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Patellofemoral Joint Arthroplasty: Early Results and Functional Outcome of the Zimmer Gender Solutions Patello-Femoral Joint System

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Background: Improved knee prosthesis designs have led to an increase in the use of patellofemoral arthroplasty as a primary treatment option in recent times. We report the early results and outcomes of the Zimmer Gender Solutions Patello-Femoral Joint (PFJ) system used to treat isolated patellofemoral osteoarthritis (PFA).

Methods: We retrospectively reviewed and analysed data of patients who underwent PFJ replacement (PFJR) at our institution with a minimum follow-up of 2 years.

Results: Median Oxford Knee score (OKS) was 38 (interquartile range, 28 to 42) at the latest follow-up with a significant improvement from preoperative scores ($p < 0.0005$). Median OKS was 40 for unilateral PFJRs and 39 for nonobese patients (body mass index [BMI] < 30 kg/m^2). There was no significant difference in OKS between unilateral and bilateral procedures ($p = 0.462$). Likewise, there was no significant difference in OKS between obese and nonobese patients ($p = 0.272$). Two knees (4%) were revised for progression of osteoarthritis. No complications were reported related to infectious or thromboembolic causes.

Conclusions: Our study showed good early results of the PFJ system, at least equal to those of other leading brands in the National Joint Registry for England, Wales and Northern Ireland (NJR). There have been no complications related to either the implantation technique or prosthetic design for this new implant. Progression of tibiofemoral arthritis remains a major concern. Our study also suggests that PFJR in obese patients and bilateral procedures can have good results.

Keywords: *Knee joint, Patellar, Patellofemoral, Prosthesis, Arthroplasty*

The surgical treatment of isolated patellofemoral osteoarthritis remains a challenging and controversial area, especially in younger patients. Surgical procedures, such as bony and/or soft tissue realignment surgery, autologous chondrocyte implantation and patellectomy, may provide early symptom relief and even delayed disease progression, but rarely provide a consistent long-term solution.[1-4] For this, surgeons have historically turned to joint replacement to deliver a more consistent and longer-term solution. There is a debate between the relative merits of total knee arthroplasty (TKA) and a patellofemoral joint replacement (PFJR). TKA has been the more common procedure used to produce a predictable outcome.[5] However, some see this as too aggressive a solution for what is essentially a single compartment disease. Hence the attraction for the PFJR which only replaces the affected patellofemoral joint, retaining the other unaffected joint surfaces and its associated normal knee mechanics.

The outcome of the first generations of PFJR prosthesis showed very mixed results.[6] The first series of PFJR prosthesis reported designed by Mckeever[7] was essentially

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a patellar resurfacing shell made of Vitallium. Predictably, an articulation between a hard patellar shell and the soft trochlear cartilage would always cause more damage to the softer trochlear resulting in poor patient satisfaction and outcome. Tauro et al.[8] also reported poor short- to medium-term results with the Lubinus Total Patellar Glide Replacement (Waldemar Link, Hamburg, Germany) prosthesis which replaced both the patellar and trochlear surfaces. They reported a cumulative survival rate of 65% and revision rate of 28% at 8 years of follow-up. Similarly Board et al.[9] in their series of 17 Lubinus (Waldemar Link) prosthesis reported a revision rate of 35%.

Other first generation implants fared slightly better. van Wagenberg et al.[10] reported a 5-year survival rate of 75% for the Autocentric II (DePuy, Warsaw, IN, USA) prosthesis. Much better though was the Richards II (Smith & Nephew, London, UK) which had an 84% survivorship at 10 years in the series of 181 knees reported by van Jonbergen et al.[11] Most of the complications from these early implants centred on the problem of persisting patellofemoral symptoms due to patellar maltracking, subluxation, catching and eventual failure.[6,12] A better understanding of knee kinematics and improvement in implant design led to the development of second and third generation PFJR prosthesis. In addition, some of these design improvements were borrowed from successful total knee replacement prostheses known to have minimal patellofemoral complications.

