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Hallux Valgus Correction With Rotational Scarf Combined With Adductor Hallucis Tendon Transposition

Anton V. Boychenko, MD, PhD[1,2], Leonid N. Solomin, MD[3,4], Maria S. Belokrylova, MD[5,6], Evgeny O. Tyulkin, MD[5,7], Denis V. Davidov, MD[8], Denis M. Krutko, MD[9]

[1] *Surgeon, Faculty of Medicine, Department of General Surgery, St. Petersburg State University, St. Petersburg, Russian Federation*
[2] *Surgeon, City Hospital No. 2, St. Petersburg, Russian Federation*
[3] *Professor, Faculty of Medicine, Department of General Surgery, St. Petersburg State University, St. Petersburg, Russian Federation*
[4] *Professor, Russian Research Institution of Traumatology and Orthopedics named after R.R. Vreden, Federal State Healthcare Organization, Ministry of Health of the Russian Federation, St. Petersburg, Russian Federation*
[5] *Associate Registrar, Faculty of Medicine, Department of General Surgery, St. Petersburg State University, St. Petersburg, Russian Federation*
[6] *Associate Registrar, Russian Research Institution of Traumatology and Orthopedics named after R.R. Vreden, Federal State Healthcare Organization, Ministry of Health of the Russian Federation, St. Petersburg, Russian Federation*
[7] *Associate Registrar, City Hospital No. 2, St. Petersburg, Russian Federation*
[8] *Professor, The Main Military Clinical Hospital named after N.N. Burdenko, Moscow, Russian Federation*
[9] *Associate Registrar, Faculty of Medicine, Department of Introductory Course of Internal Diseases, St. Petersburg State University, St. Petersburg, Russian Federation*

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ABSTRACT

Hallux valgus affects 23% of people older than 40 years, and there are hundreds of methods dealing with this pathology, which have their advantages and disadvantages. The aim of the present prospective cohort study was to report our experience in treating the patients with hallux valgus and to perform a comparative analysis of the outcomes of the innovative and standard methods of surgical correction. Data on 78 patients (113 feet) with hallux valgus operated on between March 2010 and December 2015 using either an innovative method, which included rotational scarf osteotomy with bone fragment impaction and adductor hallucis tendon reinsertion, or the classical scarf osteotomy were analyzed. X-ray examination was performed preoperatively and 3 and 36 months after the procedure. A comparative analysis of the outcomes between the groups was carried out. No significant difference in mean radiographic data ($p > .05$) was found between these 2 groups preoperatively and 3 months after surgery. Nevertheless, the mean intermetatarsal angle 36 months after surgery in standard and innovative groups was 9.7 ± 0.7° and 9.0 ± 0.8° ($p < .01$) and the mean metatarsophalangeal angle 13.6 ± 0.9° and 13.2 ± 1.1° ($p = .01$), respectively. The innovative method of surgical correction of hallux valgus was seen to produce improved radiographic results.

Lateral deviation of the big toe (hereafter hallux valgus) occurs in 23% of people older than 40 years, the majority of them being women (1). Over the past century, a huge number of methods have been proposed for the treatment of hallux valgus (2–4). The significance of metaphyseal-diaphyseal osteotomies for the treatment of various degrees of hallux valgus is quite considerable. One such method is the scarf, a Z-shaped first metatarsal osteotomy with the possibility of lateral translation of the plantar bone fragment and alteration of the length of the first metatarsal. The advantages of a scarf osteotomy result from the ability to redistribute the load across the whole area of the osteotomy, high stability, and consistent compression in the fracture zone, which permits early loading. Yet despite good functional outcomes (5,6), there are complications associated with this procedure, one of which is the phenomenon of "troughing" (7), the incidence of which, according to the data cited by various authors (8–10), can reach 35%.

Troughing occurs when dorsal fragment of the first metatarsal wedges in the plantar one, which leads to the elevation of the first metatarsal head, resulting in the overloading of the lateral rays. According to Murawski et al (10), using a rotational osteotomy makes it possible to reduce the probability of troughing, although there was no control group in this study. Meanwhile, Kilmartin and O'Kane (11) assessed the long-term results of rotational scarf osteotomy and noted that, alongside the absence of troughing, the incidence of hallux valgus recurrence reached 8%.

