early rehabilitation. However newer techniques may reduce the incidence of this implant failure. In addition, wire fixation is relatively poor in regards to its biomechanical stability, and the high rates of hardware failure and loss of fracture reduction reveal this to be a relatively poor construct in vivo. Due to these poor results, there has been a movement to create more stable constructs, including the use of cannulated screws, which have been shown to be biomechanically superior in several studies, as well as have clinical success in several recent reviews. However, the use of isolated screws is only recommended in simple fracture patterns in the absence of comminution. Additionally, lag screws are frequently utilized in patellar fractures, most commonly as a substitute to, or in combination with, tension band wiring or for compression of large fragments. Our technique of using fiber wire provides one such option for a stable construct. Fiber wire offers added advantage of no hardware failure, early mobilization, stable fixation and has good compliance and follow up. Also this may be a good option particularly for the osteopenic patient. Bostman and colleagues compared the outcomes of fragment excision with that of internal fixation for comminuted patellar fractures and found that poor outcomes were observed when greater than 40% of the patella was removed. Care should be taken to leave as much of the intact bone as possible, as well as, avoid resection of the inferior pole due to the largest arterial contribution to the patella entering infero-medially. Total patellectomy, on the other hand, should be avoided when at all possible. Despite several treatment modalities, there are several limitations and drawbacks to their utilization. Due to the superficial nature of the patella, prominence and pain remains problematic and often requires hardware removal. Lazaro and colleagues found an 80% incidence of anterior knee pain following tension band wiring, cannulated screw tension band wiring, or suture fixation, with 37% undergoing implant removal.<sup>4</sup>

Hoshino et al found that patients who were treated with Kirschner wires alone were twice as likely to undergo implant removal than those treated with screw fixation, potentially jeopardizing the repair. None of our patients had complications like loss of reduction secondary to suture breakage and none of them required removal of fixation material due to knot prominence or any other reason as compared to other studies.<sup>5</sup> According to Po-Hua Huang et al, K-wire migration and K-wire loosening or breakage, with loss of the tension band effect was found with standard tension band wiring. But according to this study, no such adverse effect was found with Fiber wire.<sup>6</sup>

In our study, we found that the age of the patient was ranging from 16 to 62 years with mean age of the patients was  $35 \pm 7.8$  years (males  $30 \pm 5.3$  years, females  $44.5 \pm 3.2$  years). Sudheendra et al study shows youngest patient was of 21 years age and oldest was 62 years of age.<sup>9</sup> Smith et al mentioned the mean age as 48 years in their study.<sup>10</sup> Most of the patients had trauma due to road traffic accidents due to male preponderance. The mean injury-operation interval was 5 days. Shetty stated that commonest mode of injury was fall on knee and the rest were due to road traffic accident.<sup>11</sup> Levack et al in his study of 30 patients found 21 cases were male and 09 cases were female. He also concluded men are more prone to road traffic accident due to more outdoor activities.<sup>15,16</sup> The average operative time was 59-75 minutes with minimal blood loss. The knee range of motion also improved significantly from  $30^\circ$  pre-operatively to  $110^\circ$  post-operatively. This was statistically significant ( $p < 0.05$ ). All patients except one resumed their activities of daily living as well as pre-trauma occupational status. Sudheendra et al mentioned only one patient having range of knee motion of less than 90 degrees and was associated with a poor outcome.<sup>9</sup> We found excellent to good outcomes in nine patients according to Lysholm score and Bostman score which is comparable to similar studies in the literature. Sudheendra et al recorded excellent in 25 cases, good in 7 cases, fair in 8 cases and poor in 2 cases.<sup>9</sup> Shetty mentioned the cases treated with modified tension band wire, excellent to good results were seen in 90% of cases.<sup>11</sup> None of the patients had any complications such as hardware impingement or breakage of suture material. One patient had poor outcome due to knee stiffness as he had lost to regular follow-up. He was subsequently put on continuous passive motion (CPM) which enabled him to do his routine activities with gradual improvement in pain and stiffness. John et al study mentioned loosening of K-wires is considered the main complication of the modified K-wire band fixation of patella fracture.<sup>12</sup> Chengxue et al recorded 6.9% patients with the modified K-wire tension band were badly affected by skin irritation probably due to K-wire prominence and migration.<sup>13</sup> Heusinkveld et al study shows pain and irritation were most commonly present following this modality of treatment.<sup>14</sup> Skin irritation, wire migration or K-wire loosening were observed. The major limitation of our study is small sample size and short duration of follow-up. Further research and similar study is required to validate our results.

## CONCLUSION

Open reduction and internal fixation with figure of eight suturing technique using fiber wire are an effective method for the treatment for comminuted patella fractures and multi-fragmentary lower pole patella fractures. This technique can provide sturdy and firm fixation with good clinical, radiological, and functional outcomes with minimum complications. With good functional outcome and minimum complications, this technique can thus be an effective tool in the management of complex comminuted patella fractures.

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