Hence the evolution of the Avon (Stryker Howmedica Osteonics, Allendale, NJ, USA) PFJR prosthesis which arose from the Stryker Kinemax Plus total knee replacement design.[1,6] The Avon prosthesis has shown good short- to mid-term results from both the design centre[13] and independently,[14-16] reporting a minimum 95% 5-year survival rate. Sisto and Sarin[17] reported 100% survivorship at 73 months for 25 custom prosthesis PFJRs with no additional surgery or component loosening. This prosthesis as the name suggests is the produced three-dimensional model of the patients' knees generated from a preoperative computed tomography (CT) scan. Beitzel et al.[18] using the Journey PFJR for treatment of significant patellofemoral arthritis demonstrated improved clinical scores at 2 years in 22 knees treated.

The Australian Joint Registry has the longest experience of PFJR and shows that PFJR is most commonly performed on females (76.6%).[19] The Zimmer Gender Solutions Patello-Femoral Joint System (Zimmer Inc., Warsaw, IN, USA) was developed in recognition of the differences in anatomy of the distal femur between sexes and the fact that at least 75% of these procedures are performed on females.[12,20] Its trochlear groove angle is increased as seen typically in females, improving positioning of the trochlear component and also patellar tracking and stability.[12] According to data from the Australian Orthopaedic Association National Joint Registry, the Zimmer PFJR has been the most used PFJR prosthesis over the last 4 years with a cumulative 3-year revision rate of 5.3%.[19] It is also currently the second most used PFJR prosthesis from the National Joint Registry for England, Wales and Northern Ireland (NJR).[21] However, as far as the authors are aware, there are currently no publications relating to early use of the prosthesis or early study of functional outcome scores in the literature.

We present our initial experience with this new prosthesis in an independent centre with a minimum 2-year follow-up (mean, 40 months; range, 24 to 58 months). This assessment includes survivorship at last follow-up, clinical outcomes based on the Oxford Knee score (OKS), and Knee Society objective (KSS objective) and functional (KSS functional) scores. We hypothesize that the results for this prosthesis will be at least as good as those reported in the literature for other PFJR prostheses.

METHODS

Between 2010 and 2012, all PFJR procedures performed in Warwick hospital were identified. Indications for surgery were according to well established selection criteria including[22] failed conservative treatment of focal symptomatic patellofemoral osteoarthritis as assessed on preoperative X-ray imaging (Fig. 1) or confirmed during previous arthroscopic surgery treatment. Exclusion criteria included active infection, inflammatory arthropathy, degenerative changes involving the tibiofemoral surfaces, fixed joint deformities and uncorrected patellofemoral instability or malalignment.[22] Using revision as an endpoint, a case note analysis was performed for each patient to determine implant survivorship, complications and outcomes using the OKS, KSS functional, and KSS objective. Postoperative skyline and lateral views of X-ray images (Fig. 2) were also reviewed by authors (DO and FS) for disease progression using the modified Kellgren-Lawrence classification.[23] The outcome scores used in this study allowed us to compare our results with similar studies in the literature. The nature of this study did not require Institutional Review Board approval and this was not sought.

Surgical Technique

We followed the same operative procedure in all patients as per manufacturer guidelines.[24,25] Exposure was under-

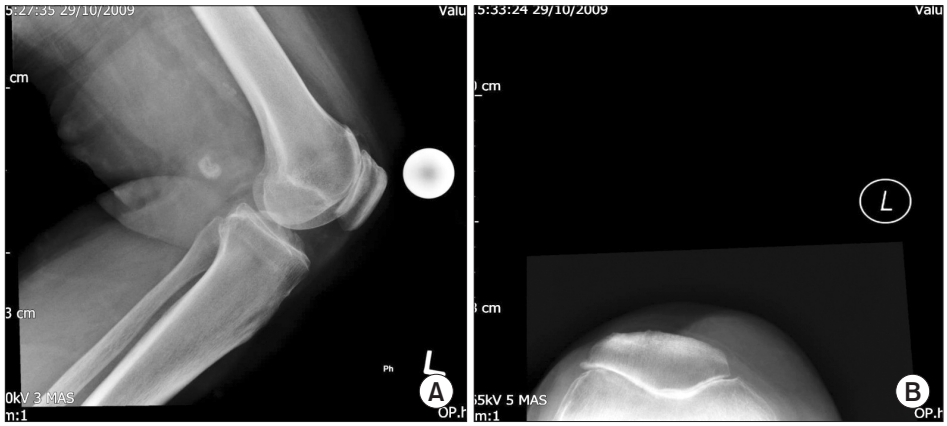

Fig. 1. Preoperative radiographs of the knee showing patellofemoral osteoarthritis: lateral view (A) and skyline view (B).

