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Midterm results of mobile-bearing knee replacements

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Abstract We examined the clinical and radiographic results of 93 patients affected by knee arthritis or osteonecrosis subjected to unilateral cementless mobile-bearing total knee arthroplasty with the LCS prosthesis (Depuy/Johnson & Johnson). The mean follow-up was 9.5 years (range, 7–12 years). Clinical evaluation was performed using the Knee Society rating system, while radiographic evaluation was done according to the Knee Society roentgenographic system. At the latest follow-up, the mean knee score was 87 points: the func-

tional score improved from 40 to 90. Radiolucent lines were small and not progressive. The implant survival at 12 years was 88%. Six knees (7%) required revision for implant-related problems. We conclude that the mobile-bearing prosthesis is a successful device even at long-term follow-up.

Key words Cementless knee prosthesis • Mid-term follow-up • Osteoarthritis • Rotating platform mobile bearing knee • Total knee replacement

Introduction

Models of mobile-bearing total knee prostheses available to orthopaedic surgeons historically have come in either of two basic functional designs: the rotating platform or the anatomical meniscal-bearing knee. The LCS Rotating Platform knee prosthesis is indicated in knees considered to have a non-functional posterior cruciate ligament (PCL). Meniscal bearings are indicated in presence of a functional PCL. The main benefit of the mobile bearing's ability to move and rotate on the tibial tray is its potential to produce large areas of contact, approximately 1000–1500 mm². Such high in surface congruity allowed reduction of bearing contact stresses to within tolerable limits (10 Mpa) compared to 25–32 MPa in fixed-bearing knees [1–4].

The current study assessed the long-term outcome of mobile-bearing total knee arthroplasty.

Materials and methods

Ninety-three patients with osteoarthritis (75 patients) or osteonecrosis (18 patients) underwent unilateral cementless total knee arthroplasty using the LCS Rotating Platform total knee prosthesis (Depuy/Johnson & Johnson, Warsaw, USA). The patients' mean age at the time of operation was 69.5 years (range, 60–80 years). None of the patients had rheumatoid arthritis, muscular atrophy or collateral ligaments deficiency; no patient had previously undergone other surgical procedures (e.g. tibial osteotomy, knee arthroplasty).

All operations were performed using a combination of intramedullary femoral and extramedullary tibial alignment guides. The surgery was performed through a straight midline incision combined with a median parapatellar capsular approach. A sub-periosteal medial capsular elevation was performed. Flexion contracture was corrected by removal of posterior osteophytes and, when necessary, by elevation of the capsule from the posterior femur. The flexion and the extension spaces were balanced using spacers. The patella was never resurfaced.

On the fourth postoperative day, patients began knee motion using a continuous passive motion machine for 4–5 hours daily. On the fifth day, they were allowed to bear weight using 2 canes.

The patients returned for clinical examination and radiographic evaluation. Clinical evaluation was done using the rating system of the Knee Society [5]. The system is subdivided into a knee score that rates only the knee joint itself and a functional score that rates the patient's ability to walk and climb stairs: 100 points are obtained by a "well-aligned" knee with no pain, 125° of motion and negligible anteroposterior and medio-lateral instability. The maximum functional score, which is also 100, is obtained by a patient who can walk an unlimited distance and go up and down stairs normally.

The Knee Society's roentgenographic evaluation system was developed for uniform reporting of the results of total knee arthroplasty [6]. For the tibia and femur, five to seven zones are assigned and three to five zones are assigned for the patella. The score for each of the three components (tibia, femur, patella) is determined by summing the widths of the radiolucent lines for each of the zones.

Statistical analysis was done using a 2-tailed paired *t* test with level of significance set at $p=0.05$. Implant survival was examined using the life table method [7]. The patients who required a revision, who had a poor clinical knee score or who had evidence of radiographic loosening, massive bearing wear or bearing dislocation, were considered to have failed results.

Results

We performed unilateral cementless total knee arthroplasty in 93 elderly patients (Table 1). Preoperatively, pain was rated as moderate or severe in 92 patients (99%). At the last follow-up, performed at a mean of 9.5 years (range, 7–12 years) after surgery, 85 patients (91%) reported occasional or no pain. The average range of

motion improved from 93° preoperatively to 110° postoperatively ($p=0.042$). Postoperatively, 88 patients had less than 5 mm anteroposterior motion and 86 patients had less than 5° varus or valgus motion in full extension. The mean preoperative Knee Society combined score was 97 out of 200 (knee score, 57; functional score 40; 95% confidence interval, 87 to 101). This improved significantly to a mean combined score of 177 (knee score, 87; functional score 90; 95% confidence interval, 171 to 186; $p=0.039$).