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Address correspondence to: Anton V. Boychenko, MD, PhD, City Hospital No. 2, Traumatology Department 194354, Uchebny pereulok 5, St. Petersburg, Russian Federation.
E-mail address: aboychen@yandex.ru (A.V. Boychenko).

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The question of the restoration of the muscle balance of the first metatarsophalangeal joint and its influence on the results of correction and the incidence of troughing remains a matter of debate. Several publications (12,13) suggest not limiting the procedure to adductor hallucis release and to supplement the osteotomy with fixation of the distal end of the tendon to the head of the first metatarsal. Havlícek et al (14), however, find that this method increases the probability of varus deformation development. Some authors report no advantages in adductor plasty (15). At the same time, Granberry and Hickey (16) and Vega and Jackson-Smith (13) argued that adductor reinsertion improves the radiographic results of osteotomies of the first metatarsal in patients with hallux valgus. Steck and Ringstrom (17) devoted particular attention to the combination of scarf osteotomy and tendon plasty (transferring the tendon of the adductor through the horizontal aspect of the osteotomy) for the prevention of troughing; their modification produced good short-term results: the absence of instances of troughing was noted.

The scarf osteotomy is one of the most popular and widely used methods of correcting hallux valgus owing to its predictably good clinical and x-ray results. The procedure does, however, also have several unresolved problems associated with it, such as troughing, and our article is devoted to tackling these problems. The primary aim of the present prospective cohort study was to find out whether a modified rotational scarf combined with adductor tendon transposition improves the radiographic outcomes of hallux valgus surgical correction compared with classical scarf.

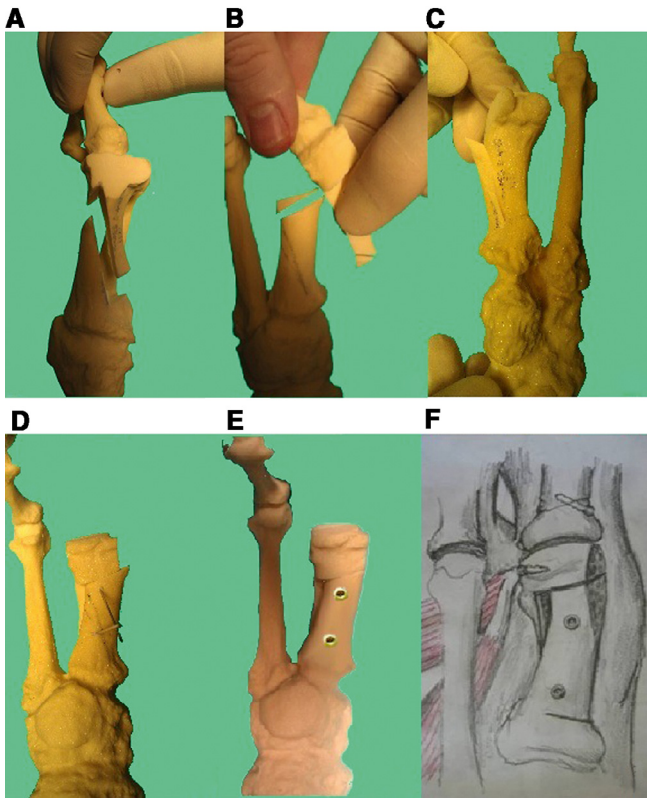

Fig. 1. Stages of the operation in the study group. (*A*) Standard Z-shaped osteotomy. (*B*) Wedge resection of the ends of the bone sections. (*C, D*) Rotation of the plantar fragment and head of the first metatarsal in the horizontal plane and its impaction into the medullary canal of the dorsal section (views from the plantar and dorsal sides). (*E*) Resection shaping of the inner edge of the dorsal section and fixation of the plantar and dorsal sections with screws. (*F*) Refixation of the previously abscised tendon muscle adductor hallucis to the head of the first metatarsal using an anchor.

Patients and Methods

Our prospective study was carried out between March 2010 and December 2015 and was approved by the institutional ethics committee. It comprised 2 stages: surgical correction of the hallux valgus (March 2010 through December 2012) and the results assessment (January 2013 through December 2015). Data were obtained for 113 consecutive instances of the surgical correction of hallux valgus performed by the senior author (A.V.B.) in 78 patients with a diagnosis of hallux valgus without serious accompanying pathology. Based on a pregiven effect size (0.5), we calculated using G Power (version 3.9.1.5), which we would need 102 samples to give 80% power to detect a significant difference between investigated groups (with a 1-sided type 1 error of 5% and a critical *t* value of 1.66).

