Standard Versus High-Flexion Posterior Stabilized Total Knee Prostheses

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abstract

This meta-analysis compared clinical outcomes between standard and high-flexion posterior-stabilized total knee prostheses to evaluate which type of total knee prosthesis was superior. Randomized, controlled trials published until October 2013 comparing standard and high-flexion posterior-stabilized total knee prostheses were reviewed. Methodologic quality was assessed with the Physiotherapy Evidence Database scale. After data extraction, the authors compared results with fixed effects or random effects models, depending on the heterogeneity of the included studies. Eight randomized, controlled trials involving 660 patients met the predetermined inclusion criteria. No statistically significant differences between patients undergoing standard and high-flexion posterior-stabilized total knee prostheses were noted in postoperative range of motion (ROM) (weighted mean difference, -1.43; 95% confidence interval [CI], -4.52 to 1.67; \( P = .37 \)); flexion angle (weighted mean difference, 0.54; 95% CI, -3.75 to 4.84; \( P = .80 \)); Knee Society Score (weighted mean difference, 0.92; 95% CI, -0.64 to 2.48; \( P = .25 \)); Hospital for Special Surgery knee score (weighted mean difference, 0.57; 95% CI, -0.42 to 1.55; \( P = .26 \)); or Knee Society function score (weighted mean difference, 1.00; 95% CI, -1.49 to 3.49; \( P = .43 \)). No statistical difference was found between the 2 prosthesis types in complications, involving 21 cases in the standard group and 14 cases in the high-flexion group. The current findings confirm that high-flexion posterior-stabilized total knee prostheses are not superior to standard prostheses in terms of ROM, flexion angle, knee scores, or complications with 5 years or less of follow-up. [Orthopedics. 2015; 38(3):e206-e212.]
Total knee prostheses are used to treat patients with end-stage osteoarthritis, rheumatoid arthritis, and other knee disorders. Recently, to improve knee flexion, high-flexion total knee prostheses were introduced with improved range of motion (ROM) and the ability to reach higher flexion angles. This type of prosthesis can meet the need for increased flexion during deep kneeling, squatting, and cross-legged sitting.

Theoretically, the design of high-flexion total knee prostheses may increase the arc of motion. A meta-analysis showed that the high-flexion implant design improves overall ROM compared with standard implants. However, 2 meta-analyses showed that high-flexion total knee prostheses do not appear to provide increased flexion compared with standard prostheses in the short term.

Several meta-analyses were published, but all of them included cruciate-retaining and posterior-stabilized prostheses to compare clinical outcomes between standard and high-flexion total knee prostheses. Cruciate-retaining and posterior-stabilized total knee prostheses have a difference in postoperative flexion angle of 2.88° or more, so it was more suitable to conduct a meta-analysis to include 1 type of total knee prosthesis, either the cruciate-retaining type or the posterior-stabilized type. Each published meta-analysis had several limitations, as discussed by the authors. For example, 2 meta-analyses included case-control studies to increase the number of patients.

With the publication of additional randomized, controlled trials, an updated meta-analysis was needed to evaluate postoperative ROM, flexion angle, knee scores, and complications in patients treated with either standard or high-flexion posterior-stabilized total knee prostheses.

**Materials and Methods**

**Search Strategy**

Two independent reviewers searched electronic databases (MEDLINE, EMBASE, and Cochrane Central Register of Controlled Trials) without limit for studies published through October 2013. The search terms used were “high flexion,” “total knee arthroplasty,” and “randomized controlled trial.” Reference lists of selected articles were hand-searched for additional trials.

**Eligibility Criteria**

Studies were identified according to the following criteria: (1) the comparison was between standard and high-flexion posterior-stabilized total knee prostheses, regardless of whether the prosthesis design was fixed bearing or mobile bearing; (2) some key postoperative outcomes were described, such as ROM, flexion angle, Knee Society Score, Hospital for Special Surgery knee score, Knee Society function score, and complications; (3) a randomized, controlled trial was designed; (4) the full text was published in English.