Radiolucent lines occurred on the tibial plateau (Table 2) but were small and none was progressive. No radiolu-

Table 2 Periprosthetic radiolucencies according to the Knee Society scoring system

	Zone	Radiolucencies ≤2 mm n (%) of patients
Femoral lateral view	
	1	0 (0)
	2	0 (0)
	3	0 (0)
Tibial anteroposterior view	
	5	7 (7.5)
	6	3 (3)
	7	5 (5)
Tibia lateral view	
	8	5 (5)
	9	3 (3)
	10	5 (5)

Table 1 Clinical characteristics of 93 patients with osteoarthritis or osteonecrosis, before surgery and at the latest available follow-up

	Before surgery	Latest follow-up	<i>p</i> ^a
Pain rating, no. of patients			ND
Severe	92 (99%)	-	
Moderate	92 (99%)	8 (9%)	
Occasional	1 (1%)	85 (91%)	
None	-	85 (91%)	
Range of motion, mean (SD)	93	110	0.042
Anteroposterior motion <5 mm, no. of patients	90	88	-
Varus or valgus motion in extension <5°, no. of patients	90	86	-
Knee Society score, mean (95% CI)			
Combined	97 (87-101)	177 (171-186)	0.039
Knee score	57	87	
Functional score	40	90	

CI, confidence interval

^a Paired, two-tailed *t* test

Table 3 Survival rates of mobile-bearing knee prostheses

Reference	Year	Cases, <i>n</i>	Type	Survival rate
Sorrells [18]	1996	665	Rotating platform	95% at 11 years
Stiehl and Voorhorst [15]	1999	44	Rotating platform	100% at 7 years
Sorrells et al. [16]	2001	117	Rotating platform	88% at 14 years
Buechel et al. [17]	2001	109	Rotating platform	97% at 10 years
Callaghan [19]	2001	119	Rotating platform	100% at 12 years
Huang et al.	2003	267	Meniscal bearings	92% at 15 years

cencies greater than 2 mm were observed and no continuous lines were apparent around any component.

The incidence of anterior knee pain was 9% (8 patients); however, only one patient had pain severe enough to require medication. Six knees (7%) required revision surgery for implant-related problems (e.g. malpositioning in varus, severe polyethylene wear, periprosthetic osteolysis, infection). The estimated 12-year implant survival rate was 88%.

Discussion

Retaining or sacrificing the posterior cruciate ligament (PCL) remains an open question. Some authors [8, 9] believe that prostheses with PCL have better kinematics. Dennis et al. [9] observed that PCL-retaining total knee prostheses had higher magnitudes of translation during knee bending than did PCL-sacrificing knee prostheses. Alexiades and Scott [10] showed that the microscopic nature of the ligament was not normal, but was characterized by fibrillation, calcification, vacuole formation and inclusion bodies. Histological damage to the PCL can make retention dubious and detrimental to the outcome of arthroplasty [11, 12]. In 1996, Laskin [13] reported the late results (10 years) of retaining the PCL in patients with severe varus or valgus and flexion deformities. In this group of patients, there was an increased incidence of pain and bone cement radiolucencies, and a higher revision rate. In the study of Matsuda et al. [14], approximately half of the knees that underwent PCL-retaining total knee arthroplasty did not have a good anteroposterior stability in flexion at an average of 9 years after surgery. These knees were considered to have a non-functional PCL. These results suggest that for almost all patients with a fixed varus deformity, PCL release should be performed and a posterior stabilized implant should be used.

Mobile-bearing total knee prostheses with adequate ligamentous stability have had favourable short to mid-

term results, with a survival of 92%–100% at 7–15 years (Table 3). Stiehl and Voorhorst [15] reported an overall 7-year implant survival of 100%. Sorrells et al. [16] evaluated the long-term results of 117 total knee arthroplasties in 99 patients younger than 65 years, and found an overall revision rate of 7% and survival at 14 years of 88%. Buechel et al. [17] evaluated 109 knee replacements that were followed more than 10 years. The 10-year survival of cemented prostheses was 97% and the 6-year survival of the uncemented prosthesis was 98%. Independent observers showed that the implant survival rate was 95% at 11 years for 665 cemented LCS prostheses [18] and 100% at 12 years for 119 cementless LCS prostheses [19]. Huang et al. [20] reported a survival of 92% at 15 years. In the current study, implant survival was 88% at 12 years; the overall revision rate was 7% (6 patients).

