

Multifragment fracture of the patellar apex: basket plate osteosynthesis compared with partial patellectomy

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Abstract

Introduction The purpose of the present study was to evaluate and compare the long-term results of operative treatment of a multifragment fracture of the inferior patellar pole by basket plate osteosynthesis and partial patellectomy.

Materials and methods We retrospectively studied two groups of patients who had operative treatment of a multifragment fracture of the inferior patellar pole between 1988 and 2004. Seventy-one patients who had osteosynthesis by basket plate (Group 1) and 49 patients who had partial patellectomy (Group 2) were followed for an average of 5.3 years. The final evaluation was based on the modified Cincinnati Knee rating system test.

Results The results were excellent or good in 90.1% patients of Group 1, and 73.5% patients of Group 2. Significant differences between the groups were noted with regard to knee pain, swelling, level activity, compression pain, range of motion, muscular atrophy, muscular strength, and final patellofemoral score which confirms statistical analysis.

Conclusion The stability of the osteosynthesis by basket plate allows osseous consolidation of the fracture and permits immediate mobilization and early weight bearing. Osteosynthesis by basket plate can provide better clinical results.

Keywords Fracture of distal pole of the patella · Partial patellectomy · Basket plate osteosynthesis

Introduction

The patella is a sesamoid bone, situated within the tendon of the quadriceps femoris muscle; it is functionally part of the knee extension system. Patellar fractures comprise 1–2% of all fractures, and imply a functional disability of the knee extension system [3, 5, 7, 13]

In most fracture classification systems, multifragment fractures of the inferior patellar pole fall into a separate category. Such fractures account for 9.3–22.4% of all patellar fractures that are treated surgically [17, 19, 20] (Fig. 1a, b).

Multifragment fractures of the patellar apex are conventionally treated by partial patellectomy with good results [1, 9, 11].

A multifragment fracture of the distal patellar pole results from a blow to the flexed knee and the simultaneous forceful pull of the quadriceps muscle. The treatment of this type of fracture poses a special problem because of the structure of the injured patellar pole. An avulsion fracture with a single solid patellar pole fragment is best treated with fixation with the use of a compression screw and cerclage wire [2, 4, 6, 15, 23]. Because of the trauma mechanism, however, the patellar pole (usually multifragment fractured) has often been removed and repair of the patellar ligament has been provided. Some authors, however, have recommended preservation of the patellar pole by separate vertical wiring for the fixation of comminuted fractures of the inferior pole of the patella [22].

Osteosynthesis with a basket plate is an alternative method of treatment that, in contrast with other methods, allows for the preservation of the patella. The basket plate was designed

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Fig. 1 Biomechanical model: osteosynthesis by basket plate was tested experimentally on an anatomical knee preparation as a biomechanical model. First, osteotomy and then, osteosynthesis were performed using the basket plate, together with two malleolar and two small spongiosa screws

for the treatment of multifragment fractures of the patellar apex by Smiljanić in 1998 and was constructed in the Zagreb Department of Instrumentaria Research [10, 18]. It has been tested mechanically in the Zagreb Faculty for Electrotechnology and Computing, and it has been tested clinically in the “Sestre milosrdnice” Clinic in Zagreb, Croatia. Since 1990, it has been used in Croatia, Slovenia, Italy, Bosnia and Herzegovina, Macedonia, Yugoslavia, and other countries of the region. The device is available from Instrumentaria Zagreb, Rapska b.b., Cro-10000 Zagreb, Croatia (Fig. 2).

The operation is straightforward (Fig. 3). We prefer longitudinal access to the knee. The fragments are repositioned



Fig. 2 The operation: the fragments are repositioned with spiked pincers and the basket plate is positioned into the patellar ligament so that all fragments of the distal pole of the patella can be collected into the basket. The basket plate and the fracture are fixed by the two malleolar, and if necessary, the two additional small spongiosa screws. A split retinaculum will require suturing

with spiked pincers and the basket plate is positioned into the patellar ligament so that all fragments of the distal pole of the patella can be collected into the basket. The basket plate has the shape of the inferior pole of the patella, which allows it to hold the multifragment patellar pole in position. Fibers of the patellar ligament are pushed apart by four hooks on the plate that can be curved to fit the shape and size of the patella without damaging the articular surface. The basket plate is fixed to the main patellar fragment with two parallel cancellous screws positioned obliquely, to increase stability against distraction forces, and if necessary, by the two additional, small spongiosa screws. A split retinaculum requires suturing (Fig. 4a–c).

