The authors did percutaneous, arthroscopic-assisted osteosynthesis of patellar fractures associated with skin abrasions and lacerations in 11 patients. Skin problems did not delay the operation and the rehabilitation. The average followup was 2.8 years. All fractures healed without complications and good results were obtained in all patients using the criteria of Levack et al. This technique avoids the problems of patellar fractures with skin abrasions and may be adapted to other fractures of the patella.

In fractures of the patella, precise reduction of the articular surface and stable fixation of the fragments restores the extensor mechanism of the knee, allowing early mobilization. To achieve this goal, early stabilization is of paramount importance, because delay retards convalescence and to some extent unfavorably affects the results.12 Except for poor general health of the patient, lacerations or abrasions over the skin of the patella seem most often to cause a delay in surgery.12 To avoid this problem, percutaneous arthroscopic-assisted osteosynthesis has been done for these fractures. To the authors’ knowledge, this is the first report of such treatment.

MATERIALS AND METHODS

Eleven patients who had a displaced fracture of the patella were treated by percutaneous, arthroscopic-assisted osteosynthesis. There were nine men and two women with an average age of 38 years (range, 26–53 years). All patients had transverse fractures. Three patients had comminution of the distal fragment. All patients had Grade 1 soft tissue injuries according to the classification of Oestern and Tscherne,11 with superficial abrasion and local contusion to the skin. Two patients also had ipsilateral femoral shaft fractures. The period between the trauma and the surgery ranged from 24 hours to 120 hours with an average of 76 hours.

Technique

The patients were placed in the supine position on the operating table with the leg prepared in full extension. A standard inferolateral arthroscopic portal was made and hemorrhage and clots were evacuated from the joint until the fracture was visualized. The fracture then was reduced by manipulation and by towel clips that were applied percutaneously. Reduction was checked by arthroscopy and by c-arm fluoroscopy. Three stab incisions were made at the superolateral, superomedial, and inferomedial corners of the patella and two Kirschner (K) wires were driven from superolateral to inferomedial, and from superomedial to inferolateral incisions (Fig 1).
A cerclage wire then was inserted from the superolateral incision, with the aid of a straight needle, and advanced medially and taken out of the skin from the superomedial incision. The needle was reinserted from the superomedial incision and taken out from the inferomedial incision. The procedure was repeated by placing the wire circumferentially around the patella until the end of the wire was taken out from the superolateral incision. The cerclage wire was tightened circumferentially around the patella. After checking the reduction by arthroscopy and fluoroscopy, both ends of the wire were twisted several times and the remaining ends of the wire and the K wires were resected and the stump of the cerclage wire was buried in the subcutaneous tissue (Fig 2).

When the inferior portion of the patella was comminuted, the towel clips were not used and the arthroscope was advanced to the suprapatellar pouch under the patella. Reduction was achieved and maintained by the arthroscope throughout the procedure. In fractures of the inferior pole, a transpatellar arthroscopic portal was used rather than the standard inferolateral arthroscopic portal. If the comminution was distal to the articular surface of the patella, then no attempt was made for reduction. Bony fragments were kept together without damage to the soft tissue envelope (Fig 3).

The stab wounds then were closed by one suture. The operation time ranged from 25 minutes to 50 minutes with an average of 35 minutes. In all patients quadriceps setting exercises were encouraged immediately after the operation. In three patients with comminution of the distal fragment and in two patients with ipsilateral femoral fractures, a posterior splint with the extremity in full extension was applied for 3 weeks (Fig 4). After 3 weeks, the posterior splint was discontinued and the patients were allowed to walk with crutches and partial weightbearing was encouraged. Also, gentle active range of motion (ROM) exercises were begun.

In six patients with transverse fractures, a posterior splint was applied for 3 days. On the third
postoperative day, an elastic bandage was applied, and the patient was encouraged to walk with crutches without weightbearing. Also, limited ROM exercises were begun. Partial weightbearing was allowed 3 weeks postoperatively.

In all patients, full weightbearing was allowed after the fracture was healed radiographically. This time varied from 6 to 8 weeks depending on the type of the fracture.

The results, including pain, limitation of activity, quadriceps power, and subjective functional assessment were assessed using the criteria of Levack et al.8

RESULTS

No early postoperative complications were observed. Skin problems including superficial abrasions and contusions healed by local care, within the immobilization period. In two patients who were operated on within 24 hours of injury, arthroscopic evaluation of the patellofemoral chondral surfaces was difficult because of hemarthrosis. This difficulty was not observed in patients operated on later than 48 hours after trauma.

