

# Scarf Osteotomy without Internal Fixation for Hallux Valgus: A Systematic Review

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## ABSTRACT

**Background:** Scarf osteotomy is traditionally performed with screw fixation and has been found to be useful for moderate to severe grade deformities. Our study aimed to evaluate the efficacy and safety of scarf osteotomy without internal fixation for hallux valgus deformity correction based on the available literature.

**Methods:** A systematic search of PubMed and the Cochrane database of controlled trials was performed to include any available studies that examine the effectiveness of scarf osteotomy without internal fixation in terms of clinical or radiographic outcomes, as well as complications. The methodological quality of each study was assessed using the MINORS criteria.

**Results:** Five studies were included in this systematic review (four cases series and one retrospective comparative study). We noted that all studies concluded acceptable outcomes using scarf osteotomy without internal fixation with the American Orthopaedic Foot and Ankle Society (AOFAS) score improving from an average of 46.5–91, the mean hallux valgus angle improving from 32.9°–9.7°, the mean intermetatarsal angle improving from 14.5°–6.1°, and lastly, the mean distal metatarsal articular angle from 15.5°–5.9°. Complication rates were low across all studies with a 5.5% in 305 patients, with displacement being the most common complication accounting for 2.2% across all studies.

**Conclusion:** Scarf osteotomy without internal fixation has been shown to have potential in the treatment of hallux valgus deformities. Acceptable results and complication rates suggest that this technique can be a viable alternative for patients, especially those who are financially burdened and those who cannot afford increased hospital time. However, there is limited knowledge and small number of research studies on this surgical technique. The current systematic review hopes to invoke renewed interest in this technique.

**Clinical significance:** Scarf osteotomy without internal fixation can provide a cheaper alternative to the standard protocol of hallux valgus correction as it does not need an implant for internal fixation and can theoretically provide comparable results which can lessen the financial burden for patients such as those living in third-world countries.

**Keywords:** Hallux valgus, Implantless, Scarf osteotomy, Screwless, Systematic review, Without internal fixation.

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## HIGHLIGHTS

- Scarf osteotomy without internal fixation resulted in acceptable results in terms of clinical and radiographic outcome in the limited number of studies available.
- Displacement was the most common complication of scarf osteotomy without internal fixation.
- This technique can potentially lessen the financial burden for patients as it does not require any implants and can lessen hospital stay due to decreased need for revision surgery related to hardware-related complications when done correctly.

Limited data are available on this technique with no randomized-controlled trials being conducted as of date.

## INTRODUCTION

Hallux valgus (HV) is a common foot deformity with progressive abduction and pronation of the first phalanx, adduction, pronation and elevation of the first metatarsal, and lateral capsular retraction of the first metatarsophalangeal joint leading to claw-toe deformities and transfer metatarsalgia.<sup>1-4</sup> Patients usually complain of pain and difficulty with footwear, which are indications for surgical correction of the deformity.<sup>5</sup> With the complexity of this

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condition, over a hundred surgical techniques have been developed with no consensus on the best method.<sup>6,7</sup>

Scarf osteotomy is a complex surgical technique done in the midshaft which allows a wide range of translation.<sup>8</sup> It can be utilized to allow rotation and supination and in order to provide three-dimensional correction.<sup>9</sup> Scarf osteotomy is typically used for moderate to severe HV deformities with satisfactory results.<sup>7,10</sup> A proximal phalangeal (Akin) osteotomy can be used as an adjunct if the deformity persists after scarf osteotomy.<sup>8,10</sup> Complications

reported with scarf osteotomy include infections, rotational malunion, delayed union, recurrence of deformity, and troughing of the metatarsal with loss of height.<sup>11</sup>

