



Prospective Comparative Study of Fixing Displaced Transverse Patellar Fracture by Tension Band Wiring Versus Cannulated Screws with Wiring

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Abstract

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BACKGROUND: Transverse fractures of the patella are important fractures with a wide variety of subtypes, the common incidence in the age group of 20–50 years. Surgical interference aims to achieve a perfect alignment of the joint surface, in addition to rigid fixation of the fracture for early re-habitation and early movement to retain the extensor mechanism of the knee joint.

AIM: The aim of this study was to compare the radiological and functional outcomes of the displaced transverse patella fracture in adult patients treated by ORIF using tension band wiring versus cannulated screws with wiring.

METHODS: A prospective analytic comparative study was conducted in Al-Kindy Teaching Hospital/Baghdad/Iraq for 18 months from April 1, 2019, to October 1, 2020. It included 32 patients with isolated displaced transverse patellar fracture AO type 34-C1. The patients have undergone operative fixation with two different surgical techniques divided randomly by choosing every other patient into two groups. Group A, the fracture was fixed by cannulated screws with wiring and Group B, the fracture was fixed by two K-wires and with tension band technique. Postoperatively, assessment of the knee function by Lysholm score, the visual analog scale for pain intensity, and active flexion range of movement were measured in degree as primary outcomes, while time to union in weeks assessed radiographically as secondary outcomes.

RESULTS: The patients' age was ranging from 26 to 49 years, with males predominant. Low-energy falls occupying a major part of the mechanism of injury in both groups. Lysholm score was significantly increased after 3, 6, and 12 months compared to that after 1 month in both groups with no statistical differences. The mean visual analog score significantly decreased in Group A after 1 month than that in Group B with no significant change in the other follow-up periods. There were no statistically significant differences in both groups regarding the range of knee movement and the radiographic assessment of fracture healing.

CONCLUSION: Both techniques are good and effective with taking into consideration that open reduction and cannulated screws fixation with wiring technique is shown to be associated with lower post-operative pain and a lower frequency of complications mainly surgical site infection.

Introduction

Patella is the largest sesamoid bone found anterior to the knee joint embedded in the quadriceps tendon. Its chief role is to progress the effective capacity of the quadriceps muscle extension protects the quadriceps tendon from frictional forces and acts as bony protection for inner structures of the knee joint [1].

Fractures of the patella are serious injuries, common in the age group of 20–50 years [2]. Men are double occurrence than women and account for about 1% of all skeletal injuries. Since the subcutaneous location, the biomechanical, character and the great level of energy transmission in extension and flexion of the knee, rigid restoration of patellar fractures is a major surgical task [3].

The mechanism of the patella fractures is either direct trauma or indirectly by contractions of the quadriceps muscle or extensor mechanism stress which usually accompanied by vastus muscles and retinaculum tear [4], [5].

The majority of fracture is closed type, and open one represents about 7% of the cases [5]. Several indications for surgical fixation of the patella which represent about 30% of patella fracture including when extensor mechanism injury or 2 mm step-off incongruity of a patella fracture, also several methods for surgical fixation of the patella by cancellous screw fixation, tension band wiring technique, cerclage wiring, and plate fixation [6].

Fracture patella is classified as transverse, vertical, comminuted, marginal, or osteochondral. Cramer and Moed. hypothesized that displaced fracture up to 3 or

4 mm is regarded as a non-displaced fracture [7]. Another classification is the AO classification divided into three groups: Extra-articular, partial (sagittal), or complete articular (both coronal or multifragmentary) [8]. Computed tomography (CT) plays an important role to identify the exact pieces of the fracture, its displacement, or diagnosed osteochondral fractures [5], [9], [10].

The history, the clinical outcomes, and the shape and displacement of the fracture determined the management modalities. The aim is to return the articular surface anatomically and the extensor mechanism, both conservatively or surgical methods. Conservative one used when the fracture is non-displaced or less than 3 or 4 mm displacement, about 2 mm articular step-off, and normal extensor mechanism [9], otherwise surgical treatment mainly in transverse, stellate, or comminuted fractures [11].

A different method for fixation includes tension band constructs which convert the tension forces into compression type, with about 80% successful result [9], screw fixation [14], percutaneous fixation assisted by arthroscopy [15], screwing-bracing [16], plate fixation [17], and patellectomy either partial or total [18].