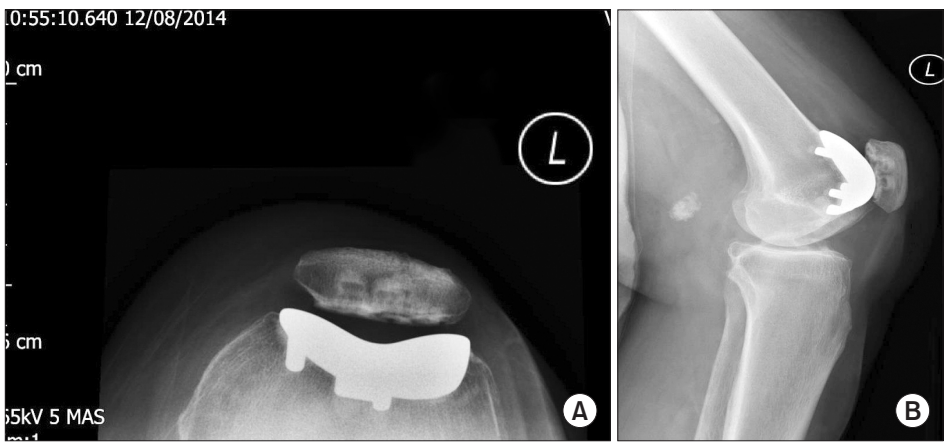

Fig. 2. Postoperative radiographs following the Zimmer patellofemoral joint replacement: skyline view (A) and lateral view (B).

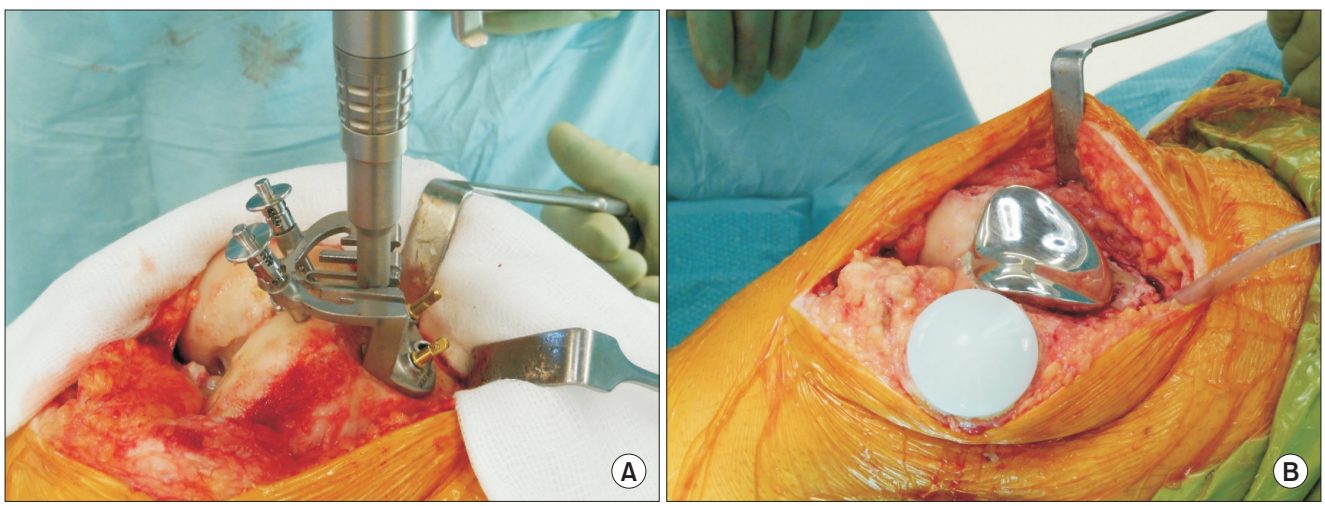

Fig. 3. (A) Intraoperative photograph showing the unique trochlea implantation jig. (B) Intraoperative photograph showing the implanted patellofemoral joint prosthesis.

taken via a medial parapatellar approach with preservation of menisci and fat pad.

