A commentary by Gregory P. Guyton, MD, is linked to the online version of this article at jbjs.org.

The Scarf Osteotomy with Minimally Invasive Lateral Release for Treatment of Hallux Valgus Deformity

Intermediate and Long-Term Results

Peter Bock, MD, Rainer Kluger, MD, Karl-Heinz Kristen, MD, Martina Mittlböck, PhD, Reinhard Schuh, MD, and Hans-Joerg Trnka, MD

Investigation performed at the Danube Hospital Vienna, Vienna, Austria

Background: Little is known about the long-term results of surgical correction of hallux valgus deformity, in particular, the recurrence rate and factors leading to recurrence.

Methods: Of one hundred and eight patients (115 feet) who underwent a Scarf osteotomy, ninety-three patients (ninety-three feet) were examined at an average duration of follow-up of 124 months. Clinical examination before surgery and at the time of final follow-up included an evaluation of range of motion, pain as measured with a visual analog scale, and American Orthopaedic Foot & Ankle Society (AOFAS) scores. The Foot and Ankle Outcome Score (FAOS) was also assessed postoperatively. Radiographic data were evaluated preoperatively, at six weeks postoperatively, and at the time of final follow-up. Additional radiographic data were available for seventy-nine patients of the same patient cohort at an average of twenty-seven months postoperatively.

Results: The median overall AOFAS score improved from 57 points preoperatively to 95 points at the time of final follow-up. All radiographic measurements (hallux valgus angle [HVA], intermetatarsal angle [IMA], distal metatarsal articular angle [DMAA], and sesamoid bone position) showed significant ($p < 0.05$) improvement at the time of final follow-up compared with preoperatively. The rate of recurrence (an HVA of ≥20°) at the time of final follow-up was 30%. We were unable to determine if recurrence resulted in functional impairment or consequences for quality of life.

Conclusions: The recurrence rate after ten years was 30%, and a higher final HVA resulted in higher pain levels. The limitations imposed by nonvalidated outcome measures precluded conclusions about the influence of HVA on function or quality of life.

Level of Evidence: Therapeutic Level IV. See Instructions for Authors for a complete description of levels of evidence.

Peer Review: This article was reviewed by the Editor-in-Chief and one Deputy Editor, and it underwent blinded review by two or more outside experts. It was also reviewed by an expert in methodology and statistics. The Deputy Editor reviewed each revision of the article, and it underwent a final review by the Editor-in-Chief prior to publication. Final corrections and clarifications occurred during one or more exchanges between the author(s) and copyeditors.

Hallux valgus is a common orthopaedic problem. Surgical treatment of hallux valgus deformity includes an osteotomy of the first metatarsal bone (MT-I) and a soft-tissue procedure. The Scarf osteotomy, a midshaft osteotomy of the MT-I that is often performed in combination with a closing-wedge osteotomy of the proximal phalanx of the big toe (Akin osteotomy[1]), is one of the established methods[2-10]. The Scarf osteotomy is characterized by its "Z" shape (Figs. 1 and 2), which provides good inherent postoperative stability[11].

The Scarf osteotomy is combined with a soft-tissue procedure that includes a lateral release, which can be accomplished from a dorsal approach[2], through the first intermetatarsal web

Disclosure: None of the authors received payments or services, either directly or indirectly (i.e., via his or her institution), from a third party in support of any aspect of this work. None of the authors, or their institution(s), have had any financial relationship, in the thirty-six months prior to submission of this work, with any entity in the biomedical arena that could be perceived to influence or have the potential to influence what is written in this work. Also, no author has had any other relationships, or has engaged in any other activities, that could be perceived to influence or have the potential to influence what is written in this work. The complete **Disclosures of Potential Conflicts of Interest** submitted by authors are always provided with the online version of the article.

TABLE I Patient Demographics

Total no. of patients/feet	108/115
No. (%) of patients/feet at final follow-up	99 (92%)/105 (91%)
Study group with unilateral surgery	
No. (%) with unilateral surgery	93 (86%)/93 (81%)
Clinical follow-up duration* *(mo)*	124.1 (110-140)
Patient age at time of surgery* *(yr)*	50 (21-78)
Female/male *(no.)*	87/6

*Values are expressed as the mean with the range in parentheses.

space; a single dorsomedial approach[8]; or an intra-articular approach[6,12]. In our series, the lateral release was achieved via a dorsal skin incision not longer than 0.5 cm.

Little is known regarding the long-term results after hallux valgus surgery in general[13-18], and, to our knowledge, no long-term results after Scarf osteotomy have been reported; the longest reported average follow-up was 44.9 months[6].

We analyzed results following Scarf osteotomy with a minimum duration of follow-up of 110 months, comparing them with intermediate-term results for a subgroup of the patients. The objectives of our study were to (1) assess the patients' long-term clinical outcomes, including the American Orthopaedic Foot & Ankle Society (AOFAS) score, range of motion, and the Foot and Ankle Outcome Score (FAOS); (2) assess the degree of pain relief using a visual analog scale (VAS) pain score; (3) assess radiographic outcome variables; (4) evaluate the rate of recurrence and the revision rate among those with recurrence; (5) ascertain the time period during which recurrence is most likely to occur; and (6) assess factors that influence recurrence.

