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ORIGINAL ARTICLE

Advanced Age, Severe Deformity and Diminished Expectations: Functional and Radiological Outcomes of Different Osteotomies for Hallux Valgus in The Elderly

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Abstract

Background: Although advanced age is often linked to reduced bone quality in hallux valgus (HV), its direct impact on surgical outcomes is unclear. This study aimed to compare the functional and radiological outcomes of HV surgeries between patients aged ≥65 and <65 years.

Methods: A retrospective analysis of 102 patients who underwent HV surgery between 2011 and 2024 was conducted. Surgical methods included distal and proximal osteotomies and Lapidus arthrodesis. Functional outcomes were assessed using the visual analog scale (VAS) and American Orthopaedic Foot and Ankle Society (AOFAS) Hallux Metatarsophalangeal-Interphalangeal Rating System score. Radiographic outcomes were evaluated using preoperative and postoperative measurements of the hallux valgus angle (HVA) and the intermetatarsal angle (IMA).

Results: Among the 102 patients, 87 were under 65 years of age (85.3%) and 15 were older (14.7%). No significant differences were found between the age groups in terms of AOFAS scores (p=0.916), VAS scores (p=0.481), or radiographic parameters (p>0.05). However, surgical technique significantly affected outcomes; arthrodesis resulted in greater angular correction and lower VAS scores than distal osteotomies (p<0.05). Proximal osteotomies showed better correction than distal procedures, but without significant differences in functional scores (p>0.05).

Conclusions: Age does not significantly affect functional and radiological outcomes in HV surgery. The likelihood of surgical success depends on the technique used rather than the patient's age. The utilization of individualized treatment plans tailored to the severity of the deformity has been demonstrated to yield superior outcomes, irrespective of the patient's age.

Keywords: Hallux valgus, osteotomy, arthrodesis, aged.

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INTRODUCTION

Hallux valgus (HV) is defined as a progressive three-dimensional deformity of the first metatarsophalangeal joint, the prevalence of which increases with age and can reach up to 30% in the population aged 65 years and older (1-3). The most common clinical complaints associated with HV are aesthetic concerns and pain. While aesthetic concerns are a significant complaint, particularly among younger individuals, pain is the predominant symptom that hinders daily functioning and is more pronounced in the elderly (2,3). The standard treatment for HV involves a combination of lifestyle modifications and shoe alterations; however, more advanced deformities may necessitate more invasive interventions, such as distal metatarsal osteotomies (i.e., modified Chevron osteotomies), proximal metatarsal osteotomies (PMO), and arthrodesis, as documented in the literature (4-7). The surgical outcomes of these interventions may be influenced by numerous factors, including the severity of the deformity, patient age, and the specific osteotomy technique preferred (8-12).

A 2023 systematic review revealed an increase in the prevalence of HV with age, with 11% in individuals younger than 20 years, 12.22% in adults aged 20-60 years and 22.7% in the elderly over 60 years (13). Advanced age has been associated with an increase in HV prevalence and deformity progression. Moreover, surgical outcomes are predicted to be suboptimal because of compromised bone quality. As demonstrated in the extant literature, the presence of multiple comorbidities in elderly patients has been shown to be associated with elevated revision rates following HV surgery (14). Furthermore, a specific and progressive decrease in hallux plantar flexion strength has been observed in accordance with HV severity in older adults (15). However, as established in the field of orthopedics, patient expectations may decline with increasing age. This may result in increased postoperative satisfaction despite decreased bone quality and worsening radiologic results, as demonstrated in examples documented in the literature (16,17). Indeed, a study undertaken in 2022 revealed that older HV patients exhibited substantial enhancements in clinical scores 24 months following surgery, with no statistically significant difference between the younger patient groups, suggesting that older individuals may also benefit from hallux valgus surgery (18). Similarly, a study conducted in 2021 reported that advanced age did not affect the functional or subjective outcomes after HV surgery (19).

The objective of the present study was twofold: first, to ascertain whether the functional and radiological outcomes of different HV surgeries differ according to age group (≥65 and <65 years), and second, to investigate the superiority of different surgical techniques in the elderly.

