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Lessons learned using screws and cable in patellar fractures

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Abstract
The patella is an important component of the extensor mechanism of the knee. Displaced patellar fractures need to be fixed. Several techniques for internal fixation have been employed. The aim of this work was to evaluate the results and the lessons learned from treatment of transverse patellar fractures with figure of eight wiring through 4.0mm cannulated screws. Forty patients were included. All were treated by open reduction and internal fixation with this technique. Assessments occurred at 6 weeks, 3 months and 12 months using a modified Hospital for Special Surgery (HSS) knee scoring system. The final results showed twenty-eight patients (70%) had excellent results, ten patients (25%) good results and two patients (5%) fair result. There was a statistically significant improvement of the patients' score throughout the follow up period. The complications that occurred included knee pain in one patient (2.5%) and loss of terminal flexion in three patients (7.5%). There were no cases with extension lag. Treatment of patellar fractures using figure of eight wiring through cannulated screws is a reproducible technique, which gives good stability leading to good results with a low complication rate.

Keywords: Patella, Tension band, Cannulated screws

Introduction
The patella is the largest sesamoid bone of the body, and it lies within the fibers of the quadriceps tendon. Its primary function is increasing the lever arm of the extensor mechanism around the knee, improving the efficiency of the quadriceps muscle [1].
Patellar fractures constitute around 1% of skeletal injuries. A displaced patellar fracture causes a discontinuity in the extensor mechanism leading to inability to extend the knee. These fractures are intra-articular and can be debilitating injuries. Being so, the main aim of internal fixation is to preserve patellar function, restore continuity of the extensor mechanism, and reduce complications associated with such fractures. This can be achieved by anatomical reduction of the articular surface using a stable construct that allows early mobilization. Even after achieving that post traumatic arthritis may still occur [2].
There are several methods for fixation of the patella. The most widely accepted being the modified tension band wiring [3].
The principle behind tension band wiring is transforming the tensile forces on the anterior surface into compressive forces at the articular surface. This improves fracture stability and healing. However, this technique has its complications in the form of loosening and migration of wires, lack of interfragmentary compression that may lead to loss of reduction and lastly local soft tissue irritation that may lead to need for removal of implants [4].
Screws alone have been used but have not provided enough stability to overcome the bending forces occurring at the knee during flexion [4].
The aim of this work was to evaluate our results and the lessons learned from treatment of transverse patellar fractures with figure of eight wiring through cannulated screws combining screw fixation with tension band wiring.

Materials and methods
The study included forty patients with displaced transverse patellar fractures aged 19 to 58 years (mean 39.25 years). All fractures were closed and the mechanism of injury was a simple fall in 28 (70%) patients and a road traffic accident in 12 (30%) patients.

The time lapse before operation was 1 to 11 days (mean 2.7 days). Delays were mainly for optimization of patients with pre-existing medical conditions such as diabetes and haemophilia.

All fractures were treated by open reduction and internal fixation using figure of eight tension band wiring through two parallel 4.0mm cannulated screws. A standardized rehabilitation protocol with gradual active exercises was used. All patients completed a 12-month follow up period.

The operation was performed through an anterior longitudinal midline incision. Exposure of the fracture site was performed followed by evacuation of the fracture haematoma. Reduction was done using a reduction forceps and was assessed by digital palpation of the patellar articular surface either through a retinicular tear if present or through an arthrotomy performed during surgery. Once satisfactory reduction was reached two parallel threaded guide pins were placed within the patella and the screw lengths were measured (Figure 1). Two 4.0mm cannulated screws were inserted over the guide pins to achieve interfragmentary compression. We found it technically easier to insert them from distal to proximal due to the patella being narrower and thinner distally avoiding any articular damage. A 1.2mm stainless steel wire was passed in a figure of eight through the two screws. The screws should be just flush with or short of the end of the patella to prevent subjecting the wire to a sharp corner that may increase the risk of wire breakage. Appropriate screw length and satisfactory reduction was confirmed intraoperatively using the Image Intensifier (Figure 2).

