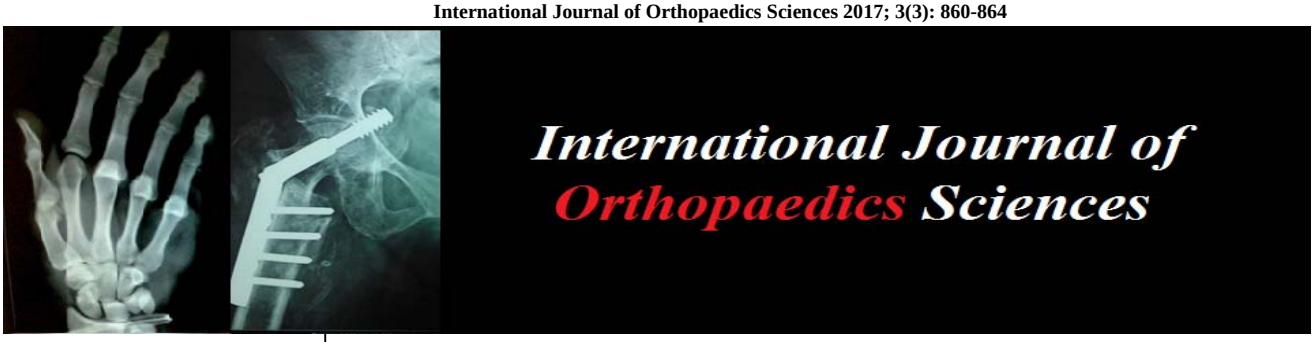

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Vertical and figure of eight fibre wiring for patella fractures

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Abstract
Background: Displaced patella fractures need to be treated by internal fixation for achieving good outcome. Metallic hardware related pain and irritation are one among the many reasons for reoperations. Fracture displacement can happen due to early mobilisation depending on bone quality and fracture pattern. The aim of our study was to evaluate the postoperative outcome and complication rates of patella fractures fixed with fibre wires in a vertical and figure of eight pattern.
Methods: We retrospectively followed up all patella fractures fixed using fibre wires utilising Krackow stitches through patellar tendon, longitudinal fixation through fracture fragments and figure of eight wiring on anterior patella. We evaluated their clinical outcome, range of movement, time to union and complication rates. We also evaluated these for arthritic scenario and different fracture patterns.
Results: We had 22 patients (mean age 50.7) with a mean follow up of 22.7 months, mean Bostman score of 23.5, mean range of movement 115^0 and mean time to union 13.5 weeks. Arthritic patients though united without any complications had an unsatisfactory score. None of the patients developed any hardware related complications, fracture displacement or needed an implant removal.
Conclusion: Fibre wires can be used in vertical and figure of pattern for achieving fracture union with good clinical outcome without fracture displacement or symptomatic hardware problems.

Keywords: Fibre wire, patella fractures, hardware, tension band

1. Introduction
Patella fracture management can vary from conservative non operative treatment to excision of patella. Since patella improves the quadriceps lever arm, excision of patella is avoided as much as possible. Fractures with an intact extensor mechanism and minimal articular incongruity can be treated nonsurgically [3]. Displaced fracture with a torn extensor mechanism has to be operated aiming for a stable fracture fixation and early mobilisation. Fracture pattern, comminution, site of fracture and bone quality adds to the complexity of internal fixation. Traditionally Kirschner(K) wires, stainless steel wires, cannulated and non cannulated screws or a combination of these were used for fracture fixation.
Patella being placed subcutaneously is prone to soft tissue breakdown, metallic hardware irritation, pain and infection in the course of treatment [11, 12, 17]. Hardware removal is a very common requirement for these reasons in patella fracture treatment. Non absorbable braided sutures are been used by many authors in various ways to avoid these hardware problems [6-11, 18]. Internal fixation of patella with vertical wiring augmented with Krackow sutures are also being done for inferior pole patella fractures [24]. Fibre wires being stronger are now being used instead of braided nonabsorbable sutures. Similarly fibre wire tension band technique augmented with peripatellar circumferntial circlage is also done for patellar fractures to avoid hardware complications [23].
Improving stability of fixation can provide early mobilisation without fracture displacement. Modified tension band technique using longitudinal K wires and 18Guage stainless steel figure of eight wiring on anterior patella has been historically used and proved to give good stability [5, 20]. Therefore we addressed the hardware and stability problems by using fibre wires and applying the biomechanical concept of tension band wiring and vertical wiring augmented with Krackow suturing of patellar tendon.

