Unicompartmental knee replacements with Miller-Galante prosthesis: Two to 16-year follow-up of a single surgeon series

Joby John • C. Mauffrey • Peter May

Received: 7 January 2010 / Revised: 13 February 2010 / Accepted: 15 March 2010 / Published online: 25 April 2010
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Abstract We report the outcome of 94 Miller-Galante unicompartmental knee replacements done by a single surgeon over 16 years in a district general hospital in the UK. Patellofemoral arthritis was considered a contraindication only if symptomatic and confirmed on radiography and surgery. Deformity when present was correctable. The mean age at surgery was 66.54 years. The mean follow-up was 10.8 years (2–16 years). The mean Bristol knee score was 43.1 (28–50); 86% of the patients had good or excellent scores. The average range of flexion was 110.6° (80–130°); 89% of the knees had an appropriate alignment. Using revision as the endpoint, outcome for every knee was established. The survival rate for medial unicompartmental knee replacements was 94% at ten years and 87% at 15 years. Although the survival rate for the lateral unicompartmental knee replacement was 97% at five years, it dropped to 41% at eight years. Lateral unicompartmental knee replacements formed only 9.6% of all the replacements in this series. The results for medial unicompartmental knee replacements are similar to reports by other authors for similar and mobile bearing designs. Unicompartmental knee replacement results in a more kinematic knee and produces good functional results.

Introduction

Unicompartmental osteoarthritis of the knee is common and patients derive benefit from replacement of the affected compartment. Different designs of unicompartmental knee replacements have been used with increasing success, although early reports suggested a high failure rate [8, 11]. The advantages of unicompartmental arthroplasty over total knee replacement are preservation of bone stock, minimal blood loss, quicker recovery, better range of movement and near normal kinematics [12, 24]. Unicompartmental knee replacements have been reported to be more cost-effective than total knee replacement [24]. Follow-up studies of unicompartmental implants have demonstrated ten year survival rates of 85–98% with revision as the endpoint [1, 2, 5, 7, 18, 19, 23, 26, 27] (Table 1). The Miller-Galante unicompartmental knee prosthesis has been reported to have very good survival rates with revision as the endpoint [2, 5, 19].

We report the outcome of unicompartmental knee replacements performed over a period of 16 years by a single surgeon in a district general hospital in the UK.

Patients and methods

Between 1989 and 2006, 94 Miller-Galante unicompartmental knee replacements were implanted in patients by a single surgeon (PCM) in a district general hospital (Princess Royal Hospital, Telford). There were 66 unilateral, 18 staged bilateral procedures and 5 (10 knees) bilateral procedures done at the same sitting.

All the knees had primary single compartment osteoarthritis. Fibrillation or marginal erosions of the opposite compartment and/or patellofemoral compartment were not a

J. John (✉)
Department of Trauma and Orthopaedics, Royal Derby Hospital,
Derby City, UK
e-mail: jobyjohnm@yahoo.com

C. Mauffrey
University Hospitals of Coventry & Warwick,
Coventry, UK

P. May
Princess Royal Hospital, Orthopaedics,
Telford, UK

Table 1 Follow-up studies of unicompartmental implants

Author	Year	Prosthesis	10-year survival
Ansari et al. [1]	1997	St. Georg sled	87%
Argenson et al. [2]	2002	Miller-Galante	94%
Berger et al. [5]	1999	Miller-Galante	98%
Heck et al. [7]	1993	Non-metal-backed	91%
Mercier et al. [17]	2009	Oxford	86%
Murray et al. [18]	1998	Oxford	97%
Naudie et al. [19]	2004	Miller-Galante	90%
Perkins et al. [22]	2002	Zimmer MGII	97%
Rajasekhar et al. [23]	2002	Oxford	94%
Squire et al. [27]	1999	Marmor	90%
Scott et al. [26]	1991	Unicondylar	85%

contraindication, as long as asymptomatic. All patients had a functionally intact anterior cruciate ligament. If the pre-operative status of the anterior or posterior cruciate ligament examination was equivocal, the patient was considered to be a candidate for either unicompartmental or total knee arthroplasty (TKA), and the type of arthroplasty was determined at the time of surgery after inspection of the cruciate ligaments and the uninvolved tibiofemoral and patellofemoral compartments. The contraindications to the procedure were night pain, synovitis and other haematological parameters suggestive of inflammatory arthritis. Patients with a fixed flexion deformity of more than 15° and those with a fixed varus deformity were excluded.

The Miller-Galante unicompartmental arthroplasty system which consists of a cobalt-chromium alloy femoral component and a titanium alloy tibial tray was used in all patients. A standard midline incision and medial parapatellar arthrotomy were used to implant the prosthesis. The patella was everted in all cases to allow for inspection of the cruciate ligaments and both the tibiofemoral compartments. If the anterior or posterior cruciate ligament was found to be totally deficient at the time of surgery, a TKA was performed.