Knee stiffness and the anterior knee pain [19], are the chief practical complications mainly due to prolonged casting after non-surgical or surgical treatment, less common complications include deep infection [19], [20], and post-traumatic OA [21].

Lysholm score usually used for assessment of knee functional outcome clinically based on eight objects to be measured: Pain, instability (25 points for each), locking (15 points), swelling, stair climbing (10 points for each), limp, squatting, and need for support (five points for each). The total score was up to 100 points. Higher scores indicated a better outcome with fewer signs or debility [22], and pain assessment with a visual analog scale (VAS) score [23].

Aim of the study

The aim of this study was to compare the radiological and functional outcomes of the displaced transverse patella fracture in adult patients treated by ORIF using tension band wiring versus cannulated screws with wiring.

Patients and Methods

A prospective analytic comparative study was done between April 2019 and October 2020, on (32) patients in Al-Kindy Teaching Hospital/Baghdad/Iraq, between 25 and 50 years old with a mean of 36.68, with isolated displaced transverse patellar fracture AO classification type (34-C1), isolated, closed with

more than 2 mm displacement, while open fracture or multiple fractures, a patient who presents more than 7 days after initial injury and fracture associated with other knee joint injuries was excluded from the study.

Our patients were divided randomly by choosing every other patient into two groups.

Group A: Including 16 patients to undergo cannulated screws with wiring technique for fixing the fracture.

Group B: Including 16 patients to undergo tension band technique for fixation.

Informed consent was received from all patients.

Patient was collected and evaluated in the outpatient clinic and emergency department unit of Al-Kindy Teaching Hospital.

At the emergency department, X-ray AP and Lat views had been taken to evaluate the initial fracture pattern and a CT scan was taken preoperatively for candidates for accurate patellar fracture character and gap measurement and to detect exclusion criteria of this study (Figure 1).



Figure 1: Pre-operative photo and X-ray

Postoperatively, knee function was assessed by Lysholm score, pain evaluation using VAS score and active knee flexion range of movement was measured in degree by goniometry as primary outcomes, while time to union in weeks assessed radiographically, post-operative fracture gap assessed radiographically in post-surgical first follow-up visit, infection, painful hardware, and implant removal rate as a secondary outcome.

Pre-operative fitness workup was done and the affected knee was immobilized in extension by a splint to avoid additional displacement of the fracture.

The surgery was done to all patients after a range of 1–3 days of injury.

Pre-operative one dose of antibiotic (third-generation cephalosporin) was given 30 min before surgery.

During surgery after skin incised in the midline longitudinally over the knee joint for 8–10 cm, the fracture was reduced using clamp or towel clips then inserted wires across the fracture line at 30° flexion



Figure 2: Intraoperative photograph of open fixation with cannulated screws and wiring technique

perpendicularly with 2–3 cm distance between wires in the coronal plane. In Group A after checking the screw size, two-partially threaded cannulated screws (4 mm) were fixed in ante grade or retrograde direction after drilling the fracture fragments guided by wires; then, the wires were detached and an 18 G stainless steel wire was passed over the cannulated screws and crisscrossed done on the anterior part of the patella. The screws were tightened with the knee incomplete extension (Figure 2).

While in Group B, we used two longitudinal K-wires (1.5–2 mm in diameter) inserted across the fracture line perpendicularly with 2–3 cm distance between wires in the coronal plane and then used a steel wire as cerclage-wire around two K-wire proximally and distally with figure-eight construct. Then, tensioning of cerclage-wire nuds until compression across fracture site was achieved (Figure 3).

The last stability of the device was tested by taking the knee through the range of motion and then suturing in layers, dressing, and back-slap for 5–7 days to alleviate pain at the site of surgery.

Quadriceps contraction exercise as early as the patient can do it without significant pain, passive range of motion started as early as possible and usually started after the 7th day postoperatively. Active range of motion encouraged at the 4th week postoperatively, full weight-bearing encouraged at the 8th week postoperatively.

Post-operative all candidates in this study were followed-up once weekly for the 1st month postoperatively, 2nd month, 3rd month, 6th month, and 12th month with clinical and radiographic assessment, both primary and secondary outcome.

