Original Article

A Comparison of the Efficacy of Cannulated Screws against Modified Tension Band Wire in the Management of Slightly Displaced Fractures of the Patella: A Novel Technique

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Aim: The study aimed to compare the outcomes of Open Reduction and Cannulated Screw Fixation (ORCF) and Open Reduction and Tension Band Wire Fixation (ORTF) for treating minimally displaced patellar fractures, with the intention to discern the more efficacious surgical method in terms of various clinical and radiographic parameters. **Methods:** The research was a retrospective controlled trial encompassing 63 patients, culminating in a final data set of 52 patients with transverse patellar fractures with less than 8 mm of displacement. Patients were assessed postoperatively at three, six, and twelve months using measures such as the Lysholm score, Visual Analog Scale (VAS) for pain, and goniometry for active knee extensions and flexion. Statistical analyses were performed using SPSS version 22.0. **Results:** Results indicated superior clinical outcomes for the ORCF group at twelve months post-treatment, with notable higher Lysholm scores and lower VAS scores for pain at three-, six-, and twelve-month intervals. The ORCF group also demonstrated improved flexion and range of motion, with an average fracture healing time of 2.65 months and significantly lower complication rates, compared to the ORTF group. **Conclusions:** The ORCF method, leveraging headless compression screws and cerclage wire fixation, emerges as a promising approach for managing minimally displaced transverse patellar fractures, potentially offering improved clinical results and patient satisfaction in comparison to the traditional ORTF method. Further expansive and diverse studies are warranted to substantiate these findings.

Keywords: *Cannulated screw fixation, tension band wire fixation, transverse patellar fractures*

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Introduction

Patellar fractures account for approximately 1% of all skeletal injuries and are commonly associated with significant morbidity and functional impairment.[1] The most widely used treatment for displaced patellar fractures is open reduction and internal fixation (ORIF) using Kirschner wire (K-wire) fixation with tension band wiring.[2] This technique has been reported to yield satisfactory results; however, it is associated with several drawbacks, including implant discomfort, the requirement for open reduction, the occurrence of palpable implants, and the need for implant removal.[3,4] Therefore, alternative treatment methods that can overcome these limitations are needed.

The open reduction and cannulated screw fixation (ORCF) technique has been referred to in previous literature, using smaller incisions and less dissection compared to the traditional open reduction and tension band wire fixation (ORTF) approach.[5] Some studies

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have reported favorable outcomes with ORCF for the treatment of patellar fractures;[6,7] however, few studies have directly compared the clinical results of ORCF versus ORTF in patients with minimally displaced patellar fractures. The aim of this study was to compare the treatment outcomes of patients with minimally displaced patellar fractures treated with ORCF versus ORTF and to evaluate whether cannulated screw fixation was associated with better clinical outcomes at 12 months, as defined by the Lysholm score, pain ratings, degree of flexion, range of motion, time to radiographic union, radiographic outcomes, and complication rates.

Materials and Methods

This retrospective case series presents a new open surgical technique for treating inferior–superior transverse patellar fractures. The procedure involves the use of headless compression screws and cerclage wire fixation, with the cerclage wire passing through the screw. A description of the surgical technique, along with a review of the outcomes in a series of patients treated with this approach, is provided in Figure 1.

Surgical technique

1. Under general or just regional pain medication, the patient is positioned in a supine position with the affected knee flexed at approximately 30
2. A longitudinal skin incision is made over the patella,and the fracture site is exposed through meticulousdissection of the soft tissue.
3. The fracture is reduced under direct visualization, and temporary fixation is achieved using bone forceps or pointed reduction.
4. A guide wire is inserted from the inferior to the superior aspect of the patella, engaging the opposite The position and length of the guide wire are confirmed using intraoperative fluoroscopy.
5. Over the guide wire, a headless compression screw is inserted, ensuring that it is of appropriate length and diameter to achieve adequate fixation without causing discomfort or protrusion through the superior
6. A cerclage wire is passed through the eyelet of the headless compression screw, ensuring that it is placed beneath the retinaculum and the quadriceps tendon to avoid soft tissue.
7. The cerclage wire is tightened to provide additional compression across the fracture site and then twisted and cut flush with the wire.
8. The fracture site is examined to confirm adequate reduction and fixation, and the wound is closed in layers over a drain if necessary.

