Henry Ricardo Handoyo

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1-Scarf-Akin versus Lapidus-Akin Osteotomy in Hallux Valgus Deformity

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Scarf-Akin *versus* Lapidus-Akin Osteotomy in Hallux Valgus Deformity: a Systematic Review and Meta-analysis Examining Radiological and Patient Reported Outcomes

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SUMMARY

Introduction. Scarf-Akin and Lapidus-Akin osteotomies are both well-known techniques used in managing hallux valgus deformities. The aim of this study is to determine the difference between Scarf-Akin and Lapidus-Akin osteotomies, examining both radiological and patient reported outcomes.

Methods. Articles were obtained using the PubMed and ScienceDirect database. A total of 31 articles were included in the final review. Hallux valgus angle (HVA), intermetatarsal angle (IMA), and American Orthopedic Foot and Ankle Society Hallux Metatarsophalangeal-Interphalangeal (AOFAS Hallux MTP-IP) score were analyzed using random-effects meta-analysis.

Results. A total of 1,437 feet and 171 feet underwent Scarf-Akin and Lapidus-Akin osteotomies, respectively. Both Scarf-Akin and Lapidus-Akin osteotomies were effective in improving HVA, IMA, and AOFAS Hallux MTP-IP score ($p < 0.00001$). No significant differences were found in comparing Scarf-Akin and Lapidus-Akin outcomes in HVA (Scarf-Akin Mean Difference: -22.16, 95% Confidence Interval [-24.72 to -19.60], Lapidus-Akin Mean Difference: -21.32, 95% Confidence Interval [-25.75 to -16.88], $p = 0.75$), IMA (Scarf-Akin Mean Difference: -7.73, 95% Confidence Interval [-8.55 to -6.91], Lapidus-Akin Mean Difference: -10.55, 95% Confidence Interval [-14.42 to -6.68], $p = 0.16$), and AOFAS Hallux MTP-IP score (Scarf-Akin Mean Difference: 35.83, 95% Confidence Interval [29.65-42.01], Lapidus-Akin Mean Difference: 28.90, 95% Confidence Interval [18.37-39.44], $p = 0.27$).

Conclusions. No statistically significant difference was found between Scarf-Akin and Lapidus-Akin osteotomies in HVA, IMA, and AOFAS Hallux MTP-IP score. Further research is needed especially in examining Lapidus-Akin osteotomy due to its low quantity of published studies compared to Scarf-Akin osteotomy.

KEY WORDS
AOFAS; hallux valgus; HVA; IMA; Lapidus-Akin; Scarf-Akin.

INTRODUCTION

Hallux valgus is the most common forefoot deformity, linked to functional disability, including foot pain, impaired gait patterns, poor balance, and falls. Prevalence rate of hallux valgus was estimated to reach 35.7% in elderly people over 65 years old and 23% in adults aged 18-65 years old (1). Various surgical techniques have been described in hallux valgus management, ranging from open to minimally

invasive surgery, such as the Reverdin-Isham technique and minimally invasive intramedullary nail device (MIIND), with both Scarf-Akin and Lapidus-Akin osteotomy being one of the most popular methods (2-4). In the correction of hallux valgus, the use of Akin osteotomy on its own is not recommended, necessitating the implementation of additional Scarf or Lapidus osteotomy to achieve the desired outcome (5). The different approaches in Lapidus osteotomy, where a first tarsometatarsal joint arthrodesis is performed, and Scarf osteotomy, utilizing a Z-cut of the first metatarsal, results in advantages and disadvantages in both techniques. The scarf osteotomy was associated with shorter recovery time, but was often accompanied by collapsing height, with or without rotation of the metatarsal. On the other hand, the Lapidus osteotomy was associated with longer recovery time and a higher non-union rate (6). The objective of this study is to determine the difference between Scarf-Akin and Lapidus-Akin osteotomies, examining both radiological and patient reported outcomes, where the hallux valgus angle (formed by the longitudinal axis from the first metatarsal and the proximal phalanx) (7), intermetatarsal angle (formed by the first and second metatarsal shaft axis) (8), and American Orthopedic Foot and Ankle Society Hallux Metatarsophalangeal-Interphalangeal (AOFAS Hallux MTP-IP) score, a questionnaire devised to assess patients' experience, were analyzed.