The aim of our study was to evaluate the postoperative outcome and complication rates using this combination. The authors hypothesised that vertical and figure of eight fibre wiring combination can unite patella fractures without hard ware complications and good functional outcome.

2. Materials and methods

Retrospectively we evaluated all patella fractures treated by the senior author in two institutions (MGM Muthoot Medical Centre Pathanamthitta, Kerala, India and Believers Church Medical College Hospital, Thiruvalla, Kerala, India). There were 48 patella fractures from 2009 to 2016. All patella fractures treated with fibre wire were included in the study. All other patella fractures were excluded including ones in which K wires, stainless steel wires and or screws were used along with fibre wire. 22 patients were available for the study. All patients were followed up at 2 weeks; 6 weeks, 3 months, 6 months and 10 months by the senior author and range of movement and fracture union time was recorded. Six patients did not come for any further follow up. They were contacted by telephone and emails and clinical outcome was documented. All remaining patients were followed up by the corresponding authors and the clinical outcome was assessed. A formal informed consent was not required for this type of study.

2.1 Surgical technique

All patients were operated within 48 hours unless they were on antiplatelets or anticoagulants for various medical reasons. All surgery was done by the senior author. Tourniquet was used for all patients. A longitudinal incision was used. Number 5 fibre wire is used for vertical wiring. The distal fragment was prepared first. Three holes were drilled with 2mm drill bit so that the Krackow sutures from the patellar tendon will come out. One suture thread comes through each side hole and two threads come though the middle hole. Next the proximal fragment is drilled in a similar manner that the distal and proximal holes appose each other after tying. Suture threads are passed through the corresponding proximal holes but not tied. Next a reduction clamp is used and the fracture is held in position. Next a Number 2 fibre wire is used in a double strand pattern and a tension band figure of eight is applied anterior to the patella. Finally the vertical wires are tightened and knotted [fig: 1]. Stability is checked by bending the knee to identify the allowable immediate post operative range of movement during mobilisation. In case of inferior pole patella fracture distal fragment will have only one centre hole with two threads and proximal fragment will have the same hole pattern. If the proximal fragment is comminuted the three holes passes through the fragments in such a way that each major fragment gets one fibre wire thread each.

All patients were given a hinged knee brace postoperatively. Active and passive knee flexion was allowed till 30 to 40degree. Weight bearing was allowed as tolerated. Knee flexion up to 90 degree was allowed only after 6 weeks. Full knee flexion was allowed after 3 months. All inferior pole patella fractures and comminuted fractures were allowed knee flexion only after 3 weeks. Bostman scoring was done to assess the outcome at 10 months [1]. Loss of reduction was evaluated with serial Xrays at 6 weeks, 3 months and 6 months postoperatively [fig: 2].

3. Results

Among the 22 patients there were 17 males and 5 females. Age of the patients ranged from 32 to 75 (mean 50.72). Ten patients (45.45%) fell at home and surroundings and sustained fracture while the majority were high velocity road traffic accidents (54.54%). Twelve patients had transverse fracture, 7 patients had inferior pole fracture and 3 had comminuted fractures. Among the 22 patients 7 had pre-existing osteoarthritis and one had rheumatoid arthritis. Two patients were on antiplatelet medication and had severe haemarthrosis. 4 patients had contused skin and none were compound fractures. The minimum follow up was 10 months for all patients during which the scoring was done. The average follow up was 22.72 months.

The Range of movements averaged to 115^0 (80^0 to 140^0). At the end of 10 months 3 patients had a mean fixed flexion deformity of 11.6^0 (range 10^0-15^0) and 3 patients had a mean extensor lag of 6.6^0 (range 5^0-10^0). The average range of flexion among those with pre existing arthritis was 97.5^0 (range 80^0 to 110^0). Bostman score was overall good with a mean of 23.5 ranging from 11 to 30. Unsatisfactory outcome was noticed in 5 patients and all of them had prexisting arthritis. Among the 7 patients who had arthritis before injury, the Bostman score averaged 16.75(range 11-20). Mean time for fracture union radiologically was 13.5 weeks (range 12-20 weeks) [Table 1, 2 and 3]. None of the patients developed infection. No patients came for or had removal of fibre wire. None of the fractures had a displacement during the course of treatment and follow up.

