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Percutaneous vs Open Surgery for Hallux Valgus Correction: A Meta Analysis

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ABSTRACT

Background: Hallux valgus is a common forefoot deformity often corrected through either open or minimally invasive surgery (MIS). MIS has gained popularity due to its potential benefits, including reduced tissue trauma and quicker recovery. However, the comparative effectiveness of MIS versus open surgery remains unclear.
Objective: To compare clinical outcomes between percutaneous (MIS) and open surgical techniques for hallux valgus correction.
Methods: A systematic review and meta-analysis were conducted following PRISMA guidelines. Databases searched included PubMed, ProQuest, and Google Scholar for studies published between January 2007 and March 2022. Inclusion criteria were studies comparing MIS with open surgery and reporting at least one of the following outcomes: AOFAS score, VAS score, complication rate, or length of hospitalization. Data were analyzed using RevMan 5.4 and R software.
Results: Six studies involving 472 feet (214 MIS, 258 open surgery) met the criteria. No significant differences were found in AOFAS scores preoperatively (MD = 0.95; $p = 0.50$) or postoperatively (MD = 0.00; $p = 0.34$). Postoperative VAS scores favored MIS (MD = -0.93; $p < 0.05$), indicating lower pain levels. Complication rates were significantly higher in the open surgery group (RR = 1.56; $p < 0.05$), and length of hospitalization was shorter in the MIS group (MD = -0.66; $p < 0.05$).
Conclusion: MIS provides similar functional outcomes to open surgery but results in lower postoperative pain, fewer complications, and shorter hospital stays. These findings support MIS as a safe and effective alternative for hallux valgus correction.

Keywords: Hallux Valgus Correction, Minimally Invasive Surgery (MIS), Clinical Outcome Comparison

INTRODUCTION

Hallux valgus is a prevalent forefoot deformity characterized by lateral deviation of the hallux exceeding 15 degrees relative to the first metatarsal, often accompanied by medial displacement of the first metatarsal itself. This deformity is frequently associated with osteoarthritis of the first metatarsophalangeal joint and contributes to various health issues, including increased fall risk, impaired postural stability, and diminished daily quality of life. Common surgical options for symptomatic hallux valgus include chevron osteotomy, the

Lapidus procedure, and scarf osteotomy. Although more than 150 open surgical procedures have been described for correcting hallux valgus, no single technique has been definitively proven superior. In recent years, minimally invasive surgery (MIS) has gained popularity due to its reduced operative duration and faster postoperative recovery when compared to traditional open approaches. Three successive generations of MIS techniques have now been introduced. [1, 2]

The distal chevron osteotomy of the first metatarsal is commonly employed to manage mild to moderate hallux valgus deformities, demonstrating favorable radiographic and clinical outcomes over time in several studies. However, open procedures may result in postoperative scar formation that limits joint mobility. [3]

MIS techniques offer potential clinical advantages, including reduced surgical trauma and faster recovery. Minimally invasive chevron osteotomy, in particular, has become a preferred approach due to these benefits. [1] Despite its theoretical advantages of minimizing soft tissue disruption, postoperative pain, and range of motion loss, the MIS approach remains under ongoing evaluation. Though early findings from systematic reviews of MIS for hallux valgus have been promising, consistent clinical recommendations are still lacking. A recent randomized prospective trial comparing MIS and open chevron osteotomy revealed similar radiographic and functional outcomes after a 9-month follow-up period. By avoiding large incisions, MIS limits soft tissue damage and may reduce surgical morbidity. [1,3]

MATERIALS AND METHODS

This systematic review and meta-analysis was conducted in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines and followed the methodological framework outlined in the Cochrane Handbook.

Search Strategy

A comprehensive literature search was conducted using PubMed, ProQuest, and Google Scholar databases. The following search terms were applied: ("bunion" OR "hallux valgus" OR "hallux abductovalgus") AND ("percutaneous" OR "percutaneous chevron-Akin" OR "Bosch" OR "minimally invasive surgery" OR "minimally invasive chevron-Akin" OR "minimally invasive" OR "Bösch" OR "SERI" OR "simple, effective, rapid, inexpensive"). The search covered studies published from January 1, 2007, to March 1, 2022.