METHODS

Search strategy

Articles were searched using the PubMed and ScienceDirect database. Articles returned by the database according to the keywords were analyzed by authors for inclusion eligibility. The process was done according to the PRISMA guideline (9).

Inclusion and exclusion criteria

Studies were eligible for inclusion if it examines the effect of either Scarf-Akin or Lapidus-Akin osteotomy on hallux valgus, published in English, and collected data regarding radiological (HVA and IMA) or patient reported outcomes (AOFAS Hallux MTP-IP score). Studies were excluded if the full-texts were not available, published in languages other than English, or the data were not expressed clearly in mean and standard deviation. Review articles and letters/comments were also excluded.

Selection process

The PubMed database returned a total of 17 articles from the keyword "Lapidus Akin" and 56 articles from the keyword "Scarf Akin". A total of 21 duplicate articles were identified and removed, leaving 52 articles for further screening. The ScienceDirect database, using the keyword "Scarf Akin Lapidus Akin", returned 165 articles, specifying the article type to research articles and the language to English returned a total of 42 articles for further screening. **Figure 1** describes the article selection process.

Data extraction

The following data were extracted from articles included:

1. Author name
2. Year of publication
3. Surgical method
4. Radiological outcomes
5. Patient reported outcomes
6. Sample size

Data analysis

All data obtained from included articles were analyzed using Review Manager 5 software by the authors. Random effects model was used to compare the difference between Scarf-Akin and Lapidus-Akin osteotomies. Data were expressed in mean ± standard deviation. Data extraction process was done according to the Cochrane Handbook Version 5.1.0. A P-value of < 0.05 were considered to be significant.

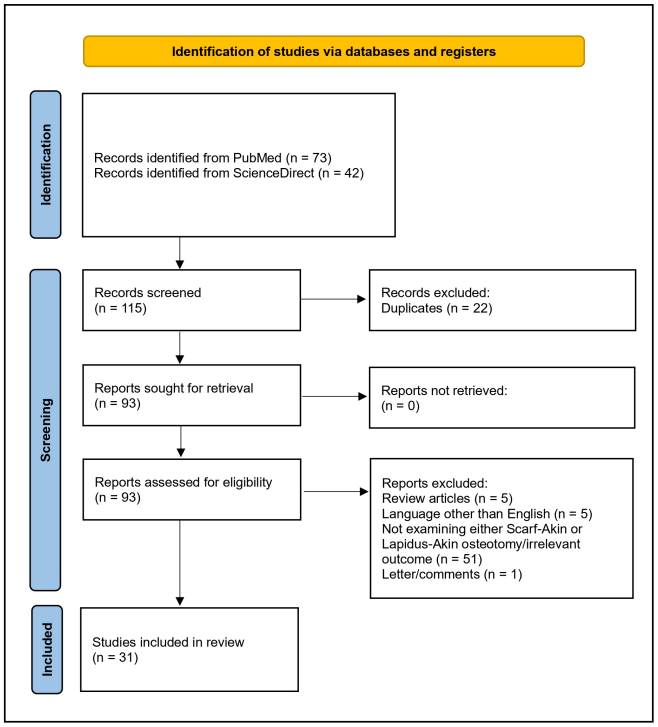

Figure 1. Article selection process.

