International Orthopaedics (SICOT) (2009) 33:1597–1601
DOI 10.1007/s00264-008-0692-y

ORIGINAL PAPER

Patellofemoral arthroplasty: a multi-centre study with minimum 2-year follow-up

Wayne B. Leadbetter · Frank R. Kolisek · Richard L. Levitt · Andrew F. Brooker · Patrick Zietz · David R. Marker · Peter M. Bonutti · Michael A. Mont

Received: 23 August 2008 / Revised: 23 September 2008 / Accepted: 24 September 2008 / Published online: 5 December 2008

Abstract Recently, patellofemoral arthroplasty has attracted increased interest as a salvage treatment for isolated patellofemoral arthritis. However, there are very few reports of the experience with modern generation patellofemoral arthroplasties. This investigation describes a collective experience of four centres reporting on the outcome in patients of the use of one patellofemoral arthroplasty device. There were 70 patients (79 knees) who had failed an extensive non-operative treatment regimen and/or various conventional alternative surgical treatments. At a mean follow-up of three years (range: 2–6 years), there were 66 knees that had Knee Society Scores greater than 80 points (84%). Seventy-one knees (90%) functioned without pain in daily activity and stair climbing. Symptomatic isolated patellofemoral arthritis was successfully treated with a patellofemoral arthroplasty in the short term. We are encouraged by these excellent early results and await longer follow-up.

Résumé Les prothèses fémoro patellaires ont connu récemment un intérêt croissant dans le traitement des arthroses fémoro patellaires isolées. Cependant, peu de nouveaux travaux sont publiés concernant la nouvelle génération des prothèses fémoro patellaires. Cette étude a pour but de décrire l'expérience collective de 4 centres rapportant le devenir de patients ayant bénéficié d'une prothèse fémoro patellaire. 70 patients (69 genoux) traités après échec d'un traitement médical alternatif. Après un suivi moyen de 3 ans (2 à 6 ans), 66 genoux ont un score IKS supérieur à 80 points (84%). 71, 90% ne présentent pas de douleur dans les activités habituelles de la vie telle la montée des escaliers. La symptomatologie de l'arthrose fémoro patellaire peut être traitée avec succès par une prothèse fémoro patellaire dans le court terme. Encouragés par ces excellents résultats précoces il est nécessaire d'avoir une nouvelle évaluation avec un plus long suivi.

W. B. Leadbetter · D. R. Marker · M. A. Mont (✉)
Center for Joint Preservation and Replacement,
Rubin Institute for Advanced Orthopedics,
Sinai Hospital of Baltimore,
2401 W. Belvedere Ave.,
Baltimore, MD 21215, USA
e-mail: mmont@lifebridgehealth.org
e-mail: rhondamont@aol.com

F. R. Kolisek
OrthoIndy, Indiana Orthopaedic Hospital,
Indianapolis, IN, USA

R. L. Levitt
Doctors' Hospital,
Miami, FL, USA

A. F. Brooker
Northwest Texas Hospital,
Amarillo, TX, USA

P. Zietz
West Michigan Orthopaedics,
Grand Rapids, MI, USA

P. M. Bonutti
The Bonutti Clinic,
Effingham, IL 62401, USA

Introduction

The use of patellofemoral arthroplasty (PFA) in the knee with severe chondrosis or arthritis of the patellofemoral joint has been reported since 1979 [4]. Until recently, available prostheses were not considered reliable enough to be used on a regular basis when compared to outcomes from total knee arthroplasty (TKA) [13]. Observed short-

comings in design features were perceived as a common problem [16]. However, in recent years, new devices with designs that attempt to mimic more accurately normal knee anatomy in an attempt to reproduce patellofemoral joint function have been introduced. This trend appears to be an extension of the development of the more anatomically designed and functioning PFA part of recent modern TKA designs [16].

The Avon™ patellofemoral prosthesis (Stryker Howmedica Osteonics, Mahwah, NJ, USA) was developed in 1996. Its features were based on the Kinemax Plus TKA design (Howmedica, Limerick, UK). Initial reports on short- and long-term results of this prosthesis have been encouraging with low complication rates and excellent outcomes [1, 2, 12]. However, with the exception of one series by the designer of the prosthesis, these reports have included relatively few knees or have had high loss of follow-up. This study analysed the clinical and radiographic outcomes of a multi-centre experience with this PFA.

