Abstract: The goal of arthroscopic partial meniscectomy is to preserve a stable rim of meniscal cartilage, removing only unstable, diseased tissue. As one of the most common orthopedic procedures performed in the United States, arthroscopic partial meniscectomy developed as an alternative to open total meniscectomy that leads to degenerative changes in the knee over time. The short-term results of this meniscal-sparing procedure are favorable. Evidence of long-term results is limited to outcome measures that are not standardized. However, the long-term trend of clinical outcomes is satisfactory, whereas that of radiographic outcomes is significant for signs of osteoarthritis.

Key Words: arthroscopic partial meniscectomy, arthritis, meniscus tear

ANATOMY AND BIOMECHANICS

The role of the meniscus in load transmission, shock absorption, and as a secondary stabilizer of the knee, and more than just a vestigial remnant has been delineated. In 1948, Fairbank reported the radiographic changes in the knee after total meniscectomy. He described osteophyte formation, flattening of the femoral condyle, and joint space narrowing. He surmised that these changes were due to the loss of the weight-bearing function of the meniscus.

Beginning in the 1970s, biomechanical studies demonstrated the weight-bearing role of the menisci. Seedhom compared total and partial removal of the meniscus and reported that, if a stable circumferential rim was preserved, the latter resulted in less compressive stress concentration in the tibiofemoral joint than total meniscectomy. They also demonstrated that 70% to 99% of the compressive force of the knee joint is transmitted through the menisci and that this force increases with knee flexion.

Baratz et al confirmed these findings and demonstrated that the decrease in contact area of the tibiofemoral joint after meniscectomy is indirectly proportional to the increase in contact stress of that joint. After a partial meniscectomy, the contact area of the tibiofemoral joint decreases by 10%, whereas the peak local contact stress increases by 65%. After total meniscectomy, these parameters change by 75% and 235%, respectively.

Johnson and Pope demonstrated that load transmission and shock absorption by the menisci occur by way of the orientation of the collagen fibers within the meniscus. Arranged in a circumferential pattern held together by radially oriented struts, axial load is transmitted to the circumferentially arranged collagen fibers. These hoop stresses absorb energy and prevent its transmission to the articular cartilage and subchondral bone.

Much has been done to define the role of the meniscus in joint stability. Tapper and Hoover cite joint instability as predisposing the knee to degenerative changes after total meniscectomy. Both varus-valgus and anteroposterior (A-P) laxity were increased in follow-up exams of a subset of patients after total meniscectomy. Hsieh and Walker concluded that the resistance to A-P translation provided by the meniscus is significant only in cruciate-deficient knees. Levy et al refined this conclusion and specified that the medial meniscus provides resistance to A-P translation in anterior cruciate ligament-deficient knees.

Although the meniscus do resist A-P translation of the knee in anterior cruciate ligament-deficient knees, Hollis et al demonstrated the significant strain placed on the menisci in this situation.

As a result of these studies, total meniscectomy began to be rejected in favor of partial meniscectomy. As arthroscopic techniques developed, arthroscopic partial meniscectomy became the gold standard for irreparable and symptomatic tears of the meniscus.

MENISCECTOMY AND OSTEOARTHRITIS

Historically, there has been an association between meniscectomy and the development of osteoarthritis. Tapper and Hoover sought to quantify subjective results after meniscectomy based on patients' subjective symptoms and disability. They concluded that only 40% of patients had normal knees with 40% to 90% having good to excellent results and 10% having bad results. The methodology of this study consisted of a retrospective questionnaire to which 36% of the patients replied and a clinical exam of 35% of the patients in the study. The study population underwent open total and partial meniscectomy (from 1936 to 1956), and the authors did not demonstrate a difference between these 2 groups, bringing power into question. They did conclude that the best results were achieved in those
patients who underwent partial meniscectomy with a peripheral rim of meniscus left intact.

Roos et al\textsuperscript{23} reported a 14.0 relative risk of developing osteoarthritis at an average of 21 years after meniscectomy. However, the patients studied underwent total meniscectomy.

Rangger et al\textsuperscript{24} demonstrated a progression of radiographic arthritis in 38\% of patients after arthroscopic partial medial meniscectomy and in 24\% of patients after partial lateral meniscectomy at an average of 53-month follow-up. Although primarily a radiographic study consisting of a comparison of non-weight-bearing radiographs preoperatively and postoperatively obtained, they did include an evaluation of subjective symptoms. These subjective findings did not correlate with the increase in radiographic osteoarthritis.

Excluding patients with greater than Outerbridge grade 2 chondral damage, Kruger-Franke et al\textsuperscript{25} demonstrated 96\% excellent clinical results in patients with various configurations of medial meniscal tears. However, they showed a 33\% increase in the amount of radiographic osteoarthritis, comparing preoperative and postoperative weight-bearing radiographs of affected knees.