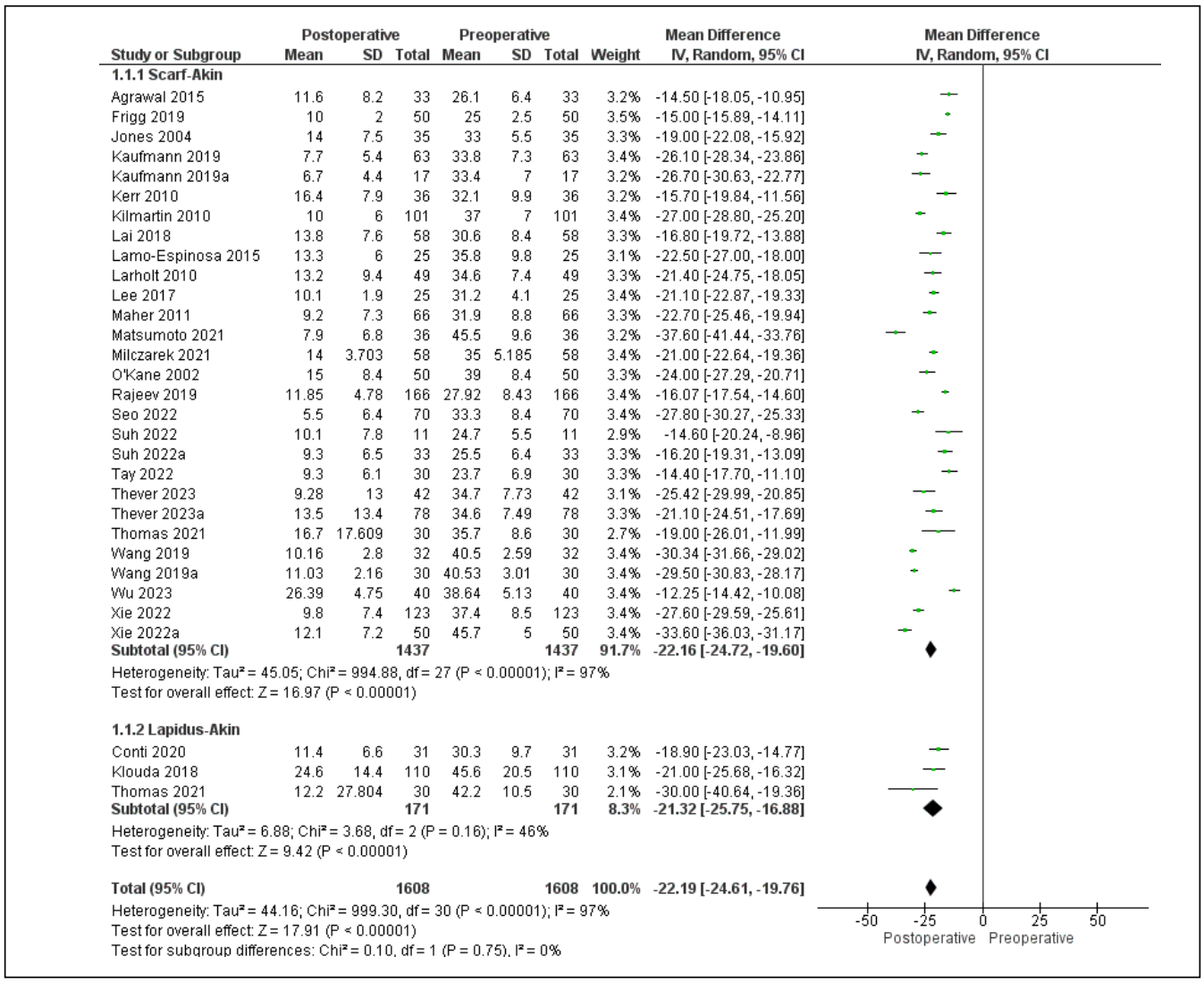

Figure 2. Forest plot for HVA values.

RESULTS

A total of 31 articles were identified and included in the final review (2, 10-39). Initial search from the PubMed database yielded 73 articles. The search in ScienceDirect database resulted in 42 articles. A total of 22 duplicates were excluded, leaving 93 articles for retrieval and further assessment. Reasons for exclusion were explained in **figure 1**, with 62 articles excluded for various reasons. A total of 31 articles were included in the final review. A wide range of studies were included due to lack of high quality studies examining Lapidus-Akin osteotomy specifically.

The radiological and patient reported outcomes assessed in most of the studies and are possible for comparison between Scarf-Akin and Lapidus-Akin osteotomies are hallux valgus angle (HVA), intermetatarsal angle (IMA), and American Orthopedic Foot and Ankle Society Hallux Metatarsophalangeal-Interphalangeal (AOFAS Hallux MTP-IP). Sample size, mean, and standard deviation were extracted from the studies included and were inputted for statistical analysis. Missing data were extrapolated according to the methods described in Cochrane Handbook Version 5.1.0.

