Comparison between the outcomes of cannulated screws and Kirschner wires in tension band fixation of patellar fractures

Faris Kh. Shihab[*1] ; Falih W. Hashim[*2]

[*1] Kirkuk health department-Kirkuk teaching hospital, Iraq;[*2]Consultant orthopaedics M.B.Ch.B., F.I.C.M.S, University of Basrah/ Al-Zahra College of Medicine

Abstract

Background: Patellar fractures represent significant challenges in orthopaedic practice, affecting patients' mobility and quality of life. These fractures are one of the main problems in orthopaedic practice, establishing multiple complicated challenges in treatment and recovery.**Aim of the study**: This study compares between the outcomes of two tension band techniques for patellar fracture fixation: cannulated screws with cerclage wire versus Kirschner wires (Kirschner wires) with cerclage wire.. **Methods**: This prospective and retrospective study was conducted at Basrah Teaching Hospital from May 2023 to May 2024 on (30) patients with displaced patellar fractures treated with either cannulated screws and cerclage wire (Group A) or Kirschner wires and cerclage wire (Group B). Data on demographics, fracture characteristics, operative details, and postoperative outcomes were collected. The primary outcomes assessed included knee stability, knee function (measured by the range of motion and Bostman score), complications rate, and overall patient satisfaction. **Results**: The mean age of group A who were treated with cannulated screws and cerclage wire was (47.67±16.60) years, compared to (54.60±18.68) years in Group B, who were treated with Kirschner wires and cerclage wire, with a non-significant difference ($p=0.292$). Non-significant difference was found between the two groups in regard to gender distribution ($p=0.136$). Non-significant differences ($p>0.05$) were found in each of function status before the fracture, type of fracture, soft tissue status, and degree of displacement, and no significant differences were detected in complication rates including infection, knee stiffness, or hardware failure. **Conclusions**: Both tension band techniques, using cannulated screws with cerclage wire and Kirschner wires with cerclage wire were effective in treating patellar fractures, with comparable functional outcomes and complication rates.

Keywords: Patellar fractures, Cannulated screws, Kirschner wires, Tension band fixation.

Introduction

Patellar fractures are a major concern in orthopedic practice, posing complex challenges in treatment and recovery. These fractures significantly affect a person's mobility and quality of life. The patella, the largest sesamoid bone in the body, is crucial for improving the effectiveness of the quadriceps by increasing its mechanical advantage (1). It does so by shifting the connection between the quadriceps tendon and the patellar tendon away from the knee's axis of rotation. This action effectively lengthens the lever arm of the quadriceps, allowing it to generate forces up to five times the body weight (2). Its position within the tendon of the quadriceps femoris muscle continues distally as the patellar ligament attaches to the tibial tuberosity. The medial patellofemoral ligament (MPFL), a key stabilizer preventing lateral displacement, originates from the medial femoral condyle and inserts on the superomedial patella, often intertwined with the vastus medialis obliquus tendon. Detailed anatomical studies reveal that the MPFL's complex structure includes variations in its attachment points and fiber orientation, influencing surgical approaches for knee stability. The pathophysiology of the patella involves a range of conditions affecting its structural integrity and function, often leading to significant clinical symptoms and compromised knee function (3).

Patellar fractures can occur by two primary mechanisms: indirect and direct mechanisms (4, 5). The indirect mechanism involves fractures caused by forces applied to the knee without direct impact on the patella itself. Instead, excessive force transmitted through the extensor mechanism, including the quadriceps and patellar tendons, can exceed the patella's tensile strength, resulting in a transverse fracture (6,7). In contrast, direct mechanisms involve a direct blow to the patella, often occurring when the knee is flexed (7, 8).

The diagnosis of a patellar fracture is usually based on made on the injury mechanism, clinical and radiological findings. It should be suspected in all patients who have subjected direct impact to the anterior knee or acute resisted knee flexion (9).

The treatment for patellar fractures aims to achieve a functional extensor mechanism, establish articular congruity, and restore full, painless motion of the knee (4).

Surgery is typically considered for more severe cases (5), focusing on preserving as much of the patella as possible to maintain the lever arm of the knee extension mechanism (5, 10). The favoured approach for securing fractures is an adapted tension-band technique (10). This method aims to transform tension forces on the front side into compression forces on the joint surface,

ensuring stability and proper alignment during the healing process (11,12). Kirschner wires are commonly used in tension-band technique where they are inserted across the fracture in a parallel fashion, followed by the application of a figure-of-eight wire loop that exerts compression (11). As a modification, cannulated screws are being used instead of Kirschner wires for precision placement and stable fixation. (13).

