Arthroscopic-Assisted Percutaneous Screw Fixation of Select Patellar Fractures

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Purpose: To describe a technique of arthroscopic-assisted reduction and percutaneous cannulated screw fixation for displaced patellar fractures and to present the results of 5 cases. Type of Study: Case series. Methods: Five patients (3 male, 2 female) with displaced patellar fractures treated with an arthroscopic-assisted reduction and percutaneous cannulated screw fixation were prospectively analyzed. The mean age was 53 years (range, 27 to 74 years). All fractures were fixed with at least 2 4-mm cannulated screws under arthroscopic visualization. Cerclage wiring through the cannulated screws was necessary in 2 patients with osteopenic bone. Controlled passive range of motion exercises were started on the first postoperative day. Full weight bearing with an immobilizer-type brace was allowed as tolerated. The mean follow-up was 28 months (range, 24 to 35 months). The patients were evaluated with Lysholm II scores, clinical examination, knee range of motion, thigh circumference measurements, and radiographs. Results: All fractures healed uneventfully. The mean Lysholm II score was 84.8 (range, 75-96). All but 1 patient regained full knee range of motion. A mean quadriceps atrophy of 0.8 cm compared with the contralateral side was seen in unilateral cases. There was no implant failure or infection. Conclusions: Arthroscopic-assisted reduction and percutaneous cannulated screw fixation is appropriate for displaced transverse patellar fractures without major separation and comminution. Longitudinal or oblique fractures, even if there are more than 2 major fragments, are amenable to arthroscopic techniques, providing the fragments are large enough to be fixed with screws. This technique is minimally invasive and does not disturb the vascular supply of patella. It allows clear visualization of the reduction and stability of the fracture, and facilitates early postoperative range of motion exercises. This method is not suitable for highly comminuted fractures or transverse fractures with major separation that are accompanied by rupture of the extensor mechanism. Key Words: Patella fracture—Arthroscopic treatment—Cannulated screws.

Patellar fractures are quite common, constituting approximately 1% of all skeletal injuries. It is generally accepted that displaced fractures without significant comminution should be treated with anatomic reduction and stable internal fixation. Tension-band wiring using AO principles has been the gold standard, although several other techniques involving combinations of K-wires, screws, and cerclage wiring have been reported. We describe a technique of arthroscopic-assisted reduction and percutaneous cannulated screw fixation for displaced fractures of the patella, followed by early postoperative mobilization. We have found that this technique combines the advantages of minimally invasive surgery and rigid internal fixation, thereby permitting early and aggressive rehabilitation. This method is indicated for displaced fractures without extensor mechanism disruption. It is not possible to treat fractures accompanied by laceration of the medial and lateral retinacula with this method because these cases require open repair of the soft tissues and internal fixation of the fracture.
We used an arthroscopic-assisted technique to treat patellar fractures in 5 patients from 1997 through 1998. These cases constituted 8% of all the surgically treated patellar fractures in our institution during the same time period. The mean age was 53 years (range, 27 to 74 years); and 3 of the patients were male and 2 were female (Table 1). One patient had bilateral patellar fractures, but only 1 of these was amenable to arthroscopic-assisted surgery. The other side was treated by open screw fixation, cerclage wiring, and repair of the extensor mechanism. The mechanism of injury was a fall on a flexed knee in 4 cases and a small-caliber handgun injury in 1 case. One of the fractures was vertical (lateral facet), 1 was comminuted, 1 was transverse, and 2 were polar fractures (1 proximal, 1 distal). The patient with the handgun injury also had an osteochondral defect on the medial femoral condyle that was debrided at the time of bullet retrieval and internal fixation of the patella. One patient had mild pre-existing patellofemoral arthritis at the time of surgery. No other intra-articular pathology was discovered during arthroscopy.

