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ORIGINAL ARTICLE

Outcome of Patellar Fractures Fixation Using Cannulated Screws with Tension Band Wiring

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ABSTRACT

Background: Several techniques were utilized for internal fixation of patellar fractures which include the AO modified tension band wiring, interfragmentary screws or figure of eight wiring using the cannulated screws. This research aimed to assess the outcomes of fixation of patellar fractures using cannulated screws with tension band wiring.
Methods: This prospective clinical study was carried out in orthopedic surgery department of Zagazig University Hospitals on 18 cases who had fracture patella. Patellar fractures fixation was done utilizing cannulated screws with tension band with follow up period of at least 2 years. Postoperative evaluation was performed according to range of motion, radiological evaluation and Bostman's score.
Results: Progressive improvement of range of motion of knee in both flexion and extension at each follow-up was noted. 94.4% (17 cases) had flexion of > 120° and 100% (18 cases) had extension ≥ 15° by the end of 24 weeks. Radiological union occurred at the 6th postoperative week in 15 patients (83.3%) and after 12 weeks in 17 patients (94.4%). At the follow-up all patients achieved union. Regarding the Bostman's score, at the end of final follow up, it was excellent in 15 patients (83.3%), good in 2 patients (11.1%) and poor in one patient (5.6%).
Conclusions: The use of cannulated screws in conjunction with anterior tension band wire to treat transverse patellar fractures is an effective, reliable, and reproducible procedure, Improvements in radiological and functional outcomes, as well as curative effects on patella fracture, complication rates, and the timing of postoperative functional activity, are all benefits of this procedure.
Keywords: Outcome; Patellar Fractures; Tension Band Wiring; Cannulated Screws.

INTRODUCTION

Although patellar fractures account for 1% of all skeletal injuries, only around 1/3 of these cases necessitate surgical correction. Fractures are more common in the 30–60 age bracket. Joint incongruence, a failing extensor mechanism, or a fracture breach larger than 2-3 mm necessitate surgical intervention [1]. Direct or indirect causes can cause patellar fractures [1].

One of the most crucial components of the knee joint is the patella. Maintaining knee range of motion after surgery requires vigorous post-operative rehabilitation in addition to proper treatment. The patella can be fractured in two ways: with or without displacement. If the extensor mechanism is uninjured, the standard treatment for an undisplaced fracture is to immobilize the affected limb in a cylindrical cast and gradually allow mobilization when the patient feels comfortable. To reduce the likelihood of PTOA and subsequent open reduction surgery. Displaced patellar fractures are usually managed surgically [2]. Over time, tension band wiring (TBW) has replaced simpler cerclage wiring as the surgical treatment of patellar fractures. TBW has been improved to increase its strength [3].

Transverse patellar fractures have also been managed with cancellous screws, however they have a far higher failure rate than modified tension band wiring. The construction is now stronger because of the cannulated cancellous screws and anterior tension band wire. The surgical treatment of patellar fractures is an ever-

changing field, instance, the most recent developments in the cable pin system [4], a fixed-angle plate fixation system and a mini-screw fragment fixation system for different types of patellar fractures [5].

Stable fixation has allowed for early mobilization and intensive rehabilitation to preserve the range of motion in the knees of young, physically active patients, which has led to developments in patellar fracture therapy. Tension band wiring, first introduced in the 1950s and later improved with the addition of Kirschner wires (K-wires) to boost the construct's strength and for early mobilization and rehabilitation. It sparked a revolution in the treatment of patellar fractures. The range of motion in the knee may be limited because the K-wires protrude and irritate soft tissues. The quadriceps pull is straight in the early post-operative phase due to the knee being immobilized in extension. This pull could cause traction on the K-wires and result in loss of reduction [6].

