

X-Ray Aspects of the Forefoot Reconstruction

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Abstract:

Background: Hallux valgus is a pathology that directly affects the quality of life of patients. Dissatisfaction with the results of treatment with Hallux valgus suggests the search for surgical options that can improve the anatomical and biomechanical parameters of the forefoot.

The purpose of the study was an X-ray analysis of the results of surgical treatment of hallux valgus deformity of the first toe using methods saving the metatarsophalangeal joint (osteotomy of the first metatarsal bone according to the method of Scarf, Austin, Bosh-Magnan).

Materials and Methods: The results of treatment of 342 patients with hallux valgus deformity of the first toe of I, II, III degree who underwent surgical treatment in the Regional Clinical Hospital No. 1 of Chelyabinsk for the period from January 2015 to May 2019 were analyzed. Radiographs of the feet were analyzed in the preoperative period and 3, 6 and 12 months after surgery with the study of the angles of HVA, IMA, DMMA. To evaluate the results of surgical treatment, the scale of the American Association of Orthopedic Surgeons AOFAS (Kitaoka) was used.

Results: The greatest correction of the HVA angle was achieved after an osteotomy using the Scarf technique. The average AOFAS score was the highest in the group of patients operated on by the Scarf method and averaged 86.0 points after surgery. Austin osteotomy led to a greater correction of the IMA angle. The greatest correction of the DMMA angle was detected after osteotomy according to Bosh-Magnan.

Conclusion: Scarf osteotomy allows the best way to normalize the X-ray anatomical parameters of the HVA angles in Hallux valgus. Patients with Scarf osteotomy in the postoperative period showed the highest AOFAS scores, which reflects a good functional result.

Key Word: osteotomy of the first metatarsal bone, Hallux valgus, osteotomy according to Austin, Bosh-magnan, Scarf, angle of valgus deviation of the first finger, tarsal angle, distal metatarsal articular angle.

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I. Introduction

Various diseases and damage to the support organs are often accompanied by serious violations of the motor apparatus, loss of ability to normal movements, which, in the end, leads to disability and subsequent disability [1]. The foot is a structural segment of the musculoskeletal system, which provides its stato-locomotor function [2,3].

Hallux valgus (HV) is the most common deformity of the forefoot. Its prevalence is up to 23% in patients from 18 to 65 years old and 35% in elderly people over 65 years old. The causes of HV are, most often, wearing inappropriate shoes and a genetic predisposition. In women, this pathology is more common and proceeds much harder than in men. Appeared complaints of pain, hyperemia, "bump" in region metatarsophalangeal joint I, inability to pick up shoes of a certain size, cosmetic defects force patients to turn to an orthopedic - traumatologist [4].

The pathogenesis of HV is multifactorial [5]. Hallux valgus deviation of the first toe is, as a rule, a manifestation of transversely spread flatfoot [6].

Only during the twentieth century, the number of surgical techniques for the treatment of transverse flatfoot has increased significantly, and today there are up to 400 methods of surgical treatment of transverse flatfoot [7].

Most surgical methods for reconstruction of the forefoot are based on an intervention to correct bone structures. To a lesser extent, corrective interventions on the soft tissues are used [8]. In the process of HV treatment, the degree of deformation of the forefoot is first determined: light, medium and severe, then distal, diaphyseal and proximal osteotomy is performed, and arthrodesis of the first metatarsophalangeal joint is also possible [9]. Mild deformities are corrected by osteotomy of the distal metatarsal bone, for example, using a chevron osteotomy (Austin osteotomy) [10]. Recently, there has been a tendency in foreign literature to increase the number of publications on the implementation of corrective arthrodesis of the first metatarsopharyngeal joint of Lapidus in the treatment of both relapses of HV and primary pathology [11]. Due to the widespread use of diaphyseal Scarf-osteotomy technique in modern foot surgery [12], it seems relevant to study its effect on the mobility of the first metatarsal-wedge-shaped joint.

Often, reconstructive operations are performed “by pattern”, using the few traditional methods that have developed in the clinic, which cannot be a universal approach to solving the problem, suitable for treating all patients [13]. Surgical treatment of patients should be based on a single medical doctrine that optimizes the biomechanical properties of the foot and limb as a whole, be functional, effectively relieve pain and ensure social, professional and domestic reintegration [14].

In our opinion, one of the best ways to treat hammer-like deformation of the II-V toes of the foot is the method in which short extensors of the foot are projected in the place of the metatarsophalangeal joints, and the long flexor of the affected finger is crossed at the level of the middle phalanx with subsequent extension of the main phalanges, which improves support, reduces tissue trauma, allows early activation of the limb [15].

