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# Patellar Resurfacing in Total Knee Arthroplasty

## A Prospective, Randomized, Double-Blind Study with Five to Seven Years of Follow-up

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**Background:** Whether to resurface the patella during a primary total knee arthroplasty performed for the treatment of degenerative osteoarthritis remains a controversial issue. Parameters that have been suggested as being useful in guiding this decision include patient height and weight, the presence of anterior knee pain preoperatively, and the grade of chondromalacia encountered intraoperatively. The purpose of this study was to determine whether these parameters were predictive of the clinical result following total knee arthroplasty with or without patellar resurfacing.

**Methods:** Eighty-six patients (118 knees) undergoing primary total knee arthroplasty for the treatment of osteoarthritis were enrolled in a prospective, randomized, double-blind study. All patients received the same posterior-cruciate-sparing total knee prosthetic components. Patients were randomized to treatment with or without resurfacing of the patella. Evaluations consisted of the determination of a Knee Society clinical score, the completion of a patient satisfaction questionnaire, specific questions relating to patellofemoral symptoms, and radiographs. Sixty-seven patients (ninety-three knees) were followed for a minimum of five years (range, sixty to eighty-four months; average, 70.5 months).

**Results:** With the numbers available, there was no significant difference between the groups treated with and without resurfacing with regard to the overall Knee Society score or the pain and function subscores. Obesity, the degree of patellar chondromalacia, and the presence of preoperative anterior knee pain did not predict postoperative clinical scores or the presence of postoperative anterior knee pain.

**Conclusions:** The occurrence of anterior knee pain could not be predicted with any clinical or radiographic parameter studied. On the basis of these results, it seems likely that postoperative anterior knee pain is related either to the component design or to the details of the surgical technique, such as component rotation, rather than to whether or not the patella is resurfaced.

Whether to resurface the patella in total knee arthroplasty remains controversial. Patellar resurfacing was not a feature of many early total knee arthroplasty designs. The occurrence of postoperative patellofemoral pain, particularly in rheumatoid patients, resulted in the incorporation of patellofemoral resurfacing into most subsequent designs[1-3]. With the advent of modern condylar components, resurfacing of the patella became a standard part of total knee arthroplasty for many surgeons[4]. Complications related to the patellar resurfacing[5-9], however, revived interest in performing the procedure without resurfacing. Selective patellar resurfacing has been suggested as a means of lowering the prevalence of patellofemoral complications following total knee arthroplasty[2,9,10]. The suggested criteria for patellar resurfacing have varied widely and have included patient weight and height, preoperative anterior knee pain, the degree of patellar chondromalacia, and patellar tilt or deformity[11]. A study was undertaken to determine if any of these parameters were predictive of the clinical result following total knee arthroplasty with or without patellar resurfacing. We previously reported the short-term results of a prospective, randomized, double-blind study investigating the indications for patellar resurfacing in total knee arthroplasty[12], and we now report the results after five to seven years of follow-up of these patients.

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## Materials and Methods

Between January 1992 and December 1993, all patients undergoing total knee arthroplasty by one of the authors at one of three university-affiliated teaching hospitals (Tulane University Hospital, Veterans Affairs Medical Center, New Orleans, and Veterans Affairs Medical Center, Alexandria, Louisiana) were considered for this study. The indication for the

operation was osteoarthritis that was severe enough to warrant total knee arthroplasty after an adequate trial of nonoperative therapy. Exclusion criteria included a previous tibial osteotomy or an operation involving the extensor mechanism, a history of septic arthritis or osteomyelitis, severe medical disability limiting the ability to walk, disabling joint disease in another lower-extremity joint, inflammatory arthropathy, and severe deformity. Severe deformity was defined as varus, valgus, or a flexion contracture of >15°.

During the enrollment period, 137 patients were evaluated for possible inclusion in the study. Forty patients (fifty-four knees) met one of the exclusion criteria and were not offered enrollment. Ninety-seven patients who met the inclusion criteria were offered enrollment in the study, and eighty-nine patients (121 knees) agreed to participate. This represented 92% of all eligible patients. Three early postoperative deaths left 118 knees in eighty-six patients for analysis in the previous report[12].