Inclusion and Exclusion Criteria

Studies were eligible for inclusion if they: (1) directly compared minimally invasive surgery (MIS) with open surgical techniques for hallux valgus correction; (2) involved patients diagnosed with hallux valgus; (3) reported a minimum follow-up duration of 6 months; and (4) included at least one of the following outcome measures: American Orthopaedic Foot and Ankle Society (AOFAS) score, Visual Analog Scale (VAS) score, complication rates, or length of hospital stay. Exclusion criteria were: (1) unpublished studies; (2) case reports, case series, reviews, and conference abstracts; (3) biomechanical-only studies; and (4) studies lacking extractable outcome data.

Data Extraction and Quality Assessment

Data extraction was performed using EndNote X9. Any discrepancies were resolved through discussion to achieve consensus. The extracted variables included publication year, study location, design, sample size, patient age, surgical technique, AOFAS score, VAS score, complication rate, and length of hospital stay. Methodological quality was assessed using the Cochrane Handbook for randomized controlled trials (RCTs) and the Methodological Index for Non-Randomized Studies (MINORS) for non-RCTs, with a MINORS score above 14 considered acceptable for inclusion.

STATISTICAL ANALYSIS

Data analysis was conducted using Review Manager (RevMan, version 5.4; The Cochrane Collaboration, Oxford, UK) and R statistical software version 4.0.3 with the 'meta' package. For dichotomous outcomes, risk ratios (RRs) with 95% confidence intervals (CIs) were calculated. For continuous variables, standardized mean differences (SMDs) and 95% CIs were used. A p-value below 0.05 was considered statistically significant. Heterogeneity was assessed using the I^2 statistic; thresholds were defined as low (25–50%), moderate (50–75%), and high (>75%). A random-effects model was applied when I^2 exceeded 50% or when $p < 0.10$; otherwise, a fixed-effects model was used. Subgroup analyses were conducted based on study design (RCT vs. non-RCT) and surgical technique (2nd vs. 3rd generation MIS). Egger's test was utilized to evaluate publication bias.