MATERIALS AND METHODS

Following ethical board approval (Marmara University, Faculty of Medicine, Non-Pharmaceuticals and Non-Medical Devices Research Ethics Committee, Protocol No: 09.2024.1588, 24.12.2024), a retrospective evaluation was conducted of all patients who underwent surgery for hallux valgus in our clinic between 2011 and 2024 by the same surgical team. The study population comprised patients aged > 18 years who had undergone proximal or distal osteotomy or arthrodesis with the Lapidus procedure. The indication for hallux valgus surgery was never based on aesthetic concerns in any of the patients, and the operation was planned for patients whose VAS score was ≥ 7 out of 10 in the preoperative evaluation and affected their quality of life. Patients who underwent isolated bunionectomy, tarsal corrective osteotomy, and isolated phalanx osteotomy and those who failed to attend the last follow-up visit were excluded from the study. The final evaluation included 102 patients in total.

The decision to perform a surgical intervention was made by consensus of the surgical team specializing in foot and ankle surgery, considering multiple factors. Although distal osteotomy was indicated for mild HV ($IMA \leq 13°$, $HVA \leq 30°$), proximal osteotomy for moderate HV ($13° < IMA < 20°$, $30° < HVA < 40°$), and arthrodesis for severe deformity ($IMA \geq 20°$, $HVA \geq 40°$), the clinical condition of the patient, their personal expectations, the expertise of the operating surgeon, and the surgeon's preference for a familiar osteotomy were among the influential parameters that were considered. Arthrodesis is the preferred treatment for all patients with arthritis or ligamentous laxity in the tarsal-metatarsal joint (6-12). In the postoperative follow-up, push-off of the foot was avoided, and patients were allowed to mobilize with partial weight-bearing in the initial period. Following a six-to-eight-week period of follow-up, mobilization with full load was initiated. No additional

physical therapy or rehabilitation protocols were applied to any patient.

All patients were invited to attend the final follow-up visit in March 2025. At the final follow-up visit, anteroposterior and lateral radiographs of the foot were obtained, and active complaints, if any, were evaluated. While recording demographic information, it was determined that the age of patients at the time of surgery was to be considered, rather than the age at the time of final follow-up. In addition to demographic information, the type of operation and active complaints were recorded. In the radiological evaluation, the hallux valgus angle (HVA) and intermetatarsal angle (IMA) were measured in the preoperative and final control radiographs of the patients, as described in the literature (7). The number of angular corrections was also recorded. The Visual Analogue Scale (VAS) and the American Orthopaedic Foot and Ankle Society (AOFAS) Hallux Metatarsophalangeal-Interphalangeal Rating System Score were measured in order to evaluate functional clinical outcomes (20,21). The VAS is a visual assessment measure used to evaluate the intensity of pain experienced by patients, providing a one-dimensional analysis of their current pain level. The AOFAS Hallux Metatarsophalangeal-Interphalangeal Rating System, on the other hand, is a scoring system that evaluates pain, activity limitations, footwear requirements, joint motion, stability, and alignment, and takes a value between 0-100, with increasing scores representing a more pain-free and active foot and ankle function.

Statistical analyses were performed using IBM® SPSS® version 26.0. The conformity of the variables to a normal distribution was examined using visual (histogram and probability plots) and analytical (Kolmogorov-Smirnov test) methods. Given that the data exhibited a skewed distribution, the median, interquartile range and minimum-maximum values were employed in the descriptive statistics of numerical data, whereas percentage frequency values were utilized in categorical data. The Kruskal-Wallis test was used in the triadic group analyses of the evaluated datasets, whereas the Mann-Whitney U test was used in post-hoc analyses and pairwise group comparisons. In the comparison of categorical data, the Chi-Square Test was employed, and in instances where the chi-square assumption was not met, Fisher's Exact Test was used. Statistical significance was set at "p" < 0.05.

RESULTS

The study included 102 patients, with 87 patients (85.3%) falling within the younger aged group of less than 65 years and 15 patients (14.7%) belonging to the older aged > 65 years. The surgical techniques employed included distal osteotomy in 70 patients (68.6%), proximal osteotomy in 16 (15.7%), and arthrodesis in 16 (15.7%). The median follow-up time was 83 (111) (11-158) months in the younger patients and 80 (63) (12-155) in the older patients. The demographic characteristics of the patients are presented in Table 1.