**Quality Assessment**

Two investigators independently assessed the methodologic quality of each included randomized, controlled trial using the Physiotherapy Evidence Database (PEDro) scale. The 11 items were based on the Delphi list. Each item was scored “yes” or “no,” with a maximum score of 10 because criterion 1 was not scored. Trials with a score of 6 or greater were considered high quality. Conflicts were resolved by discussion with another investigator.

**Data Extraction**

Both researchers extracted relevant data, including sample size, study design, patient age, sex, body mass index, length of follow-up, ROM, flexion angle, Knee Society Score, Hospital for Special Surgery knee score, Knee Society function score, and complications.

**Statistical Analysis**

Meta-analysis was conducted with Cochrane Collaboration Review Manager 5.0. If standard deviation was not reported, it was imputed with use of the technique described by Ma et al. For continuous data, weighted mean difference and 95% confidence interval (CI) were used.
The statistical method was inverse variance. For dichotomous outcomes, odds ratio and 95% CI were calculated as summary statistics. Statistical heterogeneity was tested with the chi-square test and the $I^2$ test. $I^2$ of 0% to 25% was considered low statistical heterogeneity, $I^2$ of 26% to 50% was considered moderate statistical heterogeneity, and $I^2$ of 51% to 75% was considered high statistical heterogeneity. The source of high heterogeneity was calculated by random effects after clinical heterogeneity of the included studies was excluded.

RESULTS

Study Selection

A literature search initially yielded 237 relevant trials, with 156 articles left after duplicates were removed. The authors excluded 138 of these articles on the basis of titles and abstracts, leaving 18 potentially relevant studies. Randomized, controlled trials were retrieved for full-text evaluation. Subsequently, 10 were excluded for the following reasons: 1 study was reported with unclear data, 2 studies overlapped with other randomized, controlled trials, 3 studies compared high-flexion and sex-specific high-flexion total knee prostheses, and 4 studies included cruciate-retaining total knee prostheses. Finally, 8 randomized, controlled trials published in English met the predetermined inclusion criteria (Figure 1).

Study Characteristics

The demographic characteristics of 8 studies are shown in Table 1. The data set included 660 patients involving 407 standard and 407 high-flexion posterior-stabilized total knee prostheses. Mean preoperative age, sex ratio, and body mass index were generally consistent between the 2 total knee prosthesis designs. Surgical procedures were conducted by senior orthopedic surgeons. Rehabilitation exercise was conducted on the first postoperative day. Follow-up was 1 to 5 years.
The methodologic quality of each included randomized, controlled trial was assessed in accordance with the PEDro scale. Of the trials, 7 were of high methodologic quality and 1 was of low methodologic quality. All studies used the randomized method, 3 used concealed allocation, and 5 used blinding. The methodologic score of each included trial is shown in Table 2.

**RESULTS**

The forest plot for preoperative ROM showed no statistical difference between standard and high-flexion posterior-stabilized total knee prostheses (weighted mean difference, -0.25; 95% CI, -3.19 to 2.69; P=0.87) (Figure 2), and so did postoperative ROM, with high statistical heterogeneity at 2 years (weighted mean difference, -1.43; 95% CI, -4.52 to 1.67; P=0.37) (Figure 3). Preoperative flexion angle showed a difference of 0.54° between standard and high-flexion posterior-stabilized total knee prostheses (weighted mean difference, -0.54; 95% CI, -3.73 to 2.65; P=0.74) (Figure 4). The difference in postoperative flexion angle 1 to 3 years after surgery was 0.54°, with high statistical heterogeneity (weighted mean difference, 0.54; 95% CI, -3.75 to 4.84; P=0.80) (Figure 5).