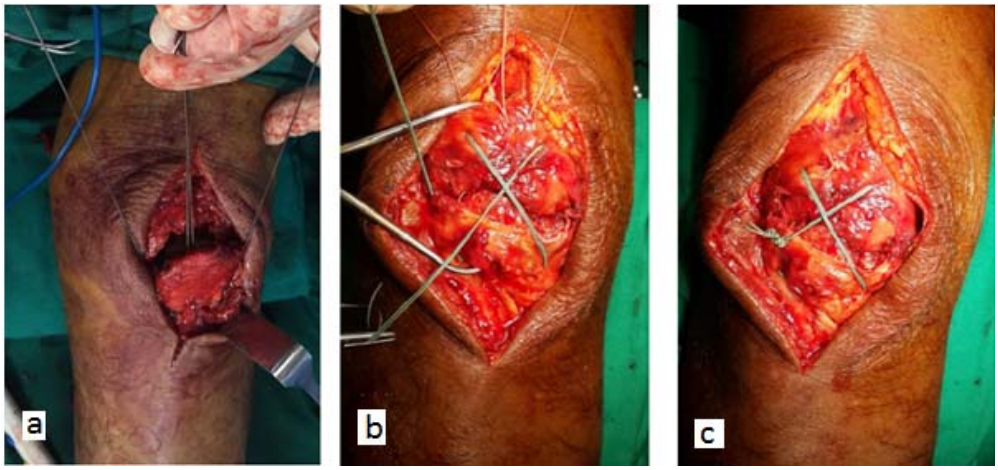

Fig 1: Krackow sutures through patellar tendon and through the distal fragment (a); sutures passed through proximal pole and fracture reduced with reduction clamp (b);double stranded figure of eight tension band wiring and final knotting (c)

Fig 2: Preoperative Xray (a); postoperative Xray (b); follow up Xray(c)

Table 1: Demographic data, clinical outcome, complications and time to union of patellar fractures treated with fibre wires.(OA: osteoarthritis, RA: Rheumatoid arthritis, RTA: Road traffic accident, ROM: Range of movement, FFD: Fixed flexion deformity)

Patient	Age (years)	Sex	Type of fracture	Injury	Follow Up(months)	Bostman score	ROM	Pre existing Arthritis	FFD	Extensor lag	Union (weeks)
1	46	M	transverse	RTA	10	30	130	Nil	Nil	Nil	12
2	52	M	transverse	Fall	26	30	130	Nil	Nil	Nil	12
3	65	F	transverse	Fall	10	20	110	OA	Nil	Nil	14
4	62	M	inferior pole	Fall	24	15	90	OA	Nil	5	16
5	70	M	transverse	Fall	10	15	100	OA	10	Nil	12
6	75	M	transverse	Fall	22	20	100	OA	Nil	Nil	12
7	52	F	inferior pole	Fall	36	11	80	RA	15	Nil	20
8	49	M	comminuted	RTA	10	22	110	Nil	Nil	Nil	14
9	59	M	comminuted	RTA	10	17	100	OA	Nil	10	16
10	45	M	comminuted	RTA	28	21	110	Nil	Nil	Nil	14
11	41	F	tranverse	Fall	10	30	130	Nil	Nil	Nil	12
12	36	M	transverse	RTA	16	30	130	Nil	Nil	Nil	12
13	38	M	transverse	RTA	52	30	140	Nil	Nil	Nil	12
14	45	M	transverse	Fall	26	30	130	Nil	Nil	Nil	12
15	52	M	inferior pole	RTA	31	20	110	Nil	Nil	Nil	16
16	62	F	inferior pole	Fall	40	16	90	OA	10		17
17	49	M	inferior pole	RTA	15	20	110	OA	Nil	5	12
18	34	M	inferior pole	RTA	24	25	120	Nil	Nil	Nil	12
19	32	M	inferior pole	RTA	39	25	120	Nil	Nil	Nil	14
20	45	F	transverse	Fall	19	30	130	Nil	Nil	Nil	12
21	54	M	transverse	RTA	18	30	130	Nil	Nil	Nil	12
22	53	M	transverse	RTA	24	30	130	Nil	Nil	Nil	12
Mean	50.7				22.72	23.5	115				13.5

Table 2: Mean post operative range of movement of various categories

No:	Category	Mean
1	ROM of arthritic patients	97.5
2	Rom of all inferior pole #	102.8
3	ROM of inferior pole # without OA	115
4	ROM of all transverse fracture	124.1
5	ROM of transverse fracture without OA	131.1
6	ROM of comminuted fracture	106.6
7	ROM of comminuted # without OA	110