**Operative Technique**

The procedure is performed on a standard radiolucent operating table. A tourniquet is applied to the proximal thigh and is inflated during the procedure. A leg holder is not necessary. Fracture reduction and fixation are carried out in full extension of the knee. Arthroscopy is performed using standard anteromedial and anterolateral portals. An ancillary superolateral portal is created 1 or 2 cm superior and lateral to the superolateral corner of the patella. The hemarthrosis is drained and the joint space is thoroughly irrigated. Small osteochondral fragments and loose bodies are removed. A full-radius shaver may be used to remove clots and debris to visualize the fracture lines. Reduction is achieved by manipulating the fragments with an arthroscopic probe from the superolateral portal. Percutaneously placed towel clamps may aid in the maintenance of the reduction. Two 18-gauge needles are placed into the joint at the proximal pole of the patella to locate the optimal entry points for the K-wires, as they may be difficult to define in swollen knees. The location of these needles should be at least 2 cm apart and they should be directed perpendicular to the fracture lines. Once these entry points are verified arthroscopically, the needles are withdrawn sequentially and K-wires are placed (Fig 1). The first K-wire is inserted by palpating the thickness of the patella and aiming for a central location in the anteroposterior plane. The second needle is withdrawn and the second K-wire is placed. Fracture reduction is assessed by fluoroscopy or radiography at this stage because reduction of the articular surface may not

**TABLE 1. Details of Patient Demographics and Surgical Results**

<table>
<thead>
<tr>
<th>Age</th>
<th>Sex</th>
<th>Side</th>
<th>Etiology</th>
<th>Fracture Type</th>
<th>Internal Fixation</th>
<th>Follow-up (mo)</th>
<th>Lysholm II Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>36</td>
<td>M</td>
<td>R</td>
<td>Fall</td>
<td>Vertical (lateral facet)</td>
<td>2 cannulated screws</td>
<td>35</td>
<td>96</td>
</tr>
<tr>
<td>70</td>
<td>F</td>
<td>L</td>
<td>Fall</td>
<td>Comminuted</td>
<td>3 cannulated screws</td>
<td>33</td>
<td>80</td>
</tr>
<tr>
<td>74*</td>
<td>M</td>
<td>R</td>
<td>Fall</td>
<td>Distal pole</td>
<td>2 cannulated screws</td>
<td>30</td>
<td>75</td>
</tr>
<tr>
<td>27</td>
<td>M</td>
<td>L</td>
<td>Gunshot injury</td>
<td>Proximal pole</td>
<td>2 cannulated screws</td>
<td>24</td>
<td>92</td>
</tr>
<tr>
<td>60</td>
<td>F</td>
<td>L</td>
<td>Fall</td>
<td>Transverse</td>
<td>2 cannulated screws</td>
<td>26</td>
<td>81</td>
</tr>
</tbody>
</table>

*This patient had bilateral patellar fractures. The right side was treated using an arthroscopic-assisted technique. The left side was treated by open reduction, internal fixation with 2 cannulated screws and cerclage wiring, and open repair of the quadriceps mechanism.

**FIGURE 1.** Placement of K-wires while fracture reduction is maintained with the use of a probe and percutaneous towel clamp.
always result in reduction of the other fragments in multipart fractures. K-wires may be used as joysticks to manipulate the fragments if necessary. After satisfactory reduction has been achieved, stab wounds are made around the K-wires, which are over-drilled with cannulated drill bits. Partially threaded cannulated 4-mm screws are inserted over the wires using a cannulated screwdriver (Fig 2). Screw length is estimated by measuring the distance between 2 needles placed perpendicular to the entry and exit points of the K-wire in the patella. The final length can be adjusted after fluoroscopic evaluation. Purchase of the distal cortex by the screw threads is necessary for stability in osteopenic bone. After insertion of the screws and interfragmentary compression, stability of the fixation is assessed by flexing and extending the knee while viewing from the superolateral portal. Cerclage wiring may be applied if stability is not satisfactory. Insertion of cerclage wiring is quite easy; additional stab wounds are made at the distal ends of the screws. An 18-gauge monofilament stainless steel wire is passed through the proximal end of the first screw, pulled out from the distal end, passed subcutaneously, inserted from the distal end of the second screw, and retrieved at its proximal end. The 2 free ends of the cerclage wire are tied under tension. A suction drain is placed, the portals and stab wounds are sutured, and the knee is placed in an immobilizer brace in full extension.