It may be difficult to kneel due to the distal pointed ends of the K-wires. A novel method has emerged, that uses cannulated cancellous screws in place of the K-wires to address these drawbacks. As lag screws, the fasteners compress the area around the crack. Screws, when used in conjunction with tension band procedures, mechanically lessen fracture separation by compressing the material at all angles of rotation and by resisting tensile loading at the end of the extension phase [6]. So, the current research aimed to assess the outcomes of patellar fractures fixation utilizing cannulated screws with tension band wiring.

METHODS

We conducted this prospective clinical study on 18 cases who had fracture patella. Patellar fractures fixation was carried out using cannulated screws with tension band at the orthopedic department, Zagazig University Hospital, from September 2023 to September 2024 with follow up period of at least 2 years.

After institutional review board approval of IRB (#101064-3/9/2023), all participants were asked to provide written informed consent. The study was conducted in accordance with the Declaration of Helsinki, which is a part of the World Medical Association's Code of Ethics for Research Involving Humans.

We included patients who had transverse patellar fractures (only or with other variations), articular displacement >2 mm, mild comminuted patellar fractures, closed fractures, and patients who had open fractures grade I, II and III with no contamination.

Exclusion criteria were all patients who had the following conditions: open contaminated fractures, comminuted patellar fractures, and patients who were medically unfit for operations.

Every patient had a thorough medical history taken, with extra attention paid using the Advanced Trauma Life Support (ATLS) protocol for an initial general assessment that focuses on potential life-threatening illnesses and their care, other systems injury and associated fractures. Examination of knee included examination of both front and popliteal fossa of knee and comparing it with the contralateral side.

Regarding radiographic evaluation, all patients were evaluated by plain X-rays and CT scan. Standard anteroposterior (AP), lateral views of knee as well as axial, coronal, sagittal and 3d films were performed.

Routine preoperative laboratory tests included complete blood picture, kidney profile, liver profile, random blood sugar, and coagulations profile.

A knee brace was used to immobilize the injured limb, which was bent at an angle. An antibiotic for preoperative use (Ceftriaxone, 1 gm) was prescribed for all patients. An intravenous dose 30 minutes prior to the onset of anesthesia, and another dose every 12 hours after the operation were administrated.

Surgical technique

All patients underwent spinal anesthesia. Before surgery, patients were placed in a supine posture without a tourniquet to ease reduction and avoid quadriceps tethering. They were then operated using a standard radiolucent orthopedic table guided by an image intensifier. All instances utilized intraoperative imaging (C-arm) during the procedure, which was a necessity.

Operative technique:

It was performed while the patient was in a supine position. Flexion of 30–40 degrees was attained using padding beneath the knee. The C-arm was positioned perpendicular to the transparent operating table, on the opposite side of the body. The surgeon made a transverse incision across the patella's anterior surface, which can be moved laterally and proximally if necessary. Identifying the location of the fracture, draining any blood from the area, and irrigating the knee joint was done. Reduction forceps was used to reduce. Digital palpation of the patellar articular surface within the knee through the arthrotomy incision and subsequent fluoroscopy were used to verify the anatomical reduction of the articular surface. Within the patella, two guide pins were inserted in a parallel fashion. Only the fracture pieces close to the cortex were drilled over the guide pins.

Screws lengths were measured, beginning with the smaller fragment for improved grip, two 4.0 mm cannulated partly threaded screws were put over the guide pins to create interfragmentary compression, either antegrade or retrograde, depending on the fracture pattern. All threads of the screws passed the fracture site to achieve lag compression effect. Cerclage wire was passed in a figure of eight through the two screws. Final fluoroscopy image AP/Lateral of patella was checked. Repairing of medial and lateral retinacula was done with 0-vicryl, sterile dressing and above knee cast was applied. All the patients were put in knee brace locked in extension.

Follow up program:

Early follow up (6 weeks):

Immediately post-operative, after vascular and neural assessment, knee brace was applied, the patient remained in the hospital overnight, and prophylactic parenteral antibiotics as (cephalosporin) were administered for the first 24 hours. Postoperatively, all patients were followed up every 2 weeks following hospital discharge. Serial x-ray radiographs in two planes (A-P and lateral views) were obtained. At **2 weeks** gentle range of motion exercises were started gradually in knee brace locked in extension with active leg extension. At **2-6 weeks** patients were allowed for active ROM as tolerated. Partial weight bearing assisted by crutches, strengthen quadriceps. At **>6 weeks** patients achieved full active ROM and full weight bearing without crutches.