The aim of our study is an X-ray analysis of short-term, medium-term and long-term results of surgical treatment of hallux valgus deformity of the first toe using the metatarsophalangeal joint saving methods (osteotomy according to the Scarf, Austin, Bosh-Magnan methods).

II. Material And Methods

This prospective comparative study was carried out on patients of Chelyabinsk Regional Clinical Hospital № 1 of from January 2015 to May 2019. A total 342 adult subjects (both male and females) of aged ≥ 18 , years were for in this study.

Study Design: Prospective open label observational study

Study Location: This was based study done in State budgetary health care institution Chelyabinsk Regional Clinical Hospital № 1, Russia

Study Duration: January 2015 to May 2019

Sample size: 342 patients.

Subjects & selection method: The analysis includes the results of treatment of 342 patients with hallux valgus deformity of the first toe of I, II, III degree who underwent surgical treatment in the Regional Clinical Hospital № 1 of Chelyabinsk for the period from January 2015 to May 2019. The first study group consisted of 126 patients who underwent an osteotomy according to the Scarf method. The second group included 93 patients who underwent Austin surgery. The third group consisted of 123 patients operated on using the Bosh-Magnan technique. After an osteotomy, walking with Baruk’s shoes was recommended.

Group A (N=126 patients) -osteotomy according to the Scarf method;

Group B (N=93 patients) -Austin surgery; and

Group C (N=123 patients) Bosh-Magnan technique.

Inclusion criteria:

1. Patients with hallux valgus deformity of the first toe of I, II, III degree
2. Aged ≥ 18 years,

Exclusion criteria:

1. The initial exclusion criteria were patients with rheumatoid arthritis
2. Patients with failed osteotomy in the past
3. Patients with hereditary neuromuscular diseases

The analysis was carried out by taking an anamnesis, analyzing the orthopedic status, examining patients and radiographs of the feet in direct projection with a load before osteotomy and after 3, 6 and 12 months after surgery with the study of the valgus angle of the first finger (HVA), intertarsal angle (IMA), distal metatarsal articular angle (DMMA). To evaluate the results of surgical treatment, the scale of the American Association of Orthopedic Surgeons AOFAS (Kitaoka) was used.

Statistical analysis

Data was analyzed using SPSS version 10 (StatSoft, USA) and Microsoft Excel. Student's *t*-test was used to ascertain the significance of differences between mean values of two continuous variables and confirmed by nonparametric Mann-Whitney test. The level $P < 0.05$ was considered as the cutoff value or significance.

III. Result

Correction of hallux valgus deviation of the first finger, fusion of osteotomies and improvement after surgery were achieved in all patients. Pain relief was marked, improvement of the functional state of the feet was found. All patients noted the achievement of a cosmetic effect and the restoration of habitual life activity. In three groups 330 people (96.5%) patients were female, and 12 people (3.5%) were male.

The average age of the patients of the first group operated according to the Scarf technique was 49.3 ± 9.26 years; in the second group with Austin osteotomy, 51.2 ± 9.48 years; in the third group, operated by the Bosh-Magnan method - 56.2 ± 13.3 years (Fig. 1)

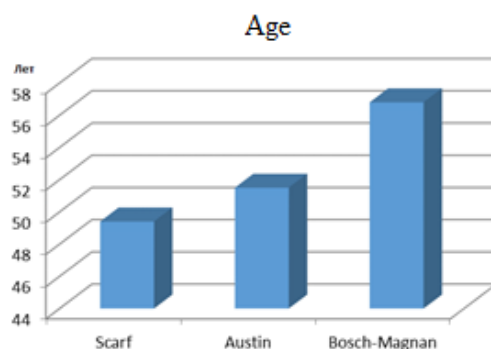


Fig. 1. The average age of patients operated on by the method of Scarf, Austin, Bosh-Magnan

The number of hospital days of patients spent in the trauma hospital averaged 5.5 ± 1 days.

In the first group, 63 patients were with III grade HV, 61 patients were with II grade HV, and 2 patients were with I grade HV. According to the Austin method, 10 patients were with III grade HV, 22 patients were with II grade, and 61 patients were with I grade HV. According to the Bosh-Magnan method, 6 patients were with I grade HV, 37 patients were with III grade, and 80 patients were with II grade HV.