RESULTS

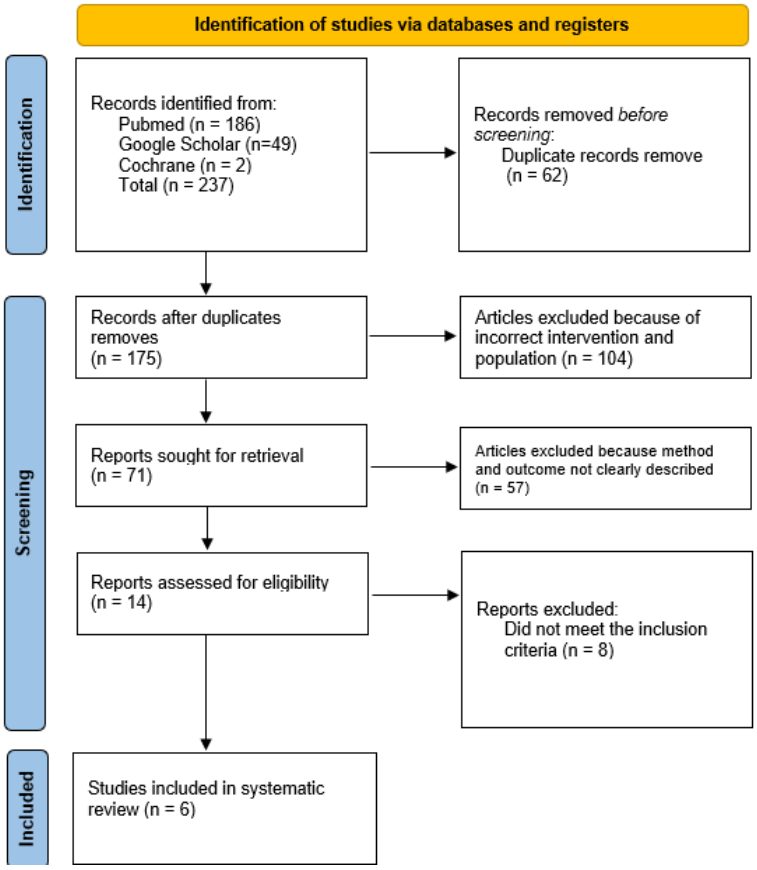

Figure 1. PRISMA Flow Chart

Study Selection and Characteristics

The initial database search yielded 237 articles. After removing duplicates and screening titles, abstracts, and full texts according to eligibility criteria, 6 studies were included in both the qualitative and quantitative analyses. Articles were excluded primarily due to lack of mean and standard deviation data or failure to meet inclusion criteria. Shown in Figure Above.

Statistical Analysis and Heterogeneity

All statistical analyses were performed using RevMan version 5.4. Sensitivity analyses were carried out to assess the robustness of the results. Study heterogeneity was evaluated using the I^2 index, with levels interpreted as low (25–50%), moderate (50–75%), and high (>75%). Fixed-effect models were employed in cases of low heterogeneity; otherwise, random-effects models were applied. A p-value of less than 0.05 was

deemed statistically significant. Meta-analysis results were visualized using forest plots.

Outcome Summary

The analysis included data from 472 feet, with 214 undergoing percutaneous (MIS) procedures and 258 receiving open surgical correction.

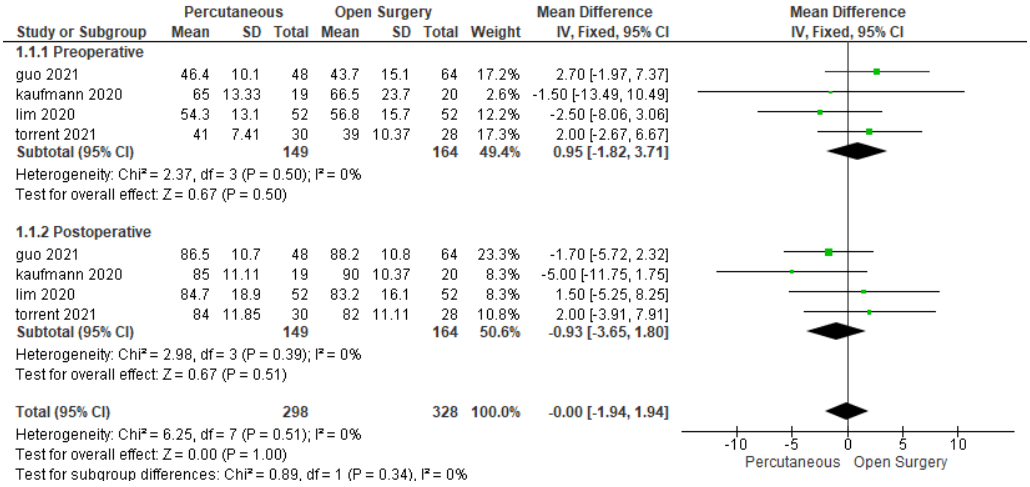

Figure 1. AOFAS Outcome

A subgroup analysis was performed to evaluate AOFAS outcome between percutaneous versus open surgery for hallux valgus correction. Figure 1 demonstrates that there was no significant difference statistically between these two groups in AOFAS score at preoperative (Heterogeneity, I2 = 0 percent; MD, 0.95; 95 percent Confidence Interval (CI), -1.82 to 3.71; P 0.5) and postoperative (Heterogeneity, I2 = 0 percent; MD, 0.00; 95 percent Confidence Interval (CI), -1.94 to 1.94; P 0.34). [4–7]

