Isolated patellofemoral osteoarthritis can be a disabling disease. When conservative treatment fails, surgical options can be unpredictable and may be considered too aggressive for middle-aged and active people. We analysed the clinical and radiological results of a new coronal osteotomy involving thinning of the patella in a selected group of patients with isolated patellofemoral osteoarthritis. Since 1991, 31 patients (35 knees) have been treated, of whom 34 were available for follow-up at a mean of 9.1 years. The Knee Society Score, the Patellar score and the Short-form-36 questionnaire were used for clinical evaluation. We also examined the radiological features to confirm bone consolidation and assess the progression of osteoarthritis. A significant improvement in the functional scores and radiological parameters was noted. All patients except one were satisfied with the operation. Radiological progression of the patellofemoral osteoarthritis was slowed but radiological femorotibial osteoarthritis progressed in 23 (65%) cases, with a total knee replacement becoming necessary in four cases without technical problems in resurfacing the patella. We compared the results with other forms of surgical treatment reported in the literature.

This treatment offers good clinical and radiological results, presenting an alternative method of managing patellofemoral osteoarthritis.
middle-aged patients with isolated PFOA and to compare them with those following other forms of treatment.

Patients and Methods
This is a descriptive, observational prospective study of clinical and radiological aspects in 31 patients (35 cases) with isolated symptomatic PFOA treated with a thinning osteotomy between 1991 and 2008. The inclusion criteria were disabling anterior knee pain in active patients with radiological evidence of patellofemoral osteophytes and a reduction of the patellofemoral joint space by over 50% as seen on the skyline view. The exclusion criteria were inflammatory or rheumatoid disease of the knee, radiological degenerative changes in the femorotibial joint, excessive wear of the patella seen as thinner than 20 mm on the skyline view, malalignment of the knee joint with varus or valgus > 5° in both lower limbs or malalignment of the extensor mechanism (Q angle > 15° in women and > 12° in men, as measured in extension or a distance of the tibial tuberosity to the trochlear groove > 20 mm).

There were seven men, one with bilateral symptoms, and 24 women, three bilateral, with a mean age of 61.5 years (44 to 77). All were followed for more than four years and 12 patients (14 cases, 40%) for more than ten years. One patient was lost to follow-up after five years. We report the results of the 35 cases followed for a mean of 9.1 years (4 to 18). Each patient was examined clinically by an independent surgeon (JAC), who then evaluated the radiographs but was not involved in the surgery. The study had local ethical approval.

Previous surgery. In three patients an arthroscopic lavage had been performed at least one year before the osteotomy, with extensive shaving of the articular surface of the patella and microfractures in two cases. The treating surgeons then offered them a TKR, which the patients rejected. One patient had undergone a lateral release ten years previously, with initial relief of pain. Prior to the osteotomy, we performed an arthroscopy in 25 cases to evaluate the intra-articular structures, with microfractures of the lateral femoral condyle in five cases of exposed subchondral bone, and a medial meniscectomy in one.

The operation is performed with a tourniquet, under regional epidural or intraradial anaesthesia through a 10 cm longitudinal midline skin incision over the patella with a lateral arthrotomy. Once the lateral retinaculum has been released, the patella is inverted and the osteophytes of the lateral rim are removed with an oscillating saw. We use a standard patellar clamp to hold the patella firmly. In the experimental study\(^1\) and in our first 11 cases we used a double saw to remove a bone sliver 5 mm thick, but we now use a 5 mm side-cutting high-speed burr (United American Medical, McMinnville, Indiana) because it is simpler and quicker to use. We start at the lateral side by making a trough with the burr, and progress with oscillating movements from lateral to medial (Fig. 1), maintaining a plane strictly parallel to the anterior cortex of the patella. When the osteotomy is completed, we tighten the clamp and collapse the central part of the patella. After apposition of the two fragments, the patella is thinner but always preserves the soft-tissue attachments at the proximal and distal poles, and a congruent joint surface. After removal of the clamp, the knee is flexed a few times to improve the alignment of the extensor mechanism by minor displacement of the fragments; the osteotomy is fixed with three or four divergent biodegradable pins (Orthosorb, Ethicon, Boston, Massachusetts) to eliminate the need for post-operative immobilisation (Fig. 2). The skin is closed with a drain left in place for 24 hours. An extension brace locked in full extension is worn, which the patient can remove to perform assisted exercises for the first month after operation. Full weight-bearing is allowed with crutches. The first five cases in our series were not fixed with pins and wore a cast in extension for four weeks. The rehabilitation programme is continued for two more weeks to obtain a full range of movement. Return to normal daily activities is permitted at approximately two months, once consolidation is completed.

