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Surgical treatment of severe valgus deformity of the first finger of foot for adults

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Treatment of static deformations of the forefoot with valgus deformation of the first toe remains relevant today. Objective. To analyze the results of surgery with severe hallux valgus using corrective proximal wedge-shaped osteotomy of the I metatarsal bone and corrective Lapidus arthrodesis. Methods. The results of surgical treatment of 104 women (147 feet) with severe hallux valgus according to the Mann classification were evaluated. Age — 27–65 years, follow-up period — from 10 months up to 5 years. Performed: 65 (56.0 %) cases — corrective proximal wedge-shaped osteotomy of the first metatarsal bone with fixation with LCP-plate or screws; 51 (44.0 %) — corrective arthrodesis of the first metatarsal-sphenoid joint with LCP-plate fixation. All patients underwent Schede operation and lateral release of the 1st metatarsophalangeal joint capsule with tenoadductorotomy. The results of treatment were evaluated on the basis of X-ray data and the AOFAS scoring scale. Results. After osteotomy of the I metatarsal bone in 58 (89.2 %) patients, the treatment result was classified as good, in 7 (10.8 %) — satisfactory. The improvement of the average score was 42 points. After the application of Lapidus arthrodesis, the treatment result was good in 47 (92.2 %) cases, satisfactory in 4 (7.8 %), improvement of the average score was 40 points. Conclusions. Under the conditions of surgical treatment of hallux valgus, the proximal corrective wedge-shaped osteotomy of the first metatarsal bone should in some cases be combined with the distal corrective osteotomy of the first metatarsal bone due to the increase in the PASA angle. The Lapidus arthrodesis technique allows to minimize possible relapses of the deformity, in contrast to traditional corrective osteotomies of the first metatarsal bone due to the formation of ankylosis of the metatarsal sphenoid joint, but has longer consolidation periods and risks of non-union.

Лікування статичних деформацій переднього відділу стопи з вальгусною деформацією першого пальця стопи залишається і на сьогодні актуальним. Мета. Проаналізувати результати хірургічного втручання пацієнтів із hallux valgus важкого ступеня з використанням коригувальної проксимальної клиноподібної остеотомії I плеснової кістки та коригувального Lapidus артродезу. Методи. Оцінено результати хірургічного втручання в 104 жінок (147 стоп) із hallux valgus важкого ступеня за класифікацією Mann. Вік — 27–65 років, час спостереження в післяопераційному періоді — від 10 міс. до 5 років. Проведено: 65 (56,0 %) випадків — коригувальна проксимальна клиноподібна остеотомія I плеснової кістки з фіксацією LCP-пластиною або гвинтами; 51 (44,0 %) — коригувальний артродез I плеснoклиноподібного суглоба з фіксацією LCP-пластиною. Усім пацієнтам виконано операцію Шеде та латеральний реліз капсули I плеснофалангового суглоба з теноаддукторотомією. Оцінювали результати лікування на підставі даних рентгенографії та за бальною шкалою AOFAS. Результати. Після виконання остеотомії I плеснової кістки в 58 (89,2 %) пацієнток результат лікування класифіковано як добрий, у 7 (10,8 %) —задовільний. Покращення середньої оцінки становило 42 бали. Після застосування Lapidus артродезу в 47 (92,2 %) випадках результат лікування добрий, у 4 (7,8 %) — задовільний, покращення середньої оцінки — 40 балів. Висновки. За умов хірургічного лікування hallux valgus проксимальну коригувальну клиноподібну остеотомію I плеснової кістки в деяких випадках слід поєднувати з дистальною коригувальною остеотомією I плеснової кістки, що обумовлено збільшенням кута PASA. Методика Lapidus артродезу дає змогу мінімізувати можливі рецидиви деформації на відміну від традиційних коригувальних остеотомій I плеснової кістки завдяки формуванню анкілозу I плеснoклиноподібного суглоба, але має довші терміни консолідації та ризики незрощення. Ключові слова. Лікування hallux valgus, коригувальна остеотомія I плеснової кістки, коригувальний артродез I плеснoклиноподібного суглоба, Lapidus артродез.

Key words. Treatment of hallux valgus, corrective osteotomy of the first metatarsal bone, corrective arthrodesis of the first metatarsal sphenoid joint, Lapidus arthrodesis

Introduction

The treatment of static deformations of the front part of the foot in the modern literature is given considerate attention, but the issue of correction of severe valgus deformations of the first toe remains relevant.

