

# Patellofemoral Arthroplasty Versus Total Knee Arthroplasty in Patients With Isolated Patellofemoral Osteoarthritis

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## Abstract

We identified all patients at our institution who underwent patellofemoral arthroplasty (PFA) or total knee arthroplasty (TKA) as treatment for isolated patellofemoral arthritis (PA) between January 2003 and December 2005. Twenty-three PFA and 22 TKA patients met inclusion criteria. Mean age was 60 years and 69 years, respectively ( $P = .01$ ). Mean follow-up was 29 months (range, 24 to 49 months) in the PFA group and 27 months (range, 24 to 33 months) in the TKA group. Mean postoperative Knee Society Clinical Rating System scores were 89 and 90 in the PFA and TKA cohorts, respectively. Mean UCLA scores were 6.6 and 4.2, respectively ( $P < .0001$ ). Mean blood loss ( $P = .03$ ) and hospital stay ( $P = .001$ ) were significantly lower among PFA patients. Linear regression analysis showed that blood loss, hospital stay, and functional outcomes were not affected by age as an independent variable. No significant complications occurred in the PFA group. There was one deep vein thrombosis in the TKA group. We conclude that PFA yields clinical outcomes comparable to that of TKA as treatment for isolated PA and may be a less invasive option for this select subgroup of patients.

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There has been a renewed interest in treatment options for patients with isolated patellofemoral arthritis (PA) of the knee. In patients over age 55 years presenting with knee pain, isolated PA has been reported in 8% of women and 2% of men, and has been associated with a relatively high rate of disability.<sup>1</sup> Davies and colleagues reported that 9% of the 209 patients in their study who had arthritis of the knee were diagnosed with isolated PA.<sup>2</sup>

Conservative treatment of PA includes strengthening exercises, bracing or taping, nonsteroidal anti-inflammatory drugs, injections of hyaluronic acid and/or corticosteroids, and activity modification.<sup>3,4</sup> Reported surgical options for early stage disease and/or patellar malalignment include arthroscopic debridement with or without lateral retinacular release, tibial tubercle elevation or anteromedialization, cartilage stimulation techniques (such as microfracture or abrasion arthroplasty), and cartilage replacement procedures.<sup>5-7</sup> For more advanced disease, patellectomy and patellar resurfacing have been described but have fallen out of favor as a result of overall unsatisfactory results.<sup>6-9</sup>

Total knee arthroplasty (TKA) has been reported to be an accepted method of treatment for advanced isolated PA.<sup>10-13</sup> Although TKA has been reported to provide pain relief and functional improvement in this population, its indications and benefits relative to patellofemoral arthroplasty (PFA) remain controversial.<sup>14</sup>

There are few studies in the literature that report outcomes of PFA using newer PFA designs,<sup>15,16</sup> and no prior study comparing the results of TKA with the results of PFA using modern implants. In this comparative retrospective study, we hypothesized that patients who underwent PFA as treatment for isolated PA would have similar outcomes as patients treated with TKA.

All patients provided verbal and/or written consent for participation in this study.

## MATERIALS AND METHODS

We reviewed all patients who underwent knee arthroplasty at our institution between January 2003 and December 2005. From this registry, we first selected only those patients diagnosed with PA. Patients were screened further for isolated disease using the following criteria: a Kellgren and Lawrence<sup>17</sup> score  $\leq 2$  at the tibiofemoral

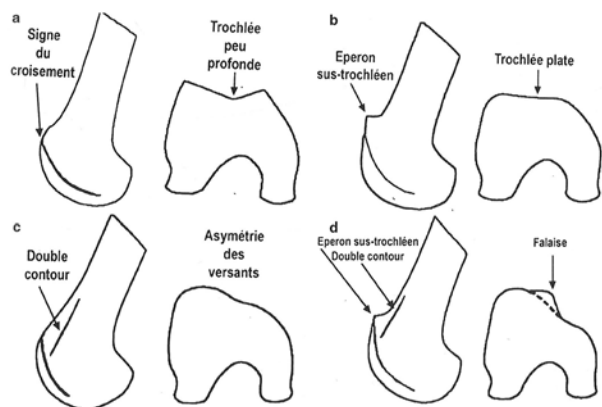


Figure 1. Trochlear dysplasia using the Dejour classification method. (A) Grade A: Crossing sign with shallow trochlea. (B) Grade B: Crossing sign, supratrochlear spur, and flat trochlea. (C) Grade C: Crossing sign, double contour, asymmetry of trochlear facets. (D) Grade D: Grades B and C plus asymmetry of trochlear facets and cliff pattern. Reprinted with permission from Springer.<sup>19</sup>

ral joint and an Iwano<sup>18</sup> score > 2 at the patellofemoral joint, determined radiographically by consensus of 2 of the authors.

