Impact of a mobile-bearing total knee arthroplasty design on non-resurfaced patellar tracking: comparative study with fixed-bearing total knee arthroplasty

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Background

Unlike fixed-bearing total knee arthroplasty (TKA), mobile-bearing TKA is designed to accommodate for small mismatches in the rotational position of the femoral and tibial components owing to mobility of the bearing insert. Thereby, central patellar tracking is potentially facilitated. The aim of this study is to determine whether the incidence of lateral retinacular release would be lower in knees replaced with a mobile-bearing TKA as compared with a fixed-bearing TKA design.

Patients and methods

A standardized surgical technique was applied in 64 consecutive cases with advanced varus osteoarthritis. A single cruciate-substituting knee design was used in all patients. The selection of a fixed-bearing versus mobile-bearing TKA was made primarily on the basis of knee stability, age, and lifestyle activities. There were 39 women and 25 men in the study, mean age 64.5 years (range, 56–77 years). A mobile-bearing TKA design was implanted in half of the cases (32) and a fixed-bearing design was equally implanted in the other half.

Results

The overall lateral retinacular release rate in this study was 12.5% (eight of 64 knees). The incidence of lateral retinacular release was higher ($P < 0.005$) for knees replaced with a fixed-bearing tibial component (18.7%, six of 32 knees) than for knees replaced with a mobile-bearing tibial component (6.25%, two of 32 knees). The overall incidence of postoperative patellar tilt of 5° or more shown on Merchant follow-up radiographs of the patella was 14% (nine of 64 knees). The incidence of residual patellar tilt was slightly higher in the fixed-bearing group (15.6%, five of 32) than in the mobile-bearing group (12.5%, four of 32). In both the fixed-bearing group ($P = 0.053$) and the mobile-bearing group ($P = 0.012$), the amount of patellar tilt was higher in patients in whom a lateral retinacular release was not performed. No patient in either study group showed patellar subluxation of more than 5 mm on follow-up radiographs.

Conclusion

In conclusion, the current study showed that decreased incidence of lateral retinacular release could be one potential advantage of the mobile-bearing TKA design. However, further long-term follow-up studies are still required to document other theoretical benefits of mobile-bearing TKA with respect to reduced polyethylene wear, durable long-term fixation, and patellofemoral performance.

Keywords:

fixed-bearing total knee arthroplasty, mobile-bearing total knee arthroplasty, total knee arthroplasty

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Introduction

Current total knee prosthetic devices are subdivided into two groups on the basis of mobility of the polyethylene bearing. In fixed-bearing knees, the polyethylene tibial insert is locked into the tibial tray, whereas in mobile-bearing total knee arthroplasty (TKA) designs, motion of the polyethylene insert relative to the tibial tray is permitted [1].

Interest in mobile-bearing TKA [2–4] has been related to the kinematic analyses showing a rotating-platform polyethylene insert that self-aligns with the femoral component during knee flexion, independent of the rotation of the tibial tray. Unlike fixed-bearing TKA, mobile-bearing TKA is designed to accommodate for small mismatches in the rotational position of the femoral and tibial components owing to mobility of the bearing insert. Thus, central patellar tracking is potentially facilitated, decreasing the need for lateral retinacular release and postoperative patellar tilt or subluxation.

Study conducted in Ain Shams University Hospital, Department of Orthopaedic Surgery, Ain Shams University, Cairo, Egypt

However, Pagnano *et al.* [5] reported no difference in the incidence of lateral retinacular release in a multisurgeon analysis of 160 fixed-bearing versus 80 rotating-platform posterior-stabilized TKA patients.

The aim of this study is to determine whether the incidence of lateral retinacular release would be lower in knees replaced with a mobile-bearing TKA design implanted using a standardized surgical technique as compared with a fixed-bearing TKA design.

Patients and methods

Primary bicompartmental TKA was performed for 64 consecutive patients with advanced varus osteoarthritis between June 2006 and March 2011. The TKA procedure was performed using a standardized surgical technique in which all patients were implanted with a single cruciate-substituting knee design (Nexgen; Zimmer Orthopedics Inc., Warsaw, Indiana, USA). The tibial component was either a mobile-bearing tibial design or a fixed-bearing tibial design. The selection of a fixed-bearing versus a mobile-bearing TKA was made primarily on the basis of knee stability, age, and lifestyle activities, with stable knees in patients younger than 65 years of age receiving a mobile-bearing TKA. There were 39 women and 25 men in the study, mean age 64.5 years (range, 56–77 years). Mobile-bearing TKA devices were implanted in 32 cases and fixed-bearing knees were equally implanted in the remaining 32 cases.