Initially, an anterior femoral flange saw-cut is made using a jig with a stylus referenced on the anterior cortex, in similar fashion to a TKA, with rotation set using a combination of Epicondylar axis and Whiteside's line as usual. The next step includes a new and unique implantation jig for preparation of the distal femoral trochlea (Fig. 3).

A high-speed burr is used through a size-specific slotted guide that is pinned in place to accurately recess the bony trochlea to allow the metal prosthesis to sit flush with the distal femoral articular surface. No free-hand cuts are required in the technique. No recuts of the bony resection were required. The patella is then prepared using the same instrumentation as used for the NEXGEN Complete Knee Solution System (Zimmer Inc., Warsaw, IN, USA).

A standard postoperative rehabilitation protocol of full weight-bearing was used in all cases. All patients received mechanical and pharmacological thromboprophylaxis in line with national guidelines.[26]

Statistical Analysis

All data analysis was performed by a statistician using the IBM SPSS ver. 22.0 (IBM Co., Armonk, NY, USA). Descriptive and comparative analysis were performed with a *p*-value of less than 0.05 considered to be significant. Paired two-tailed sample *t*-test was used to compare pre- and postoperative OKS within a 95% confidence interval at a *p*-value of less than 0.05. Kaplan-Meier implant survivorship analysis with 95% confidence interval was also calculated using revision of implant as the endpoint.

RESULTS

A total of 52 PFJRs in 38 consecutive patients with a minimum 2-year follow-up were identified from our records within the study period. One patient (1 knee) was lost to follow-up having moved out of the area and could not be traced. One patient (2 knees) died at 12 months post-surgery of unrelated causes. Hence, 49 knees (36 patients) were therefore available for clinical review. There were 9 males and 27 females with all 13 bilateral procedures in the female group. Their mean age was 59 years (range, 39 to 80 years) and mean body mass index (BMI) was 30 kg/m^2 (range, 22 to 41 kg/m^2). The mean preoperative OKS was 19 (range, 5 to 32). Nineteen patients (39%) had previously had arthroscopic procedures confirming Kellgren and Lawrence grade 4 degenerative changes in the patellofemoral joint.

At a mean follow-up of 40 months (range, 24 to 58 months), the median OKS was 38 (interquartile range [IQR], 28 to 42), KSS functional was 100 (IQR, 10 to 100) and KSS objective was 94 (IQR, 89 to 100). There was a significant improvement in the mean OKS from 19 preoperatively to 34 at follow-up (paired sample *t*-test mean, 15 (95% confidence interval, 11 to 18); $p < 0.0005$). At the latest follow-up, 88% of patients had an OKS of ≥ 25 points while 90% of patients had a KSS objective of ≥ 80 points. A strong positive was observed between the postoperative outcome scores following this procedure (Pearson correlation = 0.796, $p = 0.0005$).

Twenty-three patients (23 knees, 47%) had a unilateral procedure while 13 patients (26 knees, 53%) had a bilateral procedure. There was no statistically significant difference in median OKS between the unilateral group and the bilateral group (40 vs. 37, Mann-Whitney *U*-test, $p = 0.462$) (Fig. 4).

Twenty patients (28 knees, 57%) had a BMI of ≥ 30 kg/m^2 and 16 patients (21 knees, 43%) had a BMI of < 30 kg/m^2 with OKS similarly distributed (Fig. 5). Median OKS was 39 for the patients with BMI < 30 kg/m^2 while it was 38 for the patients with BMI ≥ 30 kg/m^2, and the difference was not statistically significant (Mann-Whitney *U*-test, $p = 0.272$).

