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Early results of patellofemoral inlay resurfacing arthroplasty using the HemiCap Wave prosthesis

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Abstract

Background: Common surgical treatment options for isolated patellofemoral osteoarthritis include arthroscopic procedures, total knee replacement and patellofemoral replacement. The HemiCap Wave patellofemoral resurfacing prosthesis is a novel inlay design introduced in 2009 with scarce published data on its functional outcomes. We aim to prospectively evaluate early functional outcomes and complications, for patients undergoing a novel inlay resurfacing arthroplasty for isolated patellofemoral arthrosis in an independent centre. **Methods:** From 2010 to 2013, 16 consecutive patients underwent patellofemoral resurfacing procedures using HemiCap Wave (Arthrosurface Inc., Franklin, Massachusetts, USA) for anterior knee pain with confirmed radiologically and/or arthroscopically isolated severe patellofemoral arthrosis. Standardized surgical technique, as recommended by the implant manufacturer, was followed. Outcome measures included range of movement, functional knee scores (Oxford Knee Score (OKS), Knee Injury and Osteoarthritis Outcome Score (KOOS) and Short Form-36 (SF-36)), radiographic disease progression, revision rates and complications. **Results:** Eight men and eight women underwent patellofemoral HemiCap Wave resurfacing, with an average age of 63 years (range: 46–83). Average follow-up was 24.1 months (6–34). Overall, post-operative scores were excellent. There was a statistically significant improvement in the post-operative OKS, KOOS and SF-36 scores ($p < 0.01$). One patient had radiological disease progression. One patient underwent revision for deep infection. Two other minor complications were observed and treated conservatively. **Conclusions:** The HemiCap Wave patellofemoral resurfacing prosthesis has excellent early results in terms of functional outcomes, radiological outcomes and low complication rates. At the very least, early results show that the HemiCap Wave is comparable to more established onlay prostheses. The HemiCap Wave thus provides a safe and effective surgical option in the treatment of isolated patellofemoral osteoarthritis in selected patients.

Keywords

arthroplasty, HemiCap Wave, inlay, patellofemoral, resurfacing

Introduction

Patellofemoral arthritis is a significant cause of morbidity treated by orthopaedic surgeons. It is an increasingly important issue, now recognized to be more common than previously thought.[1] Reports suggest that isolated symptomatic patellofemoral osteoarthritis occurs between 8% and 13% in patients over the age of 60 years.[2,3]

Risk factors for developing patellofemoral osteoarthritis include trauma, recurrent dislocations, patellofemoral misalignment and trochlear dysplasia.[4] However, often there is no obvious cause in many patients.

Initial treatment options are conservative and include weight loss, taping, bracing, physiotherapy, activity modification and anti-inflammatory medication. Surgical treatment options include procedures to correct patellofemoral

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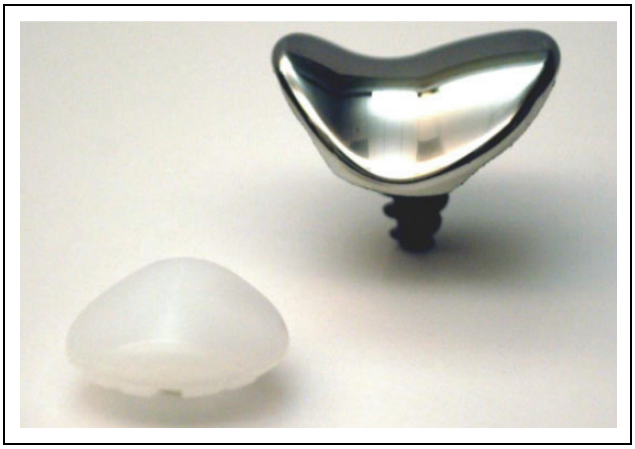

Figure 1. HemiCap Wave (trochlear and patella components).

pathomechanics, arthroscopy (debridement, microfracture and autologous chondrocyte implantation), total knee replacement (TKR), patellectomy and patellofemoral replacement.