Patellofemoral arthroplasties were performed using the Avon patellofemoral prosthesis (Stryker Howmedica Osteonics, Mahwah, New Jersey). The Avon trochlear implant is an onlay-style prosthesis that is implanted flush with the anterior femoral cortex and externally rotated parallel to the epicondylar axis. A single surgeon performed all but 2 of the PFAs included in this study, and none of the TKAs. The TKAs were performed by surgeons who did not have experience with PFA. A total of 8 surgeons used 1 of 2 modern TKA designs (Zimmer, Warsaw, Indiana; or SIGMA, DePuy Orthopedics, Inc., Johnson & Johnson, Warsaw, Indiana). Thirteen designs were posterior cruciate ligament (PCL)-substituting and 9 were PCL-retaining implants. All procedures were performed using a standard medial parapatellar arthrotomy. The TKA procedures required more distal extension of the arthrotomy than the PFA procedures, however, which did not violate the medial meniscus or intermeniscal ligament.

Patient demographics were collected for both the PFA and TKA groups. Preoperative and postoperative Knee Society Clinical Rating System (KSS) scores were calculated from standardized questionnaires given prospectively to all patients just prior to surgery, and at regular intervals thereafter. Preoperative Tegner activity scores and University of California Los Angeles (UCLA) activity scores were obtained retrospectively from patient records. Postoperative Tegner and UCLA scores that were not obtainable through chart reviews were obtained by telephone interview.

Preoperative and postoperative radiographs were reviewed. Trochlear dysplasia was assessed using the Dejour classification method<sup>19</sup> (Figure 1). Patellar position was determined using the Insall-Salvati index.<sup>20</sup> Patellar thickness before and after resurfacing was

**Table I. Incidence and Severity of Trochlear Dysplasia by Group**

Grade of Trochlear Dysplasia	PFA Group	TKA Group
A	6 (37.5%)	4 (23.53%)
B	4 (25%)	5 (29.41%)
C	5 (31.25%)	7 (41.18%)
D	1 (6.25%)	1 (5.88%)
<b>Total</b>	<b>16/23 (69.57%)</b>	<b>17/22 (77.27%)</b>

Abbreviations: PFA, patellofemoral arthroplasty; TKA, total knee arthroplasty.

documented. Postoperative patellar symmetry, tilt, and subluxation also were documented.<sup>21,22</sup>

Paired comparisons between the PFA and TKA groups were performed using Wilcoxon signed-rank tests. Multivariate regression was used to analyze the outcome effects of any independent variable showing a significant difference between the groups. All regression models were analyzed for power and fit, with significance set at .05. The statistical analysis was performed using JMP 6 statistical discovery software (SAS, Inc., Cary, North Carolina).

## RESULTS

Between January 2003 and December 2005, 3500 patients underwent a knee arthroplasty procedure at our institution. We identified 205 knees (5.8%) coded in our database for PA. After detailed radiographic review, 45 knees (1.3%) with isolated PA were identified. There were 23 knees (0.7%) that underwent PFA and 22 knees (0.6%) that underwent TKA.

Mean follow-up was 29 months (range, 24 to 49 months) and 27 months (range, 24 to 33 months) in the PFA and TKA groups, respectively. There were no statistically significant differences between the groups in regard to gender ( $P = .65$ ), race ( $P = .34$ ), body mass index (30 vs 30;  $P = .82$ ), average number of prior knee surgeries (1 vs 1;  $P = .19$ ), smoking status ( $P = .57$ ), or employment status (defined as employed, retired, or work disabled,  $P = .56$ ). Mean age at time of surgery was 60 years (range, 39 to 81 years) in the PFA group and 69 years (range, 44 to 83 years) in the TKA group. This difference in age was statistically significant ( $P = .01$ ).

