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The Avon patellofemoral joint replacement

FIVE-YEAR RESULTS FROM AN INDEPENDENT CENTRE

M. Odumenya,
M. L. Costa,
N. Parsons,
J. Achten,
M. Dhillon,
S. J. Krikler

From the University Hospitals Coventry and Warwickshire NHS Trust, Coventry, England

Between May 1998 and May 2007 we carried out 50 Avon patellofemoral joint replacements in 32 patients with isolated patellofemoral osteoarthritis.

There were no revisions in the first five years, giving a cumulative survival of 100% for those with a minimum follow-up of five years. The mean follow-up was 5.3 years (2.1 to 10.2). The median Oxford knee score was 30.5 (interquartile range 22.25 to 42.25). In patients with bilateral replacements the median Euroqol General health score was 50 which was significantly lower than that of 75 in those with a unilateral replacement (p = 0.047). The main complication was progression of disease, which was identified radiologically in 11 knees (22%). This highlights the need for accurate selection of patients. Our findings suggest that the Avon prosthesis survives well and gives a satisfactory functional outcome in the medium term.

Approximately 10% of patients with arthritis of the knee have symptomatic disease confined to the patellofemoral joint. Their mean age tends to be significantly lower than those with severe tricompartmental changes.[1] In the youngest patients there is often a specific predisposing risk factor such as trochlear dysplasia, recurrent patellar dislocation or trauma although in many there is no obvious cause. Typically, they complain of anterior knee pain, particularly on standing up from a chair or climbing and descending stairs. Their initial treatment may be conservative and include losing weight, modification of daily activities, quadriceps strengthening exercises and the use of anti-inflammatory agents. However, in severe cases these are ineffective and surgery is required.

The surgical options for this condition include arthroscopic procedures, patellectomy, total knee replacement (TKR) and patellofemoral joint replacement. Arthroscopic surgery is seldom beneficial in severe disease and patellectomy often leads to poor long-term function.[2] The options therefore are TKR which is considered to be the method of choice, and patellofemoral joint replacment which has been increasingly recognised as an alternative. It has the advantage of preserving the unaffected parts of the natural knee, is less invasive than primary TKR, and may allow more rapid recovery.[3]

Patellofemoral joint replacment was first performed by McKeever in 1955 as an alternative to patellectomy for isolated patellofemoral disease.[4] Other designs of implant followed, but all yielded less than satisfactory results because of residual malalignment of the patella, wear of polyethylene and progression of disease in the other parts of the joint.[5] More recent studies have shown significantly better results with patellofemoral joint replacement as a result of improvements in the design and manufacture of implants, better patient selection and an appreciation of the need to balance the soft tissues.[6] In 2005, Cartier, Sanouiller and Khefacha[7] reported an excellent functional outcome in 77% of patients at a mean follow-up of ten years. These findings substantiated those of Kooijman, Driessen and van Horn,[8] who, in an earlier retrospective consecutive case study, reported good or excellent functional results in 86% of cases at 17 years. However, both studies recorded progression of tibiofemoral arthritis in over 20% of patients. This significantly lowered the survivorship rates of these implants and led to unfavourable comparisons with TKR. These results were the catalyst for the development of a new implant, the Avon Patellofemoral Arthroplasty (Stryker Howmedica Osteonics, Allendale, New Jersey) by The Bristol Knee Group. In 2007, Ackroyd et al[9] recorded survivorship of 95.8% at five years and a significant improvement in pain and knee function with a low rate of complications.

While these results are very encouraging, it should be noted that the operations were performed in the same centre that developed the

■ M. Odumenya, BSc, MBBS, MRCS, Orthopaedic Registrar
■ M. L. Costa, PhD, FRCS(Trauma and Orth), Associate Professor of Trauma and Orthopaedics Surgery
■ N. Parsons, BSc, MSc, PhD, Medical Statistician
■ J. Achten, MSc, PhD, Research Manager
Clinical Sciences Research Institute
■ M. Dhillon, FRCR, Consultant Radiologist
■ S. J. Krikler, BSc, PhD, FRCS(Ortho), Consultant Orthopaedic Surgeon
University Hospitals Coventry and Warwickshire NHS Trust, Clifford Bridge Road, Coventry CV2 2DX, UK.