Materials and Methods

In this retrospective cohort study, we analyzed clinical data of all patients who underwent Scarf osteotomy for symptomatic hallux valgus deformity between January 1997 and December 1999. This study period was chosen for convenience. Preoperative data (including the AOFAS score and VAS for pain) were recorded before the surgery. The study was conducted in accordance with the Declaration of Helsinki and the Guidelines for Good Clinical Practice. This study was approved by our institution's review board, and informed consent was obtained from all participating patients.

One hundred and fifteen feet (108 patients; all Caucasian) underwent Scarf osteotomy. In twenty-two (19%) of the 115 feet, an Akin osteotomy[1] was also performed. Of the 108 patients, ninety-nine were followed clinically and radiographically at the hospital. For methodological reasons, results are shown only for patients who underwent unilateral surgery (ninety-three patients). The mean duration of follow-up was 124 months (Table I). Additional radiographic data were available for seventy-nine feet (seventy-nine of the ninety-three patients) from a radiographic database. The average time after surgery for those radiographs was twenty-seven months (range, twenty to thirty-four months). No clinical data were available at intermediate follow-up for those patients.

Inclusion criteria for undergoing a Scarf osteotomy were (1) symptomatic hallux valgus deformity with an intermetatarsal angle (IMA) of 10° to 20°, (2) preoperative total range of motion of ≥50°, and (3) an unsuccessful trial of conservative therapy (nonsteroidal anti-inflammatory drugs, shoe modification, and physical therapy for six months). Exclusion criteria for surgery included (1) hallux rigidus, (2) peripheral vascular disease, (3) peripheral neuropathy, and (4) first tarsometatarsal instability (as indicated by the clinical testing and radiographic sign on a lateral radiograph).

The following were used for the evaluation of preoperative and postoperative data: the 100-point AOFAS hallux metatarsophalangeal-interphalangeal scale[19]; a VAS for rating pain, ranging from 0 to 10 points (with 0 denoting no pain and 10 denoting the worst pain imaginable); and range of motion. The FAOS, a validated outcome score for hallux valgus[20], was also used, at an average of forty-four months after the final follow-up examination (an average of 162 months after surgery). Patients were mailed the FAOS questionnaire and asked to return the completed form. At that time, patients were also asked the following: "Has the position of your big toe or your clinical symptoms (pain) changed since your last clinical examination in the hospital?" Possible answers were "no change," "mild change," "moderate change," or "severe change" (in either direction; for better or worse). Radiographic analysis included weight-bearing anteroposterior and lateral images, obtained preoperatively, six weeks after surgery, at intermediate follow-up, and at the final follow-up. Radiographic analysis was conducted at one institution in a standardized manner (see Appendix). The following radiographic measurements were determined according to the guidelines accepted by the AOFAS[21]: the hallux valgus angle (HVA), the IMA, the distal metatarsal articular angle (DMAA), the metatarsal index, and the position of the tibial sesamoid (see Appendix). An HVA of ≤19° was physiologically correct; an HVA of 20° to 29° indicated mild deformity; an HVA of 30° to 39°, moderate deformity; and an HVA of ≥40°, severe deformity.

The follow-up examination was performed by two independent investigators not involved in the primary surgical treatment. The radiographs were interpreted by a person otherwise not involved in the clinical examination.

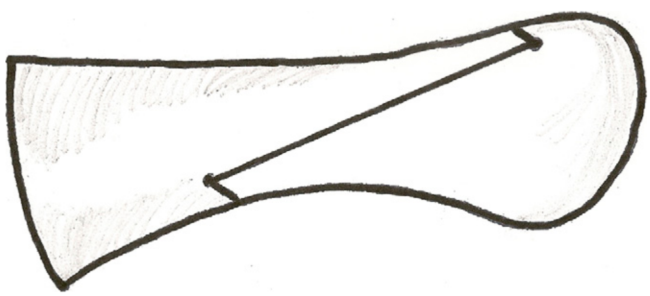

Fig. 1
Illustration showing the Scarf osteotomy (lateral view of the MTP-I joint capsule) as performed in this study.

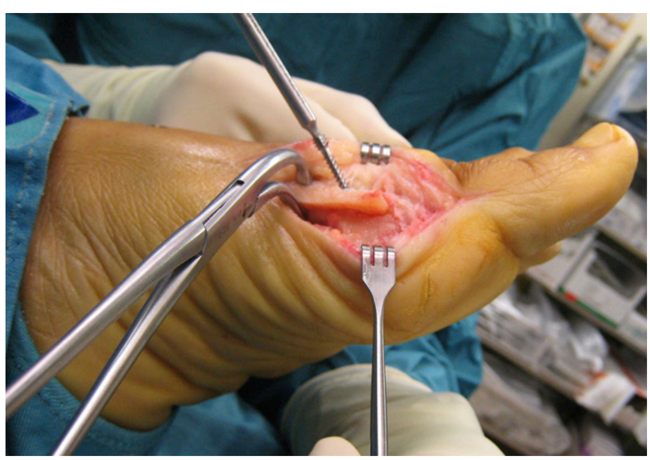

Fig. 2
Intraoperative photograph of the Scarf osteotomy, fixed with one screw.