Internal fixation was initially deemed necessary for scarf osteotomy until a study by Maestro described a technique which involved locking the two fragments distally, eliminating the need for screw fixation of the osteotomy.<sup>9</sup> This interlocking effect was done by creating a notch through a medial extension of the cephalic part of the osteotomy and fitting the distal end of the proximal fragment into the notch after lateral translation of the plantar fragment.<sup>9,12</sup> Scarf osteotomy without screw fixation was introduced to address the fixation-related complications of the classical scarf osteotomy: the presence of the screws often leading to painful conditions, or acting as an obstacle in cases where revision surgery is needed.<sup>12</sup> Revision surgeries are often difficult to accept by patients and can result in iatrogenic injuries, while also risking a range-of-motion limitation.<sup>9</sup> Furthermore, the additional hospitalization and time on sick leave for working patients may possibly entail an economic burden especially for those in countries with public health insurance.<sup>9,13</sup> Lastly, high-quality remodeling with no stress-shielding occurs at the osteotomy site, when no internal fixation is used.<sup>9</sup>

With the potential benefits of scarf osteotomy without internal fixation in mind, the authors are seeking an alternative to the standard management of osteotomy with internal fixation for HV deformity, as it can theoretically lessen the financial burden of patients while providing comparable results with the standard. The goal of this systematic review is to evaluate the latest evidence regarding the efficacy and safety of scarf osteotomy without internal fixation for HV correction.

## METHODOLOGY

### Information Sources, Search and Study Selection

A comprehensive electronic search included PubMed and the Cochrane database of controlled trials. The main keywords were “scarf” AND “osteotomy” AND “hallux valgus.” Detailed search strategies are presented in Table 1 noting the MeSH term results and the research flow diagram. The research flow diagram is shown in Figure 1. Two independent reviewers screened the search results by title and abstracts. Duplicates were removed and retrieved full-text articles were then screened for eligibility to systematic review. Retrieved articles were fully reviewed to ensure that they truly met the inclusion criteria. The bibliographies and citations of each relevant articles were reviewed to ensure that no article was overlooked. Disagreements between the authors were resolved by discussion prior to data analysis.

This study was performed in accordance with the Cochrane Handbook for Systematic Reviews of Interventions and the PRISMA (Preferred Reporting Items from Systematic Reviews and Meta-Analyses) statement.<sup>14,15</sup>

**Table 1:** The Search and MeSH terms used in the retrieval of relevant articles from the electronic databases

Search and MeSH terms
“scarf”[All Fields] AND (“osteotomie”[All Fields] OR “osteotomied”[All Fields] OR “osteotomy”[MeSH Terms] OR “osteotomy”[All Fields] OR “osteotomies”[All Fields]) AND (“hallux valgus”[MeSH Terms] OR (“hallux”[All Fields] AND “valgus”[All Fields]) OR “hallux valgus”[All Fields])

## Eligibility Criteria

The reviewers included case series, cohort studies or clinical trials evaluating the correction of HV using scarf osteotomy without any type of internal fixation. Only full-text original research reports, published in English or French. The study population comprised patients ≥18 years of age and diagnosed with HV of any severity who underwent surgical correction. The included studies described minor variations of the scarf osteotomy technique according to their respective investigators. These studies described scarf osteotomy techniques without internal fixation which entailed that any type of implant was not used to maintain stability of the corrective osteotomy. Internal fixation was described as any fixation which utilized implants such as screws, plates, or k-wires in maintaining the stability of the corrective osteotomy.

Each database was searched from January 1991 to May 2020. Exclusion criteria comprised any paper that did not meet the inclusion criteria (other osteotomy techniques for HV used, use of internal fixation, cadaveric studies, animal studies, review articles, studies with pediatric patients, biomechanical studies, and basic science studies) as well as those that included patients with any previous forefoot surgeries or significant comorbidities, such as rheumatoid disease or any underlying neuromuscular disorder.

## Types of Outcomes

Studies were included if at least one of the following outcomes was assessed: radiographic outcome, clinical outcome, foot pain, patient satisfaction, or complications particularly recurrence, displacement, nonunion, malunion, or infection. Radiographic outcomes were: hallux valgus angle, intermetatarsal angle, and distal metatarsal articular angle. Clinical outcome was described using the American Orthopaedic Foot and Ankle Society (AOFAS) score. Foot pain was described according to the visual analogue scale. Patient satisfactions were included and defined as the percentage rate of the population whom were satisfied with the treatment. Lastly, complication rate (%) were listed down and compiled.