Osteosynthesis by basket plate is stable enough to allow for mobilization and weight bearing on the first postoperative day. The patient is allowed to bear full weight on the affected extremity during level walking. For walking uphill or downhill, crutches should be used to prevent loading of the flexed knee joint for 6 weeks. The purpose of the present study was to compare the long-term results of osteosynthesis by basket plate and those of partial patellectomy, which is currently the most commonly used operative technique for the treatment of multifragment fractures of the inferior pole of the patella.

Upon implant removal (6–8 months after osteosynthesis), clinical and radiological findings were good. Biopsies of bone taken during the removal of the implant show osseous consolidation (Fig. 5).

Materials and methods

We retrospectively reviewed the records of more than 200 consecutive patients in whom a multifragment fracture of the inferior patellar pole had been operatively treated, between 1988 and 2004. All fractures were displaced. Patients with fractures that extended beyond the pole and those with sleeve avulsions were not included. About 130 patients were managed by basket plate osteosynthesis at the Department of Surgery, University Hospital Sestre milosrdnice in Zagreb, Croatia. More than 100 patients were managed with partial patellectomy at Traumatology Clinic Zagreb, Croatia. The average follow up was 5.3 years (range 2–13 years). There were 57 male and 63 female patients, with an average age of 46 years (range 33–69). All patients were invited to return for a final follow-up evaluation. Many patients were not available for the study owing to the war and subsequent migration.

The including criteria for available patients in this study were:

- At least 2 years elapsed since osteosynthesis and removal of the implant or partial patellectomy
- Giving the consent for the study.

Fig. 3 Radiograph of patellar fracture (a, b)

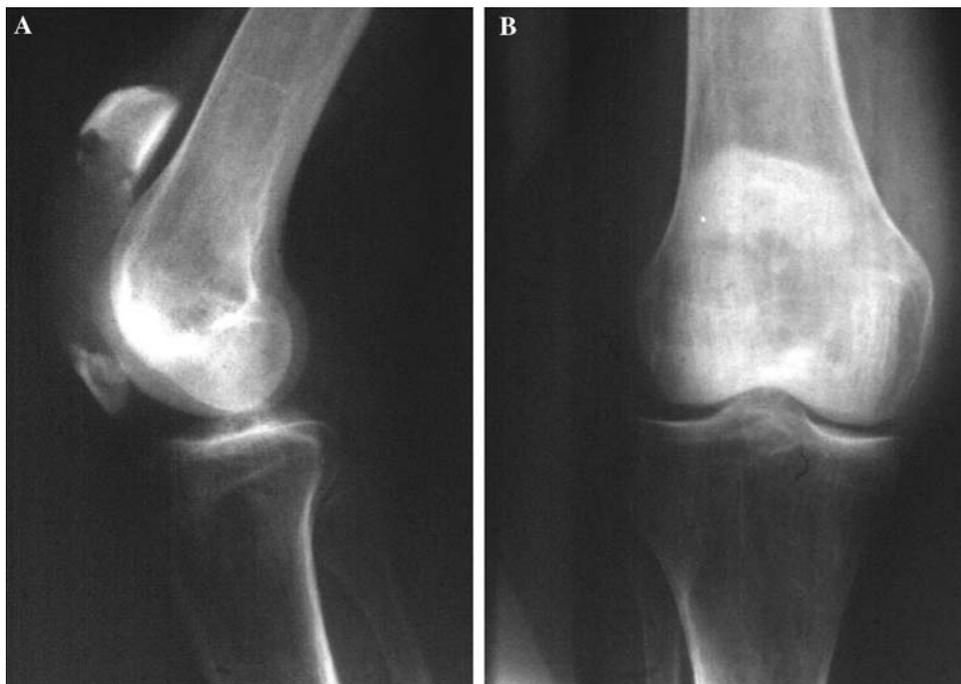


Fig. 4 Radiographs after osteosynthesis by basket plate (a–c)



After that, only 71 patients who had had osteosynthesis by basket plate (Group 1) and 49 patients who had had partial patellectomy (Group 2) were available for the study. There were no statistically significant differences between the two groups with regard to sex, age, and the manner of accident.