Study design and participants

This retrospective, controlled trial was conducted at a single tertiary care center between January 2020 and December 2022. The study is a retrospective and controlled trial that involved 63 patients with transverse patellar fractures with less than 8 mm of displacement, of whom 52 were included in the final data analysis. The study compared the treatment outcomes of two surgical methods: ORCF versus ORTF. The patients were assessed at three, six, and twelve months postoperatively for knee function, pain, and active knee extensions and flexion. The study aimed to evaluate if cannulated screw fixation was associated with better clinical results at 12 months in terms of Lysholm score, pain ratings, degree of flexion, range of motion, time to radiographic union, radiographic outcomes, and complication rates.

Randomization and intervention

Patients were randomly allocated to either the ORCF group or the ORTF group using a computer-generated randomization list. In the ORCF group (n = 32), patients were treated with open reduction and fixation using two cannulated screws and cerclage wire fixation, depending on the fracture size and configuration. In the ORTF group (n = 31), patients were treated with the modified tension band method and standard ORTF.

Postoperative care and follow-up

Postoperative care was standardized for both groups, with patients being allowed to start range of motion exercises and partial weight bearing on the second postoperative day. Full weight-bearing was allowed after radiographic confirmation of fracture union.

The patients were assessed at three, six, and twelve months postoperatively for the following:

1. Knee function: Measured using the Lysholm score
2. Pain: Evaluated using the VAS (visual analog scale).
3. Active knee extensions and flexion: Evaluated using goniometry.

These assessments serve as a form of follow-up to evaluate the patients' progress and compare the outcomes of the two surgical techniques: ORCF versus ORTF. The follow-up assessments help determine which method provides better clinical results at 12 months.

Outcome measures

The outcome measures used to compare the treatment outcomes of patients with minimally displaced patellar fractures treated with ORCF versus ORTF are as follows:

1. Lysholm score: A scale used to assess knee function and recovery after surgery.
2. Pain ratings: Measured using the VAS (visual analog scale) score, which quantifies pain level.

3. Degree of flexion: Evaluated using goniometry, which measures the angle of joint movement in the knee.
4. Range of motion (ROM): Also assessed using goniometry, it evaluates the overall knee joint mobility.
5. Time to radiographic union: The period it takes for the fracture to heal, as observed in radiographic images.
6. Radiographic outcomes: Comparing the postoperative radiographic images to assess the healing progress and quality of the fixation.
7. Complication rates: Tracking any complications, such as skin irritation or implant-related issues, that may have occurred during the follow-up period.

These outcome measures were used to evaluate if cannulated screw fixation was associated with better clinical results at 12 months compared to tension band wire fixation.

Statistical analysis

Data analysis was performed using SPSS version 22.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to summarize the data. The independent *t*-test was used to compare continuous variables, whereas the Chi-square test, or Fisher's exact test, was used for categorical variables. A *P* value of 0.05 was considered statistically significant.

Results

Baseline characteristics of the study participants are shown in Table 1. There were no significant differences between the ORCF and ORTF groups in terms of age, sex, fracture type, or other relevant characteristics.

The comparison of Lysholm scores, VAS scores, and knee range of motion between the CRCF and ORTF groups at 3, 6, and 12 months postoperatively is shown in Table 2. The average Lysholm scores for the CRCF group were significantly higher than those of the ORTF group at all time points ($P < 0.05$). The VAS scores demonstrated that the CRCF group had lower pain scores and increased flexion and total range of motion (ROM) compared to the ORTF group after three and six months of treatment, but after a year, both groups had similar results.

The mean time to radiographic union and complication rates are presented in Table 3. There was no significant difference in the time to radiographic union between the two groups ($P = 0.440$). The complication rates in the ORCF group were significantly lower than those in the ORTF group (11.5 vs. 53.4%, $P = 0.001$). Two ORCF patients and eight ORTF patients had skin irritation, and more patients in the ORTF group required implant removal due to implant-related symptoms (42.3% vs. 7.7%, $P = 0.001$).

Discussion

In our series of patients treated with this novel open technique, the clinical and radiographic outcomes were favorable, with a high rate of fracture union and minimal complications. The use of headless compression screws and cerclage wire fixation allowed for a less invasive procedure and reduced the risk of implant-related discomfort, palpable implants, and the need for implant removal [Figure 2].