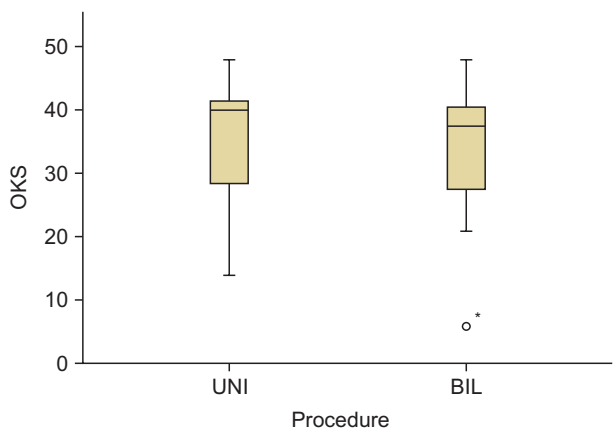

Fig. 4. Box plot showing the distribution of Oxford Knee score (OKS) for both unilateral (UNI) and bilateral (BIL) patellofemoral joint replacement patients. *The circle in the diagram represents an outlier.

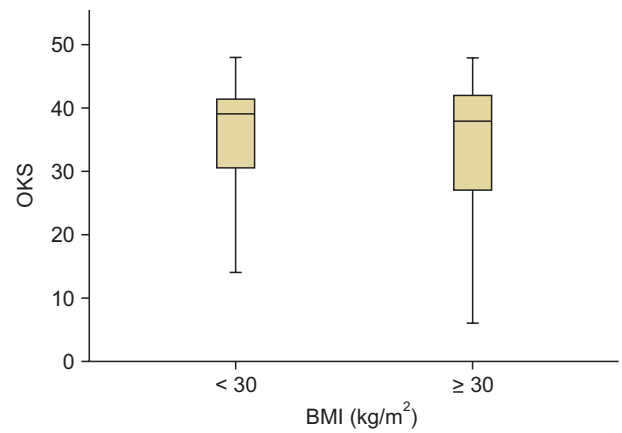

Fig. 5. Box plot showing the distribution of Oxford Knee score (OKS) for patients with body mass index (BMI) < 30 kg/m^2 and BMI ≥ 30 kg/m^2.

They was a mildly positive correlation between age and outcome scores measured, which was not found to be significant ($p > 0.05$). Twenty-three patients (32 knees, 65%) were aged ≥ 55 years and 13 patients (17 knees, 35%) were aged < 55 years. Distribution of OKS scores in the 2 groups were similar as assessed by visual inspection (Fig. 6) and median OKS for the group of patients aged ≥ 55 years was 38 and for the group aged < 55 years was 34. This difference, however, was not statistically significant (Mann-Whitney *U*-test, $p = 0.607$).

There were no infections or thromboembolic complications recorded for this patient cohort during the follow-up period. Cumulative implant survival for the study period is 95.6% (Fig. 7). Two prostheses have been revised: one at 26 months and the other at 29 months postoperatively. Both of these cases probably represent poor patient selection for this procedure, with articular cartilage changes in the remaining compartments underestimated.

The first revision was performed on a 54-year-old male with isolated patellofemoral joint disease confirmed arthroscopically prior to replacement. His outcome was always poor with persistent knee pain after the PFJR procedure. A further arthroscopy showed soft tissue impingement over the medial facet, which was debrided. It also showed mild degenerative changes (Outerbridge grade 2) over both medial and lateral compartments. As his symptoms failed to settle, he underwent revision to a total knee replacement after 26 months from the index surgery. Whilst he has improved clinically, his OKS was 30 at the latest follow-up and he continued to have some pain issues.

The second revision was performed on a 71-year-old female who had bilateral PJFRs initially. She continued to complain of right knee pain and a subsequent knee arthroscopy showed osteoarthritis disease (Outerbridge grade 3) progression affecting both medial and lateral compartments. She went on to have a revision to a total knee replacement (TKR) at 29 months after surgery and is now doing well with an OKS of 39, KSS objective of 92 and KSS functional of 90 at the latest follow-up.