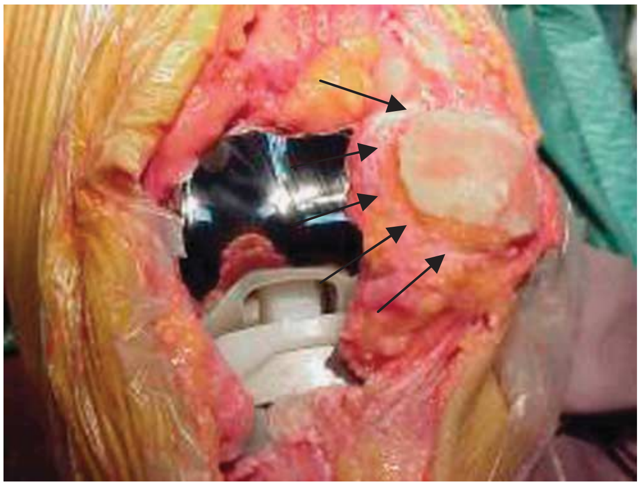
Surgical technique

A standard anterior midline skin incision and medial parapatellar arthrotomy was used to expose the knee in all patients. The medial and lateral soft tissues were balanced using standard ligamentous balancing techniques [6]. All knee replacements were performed using a gap-balancing technique, with the anteroposterior [7] and transepicondylar axes [8] serving as secondary determinants of the rotational orientation of the femoral component. Both components were sufficiently lateralized. Patellar reshaping, debulking, and nonresurfacing were performed for all cases after excision of patellar osteophytes following the same surgical routine for all cases (Fig. 1).

The intraoperative assessment of patellar tracking was performed after component insertion using the ‘Rule of no thumb’ [9], in which the patella was reduced into the trochlear groove and the knee was placed through a full range of motion without any additional thumb stabilization. A strict guideline was used in all cases to determine acceptable tracking of the patella. Acceptable tracking was defined as a patella that remained centered in the trochlear groove with bicondylar contact through 90° of flexion with no tendency for subluxation or separation of a patellar facet from the trochlear groove (Fig. 2).

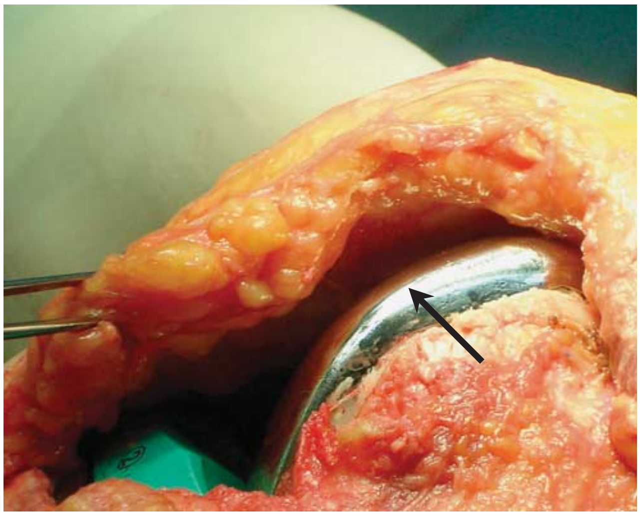
If patellar tracking was inadequate (i.e. lack of perfect bicondylar contact), a lateral retinacular release procedure was performed as an inside-out technique (Fig. 3).

Figure 1



Patellar reshaping, debulking, and nonresurfacing (arrows).

Figure 2

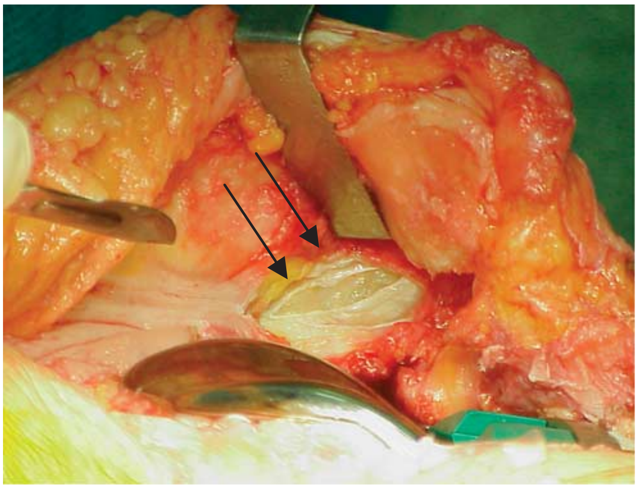


Acceptable patellar tracking with bicondylar contact at 90° flexion (black arrow).

Postoperatively, all patients began range-of-motion exercise the day after surgery. This was continued and increased daily during the patient’s hospital stay until 90° of flexion was achieved. Physiotherapy was initiated on the first postoperative day and included walker ambulation (weight bearing as tolerated), knee range of motion, muscle strengthening, and stair training.