There were no statistically significant differences between the PFA and TKA groups in relation to mean preoperative Kellgren and Lawrence score (1 vs 1,  $P = .88$ ), mean preoperative Iwano score (4 vs 4;  $P = .30$ ), or the presence/absence of trochlear dysplasia ( $P = .74$ ). Complete data on trochlear dysplasia can be found in Table I. Nineteen knees in the PFA group (83%) and 15 knees in the TKA group (68%) had preoperative patella alta per the Insall-Salvati index ( $P = .27$ ). There were no statistically significant differences between the PFA and TKA groups in regard to the following

**Table II. Sporting Activities after PFA/TKA**

Sporting Activity	PFA Group	TKA Group
Walking	20 (87%)	18 (81%)
Swimming/water aerobics	7 (30%)	1 (5%)
Running	3 (13%)	0
Bicycling	7 (30%)	1 (5%)
Hiking	3 (13%)	0
Square dancing	1 (4%)	0
Camping/fishing	1 (4%)	0
Racquetball	0	1 (5%)
No sports	2 (9%)	2 (9%)

Abbreviations: PFA, patellofemoral arthroplasty; TKA, total knee arthroplasty.

mean preoperative scores: KSS (58 vs 59, respectively;  $P = .75$ ), KSS function (42 vs 43, respectively;  $P = .78$ ), Tegner (1.7 vs 1.5, respectively;  $P = .29$ ), and UCLA (3.1 vs 2.7, respectively;  $P = .14$ ). There also were no statistically significant differences between the PFA and TKA patients for mean preoperative flexion ( $122^\circ$  vs  $119^\circ$ , respectively;  $P = .32$ ) or mean preoperative extension ( $-1^\circ$  vs  $0^\circ$ , respectively;  $P = .12$ ).

Preoperative pain was rated by the PFA group as mild in 1 knee (4%), moderate in 17 knees (74%), and severe in 5 knees (22%). The TKA group rated their preoperative pain as mild in 1 knee (5%), moderate in 15 knees (68%), and severe in 6 knees (27%). Preoperative pain was not significantly different between the groups ( $P = .33$ ). All patients localized their pain to the anterior part of the knee preoperatively. There were no statistically significant differences between the 2 groups in regard to preoperative psychiatric diagnoses ( $P = .32$ ) or preoperative narcotic use ( $P = .12$ ). Thirteen patients (34%) had 1 or more pre-existing psychiatric diagnoses at the time of surgery: 8 patients in the PFA group (42%) and 5 patients in the TKA group (26%).

Six patients (26%) in the PFA group and 4 patients (18%) in the TKA group had undergone previous knee surgery; of those, there was a mean of 2.2 prior procedures in the PFA group and 2.3 procedures in the TKA group.

Mean operating time was 112 minutes (range, 48 to 155 minutes) for the PFA group and 98 minutes (range, 48 to 164 minutes) for the TKA groups ( $P = .31$ ).

Nineteen of the 23 PFA patients (83%) had a lateral release performed, compared with 1 (5%) of the TKA patients ( $P < .05$ ).

Mean blood loss was 117 mL (range, 25 to 250 mL) and 197 mL (range, 25 to 500 mL) among the PFA and TKA patients, respectively ( $P = .03$ ). One patient in the PFA group and 6 patients in the TKA group required blood transfusion ( $P = .008$ ). Mean postoperative inpatient stay was 3.3 days (range, 2 to 5 days) and 4.4 days (range, 3 to 6 days) among the PFA and TKA patients, respectively ( $P = .001$ ).

Postoperative Merchant view radiographs were available for 18 knees (78%) in the PFA group and all 22 knees (100%) in the TKA group; of these, 14 knees (78%) in the PFA group and 17 knees (77%) in the TKA group were symmetrically resurfaced ( $P = .65$ ). The average patellar tilt was  $4.1^\circ$  (range,  $1^\circ$  to  $8.5^\circ$ ) in the PFA group and  $3.7^\circ$  (range,  $0.7^\circ$  to  $27^\circ$ ) in the TKA group ( $P = .41$ ). The average subluxation was 2.7 mm laterally (range, 0 to 7 mm) and 1.1 mm laterally (range, 0 to 8 mm) in the PFA and TKA groups, respectively ( $P = .25$ ).

There was a slight but nonsignificant trend toward improved postoperative range of motion in the PFA group compared with the TKA group. Mean postoperative flexion was  $127^\circ$  vs  $118^\circ$  ( $P = .09$ ) and mean postoperative extension was  $0^\circ$  vs  $1^\circ$  ( $P = .08$ ) in the PFA and TKA groups, respectively.