Correspondence should be sent to Miss M. Odumenya; e-mail: M.Odumenya@warwick.ac.uk

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Table I. Pre-operative radiological diagnoses in 50 knees

Pre-operative radiological diagnosis	Number of knees (%)
Isolated lateral facet arthritis	12 (*24*)
Symmetrical (general) arthritis	23 (*46*)
Isolated medial arthritis	2 (*4*)
Post-traumatic arthritis	3 (*6*)
Pre-operative radiographs not available	10 (*20*)
Total	50 (*100*)

Table II. Previous surgery in 50 knees

Previous surgery	Number of knees (%)
Arthroscopy*	22 (*44*)
Lateral release	5 (*10*)
Chondrectomy	2 (*4*)
Patellar realignment	0 (*0*)
Fixation of fracture	1 (*2*)
Nil	20 (*40*)
Total	50 (*100*)

* one patient underwent bilateral lateral facetectomy and arthroscopy

prosthesis and may not be reproducible in other centres. We therefore present our independent experience of the Avon implant with a mean follow-up of five years.

Patients and Methods

Between May 1998 and May 2007 the Avon patellofemoral joint replacement was implanted in a consecutive group of 44 patients (67 knees). Each operation was carried out by or under the direct supervision of the senior author (SJK). The surgical technique was that previously described by Ackroyd.[3] A medial parapatellar incision was used. The soft-tissue balance was assessed in all cases. Patients with obvious maltracking underwent a lateral release. Minor variations in technique included the use of an oscillating saw to contour the trochlea, a free-hand patellar cut and the use of quick-setting methacrylate-based bone cement in every case (CMW 2; DePuy International Ltd, Blackpool, United Kingdom).

Only patients with severe isolated patellofemoral arthritis were deemed to be suitable for this operation. Evidence of unicompartmental disease was identified on plain radiographs specifically, standing flexed posteroanterior[10] and lateral and skyline views[11] of the tibiofemoral joint at 45° of flexion and an axial tangential (skyline) view of the patellofemoral joint at 30° of flexion. A total of three patients with unremarkable plain films were assessed arthroscopically. Those with localised chondral lesions > 10 mm in size in areas other than the patellofemoral surfaces, or with general attrition of the articular cartilage, were not offered a joint replacement since previous studies had suggested that these defects were early signs of progression of disease.[8] In addition, patients with a considerable fixed flexion deformity of the knee were also excluded.

Data were collected retrospectively in August 2008, and included survivorship of the prosthesis using revision as the endpoint and functional outcome using the Oxford knee score (OKS).[12] We used the modified method of calculating the OKS from 0 (worst outcome) to 48 (best outcome) to allow for direct comparison with the results of the Avon study.[9] The general health status was assessed using the EuroQol VAS General Health score.[13] The OKS and EuroQol were assessed by postal questionnaire in the first instance. Those who did not respond were contacted by telephone. Pre-operative interventions, investigations and range of movement were established from the medical records. An independent consultant (MD) in musculoskeletal radiology assessed the pre- and post-operative radiographs.

Statistical analysis. Survivorship and other analyses including two-sample *t*-tests or the OKS and Mann-Whitney non-parametric test for the EuroQol VAS score using a significance level of $p < 0.05$ were performed by a medical statistician (NP).

Results

Six patients (10 knees) had died from unrelated causes. None had undergone revision surgery. A further six patients (seven knees) could not be contacted for review, leaving 32 patients (50 knees) in the study group. There were 23 women and nine men, 17 of whom had bilateral procedures. The mean follow-up was 5.3 years (2.0 to 10.0). The mean age of the patients was 66 years (42 to 88). Of the 50 knees, 23 (46%) had arthroscopic surgery for related symptoms before joint replacement. The baseline characteristics of the patients and details of their previous surgery are shown in Tables I and II.

At operation, no patient was found to have a medial or lateral meniscal injury, but one who had sustained a previous fracture to the patella, had a complete rupture of the anterior cruciate ligament. In five knees, grade-I or grade-II osteoarthritic changes as classified by Outerbridge,[14] were seen in the medial and/or lateral tibiofemoral compartments, but were not considered to be a contraindication to operation.

The functional outcome scores are shown in Figure 1. The median OKS was 30.5 (interquartile range (IQR) 22.25 to 42.25). However, the data appeared to be a mixture of two distributions with one centred around an OKS score of 24 and the other around a score of 48. The factor(s) associated with the difference between these distributions were not clear. Neither the mean length of follow-up nor the age of the patients could explain this spread. The mean follow-up for the group with an OKS < 30 was 5.87 years and for that with an OKS > 30, 4.63 (two-sample *t*-test, $p = 0.092$). The mean age of the group with an OKS < 30 was 67.38 years and for that with an OKS > 30, 64.38 years (two-sample *t*-test, $p = 0.255$).

