



## Comparison of Three Treatment Modalities for Hallux Valgus Surgery Using Xray and Functional Scoring Methods

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### Abstract

**Objective of the Study:** Evaluate the effectiveness of different options for surgical treatment of hallux valgus by functional and radiographic results of osteotomies saving the metatarsophalangeal joint.

**Materials and Methods:** 342 patients with hallux valgus I, II, III degrees were studied. Patients were examined before surgery, 3, 6 and 12 months after operation. X-ray results were assessed by the hallux valgus angle (HVA), intermetatarsal angle (IMA), distal metatarsal articular angle (DMMA) before and after the operations. AOFAS score-rating scale (Kitaoka) was used for the functional assessment of the results of surgical treatment.

**Discussion:** The result of the study showed that a positive correlation was found between the correction of the HVA and high AOFAS scores in the group of patients operated by the Scarf method. The Austin osteotomy patient group had a direct correlation between the value of the IMA correction and the increasing functional activity of the foot. There was a correlation between DMMA correction and high AOFAS scores in patients after Bosh-Magnan surgery.

**Conclusion:** According to the study Scarf osteotomy should be used in case of Hallux valgus deformity determined mainly by the HVA. Austin osteotomy should be used for Hallux valgus deformity which is predominantly determined by the IMA. Attention should be paid to the Bosch-Magnan osteotomy in case of Hallux valgus deformity determined mainly by the DMMA. The absence of complications in these types of osteotomies is explained by the analysis of long-term results, which did not reveal significant differences in soft tissues before and after surgery, since the wounds healed by primary intention.

**Keywords:** Hallux Valgus; Scarf Osteotomy; Austin Osteotomy; Bosh-Magnan Osteotomy; Correlation Analysis

### Abbreviations

HV: Hallux Valgus; HVA: Hallux Valgus Angle; IMA: Intermetatarsal Angle; DMMA: Distal Metatarsal Articular Angle; AOFAS: American Orthopaedic Foot and Ankle Society

### Introduction

Hallux valgus (HV) is a widespread pathology [1,8]. This pathology changes the kinematics of movements in the lower extremities. Subsequently, social maladjustment of the patient occurs due

to inactivity with severe pain syndrome. This pathology could decompensate many diseases. Hallux valgus plays an important role in reducing the quality of life of patients and affects its duration, therefore, this scientific research is relevant today. The etiology and pathogenesis of the disease are complex, multifactorial and require further study [7].

None of the methods of surgical reconstruction of the first metatarsal bone could be recognized as universal and effective for any type of anthropometric foot structure despite the large amount literary sources describing the long-term results of osteotomy of the first metatarsal bone. Today, there are many methods of surgical treatment for Hallux valgus. One of the significant problems after such operations is the recurrence of deformity related with hypermobility of the I metatarsal joint [5]. Minor deformities of hallux valgus are corrected by the distal metatarsal bone osteotomy, for example, using a chevron osteotomy (Austin osteotomy) [6]. The Scarf procedure is a Z-shaped diaphyseal osteotomy of the first metatarsal bone. Bosh-Magnan osteotomy consists in fixing the head of the first metatarsal bone, displaced laterally with a wire held subcutaneously along the phalanges of the first toe.

The choice of osteotomy is based on the patient's age, the degree of deformity of the first toe, and rehabilitation expectations. The indications for Scarf osteotomy are IMA up to 20° and HVA over 25° [3], Austin osteotomy is used at 15° IMA, 11° HVA. Scarf osteotomy has more possibilities for correcting deformities of the first toe compared to Austin osteotomy. It is known that Bosh-Magnan technique brings the DMMA back to normal [4]. It should be noted that one of the main disadvantages of Bosh-Magnan osteotomy, limiting the widespread use of this osteotomy, is the lack of effective correction of the IMA [2].