Mean postoperative KSS scores were 89 (range, 69 to 100) and 90 (range, 47 to 100) for the PFA and TKA patients, respectively ( $P = .85$ ). Mean postoperative KSS function scores were 84 (range, 51 to 100) in the PFA group and 73 (range, 59 to 94) in the TKA group ( $P = .05$ ). Mean postoperative Tegner scores were 4.3 (range, 3 to 6) in the PFA group and 2.6 (range, 2 to 3) in the TKA group ( $P < .0001$ ). Mean postoperative UCLA scores were 6.6 (range, 5 to 9) and 4.2 (range, 3 to 6) for the PFA and TKA patients, respectively ( $P < .0001$ ). The most commonly reported postoperative sporting activities in both groups were walking, cycling, and swimming. Two patients in the PFA group reported running postoperatively. A complete list of sporting activities is included in Table II.

**Table III. Effects of Independent Variables on Functional Outcomes**

Variable Tested	Postoperative Outcome Measures				
	KSS	KSS Function	Tegner	UCLA	Satisfaction
Age	NS $P = .053$	NS $P = .41$	NS $P = .40$	NS $P = .82$	NS $P = .08$
Presence/absence of trochlear dysplasia	NS $P = .34$	NS $P = .61$	NS $P = .96$	NS $P = .42$	NS $P = .32$
Patellar thickness	NS $P = .40$	NS $P = .78$	NS $P = .56$	NS $P = .67$	NS $P = .75$

Abbreviations: KSS, Knee Society Clinical Rating System; NS, not significant.

Pain at final follow-up was rated by the PFA group as none in 8 knees (35%), mild in 10 knees (43%), and moderate in 5 knees (22%). The TKA group rated their pain at final follow-up as none in 13 knees (59%), mild in 6 knees (27%), and moderate in 3 knees (14%). Pain at final follow-up was not significantly different between groups ( $P = .26$ ). Ten patients (26%) exhibited narcotic use at the time of latest follow-up: 6 PFA patients (32%) and 4 TKA patients (21%) ( $P = .48$ ).

Among the PFA group, 17 patients (74%) reported they were much better at final follow-up compared with their preoperative condition, 5 patients (22%) were somewhat better, and 1 patient (4%) reported being worse. Among the TKA patients, 18 (82%) were much

powered regression analysis demonstrated that age as an independent variable had no effect on postoperative KSS score, KSS function score, Tegner score, UCLA score, or satisfaction at final follow-up.

It has been reported that a common cause of failure of modern PFA prostheses is progression of tibiofemoral arthritis (TA).<sup>9,14,15,24-26</sup> Ackroyd and colleagues<sup>8</sup> noted a 20% progression of TA on radiographs with a revision rate of 4% at 5-year follow-up. Patient selection is, therefore, thought to be of paramount importance. It has been suggested that patients presenting with idiopathic PA may be more prone to progression to generalized TA, and thus caution should be used when considering these patients for PFA.<sup>27</sup> Delanois and col-

**“It has been suggested that patients presenting with idiopathic PA may be more prone to progression to generalized TA, and thus caution should be used when considering these patients for PFA.”**

better, and 4 (18%) were somewhat better. There was no statistically significant difference in satisfaction at final follow-up between groups ( $P = .66$ ).

Multivariate regression was used to analyze the effects of age; presence/absence of trochlear dysplasia; and patellar asymmetry, tilt, or subluxation on postoperative scores between the 2 groups (Table III). A well-powered (> 90%) regression analysis demonstrated that age and presence/absence of trochlear dysplasia had no statistically significant effect on postoperative KSS score, KSS function score, Tegner score, UCLA score, or satisfaction at final follow-up. With the numbers available, postoperative patellar asymmetry, tilt, and subluxation had no significant effect on outcome measures.

No patients in the PFA group required revision or further surgery. Among the TKA group, 1 patient (4%) required manipulation for stiffness and 1 patient (4%) developed deep vein thrombosis in the early postoperative period.

## DISCUSSION

The surgical treatment of advanced symptomatic PA remains somewhat controversial. Satisfactory results have been reported for both PFA and TKA in this setting.<sup>10-14,23</sup> How then, should the decision to proceed with TKA or PFA be made?