Most orthopedists use proximal osteotomy in significant (over 20°) varus deviation of the 1st metatarsal bone. It was first proposed by J. Balasescu [1].

In 1920 E. Juvara [2] developed the technique of proximal oblique wedge-shaped osteotomy of the first metatarsal bone; its line was directed at an angle of about 40° to the axis of the bone. Initially, the original technique involved resection of the trapezoid bone fragment, but later it underwent changes and by 1970, the Juvara osteotomy involved resection of the lateral wedge without crossing the medial cortical plate. The main problem when using this method was stable fixation of osteotomized bone fragments. Insufficient fixation resulted in secondary displacement and nonunion [3].

In 1923 J. Trethowan first described a proximal wedge-shaped osteotomy with a wedge opening to the inside [4]. The author predicted the displacement and submersion of the resected medial exostosis of the metatarsal head into the wedge-shaped defect that formed at the base of the metatarsal bone. This operation was modified by T. T. Stamm in 1957 [5], who proposed the use of a graft from the resected base of the proximal phalanx of the first finger (according to Keller). The problems that arose when using this technique are related to the artificial increase in the length of the first ray, and in the case of its initial excess length, the situation worsened, resulting in the recurrence of valgus deformity of the 1st toe. In addition, preservation of the lateral cortical plate prevents derotation of the 1st metatarsal bone.

In 1948 D. Logroscino developed the method of double osteotomy of the first metatarsal bone, when wedge-shaped bone fragments were resected from the head and base of the metatarsal bone. The main indication for the operation was significant M1/M2 deviation angles — the angle between the axes of the 1st and 2nd metatarsal bones. The Logroscino operation is a combination of methods proposed by Reverdin (1881), Loison and Balasescu (1902), and Trethowan (1923). Regarding this technique, there is still no unequivocal opinion among orthopedists, because most surgeons believe that the indications for performing this particular surgical intervention should be carefully understood [6].

An alternative for the correction of severe *hallux valgus* deformities can be arthrodesis of the medial sphenoid joint, which was proposed in 1934 by P. W. Lapidus [7]. The author described arthrodesis also between the bases of the 1st and 2nd metatarsal bones with correction of the soft tissue complex.

In 1989 B. J. Sangeorzan and S. T. Hansen published a report on 40 cases of arthrodesis of the metatarsal joint performed between 1979 and 1984 [8]. The main indication for the use of this technique was a significant varus deviation of the first metatarsal bone secondary to hypermobility of the first digit. In 75 % of cases, the authors obtained excellent and good outcomes, in 10 % cases arthrodesis was not performed, resulting in repeated interventions using bone autoplasty.

Additional indications for this operation are arthrotic changes of the medial metatarsal joint, osteopenia, as well as central metatarsalgia (round foot).

In recent years, more and more surgeons use arthrodesis of the metatarsal joint during the treatment of elderly patients with advanced stages of deformity. Complications after this technique are few and related to technical errors during joint resection or osteosynthesis. Strict adherence to the operation protocol allows to achieve favorable results in the absolute majority of cases [9–11].

If the final valgus deformity of the first toe persists after the proximal osteotomy of the first metatarsal bone or after Lapidus arthrodesis, then the corrective osteotomy of the main phalanx of the first toe, described by O. F. Akin in 1925 [12], is the operation of choice. It provided for a wedge-shaped osteotomy of the proximal phalanx of the first finger after a standard resection of the medial exostosis of the first metatarsal head. If necessary, derotation of the distal fragment of the phalanx was performed.

Today, several main options for surgery are proposed: wedge-shaped distal, cylindrical and wedge-shaped proximal, less often trapezoid resection of the main phalanx of the first toe. Wedge-shaped osteotomies are performed for angular correction with simultaneous shortening of the finger, and cylindrical osteotomies are done only to reduce the length of the toe, which is especially relevant in gallomegaly. Resection of the trapezoid fragment helps to achieve simultaneous shortening of the phalanges and angular correction. In all cases, derotation of the distal bone fragment is possible [13, 14].

Complications of osteotomy according to Akin include prolonged pain, swelling, delayed union, nonunion, hypercorrection (*hallux varus*), and correction with displacement in the sagittal plane [15].

Purpose: to analyze the results of surgical treatment of patients with severe *hallux valgus* using cor-

rective proximal wedge-shaped osteotomy of the first metatarsal bone and corrective Lapidus arthrodesis.