According to the results of the study, the greatest correction of the HVA angle was achieved after an osteotomy by the Scarf method compared to the results of the HVA angle after an osteotomy according to Austin, Bosh-Magnan. Scarf osteotomy led to a greater correction of HV ($p < 0.05$) (Fig. 2).

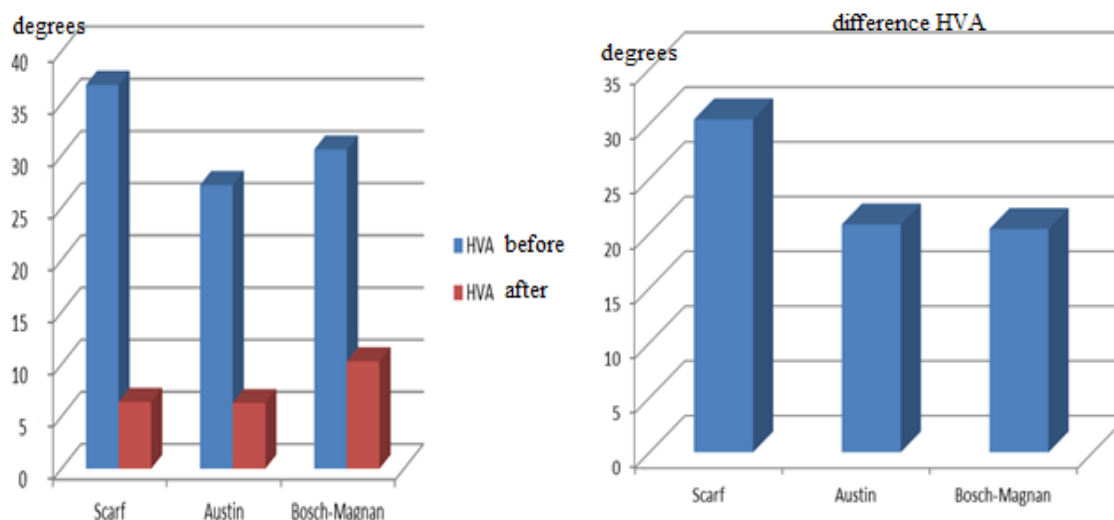


Fig. 2. Change in HVA angles before and after osteotomy

The greatest correction of the IMA angle was achieved by Austin osteotomy compared with the results of IMA angles for osteotomy according to Scarf, Bosh-Magnan. Austin osteotomy led to a greater correction of IMA ($p < 0.05$) (Fig. 3).

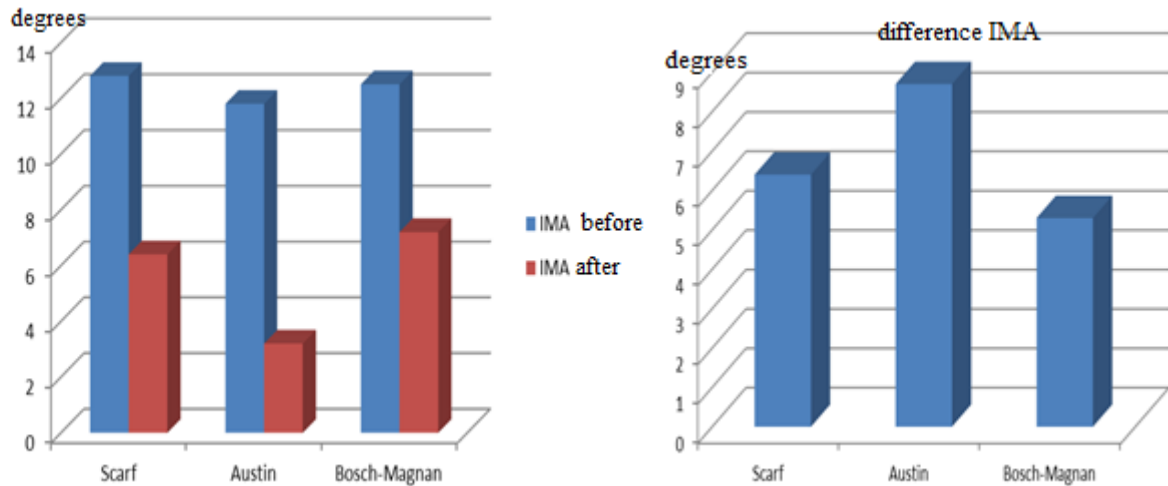


Fig. 3. Change in IMA angles after osteotomies by Scarf, Austin, Bosh-Magnan

The greatest correction of the DMMA angle was revealed after an osteotomy according to Bosh-Magnan as compared with the results of the values of the DMMA angles after an osteotomy according to Scarf, Austin. Bosh-Magnan osteotomy led to a greater correction of DMMA ($p < 0.05$) (Fig. 4).