This study compared two osteotomies (Scarf, Austin) with each other, and also compared the study between the Scarf osteotomy in patients of the first group and the Bosch-Magnan minimally invasive osteotomy in patients of the third group. Performing a standard or minimally invasive osteotomy provides different clinical and radiological results; nevertheless, the analysis of long-term results is the greatest importance, in our opinion, which makes it possible to analyze both immediate and long-term clinical and radiological parameters of surgical treatment.

## Objective of the Study

Evaluate the effectiveness of different options for surgical treatment of hallux valgus by functional and radiographic results of osteotomies saving the metatarsophalangeal joint.

## Materials and Methods

This clinical study was conducted at the Department of Traumatology and Orthopedics of the Regional Clinical Hospital in Chelyabinsk, Russia from November 2015 to November 2019. The study involved 342 patients with hallux valgus of I, II, III degrees. Among all studied patients, there were 330 women and 12 men. The average age of the patients was  $52.0 \pm 9.8$  years.

The patients were divided into 3 groups according to the performed osteotomy method. The first group (N = 126) included patients who underwent Scarf osteotomy, the second group (N = 93) consisted of patients operated by Austin method, the third group (N = 123) was operated by Bosch-Magnan method.

The effectiveness of surgical treatment was assessed by functional and radiological results. The analysis was carried out by taking anamnesis, analyzing the orthopedic status, examining patients, evaluating the functional outcome of treatment using the AOFAS rating scale - American Orthopaedic Foot and Ankle Society- also called the Kitaoka scale, assessing radiographs of the feet. On radiographs, the hallux valgus angle (HVA), intermetatarsal angle (IMA), and distal metatarsal articular angle (DMMA) were determined. We also determined the difference in HVA angles before and after osteotomy (HVA angle correction).

Patients were examined before surgery, then 3, 6 and 12 months after operation.

Packages Microsoft Excel and STATISTICA 10.0 (StatSoft, USA) applications were used for the statistical analysis of the study results. Nonparametric methods of statistical analysis were used. Student's t-test was used as the comparison criterion. Study results are presented as mean and standard deviation (SD). Differences between groups were assessed using the Mann-Whitney test. The Pearson correlation coefficient was used. Differences were considered statistically significant at  $p < 0.05$ .

## Results and Discussion

The average hospital stay was  $6 \pm 2.3$  days.

Comparisons of treatment results in groups are shown in table 1.

Indicator	M ± SD		
	First group	Second group	Third group
AOFAS, scores	86,0 ± 5,2	78,2 ± 5,3	75,3 ± 4,6
<b>HVA, degrees</b>			
Before operation	36,750 ± 1,9	27,167 ± 1,2*	30,636 ± 1,4*
After operation	6,375 ± 3,2	6,333 ± 0,9*	10,273 ± 1,2*
Angle correction	30,4 ± 2,5	20,8 ± 1,05	20,4 ± 1,3
<b>IMA, degrees</b>			
Before operation	12,750 ± 1,4	11,833 ± 5,1*	12,455 ± 4,9*
After operation	6,375 ± 0,8	3,167 ± 0,9*	7,182 ± 3,1*
Angle correction	6,4 ± 1,1	8,6 ± 3,1	5,3 ± 4,1
<b>DMMA, degrees</b>			
Before operation	19,625 ± 5,2	18,167 ± 0,9*	19,273 ± 6,9*
After operation	11,625 ± 1,3	9,00 ± 1,3*	8,273 ± 1,3*
Angle correction	9,2 ± 2,4	8,00 ± 1,25	11 ± 4,1

**Table 1:** Functional and radiological results of various osteotomies for hallux valgus.

\*- Significance of differences with the index of the first group, p < 0,05.

Thus, table 1 shows that the greatest correction of the HVA in hallux valgus occurs during the Scarf osteotomy, the angle correction in this case was 30.4 ± 2.5 degrees. The smallest correction of the HVA occurs using the Bosch-Magnan operation (angle correction - 20.4 ± 1.3°), an intermediate value in terms of HVA correction is occupied by the Austin osteotomy.