Fig 1: Photograph showing reduction and insertion of two threaded guide wires

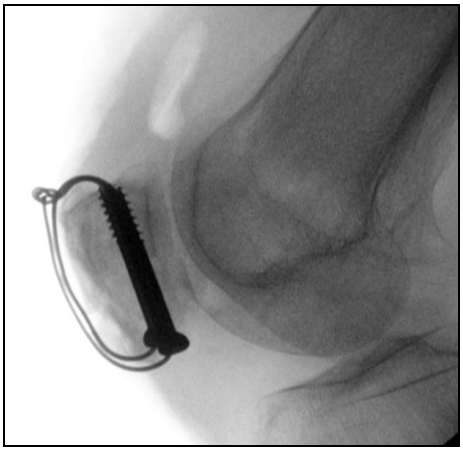

Fig 2: Image intensifier image showing intra-operative reduction

The wire was tensioned after that (Figure 3). The stability was tested by placing the knee through a range of motion and the retinacular tear or arthrotomy was repaired (Figure 4). Post-operatively active exercises were started straight away.

Fig 3: Photograph showing wire tensioned in figure of eight on patella

Fig 4: Photograph showing stability tested through range of motion

All patients had check x-rays (anteroposterior and lateral views) and were assessed using a modified Hospital for Special Surgery (HSS) knee scoring system (Table I) at 6 weeks, 3 months and 12 months after the operation. Since varus/valgus knee alignment and stability are not affected by patellar fracture fixation, the ten points assigned to them have been eliminated, making the highest score ninety points. Excellent results were considered with 75 to 90 points, good from 60 to 74 points, fair from 50 to 59 points and poor with points below 50.

Table 1: Modified HSS Knee score

Title	Points
1. Pain-30 points	
A. 1. No pain on walking	15
2. Mild pain on walking	10
3. Moderate pain on walking	5
4. Severe pain on walking	0
B. 1. No pain at rest	15
2. Mild pain at rest	10
3. Moderate pain at rest	5
4.Severe pain at rest	0
2.Function-22 points	
A. 1. Walking and standing unlimited	12
2. Walking distance of 750 meters outdoors and standing >30 min.	10
3. Walking up 350 meters outdoors and standing <30 min.	8
4. Walking inside and brief standing	4
5. Can't walk	0
B. 1. Climb stairs	5
2. Climb stairs with support	2
C. 1. Transfer activity without support	5
2. Transfer activity with support	2
3. ROM-18 points	
1. 1 point for each 8° of arc of motion maximum of 18 points	
4. Muscle strength -10 points	
1. Can't break quadriceps power	10
2. Can break quadriceps power	8
3. Moves through arc of motion	4
4. Can't move through arc of motion	0
5. Flexion deformity -10 points	
1. No deformity	10
2. Less than 5º	8
3. 5-10°	5
4. 11° or more	0

***Remarks:** Subtract 1 point for using cane, 2 points for 1 crutch and 3 points for 2 crutches. 2 points for 5° of extension lag, 3 points for 10° and 5 points for 15° or more.

4 Results

The mean Modified HSS knee score at the end of follow up was 80±7.8 points. This ranged between 58 and 90 points. According to the scoring system, twenty-eight patients (70%) had excellent result, ten (25%) had a good result and two (5%) had a fair result. There was statistically significant improvement in all parameters of the scoring system throughout the follow up period. (Table II).

Table 2: Comparison between means of all parameters of scoring system in different periods of follow up.

	6 weeks	3 months	12 months
Total score	49.2	71.35	80
Pain	15	23.25	27.25
Function	11.5	16.75	19.25
Range of motion	6.9	13.05	15.65
Muscle strength	5.8	8.4	8.9

Radiological union in which the bony trabeculae crossed the fracture gap had occurred in 39 patients at 3 months. One patient went into delayed union and although the patient was completely asymptomatic and was back to his daily activities and job, the fracture was monitored on monthly basis (Figure 5). The fracture healed at 6 months time with no complications (Figure 6). No patients had developed a non-union.

Fig 5: Lateral radiograph of delayed union at 3 months

Fig 6: Lateral radiograph showing union at 6 months

Regarding complications, one patient complained of knee pain. In this patient the fracture had united radiologically and the pain was caused by soft tissue irritation due to long screws. The patient was offered removal of the screws but refused any further surgery and the pain improved over the course of the follow up. Three patients had loss of terminal flexion of the knee, one patient lost 30 degrees, and another patient lost 20 degrees while the last patient lost 10 degrees. No patients developed any flexion contracture or extensor lag. At the end of the follow up period no patient required re-operations for removal of metal work.