TABLE II Comparison of Preoperative and Postoperative AOFAS Scores

Assessment (Max. Points)	AOFAS Score* Preop.	AOFAS Score* Final Follow-up	P Value
Overall score (100)	57 (q1 = 52, q3 = 60; 27 to 67)	95 (q1 = 90, q3 = 95; 55 to 100)	<0.05
Pain (40)	20 (0 to 30)	39 (20 to 40)	<0.05
Activity (10)	8 (4 to 10)	10 (7 to 10)	<0.05
Footwear (10)	6 (5 to 10)	9 (5 to 10)	<0.05
Metatarsophalangeal joint motion (10)	9 (5 to 10)	7 (5 to 10)	<0.05
Interphalangeal joint motion (5)	5	5	>0.05
Metatarsophalangeal-interphalangeal stability (5)	5	5	>0.05
Callus (5)	2 (0 to 5)	5 (0 to 5)	<0.05
Alignment (15)	0 (0 to 15)	13 (0 to 15)	<0.05

*Values are expressed as the median with the range in parentheses along with quartiles for overall score. AOFAS = American Orthopaedic Foot & Ankle Society.

Surgical Technique

The patient was placed in a supine position. Unless the hallux valgus deformity was reducible to a 10° varus position and no sesamoid bone subluxation was present, a lateral release of the lateral metatarsosesamoid ligament and a release of the lateral first metatarsophalangeal (MTP-I) joint capsule were performed via a minimally invasive dorsal approach (a skin incision not longer than 0.5 cm) through the first intermetatarsal web space.

The Z-shaped Scarf osteotomy (Fig. 1) was performed through a medial skin incision, with the distal plantar fragment transferred laterally by at least half of the width of the MT-I shaft. The osteotomy was fixed by one compression screw (Barouk screw; DePuy Orthopaedics, Johnson & Johnson, Warsaw, Indiana) (Fig. 2). In cases in which a hallux valgus interphalangeal deformity was also present (sixteen, or 17%, of the ninety-three feet), an Akin[1] osteotomy was performed as well. The medial capsulorrhaphy was performed as described by Kristen et al.[4]. Eighteen patients (eighteen feet) additionally underwent resection arthroplasty of the second toe to simultaneously treat hammer-toe deformity while undergoing the primary procedure.

Postoperatively, full weight-bearing was allowed with wooden-soled shoes for a minimum of six weeks.

Data Analysis

We analyzed data for ninety-three feet, including patient demographics and characteristics per foot. Continuous data are described as the mean and standard deviation along with the range in cases of normal distribution. Ordinal and non-normally distributed data are described as the median, first and third quartiles (q1 and q3, respectively), and the range. Categorical data are described as absolute and relative frequency. Differences over time were determined by the paired t test if differences were normally distributed and by the Wilcoxon signed-rank test otherwise. Correlations between variables were assessed by the Pearson correlation coefficient (r) or by the Spearman correlation coefficient (r_s) in cases of ordinal and non-normally distributed data.

All p values were two-sided, using a significance level of $p = 0.05$.

Source of Funding

No external funding was received for this study.

Results

The overall AOFAS score improved significantly from preoperatively to postoperatively. The subscore for metatarsophalangeal joint motion decreased over time; all other AOFAS subscores increased significantly or remained unchanged (Table II). The total AOFAS score ($p < 0.05$; $r_s = -0.534$), pain subscore ($p < 0.05$; $r_s = -0.315$), and alignment subscore ($p < 0.05$; $r_s = -0.720$) showed a correlation with the postoperative HVA at the final follow-up (a higher HVA correlated with a lower score). The raw AOFAS scores for patients with and without recurrence are listed in Table III.

Preoperatively, the average VAS was 6.3 points and at final follow-up, it was 0.4 points ($p < 0.05$). Five patients (five feet) postoperatively had a VAS score of >3; four of those patients had an HVA of ≥20° (recurrence) at the final follow-up. Two other patients with recurrence had a VAS of 3 points. All other patients

TABLE III Mean Raw Scores for Patients with and without Recurrence*

Assessment	With Recurrence	Without Recurrence
AOFAS		
Total (100)	85	95
Pain (40)	36.8	39.8
Function (45)	39.5	40.8
Alignment (15)	8.8	14.9
VAS	0.94	0.14
FAOS		
Pain	94.3	97.8
Symptoms	88.6	89.8
Quality of life	92.9	94.8
Function	98.9	99.8
Range of motion *(deg)*	66.9	68.2

*AOFAS = American Orthopaedic Foot & Ankle Society, VAS = visual analog scale, and FAOS = Foot and Ankle Outcome Score.