Late follow up:

To evaluate the functional results of surgically fixing the patellar inferior pole fractures, the Bostman score was utilized. Bostman ratings were utilized to evaluate functional knee outcomes, while goniometry was employed to measure range of motion in degrees. Six points for range of motion, six points for pain, four points for work, four points for atrophy, four points for ambulation aid, two points for effusion, two points for giving away, and two points for stair climbing, make up the 30-point Bostman total score method. An outstanding outcome is deemed to be a total score of 30-28, a decent result is 27-20, and a result below 20 is deemed to be unsatisfactory [7].

At 4 and 8 weeks, every 3 months, and 2 years following the start of the follow-up period, x-rays were taken to assess the follow up.

Statistical analysis

Microsoft Statistical Package for the Social Sciences, version 28, was used for data administration and statistical analysis. The quantitative data was analyzed by utilizing direct data visualization tools and the Shapiro-Wilk test to assess normality. Means, standard deviations, medians, and ranges were used to summarize quantitative data in accordance with normality testing. Numbers and percentages were used to summarize the categorical data.

RESULTS

This study included 18 cases with mean age 36.57±11.3, they were 14 (77.8%) males and 4 (22.2%) females, smoking was presented in 8 (44.4%) cases, hypertension was presented in 2 (11.1%) cases and diabetes was presented in 2 (11.1%) cases. Regarding side of injury, they were 12 cases (66.7%) with left side injury and 6 cases (33.3%) with right side injury (Table 1).

Regarding mechanism of injury, 10 cases (55.6%) were with road traffic accident, 6 cases (33.3%) with fall injury and 2 cases (11.1%) with sports-related trauma (Table 2).

The operative time ranged from (60 to 80) min with mean time of 75.4±6.9 min. The median time from injury ranged between (3 to 8) days with mean time of 4.35±2.7 days (Table 3).

Progressive improvement of range of motion of knee was obtained in both flexion and extension at each follow-up, 94.4% (17 cases) had flexion of > 120° and 100% (18 cases) had extension ≥ 15° by the end of 24 weeks (Table 4).

Regarding radiological signs of union, 15 patients (83.3%) showed union at the 6th postoperative week, 17 patients (94.4%) at the 12th postoperative week, and all patients achieved union at the end of follow-up after 24 weeks (Table 5).

As regards the Bostman's score at the end of final follow up at 24 weeks, it was excellent in 15 patients (83.3%), good in 2 patients (11.1 %) and poor in one patient (5.6%). There were 4 complicated patients (22.3%), two cases (11.1%) of superficial wound infection, one patient (5.5%) had delayed union and one patient (5.5%) suffered from mild stiffness (Table 6).

A 55-year old female average weight, After jumping and falling, she broke her left patella transversely. Two cannulated screws with a cerclage wire tension band threaded through them were used to fix the injury one day following the incident. She had excellent postoperative Bostman's score (Supplementary figure 1).

A male patient 43-year old, heavy worker, after falling down on the knee, he had a transverse fracture of his left patella. Surgery was performed one days after the trauma fixed by two cannulated screws with cerclage wire tension band through it. Excellent Bostman's score (Supplementary figure 2).

Table 1: Demographics of the studied patients.

Variables	Mean±SD	Range	
Age (Mean±SD)	**36.57 ± 11.3**	**48-25**	
		No	**%**
Sex	**Male**	14	77.8
	Female	4	22.2
Occupation	**Worker**	6	33.4
	Driver	4	22.2
	Employer	3	16.7
	Housewife	5	27.7
Smoking	**No**	10	55.6
	Yes	8	44.4
Hypertension	**No**	16	88.9
	Yes	2	11.1
Diabetes	**No**	16	88.9
	Yes	2	11.1
Side of injury	**Left**	12	66.7%
	Right	6	33.3

Table 2: Mechanism of injury among studied patients.