Patients who were managed with the basket plate technique started passive motion exercises on the first postoperative day and were encouraged to perform active flexion exercises of the knee in the prone position. Active extension exercises were allowed after the third postoperative week. The patients were encouraged to start bearing weight on the second postoperative day during level walking, and full weight bearing without limitation was encouraged from the sixth week on.

Patients who were managed with partial patellectomy had immobilization of the involved knee for 5–7 weeks (average

6.5 weeks) postoperatively, during which time, partial weight bearing with crutches was allowed. After removal of the cast, patients began a rehabilitation program consisting of exercises designed to achieve a full range of motion, muscle training, and full weight bearing. The outcome of the procedure was assessed with use of the modified Cincinnati Knee rating system test (using a manual dynamometer in the evaluation of the knee extension), which includes subjective, clinical, and radiological analysis.

The evaluation involved the completion of a questionnaire (maximum score 45 points), a clinical evaluation (maximum score 43 points), and a radiographic analysis (maximum score 12 points). The overall score was rated as excellent (90–100 points), good (80–89 points), fair (70–79 points), or poor (<70 points).

The statistical analysis of two independent samples was performed. The statistical analysis (Mann–Whitney *U* test,



Fig. 5 Radiograph after implant removal and osseous healing of fragments

chi-square test, *t* test) was used to test the correlation between attributive variables in both samples to analyze quantitative variables such as pain, swelling, function, range of motion, muscle atrophy, final outcome and so on. The level of significance was set at $P = 0.05$.

Results

In Group 1, the score was excellent for 42 patients (59.1%), good for 22 (31%), and fair for 7 patients (9.9%). In Group 2, the score was excellent for 19 patients (38.8%), good for 17 (34.7%), and fair for 13 patients (26.5%) (Table 1).

Statistical analysis showed that there is a significant difference between groups regarding the final score

Table 1 In Group 1, the score was excellent for 42 patients (59.1%), good for 22 (31%), and fair for 7 patients (9.9%), while in Group 2, the score was excellent for 19 patients (38.8%), good for 17 (34.7%), and fair for 13 patients (26.5%)

Evaluation	Group 1 <i>N</i> (%)	Group 2 <i>N</i> (%)	Totally <i>N</i> (%)
Fair	7 (9.9)	13 (26.5)	20 (16.7)
Good	22 (31.0)	17 (34.7)	39 (32.5)
Excellent	42 (59.1)	19 (38.8)	61 (50.8)
Totally	71 (100.0)	49 (100.0)	120 (100.0)

$$\chi^2 = 7.3261, \text{ ss} = 2, P = 0.0257$$

($P = 0.0257$). Fair result was more often statistically significant in Group 2 ($t = 2.409$; $P = 0.016$), and excellent result was more often statistically significant in Group 1 ($t = 2.195$; $P = 0.0282$).

There is a statistically significant difference between the groups regarding the knee pain, knee swelling, giving way, movement, level of work activity, effusion, active range of motion, patellofemoral compression pain, muscular atrophy, and dynamometry result.