Methods and materials

Data were analysed from four centres that have continuously performed the Avon (Stryker Howmedica Osteonics, Mahwah, NJ, USA) PFA for isolated patellofemoral degenerative disease since January 2001. Patients were included if they had a minimum of two years of follow-up (mean of three years, range: 2–5.5 years). Four institutions contributed a combined total of 70 patients (79 knees). Further breakdown by centre revealed an approximately even distribution of knees; the respective contributions were 18, 21, 19 and 21 knees. All patients treated during the study period were included with no patients lost to follow-up.

Selection criteria and contraindications to PFA were as defined previously [13] with the exception that 17 knees demonstrated radiographic evidence preoperatively of Kellgren-Lawrence [9] grade 2 arthritis in the medial and five grade 2 in the lateral tibiofemoral compartment. All patients had disabling patellofemoral knee pain that severely limited daily activities especially those requiring bent knee activity, stair climbing or descending.

A standardised multi-centre data reporting form was used, which included questions concerning patient demographics, indications for operation, time from onset of complaints until PFA, prior operations, preoperative and postoperative radiographic condition of the operated knee, complications, reoperation rate, highest activity level achieved and return to work. Functional outcome was measured by the Knee Society Score (KSS). Patients were also asked if they would have the operation again.

All patients were evaluated using the Knee Society objective and functional rating scales [8, 13]. Return to work success was categorised as either sedentary or active. Sedentary work included retirees and such occupations as businessmen or homemakers. Examples of an active occupation involved regular standing, walking or climbing and included construction workers, policemen, nurses and ballet or school teachers. Sports and recreational activity were recorded including frequency of participation.

The study group included 52 women and 18 men who had a mean age of 58 years (range: 34–77 years) at the time of arthroplasty. Mean duration of preoperative symptoms was 29 months (range: 6–120 months). The presumed preoperative aetiology leading to patellofemoral degeneration was malalignment and/or instability in 16 knees, patellofemoral dysplasia in six knees and post-traumatic in five knees. There were 52 knees with no clear predisposing factors that were defined as idiopathic. All patients had extensive non-operative care including physical therapy specifically for patellofemoral pain, oral and intrasynovial anti-inflammatory medication, attempts at weight loss and/or behaviour modification.

The patients had 81 prior operations in 53 knees (range: 1–7 knees) for a mean of 1.5 operations per knee. The most common prior operative salvage was an arthroscopic patellofemoral shaving or chondroplasty performed in 48 knees. The remaining procedures included: ten lateral releases, nine anteromedialisation tibial tuberosity osteotomies, eight osteoarticular graftings, three soft tissue realignments, two anterior cruciate ligament reconstructions and one high tibial valgus osteotomy.

Complications were categorised as either early onset (less than six weeks postoperatively), late onset (over six weeks postoperatively) or prosthesis related (such as mechanical catching, subluxation, retinacular pain and/or prosthetic malalignment).

Preoperative radiographic assessment revealed the following distribution of arthritic severity for the patellofemoral joint: 45 knees had Kellgren-Lawrence [9] grade 4 disease (57%), 33 had grade 3 disease (42%) and one knee had grade 2. A zonal radiographic analysis of all components was performed at most recent follow-up for prosthetic loosening, malalignment and osteolysis.

Patient selection and surgical technique

The success of compartmental salvage of knee joint arthritis is dependent upon proper patient selection as well as properly performed surgical technique. The factors involved in the appropriate use of PFA have been previously described [1, 13]. However, the selection process still remains a challenging problem as most PFA long-term failures are caused by the progression of symptomatic tibiofemoral disease. Starting with the history of present illness, patients with a familial history of early onset

idiopathic knee arthritis leading to joint replacement may be more likely to show more rapid knee degeneration in the face of compartmental salvage. In this series, only medial and lateral joint space narrowing and tibiofemoral osteophytes as classified by the Kellgren-Lawrence grading, prior arthroscopic findings or a loss of the meniscus were findings in any of the patients that have been associated with increased tibiofemoral disease progression. In the authors' experience, the use of both the preoperative magnetic resonance imaging and bone scans can be helpful in disclosing occult tibiofemoral joint degeneration as well as verifying the "isolated" nature of the patellofemoral degeneration. These preoperative tests may be particularly useful as corroborative evidence in deciding if grade 3 Outerbridge [21] damage in the patellofemoral joint is accounting for the patient's symptoms. Postoperative stiffness and arthrofibrosis have been a common problem after PFA [12]. A history of arthrofibrotic healing after prior knee operations should signal caution to the surgeon and patient.

