

Comparison of Fixed-Bearing with Mobile-Bearing Prostheses for Total Knee Arthroplasty: A Systematic Review and Meta-Analysis

Cokorda Gde Oka Dharmayuda¹, I Made Yudi Mahardika²

¹Consultant of Orthopaedics and Traumatology Department,
Faculty of Medicine Udayana University, Sanglah General Hospital

²Resident of Orthopaedics and Traumatology Department,
Faculty of Medicine Udayana University, Sanglah General Hospital

Corresponding Author: Cokorda Gde Oka Dharmayuda

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ABSTRACT

Background: The rising prevalence of severe knee joint arthritis forces the orthopedic surgeon to do joint replacement as an effective end stage joint arthritis management. Currently, there are two types of bearing plans for TKA alone, namely fixed bearing and mobile bearing. This systematic review and meta-analysis aimed to compare several outcomes between those two types of bearing plans such as ROM, KSS Clinical, KSS Functional, and WOMAC Score.

Methods: A literature search was carried out using PRISMA Guidelines in Pubmed, Google Scholar, and Cochrane Library using the terms “fixed bearing”, “mobile bearing”, “total knee arthroplasty”, and “outcome measure”. We extracted the data from each study and all of statistical analysis were performed using the Review Manager version 5.3 software.

Results: After an initial search and screening of 217 studies, 4 studies were included in our study. There was a significant difference statistically between those two groups in KSS functional score (Heterogeneity, $I^2 = 91$ percent; WMD, 9.11; 95 percent Confidence Interval (CI), 6.51 to 11.70; $P < 0.00001$) There was no significant difference statistically between those two groups in ROM outcome (Heterogeneity, $I^2 = 93$ percent; WMD, -0.11; 95 percent Confidence Interval (CI), -2.91 to 2.70; $P = 0.94$), KSS clinical score (Heterogeneity, $I^2 = 99$ percent; WMD, 1.84; 95 percent Confidence Interval (CI), -2.32 to 6.01; $P = 0.38$), and WOMAC score (Heterogeneity, $I^2 = 100$ percent; WMD, -0.90; 95 percent Confidence Interval (CI), -6.19 to 4.39; $P = 0.74$).

Conclusion: In terms of KSS Functional Score, our research found that the mobile-bearing design surpasses the fixed-bearing design. There may be no noticeable difference in ROM, KSS Clinical Score, or WOMAC Score between these two designs.

Keywords: Fixed-bearing, Mobile-bearing, Total knee arthroplasty, Systematic review, Meta-analysis

INTRODUCTION

Knee joint illnesses can cause localized discomfort, loss of joint function, and a poor quality of life. Joint replacement as a medical operation is required if the deterioration and pain in the knee caused by arthritis are too severe. Total knee arthroplasty (TKA) is a common and effective end-stage arthritis orthopaedic

surgery that can relieve pain and improve knee function. With the prevalence of knee OA and RA on the rise, it's normal that the number of TKAs will rise drastically in the future. Long-term follow-up data, on the other hand, has indicated risk of implant loosening and wear, which frequently necessitate revision surgery.^[1-3]

For TKA, there are two types of bearing plans: fixed-bearing and mobile-bearing. A fixed-bearing knee configuration has round femoral parts that well-spoken with a somewhat level tibial articular surface. Although this arrangement allows for some axial rotation, the femoral and tibial surfaces are subjected to considerable contact stress. As a result of these circumstances, the concept of a mobile-bearing knee was developed. More prominent tibiofemoral congruency can be achieved as a result of movement at the tibia-embed interface, reducing wear on the inserts and duplicating more regular kinematics of the knee. These cycles are not joined by an expansion in the pressure at the bone embed interface, resulting in expanded solidness and knee function.^[4-6] This study, we aimed to compares outcomes of fixed-bearing and mobile-bearing TKAs with a systematic review and meta-analysis of randomized controlled trials (RCTs).

MATERIALS & METHODS

Search Strategy

A systematic review was conducted in accordance to Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Figure 1).^[7] A comprehensive literature search was performed to gather a full-length, peer-reviewed paper in English on comparison of outcome between fixed-bearing and mobile-bearing prostheses for total knee arthroplasty. We searched PubMed, Google Scholar, and Cochrane Library. The focus in this systematic review and meta-analysis is to compare outcome measure fixed-bearing and mobile-bearing prostheses for total knee arthroplasty. Keywords in the search matched the MeSH rule and term used are (“Fixed-Bearing”, “Mobile-Bearing”), AND (“Total Knee Arthroplasty”), AND (“Outcome Measure”).

Inclusion Criteria

The inclusion criteria were any studies about the functional outcome after total knee arthroplasty using fix-bearing and mobile-bearing prostheses. The outcome

assessed includes Range of Motion (ROM), Knee Society Score (KSS) Clinical and Functional, and Western Ontario and McMaster Universities Osteoarthritis index score (WOMAC)

Quality Evaluation

Assessment of study quality and risk of bias assessed using criteria developed by the Oxford Center for Evidence-based Medicine, perspicacity defined by the Grades of Recommendation Assessment, Development and Evaluation (GRADE) Working Group, and sanction made by the Agency for Healthcare Research and Quality (AHRQ). While the class of evidence is categorized into "class I" for good quality RCT, "class II" for moderate to poor quality RCT and good quality cohort, "class III" for moderate or poor-quality cohorts and case-control studies, "class IV" for the case series.