In the present study, we retrospectively compared the clinical and functional outcomes of patients who underwent either PFA or TKA for treatment of isolated PA. Demographically, the 2 cohorts were remarkably similar. Radiographs were reviewed carefully to ensure that only patients treated for isolated PA were included. Although the TKA patients were significantly older than the PFA patients (mean, 69 vs 60 years, respectively), a well-

leagues<sup>27</sup> suggest that those with trochlear dysplasia or patellar fracture may be more ideal candidates for PFA, with less chance for progression of TA. Leadbetter<sup>28</sup> has advocated more widespread utilization of PFA in younger patients with isolated PA to extend function and reduce pain while avoiding a more complex TKA procedure.

In our study, the majority of patients in each group exhibited radiographic evidence of trochlear dysplasia and patella alta preoperatively; both of these conditions are commonly seen in patients presenting with patellar instability—which has been hypothesized to increase the risk of PA.<sup>6</sup> Interestingly, the presence or absence of dysplasia did not affect the postoperative knee scores of patients in either group. It should be emphasized that strict radiographic criteria were utilized in our study in order to include only patients with isolated PA. Although it is possible that with longer follow-up we will see deterioration of results in the group treated with PFA, the early benefits of improved function, return to higher activity, and less morbidity seem to outweigh the risk of revision for TA progression.

Despite a high overall satisfaction rate in both groups, with over two-thirds of patients in each group reporting they were “much better” when compared with their preoperative status, it should be noted that 22% of PFA patients and 14% of TKA patients still stated they had “moderate” pain. Furthermore, 32% of PFA patients and 21% of TKA patients used narcotic pain medication at the time of latest follow-up. The etiology of such pain is not entirely clear. Also of note, 42% of PFA patients were diagnosed with a preoperative psychiatric condition (most commonly, anxiety or depression), which is somewhat higher than that seen in the general popula-

tion (26%) and the general osteoarthritis population (21%).<sup>29,30</sup> This underscores the complexity of the diagnosis and treatment of patellofemoral pain syndrome, and the need for a comprehensive approach to management of such patients.

The strengths of this study include complete follow-up with no patients lost, a comprehensive analysis with use of standardized radiographic measures, and validated clinical outcome and activity scores. Weaknesses include the retrospective nature of the study, which is subject to selection bias, as well as the relatively small numbers in each cohort. Longer follow-up is necessary to determine the longevity of the patellofemoral prosthesis.

## CONCLUSION

In our study, patients who underwent modern PFA for treatment of isolated PA were compared with a cohort who underwent TKA for the same diagnosis during the same time period. Patients treated with PFA demonstrated similar results with respect to pain relief, but showed improved function and return to activity when compared with the patients treated with TKA. Patellofemoral arthroplasty patients also experienced less blood loss, fewer complications, and shorter hospital stay following surgery. Our results indicate that PFA is a less invasive treatment option for patients with isolated PA, yielding early outcomes that compare favorably with TKA.

## AUTHOR'S DISCLOSURE STATEMENT

The authors report no actual or potential conflict of interest in relation to this article.