The results of the EuroQol General Health scores were significantly lower for patients who had undergone bilateral procedures. They had a median score of 50 (25 to 85) compared with 75 (25 to 100) in those with unilateral replacement (Mann-Whitney U test, $p = 0.047$; Fig. 2).

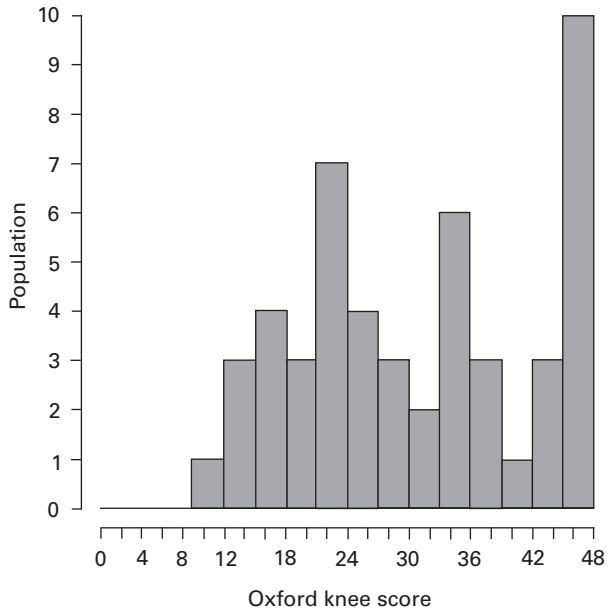

Fig. 1

Bar chart showing distribution of the Oxford knee score for 50 knees.

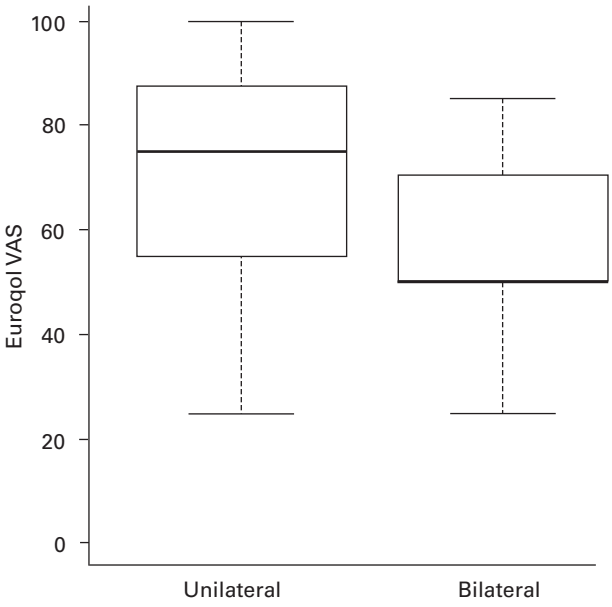

Fig. 2

Boxplot showing the distribution of the Euroqol scores for bilateral and unilateral groups (VAS, visual analogue scale).

Table III. Post-operative radiological diagnoses in 50 knees

Post-operative radiological diagnosis	Number of knees (%)
Normal*	17 (*34*)
Lateral tilt (> 5°)	8 (*16*)
Lateral subluxation	7 (*14*)
Medial tilt	0 (*0*)
Medial subluxation	0 (*0*)
Tibiofemoral disease progression	11 (*22*)
Post-operative radiographs not available	7 (*14*)
Total	50 (*100*)

* no tilt, subluxation or progression of disease

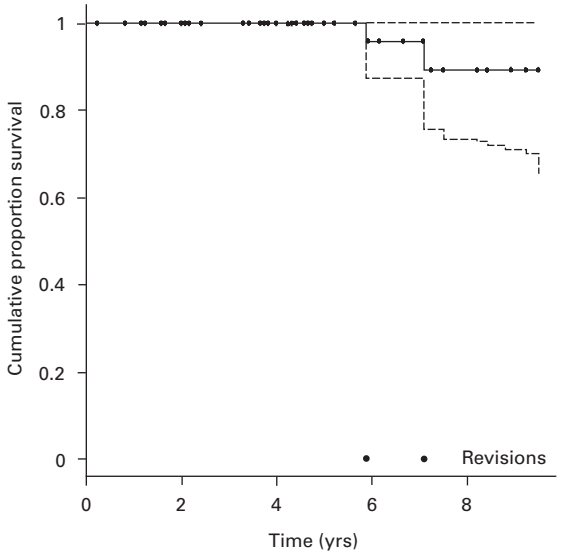

Fig. 3

Kaplan-Meier survival curve for revision arthroplasty.