## Data Collection Process and Data Items

The two reviewers extracted data from the original studies using a standardized data abstraction list, including the first author's last name, publication year, and study design. Demographic data were collected, including the number of patients, number of feet treated, male to female ratio, age, length of follow-up, and outcome of interests.

## Risk of Bias in Individual Studies

The methodological index for non-randomized studies (MINORS) score was used to assess the methodologic quality of each study.<sup>16</sup> Studies with a MINORS score over or equal to 75% were considered to have a low risk of bias. Studies with a MINORS score lower than 75% were considered to have a high risk of bias.

## RESULTS

### Study Selection

A total of 229 potential records were identified from the databases, 13 duplicate records were removed which left 216 records. Out of the 216 studies, 122 were excluded after screening the title and abstract. The full-text articles of 47 studies were assessed for eligibility resulting in the exclusion of 42 studies. The remaining five studies were included in the current systematic review and are summarized in Figure 1.<sup>9,17-20</sup>

## Study Characteristics

The included studies comprised of a retrospective comparative cohort study,<sup>20</sup> a prospective case series,<sup>18</sup> two retrospective case series,<sup>17,18</sup> and a technical note case series which did not report whether it was prospective or retrospective.<sup>9</sup> Of these five studies, three were level IV, and two were level IIIB based on the evidence levels developed by the Centre of Evidence based Medicine.<sup>21</sup> These studies were selected to determine the postoperative angle correction, the clinical score evaluation, pain scores, patient satisfaction, and complications from scarf osteotomy without internal fixation (i.e., recurrence of deformity, postoperative displacement, infection, skin irritation, malunion, nonunion, hallux varus). The mean age of the patients ranged from 54–56 years of age. A total of 305 patients underwent scarf osteotomy without internal fixation. In one level IV case series, Leemrijse et al.<sup>9</sup> described a scarf osteotomy without internal fixation on 12 patients with a total number of 15 feet treated, a mean age of 55 years, and a mean follow-up period of 92.4 months. In the retrospective level IV

case series by Ouaggag et al.,<sup>17</sup> they reported 30 patients who underwent this procedure with a mean age of 54.2 years and a mean follow-up period of 52 months. A level III prospective case series by Van Doninck et al.<sup>18</sup> had a total of 79 patients, a mean age of 54 years, and a mean follow-up period of 1.5 months. Another retrospective level IV case series by Curtin et al.<sup>19</sup> performed a scarf osteotomy for 148 feet in 120 patients with a mean age of 54.6 years and a mean follow-up period of 16.5 months. Lastly, a retrospective comparative study with level III evidence conducted by Liszka et al.<sup>20</sup> compared an implantless scarf osteotomy to two other groups which utilized screws for internal fixation. They included 64 patients in the implantless group with a mean age 56 years and had a mean follow-up period of 12 months. The characteristics of all the included studies are summarized in Table 2.

## Risk of Bias within Studies

The MINORS score revealed that only one out of the five studies scored over 75% which indicated a low risk of bias. The rest of the