Table 3: Mean post operative Bostman score of various patella fractures

No:	Category	Mean
1	Bostman score of Arthritis	16.75
2	Bostman score of all inferior pole #	18.85
3	Bostman score of Inferior pole # without OA	23.33
4	Bostman score of all transverse fractures	27.08
5	Bostman score of transverse # without OA	30
6	Bostman score of all comminuted fractures	20
7	Bostman score of comminuted # without OA	21.5

4. Discussion

Traditionally patella fracture fixation was done with two longitudinal K wires and figure of eight Stainless steel wires [5]. Modification of this technique was done using cannulated and non cannulated screws [20]. Eventhough these techniques were proved to be giving very good results, they also had high implant removal rates due to the inappropriate bone quality resulting in K wire migration or a poor screw purchase [4, 15]. The circular shape of patella and its soft tissue attachments prevent easy manipulation of stainless steel wire for good fracture fixation [6]. Metal and soft tissue impingement also creates pain and skin irritation. Bursitis around the Stainless steel wire knots and migrated K wires are very common in these patients. Hoshino *et al* in their study demonstrated an implant removal rate of 37% and 23% for patella fracture treated respectively with K-wires and cannulated screws and LeBrun *et al*. reported a hardware removal rate of approximately 52% at a mean of 6.5 years of follow-up [9,13]. On the basis of these results, some authors have advocated the use of nonmetallic implants, such as non absorbable sutures and biodegradable cannulated screws [6-10, 18, 22].

Fibre wire is a multistrand of ultra-high molecular weight polyethylene covered by braided polyester. It is in use for many soft tissue reconstruction and repair procedures like Anterior cruciate ligament reconstruction, rotator cuff repairs, quadriceps tendon repairs and tendoachillis repairs. Stainless steel wires are clearly superior to fibre wires with regards to its tensile strength and toughness [6]. But with regard to brittleness or fatigue failure on cyclical loading, stainless steel may be inferior to fibre wire [21]. Non absorbable braided sutures have shown comparable strength to stainless steel wire fixation for transverse patella fracture in studies of Patel *et al* [16]. Nonabsorbable braided sutures have shown to withstand nearly 20000 cyclic flexion and extension loading of cadaveric patella [14]. Wright *et al* demonstrated that double stranded fibre wires are superior to stainless steel with regard to fatigue failure [21].

Lawrence Camarda *et al* has recently demonstrated their excellent results with Tension band combined with circlage fibre wiring in treating patella fractures [23]. We have combined principles of tension band and longitudinal fixation of patella for biomechanical stability, fibre wires for avoiding hardware problem and double stranded fibre wire figure of eight for appropriate tensile strength. Krackow sutures through the patellar tendon also avoids fracture displacement in case of poor bone quality. There is no study in literature using these combinations for patella fracture fixation.

Our clinical outcome was good with a Boston score averaging 23.5. Among 22 patients 7 patients with pre-existing arthritic changes has influenced our final score [Table 3]. Range of movement of 115^0 at 10 months is also compounded by pre-existing arthritis [Table 2]. We had 7 patients with inferior pole patella fracture of which 3 had osteoarthritis and one had rheumatoid arthritis. Among the 3 comminuted fractures one patient already had osteoarthritis. After excluding osteoarthritis from each group, the Bostman score improved to excellent for transverse fractures (mean 30). Similarly once arthritis was excluded, unsatisfactory outcome of inferior pole fractures (mean 18.85) improved to a good score (mean 23.3). Inferior pole patella fractures are very difficult to fix and those treated by excision has shown poor results when compared to internal fixation [25]. This technique we have used allows even these fractures to adequately fixed resulting in a good outcome.

Prolonged immobilisation is shown to result in knee stiffness, extensor lag and pain after patella fractures [19]. Our technique has provided adequate stability for early mobilisation. The mean range of movement achieved was 115^0 and it showed an improvement in every category after excluding arthritis

No patients had infection, revision surgery, implant removal, soft tissue breakdown or skin irritation. The flexion deformity and extensor lag developed can also be explained by the underlying arthritis. Considering that patella fracture contributes to 1% of all skeletal injuries our sample size though less, we hope it can be allowed to represent the general population [2]. There was no delay in fracture union for any fractures. There was no displacement of fracture fragments in any point of time in spite of early mobilisation [19].

5. Conclusion

The study demonstrates that fibre wire can be used instead of metallic implants to obtain patella fracture fixation. Vertical and Figure of eight fibre wiring can give good functional outcome without any hardware symptoms. Clinical outcome also depends on the pre-existing knee arthritic status.

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