The median range of movement pre-operatively was 120° (70° to 140°) and post-operatively at a mean of 5.3 years was also 120° (60° to 155°). There were no early complications such as superficial or deep infection, loosening or periprosthetic fracture. One patient who underwent bilateral replacements complained of an audible squeak during flexion from both knees. This was not associated with pain or a limited range of movement.

On reviewing the radiographs, 11 (22%) of the 50 knees showed progression of arthritis in the medial and/or lateral tibiofemoral joints (Table III). Of these 11, five showed evidence of medial compartment osteoarthritis (three mild, one moderate and one moderate to severe), three showed mild progression in both medial and lateral compartments, three showed evidence of lateral compartment osteoarthritis (one with mild to moderate changes and two (bilateral) with severe progressive disease).

There were no revisions in the first five years, giving a survivorship of 100%, with 26 knees at risk at five years (Fig. 3, Table IV). There was one case of lateral patellar subluxation in a patient who had undergone bilateral operations. This occurred six years after the initial procedure and was treated by arthroscopic lateral release. The same patient went on to have both knees revised to a TKR because of continuing generalised pain in the knee and progression of disease in the other compartments.

Table IV. Life-table of survivorship at eight years for revision arthroplasty

Year	Number at risk	Number of events	Proportion surviving	Cumulative survival	95% CI*
0 to 1	65	0	1.000	100	100 to 100
1 to 2	61	0	1.000	100	100 to 100
2 to 3	52	0	1.000	100	100 to 100
3 to 4	48	0	1.000	100	100 to 100
4 to 5	40	0	1.000	100	100 to 100
5 to 6	26	0	1.000	100	100 to 100
5.22	25	0	1.000	100	100 to 100
5.67	24	0	1.000	100	100 to 100
5.89	23	1	0.957	95.7	87.8 to 100
5.92	22	0	0.957	95.7	87.7 to 100
6.17	21	0	0.957	95.7	87.5 to 100
6.67	20	0	0.957	95.7	87.3 to 100
7.08	19	0	0.957	95.7	87.1 to 100
7.1	15	1	0.893	89.3	75.6 to 100
7.25	14	0	0.893	89.3	75.2 to 100
7.5	11	0	0.893	89.3	73.6 to 100
8.22	10	0	0.893	89.3	72.9 to 100

* 95% CI, 95% confidence interval

Discussion

Our results suggest that the Avon patellofemoral joint replacment gives a good medium-term functional outcome with 100% survival at five years. The results were comparable with those reported in the original study from the centre which designed the prosthesis.[9]

The median post-operative functional outcome (OKS) was 30.5 (IQR 22.25 to 42.25) compared with 39 (IQR 24 to 45) achieved in the original study.[9] Although lower, this score was deemed to be 'satisfactory' by the criteria of the original studies which defined a successful result as an OKS ≥ 25 points. The Avon design is associated with a relatively low incidence of lateral maltracking and wear of polyethylene,[9] complications which have undermined the reputation of previous designs such as the Lubinus.[15] In our series there was only one case of maltracking and lateral subluxation of the patella. This low incidence was most probably due to the broad, shallow design of the trochlear component and its position on the femur.[9]

Although survivorship at five years was 100% in our series (compared with 95.8% in the original series),[9] the number of knees in our study (50) was less than in the original (83). The three revisions in our series occurred at 5.6, 5.9 and 7.1 years. Two were in the same patient who complained of persistent generalised knee pain and had radiological evidence of mild progression of disease. Beyond five years the number of patients was too small to allow any conclusions to be drawn from the survivorship data (Table IV).

The Euroqol general health scores showed that the patients with bilateral procedures had a significantly lower score than those with a unilateral replacement. Although unsurprising, we believe that this may not simply have been due to the bilateral disease since the Euroqol score may be influenced by other variables such as existing comorbidities, including arthritis in other joints, and patient expectations.

The median range of movement was the same before and after surgery. This finding is in keeping with other studies, which show that the pre-operative range of movement is the best predictor of the post-operative range.[16,17]

We identified 11 knees (22%) with radiological evidence of medial and/or lateral tibiofemoral joint progression of disease (Table III). In the original Avon paper, 25 patients (28%) showed evidence of progression of disease.[9] This small difference may have been due to criteria in the selection of patients. In our series 10% of the patients had mild pre-operative tibiofemoral disease, but in the previous study, 44% had some arthritic changes in the tibiofemoral compartment. Ackroyd et al[9] stated that "in retrospect, our original indications for patellofemoral arthroplasty were too general". Unicompartmental joint replacement will always be associated with the risk of development of disease in another compartment. Some authors have argued that this is a good reason to treat unicompartmental disease by TKR as a primary procedure.[18-21] However, this would ignore the potential benefits of maintaining more of the original structure of the knee in terms of both function and the complexity of revision procedures, if these are required. Future comparative trials may help to address these questions.