Material and methods

The materials of the study were discussed and approved at the meeting of the Bioethics Committee at the State Institution «Professor M. I. Sytenko Institute of Spine and Joint Pathology of the National Academy of Sciences of Ukraine» (Protocol No. 224 of 13.06.2022).

The study involved assessment of surgical treatment outcomes in 104 patients (147 feet) with severe *hallux valgus* who were operated on at the State Institution «Professor M. I. Sytenko Institute of Spine and Joint Pathology of the National Academy of Sciences of Ukraine». Among them, 22 patients (31 feet) were excluded from the study due to non-attendance at follow-up examinations and, accordingly, lack of results of follow-up examinations. All patients were female; their average age was 43 years and 10 months (from 27 to 65 years old). The average time of observation in the postoperative period was 29 months (from 10 months to 5 years).

Patients underwent standard clinical and X-ray examination [16]. Radiometric indicators included measurements of the M1/M2 intermetatarsal angle, the angle of valgus deviation of the first finger (M1/P1), the angle of inclination of the articular surface of the head of the first metatarsal bone (PASA — Proximal Articular Set Angle) [16]. The degree of *hallux valgus* severity was defined according to the Mann classification [17] as third (severe).

In 65 (56.0 %) cases, a corrective proximal closing wedge osteotomy of the first metatarsal bone with fixation with an LCP plate or screws was performed. Among them, in 14 (21.5 %) cases, a second distal (closing wedge) osteotomy of the first metatarsal bone was done with fixation with a screw or screws to restore the anatomical orientation of its distal articular surface (normalization of the PASA angle).

In 51 (44.0 %) cases, corrective arthrodesis of the first metatarsal joint with LCP-plate fixation was carried out.

In 26 (22.4 %) cases, corrective osteotomy of the main phalanx of the first toe according to Akin with screw fixation was additionally performed to correct residual valgus deformity of the first toe.

All patients underwent Schede's operation and lateral release of the capsule of the first metatarsophalangeal joint with tenoadductorotomy.

Treatment outcomes were evaluated based on X-ray data and the AOFAS scoring scale [18]. Statistical data were processed using the Pearson test.

Results and their discussion

According to the AOFAS scoring scale, after osteotomy of the 1st metatarsal bone, the treatment result was classified as good in 58 (89.2 %) patients, and satisfactory in 7 (10.8 %) patients. The improvement of the average grade was 42 points (Table 1).

After Lapidus arthrodesis in 47 (92.2%) cases, the treatment result was considered good and in 4 (7.8 %) satisfactory. The improvement of the average grade was 40 points (Table 2).

The average value of the intraoperative correction of the M1/M2 angle in patients after osteotomy of the first metatarsal bone was 13.5°, and at the time of the last control examination it had decreased to 10.3° (Table 1). An increase in the M1/M2 angle over time after correction of the deformity was associated with the further development of static deformity of the forefoot due to the neglect of signs of hypermobility of the metatarsal-cuneiform joint.

The amount of intraoperative correction of the valgus deformity of the 1st finger in patients after osteotomy of the 1st metatarsal bone was on average 41.4° (Table 1), at the time of the control examination, a decrease to 29.4° was noted. In 4 (6.2 %) patients, there was a partial recurrence of *hallux valgus* up to the size of the M1/P1 angle of 25°, caused by an increase in the M1/M2 intermetatarsal angle as a result

Table 1

Clinical and radiological evaluation of the results of surgical treatment in patients after corrective proximal osteotomy of the first metatarsal bone

Indicator	Before surgery	After surgery	Control examination
AOFAS, points	43 (37–45)	—	85 (62–92)
M1/M2 angle, degrees	21,2 (20–27)	7,7 (5–9)	10,9 (5–13)
M1/P1 angle, degrees	46,8 (40–58)	5,4 (2–8)	17,4 (3–21)
PASA, град.	10,4 (5–24)	11,8 (10–21)	12,1 (7–21)

Table 2

Clinical and radiological evaluation of the results of surgical treatment in patients after Lapidus arthrodesis

Indicator	Before surgery	After surgery	Control examination
AOFAS, points	42 (37–45)	—	82 (57–92)
M1/M2 angle, degrees	22,8 (20–29)	8,9 (6–11)	9,4 (7–12)
M1/P1 angle, degrees.	49,2 (40–61)	6,5 (2–10)	16,3 (5–22)
PASA, град.	11,9 (4–20)	11,7 (6–21)	13,4 (7–22)