A detailed analysis according to age groups showed no significant differences between the groups in terms of demographic characteristics ($p>0.05$ for each) (Table 2). As previously stated, despite the absence of a definitive objective evaluation, both younger and older patient cohorts exhibited preoperative VAS scores of ≥7. In the younger patient group, the mean VAS score was 2 (3) (0-6), and the mean AOFAS score was 90 (8) (70-100) at the last follow-up. In the elderly patients, the mean scores were 2 (2) (0-4), and 90 (5) (80-100), respectively, with no significant difference found between the groups ($p>0.05$ for each) (Table 2).

A similar observation was made in the radiological evaluation, wherein no significant differences were observed between age groups in terms of preoperative and final control HVAs, IMAs and angular corrections ($p>0.05$ for each) (Table 3).

When the patients were evaluated according to the type of osteotomy, there was no difference between the groups in terms of demographic characteristics. However, a significant difference was observed between the VAS score at the last follow-up, preoperative HVA and IMA angles, and the amount of HVA and IMA angular correction (Table 4). Post-hoc analysis revealed that the VAS score was comparable between the distal and proximal osteotomy groups ($p=0.919$); however, a significant difference was observed in patients who underwent arthrodesis, with pain levels being significantly lower in the arthrodesis group (Tables 4 and 5).

Radiological analysis revealed substantial variations in both preoperative HVA and IMA, as well as the amount of HVA and IMA angular correction, in patients who underwent arthrodesis compared to those who underwent distal osteotomy ($p<0.05$ for each) (Table 5). No significant differences were observed between the radiological

Table 1. Demographic Profile of the Patients

		Number of Patients (%)
Age (years)		46 (22) (18-76)
Age Group	Young	87 (85.3)
	Elderly	15 (14.7)
Gender	Female	88 (86.3)
	Male	14 (13.7)
Side	Right	56 (54.9)
	Left	46 (45.1)
Osteotomy	Distal Osteotomy	70 (68.6)
	Proximal Osteotomy	**16 (15.7)**
	Arthrodesis	16 (15.7)
Follow-up (months)		82.5 (110) (11-158)

Table 2. Demographic and Functional Analysis by Age Groups

		Younger Patients (%) (n=87)	Elder Patients (%) (n=15)	p
Age (years)		43 (21) (18-60)	69 (5) (65-76)	***<0.001***
Gender	Female	74 (84.1)	14 (15.9)	0.687
	Male	13 (92.9)	1 (7.1)	
Side	Right	49 (87.5)	7 (12.5)	0.488
	Left	38 (82.6)	8 (17.4)	
Osteotomy	Distal Osteotomy	59 (84.3)	11 (15.7)	0.581
	Proximal Osteotomy	13 (81.3)	3 (18.8)	
	Arthrodesis	15 (93.8)	1 (6.3)	
Complaint at the Final Follow-up	None	77 (84.6)	14 (15.4)	0.790
	Pain/Numbness	8 (88.9)	1 (11.1)	
	Wound Site Problem	2 (100)	0	
Follow-up (months)		83 (111) (11-158)	80 (63) (12-155)	0.481
VAS Score		2 (3) (0-6)	2 (2) (0-4)	0.664
AOFAS Score		90 (8) (70-100)	90 (5) (80-100)	0.916

n: number of patients, p: statistical significance value, VAS: The Visual Analogue Scale, AOFAS: The American Orthopaedic Foot and Ankle Society

Table 3. Radiological Analysis by Age Groups

	Younger Patients (n=87)	Elder Patients (%) (n=15)	p
Preoperative HVA (°)	36 (10) (23-65)	39 (14) (24-52)	0.085
Final Follow-up HVA (°)	12 (5) (4-22)	12 (6) (5–22)	0.729
HVA Angular Correction (°)	24 (9) (10-46)	24 (11) (14-39)	0.228
Preoperative IMA (°)	15 (5) (10-29)	16 (4) (10-27)	0.377
Final Follow-up IMA (°)	11 (3) (4-19)	11 (5) (8-15)	0.927
IMA Angular Correction (°)	4 (5) (0-14)	4 (5) (0-18)	0.909

n: number of patients, p: statistical significance value, HVA: hallux valgus angle, IMA: intermetatarsal angle.