Patients and methods

This prospective and retrospective study was conducted at the Orthopedic Department of Basrah Teaching Hospital, during the period from May 2023 to May 2024. The study group included (30) patients who were divided into two groups; group (A) included patients treated with cannulated screws and cerclage wire, and group (B) included patients treated with K-wire and cerclage wire.

Patients older than 18 years and diagnosed with displaced patellar fractures requiring surgical intervention were included in the study, while patients with open fractures or infection at the fracture site, patients who received previous surgical treatment for patellar fractures, patients with systemic conditions that could affect bone healing and functional results, such as seronegative or positive arthropathies, patients with comminuted fractures, and patients with osteoarthritis were excluded from our study. Data on demographics, fracture characteristics, operative details, and postoperative outcomes were collected. The primary outcomes assessed included Knee stability, knee function (measured by the range of motion and Bostman score), complications rate, and overall patient satisfaction.

The stability of the patellar fixation was assessed through clinical examination and imaging. were crucial for assessing functional outcomes, with particular attention to the knee's ability to achieve normal or near-normal movement post-recovery. Signs of bone healing and union was evaluated through clinical examinations and radiographic imaging. Rate of Hardware Complications included any issues related to the surgical hardware used in the fixation process. A comprehensive evaluation of knee function and patient satisfaction post-operation included Knee Score and Function Score. The Knee Score evaluates pain, range of motion, and stability of the knee, as well as alignment and other clinical parameters. The Function Score focuses on the patient's ability to perform daily activities such as walking and climbing stairs. Each component is scored out of 100 points, with higher scores indicating better function and less pain.

The study protocol was rigorously reviewed and approved by the University of Basrah, College of Medicine, and the Diploma Center of Orthopedic, ensuring compliance with ethical standards and patient safety guidelines. Informed consent was obtained from all participants, emphasizing the voluntary nature of participation, the confidentiality of personal health information, and the right to withdraw from the study at any point without affecting their standard of care.

Statistical analysis

The statistical analysis was conducted using SPSS version 26. The Chi-square test and Fisher's exact test were employed to evaluate categorical data and determine the association between different groups. For comparisons involving two independent groups, the MannWhitney U test was utilized. The significance level was set at a p-value of <0.05, indicating that results with p-values below this threshold were considered statistically significant.

Results

Distribution of the study groups according to age in table (1) showed that the mean and SD of age in the cannulated screw group was (47.67±16.60) years, while in the K-wire group was (54.60±18.68) years, with a non-significant difference (p=0.292). The same table showed that the number and percentage of males in the cannulated screw group was 11 (73.3%) and the number and percentage of females in the cannulated screw group was 4 (26.7%), while the number and percentage of males in the K-wire group was 7 (46.7%) and the number and percentage of females in the K-wire group was 8 (53.3%), with a non-significant difference between the two groups (p=0.136).

Table (1): Distribution of the study groups according to age and gender

Variable		Cannulated screw group	K-wire group	P value
Age (years) (Mean±SD)		47.67±16.60	54.60±18.68	0.292
Gender	Male	11 (73.3%)	7 (46.7%)	0.136
	Female	4 (26.7%)	8 (53.3%)	

Non-significant differences (p>0.05) were found in each of function status before the fracture, type of fracture, soft tissue status, and degree of displacement as observed in the table (2).

Table (2): Distribution of patellar fracture data among study groups

Variable	Cannulated screw group	K-wire group	P value

Function status before the fracture	Full range of motion	15 (100.0%)	14 (93.3%)	0.98
	Limited range of motion	0 (0.0%)	1 (6.70%)	
Type of fracture	Transverse	13 (86.7%)	9 (60.0%)	0.107
	Polar	2 (13.3%)	6 (40.0%)	
Soft tissue status	Normal	15 (100.0%)	15 (100.0%)	--------
Degree of Displacement	<1 cm	1 (6.7%)	3 (20.0%)	0.842
	1-3 cm	11 (73.4%)	10 (66.7%)	
	3-5 cm	1 (6.7%)	1 (6.7%)	
	>5 cm	2 (13.3%)	1 (6.7%)	

Results in table (3) revealed that patients treated with cannulated screws and Kirschner wires had similar complication rates, with no significant differences in displacement, hardware failure, infection, knee stiffness, instability, hardware complications, or union complications. Both groups had equal rates of infection and knee stiffness, and no cases of displacement or hardware failure were observed. The incidence of instability and union complications were also comparable.

