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Clinical Outcomes of Gap Balancing vs Measured Resection in Total Knee Arthroplasty: A Systematic Review and Meta-Analysis Involving 2259 Subjects

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ABSTRACT

Background: The argument on the clinical effects between gap balancing (GB) and measured resection (MR) in total knee arthroplasty remains to be resolved. A systematic review and meta-analysis was performed to investigate which technique in total knee arthroplasty has better clinical effect.

Methods: A total of 20 studies involving 2259 cases were included in the meta-analysis. The primary outcome measure was Knee Society Score (KSS), whereas the secondary outcomes included other function assessment systems (eg, range of motion, Western Ontario and McMaster University Osteoarthritis Index), radiological outcomes (eg, femoral component rotation, total outliers), revision rate, complications (eg, infection, loosening, instability), and surgical time.

Results: The GB technique was associated with statistically significant increases in the primary outcomes of KSS-function in 1 year. However, a mean difference of 2.12 points was below the minimal clinically important difference of 6 points. No differences were found in the analyses of KSS-knee and KSS-function in any other follow-up periods. Secondary outcome assessments showed significant decreased surgical time (mean difference, 16.18; $P < .00001$) for MR. Although statistically significant difference in favor of GB was identified in total outliers (risk ratio, 1.72, $P = .0004$), the 2 techniques were comparable in range of motion, Western Ontario and McMaster University Osteoarthritis Index, femoral component rotation, complications, and revision rate.

Conclusion: We conclude that both techniques can result in equivalent results when done properly, and each surgeon must understand the strengths and weaknesses of each technique.

Total knee arthroplasty (TKA) may be the best treatment for the elderly patients with end-stage osteoarthritis [1]. To achieve a balanced knee, 2 techniques have been widely used: measured resection (MR) and gap balancing (GB). In the MR, anatomic landmarks such as posterior femoral condylar axis and anterior-posterior are used to direct the resection of bone and determine femoral component rotation. And soft tissue releases are subsequently undertaken to ensure balance of the extension and flexion gaps [2,3]. In contrast, the GB uses soft tissue releases to create a rectangular gap in extension. The flexion gap in the GB technique is determined by placing the knee under tension in flexion and rotating the femoral component to create a symmetric flexion gap, which is performed parallel to the resected surface of the tibia [2,4]. On the basis of decreased incidence of condylar lift-off, the GB technique has been thought to potentially improve implant instability when compared with the MR technique [4]. Moreover, the difference in femoral component rotation in favor of GB has been noted in 2 meta-analyses [5,6]. Overall, clinical results after TKA might be affected by kinematic differences between the 2 techniques.

Recently, controversy still exists regarding the clinical effects of MR or GB technique in TKA. As far as we know, few meta-analyses have directly compared clinical outcomes between the 2 techniques. Only 1 meta-analysis has been recently published in 2017 to

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compare Knee Society Score (KSS) between the techniques based on 3 randomized, controlled trials (RCTs) [6]. Between 2016 and 2018, many new controlled trials were published to investigate clinical outcomes between the 2 techniques [7–13]. Thus, we included 20 articles (15 RCTs) to conduct a systematic review and meta-analysis to make a relatively more credible and overall assessment about which technique in TKA has better clinical effects.

Methods

Search Strategy

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses reporting guidelines [14] and the recommendations of the Cochrane Collaboration [15] were followed to conduct the present meta-analysis. From the inception to January 2018, 2 independent investigators searched the PubMed, EMBASE, Web of Science, and Cochrane Library electronic databases using the key phrases "gap balancing," "gap balanced," "measured resection," "total knee arthroplasty," and "total knee replacement" for all relevant English language trials. In addition, references cited by the relevant sources were also hand-searched to identify any additional articles that were not found in our database query.

Inclusion and Exclusion Criteria

Study included in our meta-analysis had to meet the following criteria: (1) patients with noninflammatory osteoarthritis of the knee requiring primary TKA; (2) RCTs or nonrandomized, controlled trials (nRCTs) focusing on comparing MR and GB techniques during TKA intervention; (3) articles written in the English language; (4) at least one of the following outcome measures was reported: functional assessment (eg, KSS, range of motion [ROM], Western Ontario and McMaster University [WOMAC] Osteoarthritis Index), radiological outcomes (eg, femoral component rotation, total outliers), revision rate, complications, and surgical time.