Indications for isolated patellofemoral arthroplasty (PFA) include the following[5]:

1. failure of conservative treatment,
2. absence of tibiofemoral arthritis,
3. normal patella alignment/tracking, and
4. intact/stable menisci and ligaments.

Patellofemoral replacement has been described since 1955, when McKeever performed patellar resurfacing in 40 knees, with initial designs yielding less than satisfactory results.[6] Patellofemoral joint resurfacing gained further interest in the 1970s with publication of the results of the first generation of prostheses.[7] In 1974, Bechtol introduced both patellar and femoral resurfacing components designed to be used either in isolation or in conjunction with a unicondylar or TKR.[8] Results with first-generation prosthesis have been variable, with significant improvements in newer designs.[4,9] The high failure rates reported with some of the early onlay designs, such as the Lubinus,[10] resulted in many surgeons preferring TKR for isolated patellofemoral arthritis.[11]

The HemiCap Wave patellofemoral prosthesis is an inlay design, intended for patients with isolated patellofemoral arthritis and normal patella tracking. This prosthesis was only introduced in 2009 and little data has been published on its functional outcomes. HemiCap Wave is the only true complete inlay type patellofemoral replacement (Figure 1). The prosthesis aims to maintain native joint biomechanics by intraoperative three-dimensional joint mapping, and the use of contoured implants enables a more anatomical resurfacing.[12] A biomechanical study assessing patellofemoral kinematics of the inlay focal HemiCap resurfacing demonstrated anatomic re-approximation of the patellofemoral surface and knee contact pressures.[13]

One study evaluated clinical outcomes and sports-related results in a cohort of 27 patients aged 42 years ($\pm$13) who had undergone HemiCap Wave resurfacing. Results revealed statistically significant improvements post-operatively in Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), pain visual analogue scale (VAS) and subjective International Knee Documentation committee (IKDC) scores.[12]

Verma et al.[14] published a case series assessing a similar prosthesis, the focal HemiCap resurfacing. This is a much smaller inlay design and is used for isolated patellofemoral focal defects. Forty-three procedures were undertaken and patients were followed up for a mean of 9 months (range: 1–20). Overall, good post-operative functional results and surgeon satisfaction were demonstrated.

The aim of this study is to present our early results on functional outcomes and complications for patients undergoing HemiCap Wave PFA for isolated patellofemoral arthrosis.

Methods

Sixteen patients were included in this study who underwent patellofemoral resurfacing using HemiCap Wave (Arthrosurface Inc., Franklin, Massachusetts, USA) for isolated patellofemoral arthrosis from March 2010 to July 2013. No children or vulnerable adult groups were included.

Indications for patellofemoral replacement included severe isolated patellofemoral osteoarthritis characterized by anterior knee pain and osteoarthritic changes on radiographs only in the patellofemoral joint with normal tibiofemoral compartments and normal patella alignment. Diagnosis of isolated patellofemoral osteoarthritis was based on clinical, radiological and, where available, arthroscopic findings (some patients previously underwent arthroscopy to assess and debride the patellofemoral joint (PFJ), specifically any loose patellofemoral chondral flaps). Patients with any degree of fixed flexion deformities were excluded.

All patients had preoperative weight-bearing standard anteroposterior, lateral and patella skyline radiographs. MRI scanning was also undertaken to confirm normal tibiofemoral cartilage surfaces and assess PFJ. Surgery was performed in consecutive patients by the senior author or under his direct supervision.

Post-operatively, patients were allowed to weight bear as tolerated and followed a standardized physiotherapy protocol.

Primary functional outcomes were measured using the Oxford Knee Score (OKS),[15] Knee Injury and Osteoarthritis Outcome Score (KOOS)[16] and Short Form-36 (SF-36)[17] recorded pre- and post-operatively. The OKS has been used in multiple studies assessing other PFA designs[11,18,19] and is a validated patient-reported functional outcome measure.

Use of the OKS allows direct comparison of the HemiCap Wave resurfacing with other patellofemoral joint

Table 1. Comparison of pre- and post-operative functional outcome measures.