All patients were female with a mean age of 49 years. They were divided randomly into 2 clinical groups—control and study—using a computer-generated list of random numbers. Patients in the control group (41 feet on 30 patients) underwent adductorotomy, lateral soft tissue release, a scarf osteotomy with lateral translation of the plantar fragment, and fixation in the corrected position with cannulated compression screws. Patients ranged in age from 32 to 65 years, with a mean of 49 years. In the study group (72 feet on 48 patients), patients ranged in age from 35 to 70 years, with a mean of 49 years. The method differed from that used in the control group as follows:

1. Wedge resections of the ends of the bone fragments after the Z-shaped osteotomy of the first metatarsal were performed, making it possible to obtain firm contact between the dorsal and plantar parts of the bone.
2. We rotated the plantar section and head of the first metatarsal in the horizontal plane with the lower medial angle of the plantar section impacting into the medullary canal and spongy tissue of the dorsal section of the metatarsal. The degree of rotation was determined from the initial value of the intermetatarsal angle (M1M2) by subtracting 7° (M1M2 − 7°).
3. We refixed the detached tendon muscle adductor hallucis to the head of the first metatarsal. For this purpose, an anchor of the original design can be used that allows the surgeon to stitch first through the tendon and then fix it to the anchor by pulling on that ligature; allowance is also made for altering the depth to which the anchor is sunk with the stretched tendon already attached to increase the amount of tension in the muscle (Fig. 1). Or a classic way, described by McBride (18), can be used.

In both groups, Akin osteotomies were performed when indicated in 80.4% of cases in the control group and 83.3% in the study group. Until consolidation of the fracture (4 to 6 weeks), all patients were allowed to walk using a Barouk shoe. Immobilization with a cast was not required.

All patients were examined before their operation and then 3 and 36 months after the surgical procedure by the assessor, who was not a member of surgical team (M.S.B.). Weightbearing x-rays of the foot were used to determine the first intermetatarsal and hallux valgus (M1P1) angles. All x-rays were reviewed and measured by a single independent blind assessor (the hospital's staff radiologist). The data were analyzed using Statis-

Table 1
Dynamics of the values for the first intermetatarsal angle and the hallux valgus angle

		Control Group (n = 41), Mean (95% CI), SD	Study Group (n = 72), Mean (95% CI), SD	*p*
Preoperation	M1M2	15.6 (15.1–16.1), 2.0	16.0 (15.5–16.4), 1.8	.05
	M1P1	39.3 (38.0–40.7), 5.3	39.0 (37.4–40.7), 7.1	.05
3 months	M1M2	8.3 (8.1–8.6), 1.0	8.2 (8.1–8.4), 0.7	0.05
	M1P1	11.7 (11.5–11.9), 0.8	11.9 (11.6–12.3), 1.5	.05
36 months	M1M2	9.7 (9.5–9.8), 0.7	9.0 (8.9–9.2), 0.8	.01
	M1P1	13.6 (13.4–13.8), 0.9	13.2 (12.9–13.4), 1.1	.01

Abbreviations: CI, confidence interval; SD, standard deviation.

tica 10.0.1011.0 software (Statsoft Inc., Tulsa, OK). The quantitative data are given as means ± root-mean-square deviation.

Results

Average values for the first intermetatarsal angle and the hallux valgus angle in the control and study groups are shown in Table 1. No significant difference ($p > .05$) between the 2 groups of patients was found either in the initial value of the first intermetatarsal angle and the hallux valgus angle or 3 months after the surgery. Subsequently, a tendency toward a certain regression in the results can be observed. Patients in the group that received the innovative surgical procedure displayed more stable results in the postoperative period: by the 36-month mark, the intermetatarsal angle had increased in the control group by 1.4° on average, whereas the corresponding figure for the study group was just 0.8° ($p < .001$).

Surgical treatment produced adequate correction of the hallux valgus angle in both groups, but an analysis of postoperational radiographs taken 36 months after the procedure showed that in patients of the study group, the hallux valgus angle had greater stability (increasing by 1.3°) than that of the control group (with an increase of 1.9°) ($p < .001$). Next, the number of patients with significant loss of reduction was estimated. The amount of feet 36 months after the intervention with M1M2 > 10 in the control and study groups was found to be 46.3% and 26.4%. We compared the proportions of feet with different values of the M1M2 angle using the chi-square test and found that the difference was statistically significant (2-tailed $p = .0391$).