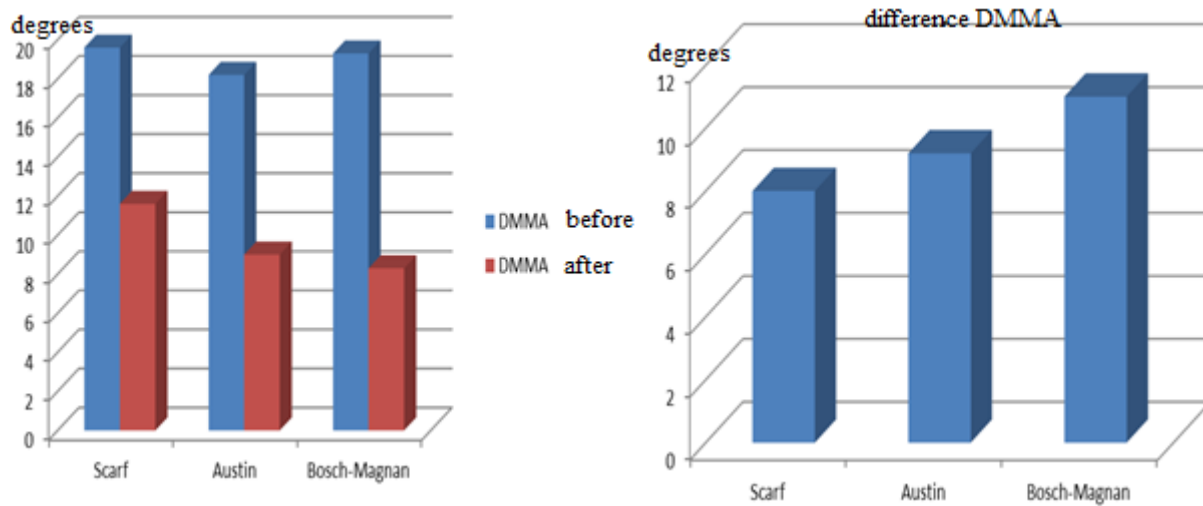


Fig. 4. Changes in the values of the DMMA angle after osteotomies by Scarf, Austin, Bosh-Magnan

Table no 1. Indicators of HVA, IMA, DMMA values for different methods osteotomy

	The first group (Scarf)	The second group (Austin)	The third group (Bosh-Magnan)
The average value of HVA before surgery	36.750±1.9	27.167±1.2	30.636±1.4
The average value of HVA after surgery	6.375±1.2	8.333±0.9	10.273±1.2
Average IMA before surgery	12.750±1.4	11.833±1.1	12.455±0.9
Average IMA after surgery	6.375±0.8	3.167±0.9	7.182±1.1
The average value of DMMA	19.625±1.2	18.167±0.9	19.273±0.9

before surgery			
The average value of DMMA after surgery	11.625±1.3	9.000±1.3	7.273±1.3

Table 1 shows that HVA angle correction, IMA of HV was the smallest for Bosh-Magnan osteotomy.

The most complete results of the surgical treatment of forefoot deformities are displayed by the AOFAS scale. AOFAS scores show that the results in all three groups of patients were “good”. No «excellent», «satisfactory», or «poor» results were found. However, it is worth noting that the average score on the AOFAS scale is higher in the first group (Scarf) and averages 86.0 points after surgery. In the second group (Austin), the average score was 78.0 after surgery, and in the third group (Bosh-Magnan), 75.3 points after surgery (Fig. 5)