Table (3): Complications among the studied patients

Variables	Cannulated Screw group	K-wire group	P value
Displacement	0 (0.0%)	0 (0.0%)	
Hardware failure	0 (0.0%)	1 (6.7%)	0.082
Infection	1 (6.7%)	2 (13.3%)	0.55
Knee stiffness	1 (6.7%)	2 (13.3%)	0.55
Instability	0 (0.0%)	0 (0.0%)	------
Hardware complications	0 (0.0%)	3 (20.0%)	0.053
Union complications	0 (0.0%)	1 (6.7%)	0.309

Discussion

Despite the abundance of research in the literature, controversy persists regarding the optimal choice of fixation for patellar fractures. It is widely recognized that employing an optimal technique is essential for accelerating fracture healing, improving function and minimizing postoperative complications (14). This study aimed to compare the outcomes

of patellar fracture fixation using two different surgical techniques: cannulated screws with cerclage wire versus Kirschner wires with cerclage wire.

Regarding the distribution of patellar fracture data among patients treated with either cannulated screws or Kirschner wires, the mechanism of injury was predominantly falls on the ground in both groups, shows no significant difference, indicating a similarity in the circumstances leading to the fractures. Moreover, preoperative functional status, fracture type, soft tissue status, degree of displacement exhibits no significant differences, indicating a homogeneous distribution in these variables. These similarities ensure a balanced basis for evaluating treatment outcomes between the two fixation methods. On the other hand, the operative data from our study indicates notable variations in surgical practices between the Cannulated Screw and K-wire groups.

Both groups exhibit similar complication profiles, with no significant differences in rates of displacement, hardware failure, infection, knee stiffness, instability, hardware complications, or union complications. Specifically, infection and knee stiffness are equally present in both groups (13.3% each), with a non-significant p-value of 0.98 and 0.85, respectively. In a retrospective cohort study investigating the prevalence of postoperative complications in comminuted patellar fractures, specifically comparing those stabilized with Cannulated-Screw versus Kirschner-Wire, Zhu et al. concluded that there were no significant differences in the occurrence of skin breakdown and infection between the groups (15).

Notably, there are no cases of displacement or hardware failure in either group, indicating stable surgical outcomes. However, these findings contrast with those of Zhu et al., who reported significant variation in fixation failure across fixation types. Specifically, they noted that 7 patients (4.7%) in the Kirschner Wire group experienced fixation failure, while 12 patients (14.5%) in the Cannulated-Screw group experienced similar failures, although the included cases were comminuted fractures (15). Moreover, Lin et al. (14) and Hoshino et al. (16) found that the incidence of fixation failure in the Cannulated-Screw with tension Band group was more than twice that in the Kirschner-Tension with Band group, which also contradicts the finding of this study. When using K-wire for fixation, the most common issue is that the cerclage wire tends to slip, causing the Kirschner wire to sink into the patella. This slippage undermines the stability of the

fixation, often leading to poor alignment or movement of the fracture (16). On the other hand, with Cannulated-Screw Tension Band fixation, problems can arise due to the difficulty of correctly inserting the cannulated screws (14). As the patella heals, it experiences various biomechanical forces that can cause the implant to fail or become loose. These forces include bending, tension, and compression. Moreover, issues such as the fragmentation of the fracture and weakened bone due to osteoporosis can further challenge the stability of the fixation (17). Consequently, there is a notable incidence of fixation failures, particularly when early aggressive rehabilitation protocols are implemented (18). Prior research has indicated comparable rates of fixation failures for both transverse and stellate fractures when utilizing either the Cannulated-Screw Tension Band or Kirschner-Tension Band methods (19).

Interestingly, laboratory biomechanical studies have suggested potential advantages of the cannulated-screw tension band method over the KirschnerTension Band method specifically for the fixation of transverse patellar fractures (20).

The incidence of instability and union complications also shows no significant variance, suggesting comparable efficacy and safety profiles for both treatment methods. These findings align with existing literature. Overall, while the incidence of instability and union complications does not significantly vary between the groups, the contrasting findings from previous research highlight the need for further investigation to detect the underlying factors contributing to complication rates in patellar fracture fixation (21).

One of the strengths of this study is that, despite the final six-month follow-up results being comparable between both methods, the intraoperative assessment of the Cannulated screws technique demonstrated more secure fixation. This increased security encourages the earlier implementation of rehabilitation programs and leads to quicker improvements in knee range of motion.