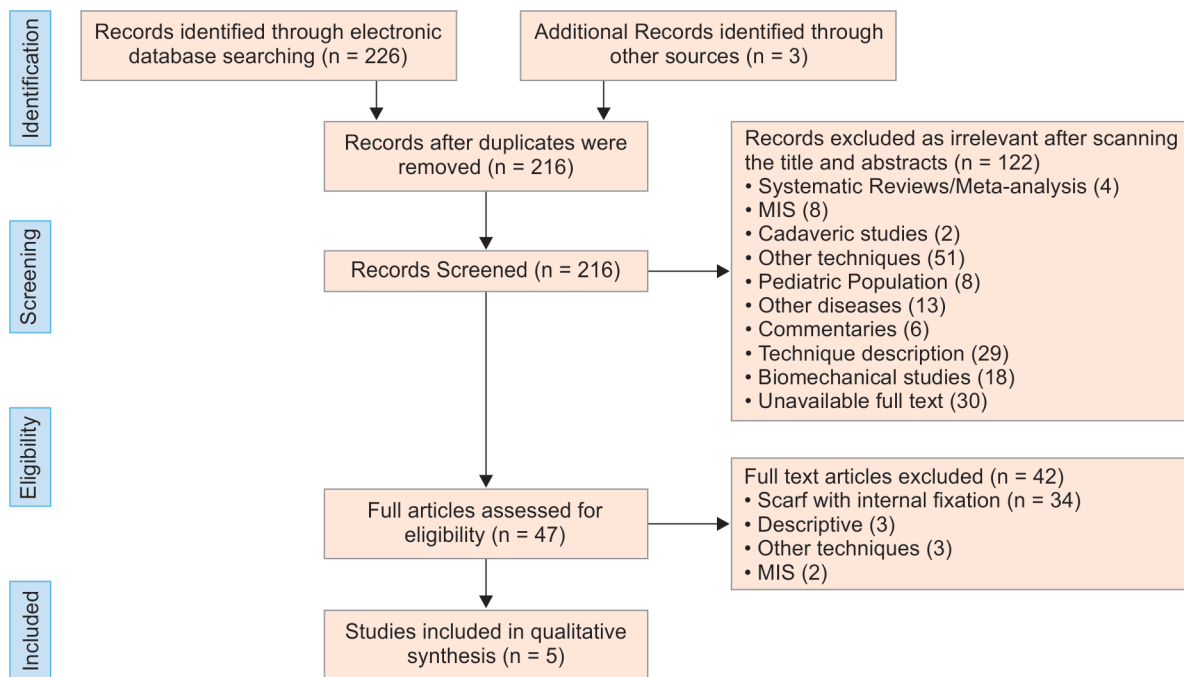


Fig. 1: Search strategy. PRISMA flow diagram

Table 2: Characteristics of included studies

Investigator (Year)	Evidence level	Study design	No. of patients	No. of feet	Sex (M/F)	Mean age, years	Mean follow-up, months
Leemrijse et al. (2012)	IV	Case series	12	15	2/10	55	92.4
Ouaggag et al. (2015)	IV	Retrospective case series	30	35	2/28	54.2	52
Van Doninck et al. (2017)	IIIB	Prospective case series	79	NR	12/67	54	1.5
Curtin et al. (2017)	IV	Retrospective case series	120	148	13/135	54.6	16.5
Liszka et al. (2018)	IIIB	Retrospective comparative cohort	64	NR	5/61	56	12

HV, Hallux Valgus; M, Male; F, Female; NR, Not Reported

studies scored lower than 75% which were considered to have a high risk of bias. The criteria and assessment of each study is found in Table 3.

### Summarized Results of Included Studies

Results of the studies are summarized in Table 4. Clinical outcome was evaluated using the AOFAS scale score in three studies,<sup>9,17,20</sup> and the Foot and Ankle Disability Index was used in one study.<sup>19</sup> One study did not report any clinical outcome scores.<sup>18</sup> The AOFAS score was reported in only three cases and improved from an average of 46.5 (range 42–51) preoperatively to 91° postoperatively.<sup>9,17,20</sup>

The average hallux valgus angle improved from 32.9° (range 27.9°–38.5°) preoperatively to 9.7° (range 4.2°–12.4°) postoperatively. For the IMA, the average preoperative value of 14.5° (range 13.2°–15.7°) improved to a postoperative 6.1° (range 4.8°–7.8°). Distal metatarsal articular angle was reported in only two studies, with a preoperative value of 15.5° (range 15.4°–15.7°) to a postoperative value of 5.9° (range 5.4°–6.5°).

