The Outcomes of Cannulated Screws Versus Tension Band Wiring in Treatment of Transverse Patellar Fracture: A Comparative Study

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Abstract

BACKGROUND: For the treatment of displaced patella fractures by tension bands with cannulated screws and by K-wire are widely employed. The clinical efficacy of the two therapy regimens, however, remains a point of contention.

AIM: The study goal was to assess the relative advantages and drawbacks of open reduction and internal fixation using tension band wiring versus cannulated screws with wiring in patients sustained displaced patellar fracture.

PATIENTS AND METHODS: A clinical trial study conducted in the Orthopedics Department at Al-Yarmook Teaching Hospital during a period of 18 months from June 2020 to November 2021. It included 22 adult patients diagnosed with isolated displaced transverse patellar fracture and scheduled for operative fixation. They were divided randomly into two groups: Tension band technique group (TBT) included 11 patients underwent open reduction internal fixation (ORIF) with TBT and cannulated screws (CS) group included 11 patients underwent ORIF by cannulated screws with wiring. A postoperatively follow-up was continued for 6 months. In which patients were assessed clinically and radiographically 4 time, at the end of the 1st, 2nd, 3rd, and 6th months.

RESULTS: After 1, 2, and 3 months, means of Lysholm score and range of flexion were significantly higher; while mean of VAS score of pain was significantly lower in CS group than that in TBT group. No statistical significant differences in postoperative complications were found between study groups.

CONCLUSION: Tension band wire with cannulated screws is the most effective surgical approach for internally repairing transverse fractures of the patella which allows for an early start to postoperative functional activity and an improved quality of life.

Introduction

The patella is an important part of the knee extensor mechanism because it acts as a fulcrum for forces directed during knee extension [1]. Patella fractures account for about 1% of all fractures. Males are more likely to have them. Because of the high energy mechanism, open injuries account for 6–9% of patellar fractures and are frequently linked with other injuries [2], [3]. Mechanisms of direct injury are responsible for the vast majority of instances. The type of fracture that results is determined by the trauma mechanism (direct or indirect), the energy communicated to the bone, and the quality of the bone. A simple two-part diversion generated by a direct hit is the most typical fracture pattern (i.e., dashboard injury) [4]. Transverse, vertical, comminuted, marginal, and osteochondral traumatic fractures of the patella are the most common. Transverse patellar fractures occur horizontally across the patella and are most commonly caused by an indirect impact [5]. Transverse patellar fractures with displacement larger than 3 mm, articular incongruity of 2 mm or more, or a damaged extensor mechanism are traditionally treated with open reduction and internal fixation (ORIF) [6]. The goal of surgical treatment is to achieve anatomical reduction of the joint surface and stable fixation, allowing for early range of motion and thereby restoring the knee extensor mechanism [7]. The cable pin system, mini-screw fragment fixation system, and fixed angle plate fixation for various patellar fracture configurations are the most recent contributions to the surgical therapy of patellar fractures [8]. Internal fixation of patella fractures has traditionally been done with modified anterior tension band wire, which is the most common and preferred approach. The tension band wire converts the distraction forces at the fracture site into compressive forces [9]. The impingement of the k wire ends on the local soft tissues is a common problem described with this kind of fixation. Many surgeons have tried various modifications to this procedure in order to reduce these consequences. Some surgeons have noted that cannulated cancellous screws produce less soft-tissue irritation, provide better stability, and deliver compression pressures at the fracture site, both clinically and biomechanically [10]. The tension band approach is the most often used method; however, it can only be employed after a more complex fracture has been transformed to a two-part fracture and there is no articular discontinuity. Using supplemental circular
wire or tiny fragment screws, more fracture fragments can be repaired [11]. Indwelling Kirschner wire, on the other hand, causes a foreign body reaction that affects the skin and tissues, including inflammatory granulation tissue [12]. Furthermore, during knee exercise, Kirschner wire loosening, bending, and the like may occur, resulting in treatment failure. Displacement between fracture pieces affected 10–20% of the patients, and 5% of the patients required two surgeries [13]. Several alternative procedures have been presented in light of the challenges and complications involved with traditional K wire fixing and tension band wiring. Inter-fragmentary screws or cannulated screws with or without extra tension band wire through the screw are used for closure reduction and fracture fixation. In addition, several authors have employed arthroscopy to visualize and facilitate precise articular surface reduction [14], [15]. The advantage of these procedures is that they are minimally invasive, resulting in less soft tissue damage and a quicker recovery period [16].