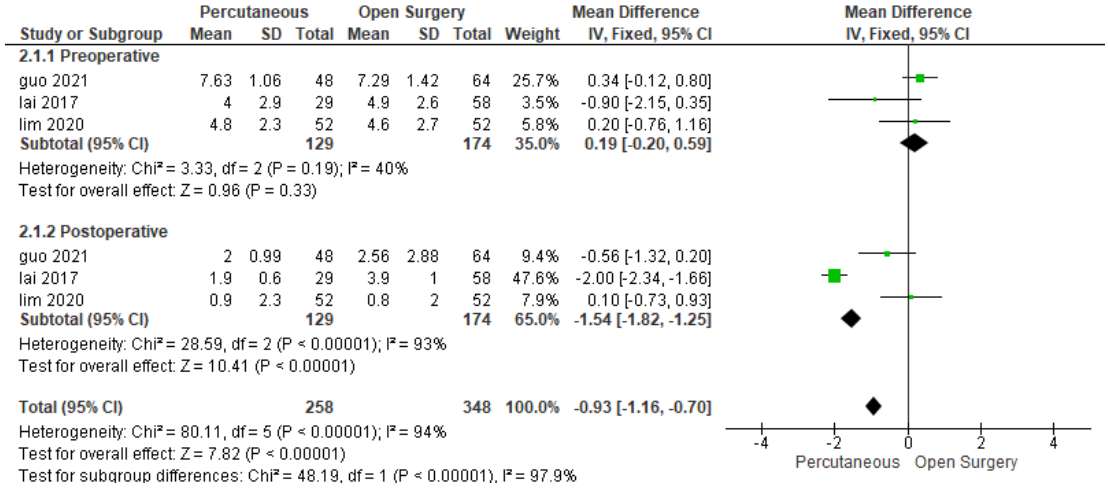

Figure 2. VAS Outcome

Figure 2 demonstrates the subgroup analysis evaluating VAS outcome, showing that there was no significant difference statistically between these two groups in VAS score at preoperative (Heterogeneity, I^2 = 40 percent; MD, 0.19; 95 percent Confidence Interval (CI), -0.20 to 0.59; P 0.33) but there was significant difference statistically between these two groups in VAS score at postoperative (Heterogeneity, I^2 = 94 percent; MD, -0.93;

95 percent Confidence Interval (CI), -1.16 to -0.79; P < 0.05). [6,8,9]

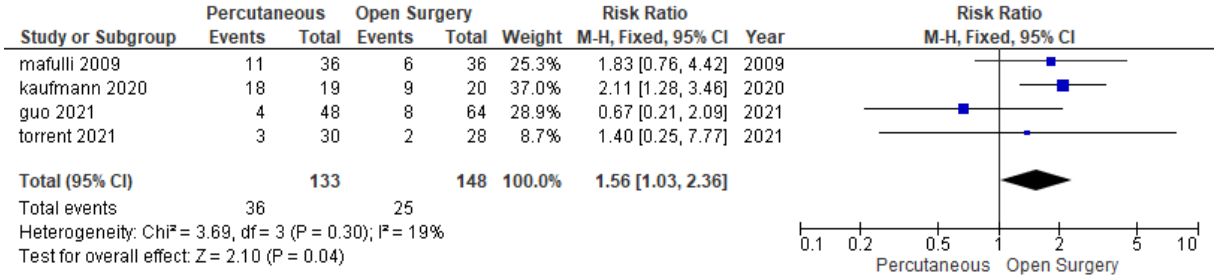

Figure 3. Complication Rate Outcome

The complication rate outcome between percutaneous versus open surgery for hallux valgus correction were evaluated through subgroup analysis. Figure 3 demonstrates statistically significant difference between these two groups in complication rate. (Heterogeneity, I2 = 19 percent; RR, 1.56; 95 percent Confidence Interval (CI), -1.03 to 2.36; P < 0.05). [5,8,10,11]

