Bilateral total knee arthroplasty: One mobile-bearing and one fixed-bearing

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ABSTRACT

We compared the early results of mobile-bearing knee prosthesis with fixed-bearing knee prosthesis in 16 patients who had one-stage, sequential, bilateral replacements. In each patient, a Low Contact Stress (LCS, Depuy) rotating-platform prosthesis was inserted in one side, and an Anatomic Modular Knee (AMK, Depuy) posterior-stabilised prosthesis was inserted in the other side. The same surgical routines were adopted for both sides in each patient. There were significant improvements in the Knee Society knee score and functional score, as well as the Oxford Knee score after both mobile-bearing and fixed-bearing knee replacements \((p < 0.001)\). However, we could not find any significant difference between the clinical results of the two prostheses. The authors’ early experience with the mobile-bearing total knee prosthesis was as favourable as the medium-term experience of the fixed-bearing total knee prosthesis in this prospective, match-pair study.

Key words: total knee arthroplasty, mobile-bearing

INTRODUCTION

In recent years, mobile-bearing total knee arthroplasty (TKA) has gained a lot of popularity. In mobile-bearing TKA, the polyethylene insert articulates with a metallic femoral component and a metallic tibial tray. Such a dual-surface articulation is designed to gain low contact stress and low constraint forces. The congruity or conformity of the femorotibial articulation can be maximised to reduce the contact and subsurface stresses, which in turn minimises polyethylene wear. The mobility of the polyethylene insert permits rotation and gliding; the load can thus be shared by the soft tissues, and there is less loosening stress being transferred to the bone-prosthesis interface.

Almost every manufacturer has introduced a mobile-bearing TKA system, or is developing one to introduce into the market. However, most studies on the outcomes of mobile-bearing TKA are open studies. We could not find any report that compared mobile-bearing and fixed-bearing TKA. We report the early results of a small series of patients, which are unique due to the match-pair study design. Each of the patients had one-stage, sequential, bilateral replacements. A mobile-bearing prosthesis was inserted in one knee, and a fixed-bearing prosthesis was inserted in the other knee.
MATERIALS AND METHODS

From March 1997 to December 1998, 22 consecutive patients were included in a study. To be included, the two knees of each patient had to be similarly affected. A fixed-bearing total knee prosthesis (posterior-stabilized design of Anatomic Modular Knee, AMK, Depuy) was inserted in one knee, and a mobile-bearing total knee prosthesis (rotating platform design of Low Contact Stress, LCS, Depuy) (Fig. 1) was inserted into the other knee of each patient. Both sides were replaced on the same day under the same anaesthesia in a sequential manner (Fig. 2a & b). There was no strict guideline on which knee was to be replaced first or which knee was to receive the mobile-bearing knee prosthesis.

Six patients were excluded. In three patients, the mobile-bearing prostheses were inserted without cement. The post-operative rehabilitation of this side was modified. Protected weight bearing was practiced in the initial six weeks, which was different from the fixed-bearing side. One patient had deep infection and septic loosening of the mobile-bearing knee replacement, which was revised in a two-stage manner 18 months after surgery. The second patient suffered from rheumatoid arthritis; the tibial component of the fixed-bearing knee was radiologically loose three years after the operation. The third patient had poor motivation and needed manipulations and open releases of both knees for poor range of motion.

This left 16 patients for analysis, and all of them were followed up for a minimum of one year. The mean follow-up period was 24 months (S.D. 4, range 16–29). There were 2 men and 14 women. The average age at the time of operation was 68 years (S.D. 8 years, range 51–79). The underlying knee diseases that led to replacements were osteoarthritis in 14 patients and rheumatoid arthritis in 2 patients.

The surgical routines were the same for the two sides in each patient. A three-foot standing, long film of both lower limbs was routinely taken before the knee replacements. Pre-operative planning was done by templating and drawing out the axes and the bone cuts at distal femur and proximal tibia. The aim was to restore the mechanical axis of the lower limb, with the centres of hip, knee and ankle falling on the same line. The operation was performed in an operating theatre equipped with a vertical laminar airflow system. Every surgical team member used the body exhaust system. One dose of cephalixin was administered at the time of induction of anaesthesia, and another dose was given about 30 minutes before the tourniquet was inflated in the second knee. No drug was given for prevention of thromboembolism or heterotopic ossification. All operations were performed via the Insall’s approach with a thigh tourniquet. For the proximal tibia cut, an extramedullary guide was routinely used. An intramedullary guide was routinely used in the femoral side, with the entry hole and angle of distal femoral cut determined by the pre-operative planning. Post-operatively, the patients had active mobilization of their knees. No continuous passive motion machine was given.