RESULT

Literature Search, Study Selection and Study Characteristics

The electronic research resulted in 217 records from various databases. After the process of identification, screening, eligibility, duplication elimination, and exclusion, the remaining 4 studies were included in qualitative and quantitative synthesis. The remaining articles were excluded due to lack of mean and standard deviation data and did not meet the inclusion and exclusion criteria.

Statistical Analysis

We utilized the Review Manager version 5.3 software (RevMan; The Cochrane collaboration Oxford, England) to perform all statistical analyses. Based on heterogeneity of the current study, we performed a sensitivity analysis to further assess the overall results. The heterogeneity across studies was examined through the I^2 statistic describing as follows: low, 25% to 50%; moderate 50% to 75%; or high >75%. We applied the fixed-effect models to calculate the total MDs/ORs when low heterogeneity was seen in studies. In other cases, we used the random effects model.

Studies with a *P* values less than .05 were thought to have statistical significance. Forest plots showed the findings of out meta-analysis.

Outcome Analysis

This meta-analysis included a total number of 633 patients with 289 patients undergoing fixed-bearing total knee arthroplasty, 321 patients undergoing mobile-bearing total knee arthroplasty, and 23 patients undergoing both design. The follow-up period differed within each study, ranging from two until ten years post-

operatively. The patient's age ranged from 48 until 82 years old.

ROM outcome

We performed a subgroup analysis to evaluate ROM outcome between Fixed-bearing versus mobile-bearing for total knee arthroplasty. Figure 1 demonstrates that there was no significant difference statistically between these two groups in ROM outcome. (mean difference -0.11; 95% CI, *P* = 0.94); (mean difference -0.11; 95% CI, -2.91, 2.70).^[8-10]

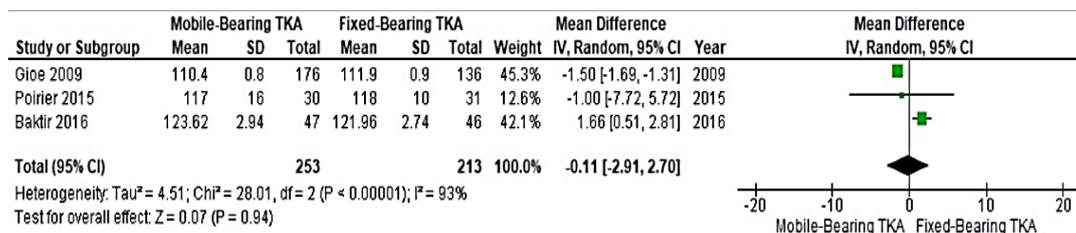


Figure 1 Pooled analysis of ROM outcome

KSS Clinical Score outcome

We performed a subgroup analysis to evaluate KSS Clinical Score between Fixed-bearing versus mobile-bearing for total knee arthroplasty. From four studies added in this

subgroup analysis, we found no statistically difference in between those two groups for the KSS Clinical Score (Figure 2). (mean difference 1.84; 95% CI, *P* = 0.38); (mean difference 1.84; 95% CI, -2.32, 6.01).^[8-11]

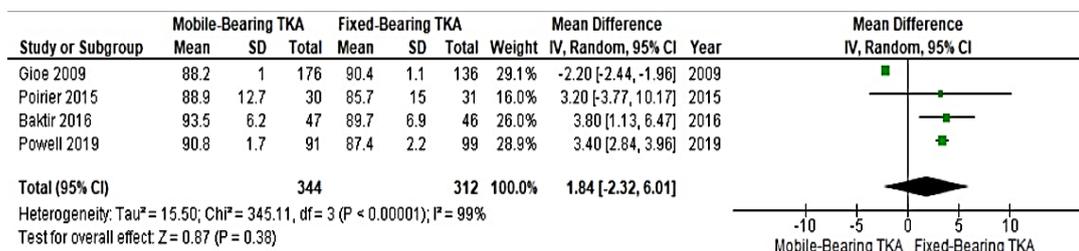


Figure 2 Pooled analysis of KSS Clinical Score outcome

We also performed a subgroup analysis to evaluate KSS Functional Score between Fixed-bearing versus mobile-bearing for total knee arthroplasty. From four studies added in this subgroup analysis, Figure 3 shows that the mobile-bearing design, in

contrast to the fixed bearing design, can significantly increase the KSS Functional Score. (mean difference 1.84; 95% CI, *P* = 0.38); (mean difference 1.84; 95% CI, -2.32, 6.01).^[8-11]