TABLE IV Comparison of Preoperative and Postoperative Radiographic Outcomes*

Parameter	Preop.	Final Follow-up	P Value
HVA† *(deg)*	31.1 ± 8.2 (18 to 60)	15.0 ± 11.2 (−10 to 39)	<0.05
IMA† *(deg)*	13.9 ± 3.0 (10 to 20)	7.0 ± 3.1 (1 to 17)	<0.05
Sesamoid bone position‡ *(grade)*	3 (q1 = 1, q3 = 3; 0 to 5)	1 (q1 = 0, q3 = 2; 0 to 5)	<0.05
DMAA† *(deg)*	12.1 ± 5.7 (0 to 24)	8.6 ± 6.4 (0 to 30)	<0.05
Metatarsal index† *(mm)*	0.63 ± 2.9 (−6 to 8)	−1.63 ± 2.5 (−10 to 6)	<0.05
Range of motion† *(deg)*			
Total	87.5 ± 15.4 (50 to 120)	67.9 ± 16.1 (20 to 105)	<0.05
Extension	55.2 ± 12.6 (30 to 80)	53.1 ± 14.5 (10 to 75)	<0.05
Flexion	32.3 ± 12.2 (10 to 65)	14.8 ± 9.7 (0 to 40)	<0.05

*HVA = hallux valgus angle, IMA = intermetatarsal angle, and DMAA = distal metatarsal articular angle. †Values are expressed as the mean and the standard deviation with the range in parentheses. ‡Values are expressed as the median with the quartiles and range in parentheses.

TABLE V Comparison of Postoperative Radiographic Outcomes

Parameter	Follow-up			P Value (6-Wk to Final Follow-up)
	6-Wk	Intermediate	Final	
HVA* *(deg)*	10.6 ± 7.9 (−8 to 36)	13.6 ± 10.5 (0 to 42)	15.0 ± 11.2 (−10 to 39)	<0.05
IMA* *(deg)*	6.2 ± 2.3 (1 to 12)	7.1 ± 2.9 (0 to 15)	7.0 ± 3.1 (1 to 17)	<0.05
Sesamoid bone position† *(grade)*	1 (q1 = 1, q3 = 2; 0 to 4)		1 (q1 = 1, q3 = 2; 0 to 5)	>0.5
DMAA* *(deg)*	7.7 ± 5.0 (0 to 25)		8.6 ± 6.4 (0 to 30)	>0.5

*Values are expressed as the mean and the standard deviation with the range in parentheses. HVA = hallux valgus angle, IMA = intermetatarsal angle, and DMAA = distal metatarsal articular angle. †Values are expressed as the median with the quartiles and range in parentheses.

with recurrence reported a VAS of 0 points. A positive correlation was demonstrated between the postoperative HVA and the VAS ($p < 0.05$; $r_s = 0.498$); a higher postoperative HVA correlated with a higher VAS (see Table III for the raw VAS scores).

The FAOS was evaluated for eighty-five patients (eighty-five feet). All patients with recurrence were included. No patient mentioned a change of position of the great toe or a change in symptoms since the last clinical follow-up. All subscales could be evaluated except for the function in sports and recreational activities subscale; no patient performed three or more of the activities listed in that subscale. Only the FAOS pain subscale showed a significant correlation with the HVA at the final follow-up ($p < 0.05$; $r = 0.302$); a higher HVA correlated with a higher level of pain (see Table III for the raw FAOS subscores). The other subscales (symptoms, function in daily living, and quality of life) did not show any correlation ($p > 0.05$), although the sample size was small enough that the study was likely underpowered for detecting such a difference.

All radiographic measurements had improved significantly at the time of final follow-up compared with preoperatively (Table IV). The HVA increased significantly during the period between the six-week and the intermediate follow-up as well as between the six-week and the final follow-up, but not between the intermediate and the final follow-up (Fig. 3, Tables V and VI).

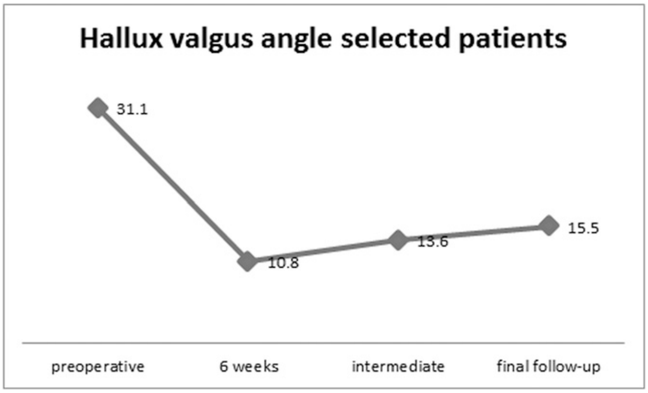

Fig. 3
Development of the hallux valgus angle (HVA) preoperatively and at the six-week, intermediate, and final follow-ups for the subgroup of seventy-nine patients.