## REFERENCES

- McAlindon TE, Snow S, Cooper C, Dieppe PA. Radiographic patterns of osteoarthritis of the knee joint in the community: the importance of the patellofemoral joint. *Ann Rheum Dis*. 1992;51(7):844-849.
- Davies AP, Vince AS, Shepstone L, Donell ST, Glasgow MM. The radiologic prevalence of patellofemoral osteoarthritis. *Clin Orthop Relat Res*. 2002;(402):206-212.
- Mihalko WM, Boachie-Adjei Y, Spang JT, Fulkerson JP, Arendt EA, Saleh KJ. Controversies and techniques in the surgical management of patellofemoral arthritis. *Instr Course Lect*. 2008;57:365-380.
- Whitelaw GP Jr, Rullo DJ, Markowitz HD, Marandola MS, DeWaele MJ. A conservative approach to anterior knee pain. *Clin Orthop Relat Res*. 1989;(246):234-237.
- Federico DJ, Reider B. Results of isolated patellar debridement for patellofemoral pain in patients with normal patellar alignment. *Am J Sports Med*. 1997;25(5):663-669.
- Fulkerson JP. Alternatives to patellofemoral arthroplasty. *Clin Orthop Relat Res*. 2005;(436):76-80.
- Maquet P. Advancement of the tibial tuberosity. *Clin Orthop Relat Res*. 1976;(115):225-230.
- Ackroyd CE, Polyzoides AJ. Patellectomy for osteoarthritis. A study of eighty-one patients followed from two to twenty-two years. *J Bone Joint Surg Br*. 1978;60-B(3):353-357.
- Arciero RA, Toomey HE. Patellofemoral arthroplasty. A three- to nine-year follow-up study. *Clin Orthop Relat Res*. 1988;(236):60-71.
- Laskin RS, van Steijn M. Total knee replacement for patients with patellofemoral arthritis. *Clin Orthop Relat Res*. 1999;(367):89-95.
- Meding JB, Wing JT, Keating EM, Ritter MA. Total knee arthroplasty for isolated patellofemoral arthritis in younger patients. *Clin Orthop Relat Res*. 2007;(46):78-82.
- Mont MA, Haas S, Mullick T, Hungerford DS. Total knee arthroplasty for patellofemoral arthritis. *J Bone Joint Surg Am*. 2002;84-A(11):1977-1981.
- Parvizi J, Stuart MJ, Pagnano MW, Hanssen AD. Total knee arthroplasty in patients with isolated patellofemoral arthritis. *Clin Orthop Relat Res*. 2001;(392):147-152.
- Lonner JH. Patellofemoral arthroplasty: pros, cons, and design considerations. *Clin Orthop Relat Res*. 2004;(428):158-165.
- Ackroyd CE, Newman JH, Evans R, Eldridge JD, Joslin CC. The Avon patellofemoral arthroplasty: five-year survivorship and functional results. *J Bone Joint Surg Br*. 2007;89(3):310-315.
- Merchant AC, Mercer RL, Jacobsen RH, Cool CR. Roentgenographic analysis of patellofemoral congruence. *J Bone Joint Surg Am*. 1974;56(7):1391-1396.
- Kellgren JH, Lawrence JS. Radiological assessment of osteoarthrosis. *Ann Rheum Dis*. 1957;16(4):494-502.
- Iwano T, Kurosawa H, Tokuyama H, Hoshikawa Y. Roentgenographic and clinical findings of patellofemoral osteoarthrosis. With special reference to its relationship to femorotibial osteoarthrosis and etiologic factors. *Clin Orthop Relat Res*. 1990;(252):190-197.
- Tecklenburg K, Dejour D, Hoser C, Fink C. Bony and cartilaginous anatomy of the patellofemoral joint. *Knee Surg Sports Traumatol Arthrosc*. 2006;14(3):235-240.
- Insall J, Salvati E. Patella position in the normal knee joint. *Radiology*. 1971;101(1):101-104.
- Gomes LS, Bechtold JE, Gustilo RB. Patellar prosthesis positioning in total knee arthroplasty. A roentgenographic study. *Clin Orthop Relat Res*. 1988;(236):72-81.
- Pagnano MW, Trousdale RT. Asymmetric patella resurfacing in total knee arthroplasty. *Am J Knee Surg*. 2000;13(4):228-233.
- Merchant AC. Early results with a total patellofemoral joint replacement arthroplasty prosthesis. *J Arthroplasty*. 2004;19(7):829-836.
- Argenson JN, Guillaume JM, Aubaniac JM. Is there a place for patellofemoral arthroplasty? *Clin Orthop Relat Res*. 1995;(321):162-167.
- Cartier P, Sanouiller JL, Grelsamer R. Patellofemoral arthroplasty. 2-12-year follow-up study. *J Arthroplasty*. 1990;5(1):49-55.
- Krajca-Radcliffe JB, Coker TP. Patellofemoral arthroplasty. A 2- to 18-year followup study. *Clin Orthop Relat Res*. 1996;(330):143-151.
- Delanois RE, McGrath MS, Ulrich SD, et al. Results of total knee replacement for isolated patellofemoral arthritis: when not to perform a patellofemoral arthroplasty. *Orthop Clin North Am*. 2008;39(3):381-388, vii.
- Leadbetter WB. Patellofemoral arthroplasty in the treatment of patellofemoral arthritis: rationale and outcomes in younger patients. *Orthop Clin North Am*. 2008;39(3):363-380, vii.
- Kessler RC, Chiu WT, Demler O, Merikangas KR, Walters EE. Prevalence, severity, and comorbidity of 12-month DSM-IV disorders in the National Comorbidity Survey Replication. *Arch Gen Psychiatry*. 2005;62(6):617-627.
- Sale JE, Gignac M, Hawker G. The relationship between disease symptoms, life events, coping and treatment, and depression among older adults with osteoarthritis. *J Rheumatol*. 2008;35(2):335-342.