Patient satisfaction was reported in two studies with a mean of 99.3% (range 98.6–100%).<sup>9,19</sup> Visual analogue scale was reported in only one study with 120 patients with an average pre-operative score of 7.04 improving to 0.29 postoperatively.<sup>19</sup>

The complications are reported in Table 5. The total complication rate in this review was 5.5% in 305 patients. The main complication with scarf osteotomy without internal fixation was displacement after the procedure with 2.2% rate across all included studies. Other complications noted were skin scar irritation, bony wedge irritation, hallux varus, and transient numbness. A patient in one study suffered a pulmonary embolus 6 weeks after surgery and made an uneventful recovery after medical treatment.

### DISCUSSION

The current study is the first systematic review to evaluate the efficacy of scarf osteotomy without internal fixation. The results of the present review highlights the lack of high-level studies, majority of which were case series.<sup>9,17-19</sup> Of the five included studies, only one was a comparative study with level III evidence.<sup>20</sup> The goal of this systematic review was to evaluate the efficacy and safety of scarf osteotomy without internal fixation for HV correction. The authors were interested in finding a viable implantless alternative to the

standard management of HV deformities. The current study revealed good results in terms of adequate correction of HV deformity and improvement of radiographic measures and clinical outcomes in all the included studies. Overall, there was a total complication rate of 11% with displacement being the most common complication. The risk of displacement or shortening associated with this technique is probably due to the lack of internal fixation and its reliance on impaction of both bone fragments for stability.<sup>9,17-20</sup> The original technique of scarf osteotomy without internal fixation was described by Maestro which allows preservation of the lateral collateral ligament leading to shortening but improving stability and range of motion.<sup>12</sup> A recent study by Curtin et al. performed this technique in 148 feet with significant improvements in pain, clinical scores, and radiographic measurements with good satisfaction rates with this procedure.<sup>19</sup> In another study, Van Doninck et al. focused on radiographic evaluation after screwless scarf osteotomy and evaluated the risk of shortening of the first metatarsal with majority noted to have significant shortening of the first metatarsal postoperatively due to the impaction of both bone to achieve stability.<sup>18</sup> Leemrijse et al. addressed the issue of shortening and described a variation of scarf osteotomy without internal fixation wherein a diverging cut is done perpendicular to the axis of the second metatarsal proximally then directed towards the distal metatarsal with subsequent re-impaction.<sup>9</sup> The range of translation of this technique can be increased through a modification of proximal stabilization by using a cortical-cancellous graft taken from the medial overhanging edge of the proximal fragment.<sup>9</sup> In a study by Ouaggag et al., they utilized the technique described by Maestro but forego the notch at the metatarsal head while reinforcing the stability by tying the proximal fragment with a self-locking knot suture at the level of the metaphyseal region which provided excellent results and low complication rates.<sup>17</sup> In a retrospective study by Liszka et al., they compared implantless scarf osteotomy to the standard scarf osteotomy with screw fixation and found no significant differences in the clinical and radiographic outcomes at an average of 12 months follow-up.<sup>20</sup> This comparative study suggested that scarf osteotomy without internal fixation is comparable to the standard scarf osteotomy and found that it was significantly cheaper with no risks of hardware-related complications.<sup>20</sup>

One implication from this systematic review is the possibility to achieve acceptable outcomes for HV correction even without

**Table 3:** MINORS score for study quality assessment

Investigator (Year)	Score	Risk of bias	1	2	3	4	5	6	7	8	9	10	11	12
Leemrijse et al. (2012)	3/16	High	1	0	0	0	0	2	0	0				
Ouaggag et al. (2015)	6/16	High	2	0	0	2	0	2	0	0				
Van Doninck et al. (2017)	13/16	Low	2	2	2	2	1	1	1	2				
Curtin et al. (2017)	6/16	High	2	1	0	1	0	2	0	0				
Liszka et al. (2018)	8/16	High	2	2	0	2	0	2	0	0				