In Group 1, there were more patients without knee pain at all, and in Group 2, there were more patients with continuous knee pain ($P = 0.0445$). In Group 1, there were more patients without knee swelling ($t = 2.035$; $P = 0.0418$), and in Group 2, there were more patients with knee swelling during everyday activity ($t = 2.195$; $P = 0.0282$). In Group 1, there were more patients with knee giving way during intensive activity, and in Group 2, there were more patients with knee giving way during recreational sport ($P = 0.0308$). In Group 1, there were more patients with unchanged level of work activity, and in Group 2, there were more patients with reduced work activity ($P < 0.0445$). In Group 1, there were more patients with unchanged knee movement, and in Group 2, there were more patients having knee movement with pain and swelling ($P < 0.0445$). In Group 1, there were more patients with active range of motion of 80–90%, compared with non-injured leg, and in Group 2, there were more patients with reduced active range of motion (70–80%) compared with non-injured leg ($P = 0.0308$). In Group 1, there were more patients without any pain during patellofemoral compression, and in Group 2, there were more patients with pain during the patellofemoral compression ($P < 0.0308$). In Group 1, there were more patients with thigh circumference of the injured leg minus non-injured leg as less than 12 mm, and in Group 2, there were more patients with thigh circumference of injured leg minus non-injured leg in the range 12–25 mm ($P < 0.0308$). In Group 1, there were more patients with dynamometry result showing less than 10% of strength of the non-injured leg, and in Group 2, there were more patients with dynamometry result at 10–20% strength of the non-injured leg ($P < 0.0308$). There were no statistically significant differences between the groups regarding the knee effusion and also regarding radiological findings (narrowing $P = 0.1451$; cysts $P = 0.8926$; osteophytes $P = 0.3306$), except narrowing of lateral compartment, which was more often significant in Group 2.

Discussion

We retrospectively studied 120 consecutive patients who had had operative treatment of a multifragment fracture of the patellar apex. The present study did not include patients

with multifragment fractures that extended beyond the patellar pole or patients with sleeve avulsions. The groups were comparable regarding the number of patients, the age and sex of the patients, and the type and cause of injury. We compared two methods that are used to treat such injuries, specifically, osteosynthesis by a basket plate and partial patellectomy.

In our review of the literature, we found no studies that separately evaluated different methods of treatment of only multifragment fractures of the patellar apex, including enough number of operated patients, which allows statistical evaluation.

Saltzman et al. [16] evaluated the results of partial patellectomy, but that study did not include only apex fractures but rather included all fractures for which partial patellectomy has been performed. Neumann et al. [12] evaluated the long-term results for 135 patellar fractures that had been treated operatively between 1973 and 1989. Only fifteen of those fractures had been treated with partial patellectomy. Pandey et al. [14] evaluated the results for 64 patients with comminuted patellar fractures. Twenty-eight of the fractures had been treated with partial patellectomy, which was performed in all cases in which a solid proximal fragment formed at least two-thirds of the patellar size.

There are only few studies that evaluated multifragment fractures of the patellar apex separately. Yang and Byun [22] used separate vertical wiring for the fixation of comminuted fractures of the inferior pole of the patella in 25 patients with good healing and without complications. Kastelec and Veselko [8, 21] compared osteosynthesis by

basket plate with pole resection for avulsion fractures of the inferior pole of the patella in two groups of patients, 14 with internal fixation by basket plate, and 14 with pole resection, and the final result indicates that internal fixation by basket plate can provide better clinical results.