The technical pitfalls and proper steps for successful performance of a PFA have been recently described [14]. These include proper muscle-sparing exposure, attention to the avoidance of retroversion or internal rotation of the femoral cutting guide, avoidance of femoral notching, avoidance of overtensioning the patellofemoral retinaculum by measured patella resection, releasing tension in flexion upon the lateral retinaculum by "peeling" without formally releasing the lateral capsule, avoiding medialisation of the patella prosthesis to reduce medial impingement in flexion and carefully balancing the soft tissues upon closure (a step made easier by closing the capsule in 20–30° of flexion).

Results

At final follow-up, there were 66 knees (84%) that achieved KSSs greater than 80 points. This included 34 scores greater than 90 points and 32 greater than 80 points. The overall mean KSS improved from 56 to 83 points (range: 60–100 points). Excluding failures, the mean KSS was 88 points at final follow-up. Seventy-one knees (90%) functioned without pain in daily activity and stair climbing.

There were 13 clinical failures (KSS less than 80 points). Five of these knees were revised to total knee replacements (four because of disease progression in other compartments) and one for refractory patellofemoral prosthetic instability. Other reasons for failure included one patient who fell five days postoperatively and ruptured her patella tendon as well as suffering from a wound dehiscence. She required a staged allograft extensor reconstruction and was converted to a total knee replacement two years postoperatively for progressive disease and now has a persistent extension lag of 20°. One patient with a poor result required open repair of a tibial tuberosity fracture after a fall several months after the PFA. The repair was complicated by a superficial infection that did not involve the prosthesis, but contributed to slow functional recovery and stiffness. The patient had previously undergone an anteromedialisation tuberosity osteotomy. A 41-year-old patient suffered severe loss of motion with arthrofibrosis. The patient with patellofemoral malalignment represented a failure of selection as, in retrospect, she had tibiofemoral compartment disease. The remaining failures ($n=5$) were due to persistent pain and/or recurrent effusions.

Forty-six patients returned to sedentary work and 18 returned to active occupations. There were three workman's compensation-related cases; two returned to work; one patient claimed disability. Fifteen patients returned to regular fitness exercising, three played tennis, two cycled and skied, one taught ballet and another continued black belt karate.

Nine patients underwent a PFA as a salvage for a failed attempt at patellofemoral realignment and unloading with an anteromedialisation tibial tuberosity osteotomy. While this group presented more challenges due to such acquired problems as patella infera, the overall group score was 84 points (range: 72–100 points) at final follow-up with six of nine knees achieving Knee Society objective scores greater than 80 points.

Postoperative review found tibiofemoral joint progressive deterioration of at least one grade in nine knees. There were no changes in position or alignment or progressive radiolucencies of any of the surviving knees.

Discussion

Symptomatic patellofemoral joint arthritis and severe chondrosis is recognised as a relatively common and often disabling knee disorder [23]. Several operative procedures have been advocated to salvage this condition [7]. To date, it has been difficult to reach a consensus on the best treatment in any individual case. Recent studies would suggest that for chronologically and physiologically younger patients with isolated patellofemoral degenerative disease, it may be preferable to conserve the patella while avoiding the relative morbidity of a patellectomy or full TKA. Specifically, patellectomy has been largely abandoned due to the observed accelerated tibiofemoral degeneration in the patellectomised knee [6]. Some studies show excellent outcomes in patients over the age of 55 years when using TKA as a reliable solution for the pain of patellofemoral arthritis [11, 20, 22]. However, it can be argued that the complexities of soft tissue balancing, potential infection risk, need for future revision and residual pain after TKA might discourage routine use in these cases.