The scoring system of the Knee Society was used to rate the patient’s overall function (maximum score 100 points) and the performance of the replaced knee (maximum score 100 points). The flexion range and the presence of flexion contracture were carefully assessed using goniometer measurement. An Oxford knee score (12 items, 5 points each; best case 12 points, worst case 60 points) questionnaire was filled in before surgery, and at the time of the final follow-up. Also at the final follow-up, the patients were asked to which side they preferred or if the two sides were the same.

The differences in Knee Society knee scores, knee flexion and flexion contracture, change in motion arc, and the Oxford knee scores between the fixed-bearing knees and the mobile-bearing knees were assessed. The differences in the Knee Society knee scores, knee flexion and flexion contracture, and the Oxford knee scores of the fixed-bearing knees, the mobile-bearing knees and all the knees before and after surgery were also studied. Since the study was of a match-pair design, the paired t tests were used in the statistical evaluation. Significance was assumed if the p value was less than 0.05.

RESULTS

Knee Society Knee Scores

Before surgery, the average Knee Society knee score was 49.7 points (S.D. 12.0, range 32–80) for all the knees. The average Knee Society knee score for all the knees at final follow-up was 86.7 points (S.D. 11.9, range 47–99). The improvement was statistically significant (p < 0.001).

Before surgery, the knee score was 48.6 points (S.D. 10.4, range 36–70) for the fixed-bearing knees and 50.8 points (S.D. 13.7, range 32–80) for the mobile bearing knees; the difference was insignificant (p = 0.37). At final follow-up, the knee score was 88.2 points (S.D. 10.1, range 58–99) for the fixed-bearing knees and 85.3 points (S.D. 13.7, range 47–97) for the mobile bearing knees; the difference was also insignificant (p = 0.39).
Knee Society Functional Scores

Before surgery, the average Knee Society functional score was 46.9 points (S.D. 17.2, range 5–70). The average score at final follow-up was 70.6 points (S.D. 19.0, range 30–100). The improvement was statistically significant (p = 0.001).

Range of Motion

Before surgery, the average knee flexion was 108.1° (S.D. 25.2, range 30–125), and the average flexion contracture was 8.9° (S.D. 7.8, range 0–30) for all the knees. There was no difference between the mobile-bearing and the fixed-bearing knees. The pre-operative knee flexion was 110.6° (S.D. 24.6, range 30–125) for the fixed-bearing knees and 105.6° (S.D. 26.4, range 30–125) for the mobile-bearing knee (p = 0.21). The pre-operative flexion contracture was 8.1° (S.D. 7.5, range 0–25) for the fixed-bearing knees and 9.7° (S.D. 8.3, range 0–30) for the mobile-bearing knee (p = 0.19).

At final follow-up, the average knee flexion was 97.0° (S.D. 15.9, range 60–140) for all the knees; it significantly decreased compared with before surgery (p = 0.029). The average flexion contracture was corrected to 1.3° (S.D. 6.1, range –10–25) for all the knees; it was significantly better than before surgery (p < 0.001). There was no difference between the mobile-bearing and the fixed-bearing knees. The knee flexion at final follow-up was 96.9° (S.D. 11.2, range 80–120) for the fixed-bearing knees and 97.2° (S.D. 19.9, range 60–140) for the mobile-bearing knees (p = 0.94). The flexion contracture at final follow-up was 1.6° (S.D. 7.2, range –10–25) for the fixed-bearing knees and 0.9° (S.D. 4.9, range –10–15) for the mobile-bearing knees (p = 0.32).

The motion arc of the fixed-bearing knees averaged 102.5° (S.D. 25.9, range 25–125) before surgery and 95.3° (S.D. 14.2, range 65–120) at final follow-up; the average loss of motion was 7.2° (S.D. 27.3, range 75–40). The average motion arc of the mobile-bearing knees was 95.9° (S.D. 28.2, range 30–125) before surgery and 96.3° (S.D. 18.2, range 60–125) at final follow-up; the average gain of motion was 0.3° (S.D. 30.1, range 65–70). However, the difference in the change in motion arc between fixed-bearing and mobile-bearing knees did not reach statistical significance (p = 0.21).

Oxford Knee Scores

Before surgery, the average Oxford knee score was 42.1 points (S.D. 5.9, range 32–50) for all the knees. The improvement was statistically significant (p < 0.001). Before surgery, the Oxford knee score was 42.1 points (S.D. 5.9, range 32–50) for the fixed-bearing knees and 42.0 points (S.D. 6.2, range 32–51) for the mobile bearing knees; the difference was insignificant (p = 0.70). At final follow-up, the Oxford knee score was 24.1 points (S.D. 6.7, range 13–35) for the fixed-bearing knees and 24.0 points (S.D. 6.8, range 13–38) for the mobile bearing knees; the difference was also insignificant (p = 0.84).