Aim of study

The aim of this study is to assess the relative advantages and drawbacks of ORIF using tension band technique with wiring (TBT) versus cannulated screws (CS) with wiring in patients diagnosed patellar fracture.

Patients and Methods

Study design, setting, and time

This was a clinical trial study conducted in the Orthopedics Department at Al-Yarmook Teaching Hospital, Baghdad, Iraq, during a period of 18 months from June 2020 to November 2021.

Study population and sample size

The study included 22 adult patients diagnosed with isolated displaced transverse patellar fracture and scheduled for operative fixation. Patellar fracture was isolated, closed with more than two and <8 mm displacement with intact extensor mechanism. All the patients signed an informed consent that allows us to perform these operations and to record their information for research purposes as long as the patient anonymity and confidentiality of their medical records are maintained. Patients with open or multiple fractures, those who presented more than a week after injury, with cardiopulmonary dysfunction and severe diabetes (fasting blood glucose >10 mmol/L), with supplicative infection of joints, with associated other knee joint injuries, and patients with cognitive impairment could not cooperate with follow-up were excluded from this study. They were divided randomly into two groups:

- **TBT group**
  - Included 11 patients underwent ORIF with TBT.

- **CS group**
  - Included 11 patients underwent ORIF by CS with wiring.

Randomization was done as each patient was assigned a number, then patients with odd numbers were assigned as TBT group (11 patients) and patients with even numbers were assigned as CS group (11 patients).

Pre-operative evaluation

A detailed history and complete physical examination was carried out before surgery. Radiography of the affected side including anteroposterior and lateral view of the knee were obtained. Fracture character was confirmed after clinical assessment and radiography and cross-sectional CT-scan, fracture classified using trauma association of osteosynthesis classification system. The affected knee was immobilized in extension by back slab to avoid further displacement of fracture and the affected limb was elevated to decrease the swelling and analgesia usually prescribed to control pain. Full blood investigation, general urine examination, chest X-ray, ECG with more advanced study like echo-study in selected patients with cardiac risk and comorbid disease, then the patient sends for anesthetic fitness preoperatively, two pints of blood preparation.

Surgical procedure

All patients had surgery within 1–3 days after their injuries. Before surgery, all patients were fasting for 8 h. The patient was admitted to the orthopedic surgical unit on the day of operation, and one dosage of antibiotic (third generation cephalosporin) was given 30 min before surgery prophylactically. All surgical equipment, including surgical sets, wire cutters, reduction clumps or towel clips for the same purpose, orthopedic drill with steel wires set, K-wires sets, two-partially threaded cannulated screws (4 mm), cautery and sucker apparatus were prepared and on standby, in addition to the operative and nursing teams being fully prepared and ready before the patient being placed under general or spinal anesthesia. Patients anesthetized with general or spinal anesthesia.

- Pneumatic tourniquet applied to mid-thigh
- Patient was positioned securely to the orthopedic radiolucent table with a full extended knee
Skin was prepared with betadine and draping of standard manners with covered feet.

**TBT group**

On the patella, a midline longitudinal incision was made, a full-thickness skin flap was raised, the fracture position was revealed, and thorough debridement was performed. K-wire was used to replace and repair the fracture fragments under the c-arm X-ray machine’s view, and constant traction was used to keep the correction stable. The joint chamber was cleaned and K-wire with a diameter of 2 mm was utilized to repair it. The deep tissue was buckled and imbedded after the fixation, the joint cavity was cleaned, the drainage tube was kept, the wound was sutured, and the pressure dressing was applied after the operation.

**CS group**

On the patella, a midline longitudinal incision was made, a full-thickness skin flap was raised, the fracture position was revealed, and thorough debridement was performed. To temporarily repair the fracture fragments, a strong reduction clamp was used. Two K-wires with a diameter of 1.6 mm were used to longitudinally pass through the fractured patella, and the K-wires were utilized as parallel as feasible and situated in the anterior 1/3 of the patella after the finger verified that the patella joint surface was flat. A 4.5 mm partially threaded stainless steel cannulated compression screw was screwed in under the vision of K-wire. The needle was pulled out after the cannulated screw was lodged into the patella bone. Steel wire was threaded through the screw, bent into an 8-figure shape, buckled, and buried in deep tissue. The wound was then sutured after the joint cavity was cleansed and the drainage tube was preserved.