Variables		No	%
Mechanism of injury	**Road traffic accident**	10	55.6
	Fall injury	6	33.3
	Sports-related trauma	2	11.1

Table 3: Operation time and time from injury distribution.

	Operation time	Time from injury
Mean± SD	75.4±6.9	4.35±2.7
Median (Range)	40 (60-80)	4.0 (3-8)

Table 4: Knee range of motion for each follow up.

Follow up	Flexion, n (%)					Extension			
	0–30°	30–60°	60–90°	90–120°	> 120°	≥ 15°	10–15°	6–10°	≤ 5°
6 weeks	5 (27.8)	11 (61.1)	2 (11.1)	0 (0)	0 (0)	9	0 (0)	10	8 ()
12 weeks	0 (0)	0 (0)	3 (16.7)	6 (33.3)	9 (50)	17	0 (0)	10	0 (0)
24 weeks	0 (0)	0 (0)	0 (0)	1 (5.6)	17 (94.4)	18 (100)	0 (0)	0 (0)	0 (0)

Table 5: Union rate at 6, 12 weeks, and 24 weeks.

Follow up	Yes	No
6 weeks	15 (83.3%)	3 (16.7)
12 weeks	17 (94.4)	2 (5.6)
24 weeks	18 (100)	0 (0)

Table 6: Bostman's score among studied patients and postoperative complications at 24 weeks follow up.

		No	%
Bostman's score	**Excellent**	15	83.3%
	Good	2	11.1%
	Poor	1	5.6%
		No	**%**
Superficial skin infection		2	11.1%
Delayed union		1	5.6%
Stiffness		1	5.6%
Total		4	22.3

DISCUSSION

The patella, the biggest sesamoid bone in the human body, helps the knee's extensor mechanism work better. Fractures of the patella make up to 1% of all injuries. Direct or indirect force can cause a patella fracture. A transverse patellar fracture is caused by indirect force, such as an overstretched or contracted extensor mechanism, whereas a comminuted fracture is typically the result of a direct hit. Surgery may be necessary to repair a misplaced fracture or one that has damaged the extensor mechanism. Anatomical reduction with a congruent joint and extensor mechanism restoration with strong fixation are the goals of the surgical treatment [8].

Disruption of the extensor mechanism is a common complication of patellar fractures, particularly transverse ones. Restoring the extensor mechanism and achieving anatomic reduction of the articular surface while preserving the patella are the goals of surgical treatment. In order to keep the fracture from moving as it heals; internal fixing is utilized. It reduces the occurrence of postoperative knee stiffness and decrease the disability after patellar fractures by increasing the knee's range of motion early on [9].

This study included 18 cases with mean age 36.57±11.3, they were 14 (77.8%) males and 4 (22.2%) females. Smoking was presented in 8 (44.4%) cases, hypertension was presented in 2 (11.1%) cases and diabetes was presented in 2 (11.1%) cases. Similarly, Agrahari et al. [10] found that in a 30 cases of transverse fracture patella, 22 patients (73.3%) were males and 8 (26.7%) were females.

Also, Dhakal et al. [11] found that in a study included 30 patients with transverse displaced patella fracture, from 27 to 68 years old, the participants' ages had an average of 42±9.7 years. There were 22 guys, or 73.33%, who sustained injuries. Abouelwafa et al. [12] found that in a study included 30 patients the mean age was 32.83±9.84, they were 22 (73.3%) males and 8 (26.7%) females, smoking was presented in 19 (63.3%). But Hoshino et al. [13] found that the mean age was 58±19.5 years, males were 41 (30.8%) and females were 92 (69.2%), smokers were 11 (8.3%) and diabetes mellitus was presented in 24 (18%) of patients.