During the period between 1990 and 2006, 94 knees (70 patients) were replaced. Of these 60 were in men and 34 in women. Of these 18 patients (27 knees) died and five were lost to follow-up. In the deceased patients we determined the state of the implant from hospital and general practitioner records establishing if a further surgical procedure had been carried out. Seven revisions had been performed, six by the same surgeon and one elsewhere. The remaining 41 patients (56 knees) attended a follow-up clinic. They were assessed both clinically and radiologically. The clinical assessment was done using the Bristol knee score [14]. The Bristol knee score has a functional component as part of the total knee score. The Bristol knee score assesses pain, deformity and function which includes rising from the chair, walking distance and

stair climbing. The maximum score is 50. A simple questionnaire recorded overall satisfaction with surgery and whether the patients would undergo the same procedure again.

All patients had a long leg view to assess the mechanical axis apart from the routine anteroposterior and lateral radiographs of the knee. The mechanical axes (Fig. 1) of limbs were assessed with long leg views. A line from the centre of the hip was drawn and the zone of intersection on the tibial plateau (Fig. 2) was recorded for each knee as described by Kennedy and White [10]. Appropriate alignment was defined as the mechanical axis passing through the central zone or any of the zones medial to the central zone in medial unicompartmental knee replacements (central or varus) and central or lateral in lateral unicompartmental knee replacements (central or valgus).

Statistical analysis was done using SYSTAT vs. 11 (Systat Software Inc, Point Richmond, CA, USA). Rate of survival was determined using Kaplan-Meier survival analysis using revision of the prosthesis for any cause as the endpoint.

Results

The mean age at surgery was 66.54 years. The mean follow-up was 10.8 years (2–16 years). The mean total Bristol knee score at follow-up was 43.61 (range: 28–50). The mean functional score was 16.3 (9–20). A total of 88% of patients had good or excellent total score and 73% patients had good or excellent functional score. Fifteen patients had a fair/poor functional score while only eight had their total score in the fair/poor category. This discrepancy can be attributed to increasing age, medical co-morbidity and disease in patients with otherwise well implanted joints. The mean range of movement at follow-up was 110.6° (80–130°). Overall, 25 (45%) of the knees had no pain, 24 (43%) mild or occasional pain and 7 (12%)

Fig. 1 Illustration of mechanical axis

moderate pain. All patients stated that they had improved after the procedure.

Seven (10%) patients required blood transfusion. There were no deep infections. Three knees had a superficial wound infection which responded to antibiotics.

On radiological analysis, five (9%) knees showed lucent zones on the tibial side. These were <2 mm, stable and non-progressing. The alignment in 50 knees (89%) was appropriate, i.e. central/varus in medial unicompartmental knee replacements and central/valgus in lateral unicompartmental

Fig. 2 Illustration of tibial plateau divided into various zones as per Kennedy and White [10]

mental knee replacements. Of the 50 knees in appropriate alignment 5 knees had the mechanical axis passing through the appropriate side of the centre of the tibia but outside the tibial plateau itself. This increases the moment arm and possible wear of the prosthesis. In four medial unicompartmental knee replacements, the mechanical axis passed through the lateral compartment, suggesting inadvertent overcorrection. One patient had a total hip replacement (THR) ten years after the medial unicompartmental knee replacement resulting in alteration of alignment. The mechanical axis passing through the lateral compartment resulted in accelerated arthrosis, but he had good function in this knee (Fig. 3). There was a significant correlation between function measured by the Bristol knee score and alignment ($r=0.38$, $p<0.01$). The ideal alignment is when the mechanical axis passes through the inner half (Fig. 4) or the central portion of the tibial plateau (Fig. 5) being replaced.

Seven knees, in total, underwent revisions for either progression of arthritis of the non-replaced compartment or loosening of the prosthesis. Only two medial unicompartmental knees were revised for loosening, at the tenth and the 13th year, respectively.

The Kaplan-Meier survival curves with confidence limits are shown in Fig. 6 for medial unicompartmental knees. The survivorship at ten years is 94% and at 15 years is 87%.

The lateral unicompartmental knee replacements did significantly worse, especially in women. In our series all patients who underwent lateral unicompartmental knee replacements were women. Three of these patients had

Fig. 3 Postoperative image 14 years after medial unicompartmental knee replacement. Four years after THR, the alteration of alignment resulted in accelerated arthrosis of the lateral compartment (Bristol knee score: 42)

Fig. 4 Postoperative image 16 years after medial unicompartmental knee replacement (Bristol knee score: 48)

Fig. 5 Postoperative image at 12 years (mechanical axis showing neutral alignment; Bristol knee score: 48)

overcorrection of the mechanical axis and progression of arthritis in the non-replaced compartment. In two patients, progression of arthritis occurred despite the mechanical axis passing through the replaced compartment, indicating that alignment is not the only factor in the progression of arthritis in the compartment unaffected at the time of surgery. It is possible that in lateral compartment osteoarthritis, early minimal degeneration of the opposite tibiofemoral compartment and patellofemoral compartment are of significance and not to be ignored.

Although lateral unicompartmental knee replacements showed a survivorship of 97% at five years, it dropped to 41% at eight years (Fig. 7).