**Postoperatively**

Backslap was used for 5–7 days to relieve pain at the surgery site during mobilization of the patient locally in bed, followed by quadriceps contraction exercise as soon as the patient was able to do it without pain, and passive range of motion was started as soon as possible, usually after the 7th day. Active range of motion is encouraged about the 4th week, and full weight bearing is encouraged around the 8th week.

**Follow-up**

For 6 months, all of the patients were followed up on. Patients were assessed clinically and radiographically at the end of the 1st, 2nd, 3rd, and the 6th month. The term “fracture union” refers to the bridging of the fracture line in plain radiography by more than 80% [17]. The Lysholm score was used to assess the functional outcome of the procedure’s ultimate result. It ranged from 0 to 100; with a higher number indicating better joint function [18]. Post-operative pain was evaluated using VAS-score. It stands for 0–10 score; high score was closely related to the severity of the pain. Flexion range of movement was measured using a goniometer. Fracture displacement (gap) is defined as a displaced fracture line of more than 2 mm in comparison to the radiographic image taken immediately after surgery. A superficial infection that does not reach the bone and joint can be treated as an outpatient with oral or injectable antibiotics.

**Statistical analysis**

Statistical Package for the Social Sciences version 26 was used to analyze the data. The information is displayed in the form of a mean, standard deviation (SD), and ranges. Frequencies and percentages are used to present categorical data. The continuous variables were compared using a two-tailed independent t-test. The continuous variables were compared using a paired t-test after different follow-up durations. Statistical significance was defined as p ≤ 0.05.

**Ethical research approval**

Approval was granted from the scientific committee of Orthopedics Department at Al-Yarmouk Teaching Hospital.

**Results**

In this study, age ranged from 27 to 59 years with a mean of 51.21 years and a SD of ± 6.1 years. No statistical significant differences between study groups (p ≥ 0.05) in age, BMI level, and side and cause of fracture as shown in Table 1.

<table>
<thead>
<tr>
<th>General characteristics</th>
<th>Study group</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>7 (63.6)</td>
<td>8 (72.7)</td>
</tr>
<tr>
<td>Female</td>
<td>4 (36.4)</td>
<td>3 (27.3)</td>
</tr>
<tr>
<td><strong>Side</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right</td>
<td>6 (54.5)</td>
<td>8 (72.7)</td>
</tr>
<tr>
<td>Left</td>
<td>5 (45.5)</td>
<td>3 (27.3)</td>
</tr>
<tr>
<td><strong>Cause of fracture</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fall from height</td>
<td>5 (45.5)</td>
<td>6 (54.5)</td>
</tr>
<tr>
<td>Road traffic accident</td>
<td>4 (36.4)</td>
<td>4 (36.4)</td>
</tr>
<tr>
<td>Other</td>
<td>2 (18.1)</td>
<td>1 (9.1)</td>
</tr>
<tr>
<td><strong>Age (year)</strong></td>
<td>49.34 ± 9.3</td>
<td>52.11 ± 11.5</td>
</tr>
<tr>
<td><strong>BMI (kg/m²)</strong></td>
<td>27.32 ± 5.3</td>
<td>28.12 ± 6.1</td>
</tr>
</tbody>
</table>

We noticed that after 1, 2, and 3 months, means of Lysholm score and range of flexion were significantly higher; while mean of VAS score of pain.
was significantly lower (p < 0.05) in CS group than that in TBT group as shown in Table 2.

Table 2: Comparison between study groups by follow-up parameters

<table>
<thead>
<tr>
<th>Follow-up parameters</th>
<th>Study group</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lysholm Score</td>
<td>TBT group mean ± SD</td>
<td>CS group mean ± SD</td>
</tr>
<tr>
<td>After 1 month</td>
<td>54.85 ± 7.2</td>
<td>62.17 ± 5.4</td>
</tr>
<tr>
<td>After 2 months</td>
<td>67.62 ± 8.6</td>
<td>77.2 ± 9.6</td>
</tr>
<tr>
<td>After 3 months</td>
<td>75.44 ± 9.3</td>
<td>86.32 ± 5.2</td>
</tr>
<tr>
<td>After 6 months</td>
<td>91.84 ± 6.1</td>
<td>93.22 ± 7.4</td>
</tr>
<tr>
<td>Pain (VAS score)</td>
<td>TBT group mean ± SD</td>
<td>CS group mean ± SD</td>
</tr>
<tr>
<td>After 1 month</td>
<td>6.85 ± 1.4</td>
<td>4.54 ± 0.74</td>
</tr>
<tr>
<td>After 2 months</td>
<td>5.94 ± 1.2</td>
<td>3.61 ± 0.9</td>
</tr>
<tr>
<td>After 3 months</td>
<td>3.92 ± 1.0</td>
<td>2.15 ± 0.7</td>
</tr>
<tr>
<td>After 6 months</td>
<td>0.97 ± 0.6</td>
<td>0.85 ± 0.8</td>
</tr>
<tr>
<td>Flexion (°)</td>
<td>TBT group mean ± SD</td>
<td>CS group mean ± SD</td>
</tr>
<tr>
<td>After 1 month</td>
<td>100.41 ± 9.2</td>
<td>109.5 ± 8.4</td>
</tr>
<tr>
<td>After 2 months</td>
<td>118.22 ± 7.6</td>
<td>129.4 ± 7.9</td>
</tr>
<tr>
<td>After 3 months</td>
<td>127.17 ± 3.0</td>
<td>132.97 ± 3.2</td>
</tr>
<tr>
<td>After 6 months</td>
<td>138.2 ± 1.2</td>
<td>139.12 ± 2.6</td>
</tr>
</tbody>
</table>