The current study showed that regarding side of injury, there were 12 cases (66.7%) with left side injury and 6 cases (33.3%) with right side injury. Regarding mechanism of injury, 10 cases (55.6%) were with road traffic accident, 6 cases (33.3%) with fall injury and 2 cases (11.1%) with sports-related trauma. Similarly, Agrahari et al. [10] found that in a 30 cases of transverse fracture patella, 17 patients (56.7) were with left side injury and 13 cases (43.3%) with right side injury, and regarding mechanism of injury, 15 cases (50%) were with road traffic accident, 13 cases (43.3%) with fall injury and 2 cases (6.7%) with sports-related trauma.

Bayomy & Shaheen. [9] found that more than half of the patients had right- sided affection (56.7%). The mechanisms of injury were direct (30%), falling down (46.6%), or road traffic accident (RTA) (23.3%).

The current study showed that the operative time ranged from (60 to 80) min with mean time of 75±6.9 min. The median time from injury ranged

between (3 to 8) days with mean time of 4.35±2.7 days, which is similar to the study of Xiang et al. [14] who found that the mean operative time in the TBWC group was 71.21 min, while Tian et al. [15] found that the mean operation time was 55 minutes (range, 45–70 minutes), and the time between the fracture and the operation ranged from 1 to 7 days, with a mean of 3 days. The older age of their patients can be a contributing factor to the disparity in operation time.

The current study showed that range of motion of knee in flexion and extension showed progressive improvement for each follow-up. 94.4% (17 patients) had flexion of > 120° and 100% (18 patients) had extension ≥15° by the end of 24 weeks, which is in agreement with the study of Drolia et al. [16] who reported that range of motion of knee in flexion and extension showed a statistically significant improvement in the CCS group for each follow-up. 28 patients (93.3%) had flexion of > 120° and 30 patients (100%) had extension ≥ 15° by the end of follow up.

Also, Agrahari et al. [10] found that after each follow-up, the knee's range of motion (ROM) significantly improved; at six months, it was 122 to 145 degrees for flexion and 0 to 8 degrees for extension lag. Ching et al. [17] found that the final range of motion at 6 months was flexion ranging from 122 to 145 degrees and extension lag from 0 to 8 degrees. Malik and Halwai. [18] found that the average range of motion attained in the knee was 119.8 degrees (range, 90-135 degrees) at the 3-month follow-up, which occurred approximately when the bones fused. Mean range of motion at 1-year follow-up was 129.7 degrees (range, 115-140 degrees).

The current study showed that signs of the radiological union were observed at the 6th post operative week in 15 patients (83.3%) and after 12 weeks in 17 patients (94.4%). At the end of follow-up after 24 weeks all patients achieved union. In the same line, Drolia et al. [16] reported that the signs of radiological union were seen at the 6th post operative week in 86.7% of patients (n=26) in the cannulated screws (CCS) group. At 12th postoperative week, 96.7% of patients (n=29) in CCS group showed signs of union on plain radiographs. Dhakal et al. [11] found that 11.4±2.3 weeks was the average time it took for the fracture to heal. Neither nonunion nor hardware failure occurred.

The current study showed that as regards the Bostman's score, at end of final follow up at 24 weeks, it was excellent in 15 patients (83.3%), good in 2 patients (11.1 %) and poor in one patient (5.6%). Similarly, Khan et al. [2] found that at three months, the average Bostman score was 26.04, and by the conclusion of the final follow-up at one year, it had improved to 27. 36. Dewidar. [19] found that among the fifteen patients who underwent cannulated screw with tension band wiring procedures, twelve patients (80%) achieved excellent results, three patients (20%) achieved good results, and no patients had a fair result.

Tan et al. [20] found that within the cannulated screws with tension band (CSTB) group, 22 patients (85%) achieved an outstanding outcome, 4 patients (15%) achieved a good result, and zero patients had a fair result at the follow-up examination prior to implant removal. They also noted that cannulated screw tension bands reduced implant-related pain and loosening, and that they were more effective in treating patella fractures than Kirschner wire tension bands.