Examination of the HVA, IMA, and AOFAS Hallux MTP-IP values from both Scarf-Akin and Lapidus-Akin osteotomies reveals that both techniques succeeded in improving these values significantly. Scarf-Akin osteotomy reduced HVA (Mean Difference: -22.16, 95% Confidence Interval [-24.72

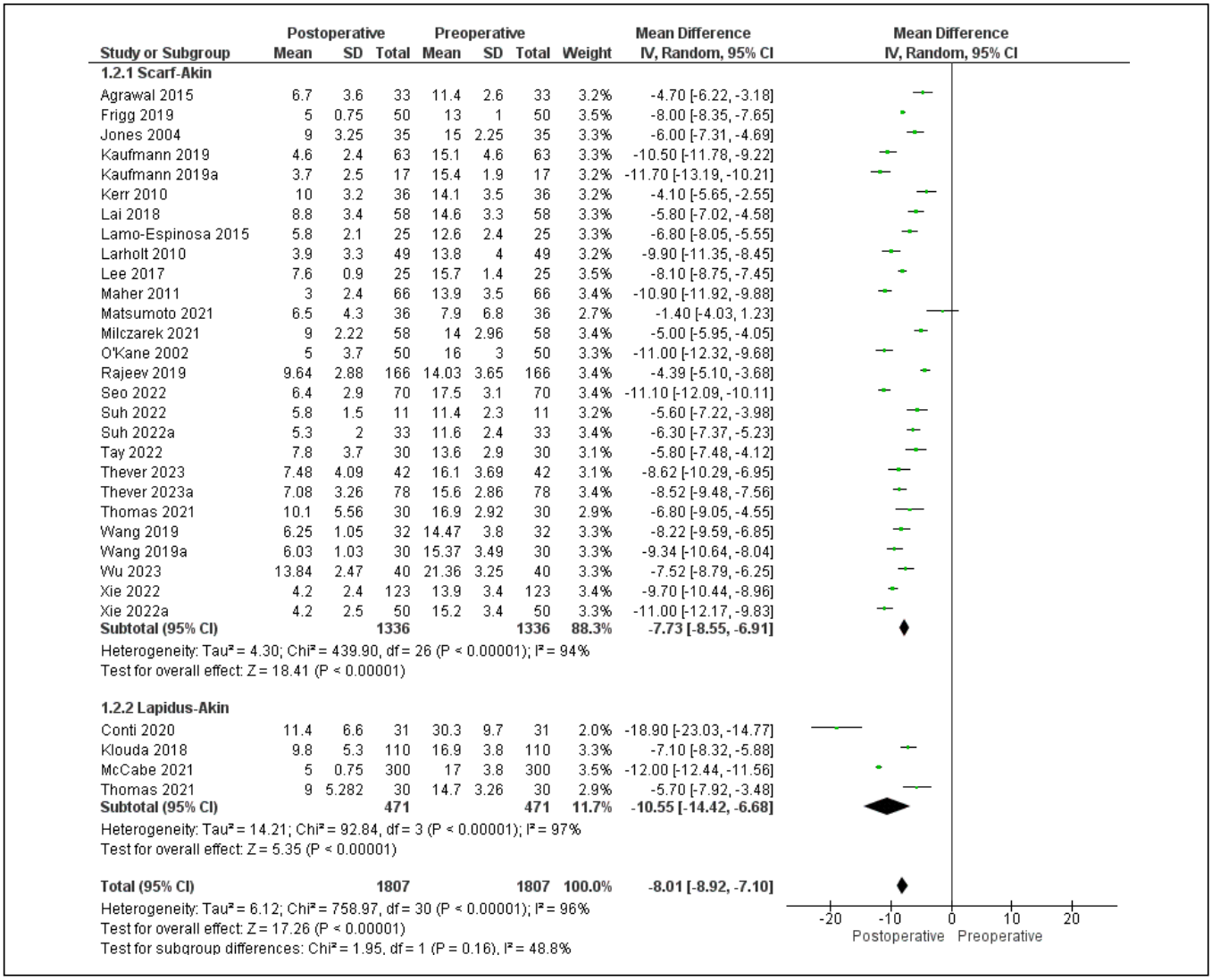

Figure 3. Forest plot for IMA values.

to -19.60]), IMA (Mean Difference: -7.73, 95% Confidence Interval [-8.55 to -6.91]), and AOFAS Hallux MTP-IP (Mean Difference: 35.83, 95% Confidence Interval [29.65- 42.01] significantly ($p < 0.00001$). Meanwhile, Lapidus-Akin osteotomy also managed to successfully reduce HVA (Mean Difference: -21.32, 95% Confidence Interval [-25.75 to -16.88]), IMA (Mean Difference: -10.55, 95% Confidence Interval [-14.42 to -6.68], and AOFAS Hallux MTP-IP (Mean Difference: 28.90, 95% Confidence Interval [18.37-39.44]) significantly ($p < 0.00001$).