Table 4. Investigating the Superiority of Different Surgical Techniques in the Hallux Valgus

		Distal Osteotomy (%) (n=70)	Proximal Osteotomy (%) (n=16)	Arthrodesis (%) (n=16)	p
Age (years)		45 (20) (18-72)	44 (28) (19-68)	53.5 (23) (18-76)	0.214
Age Group	Younger	59 (67.8)	15 (17.2)	13 (14.9)	0.586
	Elder	11 (73.3)	3 (20)	1 (6.7)	
Gender	Female	59 (67)	15 (17)	14 (15.9)	0.756
	Male	11 (78.6)	1 (7.1)	2 (14.3)	
Side	Right	41 (73.2)	8 (14.3)	7 (12.5)	0.545
	Left	29 (63)	8 (17.4)	9 (19.6)	
Complaint at the Final Follow-up	None	63 (69.2)	14 (15.4)	14 (15.4)	0.629
	Pain/ Numbness	6 (66.7)	2 (22.2)	1 (11.1)	
	Wound Site Problem	1 (50)	1 (50)	0	
Follow-up (months)		79.5 (104) (11-157)	149.5 (15) (83-158)	49.5 (49) (12-150)	0.135
VAS Score		2 (3) (0-6)	2 (2) (1-5)	1 (1) (0-4)	***0.037***
AOFAS Score		90 (8) (70-100)	85 (8) (70-93)	91.5 (9) (75-100)	0.226
Preoperative HVA (°)		35 (8) (23-55)	39 (10) (26-54)	44 (14) (24-65)	***0.001***
Final Follow-up HVA (°)		12 (5) (5-22)	10.5 (6) (4-18)	12.5 (5) (4-19)	0.612
HVA Angular Correction (°)		23 (8) (10-14)	25.5 (7) (16-40)	33 (11) (14-46)	***<0.001***
Preoperative IMA (°)		15 (4) (10-21)	17 (4) (10-21)	19.5 (7) (10-29)	***0.001***
Final Follow-up IMA (°)		11 (3) (4-15)	10 (4) (6-14)	10 (2) (9-19)	0.499
IMA Angular Correction (°)		3.5 (4) (0-11)	6 (3) (1-12)	9 (7) (0-18)	***0.002***

n: number of patients, p: statistical significance value, VAS: Visual analog scale, AOFAS: American Orthopaedic Foot and Ankle Society, HVA: Hallux valgus angle, IMA: Intermetatarsal angle.

results of patients who underwent proximal osteotomy and those who underwent arthrodesis. However, a significant difference was identified between the radiological analysis of patients who underwent proximal and distal osteotomy in terms of HVA and IMA angular correction (Table 5). Post-hoc analyses demonstrated that distal osteotomies exhibited significantly lower levels of both HVA and IMA corrections than proximal osteotomies and arthrodesis (Tables 4 and 5).

DISCUSSION

This retrospective cohort study provides substantial evidence that age is not a significant predictor of functional or radiological outcomes following hallux valgus surgery. The findings of this study are consistent with the extant literature in that there was no significant difference between the elderly and younger patient groups in terms of AOFAS and VAS scores, complication rates,

Table 5. Post-hoc Analysis of the Investigation of Osteotomies

	Distal Osteotomy	Proximal Osteotomy	Arthrodesis
	VAS Score		
Distal Osteotomy	N/A	0.919	**0.037**
Proximal Osteotomy	0.919	N/A	**0.034**
Arthrodesis	**0.037**	**0.034**	N/A
	Preoperative HVA (°)		
Distal Osteotomy	N/A	0.050	**0.001**
Proximal Osteotomy	0.050	N/A	0.119
Arthrodesis	**0.001**	0.119	N/A
	HVA Angular Correction (°)		
Distal Osteotomy	N/A	**0.003**	**<0.001**
Proximal Osteotomy	**0.003**	N/A	0.184
Arthrodesis	**<0.001**	0.184	N/A
	Preoperative IMA (°)		
Distal Osteotomy	N/A	0.161	**0.001**
Proximal Osteotomy	0.161	N/A	0.051
Arthrodesis	**0.001**	0.051	N/A
	IMA Angular Correction (°)		
Distal Osteotomy	N/A	**0.006**	**0.002**
Proximal Osteotomy	**0.006**	N/A	0.254
Arthrodesis	**0.002**	0.254	N/A