Of these eighty-six patients, eight died, three had a severe stroke that prevented further follow-up, and two had failure of the total knee replacement due to late deep infection; this left a total of seventy-three patients (102 knees) available for follow-up. Sixty-seven (92%) of the seventy-three patients and ninety-three (91%) of the 102 knees were followed. Evaluations consisted of determination of a Knee Society clinical score and completion of a patient questionnaire including a series of questions relating to patellofemoral symptoms by sixty-four patients, and completion of a telephone questionnaire by three patients. The same nurse performed all evaluations in a double-blind fashion, independent of any physician involvement. The institutional review boards of all of the involved hospitals approved the study protocol, including the consent forms. Patients agreed to be blinded to which procedure they had received to reduce bias in their responses to follow-up questionnaires. All patients received the same posterior-cruciate-sparing prosthetic components (Miller-Galante II; Zimmer, Warsaw, Indiana), and all operations were performed by, or under the direct supervision of, one of the authors.

Randomization was accomplished by opening a randomly selected envelope in the operating room after all femoral and tibial cuts had been made and immediately prior to patellar preparation. When a patient was to have a bilateral arthroplasty, the first knee received the treatment indicated by the envelope and the contralateral knee received the other treatment. All procedures were performed with a uniform approach and technique, as previously described[12]. If the patella subluxated during passive range-of-motion testing (the so-called no-thumbs test[13]), a lateral retinacular release was performed. When resurfacing was performed, a cemented, three-peg, all-polyethylene component was utilized. Calipers were used to ensure restoration of the preoperative thickness within 1 mm[12]. When resurfacing was not performed, patelloplasty was carried out. This included removal of osteophytes, smoothing of fibrillated cartilage, and drilling of eburnated bone.

Study evaluations were conducted preoperatively and at follow-up visits conducted at six months, at twelve months, and annually thereafter. All physical examinations were performed by the same trained nurse-clinician, and radiographs were repeated. At all preoperative and postoperative visits, a Knee Society clinical score was recorded. These scores were obtained for each knee in a double-blind fashion.

To explore the relationship between patient weight and the clinical result, the percentage by which the patient's weight exceeded the maximum allowed for a "large frame" on the Metropolitan Life Insurance Company (1983) weight-for-height tables[14] was calculated. Analysis of covariance was performed to assess the relationship of the Knee Society clinical score to obesity and the presence or absence of patellar resurfacing, which were used as independent variables. The preoperative score was used as a covariant, to adjust for any preoperative differences among the subjects.

Patient satisfaction was assessed with use of questionnaires. All patients completed detailed questionnaires preoperatively and at follow-up visits. Of particular interest in this study population were items related to patellofemoral joint function. The instruments included visual analog scales for pain and function and assessments of patient satisfaction. Questionnaire items asked to what degree knee symptoms interfered with activities of daily living, work, and recreation. The ability to climb stairs, rise from a chair, and exit an automobile were specifically assessed, as was the presence or absence of anterior knee pain as a means of identifying symptoms related to the patella.

Of the sixty-seven patients, sixty-four (eighty-eight knees) returned for reevaluation and three (five knees) were evaluated by telephone questionnaire. A Knee Society clinical score was not determined for these five knees. Thus, although a total of forty-seven knees with the patella resurfaced and forty-six without patellar resurfacing were analyzed, Knee Society clinical scores were obtained for forty-four knees in each group. Five patients (five knees) who had originally had the arthroplasty without resurfacing had undergone a revision to resurface the patella. Their scores and questionnaires were analyzed with those of the nonresurfaced group.

Descriptive statistics (averages, medians, and so on) were used to summarize the data. Because some individuals contributed scores for both knees, generalized estimating equation regression methods were used to test for significance while controlling for the dependence between scores. Both categorical and continuous outcomes were analyzed with use of generalized estimating equation regression methods, and preoperative scores were controlled for when possible. Significance was defined as $p < 0.05$. All analyses were conducted with use of SAS software (version 8; SAS Institute, Cary, North Carolina).