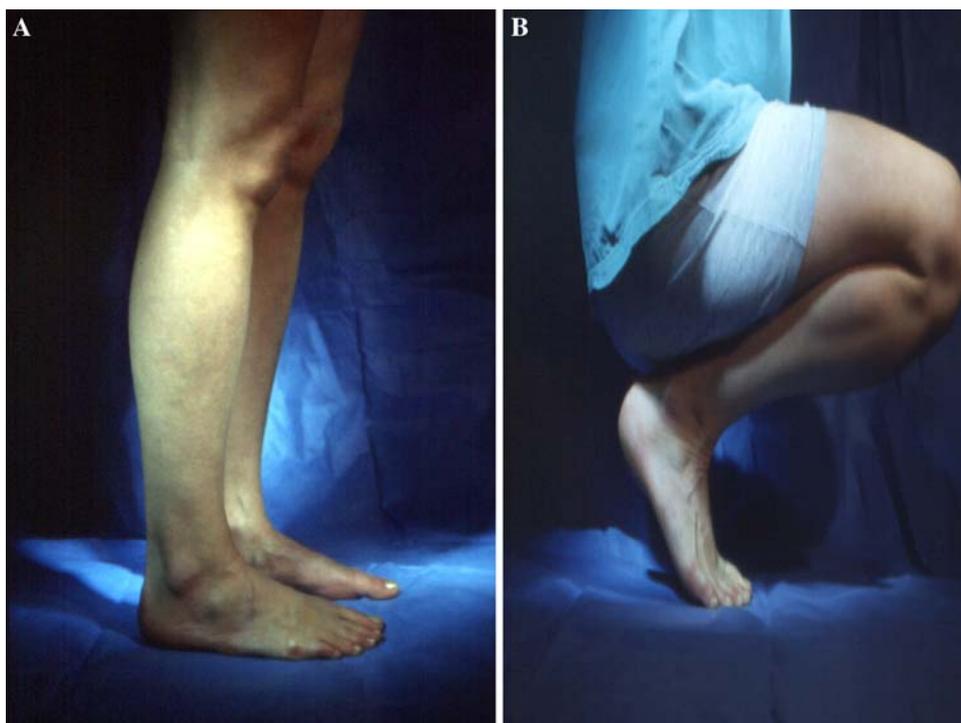
Our study group was bigger, which was enough for statistical evaluation. Related to the fact that these fractures are rare, accounting for only 9.3–22.4% of all patellar fractures that are treated surgically, it took years for collecting enough number of patients for analysis. Besides, many patients were not available for the study owing to the war and subsequent migration.

We identified 120 cases, among more than 200 patients, who had either partial patellectomy or basket plate osteosynthesis for a multifragment patellar apex fracture in two institutions over a 15-year period (University Hospital Ses-tre milosrdnice Zagreb and Traumatology Clinic Zagreb). Obvious signs of avascular necrosis of the patellar apex, a possible complication of the use of the plate, were not observed in any patient managed by basket plate.

The purpose of the present study was to evaluate and compare the long-term results of basket plate osteosynthesis and partial patellectomy. For functional evaluation, we used the Cincinnati Knee rating system test as a patellofemoral scoring system because it addresses the problems of the patellofemoral joint and is the only available system that provides a numerical evaluation of functional results of treatment of patellar fractures.

We found a notable difference between the two treated groups with regard to the final patellofemoral score. In

Fig. 6 Radiographs show excellent functional outcome of the patient a year after operation (a, b)



Group 1, the score was excellent for 42 patients (59.1%), good for 22 (31%), and fair for 7 patients (9.9%). In Group 2, the score was excellent for 19 patients (38.8%), good for 17 (34.7%), and fair for 13 patients (26.5%). Statistical analysis showed that there is a significant difference between groups regarding the final score ($P = 0.0257$). Fair result was more often statistically significant in Group 2 ($t = 2.409$; $P = 0.016$), and excellent result was more often statistically significant in Group 1 ($t = 2.195$; $P = 0.0282$).

There is a statistically significant difference between the groups regarding the knee pain, knee swelling, knee giving way, level of work activity, knee movement, active range of motion, patellofemoral compression pain, muscular atrophy, and dynamometry result. There is no statistically significant difference between the groups regarding the knee effusion and also regarding radiological findings (narrowing $P = 0.1451$; cysts $P = 0.8926$; osteophytes $P = 0.3306$).

Six weeks of immobilization in plaster cast following patellar pole resection is known to have harmful effects on the involved knee joint and muscle. Immediate postoperative mobilization and early full weight bearing on the affected joint are two important advantages conferred by basket plate osteosynthesis in addition to the advantages of preservation of the functional length of the extensor mechanism and the normal height of the patella.

The results of the present study demonstrate that the principle of retaining the fragments and maintaining normal patellar height is beneficial and that stable fixation that permits immediate mobilization of the joint and early full weight bearing can contribute to a better functional outcome in the treatment of multifragment fractures of the patellar apex (Fig. 6).

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