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Study of Miniature Plate Internal Fixation in Treatment of Patella Fracture

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Abstract

Objective: To investigate effect of miniature plate internal fixation in the treatment of patella fracture

Methods: From January 2019 to January 2020, 11 patients with patella fracture were treated with miniature plate fixation and clinical databases were retrospectively reviewed. The perioperative and postoperative outcomes were included.

Results: The average operation and hospital stay time was 45 minutes and 7 days respectively. Range of motion (ROM), knee society scores (KSS) and Lysholm scores was related to a greater increase. No patients have nonunion, infection and revision.

Results: The results showed that miniature plate internal fixation was related to greater decreases in incidence of complications and increases in postoperative range of motion (ROM), and Knee Society Score (KSS) function and Lysholm scores.

Conclusion: In this study, miniature plate internal fixation technology for the treatment of patella fracture has the advantages of simple operation, rapid recovery, and better perioperative and postoperative outcomes.

Keywords

Patella Fracture, miniature plate internal fixation, Soft Tissue Irritation, Radiological, Reoperations

Introduction

Patella fractures are common, accounting for 1% of skeletal injuries [1]. In the presence of significant fracture displacement and articular incongruity, open reduction and internal fixation is the standard of method to restore quadriceps function and prevent osteoarthritis. Classically, the fixation technique for patella fixation utilizes axial K-wires in combination with tension banding for reinforcement [2]. As a result of utilizing K-wires or metallic implants, patients commonly complain of soft tissue irritation in the knee. Most of patients subsequently require secondary procedures for implant removal to provide symptomatic relief [3,4].

Some reports suggest that circular ligation and suture can be used, but wire banding cannot effectively close the proximal articular surface of patella, and debris can easily enter the articular cavity [5]. At the same time, wire fixation will affect the distribution of blood vessels near the patella. Although it has good short-term effect, there are many potential adverse effects in the long run [6,7]. Patella fracture managed by fixation with K-wires or metal implants often cause local soft tissue irritation and necessitates implant removal. An alternative is to utilize miniature plate internal fixation methods. We have adopted miniature plate internal fixation in the management of patella fracture. Here, we report the results of the fixation techniques.

Materials and Methods

Patient demographics

We retrospectively reviewed our database, which was collected prospectively. From January 2019 to January 2020, 11 patients with patella fracture. The clinical data of 11 patients with regular follow-up were obtained, with 7 males and 4 females. The inclusion criterion was a single avulsion fracture of patella, the time of injury was less than 3 weeks, all patients had complete imaging examination of the knee joint, and they were 34C1-3 according to OTA/AO classification. The

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Table 1: Summary of Patients.

Knee	Sex	Age (year)	Job	Injury	OTA / AO classification	Operation
1	M	55	Manual worker	Traffic accident	**34C1-3**	Primary
2	F	59	Housewife	Traffic accident	**34C1-3**	Primary
3	M	61	Manual worker	Traffic accident	**34C1-3**	Primary
4	M	58	Manual worker	Fall	**34C1-3**	Primary
5	M	59	Farmer	Traffic accident	**34C1-3**	Primary
6	F	64	Housewife	Fall	**34C1-3**	Primary
7	F	61	Housewife	Fall	**34C1-3**	Primary
8	M	56	Manual worker	Fall	**34C1-3**	Primary
9	M	59	Farmer	Traffic accident	**34C1-3**	Primary
10	M	58	Farmer	Fall	**34C1-3**	Primary
11	F	59	Housewife	Traffic accident	**34C1-3**	Primary

Abbreviations: M: Male; F: Female

exclusion criteria included combined tibial plateau fractures, fractures around the knee joint, comminuted fracture, pathological fracture, and combined severe vascular and nerve injuries. Traffic accidents were the major mechanism of injury, accounting for 6 (55%) of 11 cases, along with 5 cases of fall injury (45%) (Table 1).

Patient assessment

The patients provided a standard history and underwent physical examination that consisted of measurement of the knee range of motion by a single surgeon before surgery; at 3, 6, and 12 months after surgery; and yearly thereafter. We assessed all patients preoperatively by using the scoring systems of the KSS, Knee Society Score (KSS, a 100-point scoring system), and Lysholm Score (a 100-point scoring system). We reassessed the patients at the time of the final follow-up. The average time to final follow up was 14 months (range, 12 to 16 months). We believe that the variability of the follow-up period did not affect the current result, because the clinical results did not change after 1 years postoperatively.