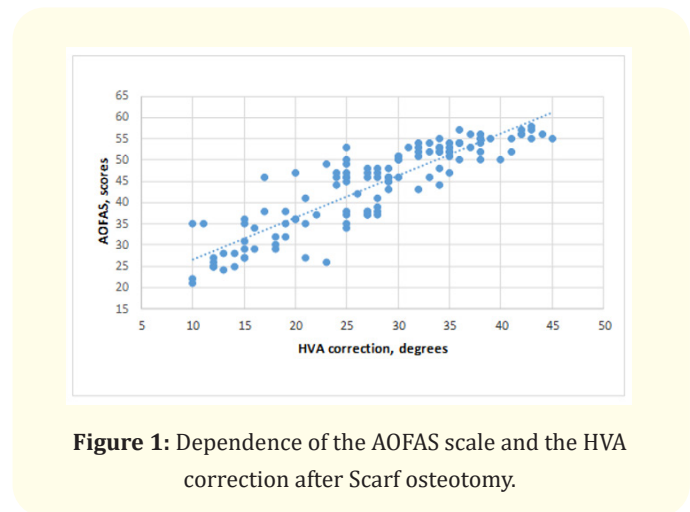
The greatest correction of the IMA were received by the Austin osteotomy (second group), the correction angle was 8.6 ± 3.1°. Slightly greater correction of the IMA occurs with the Scarf operation rather than the Bosch-Magnan osteotomy. The IMA correction angle with Scarf osteotomy is 6.4 ± 1.1°, the IMA correction angle with Bosch-Magnan is 5.3 ± 4.1°. At the same time, the differences

between the groups were insignificant, which proves the effectiveness of the analyzed types of osteotomies of the first metatarsal bone.

The greatest correction of the DMMA was carried out during the Bosch-Magnan osteotomy, the correction angle was 11 ± 4.1°. Also, the DMMA was slightly corrected with Austin osteotomy and the Scarf operation.

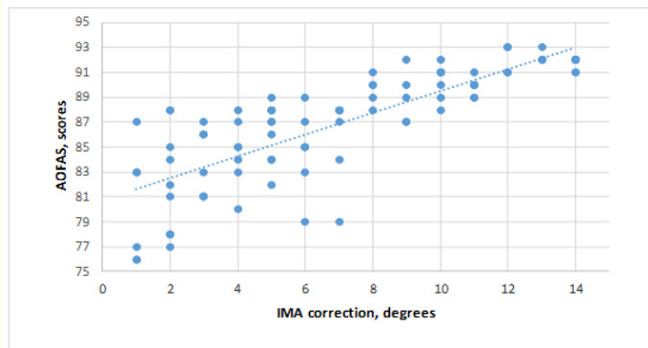
The AOFAS scale results in all three groups of patients were noted as "good". No "excellent", "satisfactory", "bad" results were found. However, it should be noted that the average AOFAS score was higher in the first group (Scarf) and averaged 86.0 ± 5.2 scores after surgery. In the second group of patients after Austin osteotomy, the mean score was 78.2 ± 5.3 after the operation, and in the third group (Bosch-Magnan) mean score was 75.3 ± 4.6 after the operation.

In the first group of patients, according to the results of the Scarf osteotomy, the Pearson correlation coefficient was the most significant between the value of the HVA angle correction and the functional result, assessed by the AOFAS scale, being 0.887 (Figure 1).



**Figure 1:** Dependence of the AOFAS scale and the HVA correction after Scarf osteotomy.

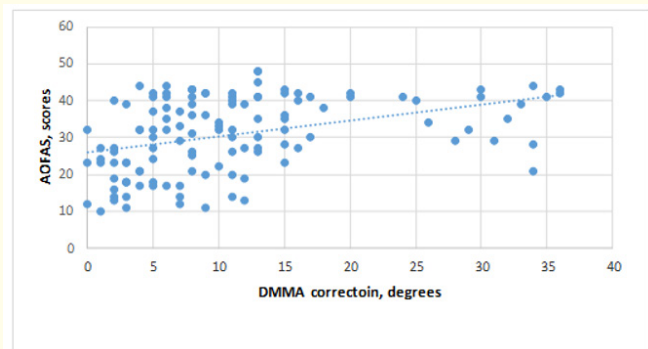
It was found that if the difference in HVA before and after osteotomy increased the functional state of the foot after surgery improved (p < 0.05). In the second group of patients, a strong correlation was found between the value of the IMA correction and the value of the AOFAS scale. Pearson's correlation coefficient was 0.801 (Figure 2).