Subjective Assessment

Thirteen patients did not feel any difference between the two knees. Three patients preferred the side with the mobile-bearing knee. No patient preferred the side with the fixed-bearing knee.

DISCUSSION

The Low Contact Stress (LCS) mobile-bearing knee system was introduced more than 20 years ago to address the problems of polyethylene wear and loosening of the tibial component. The LCS femoral component has an anatomical articulating surface, and the radii of curvature decrease posteriorly. The LCS femoral and tibial components conform in the sagittal plane, from full extension to 60° of flexion to optimise the contact area, and conform less from 60° of flexion to full flexion due to the decreasing radii of curvature of the femoral component articulating surface posteriorly. Since most of the daily walking occurred during the first 30° of flexion, the less congruent contact beyond 60° of knee flexion is considered to be acceptable and takes part only during the less frequent activities. The LCS tibial component includes a meniscal-bearing design (posterior-cruciate-retaining) and a rotating-platform design (posterior-cruciate-sacrificing). The LCS patellar component has a congruent articulating surface, and the polyethylene part rotates on the metal back to provide the needed axial rotation during patellar tracking. The fixation of the components can be cemented or cementless.

In our centre, we have not retained the posterior cruciate ligament when performing TKA for over ten years. When we started to insert mobile-bearing TKA in 1997, we decided to use the rotating-platform design. The LCS rotating-platform design has a relatively deep sagittal-plane conformity and is inherently stable in the anteroposterior direction. The polyethylene insert has a center post that mates with...
the hollow within the post of the tibial tray to allow rotation but no translation (Fig. 1). Sorrells reported his personal series of 665 consecutive cementless rotating-platform LCS knee replacements. The cementless LCS mobile bearing patella was routinely used. The average age at operation was 70 years, and 84% of knee replacements were for osteoarthritis. There were five patellofemoral subluxations (0.9%), one tibial polyethylene wear (due to poor quality polyethylene), one tibial component loosening (due to late sepsis) and one femorotibial subluxation that occurred one month after the operation. The cumulative survival rate, using revision as end-point, was 94.5% at 11 years. Callaghan et al. reviewed the nine to 12-year follow-up results of 119 consecutive cemented rotating-platform LCS knee replacements in 86 patients. The patellar component used was an all-polyethylene dome-shaped design rather than the LCS design. The average age at operation was 70 years (range 37–88), and the diagnosis was mostly osteoarthritis. Only four patients (five knees) were lost to follow-up. None of the other patients required a re-operation. Forty-nine patients (66 knees) returned for final clinical and radiographic assessments after nine to 12 years; they enjoyed good Knee Society knee scores (mean 90 points, range 63–100) and functional scores (mean 75 points, range 30–100). The average active range of motion was from 0° (range 0–10) on extension to 102° (range 15–120) on flexion. There was no loosening or periprosthetic osteolysis on follow-up radiographs.

These two studies showed that mobile-bearing TKA could achieve the objectives of improving the wear resistance and decreasing the loosening rate. The follow-up of the present study was too short to make any conclusive remark about these issues. However, we could tell from the present study whether the mobile-bearing TKA could perform as well as the fixed-bearing TKA in terms of the clinical parameters. This could answer queries such as whether mobile-bearing TKA was more difficult to insert and thus more difficult to achieve good short term clinical results. Our study was unique since we compared the mobile-bearing TKA and fixed-bearing TKA by inserting them into the two knees of the same patient. This minimised the effects of many compounding factors when two different cohorts of patients were compared. We were not aware of any other similar study.

Figure 1 The LCS rotating-platform knee prosthesis.
Figure 2  (a) Anteroposterior view of both knees before the operation. The two knees were similarly affected and had very comparable pre-operative scores. (b) Anteroposterior view of both knees after the operation. A fixed-bearing AMK knee was implanted into the left knee and a mobile-bearing (LCS) knee was implanted into the right knee on the same day.
We found that the mobile-bearing TKA performed as well as the fixed-bearing TKA in the early period. It was important to point out that although the two sides were otherwise matched, the surgical experience was not so. The AMK posterior-stabilized prosthesis has been used in our institution since 1993. We implanted more than 300 AMK posterior-stabilised knees from 1993 to 1997. We started to use the LCS rotating-platform prosthesis only in late 1997. This study was thus comparing the results of a knee system that we had been acquainted with and the results of a new system that was at that time still in the learning curve. Impressed by the favourable early results even when we were not too experienced with it, we were reassured to extend the use of mobile-bearing knee prosthesis to most of our patients. Since early 1999, the LCS rotating-platform TKA has become the knee prosthesis of choice in our unit.

REFERENCES