This retrospective, controlled trial offers crucial insights into the treatment of minimally displaced transverse patellar fractures. The study results indicate that patients treated with ORCF reported better clinical outcomes at 3 and 6 months postoperatively in comparison to those who received ORTF. These enhanced outcomes were illustrated by higher Lysholm scores, less pain, and improved range of motion. Despite these promising results, by 12 months postoperatively, the disparity in clinical outcomes between the two treatment groups was not statistically significant. Interestingly, the ORCF group exhibited a lower complication rate and fewer implant-related issues, suggesting that the less invasive nature of the ORCF technique may contribute to these benefits.

The findings of this study are consistent with previous research demonstrating the benefits of ORCF in the treatment of patellar fractures. A study by Jin-Ho Cho *et al*.[8] reported that ORCF was associated with better functional outcomes, faster recovery, and fewer complications compared to ORTF for the treatment of transverse patellar fractures. Another study by Camarda *et al*.[9] found that percutaneous cannulated screw fixation resulted in less soft tissue dissection, a shorter operative time, and fewer complications compared to the traditional tension band wiring technique. Similarly, a meta-analysis by Carpenter *et al*.[12] showed that ORCF offered superior functional outcomes and fewer complications than tension band wiring.

The incorporation of cannulated screws in the fixation of patellar fractures is argued to have several advantages over tension band wiring. The benefits include, but are not limited to, less soft tissue dissection, smaller incisions, and a lower risk of hardware irritation and prominence.[10,13] These benefits could largely be attributed to the less invasive nature of the procedure. In the existing literature, it is reported that the percutaneous aspect of the ORCF technique lowers the risk of infection and wound complications.[11,14] Although our technique does not encompass a percutaneous procedure, it is

less invasive compared to the traditional method, thus presumably reducing the risk of complications, further underlining the effectiveness of this procedure. The findings of our study bolster the argument that ORCF may serve as a more effective alternative to ORTF in managing minimally displaced patellar fractures.

This study, while providing valuable insights into the treatment of minimally displaced patellar fractures, has several limitations that warrant consideration.

Firstly, the sample size of 52 patients, while sufficient for statistical analysis, may limit the generalizability of our results to a broader population, particularly for the identification of less common side effects and complications.[15] Secondly, the retrospective nature of this trial introduces potential confounding factors that may not have been adequately controlled for, potentially influencing our results. Randomized controlled trials are considered the gold standard for evaluating treatment efficacy, and the absence of this design in our study represents a limitation. Thirdly, there is a lack of detailed demographic information regarding our patient sample. A diverse patient population in terms of age, gender, ethnicity, and other factors is important for understanding the potential effects of these variables on treatment outcomes. Fourthly, our follow-up period was 12 months, which may not be sufficient to detect late complications or side effects associated with ORCF or ORTF treatment. Long-term follow-up studies are required to fully understand these potential effects. Fifthly, the use of subjective measurement tools such as

Table 1: Baseline demographic and clinical characteristics of the study participants: Values are presented as mean±standard deviation or number (%)

Characteristic	CRCF Group (*n*=32)	ORTF Group (*n*=31)
Age (years)	38.5±6.7	39.8±7.3
Sex		
- Male	18 (56.3%)	17 (54.8%)
- Female	14 (43.8%)	14 (45.2%)
Side		
- Left	17 (53.1%)	15 (48.4%)
- Right	15 (46.9%)	16 (51.6%)
Body mass index (kg/m^2)	24.7±3.1	24.3±3.5
Time from injury to surgery (days)	4.2±1.6	4.0±1.5
Displacement (mm)	5.5±1.4	5.4±1.5
Fracture classification		
- OTA 34-A1	20 (62.5%)	19 (61.3%)
- OTA 34-A2	12 (37.5%)	12 (38.7%)

ORCF: closed reduction and percutaneous cannulated screw fixation; ORTF: open reduction and tension band wire fixation; OTA: Orthopaedic Trauma Association

