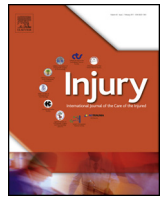




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Original article

Factors affecting the outcomes of modified tension band wiring techniques in transverse patellar fractures

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ABSTRACT

Introduction: Modified tension band wiring has been widely used to treat transverse patellar fractures. However, few studies have evaluated the clinical outcomes using different methods of Kirschner wire bending, location of the tension band, and depths of Kirschner wires. Thus, we tried to clarify these factors according to our clinical outcomes.

Patients and methods: This retrospective cohort study recruited consecutive patients underwent surgical fixation for patellar fractures using modified tension band technique between January 2010 and December 2015. Different factors in this procedure, including the bending manner of the Kirschner wires, their depth, and location of the tension band with respect to the superior and inferior border of the patella were recorded and analysed. The primary outcome was early loss of fixation. The secondary outcomes were minor loss of reduction, implant breakage, deep infection, and the need for implant removal.

Results: This study included 170 patients with patellar fractures. Regarding the bending method, similar results were obtained with bilaterally or proximally bent Kirschner wires. Regarding length, the tension band was placed closely (within 25% of the patella length) in 124 patients and distantly in 46 patients. The rates of loss of reduction and implant breakage were significantly higher in the distantly placed tension bands. Regarding depth, 37 patellar fractures were fixed with the Kirschner wires at the superficial one third of the patellae while the K-wires at the middle layer of patella were used in the remaining 133 patellar fractures. A significantly higher rate of minor loss of reduction was obtained using the superficial Kirschner wires.

Conclusion: The modified tension band technique for transverse patella fractures provides favourable clinical outcomes, with low failure (5%) and infection (2%) rates. Implant irritation is the major complication, and almost half of cases require implant removal. The location of the tension band with respect to the superior and inferior border of the patella plays an important role in clinical outcomes. Placing the wire close to the patella may prevent major loss of reduction and implant breakage. Superficially placed Kirschner wires also affect clinical outcomes by increasing the rate of minor loss of reduction.

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Introduction

Patellar fractures account for approximately 1% of all skeletal fractures [1,2]. Operative treatment is recommended for displaced patellar fractures; the treatment restores the extensor mechanism of the lower extremity and anatomically reduces congruous articulation [2,3]. Modified tension band wiring (TBW), one of the most common surgical fixation methods for patellar fractures [4], converts the anterior tension forces into compression forces at the articular surface through the extensor mechanism [1]. Modified TBW enables early motion, improves outcomes, and decreases posttraumatic arthritis [5]. However, related morbidities, including prominent implant removal [6], implant migration, and even loss of reduction [7,8], have been reported.

Conventionally, the technique consists of two parallel Kirschner wires (K-wires) perpendicular to the fracture line and one figure-of-eight wire passing anteriorly over the patella and behind the K-wires [9]. According to this principle, the K-wires are recommended to be inserted 5 mm below the anterior patella surface, and the tension band wire should be placed as close as possible to the bone [9]. To the best of our knowledge, few studies have comprehensively investigated the technique, including the method of K-wire bending, location of the tension band with respect to the superior and inferior border of the patella, and depth of K-wire insertion. Thus, by reviewing our case series, we aim to verify the contributions of the aforementioned factors to successful fixation.

The primary aim of the current study was to compare the incidence of loss of reduction after surgical fixation of patellar fractures using the modified TBW technique among groups with the K-wires at different depths, bending manner and location of the tension band. The secondary aim was to compare morbidities, namely postoperative infection, implant breakage, minor displacement, and the need for removal of irritating implants, between groups.

Patients and methods

This retrospective cohort study was approved by the institutional review board and recruited patients undergoing surgical fixation of their broken knee caps at National Cheng Kung University Hospital and its Douliu branch between 1 January 2010 and 30 December 2015. All the patients were identified using the coding system of National Health Insurance in Taiwan. The inclusion criteria were a closed transverse patellar fracture with fragment separation >3 mm or articular incongruity ≥ 2 mm, AO/

Orthopaedic Trauma Association (OTA) 34-C1 and AO/OTA 34-C2 fractures, and surgical fixation with modified TBW. The exclusion criteria were different fracture patterns (i.e. the lower pole or longitudinal split), other surgical fixations (i.e. screws, two sets of tension bands) or revision procedures, and insufficient follow-up (less than 90 days).

The medical charts of all patients were reviewed. A tension-band construct was defined as two longitudinal K-wires placed across the fracture along with the anterior tension band wire. An additional one K-wire or one cerclage wire for fixation was acceptable. Eligible patients were categorised according to the method of K-wire bending, location of the tension band with respect to the superior and inferior border of the patella, and the depth of K-wire insertion. The images of included patients were displayed and measured using digital imaging and communication in medicine (DICOM) image viewing software (π ViewTM, INFINITT Co., Ltd., Seoul, Korea).

- (1) Method of K-wire bending: Patients were divided into two groups, TBW with bilateral bending of the K-wires and TBW with only proximal bended K-wires (Fig. 1A).
- (2) Location of the tension band with respect to the superior and inferior border of the patella: The lengths of the patella and location of the tension band were measured. Patients were divided into two groups, Close and Distant. In the Close group, the location of the tension band with respect to the superior and inferior border of the patella was less than 1.25 times the patella length. In the Distant group, the location of the tension band with respect to the superior and inferior border of the patella was more than 1.25 times the patella length. The threshold of 1.25 times the patella length was determined based on the 1-cm threshold between the wire and bone edge identified in the biomechanical study of Ciocanel [10] and the average patella length of approximately 4 cm [11]. Moreover, dividing the patella length quarterly enables easier intra-operative measurement.
- (3) Depth of K-wire: The thickness of the patella was measured and divided to three equal segments. Patients were divided into three groups, Superficial, Middle, and Deep by the position of the K-wire. In the Superficial group, the K-wires were applied over the superficial third of the patella. In the Middle group, the K-wires were applied over the middle third of the patella. In the Deep group, the K-wires were applied over the deep third of the patella. If the K-wire went through the different level from proximal pole to distal pole, or the two K-

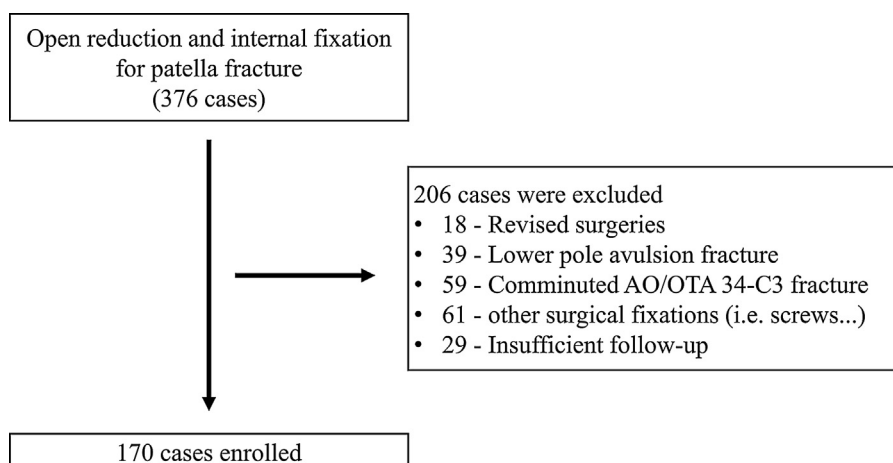


Fig. 1. Patient flow chart.

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