Results

Study patients' age was ranging from 26 to 49 years with a mean of 36.68 years and a standard deviation of ± 7.4 years.

Regarding gender, the proportion of males was higher than females in both Groups A and B (62.5% vs. 37.5% and 75% vs. 25%, respectively) with no significant differences ($p \geq 0.05$).

Regarding the Lysholm knee scoring scale, Table 1 and Figure 4 show the comparison in total

Table 1: Comparison in Lysholm score in Group A at different follow-up periods

Follow-up period					
One month	Three months	Six months	12 months		p-value
Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD		
74.75 ± 7.9	87.62 ± 6.6	-	-		0.001
74.75 ± 7.9	-	93.12 ± 6.4	-		0.001
74.75 ± 7.9	-	-	97.25 ± 2.5		0.001
-	87.62 ± 6.6	93.12 ± 6.4	-		0.019
-	87.62 ± 6.6	-	97.25 ± 2.5		0.001
-	-	93.12 ± 6.4	97.25 ± 2.5		0.021

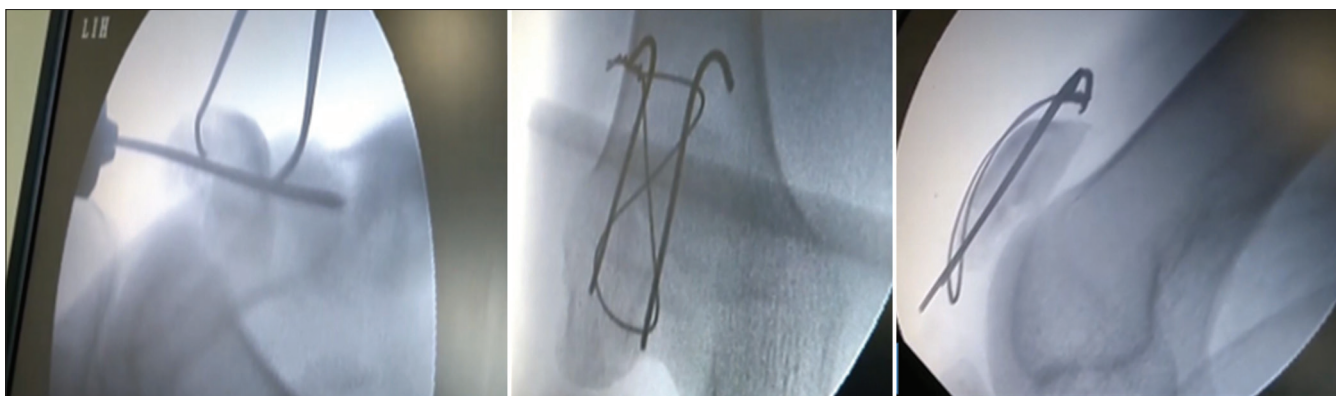


Figure 3: Intraoperative photograph of open fixation and tension band technique

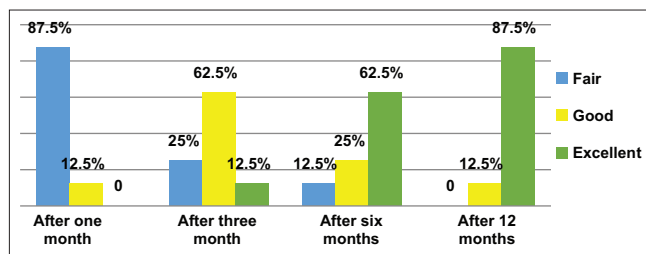


Figure 4: Lysholm score category in different follow-up periods in Group A

Lysholm score in Group A at different follow-up periods. After 1 month, most of the patients had a fair level of score (87.5%), while 62.5% of them had a good level after 3 months (Table 2).

Then, after 6 and 12 months, the majority of patients had an excellent level of Lysholm score (62.5% and 87.5%, respectively), as shown in Figure 4.

In Table 3, we noticed that the total Lysholm score was significantly increased ($p < 0.05$) after three, 6, and 12 months compared to that after 1 month.