The issues are even more difficult to reconcile in patients under the age of 55 years. In this study, the mean patient age was 58 years, but 48 patients were under the age of 55 years. This may not be surprising, as younger patients may develop an early onset of patellofemoral degeneration related to patellofemoral malalignment and/or instability, trochlear dysplasia or direct trauma. Iatrogenic chondral damage from aggressive thermal chondroplasty is another common aetiology in the younger patient. Unloading and realignment procedures may be effective in early stages of patellofemoral arthritis. However, operations such as anteromedialisation of the tibial tuberosity osteotomy and cartilage transplantation have known drawbacks and can have quite variable results [7, 19, 23].

One of the inherent advantages of PFA is that the technique depends upon the same surgical skills as for TKAs. There is a risk that the operation will be over-used, as prosthetic resurfacing appears to be a straightforward solution for what are often difficult problems. The complications related to recurrent prosthetic instability and retinacular pain in this series require experience and attention to soft tissue surgical management, which are quite important in resurfacing this minimally constrained, but highly loaded area of the knee.

Patient selection remains a challenge in PFA as with all patellofemoral surgery. Argenson et al. noted more frequent tibiofemoral compartmental progression in patients presenting with idiopathic or spontaneous osteoarthritic patellofemoral disease [3]. Presumably, these patients have genetic or as yet unidentified qualities that contribute to their generalised knee wear. Nevertheless, in a long-term follow-up of the same patient cohort of 66 knees, these same authors found that 58% of the knees were still functioning without revision of a PFA at a mean of 16 years (range: 12–20 years) [3]. More recently, Meding et al. compared the outcome of TKA versus PFA in younger patients. The study consisted of a retrospective cohort of 27 patients (33 TKAs) with average follow-up of six years (range: 2–12 years) [17]. The patients ranged in age from 38 to 60 years of age with a mean of 52 years. The authors used comparative historical data on PFA outcomes in ten studies [17]. Despite the fact that the results of TKA were only "at least as good... compared to younger patients undergoing patellofemoral arthroplasty", it was concluded that TKA was the superior procedure. There were many questionable aspects concerning these conclusions. There may have been a limited historical control as the majority of the PFA papers reviewed involved first-generation patellofemoral designs that have either been abandoned or totally redesigned [4, 10, 16]. It is claimed that reported revision rates for PFA ranged as high as 51% and that complications and/or reoperations ranged as high as 63% [17]. This appears misleading, as the reported results for revisions and complications of current widely used later generation devices are much more acceptable, ranging from 0 to 5% at a minimum two-year follow-up [2, 15, 18, 24]. Long-term results with PFA reflect the limitations of selective compartmental salvage. However, while Ackroyd et al. noted a 20% radiological progression of arthritis, the revision rate to TKA at five years or greater with the same prosthesis as that used in this study was only 4% of knees at time of follow-up [2]. Cartier et al. reported a survivorship of 75% at six to ten years with the first-generation Richards I/II prosthesis [5]. The need for revision was primarily tibiofemoral disease progression, uncorrected extensor malalignment or technical error. Prosthetic loosening, wear and infection were distinctly uncommon in contradistinction to some TKA experience [2, 13, 15]. In other words, an average of 75–80% of patients continued to enjoy the benefits of isolated patellofemoral resurfacing, while avoiding the potential technical, dysfunctional and revision risks of TKA.

Prosthetic survivorship during this study was 94%. Innovations that may have contributed to this durability over previous designs are intramedullary instrumentation, broader sizing options, patella prosthetic compatibility with total knee revision, muscle-sparing techniques, more durable forms of cement and polyethylene, superolateral extension of the trochlear flange to improve patella capture and a less constrained trochlear groove to improve capture in early flexion and reduce prosthetic patella tracking errors. The goal, to more closely approach normal knee kinematics or at least approximate those seen after standard TKA, appears to have been achieved with this prosthetic design.

PFA is a re-emerging technology for the salvage of patients with refractory pain and disability from advanced patellofemoral degenerative joint disease. However, complications and morbidity can be similar to those seen with other types of knee arthroplasty. Based upon our current experience, we disagree with the conclusions of Meding et al. that PFA should never be performed [17]. Successful PFA provides an effective and often pragmatic alternative for carefully selected patients with progressive patellofemoral arthritis or severe chondral degeneration when other measures have failed to avoid a patellectomy and to delay a TKA. We remain encouraged by these early results, but await long-term follow-up to assess whether these promising results will be sustained.