Controlled passive range of motion (CPM) is started and full weight bearing with an immobilizer type brace is allowed on the day following surgery. The initial range of motion is between 0° and 40° flexion on a CPM device. The patients are discharged with an adjustable angle knee brace allowing 0° to 40° of range of motion. The flexion angle is increased 20° to 30° weekly, with the objective of full flexion at 4 weeks. Active knee extension is allowed but quadriceps exercises against resistance are delayed for 4 to 6 weeks.

**Evaluation**

Mean follow-up was 28 months (range, 24 to 35 months). All 5 patients underwent regular radiologic examinations until union was confirmed. Clinical evaluation at the last follow-up visit included Lysholm II scores, knee range of motion, and thigh circumference measurements.

**RESULTS**

**Radiological Results**

All fractures healed uneventfully (Figs 3 and 4). No radiological incongruency in the articular surface of the patella was noted. No progression of arthritis was observed in the patient with mild pre-existing patellofemoral arthritis. The osteochondral defect on the medial femoral condyle remained unchanged in the patient with the gunshot injury.

**Clinical Results**

Table 1 lists the patients’ Lysholm II scores, with a mean score of 84.8 (range, 75-96). All but 1 patient regained full knee range of motion. The exception was a patient with bilateral fractures and senile dementia who did not comply with the rehabilitation program and was left with a 20° loss of terminal flexion in the left knee. Another patient with pre-existing patellofemoral arthritis had a slight effusion of her knee without significant complaints. Thigh circumference measurements showed were a mean 0.8 cm (range, 0.5 to 1 cm) atrophy compared with the contralateral side in the 4 unilateral cases. Two young patients returned to their previous sports activities of soccer and boxing, respectively, at 3 months postoperatively (Fig 5). There was no implant failure or infection and no implant removal was necessary.

**DISCUSSION**

The goal in treating patellar fractures is to restore the continuity of the extensor mechanism and to anatomically reduce the joint surface. Conservative treatment is limited to fractures with less than 2 mm of separation and no significant displacement of the articular surface. Surgery is indicated for displaced and/or comminuted fractures. Failure to restore the contour of the articular surface results in post-traumatic arthritis, and prolonged immobilization of the knee may cause joint stiffness. Early mobilization prevents muscle atrophy and the formation of intra-
FIGURE 3. A 70-year-old female patient with comminuted left patellar fracture. (A) Preoperative lateral radiograph. Step-off in the articular surface and mild arthritic changes in the patellar joint surface are visible. (B) Preoperative anteroposterior radiograph. Longitudinal and transverse components of the fracture lines are seen. (C) Preoperative sky-line radiograph. Displacement of the lateral facet is observed. (D) Arthroscopic view of the same patella. Displaced transverse fracture and the fracture of the lateral facet are seen. (E) The placement of percutaneous 4-mm cannulated screws over the K-wires. (F) Arthroscopic view after reduction and internal fixation. Degenerative changes in the cartilage are seen, but a congruent articular surface has been obtained. (G) Lateral radiograph 2 months postoperatively shows complete union and anatomic reduction. (H) Anteroposterior radiograph 2 months postoperatively shows complete union and anatomic reduction. (I) Sky-line radiograph 2 months postoperatively shows complete union and anatomic reduction.
Figure 4. (A) Preoperative lateral radiograph of a 60-year-old female patient, left transverse patellar fracture with poor bone quality. When arthroscopy confirmed that internal fixation with screws alone was unstable, 18-gauge cerclage wiring through the cannulated screws was added. (B) Lateral and (C) anteroposterior radiographs 3 months postoperatively show complete healing and no degenerative changes.
articulat adhesions. Early motion has also been shown to be beneficial for articular cartilage nutrition. Various techniques of internal fixation have been recommended, including cerclage wiring, tension-band wiring with or without transfixed screws, external fixation, and percutaneous suture fixation. There is universal agreement that early joint motion after the treatment of patellar fractures requires a stable internal fixation. The stability of several techniques has been compared in the literature. Benjamin et al. compared the biomechanical properties of screw fixation, modified AO tension-band wiring, Magnuson wiring, and Lotke longitudinal anterior band in cadaver knees. The authors recommended screw fixation be used in patients with adequate bone stock and modified tension-band wiring for those with osteopenic bone or comminuted fractures. Berg has shown that the addition of anterior cerclage wiring in a figure-8 construct that is passed through cannulated screws provides fixation comparable to tension-band wiring, even in elderly patients with osteopenic bone. All fractures in our series were fixed with cannulated partially threaded screws. Cerclage wiring was added to increase fracture stability in 2 elderly patients with osteopenic bone, aged 60 and 74 years. The cerclage wire was passed as a circumferential loop because figure-8 wiring was not possible with this closed technique. Carpenter et al. have shown that the addition of anterior figure-8 cerclage wiring to cannulated screws increases the load to failure of fixation from 554 N for screws alone to 732 N for screws plus cerclage wiring. Our technique probably achieves fixation strength between these 2 values; however, further biomechanical testing is necessary to confirm this. Nevertheless, this method produced satisfactory results and all fractures went on to union. The low profile of the screw heads was also an advantage, as skin irritation by prominent hardware or migration of K-wires frequently seen in patients undergoing tension-band techniques was avoided.