The patients were followed up a mean of 2.8 years (range, 1.5–4.2 years). Radiographic examination showed solid union of all fractures (Fig 5). All patients had good results with painless limited activity, no quadriceps wasting, and no subjective disability in the knee (Fig 6).

In comminuted fractures, a radiographic broadening of the patella was sustained during followup but without patellofemoral arthritic changes on radiographs. The clinical examination did not reveal abnormal findings and the patients were satisfied with the clinical result. After the fracture was healed, the K wires in four patients were removed with the patients under local anesthesia because of local irritation. The cerclage wires were not removed.
DISCUSSION

Fractures of the patella require anatomic reduction and stable fixation to begin early mobilization. This is facilitated by early fixation and keeping the soft tissue damage to a minimum. According to Benli et al,2 the most important factor adversely effecting the long-term results is the delay of the operation. Besides the patient’s health status, stabilization of patellar fractures can be delayed because of the status of the skin, which is vulnerable to injury, especially in direct trauma. Excessive abrasions and bruised or edematous skin may necessitate waiting until the skin heals to reduce the risk of wound complications, especially to avoid the danger of contaminating the operative wound.7,12 However, a delay in surgery retards convalescence and to some extent unfavorably affects the results.2,12 Percutaneous, arthroscopic-assisted osteosynthesis seems to overcome these problems because the operation is done through only four stab incisions that may be placed on intact skin, as confirmed in the current study.

Another advantage of the percutaneous technique is keeping the soft tissue damage to a minimum, which also is an important factor for early rehabilitation. Traditionally, patellar fractures are approached by a transverse incision over the midportion of the patella or by a straight midline or straight parapatellar incision.7,12 Although each of these incisions provides adequate exposure, they result in a substantial amount of adhesion.1 According to Leung et al,9 the mechanical effect of a tension band loop is well maintained whereas the soft tissue damage is reduced to a minimum. The current study is not the first to advocate mini-
nally invasive surgery for patellar fractures. Leung et al.\textsuperscript{9} and Ma et al.\textsuperscript{10} did percutaneous wiring without assistance of arthroscopy. Although they reported satisfactory results, Leung et al.\textsuperscript{9} treated undisplaced or slightly displaced transverse fractures, and Ma et al.\textsuperscript{10} achieved anatomic reduction in only $\frac{2}{3}$ of the fractures. The arthroscopic-assisted technique provides accurate reduction, and the additional use of K wires avoids the widening of the anterior fracture gap, as reported by Ma et al.\textsuperscript{10}

Appel and Siegel\textsuperscript{1} described an arthroscopic percutaneous pinning technique with cannulated screws for transverse fractures. They only described the technique but did not report on patients. The current authors used their technique with modifications for fractures with comminution. The reason for the use of the transpatellar arthroscopic portal rather than the standard inferolateral arthroscopic portal in the patients with inferior pole fractures was the ease of the fracture reduction.

Although not included in the criteria of Levack et al.,\textsuperscript{8} poor cosmesis also has been attributed to poor results.\textsuperscript{4,5} The current technique also avoids the cosmetically unpleasant scar, with only four stab incisions.

The current authors suggest that it is better to do the arthroscopic-assisted internal fixation of patellar fractures later than 48 hours after trauma to obtain better arthroscopic visualization. The major problem of this technique is that the retinacular tears cannot be repaired simultaneously as in an open technique. Ma et al.\textsuperscript{10} suggested that a ruptured quadriceps expansion need not be repaired, because the wire that is used provides sufficient strength to fix the fracture. This also maintains any fibrous union of a ruptured quadriceps expansion at either pole of the patella. Special attention should be directed to the continuity of the extensor mechanism preoperatively, probably with the aid of local anesthetic injection into the joint.\textsuperscript{7}

Although there has not been any report of patients with patellar fractures who have skin problems, the current series compares favorably with other series regarding infection, healing rate, and recovery period of the patients.\textsuperscript{3,6,8–10}

The current technique seems to avoid the problems of patellar fractures with skin problems. The advantages of the technique, including early rehabilitation, minimal dissection of the soft tissues, and good cosmesis, may be adapted to the other fractures of the patella.

\textbf{References}