Outcome measure	Mean preoperative value	Mean post-operative value	Statistical significance
Range of movement (knee)	0°–115°	0°–120°	Nil
OKS	19 (2–30)	35 (10–44)	$p < 0.01$
KOOS	39 (5–64)	55 (33–85)	$p < 0.01$
SF-36 (physical)	32 (19–40)	53 (19–70)	$p < 0.01$
SF-36 (mental)	42 (18–55)	45 (20–62)	Nil

OKS: Oxford Knee Score; KOOS: Knee Injury and Osteoarthritis Outcome Score; SF: Short Form-36.

replacements, such as the Avon prosthesis (Stryker, Howmedica Osteonics, Allendale, New Jersey, USA). Both the KOOS and SF-36 are validated and have been highly recommended in a study by Paxton and Fithian[20] assessing outcome instruments for PFA.

Secondary outcome measures included range of motion, radiological parameters (progression of tibiofemoral osteoarthritis as per Kellgren and Lawrence/Ahlback grading) as well as complications and reoperations. Data was prospectively collected using a standardized proforma from patient notes and Picture Archiving and Collection System (Philips Medical Systems, Sectra Imtec AB, Sweden).

Patients were routinely followed up in clinic, and post-operative radiographs were taken. They were reviewed by the senior surgeon and first author at 6 weeks, 3 months, 6 months and yearly from date of surgery. Range of motion was measured using a goniometer by the first author only to aid reliability of measurements. Data was analysed using SPSS (IBM-SPSS, New York, USA). To test for statistical significance, paired *t*-test was used with significance level set as $p < 0.05$.

Ethical considerations

This study was conducted as a service evaluation. No funding/sponsorship from the implant company was obtained to aid this study. As part of the clinical team caring for these patients, no consent was required to assess patient notes. Data was held in accordance with the *Data Protection Act*. Approval for this study was obtained from the Biomedical Research Ethics Sub-committee and regulatory compliance department at Imperial College London.

Results

Sixteen patients underwent patellofemoral resurfacing using HemiCap Wave for isolated severe osteoarthritis. The cohort included eight men and eight women with an average age of 63 years (46–83) and Body Mass Index 27.2 (22.5–30) at time of surgery. The mean follow-up was 24.1 months (6–34), and no patients were lost to follow-up.

Six patients had previous knee surgery. Of these, five patients had arthroscopies with debridement of patellofemoral chondral defects. Two of these five patients also had partial meniscectomies. One patient had tibial tubercle transfer and autologous matrix-induced chondrogenesis.

At operation, all patients had severe patellofemoral osteoarthritis. Only one patient had grade 1 (Outerbridge) osteoarthritis in the medial compartment. There were no intraoperative complications.

Statistically significant improvements were found in mean scores for the OKS and KOOS post-operatively ($p < 0.01$). Although there was significant improvement in the physical SF-36 post-procedure ($p < 0.01$), improvements in the mental SF-36 and increase in knee flexion of 5° post-procedure were found to be statistically insignificant (Table 1).

Three patients had post-operative complications. One patient developed keloid scarring which was asymptomatic and did not require treatment. One patient developed synovitis which settled with anti-inflammatory medication. A third patient had continuing pain and swelling post-operatively. He had persistently raised inflammatory markers with suspected deep infection. He subsequently underwent a joint aspiration which was negative with eventual revision to a TKR 18 months after initial surgery for infection.

At follow-up, only one patient had progression of osteoarthritis. She was 23 months post-surgery with grade 2 (Kellgren and Lawrence) and grade 2 (Ahlback) medial tibiofemoral compartment osteoarthritis. However, she was asymptomatic and did not require further intervention.

Discussion

Isolated patellofemoral arthritis is a significant cause of morbidity, which can be treated surgically with PFA. This study assessed outcomes of the HemiCap Wave patellofemoral replacement for patients with isolated patellofemoral osteoarthritis. We assessed 16 patients pre- and post-operatively and found a statistically significant improvement in their KOOS, OKS and SF-36 (physical) scores at an average of 24.1 months follow-up ($p < 0.01$). Only two minor complications were observed, neither of which required surgical intervention. These results suggest good short-term functional outcomes with low complication rates.