Fig. 6 Kaplan-Meier survival curves for medial unicompartmental knees

Fig. 7 Kaplan-Meier survival curves for lateral unicompartmental knees

Seven patients in our series had fair results according to the Bristol knee score. They continued to have pain on activity and occasionally at rest. Four of these patients had progression of arthrosis in the non-replaced compartment. Two of the seven patients had overcorrection of the mechanical axis. The other five patients had satisfactory alignment, but three patients showed progression of arthrosis. None of these patients deemed their symptoms bad enough to consider conversion to total knee replacement. It is possible that our method of assessment of lateral and patellofemoral compartments regarding suitability for unicompartmental knee replacements was flawed in some of these patients, which might explain the progression of arthrosis in spite of optimal alignment.

Discussion

The Miller-Galante unicompartmental prosthesis is a fixed-bearing design. Although metal-backed and all polyethylene tibial components are available, all patients in our series had a metal-backed tibial component. The results of this series suggest that this implant can provide excellent relief of pain, restoration of function and durable implant survival at 16 years follow-up, especially for medial compartment osteoarthritis.

The mean age in our series was 66.54 years. Unicompartmental knee replacement is recommended in patients over 65 years by other authors [22, 27]. Although unicompartmental knee replacements in the presence of early radiographic patellofemoral arthritis has been a contentious issue [19], none of the patients in our series required revision for progression of patellofemoral arthritis. This supports our use of clinical assessment and assessment at surgery, rather than radiological changes alone, as the rationale for single compartment resurfacing.

There has been a recent trend towards minimally invasive implantation of medial unicompartmental knee replacements. Although the clinical results of the minimally invasive approach are comparable to the traditional open approach caution has been emphasised by authors especially during the surgeon's learning curve [13]. All the patients in this series had the prosthesis implanted via an open approach as visual inspection of the lateral (or medial) compartments and the patellofemoral joints was a critical part of the assessment of suitability for medial unicompartmental knee replacement.

The effect of alignment on function has been reported and undercorrection of the deformity has been recommended [10]. In our series overcorrection of the alignment and resultant loading of the unaffected compartment resulted in accelerated arthrosis and conversion to TKA. Although progression of arthrosis in the unaffected compartments was the most common cause of early revision, one patient with an overloaded medial compartment, secondary to a lateral unicompartmental knee replacement, had good Bristol knee scores at ten years follow-up. Another patient had the mechanical axis passing through the lateral unaffected compartment following a THR ten years after the medial unicompartmental replacement. This inadvertent change of alignment resulted in accelerated arthrosis of the lateral compartment without significant deterioration in function at 14 years. This has been reported by other authors [6].

The rate of survival of implants in medial unicompartmental knee replacements is comparable to other reports of both fixed and mobile bearing designs [1, 2, 5, 7, 14, 18, 22, 23, 26, 27] (Table 1). Recent series with a large number of patients have reported higher revision rates for medial unicompartmental replacements [6], but once technical errors and surgeon-related complications were discounted good survival rates were reported [17]. Although the survival rates of lateral unicompartmental knee replacements in large series have been reported to be lower than medial unicompartmental knee replacements [3], the survival rate of lateral unicompartmental knees in our series beyond five years is disappointing. The majority of revisions were due to progression of arthrosis in the unaffected compartment. Although the number of patients (nine patients) who had lateral unicompartmental knee replacements is too small to make significant inferences about survival rates in this group of patients, we believe lateral unicompartmental knee replacements behave differently from medial unicompartmental knee replacements. A recent report with a very high rate of survival in lateral unicompartmental knee replacements has recommended placing the tibial plate in internal rotation to counter the effects of the 'screw home' phenomenon [21].

The knees that required revision had conversions to total knee replacements. Neither removal of cement nor loss of

bone stock was a significant problem at the time of surgery. In our experience the conversions were relatively straightforward as has been the experience of many other authors [2, 5, 16]. There have been reports with larger numbers of conversions to total knee replacements requiring metal wedges and allografts [9, 25] in the presence of loosening and osteolysis. The functional results of unicompartmental knees converted to total knee replacements have been found to be worse than primary knee replacements [9], but the improved kinematics and consistently better knee scores [15, 20, 28] in successful medial unicompartmental knee replacements justify their use over total knee replacements in appropriate patients.

The use of Bristol knee scores in the assessment of unicompartmental knee replacements has not been validated, although it has been used by previous investigators [14]. The discrepancies between the total score and the function score would account for variations in patients due to comorbidities even in the presence of good knee function. The Bristol knee score when compared to the Hungerford, Hospital for Special Surgery and Knee Society scores has been reported to have excellent interobserver reliability [4]. Most authors reporting on the results of Miller-Galante knee replacements have used other scoring systems, which makes direct comparison of function between cohorts difficult. This is a limitation of this study.

Conclusions

The results for medial unicompartmental knee replacements are similar to reports by other authors for similar and mobile bearing designs. Medial unicompartmental knee replacement results in good function with very good survival rates at 16 years. Conversions to total knee replacements, when necessary, have not been technically difficult procedures.

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