The average functional knee score was 90, which compares favourably with scores reported in other studies [15, 16]. The incidence of radiolucent lines was low, with the highest rate seen about the tibial component. Radiolucent lines were present immediately postoperatively or appeared within the first year; they were not progressive.

Polyethylene wear is an important mechanism of failure. In our study, bearing wear was low (only two patients required revision for polyethylene wear), similar to the results reported by Sorrells [18], Schai et al. [21] and Aebli et al. [22] who found minimal changes of the tibial insert compared with the incidence of wear in fixed-bearing total knee arthroplasty.

To resurface the patella remains one of the most controversial topics in total knee arthroplasty. Misra et al. [23] wrote that anterior knee pain after knee replacement is independent of patella resurfacing; other clinical studies with and without patellar resurfacing have reported variable results [24, 25]. In the literature, the frequency of complications related to resurfacing the patella, such as maltracking, patellar fracture, patellar tendon rupture and anterior knee pain, range from 4% to 21% [26, 27]. Arbuthnot et al. [25], Barrack [28] and Muller and Wirz

[29] observed that, because of high costs and high rate of complications, resurfacing the patella is not always justified. Boyd et al. [30] and Picetti et al. [31] reported higher incidences of anterior knee pain with unresurfaced patella. Ishii et al. [32] using the PCF Knee (Johnson & Johnson), Braakman et al. [33] with the Miller-Galante (Zimmer), Abraham et al. [34] with the variable axis knee (Howmedica), and Keblish et al. [35] with the LCS knee (De Puy) reported no difference in functional results between patients with and without patellar resurfacing.

Because of the highly variable reports in the literature, there is no consensus for the indications.

Even if in the LCS mobile-bearing knee patellar problems are low (fracture and subluxation occur in 2.6% of cases and radiolucent lines in 3% [17]), we believe that patellar resurfacing is responsible for potential complications and that nonresurfacing of the patella is the best choice. Recent improvements in instrumentation and careful attention to ligamentous balancing may have eliminated several of the failures seen in the past. Because longer follow-up is required, we think that the mobile-bearing knee prosthesis is not the end-all but merely a major advance. In our opinion, it might be the way forward to have a high success rate after 10 years or more.

