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Review article

Patellofemoral arthroplasty: Current concepts

Rory Cuthbert[a], Saket Tibrewal[a,*], Sheo B. Tibrewal[b]

[a] Department of Trauma & Orthopaedic Surgery, Lewisham & Greenwich NHS Trust, University Hospital Lewisham, Lewisham High Street, London, SE13 6LH, United Kingdom
[b] Department of Trauma & Orthopaedic Surgery, Lewisham & Greenwich NHS Trust, Queen Elizabeth Hospital, London, SE18 4QH, United Kingdom

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ABSTRACT

Isolated patellofemoral arthritis (IPA) is a debilitating condition characterised by a loss of articular cartilage on the patella facets, the trochlear groove or both. By definition, patients with IPA must have normal cartilage in the tibiofemoral compartments of their knee. It is therefore logical to pursue arthroplasty which corrects the abnormality while sparing healthy bone and preserving the knee's native kinematics, which is the premise underpinning patellofemoral arthroplasty (PFA). However, its use remains controversial, with many surgeons still favouring total knee replacement (TKR) in these patients. This paper provides a comprehensive review of PFA in the literature to date and concludes, in carefully selected patients, PFA is worthy of consideration as a functionally superior and economically beneficial joint-preserving procedure – delaying TKR until implant failure or tibiofemoral osteoarthritis progression.

1. Introduction

Isolated patellofemoral arthritis (IPA) is a debilitating condition characterised by a loss of articular cartilage on the patella facets, the trochlear groove or both. IPA affects 9% of the population over 40 years of age and between 11 and 24% of patients with knee pain,[1,2] however registry data shows that patellofemoral arthroplasty (PFA) only accounts for 1.3% of all knee arthroplasty in the United Kingdom.[3] As forecasters continue to predict an ageing population with an increased burden of arthritis, it is inevitable more patients will require treatment for this condition in the future.

Many patients with IPA can be managed with non-operative measures. If these are unsuccessful, arthroscopic debridement or soft tissue realignment procedures may be attempted. However, these interventions have provided inconsistent results – with success rates reported at 60–70%.[4] Therefore, particularly when IPA is at an advanced stage, the principal surgical intervention is arthroplasty.[4,5]

IPA often occurs in younger, active patients who, by definition, must have normal cartilage in the tibiofemoral compartments of their knee. It is therefore logical to pursue arthroplasty which corrects the abnormality while sparing healthy bone and preserving the knee's native kinematics, which is the premise underpinning patellofemoral arthroplasty (PFA). However, its use remains controversial, with many surgeons still favouring total knee replacement (TKR) in these patients.[6–8]

This paper provides a comprehensive review of PFA in the literature to date. We discuss first and second generation patellofemoral implants, outline criteria for patient selection, and compare PFA with TKR in the treatment of IPA. Finally, we describe ongoing research, and explore what the future may hold.

2. Patellofemoral implant design

2.1. Historical overview

The first "replacement" of the patellofemoral joint was reported by McKeever in 1955, who used a vitallium shell to resurface the arthritic patellar surface in 5 patients, leaving an untouched native trochlea.[9] Early results were promising, but the design was ultimately discontinued due to excessive trochlear wear. The first total PFA did not occur until 1979 following introduction of the Richards and Lubinus prostheses.[10] These were inlay designs, and are commonly referred to as first generation patellofemoral implants.

* Corresponding author.
E-mail addresses: rory.cuthbert@nhs.net (R. Cuthbert), mrtibrewal@gmail.com (S. Tibrewal), sb.tibrewal@virgin.net (S.B. Tibrewal).

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2.2. First generation patellofemoral arthroplasty

First generation implants used trochlear prostheses inset within the native trochlea and flush with the surrounding articular cartilage. This effectively replaced worn cartilage without altering the shape of the subchondral bone – meaning rotational alignment was determined by the native trochlear orientation. Outcomes were poor. In a short-term follow-up of the Lubinus implant, Board demonstrated only 53% of knees were classified as satisfactory by patients, with 24% requiring revision to total knee arthroplasty and 18% exhibiting an extension block.[11] Similarly, in long-term studies, the highest documented survivorship was 75% at 10 years with large scale studies by Tauro and Van Jonbergen reporting 65% survival of the Lubinus implant at 5 years and 69% survival of the Richards implant at 20 years respectively.[12,13]

Initially, high failure rates were attributed to poor patient selection. However, the comparative success of second generation patellofemoral implants suggests it was the first generation implants' reliance on orientation of the native trochlea which is culpable for high rates of patellar instability. Using magnetic resonance imaging, Kamath analysed trochlear inclination angles in 329 patients with either normal or dysplastic patellofemoral anatomy.[14] Both groups had trochlear inclination angles averaging 11.4° and 9.4° respectively relative to the anteroposterior and transepicondylar axes of the femur. This explains the propensity to bias the inlay-design trochlear prosthesis into internal malrotation – increasing the Q-angle and predisposing to high rates of patellar maltracking, impingement, subluxation and ultimately failure.