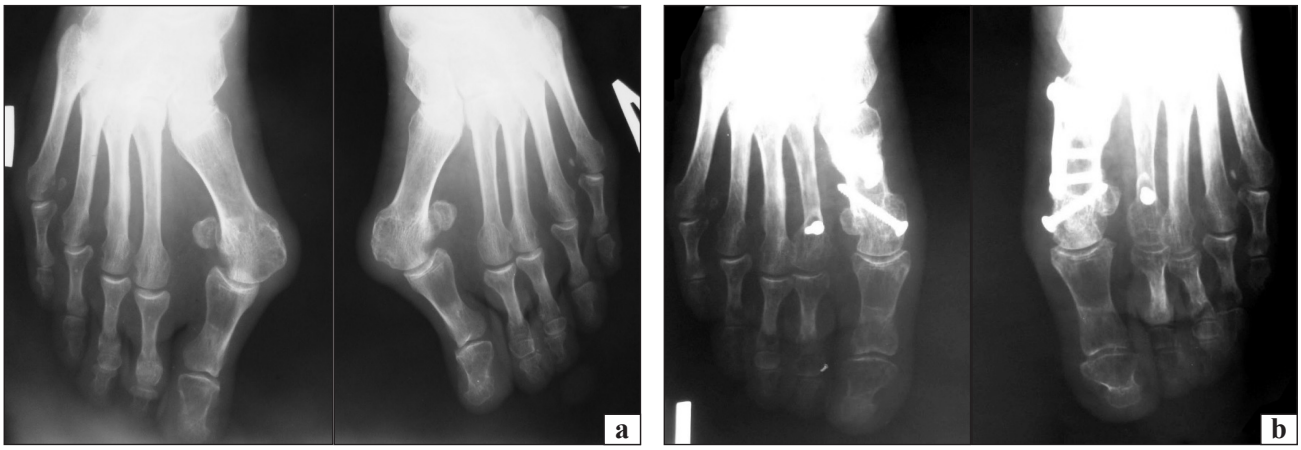

Fig. 1. Radiograms of the anterior part of the right foot of a 56-year-old patient D., anterior-posterior projection: before (a) and 2 years (b) after surgery

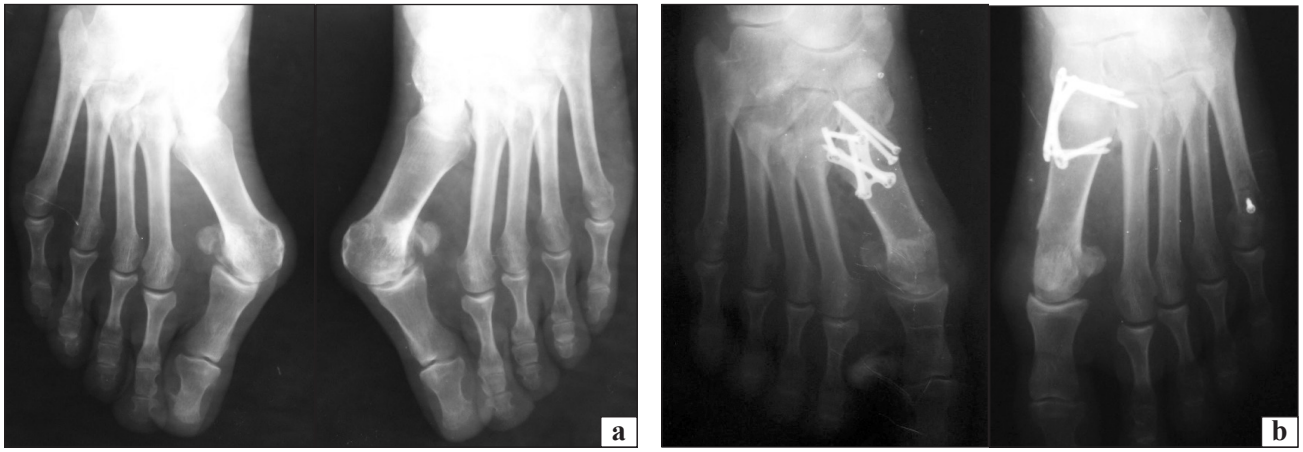

Fig. 2. Radiogram of the feet of a 32-year-old patient M., anterior-posterior projection before (a) and 2 years (b) after surgery

of the development of instability in the metatarsal-cuneiform joint.