DISCUSSION

Early PFJR implants were of the inlay type design which led to the early complications seen with this procedure. Inlay type implants were narrow with a deep sulcus which was too conforming and constrained predisposing to patellar maltracking.[27] They also did not extend proximal to the trochlear margin, hence were difficult to position flush with the rest of the trochlear surface cartilage. Many ended up malrotated or in a prominently flexed position. This means the patella did not engage with the trochlea while in full extension and could sublux or catch on the implant while moving into flexion.[27]

Improved designs have resulted in a new generation of onlay type trochlear components which, like the Zimmer PFJR,[12,25] allows for replacing the entire anterior femoral cortex, making it easier to position the trochlear component more accurately and flush with the anterior femoral cortex and trochlea articular cartilage. The Zimmer PFJR unique design also incorporates a thinner anterior flange to avoid overstuffing and an increased trochlear groove angle that reflect the differences in the Q angle between male and female patellar tracking.[12,25] The flange is wider and less constrained than the inlay type components, extending more proximal than the native trochlear cartilage. This provides a greater excursion and engagement of the patellar even in extension thus it is less likely

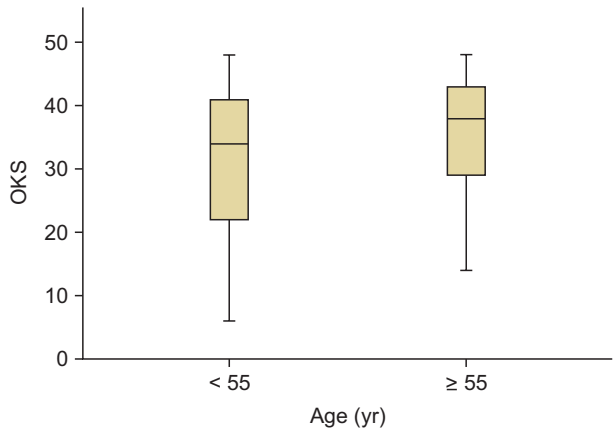

Fig. 6. Box plot showing the distribution of Oxford Knee score (OKS) for patients with age < 55 yr and ≥ 55 yr.

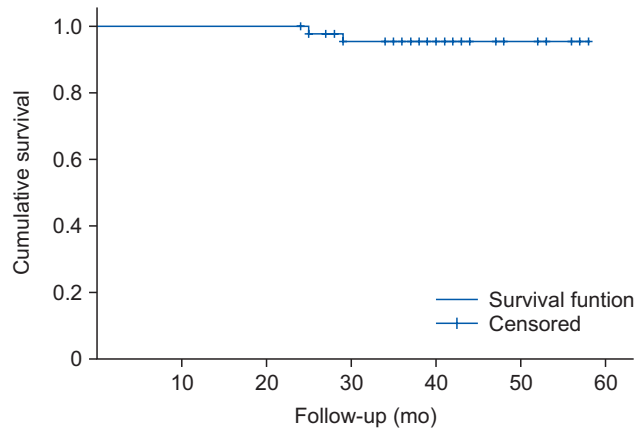

Fig. 7. Kaplan-Meier survival curve with revision as endpoint.

to sublux or catch as the knee moves from extension into flexion, reducing the problems with patellar maltracking and thus implant failure.[27] We found the new implantation jigs developed for this prosthesis to be easy-to-use, reproducible and accurate. No complications have occurred related to the prosthetic design on either the trochlea or patella side, and there have been no hardware related failures or difficulties with the jigs.

Our study confirms acceptable early results and functional outcomes for the Zimmer PFJR, which are comparable to similar implants and brands reported in the NJR[21] and literature[10,14,16,18,28] (Table 1). Our revision rate for this study was 4%, which is similar to the cumulative probability of a first revision at 3 years of 5.42% reported in the NJR[21] for PFJR implants.

The strong correlation between the OKS and KSS outcomes in this study is similar to the findings from the follow-up study by Reddy et al.[29] of 379 total knee replacement patients comparing preoperative and 1-year follow-up OKS and KSS. They also showed a good correlation between OKS and KSS and concluded that the 2 scoring systems can be concurrent and complementary to each other.