Radiography and magnetic resonance imaging

We obtained preoperative and follow-up radiographs in all patients. X-ray and CT scan was performed (Figure 1). Radiography were performed by a single surgeon before surgery; at 3, 6, and 12 months after surgery; and yearly thereafter, and this study used the final data.

Figure 1: Preoperative radiograph of patella fracture.

Determination of fixation method

Decision in regard to fixation method of the fractured patella was determined intraoperatively by the surgeon based on its configuration. Fractures were managed with miniature plate internal fixation, and those considered to be stability to prevent anterior displacement of fracture fragments. Transverse and comminuted intraarticular fractures were treated by miniature plate internal fixation.

Surgical technique

We performed all procedures using general anesthesia with patient in the supine position, used tourniquet and anterior median incision, exposed the broken end of the fracture, reduction the fracture, cover the plate on the bone surface, drill, sounding and screw in the screws. Ensure that the fracture are covered and firmly fixed by plates and screws (Figure 2). If necessary, Kirschner wire and cannulated screw shall be used to strengthen the fixation. C-arm fluoroscopy, the positions of plates, screws and patellar articular surface are satisfactory, and the knee joint is moved passively during the operation without abnormal loosening. Limb was fixed with plaster at 0 degree of extension.

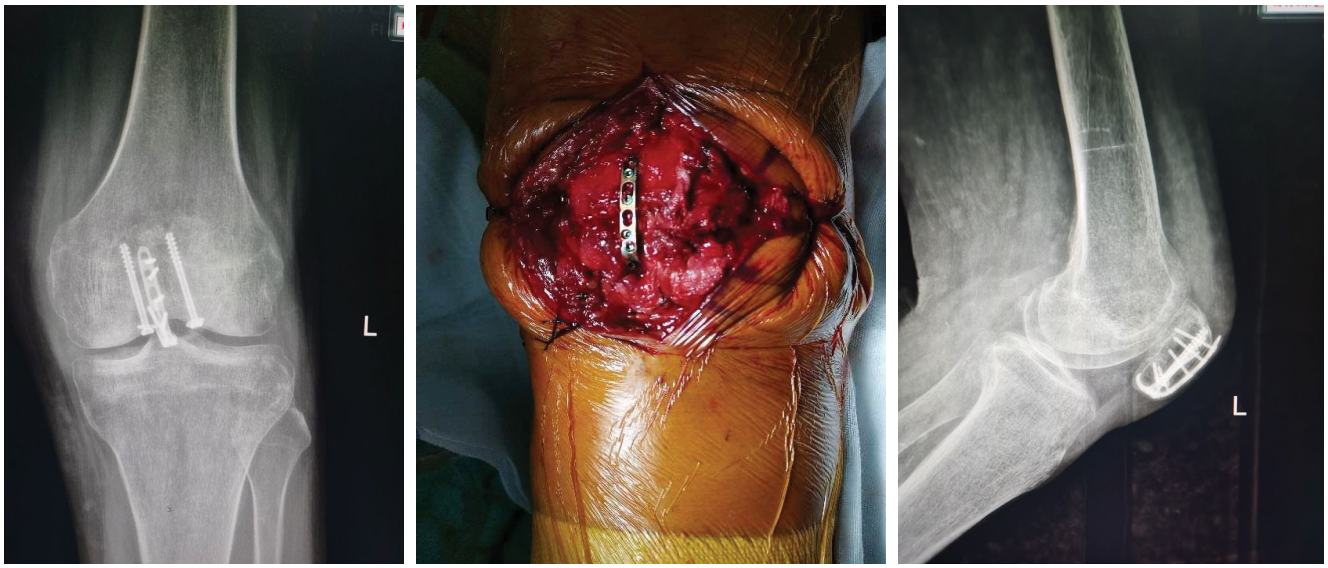

Figure 2: Intraoperative radiograph of miniature plate internal fixation.