The routine patient follow-up intervals used in this study were 3, 6 weeks, 3, 12 months, and then yearly. Initial postoperative radiographs included an anteroposterior long film, a lateral radiograph, and a Merchant view of the patella [10]. The same radiographs were obtained at sequential postoperative visits (at least annually) to recalculate alignment and the position of the components. All radiographic measurements were performed in accordance with the Knee Society roentgenographic evaluation and scoring system [11]. Patellar tilt and

Figure 3



Lateral retinacular release (arrows), inside-out technique.

subluxation were measured according to the guidelines of Gomes *et al.* [12], (Fig. 4). For our study, patellar tilt of more than 5° and subluxation of more than 5 mm were defined as noteworthy [13].

Differences in the incidence of the lateral retinacular release were compared between fixed-bearing and mobile-bearing knee replacements using Fisher's exact test. For the amount of patellar tilt, Student's *t*-test (for equal variances) and Welch's analysis (for unequal variances) were used for the statistical comparison.

Results

The overall lateral retinacular release rate in the study was 12.5% (eight of 64 knees) after primary cemented TKA. The incidence of lateral retinacular release was higher ($P < 0.005$) for knees with a fixed-bearing tibial component (18.7%, six of 32 knees) than for knees with a mobile-bearing tibial component (6.25%, two of 32 knees). The overall incidence of postoperative patellar tilt of 5° or more shown on Merchant follow-up radiographs of the patella was 14% (nine of 64 knees). The incidence of residual patellar tilt was slightly higher in the fixed-bearing group (15.6%, five of 32) than in the mobile-bearing group (12.5%, four of 32). The mean patellar tilt angle was 2.62°for the entire group, 2.72°for the fixed-bearing group, and 2.53° for the mobile-bearing group. In both the fixed-bearing group ($P = 0.053$) and the mobile-bearing group ($P = 0.012$), the amount of patellar tilt was higher in patients in whom a lateral retinacular release was not performed. No patient in either study group showed patellar subluxation of more than 5 mm on follow-up radiographs.

Discussion

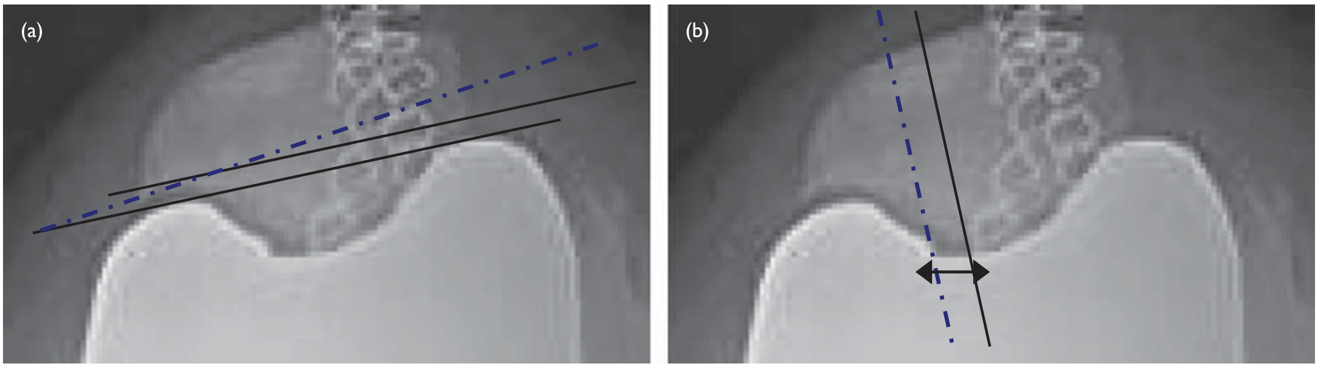
Although we evaluated the incidence of lateral retinacular release and patellar tilt in fixed-bearing and mobile-bearing TKAs, we did not evaluate other parameters such as the long-term clinical results. The sex distribution was unequal in the two groups, possibly influencing the number of lateral retinacular releases performed. In addition, preoperative alignment data and complete clinical follow-up were not available for all patients. To minimize these limitations, we selected a large cohort of consecutive patients undergoing TKA performed using a standardized surgical technique on each patient. In addition, a single TKA implant system was used, thus limiting design variations that could interfere with the results. Finally, a single, strict lateral release selection criterion was used in all cases irrespective of the type of prosthesis.

