Comparison of Automatic versus Manual Broaching Techniques in Total Hip Arthroplasty: A Systematic Review and Meta-Analysis

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INTRODUCTION: Automated broaching (AB) in total hip arthroplasty (THA) has been developed to standardize femoral canal preparation and can impact both surgical and surgeon-related outcomes. Despite the growing use of AB in THA, few studies have evaluated the effects of automated versus manual broaching (MB) techniques on patient and surgeon outcomes. This study aims to evaluate and compare both the clinical and occupational impacts of AB compared MB in THA.

METHODS: PubMed/MEDLINE, Embase, and the Cochrane Library were used to conduct a systematic review of articles from inception to July 2025. Primary studies that included AB were included regardless of whether they had a MB comparison group. Sample size and patient demographics were recorded from the primary studies. Surgical outcomes data extracted included broaching time, procedural time, canal fit ratio, stem subsidence, complications, and fractures. Surgeon-related outcomes data extracted included direct and indirect measures of surgeon efficiency and noise exposure levels. Descriptive statistics and random-effects meta-analysis models were used to analyze the available data. IRB approval was not required for this systematic review and meta-analysis.

RESULTS SECTION: There were 9 studies that met the inclusion criteria with a total of 4,007 THA procedures (2,811 AB; 1,196 MB) included. Procedural time was the most frequently studied followed by broaching time and complications. Meta-analysis revealed that AB had faster broaching times (mean 3.2 min; 95% CI, 2.11 to 5.53) compared to MB (mean 6.17 min; 95% CI, 4.06 to 8.29) with a trend towards statistical significance ($p = 0.09$). There was no statistical difference between AB and MB procedural times. The complication rate was higher in the AB group (4%) compared to the MB group (1%) ($p < 0.001$). Of note, while surgeon-related outcomes were not included in the meta-analysis, the AB group was associated with improved surgeon efficiency (e.g., reduced energy expenditure, minute ventilation, heart rate) and higher noise exposure levels.

DISCUSSION: This study shows that AB in THA may enhance broaching time and surgeon efficiency. However, AB introduces new concerns such as increased complication rates and noise exposure levels. Limitations of this study include the retrospective nature of most included studies. Future research should focus on quantitative assessments of surgeon ergonomics.

SIGNIFICANCE/CLINICAL RELEVANCE: The present findings underscore the need for assessing the long-term clinical and occupational impacts of AB in THA.

IMAGES AND TABLES:

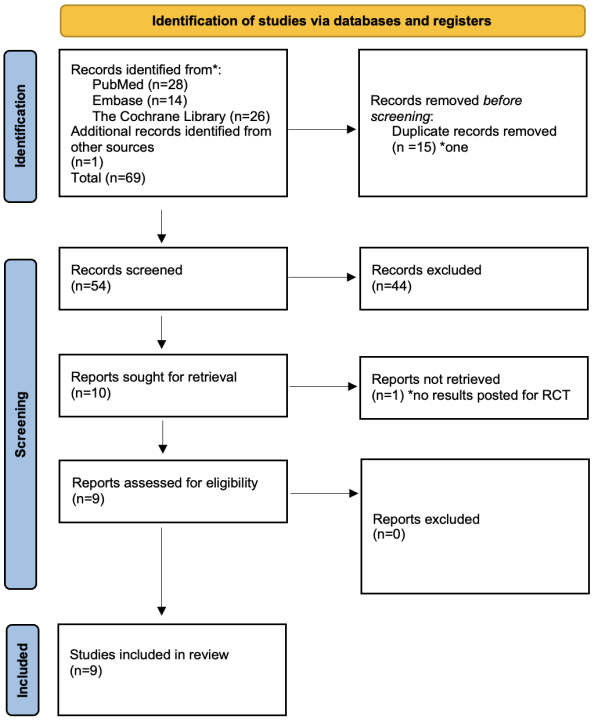

Fig. 1. Flowchart of study inclusion and exclusion conducted under the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines.

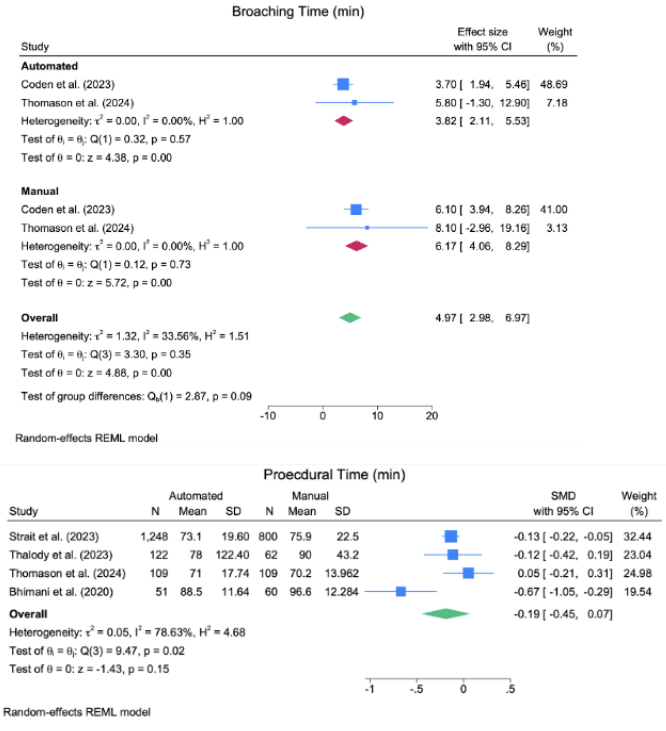

Fig. 2. Forest plots of pooled effects of automatic and manual broaching on time and procedural time in THA.