

A Novel Technique for the Treatment of Patellar Distal Pole Fracture: A Observational Study

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Abstract

Background: The patella is a triangle sesamoid bone located on the anterior part of the knee at the distal portion of the femur. Its principal function is to act as a fulcrum to enhance the moment arm of the quadriceps muscle and thus knee extensive capabilities.

Objective: This study was conducted to evaluate a clinical and functional usefulness of Separate Vertical Wirings for the treatment of Extra-Articular Fractures of the Distal Pole of Patella at National Institute of Traumatology and Orthopaedic Rehabilitation (NITOR) from July 2015 to June 2017.

Methods: The study included 40 patients with closed extra-articular fracture of the distal pole of the patella aged 18-70 years, regardless of gender. Patients with pathological fracture, multiple injuries and inability to walk before the fracture were excluded from the study.

Results: They were evaluated by Bostman knee score (ROM, pain, work, atrophy, assistance in walking, effusion, giving way, stair climbing). At final follow-up 31 (77.5%) patients had full extension and ROM 120 degree and 9 (22.5%) patients had ROM 90-120 degree. The main complications was knee stiffness which was 30%. Almost 95% patients had no pain and returned to their original job after 18 weeks of fixation with no significant limitations. The fractures united at a mean of 8 weeks (6 to 10) and no case of non-union was observed. Evaluation of outcome 18 weeks after fixation showed that 60% of the patients had excellent outcome (Bostman Score 28-30) and 40% had good outcome (Bostman Score 20-27).

Conclusion: The majority of patients with extra-articular distal pole patella fractures are farmers in early middle age. For extra-articular patella distal pole fractures, vertical wiring works well. Most patients have resumed pre-injury activities with minor knee restrictions. Larger trials are needed because this study's sample size may skew clinical efficacy assessments.

Keywords: Extra-Articular Patella Distal Pole Fractures; Vertical Wiring; Unilateral IPFP Diagnosed by Imaging

Introduction

The patella is the largest sesamoid bone in the body and is located at the anterior part of the knee joint [1]. With the predicted increase in the elderly population, there will be an inevitable increase in traumatic fractures due to an elderly's decrease in function and mobility [2]. Patellar fractures are common and account for approximately 1% of all fractures [1]. The patellar surface has seven main articular surfaces, which are divided into the superior articular surface and the inferior nonarticular surface, with a vertical ridge further subdividing the superior part into the medial and lateral surfaces [2]. The inferior pole of the patella, with no articular surface coverage, is located in the distal 1/4 of the patella. Patellar inferior pole fractures are uncommon, accounting for 9.3%-22.4% of all patellar fractures [3,4]. Patella fractures do not increase the risk of death, as the relative risk of death was 0.9. A recent study found that the average mortality rate one year after patella fractures was 2.8%, rising to 6.2% in the elderly population [5].

Inferior pole fracture of the patella (IPFP) is a type of patellar fracture that occurs in the distal 1/4 of the patella, i.e., the point of attachment of the patellar tendon, and is composed primarily of cancellous bone with no articular surface coverage and is not involved in the patellofemoral joint composition. IPFP accounts for 9.3-22.4% of patellar fractures as an extra-articular fracture [6].

IPFP has small and comminuted fracture blocks that are hard to immobilize, and it is also prone to displacement due to patellar tendon traction, so conservative treatment usually has unsatisfactory effects, necessitating surgical intervention. IPFP is currently generally treated through two surgical procedures. The first method involves inferior patellar pole resection and patellar ligament repair and reconstruction; however, this shortens the patellar ligament, causes patellar lowering, and increases pressure on the patellofemoral joint surface, resulting in complications such as limited knee flexion and anterior patellar pain [8]. The second method is reduction and immobilization with steel wires, steel plates, and sutures, with the goal of preserving the anatomical integrity of the patella [9-12]. However, it has limited stability in the immobilization of smaller IPFPs, and early mobilization may result in fracture reduction failure and immobilization failure [13-16]. As a result, restoring knee function through early rehabilitation exercise while maintaining effective immobilization remains a clinical challenge.