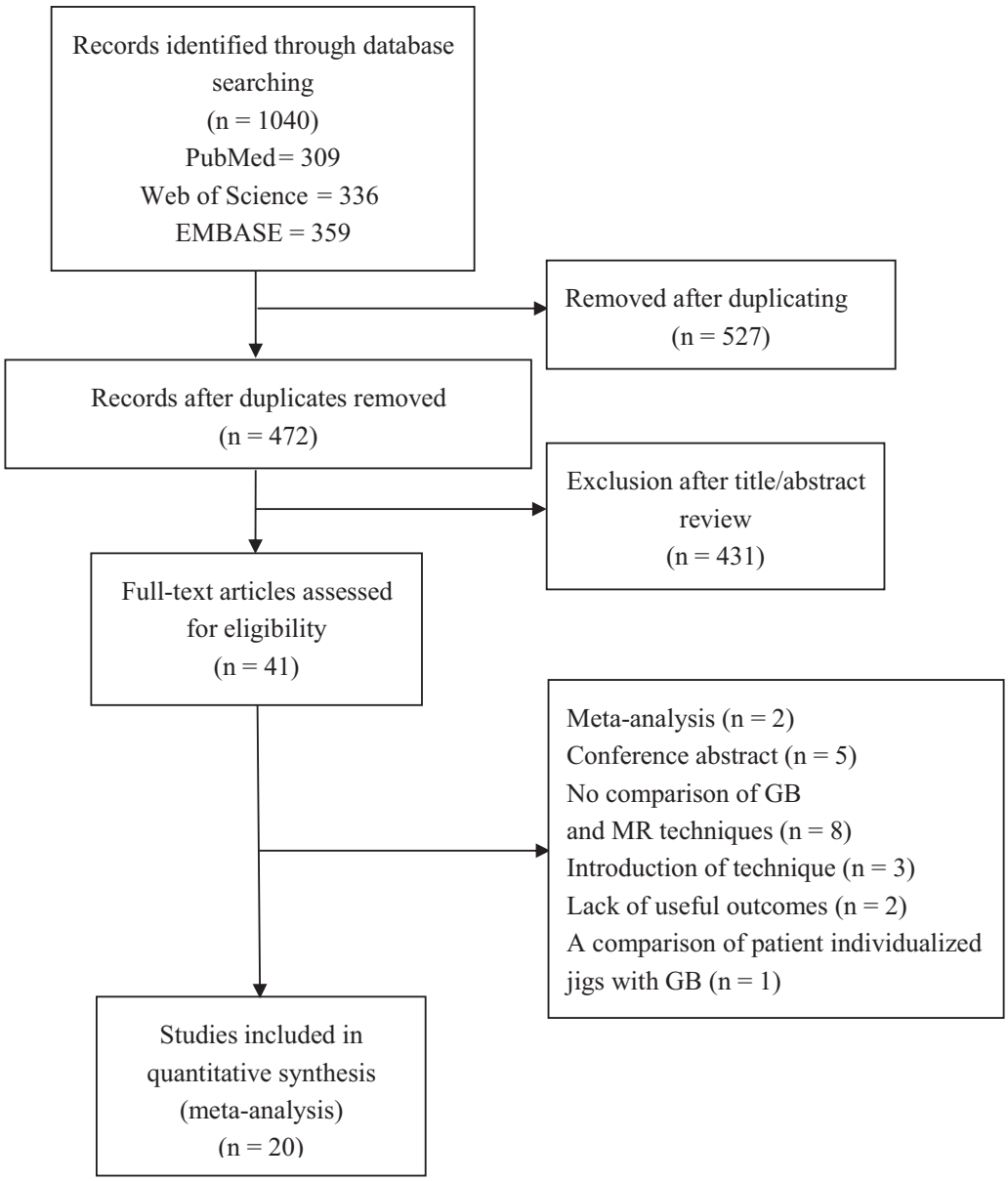

Fig. 1. Flow diagram showing details of literature search; MR, measured resection; GB, gap balancing.