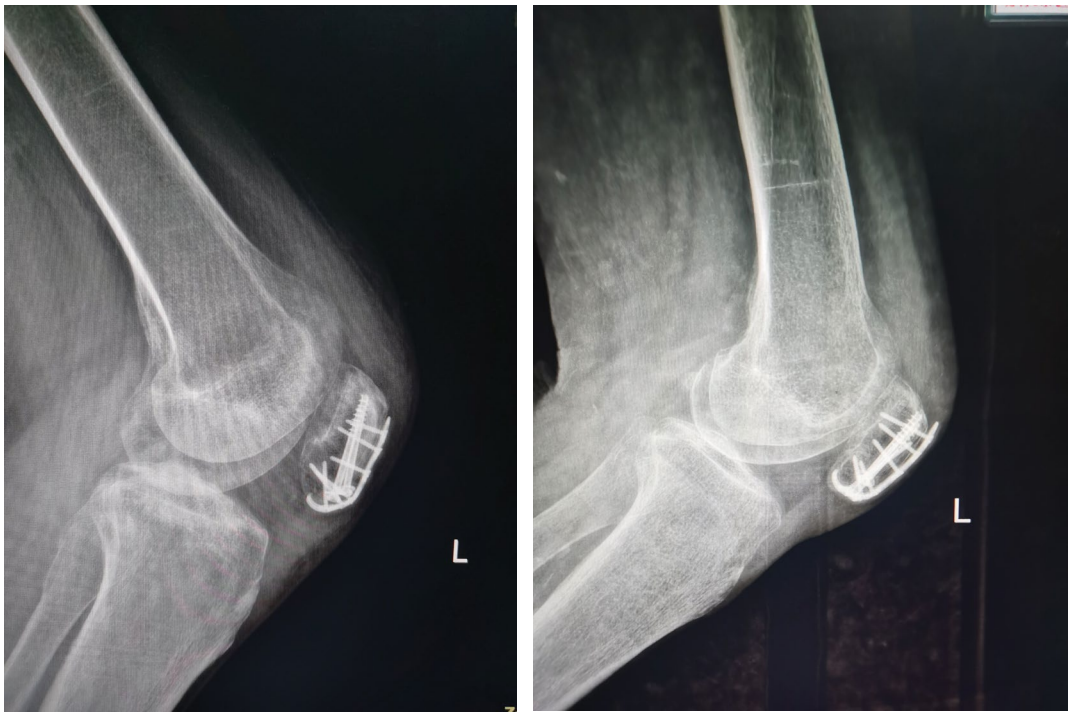

Figure 3: Postoperative radiograph of double button plate fixation (4 months).

Postoperative care and follow-up

Postoperative radiographs were taken the day after surgery. Patients were given a plaster as protection postoperatively. In general, 0 to 90 degrees of flexion in-brace was allowed for the first 2 weeks postoperatively and allowed to weight bear. Patients were given their first follow-up appointment at 2 weeks postoperatively for wound inspection, then they were followed up every 4 to 6 weeks to monitor for functional return and clinical/radiological fracture union (Figure 3).

Outcomes measures

The primary outcomes of this study were the reoperation rates for the fixation methods and the prevalence of symptomatic hardware causing soft tissue irritation. Secondary outcomes included surgical complications (fixation failure/displacement, implant breakage/dislodgement, nonunion, infection), radiological parameters, and knee function.

Statistical analysis

We compared the scores, range of motion before surgery with the values at final follow-up using the Wilcox

Table 2: Summary of Patients'Knee Functional Scores.

Knee	KSS function (scores)		Lysholm (scores)		ROM (degree)	
	Preoperative	Postoperative	Preoperative	Postoperative	Preoperative	Postoperative
1	35	90	39.5	92.5	0-35	0-125
2	40	85	40.5	91.5	0-45	0-125
3	35	85	36.5	92.5	0-35	0-115
4	45	90	40.5	91.5	0-40	0-120
5	50	90	41.5	93.5	0-45	0-125
6	40	90	39.5	92.5	0-40	0-130
7	45	90	42.5	93.5	0-45	0-120
8	40	85	37.5	90.5	0-40	0-120
9	35	90	41.5	91.5	0-45	0-125
10	40	90	40.5	90.5	0-40	0-125
11	45	85	39.5	91.5	0-45	0-120

Abbreviations: ROM: Range of Motion; KSS: Knee Society Score

Table 3: Summary of Patients'Complication.

Knee	FWB (weeks)	Nonunion	Any infection	Revision	Implant removal
1	11	N0	N0	N0	N0
2	12	N0	N0	N0	N0
3	11	N0	N0	N0	N0
4	13	N0	N0	N0	N0
5	10.5	N0	N0	N0	N0
6	11	N0	N0	N0	N0
7	11.5	N0	N0	N0	N0
8	12	N0	N0	N0	N0
9	11	N0	N0	N0	N0
10	12	N0	N0	N0	N0
11	11.5	N0	N0	N0	N0

Abbreviations: FWB: Full Weight Bearing

on matched-pairs test. We used the Mann-Whitney U test. A significant difference was defined as P<0.05.