Many investigators have proposed different surgical techniques to treat inferior patellar pole fractures, such as partial patellectomy [17], screw fixation with a titanium cable or steel wire, [18] interwoven sutures and basket plates [19-21], mesh plates [22], angle-stable locking plates [23-25]. Novel Rim Plating Technique [26], wire interwoven sutures and Krachow sutures, [27] Anchor and Krackow-"8" Suture [28]. Novel Tension Band and Patellotibial Tubercle Cerclage [29], and separate vertical wiring (SVW) [30]. In these techniques, partial patellectomy leads to patella baja, which disrupts the biomechanical anatomical relationships of the normal patellofemoral joint. As a consequence, the vertical vector forces into the patellofemoral joint increase, which further accelerates the degeneration of the patellofemoral joint [31,32]. Therefore, in a review of early foreign literature, partial patellectomy was not recommended for inferior patellar pole fractures. In contrast to partial patellar resection, fixation methods such as "mesh plates, basket plates" do not require additional bracing to immobilize the knee after surgery, and the second method allows for functional knee exercises and early weight bearing immediately after surgery [33]. Patella fractures have traditionally been treated surgically with clear wound dissection down to the fracture. After the hematoma was removed and the fracture was reduced, the alignment was temporarily held in place with Kirschner wires (K wires). After that, tensile forces over the anterior aspect of the knee joint were converted into compression forces at the joint line by inserting one metallic wire as a tension band through the quadriceps tendon and patella tendon in a figure-of-eight fashion [34].

However the nature of patella and high tensile forces challenge the standard surgical techniques used for fracture. Tension band wiring (TBW) is the traditional method for treating patella fractures, and it usually results in sound union. In a recent study, 49 patients with patella fractures discovered retrospectively were treated over a 9-year period. Suture fixation was used on 13 patients with inferior pole fractures and tension band fixation was used on 36 patients with mid-pole fractures (K-wire or cannulated screws with tension band). At one year, there was no difference in knee range of motion between cohorts. Radiographically, all fractures healed [36]. Fractures of the lower pole of the patella are difficult to reduce, and most surgeons find it difficult to fix anatomically. As a result, early range of motion of the knee joint is not permitted. Despite multiple treatments for patella fractures, patients frequently experience a lack of knee joint movement. Around 80% of patients' anterior knee pain and insufficient squatting are interfering with their daily lives. The anterior scar

becomes hypertrophied and painful in some patients [37]. Because the patella’s distal pole is an extraarticular structure that does not articulate with the femur, excessive correction for the exact anatomical reduction is not required. The separate vertical wiring technique prioritizes the preservation of the knee’s extensor mechanism over anatomical reduction. The advantage of this technique is that by tightening the vertical wires, the number of fragments can be reduced with minimal soft tissue handling. In one study of 25 patients with inferior pole patella fractures, separate vertical wiring resulted in nearly 100% union [38]. In this study, we looked at the clinical and radiological outcomes of two different vertical wiring techniques for treating extra-articular fractures of the distal pole of the patella. As a result, the goal of this study is to evaluate the outcome of separate vertical wirings in the treatment of extra-articular fractures of the distal pole of the patella.

Materials and Methods

Patients with post traumatic extra-articular fractures of distal pole of the patella within three weeks of incidence were the study population, those who are admitted in NITOR. From July 2015 to June 2017, 40 patients with selective criteria of the study were treated with displaced fractures of the patella. Displaced fractures means gap of more than 3mm and articular steps more than 2 mm. The study was a Prospective, Observational and conducted in the Department of Orthopedics, National Institute of Traumatology and Orthopaedic Rehabilitation (NITOR).