In the absence of a universally accepted functional scale to assess isolated PFOA, we used the Knee Society Score (KSS)\(^19\) to evaluate the global function of the knee and the patellar score as described by Feller\(^20\) in 1996 to evaluate the patellofemoral joint (Table I). Before this date we used a personal patellar score including all Feller's items, which was subsequently, retrospectively adapted to produce a Feller's score. Both questionnaires were used pre-operatively, and at three months, six months, and yearly until the latest follow-up. The short-form (SF)-36 Health Survey\(^21\) questionnaire which assessed the patients' perception, was used pre-operatively and annually thereafter. The radiological protocol included anteroposterior, lateral and
skyline views of the patella in 30° of flexion. In half of the cases a pre-operative CT scan was available, and in all the patients this examination was performed between six and 12 months post-operatively. A single observer (FC), blinded to the clinical status of the patient, measured the minimum width of the medial and lateral patellar facets with a calliper to assess the progression of PFOA. Reported intraobserver reproducibility was 0.5 mm. Statistical analysis was performed using the Student’s t-test and Wilcoxon’s test, a p-value of < 0.05 was considered statistically significant.

Results

Clinically, all patients achieved full extension and a degree of flexion similar to the contralateral side at the latest follow-up. All the items of KSS improved significantly (p < 0.05). The mean score increased from 131.1 points (76 to 180) before surgery to 166.9 points (110 to 200) at five years and 162.2 points (131 to 200) at ten years (Fig. 3). All the items of Feller’s patellar score improved, particularly with regard to pain. In contrast to the KSS, the gain measured by this score was maintained over time, increasing from 14.2 points (7 to 21) prior to surgery to 24.6 points (12 to 30) at five years, and from 24.8 points (19 to 30) at ten years (Fig. 4).

The subjective assessment was particularly satisfactory, as all but one said they felt better after the osteotomy. Some components of SF-36 such as role limitations due to physical health, physical function and body pain showed an important improvement during follow-up. However, the scores of psychological aspects remained unchanged, except for vitality (energy/fatigue), which improved after the operation.

In 26 cases (24 patients, 74%) radiographic evaluation confirmed a type 2 patella according to Wiberg’s classification.23 The mean angle of the trochlear groove was 138° (120° to 156°), but ten knees had a mean value of 148° (145° to 156°) due to a trochlear dysplasia. The congruence angle was abnormally high in all patients prior to surgery, with a mean of 17.1° (5° to 40°), and the tilt angle was also altered in all patients, with a pre-operative mean of 12.2° (0° to 30°). Both angles improved significantly (p < 0.05) during the follow-up (Fig. 5).

The changes in the depth of the joint space were measured on the skyline view and on the CT scan where this was available, and were stratified according to Alhback’s classification.24 The degree of patellofemoral osteoarthritis did not progress after surgery (Fig. 6), but the post-operative radiographs showed minor radiological femorotibial degeneration in 23 (65%) of cases. The mean time taken for this to appear
was 4.8 years (1 to 15). Four patients (four knees) underwent a TKR at least five years post-operatively, with no technical complications. In two a patellar component was implanted.

**Complications.** There was only one major complication in a patient who developed avascular necrosis of the articular fragment of the patella due to a technical error. The osteotomy was oblique and too close to the articular surface, resulting in a true facetectomy with a free-floating posterior fragment. The necrotic fragment was removed arthroscopically. This patient developed progressive femorotibial symptoms and underwent TKR. This was the only dissatisfied patient. Finally, in two cases the rehabilitation programme had to be continued for an additional eight weeks because of stiffness in the knee. These were our initial patients who had been immobilised in a cast without fixation of the osteotomy. Both regained a full range of movement.

**Discussion**

The 31 patients included in this study had severe symptomatic PFOA, and underwent a patellar thinning osteotomy as an alternative to more aggressive treatments, such as patellectomy, patellofemoral arthroplasty or TKR. The clinical and radiological results have been satisfactory, with four patients (12.5%) requiring a subsequent TKR, with a good functional result.

The clinical and experimental studies which have investigated the treatment of patients with PFOA have various drawbacks. The low prevalence of symptomatic isolated PFOA, the small numbers of patients that need surgery and the inclusion and exclusion criteria are the main impediments to creating a substantial cohort of patients. We found 31 patients over a period of 17 years from a catchment population of 600 000. In spite of the long follow-up we only lost one patient at five years. The study lacked a control...
group for comparison. It is difficult to compare the results with other forms of surgical treatment, but a direct prospective comparison with lateral retinacular release would be interesting. We have tried to address this problem by comparing our results with other forms of treatment reported in the literature with a follow-up longer than five years and which have used similar scores.