References

1. Ackroyd CE, Chir B (2005) Development and early results of a new patellofemoral arthroplasty. Clin Orthop Relat Res 436:7–13
2. Ackroyd CE, Newman JH, Evans R, Eldridge JD, Joslin CC (2007) The Avon patellofemoral arthroplasty: five-year survivorship and functional results. J Bone Joint Surg Br 89:310–315

3. Argenson JN, Flecher X, Parratte S, Aubaniac JM (2005) Patellofemoral arthroplasty: an update. Clin Orthop Relat Res 440:50–53
4. Blazina ME, Fox JM, Del Pizzo W, Broukhim B, Ivey FM (2005) Patellofemoral replacement. 1979. Clin Orthop Relat Res 436:3–6
5. Cartier P, Sanouiller JL, Khefacha A (2005) Long-term results with the first patellofemoral prosthesis. Clin Orthop Relat Res 436:47–54
6. Feller JA, Bartlett RJ (1993) Patellectomy and osteoarthritis: arthroscopic findings following previous patellectomy. Knee Surg Sports Traumatol Arthrosc 1:159–161
7. Fulkerson JP (2005) Alternatives to patellofemoral arthroplasty. Clin Orthop Relat Res 436:76–80
8. Insall JN, Dorr LD, Scott RD, Scott WN (1989) Rationale of the Knee Society clinical rating system. Clin Orthop Relat Res 248:13–14
9. Kellgren JH, Lawrence JS (1957) Radiological assessment of osteo-arthrosis. Ann Rheum Dis 16:494–502
10. Kooijman HJ, Driessen AP, van Horn JR (2003) Long-term results of patellofemoral arthroplasty. A report of 56 arthroplasties with 17 years of follow-up. J Bone Joint Surg Br 85:836–840
11. Laskin RS, van Steijn M (1999) Total knee replacement for patients with patellofemoral arthritis. Clin Orthop Relat Res 367:89–95
12. Leadbetter WB (2008) Patellofemoral arthroplasty in the treatment of patellofemoral arthritis: rationale and outcomes in younger patients. Orthop Clin North Am 39:363–380
13. Leadbetter WB, Ragland PS, Mont MA (2005) The appropriate use of patellofemoral arthroplasty: an analysis of reported indications, contraindications, and failures. Clin Orthop Relat Res 436:91–99
14. Leadbetter WB, Seyler TM, Ragland PS, Mont MA (2006) Indications, contraindications, and pitfalls of patellofemoral arthroplasty. J Bone Joint Surg Am 88(Suppl 4):122–137
15. Lonner JH (2007) Patellofemoral arthroplasty. J Am Acad Orthop Surg 15:495–506
16. Lonner JH (2004) Patellofemoral arthroplasty: pros, cons, and design considerations. Clin Orthop Relat Res 428:158–165
17. Meding JB, Wing JT, Keating EM, Ritter MA (2007) Total knee arthroplasty for isolated patellofemoral arthritis in younger patients. Clin Orthop Relat Res 464:78–82
18. Merchant AC (2005) A modular prosthesis for patellofemoral arthroplasty: design and initial results. Clin Orthop Relat Res 436:40–46
19. Minas T, Bryant T (2005) The role of autologous chondrocyte implantation in the patellofemoral joint. Clin Orthop Relat Res 436:30–39
20. Mont MA, Haas S, Mullick T, Hungerford DS (2002) Total knee arthroplasty for patellofemoral arthritis. J Bone Joint Surg Am 84-A:1977–1981
21. Outerbridge RE (1961) The etiology of chondromalacia patellae. J Bone Joint Surg Br 43-B:752–757
22. Parvizi J, Stuart MJ, Pagnano MW, Hanssen AD (2001) Total knee arthroplasty in patients with isolated patellofemoral arthritis. Clin Orthop Relat Res 392:147–152
23. Saleh KJ, Arendt EA, Eldridge J, Fulkerson JP, Minas T, Mulhall KJ (2005) Symposium. Operative treatment of patellofemoral arthritis. J Bone Joint Surg Am 87:659–671
24. Sisto DJ, Sarin VK (2006) Custom patellofemoral arthroplasty of the knee. J Bone Joint Surg Am 88:1475–1480