A pre-tested structured questionnaire was used to collect data on history, physical examination, radiological assessment, and pre- and post-operative follow-up. 185 patients with closed fracture patella were admitted to NITOR between July 2015 and June 2017. 52 of them had fractured the lower pole of the patella. Among the 52 patients, 46 had a closed fracture of the lower pole of the patella and were treated surgically at NITOR with separate vertical wiring. Among them, 40 patients had regular follow-up visits at NITOR. A minimum of 18 weeks of follow-up was planned to assess the final functional outcome. The Bostman knee score was used to assess the functional outcome [39].

Following data collection, raw data was compiled and tabulated by key variables. All statistical analyses of various variables were performed using SPSS (Statistical Package for Social Science) and appropriate formulas. Tables and graphs were used to present the findings. To conduct this study, permission was obtained from the Ethical Review Committee of the National Institute of Traumatology and Orthopaedic Rehabilitation (NITOR), Dhaka, Bangladesh. In

accordance with the Helsinki Declaration for Medical Research Involving Human Subjects 1964, study subjects were verbally informed about the study design, the purpose of the study, and their right to withdraw from the project at any time, for any reason.

Results

A total of 40 patients with extra-articular fractures of distal pole of the patella were included in the study to evaluate the outcome of fixation with 2 separate vertical wirings. Of the 40 patients, there were 31 male and 9 female patients. The ratio between male to female was 3.5:1. Average age for total patient group was 43.30± 15 years old. The youngest and oldest patients were 18 and 70 years old respectively. Majority of the patients were categorized in 31 to 40 years. Farmers (12,30%) were the largest group of patients with extra-articular fractures of distal pole of the patella, followed by housewives, students and business owners (7,27.5%), service holders (4,10%), and day labors (3,7.5%).

Inclusion criteria: (1) unilateral IPFP diagnosed by imaging, (2) age ≥ 18 years, (3) normal bone mineral density, (4) Patients with closed extra-articular fractures of the distal pole of the patella and 5) Patients those presented within 3 weeks of injury.

Exclusion criteria: (1) age < 18 years (2) pathological fracture, (2) fracture of the femur, tibia, or fibula on the affected side, (3) popliteal blood vessel or nerve injury, (4) other acute or chronic diseases affecting knee function, and (5) multiple injuries or intolerance to surgery due to underlying diseases and (6) Late presentation after 3 weeks.

Attributes	Variables	Frequency (%)
Age distribution of the study patients	18-30	9 (22.5)
	31-40	10 (25)
	41-50	8 (20)
	51-60	7 (17.5)
	>60	6 (15)
Gender distribution of the study patients	Male	31 (77.5%)
	Female	9 (22.5%)
Occupational distribution of the study patients	Farming	12 (30)
	Business	7 (17.5)
	Housewife	7 (17.5)
	Student	7 (17.5)
	Service	4 (10)
	Laborer	3 (7.5)

Table 1: Demographic information of study respondents.

Common causes of patients with extra-articular fractures of distal pole of the patella was road traffic accident and fall on slippery ground (n = 18, 45%). The rest 10% were sports injury. About 32.5% (n = 13) lower pole fractures were comminuted and the rest (n = 27, 68%) were non comminuted. 27(67.5%) patients had right side involvement and 13(32.5%) patients had left side involvement.

Attributes	Variables	Frequency (%)
Mechanism of injury of the study patients	Road Traffic Accident	18 (45%)
	Fall on slippery ground	18 (45%)
	Sports injury	4 (5%)
comminution of lower pole fragments of study patients	Yes	13 (32.5%)
	No	27 (67.5%)
side distribution of injured limb of study patients	Right side involvement	27 (67.5%)
	Left side involvement	13 (32.5%)

Table 2: Clinical Observation of study respondents.

Complications of the patients (n = 40): 12 (30%) had knee stiffness, 4 (10%) had symptomatic hardware and SSTI, only 2 (5%) had DVT, and the remaining 18 (45%) had no complications.