The overall lateral retinacular release rate in our entire study group was 12.5% after primary cemented TKA. On comparing fixed-bearing versus mobile-bearing TKA, the incidence of lateral retinacular release was lower in the mobile-bearing group (6.25%) than in the fixed-bearing group (18.7%). In the current literature, the lateral retinacular release rate has varied from 0% to as high as 40% [5,14,15]. Traditional teaching has emphasized the importance of performing a lateral retinacular release to enhance proper patella tracking [16–18]. A lateral retinacular release, however, risks potential complications, including an increased risk of hematoma and postoperative bleeding, disruption of patellar blood flow with subsequent patellar avascular necrosis and fracture as well as extensor mechanism disruption, wound and skin complications, medial patellar instability, and symptomatic snapping of the retinacular tissue edge over the lateral corner of the femoral component during flexion [15,19–24]. For these reasons, this procedure should be performed with caution.

The authors hypothesize that the reduced need for lateral retinacular release in patients implanted with a mobile-bearing TKA is the result of the ability of a mobile-bearing polyethylene insert to self-align with the femoral component. This phenomenon allows for accommodation of small mismatches in the rotational position of the tibial and femoral components, which can be seen in fixed-bearing TKAs. We believe that this self-aligning feature facilitates centralization of the extensor mechanism and a subsequent reduction in the incidence of patellar subluxation and the need to perform a lateral retinacular release. In contrast, if a fixed-bearing tibial component is positioned internally rotated on the proximal tibia, the potential to derotate its position to self-center with the femoral component is less, resulting in lateralization of the tibial tubercle, an increase in the Q angle, and an increased lateral force vector on the patella.

This hypothesis is supported by numerous fluoroscopic kinematic analyses [25–27]. Two fluoroscopic kinematic studies have been carried out in which tantalum beads were implanted within the polyethylene insert, which enabled fluoroscopic tracking of motion of the polyethylene bearing [25,26]. In both reports, mobility of the polyethylene bearing was observed in all patients and the bearing primarily rotated with the femoral component, confirming the self-aligning concept. In an additional

Figure 4



Radiographic measurements of (a) patellar tilt angle and (b) patellar subluxation from the center of the trochlear groove (imaginary dashed lines show the measurements).

fluoroscopic kinematic evaluation of patellofemoral kinematics of fixed-bearing versus mobile-bearing TKA, Rees *et al.* [27] observed that the patellofemoral kinematics of mobile-bearing TKA designs more closely replicated those of the normal, nonimplanted knee.

In contrast to our results, Pagnano *et al.* [5] reported on a prospective, randomized study of 240 primary TKAs (80 fixed-bearing TKAs with a modular, metal-backed tibial component, 80 fixed-bearing TKAs with an all-polyethylene tibial component, and 80 mobile-bearing TKAs with a rotating-platform tibial component) and observed no difference in the incidence of lateral retinacular release with the use of a mobile-bearing versus a fixed-bearing implant. The operative procedure in this report was performed by four different surgeons. We theorize that the differing results in these two reports may be related to differences in the threshold used by individual surgeons in choosing to perform a lateral retinacular release. The incidence of lateral retinacular release was higher in our study (12.5%) than that reported by Pagnano *et al.* [5] (nine of 240 patients, 3.8%), which is likely reflective of the strict criteria we used to perform a lateral retinacular release (perfect bicondylar contact of both patellar facets from 0 to 90° of flexion).

Patellar tilt, as observed on postoperative Merchant radiographs, may represent a more subtle form of patellar maltracking. The overall incidence of radiographic patellar tilt in our study was 14% and was slightly higher in the fixed-bearing group (15.6%) than in the mobile-bearing group (12.5%). In both groups, the amount of patellar tilt was higher in patients in whom a lateral retinacular release was not performed.

We theorize that the long-term clinical importance of the current minor differences in incidence and magnitude of patellar tilt observed between the mobile-bearing (incidence, 12.5%; mean patellar tilt, 2.53°) and fixed-bearing (incidence, 15.6%; mean patellar tilt, 2.72°) cohorts will not likely result in considerable clinical differences at long-term clinical follow-up, particularly in light of the fact that we observed no patellar subluxation greater than 5 mm in either the fixed-bearing or the mobile-bearing group. This is supported by the analysis of Bindelglass *et al.* [13], who reported that pain, flexion, and fixation were not affected by patellar tilt or displacement.

In both the fixed-bearing and the mobile-bearing groups, the amount of patellar tilt was higher in those patients in whom a lateral retinacular release was not performed. This suggests the value of a lateral retinacular release in improving patellar tracking should considerable patellar tilt be encountered.

This is in contrast to the study of Bindelglass *et al.* [13], who observed no improvement in patellar tilt in patients in whom a lateral retinacular release was performed.

Conclusion

A cruciate-substituting mobile-bearing TKA was associated with a lower incidence of lateral retinacular release compared with a cruciate-substituting fixed-bearing TKA. Further long-term follow-up studies are still required to document the other theoretical benefits of a mobile-bearing TKA design with respect to reduced polyethylene wear, durable long-term fixation, and patellofemoral performance.

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

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