Comparing HVA values between the Scarf-Akin and Lapidus-Akin osteotomies resulted in no statistically significant outcome ($p = 0.75$), the same result could be seen in both IMA ($p = 0.16$) and AOFAS Hallux MTP-IP ($p = 0.27$) values as well (**figures 2-4**).

Statistically significant heterogeneity was observed in all groups ($p < 0.00001$, $I^2 = 94\text{-}99\%$), except for the HVA measurements for Lapidus-Akin osteotomy ($p = 0.16$, $I^2 = 46\%$).

DISCUSSION

In this systematic review and meta-analysis, we tried to compare both radiological and patient reported outcomes between Scarf-Akin and Lapidus-Akin osteotomies. The number of studies strictly examining either Scarf-Akin or Lapidus-Akin osteotomies with clear boundaries regarding

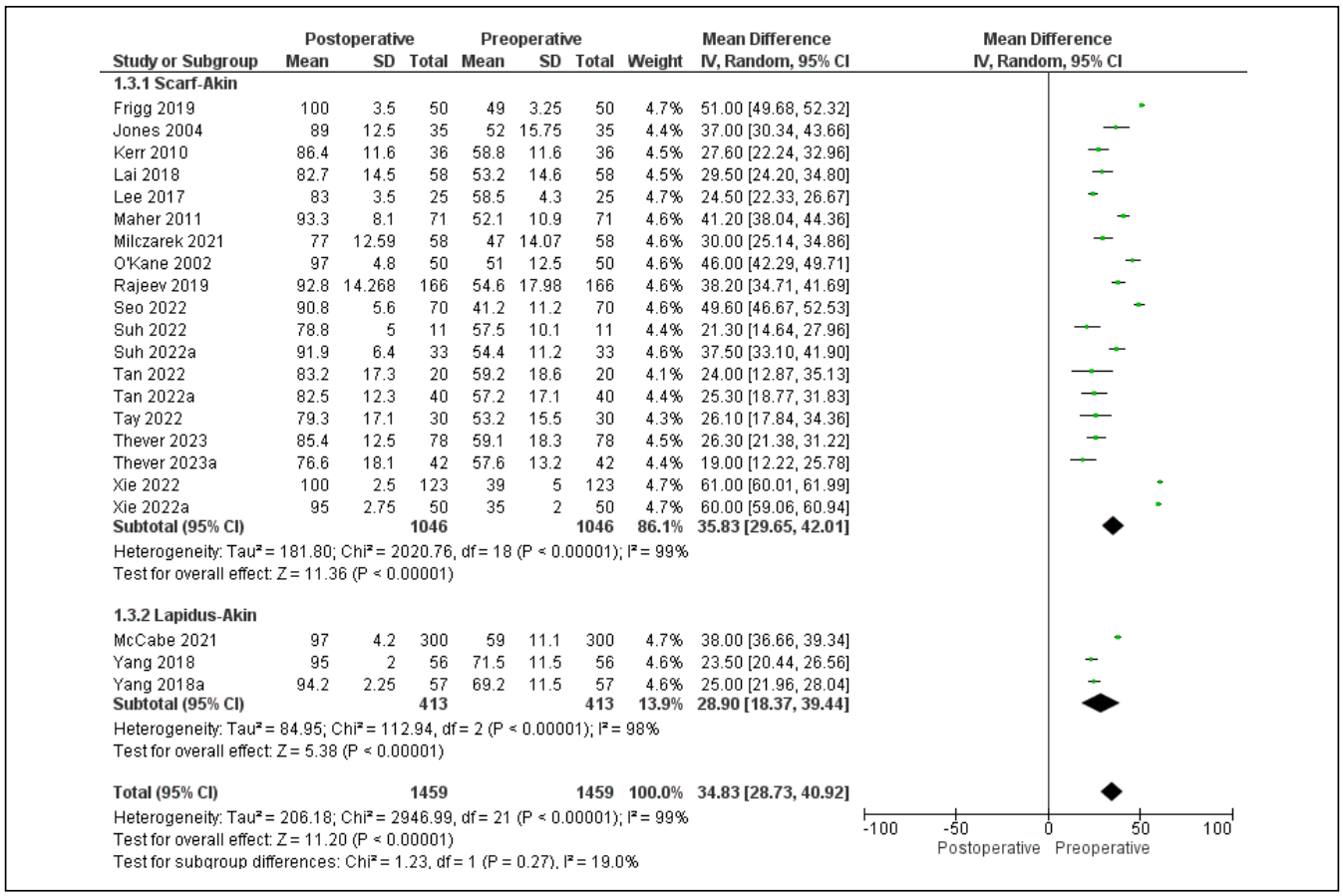

Figure 4. Forest plot for AOFAS Hallux MTP-IP score.