TABLE VI Level of Significance of Differences in Hallux Valgus Angle Between 6-Wk, Intermediate, and Final Follow-ups

	Follow-up		
	6-Wk	Intermediate	Final
6-wk		<0.05	<0.05
Intermediate			>0.05

On the basis of the grading system presented earlier, we found that radiographic recurrence occurred in twenty-eight (30%) of the ninety-three feet at the time of final follow-up; twenty-one (23%) had mild deformity, and seven (7.5%) had moderate deformity. At six weeks, an HVA of ≥20° was observed in seven (7.5%) of the feet, and at intermediate follow-up, in twenty (25%) of the available seventy-nine feet. We observed the following increases in HVA between the six-week follow-up and the final follow-up: an increase of <5° in 22% of the feet, an increase of 5° to 9° in 52%, and an increase of >9° in 26%.

When evaluating possible correlations of different factors with recurrence, we identified several significant factors (Table VII).

The cutoff point predictive of a postoperative failed correction of HVA at the time of final follow-up was a preoperative HVA of ≥30° and a preoperative IMA of ≥18° (Tables VIII and IX).

Complications

One revision surgery was performed for a recurrent deformity 118 months after the primary surgery. Three patients developed transfer metatarsalgia, which resolved with orthoses. Screw removal for pain was performed in thirteen (14%) of the patients. Two patients experienced a secondary postoperative pain-free varus tilting of the MT-I head of 5° and 10°. No patient

TABLE VII Risk Factors for Recurrence at Final Follow-up*

Parameter	Pearson Correlation Coefficient	Spearman Correlation Coefficient	Strength of Association	P Value
Preop. HVA	0.67		Moderate	<0.05
Preop. IMA	0.26			<0.05
Preop. SES		0.22		<0.05
Preop. DMAA		0.29		<0.05
6-wk HVA	0.73		Strong	<0.05
6-wk IMA	0.41		Low	<0.05
6-wk SES		0.45	Low	<0.05
6-wk DMAA		0.35	Low	<0.05
IMA difference (preop. to 6-wk)	−0.04			0.69
Sesamoid difference (preop. to 6-wk)	0.015			0.87

*HVA = hallux valgus angle, IMA = intermetatarsal angle, SES = sesamoid bone position, and DMAA = distal metatarsal articular angle. Strong association: >0.7 to 1; moderate association: >0.5 to 0.7; and low association: 0.3 to 0.5.

TABLE VIII Postoperative HVA According to Preoperative HVA*

Preop. HVA *(deg)*	20-21	22-23	24-25	26-27	28-29	30-31	32-33	34-35
Average postop. HVA *(deg)*	6.5	7.7	13.5	15.7	15.1	20.9	24.2	24.7

*HVA = hallux valgus angle.

TABLE IX Postoperative HVA According to Preoperative IMA*

Preop. IMA *(deg)*	10-11	12-13	14-15	16-17	18-19	20
Average postop. HVA *(deg)*	11.4	12.1	14.3	14.9	22.7	23.1

*IMA = intermetatarsal angle, and HVA = hallux valgus angle.

experienced head necrosis or troughing[22] (which happens when the cortices wedge into the softer cancellous bone of the metatarsal shaft, causing a functional elevation and malrotation of the first ray). Two patients had hallux varus deformity.

Discussion

Previous studies have shown that the Scarf osteotomy achieves predictable results[3,5-8,23,24]. However, none of those studies presented long-term, intermediate-term, and immediate postoperative results of the same patient cohort or reported the factors influencing long-term outcomes.

The present study demonstrated that the Scarf osteotomy in combination with Akin osteotomy and minimally invasive lateral capsular release resulted in a significant improvement in pain but a relatively high radiographic recurrence rate (30%). Symptomatic recurrence (VAS of >0) occurred in 6.5% of the patients, with a surgical revision rate of 1%. Comparisons between the six-week and intermediate follow-up radiographic results and between the six-week and final follow-up radiographic results showed a significant increase in the HVA.

Recurrence after hallux valgus correction is a known phenomenon, with recurrence rates ranging from 3% to 73%[3,5-7,13,14,16,18,25]. Still, most reports do not differentiate between symptomatic and asymptomatic recurrence. Fuhrmann et al.[7] use the term *revalgisation* for asymptomatic radiographic recurrence. We would recommend the following terminology: *symptomatic recurrence* and, for an HVA increase above normal and without pain, *asymptomatic recurrence*.

Regarding risk factors for recurrence, we identified the following significant factors: higher preoperative and six-week HVA; and higher six-week IMA, sesamoid bone position, and DMAA. A higher six-week HVA showed an especially high risk for recurrence: feet that showed a near-pathologic HVA (≥20°) at six weeks were at very high risk for recurrence.