The current study showed that 4 patients (22.2) were complicated, two cases (11.1%) of superficial wound infection who were managed by using oral antibiotics as well as dressing, one patient (5.5%) had delayed union, and one patient (5.5%) suffered from mild pain during movement.

Near to our results, Khan et al. [2] found that just two complicated cases were noted. Antibiotics and careful wound care helped one patient with a superficial wound infection. Knee stiffness was seen in the second patient. This patient spent a long time in the hospital after suffering from an episode of severe pancreatitis. After six months, this patient likewise had beneficial increases in range of motion. There were no reports of soft tissue discomfort, implant migration, or loss of reduction.

Also, Agrahari et al. [10] found that in the end, 20% of patients experienced problems. During the fourth week of follow-up, one patient experienced a loss of fracture reduction, and two patients were treated for superficial skin infections with oral antibiotics and dressings. Disengagement of hardware from the distal pole occurred during knee flexion, and the fracture was located at the distal third. Ten percent of patients reported experiencing hardware discomfort or pain. During the six-month time frame, no new issues arose.

Bayomy and Shaheen. [9] found that the reported complications were skin infection (13.3%), stiffness (6.7%), and mild pain (53.3%). Malik and Halwai. [18] found that, not a single patient experienced material failure, implant migration, or loss of fracture reduction. Having said that, two issues arose, one in each patient. After surgery, one patient had screws that were too big, limiting his range of motion to less than 90 degrees. At 8 months, he had his implants removed and his knee was manipulated simultaneously. After only a

year, he had increased his range of motion by 118 degrees. Forty days following surgery, one patient developed a joint infection that required rapid drainage. But his fracture healed within 12 weeks, and at the end of the first year, he had 128 degrees of range of motion. Singh et al. [21] reported that Joint stiffness (approximately 16.7%), wound infection (6.7%), and delayed union of the wound (3.3%) were the most commonly reported post-operative problems. Only 10% of subjects had bad post-operative outcomes, while approximately 2/3 had great ones.

For transverse patellar fractures, screws have lately replaced K-wires as the method of internal fixation due to their superior biomechanical stabilization in the face of tensile loading during knee flexion. A variation on the Kirschner wire tension band, the cannulated screw tension band is an enhanced method. Secure fixation and implant protection are two potential benefits of the cannulated screw tension band.

One option that several authors are investigating is the usage of cannulated screws instead of tension band wiring (TBW) for fixation. More stable fixation, faster union, earlier mobilization, less hardware discomfort, the option for percutaneous fixation, and quicker implant removal are all benefits of cannulated screws [22]. Nevertheless, there are a few things to keep in mind while treating patella fractures with cannulated screws tension bands. You need to use digital palpation and fluoroscopy to check the patello-femoral articular surface congruity. It is imperative that the cannulated screws used in the procedure are sufficiently large to fully embed into the bone. To limit friction loss between the screw and the steel wire, the steel wire and the patella, and to ensure that the tension band of steel wire works, the heads and tails of the screws must not go through the top and bottom ends of the patella.

There are some limitations to this study. The study had relatively smaller sample size with no long term follow up. Other limitations include the lack of a control group, and the wide exclusion criteria. It is recommended that these potential limitations should be taken into account in larger prospective studies that may be conducted in the future with more inclusion criteria. Further comparative studies are needed to establish that this relatively new technique of patellar fracture fixation is superior to modified TBW.

CONCLUSIONS

The use of cannulated screws in conjunction with anterior tension band wire to treat transverse patellar fractures is an effective, reliable, and reproducible procedure, Improvements in radiological and functional outcomes, as well as curative effects on patella fracture, complication rates, and the timing of postoperative functional activity, are all benefits of this procedure. Looking at it from a biomechanical perspective, the screw tension band is more robust, can absorb more energy, and has a better load-carrying capability.

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Citation

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