VAS: Visual analog scale; HVA: Hallux valgus angle; IMA: Intermetatarsal angle.

and osteotomy preferences. Although decreasing bone quality is expected to be associated with lower surgical success, decreasing expectations with age may explain the relative increase in functional outcomes and patient satisfaction. However, the significant effect of surgical technique on both angular correction and functional outcomes emphasizes that treatment of hallux valgus should be tailored to deformity severity and biomechanical requirements rather than patient's age.

In the present study, the median AOFAS score was 90 (70-100) and the median VAS score was 2 (0-6) in the younger age group, while the median AOFAS score was 90 (80-100) and the median VAS score was 2 (0-4) in the older age group, with no statistical difference observed between groups (p=0.916 and p=0.481, respectively). The present findings are consistent with the extant literature on the subject (1,22,23). The findings of this study support the hypothesis that surgical success and postoperative functional outcomes depend on the consistency of the technique applied, rather than on age. Furthermore, in our study, postoperative HVA and IMA and the amount of angular correction were found to be similar between age groups (p>0.05 for each, Table 3). The findings of this study are consistent with the extant literature on the subject and lend support to the hypothesis that the most effective factor in the amount of surgical correction is the type of osteotomy and that surgical efficacy is not sensitive to age (4,24).

Subsequent to conducting subanalyses according to osteotomy type, it was observed that the amount of angular correction of both HVA and IMA and VAS scores varied significantly with osteotomy type (Table 4). Post-hoc analyses demonstrated that arthrodesis was superior to distal osteotomies across all parameters, with a significantly lower VAS score than proximal osteotomies (Tables 4 and 5). Post-hoc analyses further demonstrated that the magnitude of angular correction was greater in proximal than in distal osteotomies. However, this discrepancy was not reflected in the functional outcomes, which were comparable (Tables 4 and 5). The findings of this study are consistent with those of the literature, which also reports higher levels of angular correction in arthrodesis than in other osteotomies (25,26). The finding that the functional scores of arthrodesis, which is superior in terms of both VAS scores and angular correction, are similar to those of other types of osteotomies, can be interpreted as a limitation of the scoring system. The AOFAS functional scoring system encompasses various subscales, including pain, activity limitation, and joint mobilization. Although arthrodesis surgery is superior in terms of pain and angular correction, it is not inherently superior in joint mobilization. In a recent study, Reilly et al. compared arthrodesis with rotational osteotomy and reported that, despite arthrodesis being superior in terms of IMA correction, both procedures yielded similar functional improvements (27). While substantial corrections can be achieved in the IMA and HVA with the Lapidus procedure, the extent of correction of distal osteotomies remains constrained. Consequently, these osteotomies are recommended for lower-level deformities. Although Chevron osteotomy was preferred in 68.6% of cases in this cohort, preoperative HVA and IMA of patients who underwent arthrodesis were found to be higher than those who underwent distal osteotomy. The preference for distal osteotomies, particularly modified Chevron osteotomy, in moderate deformities has also been documented in the literature (28,29). However, it is important to note the presence of conflicting reports in the literature on this subject, and the surgeon's preference is a significant factor. Furthermore, the necessity of distal osteotomy for mild deformities and proximal osteotomy for severe deformities is not always imperative, and there are reports in the literature indicating improvement in radiographic parameters, independent of the type of osteotomy. (30)