Results

Clinical results

The average preoperative scores were 42.5 points by KSS (range, 35 to 55 points), and 40.5 points by Lysholm (36.5 to 42.5 points). Average clinical outcome scores all improved significantly after surgery at the final follow-up (14 months, range, 12 to 16) months after surgery; KSS 88.2 points; Lysholm, 91.5 points (P <0.0.05) (Table 2). All manual workers and farmers returned to the same jobs. The knee active range of motion improved significantly after surgery at the final follow-up (P<0.05). Range of motion and strength were measured at 3, 6, and 12 months and yearly thereafter. However, there was no significant change beyond 1 years after surgery. There were no surgical complications such as neural injury, infection, or suture anchor problems in this series. Also we did not see any complications with the harvest site.

Overall, no patients received reoperations after initial fracture fixation (Table 3). All the patients can kneel in the follow-up 8weeks. No case happened implant-related soft tissue irritation, with analysis identifying that soft tissue irritation was specifically reduced in miniature plate internal fixation. No implant removal was requested for all cases. Patients were asymptomatic in the knee. No one patient were noted to have miniature plate internal fixation dislodgement upon follow-up X-rays. All patients receiving miniature plate internal fixation demonstrated no fracture displacement. All patients had nonunion and implant breakage. There were no cases of infection among our patient population.

Radiological and functional outcomes

During the follow-up period, there was no bone displacement, miniature plate internal fixation loosening and ligament rupture. All patients receiving metal fixation, demonstrated no exist patella baja. During the follow-up period, all radiological analysis showed no reduction in patella height (Figure 4).

Figure 4: Knee Function of 4 months later.

Discussion

Fractures of patella are mostly caused by direct violence, or are more common in patients with osteoporosis [8]. Kirschner wire tension band technique is the most commonly used method for open reduction and internal fixation of patellar fracture [9]. The use of Kirschner wire tension band leads to soft tissue stimulation. It is necessary to remove the internal fixation. The failure of internal fixation, wire slip, postoperative pain and revision are not rare in clinical research [10]. The thickness of the miniature plate used in the operation was 1mm, and the diameter of the screw was 2.0 mm and 2.7 mm. Miniature plates and screws can cover the patella to form a three-dimensional fixation. In terms of length, they cover the upper and lower patella. In terms of depth, attention should be paid to protecting the cartilage surface of the patella during fixation to prevent screws from entering the joint [11].

As for the reason why the miniature steel plate plays a strong role in fixation, the author believes that the force on the patella and the patella-femoral joint in the process of extension and flexion is equal to the resultant force of quadriceps femor is force and patellar ligament [12]. In the process of flexion, the force will increase with the increase of flexion angle, and the corresponding contact area of patellar joint will also increase. As the supporting point of the lever in the process of patella flexion, the force arm is very small, so the bending force of patella internal fixation in the process of patella flexion will not be too large, and the miniature steel plate can bear this force [13]. The miniature plate is placed in front of the patella, and the screw is fixed in the sagittal position, which can gather the fracture blocks together. This kind of fixation cannot be fixed by Kirschner wire tension band. In addition, for severe comminuted fractures, due to the small volume of the plate and firm fixation, complications such as soft tissue stimulation caused by internal fixation such as tension band can be avoided [14].

Compared with Kirschner wire tension band, the use of miniature plate internal fixation technology has the following advantages: (1) less trauma, shorter operation time, convenient use of instruments and fixtures; (2) miniature plate internal fixation have good biocompatibility, which has little impact on the anatomical structure of the knee joint; (3) It is conducive to the early recovery of the function of the patients after operation. No necessary second operation is needed to remove the implant. The small scar of the incision can meet the needs of the patients for the cosmetology of the incision.

Conclusion

In this study, miniature plate internal fixation fixation technology for the treatment of patellar fracture has the advantages of simple operation, reliable fixation, restoring patellar anatomical shape, early functional exercise to achieve rapid recovery, good healing effect, reliable internal fixation and fewer complications.

Limitation

The follow-up time of all patients in this study is short, and there is still a lack of further research on large samples, especially on biomechanics. At present, the treatment of patellar fracture with miniature plate internal fixation has been carried out for a relatively short time, and the number of cases is relatively small. There are also shortcomings in this study, such as small sample size and insufficient follow-up time, especially on biomechanics, which may lead to deviations in the evaluation of curative effect. Further expansion of sample size and long-term follow-up are needed to confirm this.

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Conflict of Interest Statement

The authors declare that they have no competing interests.

Authors' Contributions

Kai Sun designed the study protocol, participated in the data analysis, and drafted the manuscript. Meng Fan participated in the analysis and revision of the manuscript. All authors have read and approved the final manuscript.

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