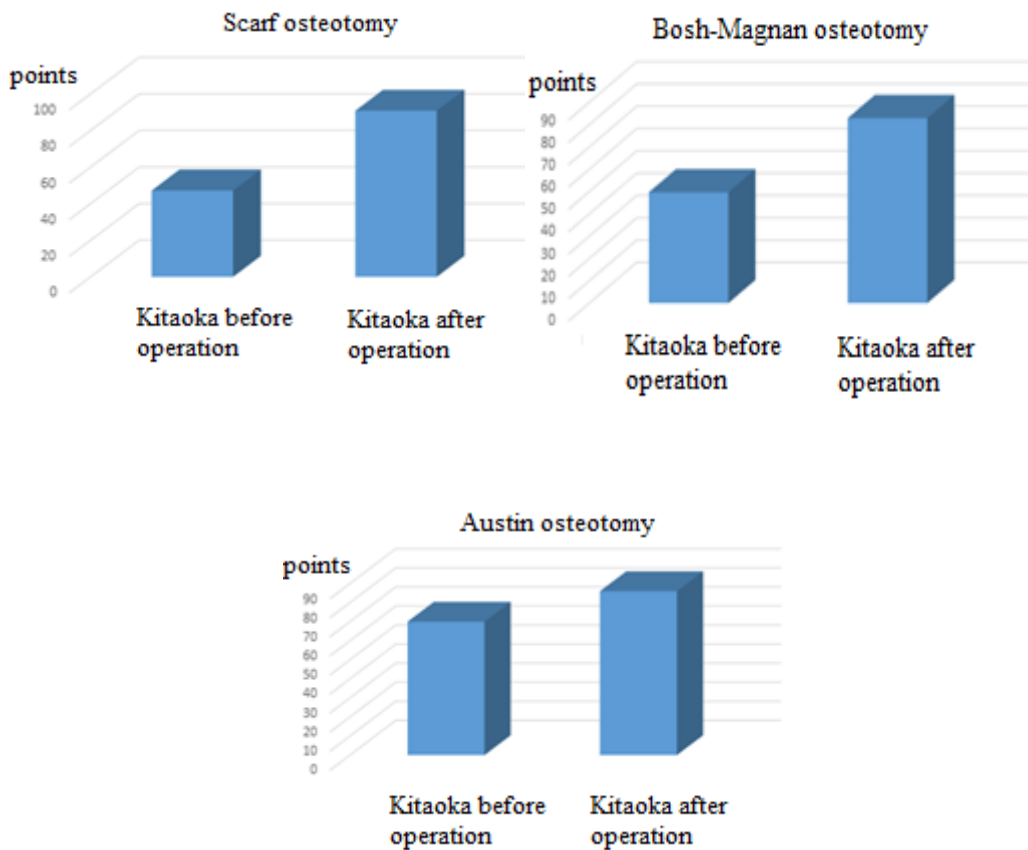


Fig. 5. Evaluation of functional results before and after osteotomy according to Scarf, Austin, Bosh-Magnan according to AOFAS scale (Kitaoka)

In this article, we also provide clinical examples for evaluating osteotomy outcomes.

Clinical example 1.

Patient K. ♀ 54 years old

Ds: Static deformation of the feet. Hallux Valgus III degrees. Central metatarsalgia.

Operation: Scarf osteotomy of the first metatarsal bone. Akin. DMMO 2-5. Percutaneous osteotomy of the main phalanx of 2 fingers.

Kitaoka score:92



Fig. 6. Clinical example Scarf Osteotomy

Clinical example 2.

Patient A. ♀ 56 years old

Ds: Static deformation of the feet. Hallux Valgus II degrees

Operation: Osteotomy by Bosch-Magnan. Percutaneous osteotomy of the main phalanx of 2 fingers.

Kitaoka score: 80



Fig. 7. Clinical example of Bosh-Magnan osteotomy

IV. Discussion

The data of the study are confirmed by the literature review. Distal osteotomy does not allow to correct the angle of valgus deviation of the first metatarsal bone, exceeding 15-16 degrees due to the fact that with a large displacement of the distal fragment of the first metatarsal bone, the plane of contact of the fragments significantly decreases and, as a result, stability. Therefore, with a greater deviation of the first metatarsal from the second, the most appropriate is the osteotomy of the diaphysis of the first metatarsal bone. The Scarf osteotomy technique has a number of significant advantages over other operations on the diaphysis of the first metatarsal bone: great correction possibilities, relative simplicity, relatively early rehabilitation, low percentage of complications [16].

Scarf osteotomy allows to normalize the main x-ray anatomical parameters of the axial relationship of the articular surfaces of the first ray of the foot, namely the angles HVA, IMA and DMMA [17].

Tight compression in the osteotomy zone provides stable fixation, which in turn allows to redistribute the load throughout the osteotomy zone. Performing a Scarf osteotomy allows an early load on the operated limb and makes it possible to perform operations on two limbs simultaneously [18].

V. Conclusion

When comparing the results of a clinical study and analyzing the results of surgical treatment of hallux valgus of the first toe, the methods used by Scarf, Austin, Bosh-Magnan revealed a significant advantage of the treatment results in the first group of patients operated on by the Scarf method. Scarf osteotomy achieves the highest HVA correction.

All participants was obtained verbal and written informed consent for the use of information in medical research.

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