14 (21.5 %) patients, after the corrective proximal wedge-shaped osteotomy of the 1st metatarsal bone, were intraoperatively found to have an increase in the PASA angle of various degrees, which was corrected by a second osteotomy of the 1st metatarsal bone in its distal part. At the time of the control examination, the PASA angle was 12.1°.

The average value of the intraoperative correction of the M1/M2 angle in patients after performing Lapidus arthrodesis was 13.9°, and at the time of the follow-up examination it was 13.4° (Table 2). Absence of loss of M1/M2 intermetatarsal angle correction in the long postoperative period was caused by ankylosis of the 1st metatarsal-cuneiform joint.

In patients after performing Lapidus arthrodesis, the value of the correction of the valgus position of the 1st toe was on average 42.7° (Table 2), in the distant postoperative period it decreased to 32.9°. In 2 (3.9%) patients there was a partial recurrence of *hallux valgus* up to the size of the M1/P1 angle of 25°, which was explained by the significant value of the initial deformation and insufficient intraoperative correction of the M1/M2 angle. At the same time, the patients were satisfied with the treatment result.

The average value of the change in the PASA angle in women who underwent Lapidus arthrodesis within the measurement error is presented in Table 2.

The average time for fusion of osteotomy zones of the 1st metatarsal bone was 7 weeks, and after corrective Lapidus arthrodesis it amounted to 12.

In 2 (3.9 %) cases, non-union was detected after performing Lapidus arthrodesis, which led to repeated surgical interventions.

Clinical example No. 1

A 56-year-old patient D. Diagnosis: transversely flattened deformity of the front part of the right foot, *hallux valgus* grade IV, AOFAS — 45 points. On X-ray: M1/M2 angle was 25°, M1/P1 — 53°, PASA — 24° (Fig. 1, a).

Surgical intervention: Schede's operation, lateral release, double wedge-shaped osteotomy of the 1st metatarsal bone, fixation with LCP plate and screw. Osteotomy according to Weil of the 2nd metatarsal bone (Fig. 1, b).

The clinical outcome of treatment according to the AOFAS scoring scale was 83 points. On X-ray: M1/M2 angle was 5°, M1/P1 — 16°, PASA — 7° (Fig. 1, b).

Clinical example No. 2

A 32-year-old patient M. Diagnosis: transversely flattened deformity of the front part of both feet, *hallux valgus* grade IV on two sides, Taylor's deformity of the left foot (Fig. 2, a). AOFAS — 45 points. On X-ray: M1/M2 angle on the right — 22°, on the left — 23°; M1/P1 angle on the right — 57°, on the left — 49°; PASA on the right — 16°, left — 18°.

Surgical interventions: Schede operation, lateral release, corrective Lapidus arthrodesis of both feet, fixation with H-shaped LCP plates. On the right foot, additional fixation of the arthrodesis zone was performed with two screws. Chevron V corrective osteotomy of the metatarsal bone of the left foot, screw fixation (Fig. 2, b).

The clinical outcome of treatment according to the AOFAS scale was 85 points. On X-ray: M1/M2 angle was 10° on the right, 10° on the left; M1/P1 angle on the right — 21°, on the left — 17°; PASA on the right — 10°, on the left — 12° (Fig. 2, b).

Conclusions

Corrective proximal wedge-shaped osteotomy of the 1st metatarsal bone and corrective arthrodesis of the 1st metatarsal-cuneiform joint is an effective method of treatment of severe valgus deformities of the 1st toe in adults.

In surgical treatment of *hallux valgus*, the proximal corrective wedge-shaped osteotomy of the first metatarsal bone should in some cases be combined with the distal corrective osteotomy of the 1st metatarsal bone due to the increase in the PASA angle.

Recurrences of *hallux valgus* after proximal osteotomy of the 1st metatarsal bone may be caused by an increase in the M1/M2 intermetatarsal angle in the distant postoperative period secondary to long-term static foot deformation and the development of instability in the 1st metatarsal-cuneiform joint.

Instability of the 1st metatarsal-cuneiform joint is an indication for Lapidus arthrodesis.

The Lapidus arthrodesis technique allows to minimize possible recurrences of the deformity in contrast to traditional corrective osteotomies of the 1st metatarsal bone due to the formation of ankylosis of the 1st metatarsal-cuneiform joint, but has longer consolidation times and risks of non-union.

Conflict of interest. The authors declare no conflict of interest.

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SURGICAL TREATMENT OF SEVERE VALGUS DEFORMITY OF THE FIRST FINGER OF FOOT FOR ADULTS

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