As an arm of the Multicenter Osteoarthritis Study, Englund et al\textsuperscript{26} examined patients aged 50 to 79 with symptomatic meniscal tears who underwent nonoperative treatment. The authors demonstrated an increase in radiographic osteoarthritis at 30-month follow-up. They concluded that meniscal damage is a risk factor for developing radiographic osteoarthritis.

**LONG-TERM OUTCOMES**

Petty and Lubowitz\textsuperscript{15} systematically reviewed the published literature regarding the long-term outcome of arthroscopic partial meniscectomy and included studies with 8- to 16-year follow-up. The results are summarized in Tables 1 and 2 below.

**Clinical Outcomes**

There are few studies with long-term follow-up, and essentially no studies report the same outcome measures. These studies also vary somewhat in demographics and types of meniscal tears. However, the trend of clinical results after arthroscopic meniscectomy seems to be toward

<table>
<thead>
<tr>
<th>Study</th>
<th>Level of Evidence: Clinical/Radiographic</th>
<th>No. Patients</th>
<th>Location of Meniscectomy</th>
<th>Age of Patients (Average in Years)</th>
<th>Length of Follow-up (Average in Years)</th>
<th>Outcome Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burks et al\textsuperscript{27}</td>
<td>IV/III</td>
<td>146*</td>
<td>Medial: 78%</td>
<td>38.5 (&lt; 60 y)</td>
<td>14.7 (13.8-16.4)</td>
<td>Modified Lysholm score</td>
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<td></td>
<td></td>
<td></td>
<td>Lateral: 19%</td>
<td></td>
<td></td>
<td>Tegner activity scale</td>
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<td></td>
<td></td>
<td></td>
<td>Bilateral: 3%</td>
<td></td>
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<td>Subjective satisfaction index</td>
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<td>Physical exam</td>
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<td></td>
<td></td>
<td>Radiographic exam</td>
</tr>
<tr>
<td>Chatain et al\textsuperscript{28}</td>
<td>IV/III</td>
<td>471†</td>
<td>Medial: 362</td>
<td>38.5 ± 12 (medial meniscectomy)</td>
<td>11 (10-15)</td>
<td>IKDC scoring form</td>
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<td>Lateral: 109</td>
<td>35 ± 12.5 (lateral meniscectomy)</td>
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<td>Patient satisfaction</td>
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<td>Repeat surgery</td>
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<td>Radiographic exam</td>
</tr>
<tr>
<td>Fauno et al\textsuperscript{29}</td>
<td>IV/II</td>
<td>136</td>
<td>Lateral in: Flap tear group: 17%</td>
<td>35.2 ± 7 (flap tear) 31.6 ± 10 (bucket handle)</td>
<td>8.5 (7.9-11.6)</td>
<td>Lysholm score</td>
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<td>Bucket-handle group: 10%</td>
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<td>Physical exam</td>
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<td>Repeat surgery</td>
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<td>Radiographic exam</td>
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<tr>
<td>Hulet et al\textsuperscript{30}</td>
<td>IV/III</td>
<td>57 (74 knees)</td>
<td>Medial: 100%</td>
<td>36 ± 11</td>
<td>12 ± 1</td>
<td>IKDC score</td>
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<td>KT-1000 testing</td>
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<td>Physical exam</td>
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<tr>
<td>Rockborn and Gilquist\textsuperscript{31}</td>
<td>IV/III</td>
<td>43 (44 lesions)</td>
<td>Medial: 25</td>
<td>19 (15-22)</td>
<td>13 (11-15)</td>
<td>Lysholm score</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Lateral: 19</td>
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<td></td>
<td>Tegner activity scale</td>
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<td>Physical exam</td>
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<td>Joint fluid analysis</td>
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<td>Radiographic exam</td>
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</tbody>
</table>

*Only 111 returned for radiographic and physical examination.
†Only 488 returned for radiographic examination.
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normal or near normal knees and satisfied or very satisfied patients.
Burks et al\textsuperscript{27} evaluated the results of arthroscopic partial medial and lateral meniscectomy at a mean follow-up of 14.7 years. Their scoring system combined the modified Lysholm score and side-to-side radiographic differences, placing patients into 3 categories. Overall, patients with stable knees had 57% excellent, 31% good, and 12% poor results. Subjective scores were also reported, demonstrating an average Lysholm score of 94, a subjective satisfaction score of 8.8 (range, 1 to 10), and a Tegner change of 0.3 in patients with stable knees.