**Figure 2:** Dependence of the AOFAS and the IMA correction during Austin operation.

It was reliably obtained if correction of the IMA after Austin osteotomy increased in the second group, AOFAS scores were higher in the postoperative period ( $p < 0.05$ ). It was possible to determine the correlation dependence showing the relationship between the difference IMA before and after Austin osteotomy in the second group of patients and the AOFAS scores received by the patient after surgery using the Pearson correlation coefficient.

In the third group of patients which were operated by the Bosch-Magnan method, a correlation with the highest Pearson coefficient 0.391 was found between the parameters of the DMMA correction and the value of the AOFAS scale (Figure 3).

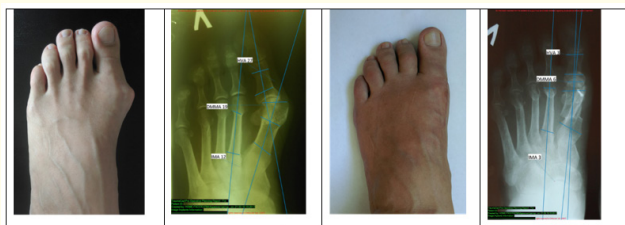


**Figure 3:** Dependence of the DMMA correction and the AOFAS scale (Kitaoka) in third group.

It was reliably obtained that if the DMMA correction increased during Bosch-Magnan osteotomy, the AOFAS scores improved ( $p < 0.05$ ). A strong correlation could be traced in the third group.

Below we provide clinical examples of evaluating the results of osteotomies.

Clinical example 1: Patient P. ♀, 56 years old. Diagnosis: Static deformity of the feet. Hallux Valgus 2. Deformity of 2-3 fingers. Central metatarsalgia. Operation: Scarf osteotomy of the first metatarsal bone. Akin. DMMO 2-4. The result on the AOFAS scale after surgery 92 (Figure 4).



**Figure 4:** Clinical example of Scarf osteotomy.

Clinical example 2: Patient G. ♀, 59 years old. Diagnosis: Static deformity of the feet. Hallux Valgus 3. Deformity of 2-3 fingers. Central metatarsalgia. Operation: Osteotomy according to Bosch-Magnan. DMMO 2-3. Percutaneous osteotomy of the 2<sup>nd</sup> metatarsal bone. Postoperative AOFAS was 80 scores (Figure 5).



**Figure 5:** Clinical example of a Bosch-Magnan osteotomy.

A clearly identified relationship between a significant decrease in the HVA and an increasing function of the foot in the postopera-

tive period in the first group shows that HVA correction in Hallux valgus indicates a significant improvement in X-ray anatomical parameters after Scarf osteotomy.

### Conclusion

According to the study Scarf osteotomy should be used in case of Hallux valgus deformity determined mainly by the HVA. Austin osteotomy should be used for Hallux valgus deformity which is predominantly determined by the IMA. Attention should be paid to the Bosch-Magnan osteotomy in case of Hallux valgus deformity determined mainly by the DMMA. The absence of complications in these types of osteotomies is explained by the analysis of long-term results, which did not reveal significant differences in soft tissues before and after surgery, since the wounds healed by primary intention.

The revealed correlations could be used in choosing the optimal osteotomy technique, each operation shows the largest angle correction of Hallux valgus.

### Conflict of Interest

The authors do not declare about financial interest and conflict of interest do not exists.

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