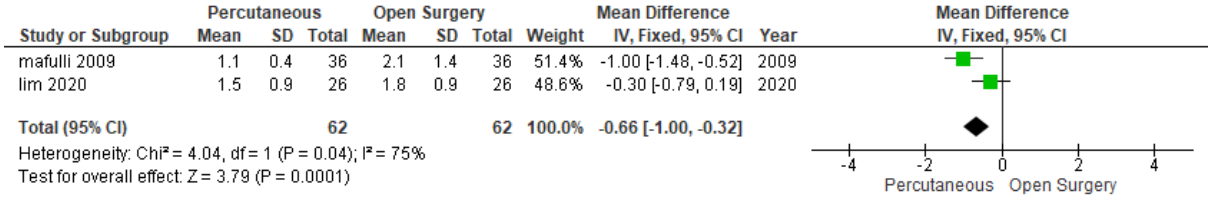

Figure 4. Length of Hospitalization

The length of hospitalization outcome between percutaneous versus open surgery for hallux valgus correction were evaluated, showing statistically significant difference statistically between these two groups in length of hospitalization as shown in Figure 4. (Heterogeneity, I2 = 75 percent; MD, -0.66; 95 percent Confidence Interval (CI), -1.00 to -0.32; P < 0.05). [6,10]

DISCUSSION

About more than 120 procedures of percutaneous surgery and more than 150 open surgery for treating the hallux valgus. In this meta-analysis, there is more of open surgical procedures rather than percutaneous one.[12–15]

Lu et al in their study have a low to moderate quality, and limited outcome measurement.[1] This meta-analysis, quite similar with the previous, will focus on AOFAS score, Complication Rate, Length of Hospitalization, and VAS.

AOFAS score was used to determine the outcome, the score consist of pain (40 points), function (45 points), and alignment (15 points). Meta-analysis by Singh et al explains that open group surgery had better AOFAS score.[16] Meanwhile, Poggio et al explained on their study that minimally invasive surgery has better result in AOFAS score than open surgery.[17] Furthermore, Lee et al and Radwan and Mansour demonstrated a better result in minimally invasive surgery's AOFAS score than the open surgery.[13,18] However, this meta-analysis from 4 studies, the AOFAS score shows no difference between percutaneous than open surgery in post-operative patients.

The use of percutaneous and open surgery will result in different complication rate because of the length of time, difficulties of the procedures, and technique. In some studies, percutaneous surgery will have less expected result on soft tissue complications, stiffness, and higher satisfaction rate. One of the reason is because in percutaneous surgery, the scar's length is shorter than in open surgery. Besides, the duration of surgery is also shorter in percutaneous

surgery.[19] Similar to that, in this study there were found a higher complication rate on the open surgery treatment for hallux valgus.

Limited exposure and steps in percutaneous surgery might lowering the length of hospitalization. This will actually change the patient's decision while choosing which surgery that will benefit their personal satisfaction.[19] In accordance to that, the length of hospitalization in this study shows better result on percutaneous surgery post-operatively than open surgery. Unfortunately, differ from that, Lai et al, explained that in the minimally invasive group having longer fluoroscopy time than open surgery group. This affect the radiation in the patients. [14]

Singh et al in their study shows that VAS score in post-operative patient shows better result in minimally invasive surgery.[16] In accordance to that, post-operative result on our study on VAS score was favorable in patients underwent percutaneous than open surgery. This could happen because percutaneous surgery only require soft tissue dissection.[3]

CONCLUSION

In this study the percutaneous or MIS procedures were more effective than the open surgery for treating hallux valgus, even though there are more open surgical procedures. For the outcome measures, it is quite similar with the previous study. We focused on AOFAS Score, Complication Rate, Length of Hospitalization and VAS. One out of 4 studies had a contradiction about AOFAS Score, it's said that the open surgery had better AOFAS Score, however, AOFAS score shows no difference between percutaneous than open surgery in post-operative patients.

From the complication rate, the studies showed that MIS will have less expected result on soft tissue complications, stiffness, and higher satisfaction rate. The limited exposure and steps in percutaneous surgery might lowering the length of hospitalization, but in a study by Lai et al explained that in the minimally invasive group having longer fluoroscopy time than open surgery group. For the VAS score in our study was favorable in patients underwent percutaneous than open surgery and it had similar result like the other studies.

Declaration by Authors

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Conflict of Interest: No conflicts of interest declared.

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