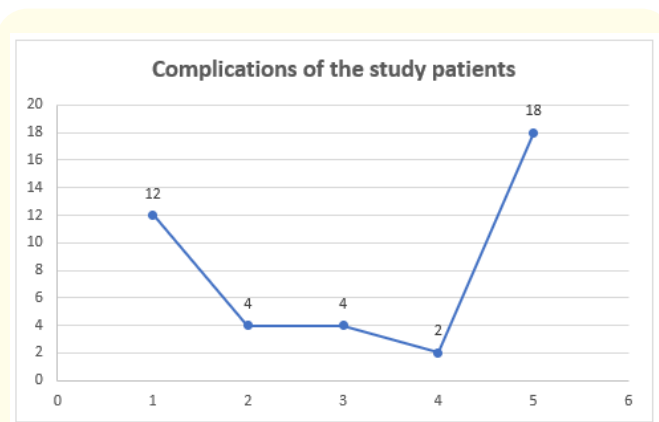


Figure 1: Bostman score [39].

ROM of the knee

31(77.5%) patients had full extension and ROM 120 degree and 9(22.5%) patients had ROM 90-120 degree at final follow-up.

Pain status, 38(95%) patients had no pain and only 2 (5%) patients had moderate pain on exertion at final follow-up.

Work status

38(95%) patients had returned to their original job and only 2 (5%) patients had engaged themselves to different jobs.

Atrophy of thigh muscles (10 cm proximal to patella)

30 (75%) patients had atrophy <12 mm and 10 (25%) patients 12-25 mm atrophy and none of them had atrophy of the thigh >25 mm.

Assistance in walking

38 (95%) patients did not need assistance in walking, only 2 (5%) patients used cane part of the time and no body used cane all the time.

Effusion of the knee joint

33(82.5%) patients did not have effusion of the knee and only 7 (17.5%) patients reported knee effusion.

Giving way of the knee joint

38 (95%) patients did not complain of giving way of the knee and only 2 (5%) patients reported giving way of the knee.

Ability of stair climbing

38 (95%) patients had normal stair climbing ability and only 2 (5%) patients reported disturbing stair climbing and none of them shown disability in stair climbing.

Bostman knee scoring

24 (60%) patients had excellent outcome, 16 (40%) patients had good outcome and no patient had unsatisfactory result.

Variable	Points	Case (n)
Range of movement (ROM)		
Full extension and the ROM >120° or within 10° of the normal side	6	31 (77.5%)
Full extension, movement 90°-120°	3	9(22.5%)
Could not be fully extended ROM <90°	0	
Pain Status		
None or minimal on exertion	6	38(95%)
Moderate on exertion	3	2 (5%)
In daily activity	0	
Work Status		
Original job	4	38(95%)
Different job	2	2 (5%)

Cannot work	0	
Atrophy, difference of circumference of thigh 10 cm proximal to the patella		
<12 mm	4	30 (75%)
12–25 mm	2	10 (25%)
>25 mm	0	
Assistance in walking		
None	4	38 (95%)
Cane part of the time	2	2 (5%)
Cane all the time	0	
Effusion		
None	2	33(82.5%)
Reported to be present	1	7 (17.5%)
Present	0	
Giving way		
None	2	38(95%)
Sometimes	1	2 (5%)
In daily life	0	
Stair-climbing		
Normal	2	38(95%)
Disturbing	1	2 (5%)
Disabling	0	
Total score		
Excellent	30–28	24 (60%)
Good	27–20	16 (40%)
Unsatisfactory	<20	0

Table 3: Distribution of Bostman score.

Most of the fractures 30 (75%) were united between 6-10 weeks followed by 10- 12 weeks (8, 20%) and 12- 14 weeks (2, 5%). Mean duration of radiological union was 8 ± 2.4 weeks.

Union (weeks)	No of patient	Percentage
<6 weeks	0	0
6-10 weeks	30	75
10-12 weeks	8	20
12-14 weeks	2	5
Delayed union	0	0
Non union	0	0
Total	15	100

Table 4: Duration of radiological union (weeks) (n = 40).