To the best of our knowledge, only two studies to date have evaluated functional outcomes of the HemiCap Wave.[12,21] Twenty-seven patients were included by Imhoff et al.[12] with an average age of 42 and were followed up over 24 months. The patients were split into two groups: those who underwent isolated patellofemoral inlay

surfacing and those who required inlay surfacing and concomitant procedures to address patellofemoral instability/malalignment and tibiofemoral malalignment. Authors found a statistically significant reduction in total WOMAC, IKDC and pain VAS scores as well as sports-related Tegner Score and found more patients partaking in sports post-operatively. Two patients required reoperation for component disassembly and graft slippage post-concomitant medial patellofemoral ligament reconstruction.

Our study is different in terms of the considerably younger cohort of patients used by Imhoff et al.[12] and some patients requiring concomitant procedures at time of resurfacing as well different functional outcomes measures used. Another paper, published by the implant manufacturer (Arthrosurface Press) commentated on a brief investigation of 22 patients with mean age of 43 years who underwent HemiCap Wave resurfacing. Follow-up was for 15 months, and preliminary results revealed clinical improvement in the Kujala and IDKC scores.[22]

One study compared an onlay design prosthesis (Journey PFJ, Smith & Nephew, UK) to the inlay HemiCap Wave in 15 patients. They found statistically significant improvements in WOMAC, Lysholm and pain VAS scores post-operatively with both prostheses. No significant difference was found in clinical outcome scores between onlay versus inlay designs. However, in the onlay group, 53% of patients exhibited progression in osteoarthritis compared to the inlay group ($p = 0.009$).

Statistics from the 12th annual report (2015) from the United Kingdom National Joint Registry (NJR) reveal that PFA makes 1.3% of all primary knee replacements. The median age for patients undergoing PFA is 59 years compared to 70 years for TKR; hence, survivorship of prosthesis is all the more important. Between 2003 and 2014, the Avon prosthesis has been most popular forming 44.8% of all PFA performed (4457 out of 9945 PFA procedures) followed by the Femoro Patella Vialli (Wright Medical, UK) with 1433 procedures. In total, there are five PFA prostheses, which data is provided for by the NJR; all of which have an onlay design. The Avon prosthesis, however, most closely resembles the HemiCap Wave patellofemoral resurfacing in terms of engineering. It is the only patellofemoral prosthesis with more than 1000 cases having longer than a 5-year follow-up. In terms of survivorship, only three prostheses had more than a thousand cases available, and the cumulative percentage probability for a first revision at 5 years was between 7.66% for Avon and 12.39% for Journey PFJ (Smith & Nephew). The most common indication for revision was progression of osteoarthritis. These results show continued use of traditional onlay designs however, as more data is collected on the newer generation of inlay design prostheses such as the HemiCap Wave; it may reveal a better alternative.

Advantages of inlay resurfacing include preservation of native geometry with minimal bone loss and soft tissue disruption, thus causing minimal disruption to natural joint biomechanics and reducing the risk of joint overstuffing. The multiple convexities of the HemiCap Wave assure anatomic fit.[12]

Weaknesses of this study include a small sample size with non-significant mental SF-36 score and range of motion outcome likely due to this reason. Strengths include the prospective design with complete pre- and post-operative scores with no loss to follow-up. This study also benefits from being a consecutive series performed or supervised by a single surgeon in an independent centre, reducing confounders, with strict inclusion criteria.

We recommend further research to be performed using a randomized controlled study, larger homogenous patient cohort with longer follow-up. Additionally, future studies should use similar functional outcome measures to allow study results to be compared.

Conclusion

In conclusion, little data exists on functional outcomes following use of the HemiCap Wave prosthesis. Our results demonstrate that the HemiCap Wave has excellent early results, in terms of functional outcomes, radiological outcomes and low complication rates. At the very least, early results show that the HemiCap Wave is comparable to more established onlay prostheses. The HemiCap Wave thus provides a safe and effective surgical option in the treatment of isolated patellofemoral osteoarthritis in selected patients.

Declaration of conflicting interests

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