Another risk factor for recurrence is increased preoperative DMAA together with the technical difficulty of correcting an increased DMAA with the Scarf osteotomy[7]. This is why Fuhrmann et al.[7] do not recommend the Scarf osteotomy for patients with an elevated DMAA. The major problem with the evaluation of the DMAA is the low interobserver and intraobserver reliability and, thus, its limited value for practical use[26].

Adam et al.[23] reported that the reason for recurrence in their study was more translation than rotation of the distal fragment. The authors proposed a modified Scarf osteotomy with more rotation to increase the correction potential of the IMA, thus increasing the DMAA. This is in contrast to our findings and the findings presented by Fuhrmann et al.[7], as a higher DMAA was associated with a higher risk of recurrence in both studies.

Coetzee[22] described the occurrence of troughing after Scarf osteotomy, leading to undercorrection. The author reported minimal correction of the preoperative IMA and HVA. In a later report, Coetzee and Rippstein[27] proposed a modification of his previous Scarf osteotomy technique.

An additional factor for recurrence is the sesamoid position. If the sesamoid bones are not positioned underneath the MT-I head but rather more laterally, a valgus force acts on the first toe via the flexor tendons and the adductor tendon. This was noticed by Okuda et al.[28] during intermediate follow-up. The reason for unreduced sesamoid bones is a lack of repositioning of the MT-I head above the sesamoid bones. Insufficient lateral release as a reason for recurrence has already been noted[6] but without the connection to the position of the sesamoid bones.

Regarding lateral release in our study, a minimally invasive dorsal approach was used through the first intermetatarsal web space, addressing the lateral metatarsosesamoid ligament and the lateral MTP-I joint capsule. Schneider[29] showed that the key to successful lateral release is transection of the lateral metatarsosesamoid ligament. This structure seems to be of special importance to assure repositioning of the first metatarsal head on top of the sesamoid bones[30]. The minimally invasive approach allowed for minimal skin trauma. However, we now think that it did not allow sufficient visualization of the anatomic structures to be released.

We saw that in most cases, recurrence occurred within the first 1.5 to 2.8 years; the average HVA differed significantly between the six-week and intermediate follow-up evaluations but not between the intermediate and final follow-up evaluations. Also, the percentage of feet with an HVA of ≥20° initially increased to 25% by the intermediate follow-up and then to 30% by the final follow-up. Our observation is in accordance with findings presented by Fuhrmann et al.[7] concerning intermediate follow-up. The authors reported that 20% of the patients had an HVA of ≥21° after an average final follow-up time of 44.9 months. They did not, however, present any data regarding long-term development of the HVA. Choi et al.[9] measured the HVA and IMA at two time points: immediately postoperatively and at the time of final follow-up examination (twenty-four months). They did not observe an increase of the HVA but observed a slight increase (2.2°) of the IMA. The authors explained the phenomenon of an increase of the IMA without an increase of the HVA by the high rate (43%) of Akin osteotomy applied. Dreeben and Mann[16], in their long-term study after crescentic osteotomy, reported an average loss of HVA of 3.8° between two months postoperatively and the final follow-up at an average of 5.3 years.

To our knowledge, no other report in the literature has assessed the results of Scarf osteotomy at three time points after surgery. Trnka et al.[30] and Schneider et al.[13] presented outcomes after chevron osteotomy at two time points: Trnka et al.[30] at two and five years and Schneider et al.[13] at 5.6 and 12.7 years postoperatively. Chow et al.[17] presented results of the crescentic osteotomy at a mean of 2.7 and eight years. Faber et al.[18] presented data at two and ten years after the Hohmann and Lapidus procedure. None of the four studies showed a significant change of the average HVA between the two time points of follow-up, and none provided immediate postoperative data.

Interestingly, a higher HVA at the time of final follow-up was correlated with a higher pain level as evaluated with use of the VAS for pain, the AOFAS pain subscore, and the FAOS pain subscale, although only six patients with recurrence had a VAS of >0 at the time of final follow-up. However, range of motion did not differ between those with and those without recurrence. The impact of pain level on the functional outcome and quality of life is unknown due to limitations of the AOFAS score. The quality-of-life subscale of the FAOS was only assessed postoperatively and did not show any correlation with an increased HVA. Statistical assessment is limited as well because only five patients had a VAS pain level of >3 at the time of final follow-up. Inadequate or biased sampling might be one reason for the discrepancy that radiographic appearance does not correlate with quality of life; another reason could be the fact that the pain level in general was not very high.

Our study was limited by its lack of intermediate radiographic follow-up data for some patients. In addition, 8% of the patients were not examined at the time of final follow-up. The study also did not include a comparison group that underwent another method of hallux valgus correction or an alternative approach for the lateral release. A comparison with other methods thus cannot be made.