Table 2: Comparison in Lysholm score in Group B at different follow-up periods

Follow-up period	One month	Three months	Six months	12 months	p-value
Mean \pm SD	72.37 \pm 5.7	80.75 \pm 9.3	-	-	0.002
	72.37 \pm 5.7	-	92.87 \pm 5.1	-	0.001
	72.37 \pm 5.7	-	-	96.25 \pm 3.1	0.001
	-	80.75 \pm 9.3	92.87 \pm 5.1	-	0.001
	-	80.75 \pm 9.3	-	96.25 \pm 3.1	0.001
	-	-	92.87 \pm 5.1	96.25 \pm 3.1	0.009

By comparing to that after 3 months, it was significantly increased ($p < 0.05$) after 6 and 12 months.

The mean of Lysholm score was also significantly increased ($p = 0.021$) after 12 months compared to that after 6 months.

Table 3: Comparison in VAS score of pain at different follow-up periods between study groups

VAS score	Study group		p-value
	Group A	Group B	
After 1 month	4.75 \pm 0.9	6.12 \pm 1.1	0.017
After 3 months	2.75 \pm 1.0	3.37 \pm 1.1	0.253
After 6 months	0.75 \pm 0.7	0.87 \pm 0.8	0.751
After 12 months	0.12 \pm 0.35	0.12 \pm 0.35	1.0

Table 2 and Figure 5 show the comparison in total Lysholm score in Group B at different follow-up periods. After 1 month, all patients had a fair level of score, while 50% of them had a good level after

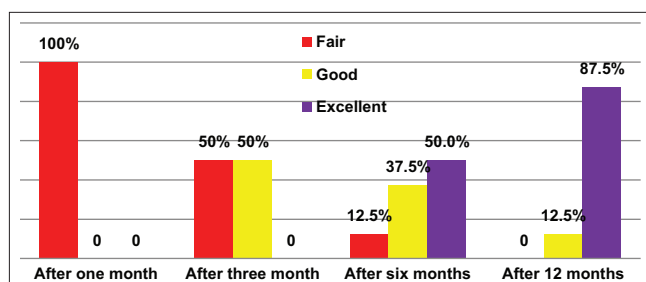


Figure 5: Lysholm score category in different follow-up periods in Group B

3 months.

After 6 months, half of our patients had excellent level of Lysholm score, and at 12 months, the majority of patients had an excellent level of Lysholm score (87.5%), as shown in Figure 5.

In Table 2, we noticed that the total Lysholm score was significantly increased ($p < 0.05$) after 3, 6, and 12 months compared to that after 1 month.

By comparing to that after 3 months, it was significantly increased ($p < 0.05$) after 6 and 12 months.

The mean of Lysholm score was also significantly increased ($p = 0.009$) after 12 months compared to that after 6 months.

In both groups the total Lysholm score at different follow-up periods showed no statistically significant differences ($P \geq 0.05$) in all follow-up periods.

The comparison in VAS score of pain at different follow-up periods between study groups is shown in Table 3. We noticed that the mean VAS score was significantly lower in Group A after 1 month than that in Group B (4.75 vs. 6.12, $p = 0.017$).

The comparison in VAS score of pain at different follow-up periods between study groups is shown in Table 3. We noticed that the mean VAS score was significantly lower in group A after one month than that in group B (4.75 versus 6.12, $P = 0.017$), while in proceeding follow up period at 3 months, 6 months, and 12 months showed no statistically significant differences ($P \geq 0.05$).

The range of knee flexion at different follow-up periods between study groups is shown in Table 4. The mean of the knee flexion in both groups showed good range of movement in the follow up periods with no statistically significant differences ($P \geq 0.05$).

Table 4: Comparison in range of knee flexion at different follow-up periods between study groups

Range of knee flexion	Study group		p-value
	Group A	Group B	
	Mean \pm SD	Mean \pm SD	
After 1 month	108.5 \pm 7.4	108.1 \pm 7.2	0.92
After 3 months	119.37 \pm 7.0	119.12 \pm 6.6	0.942
After 6 months	131.87 \pm 3.9	132.87 \pm 3.0	0.578
After 12 months	136.25 \pm 2.7	138.0 \pm 1.5	0.134

In comparison between study groups by surgical site infection, no significant difference ($p = 0.521$) in surgical site infection between study groups is shown in Table 5.