2.3. Second generation patellofemoral arthroplasty

Onlay trochlear prostheses were introduced in the 1990s. These second generation patellofemoral implants completely replace the anterior compartment of the knee – providing a design that can be universally applied to all patients irrespective of innate anatomical variation.

The trochlear component is implanted perpendicular to the anteroposterior axis of the femur and parallel to the trans-epicondylar axis – allowing the surgeon to determine the rotation of the prosthesis irrespective of the native trochlear inclination. Further, onlay prostheses are typically wider and less constraining, allowing increased movement of the patella through the arc of motion and facilitating smoother patellar tracking. Finally, by extending the prosthesis more proximally than the native trochlear cartilage and ensuring it is seated flush against the anterior femoral cortex, the risk of impingement is minimised whilst the patellar component remains engaged even when in maximally extension.

The improvement in the design of second generation prostheses has been reflected in both short and medium term results. In a multi-centre trial of 79 patients at 3 year follow-up, Leadbetter reported a 94% survival rate of the Avon prosthesis with a Knee Society Score greater than 80 achieved in 84% of patients.[15] Similarly, in a study of 109 patients at 5 year follow-up, Ackroyd documented a 96% survival rate of the Avon prosthesis with an 80% success rate based on Bristol knee scores.[16] Goh established a 92% survival rate with 76% of patients reporting "good satisfaction" with their symptomatic improvement.[17]

Longer term studies are also promising. In a study of 51 prostheses with 7 year follow-up, Konan described a 96% probability for survival (Kaplan-Meyer analysis) with revision as the end-point.[18] Equally, in a study of 71 Hermes™ prostheses at 10 year follow-up, Hernigou found no late complications attributable to the arthroplasty.[19]

Analysis of cohort studies illustrates the contrast between survivorship in first and second generation PFA. Older studies (before 2010) report an annual revision rate of 2.33% whereas more recent studies (after 2010) exhibit an annual revision rate of 1.93% with heterogeneity mainly seen in type of prosthesis.[20] However, not all second generation implants have been successful. The low contact stress (LCS) patellofemoral implant consisted of a trochlear component and a modular patellar component with a metal-backed mobile polyethylene bearing. In a study of 51 implants at 2 years follow-up by Charalambous, 33% had required revision.[21] During revision surgery, the polyethylene bearing was frequently found to have diminished mobility secondary to overgrown surrounding soft tissue. Further studies also reported dissociation of the mobile polyethylene bearing from its metal backing, and use of this prosthesis has subsequently been discontinued.[22,23]

The United Kingdom National Joint Registry uses Kaplan-Meier estimates to calculate the cumulative percentage probability of first revision of a PFA by implant brand at varying years since primary operation.[3] The Avon prosthesis has the greatest body of evidence (4842 knee joints) and exhibits the second lowest revision rate at 1 year (0.79%) with the lowest revision rate at 7 years (10.21%). The Zimmer PFJ demonstrates the lowest revision rate at 1 year (0.64%), but currently has insufficient data for longer term survivorship to be calculated. The Sigma HP implant exhibits the highest revision rate at 1 year (2.61%) and is the least frequently used prosthesis (Table 1).

3. Patient selection

Patient selection is critical to the success of PFA. Patients with patellofemoral instability and/or trochlear dysplasia are particularly likely to benefit because secondary pathologies are corrected;

Table 1
Kaplan-Meier estimates of the cumulative percentage probability of first revision (95% CI) of a PFA by implant brand at indicated number of years since primary operation.[3] Estimates in italics indicate fewer than 250 cases remain at the time shown.

Brand	Number of knee joints	Median age at primary	Cumulative percentage probability of a first revision (95% CI) if time elapsed since primary operation is:				
			1 year	3 years	5 years	7 years	10 years
Avon	4842	59 (51–68)	0.79 (0.57–1.09)	4.25 (3.67–4.91)	7.55 (6.75–8.45)	10.21 (9.22–11.31)	14.86 (13.31–16.57)
FPV	1537	59 (51–68)	0.95 (0.56–1.59)	6.54 (5.34–8.01)	9.78 (8.21–11.62)	*11.34 (9.54–13.46)*	
Journey PFJ Oxinum	1454	58 (50–67)	2.21 (1.55–3.15)	7.24 (5.92–8.83)	12.49 (10.62–14.67)	*18.43 (15.84–21.39)*	
Sigma HP	1023	59 (51–67)	2.61 (1.77–3.84)	8.03 (6.32–10.17)	*12.65 (10.10–15.79)*	*18.12 (12.00–26.87)*	
Zimmer PFJ	1448	57 (50–66)	0.64 (0.32–1.28)	3.99 (2.90–5.48)	*5.09 (3.72–6.96)*	*10.26 (5.29–19.41)*	