Table 2
Incidence of complications in the patient groups

Complication	Control Group (n = 41)	Study Group (n = 72)	*P* Value
Surface infection	1 (2.1%)	3 (4.1%)	.05
1MTP joint stiffness	2 (4.2%)	4 (5.5%)	.05
Transfer metatarsalgia	2 (4.2%)	0	.05
Recurrence	2 (4.2%)	2 (2.7%)	0.05
Hallux varus	0	0	NA
Total	7 (17%)	9 (12.5%)	.05

Fig. 2. Photographs before (*A*) and after (*B*) surgery .

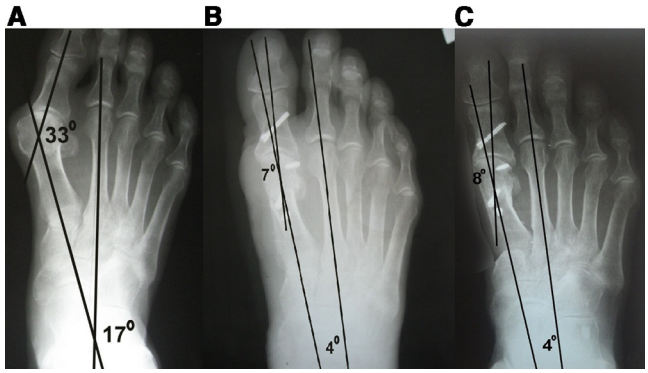

Fig. 3. (*A*) Preoperative anteroposterior radiograph and postoperative radiograph. (*B*) Three months after surgery. (*C*) Thirty-six months after surgery.

Complications

In total, complications occurred in 16 patients (14.2%) over the course of the study: 7 (17%) in the control group and 9 (12.5%) in the study group. The various complications are shown in Table 2. Overall, the incidence of complications after the operation was comparable in both groups and did not depend on the surgical technique; however, metatarsalgia was observed only in the control group. A clinical example of the use of the innovative method is shown in Figs. 2 and 3.

Discussion

The rotational scarf was described by Duke in 1992 and was supposed to take the place of closed wedge osteotomy (19). This modification was later supported by several authors (10,12,20), who showed that it prevents troughing and leads to decent functional and radiographic outcomes. However, medial rotation of the proximal part of the plantar fragment, described by those authors, results in a dramatic increase in the distal metatarsal articular angle measurement, which can be a limitation of the osteotomy. We propose to impact this fragment in the proximal metaphysis, which leads to first metatarsal head plantoflexion because of the contact of plantar and dorsal fragments distally.

Based on the assessment of the results of the study, we conclude that, in comparison to the method generally used, the correction of hallux valgus by the innovative method described did not lead to a significant improvement of functional results. However, the proposed method of surgical correction made it possible to achieve better function within 3 months of the operation. The average values of the first intermetatarsal angle and the hallux valgus angle after the surgical procedure were, in both cases, within normal limits and did not differ significantly, but in the 36 months of observation in the control group, these values increased compared with the study group.

Described loss of correction of the M1M2 angle by 9.8% in the control group and 16.8% in the study group may seem to be inappreciable; however, in practice, it means fewer patients with incomplete correction. The number of feet with an M1M2 angle > 10 in the control group 36 months after the operation was 1.75 times larger than in the study group. Similar results were shown by Shibuya et al (21). Overall reported loss of correction was 1.2° (hallux valgus angle increased from 14.2° to 15.4°), which resulted in 32% recurrences with the mean final hallux valgus angle of 24.0°.

Using the innovative method of correcting hallux valgus did not lead to an increased incidence of complications. The total number of complications was even lower in the study group, although that difference was not significant. Transfer metatarsalgia was registered only in the

classical scarf group and was the result of troughing, which was not observed in the study group.

A limitation of our method is that the technique entails a shortening of the first metatarsal, which may possibly restrict its use or require additional procedures on the lateral rays of the foot. Adductor hallucis tendon reinsertion requires an additional surgical approach, which may be a cosmetic issue. In addition, an increased distal metatarsal articular angle measurement must be taken into account when planning the surgery.

In conclusion, according to the data obtained, it is possible to reason that use of the innovative method makes it possible to retain to a greater degree the level of correction achieved and to speed up the process of restoration of function in the foot.

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