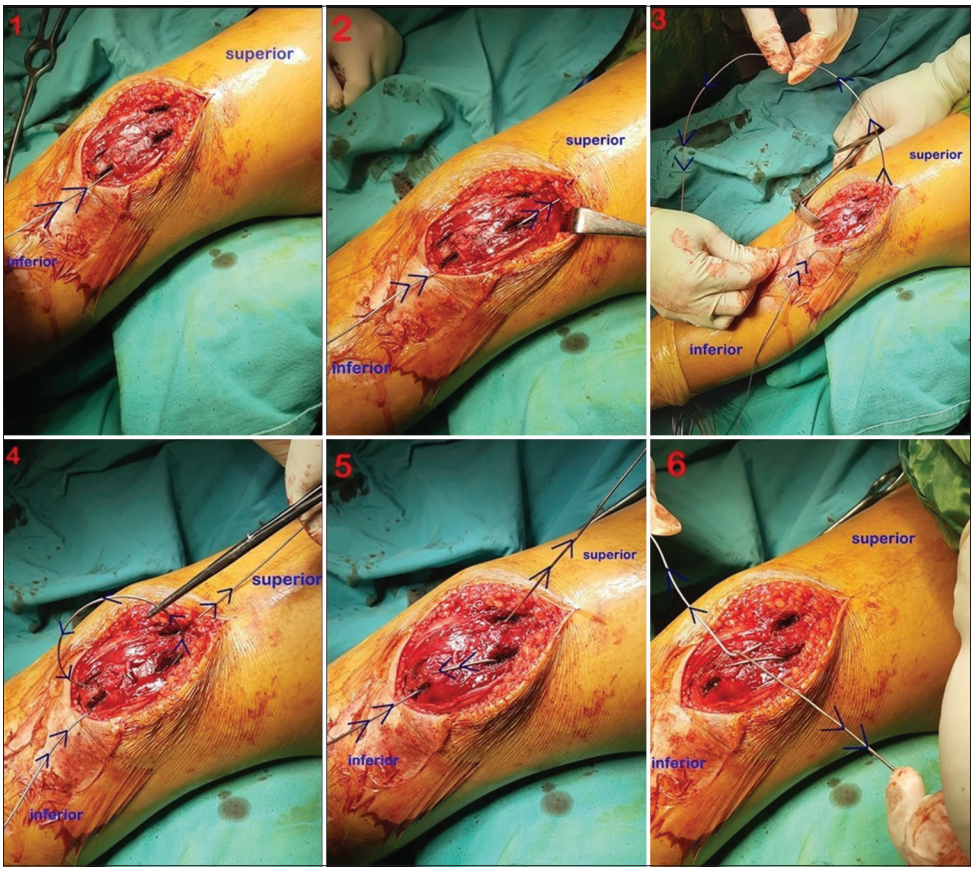

Figure 1: The cerclage wire is threaded through the headless screw

Table 2: Clinical outcomes and complications in the CRCF and ORTF groups: Values are presented as mean±standard deviation or number (%)

Outcome/Complication	CRCF Group (*n*=32)	ORTF Group (*n*=31)	*P*
Lysholm score (3 months)	84.4±5.8	79.0±5.3	0.001
Lysholm score (6 months)	86.7±6.4	81.5±4.6	0.002
Lysholm score (12 months)	93.2±5.3	89.8±6.2	0.039
VAS score (3 months)	2.1±0.8	3.2±1.0	0.001
VAS score (6 months)	1.3±0.6	1.9±0.8	0.002
VAS score (12 months)	0.6±0.4	0.7±0.5	0.440
Range of motion (degrees)			
- Flexion (3 months)	126.0±6.5	120.5±7.1	0.001
- Flexion (6 months)	135.7±4.9	132.3±4.7	0.002
- Flexion (12 months)	142.5±3.1	141.8±3.5	0.440
Time to radiographic union (months)	2.65±0.35	2.77±0.32	0.440
Complication rate	3/26 (11.5%)	14/26 (53.4%)	0.001
- Skin irritation	2 (7.7%)	8 (30.8%)	0.038
- Infection	0 (0%)	1 (3.8%)	1.000
- Nonunion	0 (0%)	2 (7.7%)	0.499
- Implant removal due to symptoms	2 (7.7%)	11 (42.3%)	0.008

ORCF: open reduction and fixation using two cannulated screws and cerclage wire fixation; ORTF: open reduction and tension band wire fixation; VAS: visual analog scale

Table 3: Comparison of postoperative complications between the ORCF and ORTF groups: Values are presented as number (%)

Complication	CRCF Group (*n*=32)	ORTF Group (*n*=31)	*P*
Skin irritation	2 (6.3%)	8 (25.8%)	0.038
Infection	0 (0%)	1 (3.2%)	1.000
Nonunion	0 (0%)	2 (6.5%)	0.499
Implant removal due to symptoms	2 (6.3%)	11 (35.5%)	0.008
Delayed union	1 (3.1%)	3 (9.7%)	0.618
Quadriceps muscle weakness	0 (0%)	2 (6.5%)	0.499
Patellofemoral joint arthritis	1 (3.1%)	2 (6.5%)	1.000
Loss of reduction	0 (0%)	1 (3.2%)	1.000
Persistent pain	1 (3.1%)	3 (9.7%)	0.618

ORCF: open reduction and fixation using two cannulated screws and cerclage wire fixation; ORTF: open reduction and tension band wire fixation

the Lysholm score and VAS score introduces potential bias, as patient responses may vary based on individual interpretation and understanding.