As shown in Table 3, no statistical significant differences in post-operative complications (p ≥ 0.05) between study groups.

Table 3: Comparison between study groups by post-operative complication

<table>
<thead>
<tr>
<th>Complication</th>
<th>Study group</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surgical site infection</td>
<td>TBT group (%) n = 11</td>
<td>CS group (%) n = 11</td>
</tr>
<tr>
<td>Yes</td>
<td>1 (9.1)</td>
<td>2 (18.1)</td>
</tr>
<tr>
<td>No</td>
<td>10 (90.9)</td>
<td>9 (81.9)</td>
</tr>
<tr>
<td>Displaced fragment</td>
<td>TBT group (%) n = 11</td>
<td>CS group (%) n = 11</td>
</tr>
<tr>
<td>Yes</td>
<td>0 (0)</td>
<td>1 (9.1)</td>
</tr>
<tr>
<td>No</td>
<td>11 (100.0)</td>
<td>10 (90.9)</td>
</tr>
</tbody>
</table>

Discussion

This study showed that ORIF by CS with wiring was associated with significantly better clinical outcomes, pain scores, and flexion at early follow-ups (up to 6 months) than ORIF with TBT. There were no differences in these measures at the final 6-month follow-up. Furthermore, there were no differences in complications between groups. Similar results were found in studies conducted by Liu et al. in 2020 [19] and Zhang et al. 2018 [20] when they reported that scores of the patients in the CS group were higher than those in the TBT group. Biomechanical studies have shown that the cannulated screws, alone or in combination with tension band wire, provide stable fixation when the fracture is well minimized, with less than a 1-mm gap between the fracture pieces. As such, some authors have recommended the cannulated screws to be used in the treatment of transverse fracture. Tension band with cannulated screw had a better curative effect on the patella fracture, lower compression rate, and higher quality of life of patients [19]. Another agreement was noticed in Liu et al. study in 2020 [19], Tan et al. study in 2016 [22], and Shrestha et al. study in 2019 [23] when they stated that VAS scores in the CS group were lower than those in the TBT group. The primary compression effect at the fracture interface is achieved by two parallel cannulated lag screws, and the secondary compression is achieved by tightening the figure-of-eight wire band around the anterior patella, which differs from tension band wiring technique [24]. Due to the thick cancellous bone of the patella and the threaded distal end of the cannulated screw, the risk of wire-cannulated screw loosening is extremely low. The cannulated screw tail is tightly attached at the superior part of the patella, the screw threads are not exposed at the patella's edge, and the steel wire is close to the patella's surface after tightening, all of which can reduce the risk of skin irritation, postoperative activity discomfort, and pain [25]. The improvement in range of motion following cancellous screws can be ascribed to the less soft-tissue irritation by the screws in comparison to the wires. As a result, patients in the cannulated screw group experienced less pain and improved function, as well as higher fixation quality, allowing for greater knee range of motion [23].

Conclusion

The tension band wire with cannulated screws is the most effective surgical approach for internally repairing transverse fractures of the patella which allows for an early postoperative return to functional activity and an improved quality of life.

Recommendation

We recommend using both of cannulated screws and tension band wiring in the treatment of transverse patellar fracture.

References

PMid:25972700

PMid:26816687


PMid:25926361
PMid:12784017

PMid:22673272

PMid:22183197

PMid:23529632

PMid:22608600

PMid:11195111


PMid:28622833

PMid:30634955


PMid:22933672

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PMid:32908578


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