data reported are relatively scarce, necessitating the need for a more lax and broad inclusion criteria, especially regarding the study designs. Studies examining the Lapidus-Akin osteotomy are especially few, creating an imbalance between the two groups examined. Future research is especially needed in assessing the results of Lapidus-Akin osteotomies, with the data clearly expressed with clear boundaries in order to make future research and analysis easier to conduct.

Both Scarf-Akin and Lapidus-Akin osteotomies were obviously shown to have significant benefits on radiological and patient reported outcomes, in this case those parameters being the HVA, IMA, and AOFAS Hallux MTP-IP score. However, when comparison is done between the two techniques, no statistically significant difference was found between the two techniques in the aforementioned values. Significant heterogeneity was found in nearly all groups. This phenomenon could be attributed to the methodological heterogeneity found between studies. A similar problem was encountered by the study done by Smith *et al.*, which compares Scarf and Chevron osteotomies in IMA values (40). Studies comparing both Scarf-Akin and Lapidus-Akin directly were also markedly scarce, and to the day when this systematic review was conducted, only one study done by Thomas *et al.* compared both Scarf-Akin and Lapidus-Akin directly (2). Thomas *et al.* in his study discovered that the Lapidus-Akin osteotomy trumps over the Scarf-Akin osteotomy in HVA value and patient satisfaction, but not IMA values (2). The pooled results of HVA values between Scarf-Akin and Lapidus-Akin osteotomy only shows a mean difference of -0.84 degrees slightly favoring Scarf-Akin osteotomy (Scarf-Akin: -22.16 degrees, Lapidus-Akin: -21.32) and were not statistically significant. Meanwhile, the IMA values displayed a mean difference of -2.82 degrees favoring Lapidus-Akin osteotomy (Scarf-Akin: -7.73 degrees, Lapidus-Akin: -10.55), showing a more marked difference, although not statistically significant. Patient satisfaction in the study done by Thomas *et al.*, were examined using the Manchester Oxford Foot Score, which differs from the

commonly used AOFAS Hallux MTP-IP score (2). Nonetheless, the results in the study done by Thomas *et al*. favors the Lapidus-Akin group significantly ($p < 0.0001$) (2). The pooled values of AOFAS Hallux MTP-IP score extracted shows a different result, with a mean difference of 6.93 favoring the Scarf-Akin osteotomy, with no statistically significant difference. The small sample size displayed by Thomas *et al*. in his study and the increased severity experienced by the Lapidus-Akin osteotomy group were mentioned as a limitation that might be affecting the outcome of the study (2).

Hypermobility of the first ray (FRH) was reported to be associated with hallux valgus (41). Reviewing the available articles included in this review, only 2 studies reported the assessment of FRH, without mentioning the measuring procedure (12, 29). Taking into account the complex interaction between FRH and hallux valgus, measurement of FRH both before and after surgery should be performed and reported routinely (41).

Future research is needed using a more robust methodology, utilizing a randomized controlled trial design with matched sample characteristics to obtain data of higher quality. Clear boundaries between groups and data reporting are also needed to help future researchers process data in an easier manner. In designing future studies, data should be reported clearly, specifying the number of samples, reporting numbers in mean and standard deviation, as opposed to median and ranges to facilitate easier and more accurate data pooling. Studies also often only reported that some percentage of the included sample underwent additional or different surgical techniques, but no separate reporting of the results was included in the article, rendering some data unusable.

CONCLUSIONS

Current data shows no significant difference between Scarf-Akin and Lapidus-Akin osteotomies in radiological and patient reported outcomes. Future research is needed with better study design and methodological measures to ensure data quality.

FUNDINGS

None.

DATA AVAILABILITY

Data are available under reasonable request to the corresponding author.

CONTRIBUTIONS

HRH: conceptualization, data curation, formal analysis, writing – original draft. KAIS, RAP, RUA: data curation, writing – original draft, writing – review & editing. WW: data curation, formal analysis, writing – original draft.

CONFLICT OF INTERESTS

The authors declare that they have no conflict of interests.

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