The present study had some limitations. First, although the incidence of HV is increasing in the elderly, surgical treatment is not widely practiced in this age group due to lower life expectancy and increased comorbidities. This distribution of patients may have potential negative effects on the study results. This imbalance may reduce the statistical power to detect true differences in the elderly cohort and raise the risk of false-negative results. This means that potentially important age-related effects may have gone undetected. The external validity of the conclusions drawn is also limited when considering the broader population of elderly HV patients. Furthermore, the absence of a stratified comorbidity analysis constitutes a significant limitation of this study. Age-related conditions, most notably diabetes and osteoporosis, significantly impact key aspects of surgical recovery. However, these conditions were not considered in the present study. Diabetes, for instance, has been shown to impair microvascular perfusion and heighten infection risk, which can delay osteotomy union or complicate wound healing. Similarly, osteoporosis re-

duces the bone's capacity to securely retain the fixation hardware, potentially limiting the extent of safe angular correction. In the absence of adjustments for the identified factors, it becomes challenging to ascertain whether the observed similarities or differences in radiographic correction and pain outcomes genuinely reflect the intrinsic efficacy of the surgical techniques or whether they are influenced by variations in bone quality and metabolic health across age groups. The retrospective design of the study and the relatively limited number of patients are important limitations. Although the extensive follow-up period of this study is a notable strength, the heterogeneity in the distribution of follow-up periods is also an important limitation. Despite the median follow-up times of 49.5 months in the arthrodesis group and 79.5 months in the distal osteotomy group being adequate for the evaluation of functional analyses, heterogeneity still poses a challenge when interpreting long-term outcome comparison. In the proximal osteotomy group, a median follow-up period of 149.5 months may have resulted in a relative increase in satisfaction, as patients became accustomed to pain and limited function, and their expectations of their feet decreased. Despite the fact that toe function will not be restored in the arthrodesis group, even with increasing follow-up time, it can be hypothesized that acceptance and relative satisfaction will occur with an increasing duration. Furthermore, the absence of preoperative functional scores was a significant limitation. Consequently, prospective randomized controlled trials with larger sample sizes, preoperative analyses, and comorbidity analyses are required to evaluate the impact of surgical techniques and age groups on functional outcomes more precisely. Future studies can provide a more objective demonstration of the effects of age on radiological and functional outcomes.

In conclusion, this study provides compelling evidence that although age does not independently predict prognosis in hallux valgus surgery, individualized surgical approaches can significantly enhance long-term clinical outcomes by underscoring the predominant impact of osteotomy type on surgical functional results and radiographic corrections. Furthermore, the fact that the number of patients was lower in the older age group can be interpreted as the person getting used to living with this deformity, decreasing their daily activities, or moving away from aesthetic concerns.

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Abbreviations List

HV: Hallux Valgus
VAS: Visual Analogue Scale
AOFAS: American Orthopaedic Foot and Ankle Society
HVA: Hallux Valgus Angle
IMA: Intermetatarsal Angle
PMO: Proximal Metatarsal Osteotomy
AP: Anteroposterior radiograph
SPSS: Statistical Package for the Social Sciences.

Ethics Approval and Consent to Participate

This study was reviewed and approved by the Marmara University Faculty of Medicine, Non-Pharmaceuticals and Non-Medical Devices Research Ethics Committee (Protocol No: 09.2024.1588, Date: 24.12.2024). Informed consent was obtained from all individual participants included in the study.

Consent for Publication

Not applicable. This study includes no identifiable patient data, and the ethics committee waived the requirement for publication consent.

Availability of Data and Materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing Interests

The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

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Author Contributions

Ufuk ARZU contributed to the conceptualization and methodology of the study, performed data curation, conducted the formal analysis, and prepared the initial draft of the manuscript. Batuhan GENCER participated in data collection, radiographic measurements, statistical analyses, and contributed to the review and editing of the manuscript. Serdar ORHAN provided surgical supervision, validated the clinical findings, assisted in the interpretation of data, and critically revised the manuscript for important intellectual content. Yılmaz Kerem AKAYOĞLU performed the literature review, supported data interpretation, contributed to visualization, and participated in manuscript review and editing. Deniz GÜLABİ oversaw the overall study design, provided project supervision, ensured methodological accuracy, and approved the final version of the manuscript

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