All of the patients 40(100%) were satisfactory (Excellent + Good) and no patients were unsatisfactory.

Result	No of Patient	Percentage
Satisfactory (Excellent + Good)	40	100
Unsatisfactory	0	0
Total	40	100

Table 5: Distribution of the results according to the final outcomes (n = 40).

Discussion

Fractures of the inferior patellar pole are extraarticular avulsion fractures that do not involve a cartilaginous articular surface, are usually less than 15 mm in vertical length, and do not involve contact with the patellofemoral articular surface during knee flexion or extension [40,41]. Loss of patellar height due to fracture of the inferior patellar pole disrupts the normal patellofemoral joint anatomy and biomechanical relationships. Therefore, proper treatment of inferior patellar pole fractures is essential to maximize restoration of knee extension and to obtain effective strong internal fixation for early functional exercise and reduce complications such as patellofemoral arthritis [32,42].

Studies are limited due to the small number of subjects and there are not enough published reports. Unfortunately, extra-articular fractures of the distal pole of the patella where the patellar tendon is attached are difficult to manage because of small bone fragments and extension mechanism of the knee. The results of the current study demonstrate that mean age of the patient’s study was 43.3 ± 15 years and the youngest and oldest patients were 18 and 70 years old respectively. Majority (77.5%) of the patients were male and farming was the prime occupation (32.5%) of the study subjects.

The knee range of motion (ROM, degrees) and the Bostman score at 12 months postoperatively were recorded. The Bostman scoring system includes eight sections: range of movement (ROM), pain, work, atrophy difference of the circumference of the thigh 10 cm proximal to the patella, assistance in walking, effusion, giving way, and stair climbing. The Bostman scale is classified into three grades: excellent (30-28 points), good (20-27 points), and unsatisfactory (<20 points) [39].

The patients regained full ROM of the knee joint without functional deficits during follow-up; the 31(77.5%) patients had full extension and ROM 120 degree and 9(22.5%) patients had

ROM 90-120 degree at final follow-up. 38(95%) patients had no pain and only 2(5%) patients had moderate pain on exertion at final follow-up.

In the present study, clinical and radiological assessments showed that firm fixation and normal joint movement were achieved at a minimum of 1 year after separate vertical wiring and the Bostman score was excellent with a mean of 27.1 points. Whereas in the study by Zhixiang, *et al.* At the latest follow-up, all patients had a mean Bostman score of 28.40 ± 1.29 (range: 26-30), with an excellent score in 11 patients and a good score in four patients [33]. In another study by Yang and Byun (2003), the mean Bostman score at the last follow-up was 29.5 points in 29 patients, who underwent separate vertical wiring for the treatment of comminuted fractures of the distal pole of the patella [42].

In the biomechanical study using cadaver knees, higher fixation strength than the tension-band wiring was reported and the method was more effective for comminuted fractures of the distal patella by using 3 separate wires when compared to the conventional method that transforms extension force into compression force by contouring 2 wires into the shape of 8. However, considering that in our study, union was achieved with bone fragments anteriorly displaced in 50% of the cases, separate transverse compression force alone may not be sufficient to provide anatomical reduction.

The distal pole of the patella is an extra-articular structure that does not articulate with the femur in the patello-femoral joint. Therefore, excessive correction for exacta anatomical reduction or excision of the distal patella that is impossible to be reduced was not necessary. Instead, it is more important to restore the extension mechanism of the knee by preserving the bone fragment of the distal patella.

Conclusion

It could be concluded that extra-articular fractures of the distal pole of the patella usually occur in early middle age with a male preponderance with most of patients being involved in farming. Separate vertical wirings are an effective method for the treatment of extra-articular fractures of the distal pole of the patella. Majority of the patients have returned to pre-injury activities with mild limitations in knee movements. The sample of this study was small, and there may be a certain bias in the assessment of clinical efficacy, so larger studies are needed.

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