5. Discussion

Transverse patellar fractures are associated with complete disruption of the extensor mechanism. The quadriceps muscle displaces the superior fragment proximally, necessitating operative treatment to achieve adequate reduction [5].

Internal fixation is used to maintain reduction until the fracture heals. Early range of motion of the knee reduces the incidence of postoperative knee stiffness and shortens disability after patellar fractures. Internal fixation techniques should be strong enough to resist the bending and distraction forces across the patella during this postoperative period to allow for early motion [6].

The most commonly used technique of internal fixation is the modified tension band wiring method by the AO group. This technique is designed to resist the forces across the patella in bending but probably is not as effective in pure distraction when the knee is in full extension. Clinically, it can also be difficult to secure the tension band wire directly down against the patella, allowing the fragments to slip apart with quadriceps contraction. In addition, patient reports of skin irritation from prominent hardware necessitating re-operation for removal of metalwork are very common postoperatively [7].

Some surgeons have used interfragmentary screws to prevent the fracture from sliding apart and to decrease the frequency of hardware irritation to surrounding soft tissues. With cannulated screws, screw fixation and tension band wiring can be combined. Wires can be inserted easily through the cannulated shaft of the screw and brought over the top of the patella, creating a secure tension band construct with the added advantage of interfragmentary compression from the screw fixation [8].

Biomechanically, Carpenter *et al* compared between three techniques for repairing transverse patellar fractures: modified tension band, interfragmentary screw fixation alone, and cannulated screw fixation combined with a tension band. In cyclic tests, the mean maximum displacement for each technique was measured and was found to be 4.37 mm, 1.52 mm & 1.04 mm respectively. While in static tests, the load to failure (defined as the point where 3 mm displacement occurred at the fracture site) was measured and found to be 395 Newtons, 554 Newtons and 732 Newtons respectively (4).

The case that went into delayed union proves that this is a stable construct that did not fail even with the patient back to full activities without restriction and it managed to hold the fracture in place till radiological union occurred, which is in line with Carpenters *et al* findings [4].

The result of this study, where 28 patients (70%) had excellent result, 10 (25%) had a good result and 2 (5%) had a fair result, were similar to those from Berg's and Tian's study [5, 9].

Tian *et al* used the Iowa knee score in comparing titanium cable-cannulated screw tension band and modified K-wire and found better scores with the first group. Scores were: excellent in 45 patients; good in four; fair and poor in none for the cannulated screw group and were: excellent in 36 patients; good in nine; fair in four and poor in three for the K-wire group [9].

Berg's study showed seven patients (70%) had satisfactory results while three patients (30%) had fair results [5].

In this study, no failure of reduction or non-unions occurred in any patient. This was similar to both Tian's and Berg's studies [5, 9].

Soft tissue irritation remains the most common complication following modified tension band wiring. The described fixation technique offered a low profile construct that caused lesser degrees of implant irritation to local soft tissue structures and was compatible with the use of early motion. Whereas with traditional tension band wiring, the K-wires protrude into the patellar and the quadriceps tendon and are often bent, which may cause local tissue irritation and requires implant removal. In this study, long screws caused pain to one patient but the patient refused implant removal. In Berg's *et al.* [5] study no patient required a second operation for hardware removal. In Tian's *et al.* [9] study, none of the patients in the cable-cannulated group experienced any irritative symptoms while five from the K-wire group did.

None of the patients in this study developed an extensor lag, which is similar to other studies as well [5, 9].

Our advice and tips for this fixation technique are:

- To insert the screws from distal to proximal to avoid any articular damage due to the anatomical shape of the patella.
- To have the screws just flush with or short of the end of the patella to prevent the wire bending on the sharp corner of the screw increasing the risk of wire breakage.
- Can be used in comminuted fractures, if the fragments are large enough allowing transformation of the fracture configuration into a transverse one by using lag screws then applying this fixation method.
- This technique can be used in polar fractures by inserting the screws through the smaller fragment first allowing compression then supplementing the fixation with the tension band wire

6. Conclusion

Treatment of patellar fractures using figure of eight wiring through cannulated screws is an easy reproducible technique, which gives good stability with a low profile construct leading to good results with a low complication rate.

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