## Results

### *Complications*

There were no acute infections (within twenty-four months postoperatively). Two late hematogenous infections neces-

**TABLE I Knee Society Clinical Scores for Resurfaced and Nonresurfaced Patellae at Five to Seven Years**

| | No. of Knees | Mean Clinical Score *(points)* | | | | | |
|---|---|---|---|---|---|---|---|
| | | Pain | | Function | | Overall | |
| | | Preop. | Postop. | Preop. | Postop. | Preop. | Postop. |
| Nonresurfaced patellae | 44 | 45.3 | 88.5 | 41.5 | 80.7 | 89.6 | 169.1 |
| Resurfaced patellae | 44 | 43.6 | 88.3 | 42.1 | 73.5 | 87.4 | 161.6 |
| All knees | 88 | 44.5 | 88.4 | 41.8 | 77.1 | 88.5 | 165.4 |

sitated a reoperation, and the two patients were excluded from the study. There were no revisions for aseptic component loosening.

Seven (12%) of the original sixty knees with a nonresurfaced patella were subsequently resurfaced, all because of anterior knee pain. Six of the resurfacings had been done by the two to four-year follow-up examination, and one had been done by the five to seven-year follow-up examination. Two of the patients with a subsequent resurfacing were not reevaluated for the present study: one could not be contacted, and the other had had a major stroke, preventing further evaluation. The seven revisions were accomplished without operative complications, and there was an initial decrease in the anterior pain in six of the seven knees. Prior to the patellar resurfacing, the anterior pain was rated as ≥8 on a scale of 1 to 10 in all seven knees. The average pain rating after the resurfacing was 2.3 at the two to four-year follow-up examination, but the rating had deteriorated in four of the five reevaluated patients (average, rating 7.4) five to seven years following the original total knee arthroplasty. The average duration of follow-up after the subsequent patellar resurfacing was 36.8 months (range, twelve to forty-eight months).

Nine knees with a resurfaced patella were painful anteriorly at the time of final follow-up, with an average pain rating of 7.2. There was no sign of patellar subluxation or maltracking, and these knees were treated nonoperatively. None of the resurfaced knees underwent revision for pain, but eight of the nine knees with a resurfaced patella that were painful anteriorly were rated as ≥4. There were no patellar fractures or dislocations and no episodes of patellar component loosening among the resurfaced patellae.

### *Clinical Results*

#### Knee Society Clinical Score

The average preoperative Knee Society clinical score was 88.5 points (median, 89 points; range, 0 to 142 points) (Table I). The average score for pain was 44.5 points (median, 44 points; range, 0 to 74 points), and the average score for function was 41.8 points (median, 45 points; range, −20 to 60 points). The average Knee Society clinical score at the time of final follow-up was 165.4 points (median, 185 points; range, 47 to 200 points). The average score for pain was 88.4 points (median, 93 points; range, 41 to 100 points), and the average score for function was 77.1 points (median, 92.5 points; range, −20 to 100 points). The average Knee Society clinical score for the resurfaced knees was 87.4 points (median, 89 points; range, 33 to 132 points) preoperatively and 161.6 points (median, 179.5 points; range, 47 to 200 points) postoperatively. The average Knee Society clinical score for the nonresurfaced knees was 89.6 points (median, 89 points; range, 0 to 130 points) preoperatively and 169.1 points (median, 191.5 points; range, 52 to 200 points) postoperatively. There was no significant difference between the resurfaced and nonresurfaced knees with respect to the overall Knee Society clinical score ($p = 0.36$) or the pain ($p = 0.77$) or function ($p = 0.16$) subscore. There was also no significant difference in the Knee Society scores or subscores between obese and nonobese patients or among patients with different grades of chondromalacia.

The average range of motion at the time of final follow-up was 101° (median, 105°; range, 65° to 130°). This was a decrease from the average of 111° (median, 105°; range, 80° to 140°) at the time of the two to four-year follow-up. There was no significant difference in the average range of motion between the knees with a resurfaced patella and those with a nonresurfaced patella ($p = 0.63$).

#### Patient Satisfaction and Questions Regarding Patellofemoral Function

In all groups, the scores related to patellofemoral function improved from 2 or 3 (on a scale of 0 ["impossible"] to 10 ["no problem"]) preoperatively to 8 or 9 postoperatively.

Patients were asked: "Are you satisfied with the results of your operation?" Overall, the answer was "yes" for eighty-six (92%) of the ninety-three knees. Forty-three (93%) of the forty-six arthroplasties without resurfacing of the patella and forty-three (91%) of the forty-seven with resurfacing of the patella resulted in patient satisfaction; there was no significant difference between these results (generalized estimating equations, $p = 0.67$).