Second point, the patients with Cannulated screws usually not complain, or feeling of the presence of metals as compared to K.wires, although this does not affects the functional recovery and final healing status.

References

1. Fox A, Wanivenhaus F, Rodeo SJTjoks. The basic science of the patella: structure, composition, and function. 2012;25(02):127-42.

2. Huberti HH, Hayes WC, Stone JL, Shybut GT. Force ratios in the quadriceps tendon and ligamentum patellae. 1984;2(1):49-54.
3. Scolaro J, Bernstein J, Ahn J. In Brief: Patellar Fractures. Clinical Orthopaedics and Related Research®. 2011;469(4):1213-5.
4. Boström ÅJAOS. Fracture of the patella: a study of 422 patellar fractures. 1972;43(sup143):1-80.
5. Carpenter J, Kasman R, Matthews L. Fractures of the patella. Instructional course lectures. 1994; 43:97-108.
6. Melvin SJ, Mehta S. Patellar fractures in adults. JAAOS-Journal of the American Academy of Orthopaedic Surgeons. 2011;19(4):198-207.
7. Gwinner C, Märdian S, Schwabe P, Schaser K-D, Krapohl BD, Jung TM. Current concepts review: Fractures of the patella. GMS Interdisciplinary plastic and reconstructive surgery DGPW. 2016;5.
8. Court-Brown CM, Caesar BJI. Epidemiology of adult fractures: a review. 2006;37(8):691-7.
9. Müller ME, Schneider R, Willenegger H. Manual of internal fixation: techniques recommended by the AO-ASIF group: Springer Science & Business Media; 2013.
10. Carpenter J, Kasman R, Matthews LJIcl. Fractures of the patella. 1994; 43:97-108.
11. Carpenter JE, Kasman RA, Patel N, Lee ML, Goldstein SA. Biomechanical evaluation of current patella fracture fixation techniques. Journal of orthopaedic trauma. 1997;11(5):351-6.
12. Zderic I, Stoffel K, Sommer C, Höntzsch D, Gueorguiev B. Biomechanical evaluation of the tension band wiring principle. A comparison between two different techniques for transverse patella fracture fixation. Injury. 2017;48(8):1749-57.
13. Li L, Zhang Q, Tao F, Wang D, Dong J, Zhou D, Song W. Management and Outcome of Elderly Patients with Patellar Fracture Treated With Novel Modified Cerclage Wiring. Geriatr Orthop Surg Rehabil. 2023 May 24;14.
14. Lee K-H, Lee Y, Lee YH, Cho BW, Kim MB, Baek GH. Biomechanical comparison of three tension band wiring techniques for transverse fracture of

patella: Kirschner wires, cannulated screws, and ring pins. Journal of Orthopaedic Surgery. 2019;27(3):2309499019882140.

15. Zhu X-z, Huang T-l, Zhu H-y, Bao B-b, Gao T, Li X-w, et al. A retrospective cohort study on prevalence of postoperative complications in comminuted patellar fractures: comparisons among stabilized with Cannulated-Screw, Kirschner-Wire, or Ring-Pin Tension Bands. BMC Musculoskeletal Disorders. 2021;22(1):60.
16. Hoshino CM, Tran W, Tiberi III JV, Black MH, Li BH, Gold SM, et al. Complications following tension band fixation of patellar fractures with cannulated screws compared with Kirschner wires. JBJS. 2013;95(7):653-9.
17. Karadeniz E, Keskinoz EN. A comparison of EFECE systems with tension band wiring for patella fracture fixation in cadavers. Journal of Orthopaedic Surgery and Research. 2020; 15:1-5.
18. Taylor BC, Mehta S, Castaneda J, French BG, Blanchard C. Plating of patella fractures: techniques and outcomes. Journal of orthopaedic trauma. 2014;28(9): e231-e5.
19. Lorich DG, Warner SJ, Schottel PC, Shaffer AD, Lazaro LE, Helfet DL. Multiplanar fixation for patella fractures using a low-profile mesh plate. Journal of orthopaedic trauma. 2015;29(12):e504-e10.
20. Wang C, Lei T, Qi B, Hou X, Huang Y, Zhang H, et al. A retrospective comparison of the modified tension band technique and the parallel titanium cannulated lag screw technique in transverse patella fracture. Chinese Journal of Traumatology. 2014;17(04):208-13.
21. Zderic I, Stoffel K, Sommer C, Höntzsch D, Gueorguiev B. Biomechanical evaluation of the tension band wiring principle. A comparison between two different techniques for transverse patella fracture fixation. Injury. 2017;48(8):1749-57.