Both open and percutaneous surgical techniques have been described for reduction and internal fixation, but the authors are aware of only a single report

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**Figure 5.** Functional results (A) standing and (B) kneeling back in a 36-year-old amateur soccer player with lateral facet fracture of right patella 2 months after arthroscopic-assisted repair.
of 11 cases about arthroscopic-assisted fixation of patellar fractures. The most obvious advantage of the arthroscopic technique is the accuracy of controlling the reduction of the articular surface without the need for large surgical incisions. Closed techniques offer the advantage of preserving the vascular supply of the fragments. Although there is no specific evidence to support this, maintenance of blood supply is a theoretical benefit in terms of fracture healing. Arthroscopy is also an effective tool for joint lavage and debridement of chondral flaps. Additional intra-articular pathology, such as the femoral lesion seen in our case with the gunshot injury, can be addressed at the time of arthroscopy. The stability of fixation can also be verified arthroscopically. No motion should be visible in the fracture line while flexing and extending the knee. Finally, postoperative pain control and rehabilitation are easier because large incisions are avoided.

Major separation of the fragments in a transverse patella fracture is almost always accompanied by rupture of the quadriceps mechanism extending laterally and medially from the patella. Weber et al. have shown that repair of the extensor mechanism contributes to the stability of internal fixation. They advised repair of the retinaculum for patients in whom early postoperative motion is desired. Although rigid fixation can be achieved with screws in cases where the extensor mechanism is disrupted, arthroscopic techniques are not suitable. Such patients require open reduction, internal fixation and open repair of the extensor mechanism.

We believe that patient selection is the main key to achieving satisfactory results with this method. Arthroscopic techniques are suited to transverse fractures of the patella with articular incongruity but without major separation and comminution of the fragments. Although there are no clear guidelines, fractures that are displaced more than 8 mm are likely to be accompanied by disruption of the extensor mechanism and, therefore, they are not suitable for arthroscopic methods. Longitudinal or oblique fractures, even in cases that involve more than 2 major fragments, are amenable to arthroscopic techniques, providing the fragments are large enough to be fixed with screws. The possibility of early controlled range of motion in the joint is a further advantage of this technique. The gradual increase in range of motion can be tailored for the type of fracture and rigidity of fixation. Immediate full weight bearing with a knee immobilizer is possible. Apart from the 1 patient with senile dementia, all of our patients attained full range of motion in their injured knees.

In conclusion, arthroscopic percutaneous fixation of select patellar fractures offers important advantages over open techniques. The technique is minimally invasive and does not disturb the vascular supply of the patella, permits ideal visualization of the reduction and stability of the fracture, allows concomitant intra-articular pathology to be addressed, and facilitates early postoperative range of motion exercises. The disadvantages of arthroscopic treatment are that it is technically demanding and does not suit all fracture patterns. Patient selection is critical because open repair of the extensor mechanism may be necessary in transverse fractures with major displacement. Although the number of patients in this report is limited, we believe that arthroscopic treatment of appropriate patella fractures is a promising technique with a very low complication rate that offers good functional results.

REFERENCES