The widely used AOFAS score is a nonvalidated outcome measurement but was still used at the final follow-up to be able to compare the preoperative and postoperative results. The FAOS was only validated for hallux valgus in 2012[20] and thus, was not available at the time of surgery. Another limitation is the fact that, for our cohort, the FAOS was only evaluated some years after the last clinical and radiographic follow-up. We do not think that evaluating the FAOS some years after the final follow-up substantially influenced the results, as we can assume that the HVA did not change substantially because we did not see any significant change between the intermediate and final radiographic follow-up. Apart from radiographic appearance, patients were asked if symptoms had changed, and all of the patients reported that they had not changed. Still, we are aware that a recall bias cannot be ruled out completely.

In conclusion, nearly one-third of all feet showed a recurrence of an HVA of ≥20°. A higher HVA was correlated with a higher pain level. The cutoff points predictive of pathologic postoperative values were a preoperative HVA of ≥30° and an IMA of ≥18°. Our data showed that recurrence of hallux valgus will most often happen within the first 1.5 to 2.8 years. We found that a higher HVA preoperatively and at the six-week follow-up and a higher six-week IMA, DMAA, and sesamoid bone malpositioning were risk factors for recurrence.

Appendix

Radiographic Analysis

Radiographic analysis was performed at one institution, in a standardized manner, with the central beam angled approximately 15° toward the heel for the anteroposterior view and with the central beam directed through the foot, perpendicular to the axis of the foot, for the lateral view.

Measurement of Metatarsal Index

The metatarsal index was measured by the length of a perpendicular line drawn from the distalmost point of the second metatarsal to the MT-I.

Measurement of the Position of the Sesamoid Bone

The position of the tibial sesamoid was measured in relation to a line drawn along the center of the longitudinal axis of the first metatarsal. Thus, measurements were obtained according to the following grading: grade 0 = no dislocation, grade 1 = dislocation up to one-quarter, grade 2 = dislocation greater than one-quarter and up to one-half, grade 3 = dislocation greater than one-half and up to three-quarters, grade 4 = dislocation greater than three-quarters and up to near-complete dislocation, and grade 5 = complete dislocation. ■

NOTE: The authors thank Dori Kelly, MA, for professional manuscript editing.

Peter Bock, MD
Hans-Joerg Trnka, MD
Orthopedic Hospital Wien Speising,
Speisinger Strasse 109,
1130 Vienna, Austria.
E-mail address for P. Bock: dr.bock@gmx.at

Rainer Kluger, MD
Danube Hospital Vienna,
Langobardenstrasse 122,
1220 Vienna, Austria

Karl-Heinz Kristen, MD
Fusszentrum Wien, Alserstrasse 43/8,
1080 Vienna, Austria

Martina Mittlböck, PhD
Department of Clinical Biometrics,
Medical University Vienna,
Spitalgasse 23, 1090 Vienna, Austria

Reinhard Schuh, MD
Department of Orthopaedics,
University Clinics Vienna,
Währinger Gürtel 18-20,
1090 Vienna, Austria

References

1. Akin OF. The treatment of hallux valgus: a new operative procedure and its results. Med Sentinel. 1925;33:678-9.

2. Dereymaeker G. Scarf osteotomy for correction of hallux valgus. Surgical technique and results as compared to distal chevron osteotomy. Foot Ankle Clin. 2000 Sep;5(3):513-24.

3. Barouk LS. Scarf osteotomy for hallux valgus correction. Local anatomy, surgical technique, and combination with other forefoot procedures. Foot Ankle Clin. 2000 Sep;5(3):525-58.

4. Kristen KH, Berger C, Stelzig S, Thalhammer E, Posch M, Engel A. The SCARF osteotomy for the correction of hallux valgus deformities. Foot Ankle Int. 2002 Mar;23(3):221-9.

5. Perugia D, Basile A, Gensini A, Stopponi M, Simeonibus AU. The scarf osteotomy for severe hallux valgus. Int Orthop. 2003;27(2):103-6. Epub 2002 Dec 03.

6. Crevoisier X, Mouhsine E, Ortolano V, Udin B, Dutoit M. The scarf osteotomy for the treatment of hallux valgus deformity: a review of 84 cases. Foot Ankle Int. 2001 Dec;22(12):970-6.

7. Fuhrmann RA, Zollinger-Kies H, Kundert HP. Mid-term results of Scarf osteotomy in hallux valgus. Int Orthop. 2010 Oct;34(7):981-9. Epub 2010 Feb 16.

8. Jones S, Al Hussainy HA, Ali F, Betts RP, Flowers MJ. Scarf osteotomy for hallux valgus. A prospective clinical and pedobarographic study. J Bone Joint Surg Br. 2004 Aug;86(6):830-6.

9. Choi JH, Zide JR, Coleman SC, Brodsky JW. Prospective study of the treatment of adult primary hallux valgus with scarf osteotomy and soft tissue realignment. Foot Ankle Int. 2013 May;34(5):684-90. Epub 2013 Jan 24.

10. Weil LS, Borelli AN. Modified Scarf bunionectomy: our experience in more than 1000 cases. J Foot Surg. 1991;30:609-22.

11. Trnka HJ, Parks BG, Ivanic G, Chu IT, Easley ME, Schon LC, Myerson MS. Six first metatarsal shaft osteotomies: mechanical and immobilization comparisons. Clin Orthop Relat Res. 2000 Dec;381:256-65.