Our study includes 13 bilateral procedures performed at the same time. Odumenya et al.[14] in their study on 50 Avon PFJR reported a significantly lower Euroquol outcome score for their 17 bilateral PFJRs compared to the group of unilateral replacements. They did highlight that the Euroquol was an imperfect outcome measure as the poor results may also have been due to associated comorbidities of their patients. Our study, however, shows good outcomes for our bilateral group of patients with a median OKS of 37. This was not significantly different from the median OKS of the unilateral group which was 40. No additional complications were seen in the bilateral group suggesting that bilateral PFJR can be safely tolerated and equivalent outcomes expected.

For a successful PFJR, appropriate patient selection is critical. Several factors have already been identified as either contraindications and/or additional factors that may adversely affect PFJR outcome. The Australian Joint Registry has the longest experience of PFJR and shows the most common reason for revision of a PFJR is tibiofemoral disease progression (43%).[19] The question therefore is whether this problem is due to progression of previous unrecognised disease or if they were other factors that influenced disease progression. To provide an answer, Nicol et al.[30] reviewed both pre- and postoperative X-rays of 103 consecutive patients who underwent PFJR in their institution. Fourteen knees (14%) were revised, 12 of which were

Table 1. Summary of Similar Studies in Literature

Study	Prosthesis	Knee (patient)	Age (yr)	Mean follow-up (mo)	Revision rate (patient)	Median OKS	OKS ≥ 25 (%)	Median KSS objective	KSS objective ≥ 80 (%)	Cumulative survival (%)
van Wagenberg et al. (2009)[10]	Autocentric II	24 (20)	63 (38–81)	58 (34–132)	29 (7)					75
Beitzel et al. (2013)[18]	Journey	22 (22)	46 (28–67)	24	4.5 (1)					
Starks et al. (2009)[16]	Avon	37 (29)	66 (30–82)	24	5.4 (2)	39		95	86	
Odumenya et al. (2010)[14]	Avon	50 (32)	66 (42–88)	67 (25–122)	6 (3)	32	64			100 at 5 yr
Williams et al. (2013)[28]	FPV	48 (48)	63 (48–81)	25 (6–49)	15 (7)					
This study	Zimmer	49 (36)	59 (39–80)	40 (24–58)	4 (2)	38	88	94	90	95.6 at 3 yr

Values are presented as mean (range).
OKS: Oxford Knee score, KSS objective: Knee Society objective score.

due to tibiofemoral disease progression. It added that this progression is seen significantly less frequently when the patellofemoral arthritis is secondary to dysplasia of the femoral trochlea, suggesting that these patients are the ideal candidates for PFJR.[21] The rate of disease progression in this study was 5 (10%), of which only 1 patient went on to have a revision to a TKR due to this problem.

In this study, we found no correlation between BMI and outcome with median OKS for patients with a BMI < 30 kg/m^2 and ≥ 30 kg/m^2 equally good at 38 and 39, respectively. This is different to several previous studies.

Tarassoli et al.[6] in their systematic review of the literature assessed 14 eligible studies and 872 knees. This highlighted a BMI > 30 kg/m^2 as a patient characteristic relating to poor outcome in PFJR. Similarly, Leadbetter et al.[22] also listed a BMI > 30 kg/m^2 as an additional factor that may adversely affect patellofemoral arthroplasty outcome. In a study of 185 Richards type II PFJR, van Jonbergen et al.[11] reported a higher revision rate in obese patients (BMI > 30 kg/m^2) than in nonobese patients. They also reported no significant differences in revision rates between patients 50 years or younger and those older than 50 years. This finding was the same as in our study.

Study limitations include the retrospective nature of the study, the small numbers and the relatively short follow-up period. However, we feel our study size and follow-up period are enough to give an early indication as to the success of a new prosthesis for a not too common procedure. In addition, our figures at this stage, are similar to those present in the literature.

In conclusion, whilst the role of PFJR remains controversial, we have shown the new Zimmer PFJR prosthesis to be a safe option to use to definitively treat isolated end-stage patellofemoral disease. We have had no prosthetic or implantation hardware-related failures.

Our early outcome results are encouraging and at least as good as those of the leading PFJR brands in the NJR. These early results also suggest that PFJR in obese patients and bilateral procedures can have good outcomes. We strongly recommend that larger studies with longer follow-up are needed to corroborate the results and add to the body of knowledge in this area.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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