As with all retrospective studies, our case series was limited by the accuracy and detail of the original medical records. Specifically, these did not include a pre-operative assessment of knee function. Also, the number of patients in our study was relatively small and therefore precluded further subgroup analysis. However, despite these limitations, our findings have verified those reported in the original paper.[9] We conclude that the Avon patellofemoral joint replacement appears to be a reliable prosthesis, which, at a mean follow-up of five years, survives well, gives a satisfactory functional outcome and maintains knee flexion.

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References

1. **Davies AP, Vince AS, Shepstone L, Donell ST, Glasgow MM.** The radiologic prevalence of patellofemoral osteoarthritis. *Clin Orthop* 2002;402:206-12.
2. **Lonner JH.** Patellofemoral arthroplasty: pros, cons and design considerations. *Clin Orthop* 2004;428;158-65.
3. **Ackroyd CE.** Development and early results of a new patellofemoral arthroplasty. *Clin Orthop* 2005;436:7-13.
4. **McKeever DC.** Patellar prosthesis. *J Bone Joint Surg [Am]* 1955;37-A:1074-84.
5. **Arcierio RA, Toomey HE.** Patellofemoral arthroplasty: a three- to nine-year follow-up study. *Clin Orthop* 1988;236:60-71.
6. **Leadbetter WB, Ragland PS, Mont MA.** The appropriate use of patellofemoral arthroplasty: an analysis of reported indications, contraindications and failures. *Clin Orthop* 2005;436:91-9.
7. **Cartier P, Sanouiller JL, Khefacha A.** Long-term results with the first patellofemoral prosthesis. *Clin Orthop* 2005;436:47-54.
8. **Kooijman HJ, Driessen APPM, van Horn JR.** Long-term results of patellofemoral arthroplasty: a report of 56 arthroplasties with 17 years of follow-up. *J Bone Joint Surg [Br]* 2003;85-B:836-40.
9. **Ackroyd CE, Newman JH, Evans R, Eldridge JDJ, Joslin CC.** The Avon patellofemoral arthroplasty: five-year survivorship and femoral results. *J Bone Joint Surg [Br]* 2007;89-B:310-15.
10. **Rosenberg TD, Paulos LE, Parker RD, Coward DB, Scott SM.** The forty-five-degree posteroanterior flexion weight-bearing radiograph of the knee. *J Bone Joint Surg [Am]* 1988;70-A:1479-83.

11. **Grelsamer RP, Bazos AN, Proctor CS.** Radiographic analysis of patellar tilt. *J Bone Joint Surg [Br]* 1993;75-B:822-4.
12. **Dawson J, Fitzpatrick R, Murray D, Carr A.** Questionnaire on the perceptions of patients about total knee replacement. *J Bone Joint Surg [Br]* 1998;80-B:63-9.
13. **No authors listed.** The EuroQol Group: EuroQol: a new facility for the measurement of health-related quality of life. *Health Policy* 1990;16:199-208.
14. **Outerbridge RE.** The etiology of chondromalacia patellae. *J Bone Joint Surg [Br]* 1961;43-B:752-7.
15. **Tauro B, Ackroyd CE, Newman JH, Shah NA.** The Lubinus patellofemoral arthroplasty: a five- to ten-year prospective study. *J Bone Joint Surg [Br]* 2001;83-B:696-701.
16. **Anouchi YS, McShane M, Kelly F Jr, Elting J, Stiehl J.** Range of motion in total knee replacement. *Clin Orthop* 1996;331:87-92
17. **Shi MG, Lu HS, Guan ZP.** Influence of preoperative range of motion on the early clinical outcome of total knee arthroplasty. *Zhonghua Wai Ke Za Zhi* 2006;44:1101-5 (in Chinese).
18. **Mont MA, Haas S, Mullick T, Hungerford DS.** Total knee arthroplasty for patellofemoral arthritis. *J Bone Joint Surg [Am]* 2002;84-A:1977-81.
19. **Laskin RS, van Steijn M.** Total knee replacement for patients with patellofemoral arthritis. *Clin Orthop* 1999;367:89-95.
20. **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;39:381-8.
21. **Meding JB, Wing JT, Keating E, Ritter MA.** Total knee arthroplasty for isolated patellofemoral arthritis in younger patients. *Clin Orthop* 2007;464:78-82.