The forest plot for postoperative Knee Society Score showed no statistical difference between standard and high-flexion posterior-stabilized total knee prostheses at 1 to 3 years (weighted mean difference, 0.92; 95% CI, -0.64 to 2.48; P=0.25) (Figure 6).
Figure 5: Forest plot for postoperative flexion angle between standard and high-flexion posterior-stabilized (PS) total knee prostheses (TKP). Abbreviations: CI, confidence interval; IV, inverse variance.

Figure 6: Forest plot for postoperative Knee Society Score between standard and high-flexion posterior-stabilized (PS) total knee prostheses (TKP). Abbreviations: CI, confidence interval; IV, inverse variance.

Figure 7: Forest plot for postoperative Hospital for Special Surgery score between standard and high-flexion posterior-stabilized (PS) total knee prostheses (TKP). Abbreviations: CI, confidence interval; IV, inverse variance.

Figure 8: Forest plot for postoperative Knee Society function score between standard and high-flexion posterior-stabilized (PS) total knee prostheses (TKP). Abbreviations: CI, confidence interval; IV, inverse variance.

Postoperative complications, such as anterior knee pain, stiffness, periprosthetic infection, deep venous thrombosis, wound healing, peroneal nerve palsy, and aseptic loosening, are shown in Table 3.

**Discusison**

High-flexion total knee prostheses were introduced with the promise of a better flexion angle as a result of improved polyethylene contact areas. In other words, high-flexion implants allowed the prosthesis to maintain optimal contact areas and stability in deep flexion. However, the most significant finding of the current study was that no differences were noted between standard and high-flexion posterior-stabilized total knee prostheses in ROM, flexion angle, knee scores, or complications.

For postoperative ROM and flexion angle, a prospective, double-blind randomized, controlled trial involving 76 patients over a period of 5 years conducted by Seng et al. showed that high-flexion total knee prostheses could reach higher degrees of knee flexion than standard prostheses. However, the current meta-analysis showed no statistical difference between the 2 prosthesis designs, which was generally consistent with the findings of the earlier meta-analyses. This phenomenon could be explained as follows. High-flexion total knee prostheses were designed to obtain a higher flexion angle, but patient factors, surgical technique, and especially preoperative ROM are all reliable contributors to postoperative ROM.

The current study showed no differences between the 2 prosthesis designs in Knee Society Score, Hospital for Special Surgery knee score, or Knee Society function score. The results of this study were similar to the clinical scores reported in the systematic review and meta-analysis by Luo et al., who found no statistically significant difference in Knee Society Score or Hospital for Special Surgery knee score between standard and high-flexion total knee prostheses.

The current study showed no statistical differences in complications between standard and high-flexion total knee prostheses. However, the number of patients included was small, and the findings of the current study are based on early postoperative studies followed for 5 years or less. To compare complications between the 2 prosthesis designs objectively, especially polyethylene wear and aseptic loosening, large-scale studies with long-term follow-up are needed.
The current meta-analysis had several strengths. First, all included trials were randomized, controlled trials. When meta-analysis was conducted, the low-quality data reported by Wohlrab et al were ignored to obtain a reliable conclusion. Second, only posterior-stabilized prostheses were included to avoid the potential effect of mixed prosthesis factors on postoperative outcomes.

Possible limitations of the current meta-analysis should be noted. First, this meta-analysis limited the included articles to those published in English. Therefore, there could be selection bias in language. Second, the included studies involved different bearing types, which could affect clinical outcomes. Third, in 8 studies, the follow-up period ranged from 1 to 5 years, so long-term clinical outcomes are unknown.

**Conclusion**

The current findings confirm that high-flexion posterior-stabilized total knee prostheses are not superior to standard prostheses with regard to ROM, flexion angle, knee scores, and complications over a period of 5 years or less. Future research with large-scale studies and long-term follow-up is needed.

**References**


### Table 3

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Abbreviations: HF, high-flexion posterior stabilized total knee prosthesis; S, standard posterior stabilized prosthesis.