The use of cannulated screws for patellar fracture fixation has several advantages over tension band wiring, such as less soft tissue dissection, a smaller incision, and a lower risk of hardware irritation and prominence.[10,13]

The results of our study further support the notion that ORCF may be a more effective alternative to ORTF for the management of minimally displaced patellar fractures.

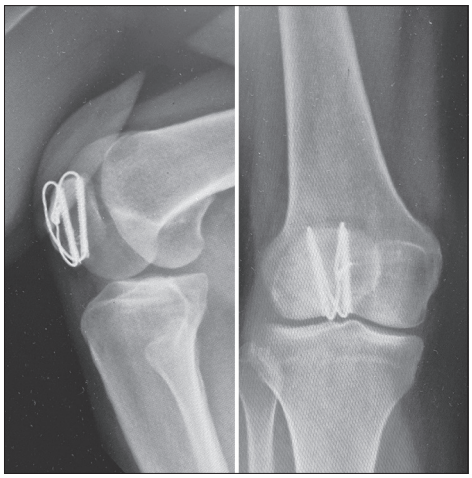

Figure 2: Postop AP and lateral x-ray

The biomechanical advantages of the ORCF technique have been reported in previous studies, which demonstrated that cannulated screws provide better fixation stability and less stress on the fracture site compared to tension band wiring.[16,17] Moreover, cannulated screws allow for precise fracture reduction and compression, which may facilitate faster bone healing.[18,19]

Despite the potential advantages of the ORCF technique, some concerns have been raised regarding the risk of patellar malreduction, screw penetration into the knee joint, and the possibility of patellar tendon injury.[20] To minimize these risks, careful preoperative planning, proper surgical technique, and meticulous postoperative care are essential.

The choice of treatment for such fractures remains a complex decision influenced by a myriad of factors, including the patient's age, overall health status, activity level, and the specific characteristics of the fracture. Yet, the findings of our study suggest that, in cases of minimally displaced transverse patellar fractures, the ORCF technique may offer a favorable risk-benefit profile compared to the ORTF method. ORCF, as a less invasive technique, might also contribute to a more satisfactory patient experience due to reduced postoperative pain and a faster recovery. This could potentially translate into better patient compliance with postoperative rehabilitation protocols, which is a critical component of overall treatment success. It is worth noting that improved patient satisfaction and adherence to rehabilitation can significantly influence long-term functional outcomes. In the context of healthcare economics, while our study did not specifically address this aspect, it is reasonable

to speculate that ORCF, by potentially reducing the rate of complications and promoting faster recovery, may also lead to cost savings. This aspect certainly warrants further exploration in future studies.

In conclusion, this retrospective, controlled trial demonstrated that the surgical treatment of minimally displaced transverse patellar fractures (less than 8 mm) using our modified ORCF technique resulted in superior clinical outcomes and excellent knee function, with less discomfort and a lower incidence of complications during the early follow-up period (up to 6 months). This observation provides considerable evidence to suggest that the ORCF technique may be a more suitable alternative to the conventional ORTF for managing minimally displaced patellar fractures.

Ethics approval and consent to participate

This study was approved by the Adana city hospital (date: 22.04.2020, approval number: 802). All participants provided written informed consent before participating in the study.

Consent for publication

All participants provided written consent for the publication of their anonymized data in this study.

Availability of data and material

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

SM is the sole author of this manuscript. They conceived the study, designed the experiments, performed data collection and analysis, and drafted the manuscript. The author read and approved the final manuscript.

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List of Abbreviations

ORCF = Open Reduction and Cannulated Screw Fixation
ORTF = Open Reduction and Tension Band Wire Fixation
ROM = Range of Motion
VAS = Visual Analog Scale
K-wire = Kirschner Wire
ORIF = Open Reduction and Internal Fixation
SPSS = Statistical Package for the Social Sciences

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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