The KSS, the patellar score and the SF-36 health perception score improved significantly and the benefits persisted over the follow-up period, with the reduction in pain being the most noteworthy outcome. Although it had previously been found in an experimental study that patellar thinning was accompanied by a reduction of 20% in patellofemoral pressures\(^\text{18}\) and a slight realignment in the frontal plane,\(^\text{16}\) we also believe that an additional biological effect may be involved. Hejgaard and Arnoldi\(^\text{15}\) showed that the intrasosseous pressure is elevated in painful knees compared to a control group, and decreased significantly after coronal osteotomy of the patella.\(^\text{17}\) In addition, this operation has a denervation effect owing to the lateral retinacular release. Fulkerson et al\(^\text{33}\) described neuromatous degeneration in the lateral retinaculum of the patella. Wojtys et al\(^\text{34}\) noted the presence of nociceptive fibres in soft tissues around the patella particularly in the lateral retinaculum. However, the results of isolated retinacular release as a treatment for PFOA are poor.\(^\text{35}\) Aglietti et al\(^\text{7}\) obtained only 14% of good results in such cases, and Jackson et al\(^\text{8}\) 56% of good results in patients aged over 30, although in both studies no distinction was made between chondromalacia and arthritis. Becker et al\(^\text{36}\) carried out partial lateral facetectomy, lateral release and medialisation of the tibial tubercle achieving similar results to other procedures. As shown in Table II, the patellar thinning osteotomy is a promising alternative in terms of functional results, with a long follow-up. Yercan, Selmi and Neyret\(^\text{37}\) presented good function results at eight years in a small group of patients with arthritis, mostly in

![Fig. 5a](image1.png) ![Fig. 5b](image2.png)

Radiographs a) prior to surgery and b) five years post-operatively of a female patient aged 72 years, showing improved congruence and tilt angles after patellar thinning osteotomy.

![Fig. 6](image3.png)

Pre-operative score and follow-up values of patellofemoral osteoarthritis according to Alhback’s classification.
the lateral facet. At 7.5 years follow-up our group of patients obtained similar mean improvements in the KSS (167, 134 to 200) (p = 0.013) (Fig. 3), but the pre-operative values in our group were lower. Patellofemoral arthroplasty or TKR achieve better functional results with a shorter follow-up at the expense of a more aggressive surgery and a higher rate of complications.

According to the measurements on the skyline view, the degree of patellofemoral osteoarthritis did not progress during the follow-up period in our study. This finding must be understood in the context of the difficulties of obtaining standardised patellar skyline radiographs. CT scans, when available, supported these observations. However, the anteroposterior projections showed radiological signs of femorotibial osteoarthritis in 65% of cases at a mean of five years post-operatively and four underwent TKR (11.4%) because of progressive changes. This is also the major reason for poor results after patellofemoral replacement leading to a TKR in series with a similar follow-up.

In 2003 Barbera Castillo and Martinez Islas presented the results of a patellar thinning osteotomy based on our surgical technique in 36 patients. Although the mean age of the patients was 55 years and the follow-up was only 15 months, the patients improved on clinical and radiological evaluation.

Improvement following patellar thinning osteotomy may be due to various factors including a reduction in patellofemoral pressure, a reduction in intra-osseous pressure, lateral retinacular release, and the slight displacement of the fragments during flexion prior to fixation which may improve patellar tracking. Our procedure did not present any problems in patients who proceeded to TKR. However, TKR has a higher complication rate and inferior results if a previous patellectomy has been undertaken. The patella in our patients who had a subsequent TKR was thick enough to permit replacement without technical complications. An experimental study demonstrated that the stress, and hence the risk of patellar fracture, is not significant if a minimal thickness of 13 mm is maintained during patellar replacement. The mean thickness of the patella measured by these authors was 23.6 mm, and a 5 mm thinning did not compromise the patella. Even so, we do not recommend this technique to be used in a patella with excessive wear and a thickness < 20 mm.

These results may encourage us to increase the indications for patellar thinning osteotomy to younger patients with severe chondromalacia who have not responded to conservative treatment.

### Supplementary material

A further opinion by Mr H. Chissell is available with the electronic version of this article available on our website at www.jbjs.org.uk

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

### Table II. Comparative results of different operations for patellofemoral osteoarthritis

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<tr>
<th>Procedure</th>
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<th>Age (yrs)</th>
<th>Follow-up (yrs)</th>
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<th>Post-operative KSS</th>
<th>Pre-operative KSS-knee</th>
<th>Post-operative KSS-knee</th>
<th>Pre-operative KSS-function</th>
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<td>Partial lateral facetectomy</td>
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<td>176</td>
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<td>79.6</td>
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* KSS, Knee Society score
References