The final score comprises the results of 8 items or 12 items in cases of comparative studies: 1 A clearly stated aim; 2 Inclusion of consecutive patients; 3 Prospective collection of data; 4 Endpoints appropriate to the aim of the study; 5 Unbiased evaluation of the study endpoint; 6 Follow-up period appropriate to the aim of the study; 7 Loss to follow-up less than 5%; 8 Prospective calculation of the study size; 9 An adequate control group; 10 Contemporary groups; 11 Baseline equivalence of groups; 12 Adequate statistical analysis

**Table 4:** Scores and radiographic results from included studies

Investigator	AOFAS score		HVA (°)		IMA (°)		DMAA (°)		VAS		Patient satisfaction (%)
	Preoperative	Postoperative	Preoperative	Postoperative	Preoperative	Postoperative	Preoperative	Postoperative	Preoperative	Postoperative	
Leemrijse et al. (2012)	51	91	38.5	9.5	15.1	6.1	15.4	5.4	NR	NR	100
Ouaggag et al. (2015)	NR	91	28.84	10.69	13.23	7.1	15.69	6.53	NR	NR	NR
Van Doninck et al. (2017)	NR	NR	27.9	4.2	13.5	4.8	NR	NR	NR	NR	NR
Curtin et al. (2017)	NR	103.27 (FADI)	35.04	11.54	15.04	4.83	NR	NR	7.04	0.29	98.6
Liszka et al. (2018)	42	91	34.7	12.4	15.7	7.8	NR	NR	NR	NR	NR

AOFAS, American Orthopedic Foot and Ankle Society; FADI, Foot and Ankle Disability Index; HVA, hallux valgus angle; IMA, intermetatarsal angle; DMAA, Distal Metatarsal Articular Angle; MOXFQ, Manchester-Oxford Foot Questionnaire; NR, not reported

**Table 5:** Complications of hallux valgus scarf osteotomy without fixation

Investigator	Patients	Complications													Total PE	Total (#)	Total (%)*
		HV Recurrence	Displacement	Insufficient correction	Infection	Skin scar irritation	Bony wedge irritation	Non-union	Mal-union	Hal-lux Varus	CRPS	Transient numbness	Osteone-crosis	Transfer Metatar-salgia			
Leemrijse et al. (2012)	12	0	1	0	0	0	0	0	0	1	0	0	0	0	0	2	13
Ouaggag et al. (2015)	30	0	1	1	0	0	0	0	0	0	0	0	0	0	0	2	6
Van Doninck et al. (2017)	79	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Curtin et al. (2017)	120	0	2	0	0	0	0	0	0	0	2	0	0	0	1	5	4
Liszka et al. (2018)	64	0	2	0	0	2	2	0	0	0	0	1	0	0	0	7	11

\*Total (%) was calculated using the total number of patients, not feet; \*\*Total complication rate of the sum of all patients in the included studies; HV, Hallux Valgus; CRPS, Complex Regional Pain Syndrome; PE, Pulmonary embolus

internal fixation. However, the study was limited in that the authors were only able to include a few studies which discussed scarf osteotomy without internal fixations. To our knowledge, no randomized-controlled trials have been conducted on this topic. The techniques described among the included studies were fundamentally similar but with variations making it difficult to have an objective assessment of the results, possibly resulting in bias. Lastly, statistical analysis for this review was very limited due to the weakness of the data reporting in the included studies, none of which reported standard deviation or confidence intervals.

This study aimed to find evidence for scarf osteotomy without internal fixation in order to aid improving techniques for HV surgery. Additionally, cost-effectiveness should be properly documented in future studies to determine if this technique will be financially beneficial for patients. We suggest that future studies be performed with adequately sized randomized-controlled trials, standardized treatment protocols, and assessment of clinical outcomes with the use validated tools and questionnaires in order to limit bias and provide objective results.

## CONCLUSION

Scarf osteotomy without internal fixation is a technically demanding procedure with limited evidence to allow recommendation. However, the acceptable outcomes and low rate of complications suggests promising results. The authors of the current study emphasize that the relevance of finding an alternative treatment option to HV deformities which do not need implants as these can be more accessible to financially-burdened patients. This technique also lessens implant-related complications and revision surgeries provided that the surgeon is proficient with this new technique.

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