12. Stamatis ED, Huber MH, Myerson MS. Transarticular distal soft-tissue release with an arthroscopic blade for hallux valgus correction. Foot Ankle Int. 2004 Jan;25(1):13-8.

13. Schneider W, Aigner N, Pinggera O, Knahr K. Chevron osteotomy in hallux valgus. Ten-year results of 112 cases. J Bone Joint Surg Br. 2004 Sep;86(7):1016-20.

14. Trnka HJ, Mühlbauer M, Zembsch A, Hungerford M, Ritschl P, Salzer M. Basal closing wedge osteotomy for correction of hallux valgus and metatarsus primus varus: 10- to 22-year follow-up. Foot Ankle Int. 1999 Mar;20(3):171-7.

15. Veri JP, Pirani SP, Claridge R. Crescentic proximal metatarsal osteotomy for moderate to severe hallux valgus: a mean 12.2 year follow-up study. Foot Ankle Int. 2001 Oct;22(10):817-22.

16. Dreeben S, Mann RA. Advanced hallux valgus deformity: long-term results utilizing the distal soft tissue procedure and proximal metatarsal osteotomy. Foot Ankle Int. 1996 Mar;17(3):142-4.

17. Chow FY, Lui TH, Kwok KW, Chow YY. Plate fixation for crescentic metatarsal osteotomy in the treatment of hallux valgus: an eight-year followup study. Foot Ankle Int. 2008 Jan;29(1):29-33.

18. Faber FW, van Kampen PM, Bloembergen MW. Long-term results of the Hohmann and Lapidus procedure for the correction of hallux valgus: a prospective, randomised trial with eight- to 11-year follow-up involving 101 feet. Bone Joint J. 2013 Sep;95-B(9):1222-6.

19. Kitaoka HB, Alexander IJ, Adelaar RS, Nunley JA, Myerson MS, Sanders M. Clinical rating systems for the ankle-hindfoot, midfoot, hallux, and lesser toes. Foot Ankle Int. 1994 Jul;15(7):349-53.

20. Chen L, Lyman S, Do H, Karlsson J, Adam SP, Young E, Deland JT, Ellis SJ. Validation of foot and ankle outcome score for hallux valgus. Foot Ankle Int. 2012 Dec;33(12):1145-55.

21. Smith RW, Reynolds JC, Stewart MJ. Hallux valgus assessment: report of research committee of American Orthopaedic Foot and Ankle Society. Foot Ankle. 1984 Sep-Oct;5(2):92-103.

22. Coetzee JC. Scarf osteotomy for hallux valgus repair: the dark side. Foot Ankle Int. 2003 Jan;24(1):29-33.

23. Adam SP, Choung SC, Gu Y, O'Malley MJ. Outcomes after scarf osteotomy for treatment of adult hallux valgus deformity. Clin Orthop Relat Res. 2011 Mar;469(3):854-9. Epub 2010 Aug 13.

24. Murawski CD, Egan CJ, Kennedy JG. A rotational scarf osteotomy decreases troughing when treating hallux valgus. Clin Orthop Relat Res. 2011 Mar;469(3):847-53. Epub 2010 Oct 26.

25. Pentikainen I, Ojala R, Ohtonen P, Piippo J, Leppilahti J. Preoperative radiological factors correlated to long-term recurrence of hallux valgus following distal chevron osteotomy. Foot Ankle Int. 2014 Dec;35(12):1262-7. Epub 2014 Sep 5.

26. Chi TD, Davitt J, Younger A, Holt S, Sangeorzan BJ. Intra- and inter-observer reliability of the distal metatarsal articular angle in adult hallux valgus. Foot Ankle Int. 2002 Aug;23(8):722-6.

27. Coetzee JC, Rippstein P. Surgical strategies: scarf osteotomy for hallux valgus. Foot Ankle Int. 2007 Apr;28(4):529-35.

28. Okuda R, Kinoshita M, Yasuda T, Jotoku T, Kitano N, Shima H. Postoperative incomplete reduction of the sesamoids as a risk factor for recurrence of hallux valgus. J Bone Joint Surg Am. 2009 Jul;91(7):1637-45.

29. Schneider W. Influence of different anatomical structures on distal soft tissue procedure in hallux valgus surgery. Foot Ankle Int. 2012 Nov;33(11):991-6.

30. Trnka HJ, Zembsch A, Easley ME, Salzer M, Ritschl P, Myerson MS. The chevron osteotomy for correction of hallux valgus. Comparison of findings after two and five years of follow-up. J Bone Joint Surg Am. 2000 Oct;82(10):1373-8.

Update

This article was updated on August 6, 2015, because of a previous error. In Table V, which presents a comparison of postoperative radiographic outcomes, the quartile values shown regarding the sesamoid bone position at six weeks had previously read "q1 = 1, q2 = 2." The text now reads "q1 = 1, q3 = 2."