Chatain et al\textsuperscript{28} compared results of lateral versus medial arthroscopic partial meniscectomies at an average follow-up of 11 years. They reported a subjective satisfaction rating with 95% of patients being satisfied or very satisfied with their knees. Only the subjective portion of the International Knee Documentation Committee (IKDC) assessment demonstrated a significant difference between medial and lateral meniscectomy. Normal or nearly normal scores were found in 90.2% and 85.9% of patients undergoing medial and lateral meniscectomy, respectively. Eighty-six percent of patients were asymptomatic after undergoing partial meniscectomy compared with 80% of those patients after lateral meniscectomy.

Fauno and Nielsen\textsuperscript{29} evaluated differences between patients with bucket-handle tears and those with flap tears at an average of 8.5-year follow-up. They used the Lysholm score as an outcome measure, with 17% of patients overall having a score <90. The only significant clinical difference between the 2 groups was more knee pain after exercise in the flap tear group. Most reoperations occurred in patients with flap tears, and the overall reoperation rate was 15.4%.

Hulet et al\textsuperscript{30} graded patients based on their IKDC scores. In a retrospective study, they evaluated 74 traumatic meniscal tears in 57 patients at an average of 12-year follow-up. Objective and subjective findings were similar with all patients receiving a grade indicating normal or nearly normal knees and 95% of patients being satisfied or very satisfied. The lower-activity group demonstrated a greater amount of anterior knee pain that was significant.

Using the French Arthroscopic Scale, the authors also graded cartilage lesions. No grade IV chondral lesions were identified, with the most severe chondromalacia identified in the patellofemoral compartment.

Rockborn and Gillquist\textsuperscript{31} reported on a younger patient population an average of 13 years after partial or subtotal meniscectomy. The latter group had significantly lower Lysholm scores, although the average score for all patients was 91. Sixteen of the 43 patients gave themselves a subjective self-assessment score between 10 and 40, with 100 representing severe disability.

### Radiographic Outcomes

Long-term radiographic outcomes are not as hopeful as clinical outcomes, suggesting that osteoarthritis will follow arthroscopic partial meniscectomy. These studies all used the contralateral knee as a control, whereas evaluation techniques of radiographic osteoarthritis differed.

Burks et al\textsuperscript{27} graded radiographic appearance of operative knees using nonoperative knees in the same patient as a control. Degenerative changes on x-ray were significantly worse in the operative group.

Similarly, Chatain et al\textsuperscript{28} compared operative and nonoperative knees in patients after medial and lateral meniscectomy. On the basis of IKDC radiographic grading, they demonstrated a 21.5% change in knees after a medial meniscectomy and a 37.5% change in knees after a lateral meniscectomy.

Hulet et al\textsuperscript{30} also used IKDC compartmental grading to compare operative and nonoperative knees. Although 21% of operative knees demonstrated narrowing, compared with 11% of nonoperative knees, statistical significance was not addressed.

Fauno and Nielsen\textsuperscript{29} used the classification of Fairbank to compare radiographic results in knees with flap tears and those with bucket-handle tears. They also used the contralateral normal knee as a control. After surgery,
77% of patients had at least 1 Fairbank change with 53% having only 1 change. These data were compared with 30% of control knees having at least 1 change and 22% having only 1 Fairbank change. The radiographic differences between the 2 types of meniscal tears were not significant.

Rockborn and Gillquist31 also used Fairbank’s classification to compare operative and contralateral knees. More changes were seen in operative knees, and the subtotal meniscectomy group was the worst.

Summary

To summarize the long-term outcomes after arthroscopic partial meniscectomy, Petty and Lubowitz15 systematically reviewed the published literature and included studies with 8- to 16-year follow-up. The article’s conclusion was that “Radiographic signs of osteoarthritis are significant at 8 to 16 years’ follow-up after arthroscopic partial meniscectomy, but clinical symptoms of knee arthritis are not significant.” Limitations of the review were the absence of clinical control groups and the heterogeneity of reported outcome measures. The authors suggested that “(F)uture research of higher levels of evidence with longer-term follow-up is required to determine whether the radiographic signs ultimately foreshadow clinical symptoms after arthroscopic partial meniscectomy.”

CONCLUSIONS

As Englund17 points out, we do not have a clear understanding of how meniscal damage and osteoarthritis are related. Because most degenerative meniscal tears are asymptomatic, he points out the dilemma in distinguishing symptoms arising from the meniscal pathology versus those arising from early osteoarthritis. The same biological changes and genetic predispositions may lead to both conditions.

We can help our patients feel better with arthroscopic partial meniscectomy, although we may not be able to stop progression of radiographic osteoarthritis. As Fabricant and Jokl1 conclude, radiographic outcomes are not important to patients, because they do not correlate with clinical measures and are, therefore, poor indicators of overall outcomes.

REFERENCES