References

1. Callaghan JJ, Insall JN, Greenwald AS (2000) Mobile-bearing knee replacement concepts and results. *J Bone Joint Surg Am* 82:1020–1041
2. Draganich LF, Pottenger LA (2000) The TRAC PS mobile bearing prosthesis: design rationale and in-vivo 3-dimensional laxity. *J Arthroplasty* 15:102–112
3. Insall JN (1989) Adventures in mobile-bearing knee designs: a mid-life crisis. *Orthopedics* 21:1021–1023
4. Kaper BP, Smith PN, Bourne RB (1999) Medium-term results of a mobile bearing total knee replacement. *Clin Orthop Relat Res* 367:201–209
5. Insall JN, Dorr LD, Scott RD (1989) Rationale of the Knee Society clinical rating system. *Clin Orthop Relat Res* 248:13–14
6. Ewald FC (1989) The Knee Society total knee arthroplasty roentgenographic evaluation and scoring system. *Clin Orthop Relat Res* 248:9–12
7. Kaplan EP, Meier P (1958) Non parametric estimation from incomplete observations. *J Am Stat Assoc* 53:457–481
8. Ishii Y, Terajima K, Koga Y et al (1998) Gait analysis after total knee arthroplasty. Comparison of posterior cruciate retention and substitution. *J Orthop Sci* 3:310–317
9. Dennis DA, Komistek RD, Mahfouz MR et al (2003) Multicenter determination of in vivo kinematics after total knee arthroplasty. *Clin Orthop Relat Res* 16:37–57
10. Alexiades M, Scott WN (1988) Histologic study of the posterior cruciate ligament in the arthritic knee. *Am J Knee Surg* 2:18–23
11. Allain J, Goutallier D, Voisin C (2001) Macroscopic and histological assessments of the cruciate ligaments in arthrosis of the knee. *Acta Orthop Scand* 72:266–269
12. Kleinhart FA, Bryk E, Evangelista J (1996) Histologic comparison of posterior cruciate ligaments from arthritic and age-matched knee specimens. *J Arthroplasty* 11:726–731
13. Laskin RS (1996) Total knee replacement with posterior cruciate ligament retention in patient with a fixed varus deformity. *Clin Orthop Relat Res* 331:29–34
14. Matsuda S, Miura H, Nagamine R (1999) Knee stability in posterior cruciate ligament retaining total knee arthroplasty. *Clin Orthop Relat Res* 366:169–173
15. Stiehl JB, Voorhorst PE (1999) Total knee arthroplasty with a mobile bearing prosthesis: comparison of retention and sacrifice of the posterior cruciate ligament in cementless implant. *Am J Orthopedics* 28:223–228
16. Sorrells RB, Stiehl JB, Voorhorst PE (2001) Midterm results of mobile-bearing total knee arthroplasty in patients younger than 65 years. *Clin Orthop Relat Res* 390:182–189
17. Buechel FF, Buechel FF, Pappas MJ (2001) Twenty-year evaluation of meniscal bearing and rotating platform knee replacement. *Clin Orthop Relat Res* 388:41–50
18. Sorrells RB (1996) The rotating platform mobile bearing total knee replacement. *Orthopedics* 19:793–796
19. Callaghan JJ (2001) Mobile-bearing knee replacement. Clinical results. *Clin Orthop Relat Res* 292: 221–225
20. Huang CH, Ma HM, Lee YM, Ho FY (2003) Long-term results of low contact stress mobile-bearing total knee replacements. *Clin Orthop Relat Res* 416:265–270
21. Schai PA, Thornhill TS, Scott RD (1998) Total knee arthroplasty with the PFC system: results at minimum of ten years and survivorship analysis. *J Bone Joint Surg* 80:850–858
22. Aebli N, Krebs J, Schwenke D et al (2004) Progression of radiolucent lines in cementless twin-bearing low-contact-stress knee prostheses: a retrospective study. *J Arthroplasty* 19:783–789
23. Misra AN, Smith RB, Fiddian NJ (2003) Five year results of selective patellar resurfacing in cruciate sparing total knee replacements. *Knee* 10:199–203
24. Burnett RS, Bourne RB (2004) Indications for patellar resurfacing in total knee arthroplasty. *Instr Course Lect* 53:167–186
25. Arbuthnot JE, McNicholas MJ, McGurty DW, Rowley DI (2004) Total knee replacement and patellofemoral pain. *Surgeon* 2:230–233
26. Malkani AL, Rand JA, Bryan RS (1995) Total knee arthroplasty with kinematic condylar prosthesis; a ten year follow-up study. *J Bone Joint Surg Br* 77:423–431

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27. Stulberg SD, Stulberg BN, Hamati Y (1988) Failure mechanism of metal-backed patellar components. *Clin Orthop Relat Res* 236:88–105
 28. Barrack RL (2003) Orthopaedic cross-fire—All patellae should be resurfaced during primary total knee arthroplasty: in opposition. *J Arthroplasty* 18[3 Suppl 1]:35–38
 29. Muller W, Wirz D (2001) The patella in total knee replacement: does it matter? 750 LCS total knee replacements without resurfacing of the patella. *Knee Surg Sports Traumatol Arthrosc* 9[Suppl 1]:S24–S26
 30. Boyd AD, Ewald FC, Thomas WH (1993) Long-term complication after total knee arthroplasty with or without resurfacing patella. *J Bone Joint Surg Am* 75:674–681
 31. Picetti GD III, McGann WA, Welch RB (1990) The patello-femoral joint after total knee arthroplasty without patellar resurfacing. *J Bone Joint Surg Am* 72:1379–1382
 32. Ishii Y, Terajima S, Bechtold JE (1997) Comparison of joint position sense after total knee arthroplasty. *J Arthroplasty* 12:541–545
 33. Braakman M, Verburg AD, Bronsema G (1995) The outcome of three methods of patella resurfacing in total knee arthroplasty. *Int Orthop* 19:7–11
 34. Abraham W, Buchanan JR, Daubert H (1988) Should the patella be resurfaced in total knee arthroplasty? *Clin Orthop Relat Res* 236:128–134
 35. Keblish PA, Varma AK, Greenwald AS (1994) Patellar resurfacing or retention in total knee arthroplasty. *J Bone Joint Surg Br* 76:930–937