There was also no difference in the patient's postoperative ability to get in and out of an automobile ($p = 0.36$) or a chair ($p = 0.94$) or to negotiate stairs ($p = 0.99$) between those who had resurfacing and those who did not. The ratings of the degrees of difficulty were virtually identical between the two groups (Table II).

**TABLE II Responses to the Questionnaire Concerning the Degree of Difficulty with Specific Activities That Stress the Patellofemoral Joint***

| | Exiting an Automobile *(points)* | | Rising from a Chair *(points)* | | Stair-Climbing *(points)* | |
|---|---|---|---|---|---|---|
| | Preop. | Postop. | Preop. | Postop. | Preop. | Postop. |
| Resurfaced patellae | 2.5 | 7.5 | 2.9 | 8.1 | 3.1 | 7.9 |
| Nonresurfaced patellae | 2.5 | 8.1 | 2.9 | 8.1 | 3.4 | 7.9 |

*All values are given as the average number of points on the basis of a 10-point scale, with 0 indicating that the patient is unable to perform the activity and 10, that the activity can be performed normally or without difficulty.

**Anterior Knee Pain**

Thirty-nine (42%) of the ninety-three knees were painful anteriorly before the operation, and thirty-three (85%) of them had this symptom relieved by the operation. As expected, patients with preoperative anterior knee pain were found to have lower preoperative Knee Society pain scores (average, 79.7 points; median, 82 points; range, 0 to 132 points) than those who did not have preoperative anterior knee pain (average, 94.7 points; median, 94 points; range, 40 to 129 points) ($p < 0.0082$), but this was not reflected in the function scores (an average, median, and range of 39.7, 50, and −20 to 60 points for the patients with anterior knee pain compared with 43.3, 45, and 0 to 70 points for those without it, $p = 0.35$). Patients with preoperative anterior knee pain were not found to have significantly different postoperative Knee Society clinical scores (average, 163.9 points; median, 180 points; range, 56 to 200 points) compared with those without preoperative anterior knee pain (average, 166.4 points; median, 192 points; range, 52 to 200 points) ($p = 0.55$).

Two (9%) of twenty-two knees with anterior pain before resurfacing of the patella continued to have anterior pain after the operation, but seven (28%) of twenty-five knees without anterior knee pain before resurfacing of the patella had anterior pain after the operation. Thus, a total of nine (19%) of forty-seven arthroplasties with patellar resurfacing were followed by anterior knee pain. Four of the seventeen knees with anterior pain before the arthroplasties without patellar resurfacing continued to have anterior pain after the operation, but new anterior pain developed in four (14%) of the twenty-nine knees that had not had anterior pain preoperatively. Thus, a total of eight (17%) of the forty-six knees without patellar resurfacing had postoperative anterior pain. There was no significant difference in the prevalence of postoperative anterior knee pain when patients with a resurfaced patella and those with a nonresurfaced patella were compared (generalized estimating equations, $p = 0.79$).

Four of the seventeen knees with anterior pain postoperatively were not satisfactory to the patients, whereas only three (4%) of the seventy-six knees without anterior pain were not satisfactory to the patients; this suggested that patients without anterior knee pain were significantly more likely to be satisfied with the results of the surgery (generalized estimating equations, $p = 0.01$). Patients without anterior knee pain were 7.5 times more likely to be satisfied (odds ratio = 7.49, 95% confidence interval = 1.50 to 37.42).

**Patients with a Bilateral Procedure**

Twenty-three (96%) of the twenty-four patients with a bilateral arthroplasty were satisfied with the results for both the resurfaced and the nonresurfaced patella. (This analysis excludes two patients with bilateral arthroplasty in whom the nonresurfaced patella was revised to a resurfaced patella.)

When asked to compare their knees, five (21%) of the patients with a bilateral procedure responded that they preferred the resurfaced side, seven (29%) preferred the nonresurfaced side, and twelve (50%) expressed no preference. The average magnitude of the difference, on a scale of 1 ("a little") to 10 ("a lot"), was 5.7 for those who preferred the nonresurfaced side and 7.0 for those who preferred the resurfaced side.