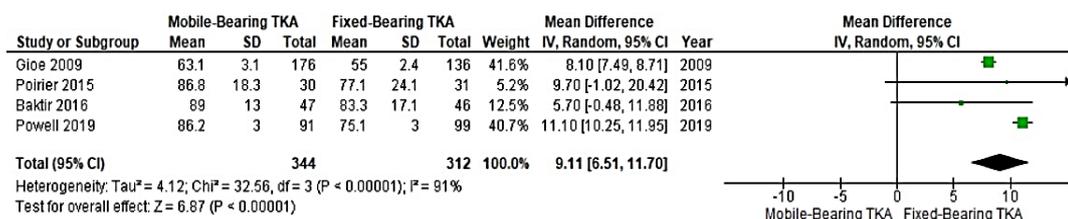


Figure 3 Pooled analysis of KSS Functional Score outcome

WOMAC Score outcome

Detailed information on WOMAC Score was provided in two studies. Figure 4 demonstrates that there was no significant difference between the fixed-bearing and

mobile-bearing design for WOMAC Score. (mean difference -0.90; 95% CI, P = 0.74); (mean difference -0.90; 95% CI, -6.19, 4.39).^[8,11]

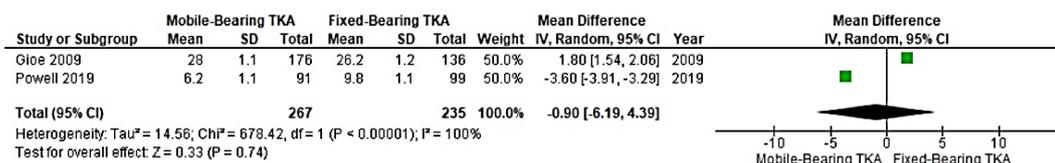


Figure 4 Pooled analysis of WOMAC Score outcome

DISCUSSION

Overall, the forest plot results imply that, in contrast to fixed-bearing designs, mobile-bearing designs can significantly improve the KSS Functional Score. The ROM, KSS Clinical Score, and WOMAC Score did not change significantly between the two bearing design groups. Our meta-analysis revealed that, following follow-up, the mobile-bearing design group had a substantially higher KSS Functional Score than the fixed-bearing design group, although the difference in KSS Clinical score was not evident between the two designs. This differs from a recent meta-analysis, which found no significant difference between the two bearing designs in terms of the KSS Clinical Score or KSS Functional Score.^{12,13} One possible explanation for this discrepancy is that the majority of our follow-up periods were consistently long, whereas the follow-up periods in their study were inconsistent. Perhaps our results were influenced by the small sample size.

The KSS Clinical Score and the WOMAC Score can be used to evaluate the knee joint in addition to the ROM. According to our meta-analysis, the fixed-bearing and mobile-bearing designs had essentially equal ROM values after follow-up, which is in line with our KSS Clinical Score and WOMAC Score results. More data and confirmation of our findings will be needed in future investigations. Other figures in the study examined the advantages and disadvantages of the two

bearing designs. B. G. Pijls et al., for example, found no significant difference in the femorotibial alignment angle, α angle (frontal angle of the femoral component), β angle (frontal angle of the tibial component), and δ angle (sagittal angle of the tibial component) between the fixed-bearing and mobile-bearing groups after approximately 10 years of follow-up.^[14] According to N. Poirier et al., there was no discernible difference in subjective patient satisfaction with the surgical outcome between the fixed-bearing and mobile-bearing groups 9 years after surgery.^[9] In contrast, A. J. Powell et al. found that the mobile-bearing group scored significantly higher on the 12-Item Short-Form Health Survey and Knee Injury than the fixed-bearing group.^[11] However, one plausible explanation is that their TKA treatment left the posterior cruciate ligament intact. Furthermore, because these outcomes were reported in only one study, we were unable to incorporate them in our metaanalysis; more research is needed to fully understand these variables.

TKA with mobile bearings was created to reduce polyethylene contact stress by reducing the increased wear associated with fixed-bearing designs, resulting in improved joint function and lower revision rates. These benefits were previously thought to be theoretical because multiple clinical trials revealed that the mobile-bearing architecture had no evident advantage over the fixed-bearing form.^[12,15] Furthermore, a recent meta-analysis found

no significant difference in radiostereographic migration rates between mobile-bearing and fixed-bearing implants in a recent meta-analysis.^[16] This suggests that the revision rates of the two bearing designs may be similar. In the KSS Functional Score, the mobile-bearing design outperformed the fixed-bearing design, according to our meta-analysis. Furthermore, given the average implant lifespan, practically all studies have a 10-year follow-up period, which may be insufficient, and longer trials should be undertaken to gather more long-term data. Despite the high methodological quality of nearly all of the included studies, there were several limitations to this meta-analysis. The number of studies considered was minimal, which could have influenced the forest plot results. We were also unable to use funnel plots to test for publication bias due to the limited sample size. Finally, we only looked at items written in English, which could have resulted in bias.

CONCLUSION

Our meta-analysis of RCTs revealed that the mobile-bearing design outperforms the fixed-bearing design in terms of KSS Functional Score. Between these two designs, there may be no discernible change in ROM, KSS Clinical Score, or WOMAC Score. However, our results may have been influenced by the limited sample size, and future studies with longer follow-up periods are needed to get more data and more solid conclusions in this hazy field of research.

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Ethical Approval: Not Applicable

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