Table 5: Comparison between study groups by surgical site infection

Surgical site infection	Study group		Total (%)	p-value
	A	B		
	n=16	n=16	n=16	
Yes	2 (12.5)	4 (25.0)	6 (18.8)	0.521
No	14 (87.5)	12 (75.0)	26 (81.2)	

Lastly, regarding the radiographic assessment of fracture time to union postoperatively, there was no statistically significant difference between study groups

and union occurred in a period from 8 to 14 weeks with a mean of 11 weeks.

Discussion

The patella has a significant role in knee joint movement [24]. There are several methods for surgical management of patellar fractures including mini-screw fragment fixation system and fixed-angle plate fixation [25], tension band wiring [26], and cannulated cancellous screws [27].

In this study, there were no significant differences ($P \geq 0.05$) in age with male predominance, this result was similar to Shrestha *et al.* study in 2019, [28], and Camarda *et al.* study in 2016 [29]. It was obvious that the maximum number of patients in all the above-mentioned studies were males, and this can be explained by a different cultural setup, where males have a more active lifestyle and remain out-door more often to earn their living, while females stay mostly indoors.

Regarding the Lysholm score in our patients, there is a significant and gradual increase in the score at one, three, and six months after operation ($P < 0.05$) in both groups, and insignificant difference when compared between the two groups. Our results are in agreement with Liu and colleagues study in 2020, [30] and against Zhang and colleagues in 2018, in which it was significantly lower in tension band wiring group than cancellous screw group at the all follow-up time [31].

In the present study, the mean of VAS score was significantly lesser in group (A) after one month than that in group (B) ($P = 0.017$), and there were no statistical differences in all other periods between the study groups, and this is against Liu *et al.* study in 2020 who showed VAS scores in the cannulated screw group were lower in all follow up periods [30], while Tan and colleagues in 2016 [32], and Shrestha *et al.* in 2019, found it significantly better in tension band technique [28].

For cancellous screw method, it has double compression effects, the primary one at the fracture edge is done by two parallel screws, and the second compression is by tightening the figure-of-eight wire at the anterior part of the patella, which is different from the tension band technique [33]. The possibility of wire-cannulated screw loosening is very low because of the solid cancellous bone of the patella and the distal part of the screw is threaded which is not exposed at the edge of the patella, and the steel wire is adjacent to the patella surface after tautened, all of these can decrease the risk of skin irritation, and post-operative pain and discomfort [34].

The results observed in our study, no statistically significant differences in the mean of the range of knee

flexion in all follow-up times between study groups ($p \geq 0.05$), and this result agrees with Shrestha *et al.* study in 2019 [28]. However, against Liu *et al.* study in 2020, as they reported a significant improvement in range of motion at 1, 3, 6, and 12 months after operation in cannulated screws fixation. [30].

The improvement in range of motion after cancellous screw can be attributed to the less soft-tissue irritation by the screws in comparison to the wires. As a result, patients in the cancellous screw group had less pain and better function, and better quality of fixation allowing a better range of motion at the knee [28].

In the present study, no significant difference (12.5% in Group A and 25% in Group B, $p = 0.521$) in surgical site infection between study groups, and this is to Hoshino *et al.* study in 2013 [35]. By comparison to a recent study conducted in 2019 by Shrestha *et al.*, a different result was observed, in which a significantly higher complication rate (superficial infection, painful hardware, and loosening or hardware breakage) was found in patients treated by tension band wire in comparison to tension band with cannulated cancellous screws group ($p = 0.01$) [28].

Severity and mechanism of injury, co-morbid conditions as DM, and type or duration of antibiotic in pre- and post-operative period can explain the difference observed above.

The infections accompanied these procedures, probably due to the open technique of these procedures [25]. In addition, meticulous soft-tissue dissection can decrease the infection rate postoperatively. Implants can cause an irritation covering soft tissue and the origin of the pain, necessitating a second operation to remove this implant [36].

Finally, regarding the radiographic assessment of fracture time to union postoperatively, in this study, there was no statistically significant difference in the study groups and union occurred in a period from 8 to 14 weeks in both groups. This finding agreed with that reported in Shrestha *et al.* study, in 2019 [28], and Lin *et al.*, in 2015 [37].

Conclusion

Both techniques are good and effective with taking into consideration that open reduction and cannulated screws fixation with wiring technique are shown to be associated with lower post-operative pain and a lower frequency of complications mainly surgical site infection although cannulated screw fixation is more technically demanding than K-wires and tension bands fixation.

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