## Discussion

With the numbers available, we found no significant differences between resurfaced and nonresurfaced patellae with respect to the Knee Society pain ($p = 0.77$), function ($p = 0.16$), and total ($p = 0.36$) scores or the assessments of patellofemoral function ($p = 0.36$, 0.94, and 0.99). Patients who had had replacement with resurfacing on one side and replacement without resurfacing on the other did not express a clear preference for either side.

Obesity, the degree of patellar chondromalacia, and preoperative anterior knee pain did not predict either a lower postoperative knee score or postoperative anterior knee pain. These three factors have commonly been considered as key in the decision whether to resurface the patella, when the so-called selective patellar resurfacing approach is utilized[9-11,15]. We did not find any differences in the ability to climb stairs, to rise from a chair, or to exit an automobile when patients were analyzed according to the degree of patellar chondromalacia. In fact, the six surviving patients with grade-IV[16] chondromalacia who had not been treated with resurfacing had a relatively high average Knee Society score of 170.2 points, and none subsequently required patellar resurfacing. Although it appears that patients with grade-IV chondromalacia with a

nonresurfaced patella scored well, only a small number were studied and the importance of this finding is uncertain.

Preoperative anterior knee pain seems a logical reason to resurface the patella, particularly since patellar resurfacing relieved anterior pain in thirty-three (85%) of thirty-nine knees in the present study. Although previously published information has suggested anterior knee pain as a reason for resurfacing[9,11], we found that preoperative anterior knee pain was not predictive of postoperative anterior knee pain. Moreover, most postoperative anterior knee pain was of new onset. There is an approximately equal likelihood that anterior knee pain will develop postoperatively regardless of whether patellar resurfacing is performed. The prevalence of anterior knee pain in this study was consistent with the rates in previously reported studies[17-19].

Brinker et al. reported an average Knee Society clinical score of 180.2 points for 200 knees of asymptomatic older individuals (average age, 59.6 years)[20]. If the average postoperative knee score of 165.4 points in our study is normalized to this rating, a score of 91.8% (165.4 of 180.2 points) is obtained, verifying the excellent clinical results attained by the study group as a whole. The normalized scores for the nonresurfaced and resurfaced groups were 93.8% (169.1 of 180.2 points) and 89.7% (161.6 of 180.2 points), respectively.

At an average of 70.5 months postoperatively, the results in the present study were analogous to the results in our short-term follow-up study in that no difference in any parameter studied was demonstrated between patients with a resurfaced patella and those with a nonresurfaced patella. The overall prevalence of anterior knee pain increased from 10% at the two to four-year follow-up interval to 18% in the present study. There were ten new patients with anterior knee pain, a significant increase from the number of patients with such pain in the earlier study (exact binomial probability, $p = 0.011$). This increase demonstrated that the pain-free period could be limited. Of the ten knees with new anterior knee pain, seven had a resurfaced patella. The difference between the knees with resurfacing and those without resurfacing was not significant in this regard ($p = 0.34$), illustrating that the occurrence of anterior knee pain is a dynamic process regardless of whether the patella is resurfaced or not. Of the seventeen patients who had anterior knee pain at five to seven years, six had had anterior knee pain preoperatively and seven had had this symptom at two to four years. Postoperative anterior pain is probably clinically important in light of the fact that four of the seventeen knees with the symptom were not satisfactory to the patients compared with three (4%) of the seventy-six knees without anterior pain (generalized estimating equations, $p = 0.01$).

A potential major disadvantage of not resurfacing the patella is the possibility that it will subsequently require resurfacing. Subsequent resurfacing was performed in seven (12%) of the original sixty knees in this series. Clinical improvement was seen initially in six of the seven knees; however, anterior knee pain recurred in four of the five patients who were evaluated more than five years after the original procedure. Patients with anterior knee pain and a nonresurfaced patella should be advised of the substantial risk of recurrence of anterior knee pain despite subsequent resurfacing. Conversely, there are fewer options available for the treatment of anterior pain in a knee with an already resurfaced patella, as isolated revision of the patellar component has been reported to be fraught with complications[21].

The results of the present study may be specific, to some degree, to the implant and the surgical techniques that were utilized. It seems clear, however, that anterior knee pain remains an important clinical issue following total knee arthroplasty. The exact etiology remains elusive, and the effects of implant design, surgical technique, and alteration of patellar tracking on the prevalence of postoperative anterior knee pain are yet to be clearly defined[22-25]. ■

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