

FOREFOOT RECONSTRUCTION IN BRACHYMETATARSIA

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ABSTRACT

Background. Brachymetatarsia is a rare disease characterized by abnormal shortening of one or more metatarsal bones. The clinical picture is most often dominated by complaints of aesthetic dissatisfaction, as well as pain in the forefoot caused by mechanical dysfunction. A radical way to solve the problem is surgical treatment. **The aim of the study.** To demonstrate a rare clinical observation of a patient with bilateral brachymetatarsia of both feet.

Materials and methods. The article presents a case of stepwise treatment of a patient with bilateral brachymetatarsia with shortening of the III and IV metatarsal bones in combination with hallux valgus.

Results and discussion. According to the protocol, the patient underwent stepwise reconstruction of the forefoot of both feet with intervention on all five metatarsal bones. After all the rehabilitation measures, there was a complete restoration of all functions of both lower limbs after the surgery, and the patient was satisfied with the aesthetic result of the surgical treatment.

Conclusions. The obtained result of treatment of a patient with bilateral brachymetatarsia allows us to conclude that the use of this group of techniques is acceptable with the obligatory preoperative calculation of the necessary shortening and lengthening of the metatarsal bones, focusing on the parameters of the metatarsal formula of the forefoot, even in combination with other deformities.

Key words: brachymetatarsia, hallux valgus, forefoot deformity, surgical treatment

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РЕКОНСТРУКЦИЯ ПЕРЕДНЕГО ОТДЕЛА СТОПЫ ПРИ БРАХИМЕТАТАРЗИИ

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РЕЗЮМЕ

Введение. Брахиметатарзия – редкий порок развития, характеризующийся аномальным укорочением одной или нескольких плюсневых костей. В клинической картине чаще всего преобладают жалобы на эстетическую неудовлетворённость, а также на боли в переднем отделе стопы, вызванные механической дисфункцией. Радикальным способом решения проблемы является хирургический метод лечения.

Цель исследования. Продемонстрировать редкое клиническое наблюдение пациента с двусторонней брахиметатарзией обеих стоп.

Материалы и методы. В статье представлен случай этапного лечения пациентки с двусторонней брахиметатарзией с укорочением III и IV плюсневых костей в сочетании с вальгусным отклонением первого пальца.

Результаты и их обсуждение. Согласно протоколу, пациентке была выполнена этапная реконструкция переднего отдела обеих стоп с вмешательством на всех пяти плюсневых костях. По прошествии всех реабилитационных мероприятий произошло полное восстановление всех функций обеих нижних конечностей после операции, а также отмечена удовлетворённость пациентки эстетическим результатом выполненной операции.

Выводы. Полученный результат лечения пациентки с двусторонней брахиметатарзией позволяет сделать вывод о приемлемости использования данной группы методик с обязательным предоперационным расчётом необходимого укорочения и удлинения плюсневых костей, ориентируясь на параметры метатарзальной формулы переднего отдела стопы, даже в сочетании с другими деформациями.

Ключевые слова: брахиметатарзия, вальгусное отклонение I пальца, деформация переднего отдела стопы, хирургическое лечение

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INTRODUCTION

Brachymetatarsia is a rare malformation characterised by abnormal shortening of one or more metatarsal bones with disruption of the metatarsal parabola by more than 5 mm [1–3]. The incidence of this disease, according to the literature, ranges from 0.02 to 0.05 %; it develops more commonly in women, with a ratio of 25:1 [2, 4–6]. Brachymetatarsia results from stunted height or premature closure of the epiphyseal plate [7]. An underlying cause of this condition may be congenital, post-traumatic, post-infectious, iatrogenic or secondary to systemic disease such as malignancy, sickle cell anaemia, pseudohyperparathyroidism, Turner syndrome, Down syndrome, Apert syndrome, atresia or osteodystrophy.

The fourth metatarsal bone is affected in most cases, varying from 36 to 72 % of cases, resulting in bilateral pathology [1, 7, 8]. Complaints of aesthetic dissatisfaction as well as forefoot pain associated with mechanical dysfunction predominate in the clinical picture most commonly [9, 10].

The deformity usually manifests at the age of 5–7 years, gradually progressing with growth, and by the age of 12 years the shortening is 15–45 % of the metatarsal bone length [11].

Brachymetatarsia treatment can be either nonsurgical or surgical. Nonsurgical treatment includes wearing comfortable shoes; however, this does not solve the cosmetic problem. Various surgical treatments have been described: gradual lengthening distraction with external fixation apparatus (EFA) and single-step lengthening. No consensus currently exists concerning surgical treatment, however, as each treatment has its own advantages and disadvantages.

THE AIM OF THE STUDY

The article presents a case of stepwise treatment of a patient with bilateral brachymetatarsia with shortening of the III and IV metatarsal bones in combination with hallux valgus.

MATERIALS AND METHODS

Patient S., 21 years old. Was admitted to the clinic of Irkutsk Scientific Centre of Surgery and Traumatology for surgical treatment with the diagnosis: bilateral congenital brachymetatarsia. Absolute shortening of the III–IV metatarsal bones. Hallux valgus. Pain syndrome. The patient signed informed consent and authorisation for her data to be processed for scientific research.

From the patient's history: the patient considers herself sick since childhood, when at the age of 6 years, against the background of complete well-being, she first noticed shortening of the III and IV toes of both

feet. The shortening of the above-mentioned toes only progressed over time, and nonsurgical treatment had no proper effect. In addition to brachymetatarsia, in adolescence the patient developed hallux valgus of both feet, which by the time of hospitalization reached 35°, which in turn only aggravated the overall aesthetic defect and was an additional source of complaints. The combination of hallux valgus and brachymetatarsia required simultaneous intervention on all five metatarsal bones (Fig. 1, 2). Stepwise surgical rehabilitation was decided: first perform surgery on the right foot, then on the left foot.



FIG. 1.
Patient S. External view of both feet before the surgery (top view)



FIG. 2.
Patient S. External view of both feet before the surgery (front view)

PREOPERATIVE PLANNING

The original technique of L.G. Makinyan et al. was considered as the method of surgical intervention [12], developed for the treatment of brachymet-

atarsia of the IV metatarsal bone only, which implied increasing its length by free bone grafting with a cylindrical fragment taken from the neighbouring V metatarsal bone. Intramedullary fixation of both osteotomized bones using cannulated screws was performed. The size of the graft was determined so that the IV metatarsal bone was 3–5 mm shorter than the III metatarsal bone. The clinical observation described here was the shortening of two metatarsal bones (III and IV) at once, which required additional grafting from the II metatarsal bone to increase the length of the III metatarsal bone (Fig. 3).



FIG. 3.
Patient S. X-ray of the right foot before the surgery (anteroposterior view)

The required shortening/lengthening of the metatarsal bones is determined by the metatarsal formula: $I \leq II > III > IV > V$ [13], and in this example it was calculated that the required shortening of the II metatarsal bone and the required lengthening of the III metatarsal bone corresponds to 10 mm. Subsequently, the required shortening length of the V metatarsal bone and the required lengthening of the IV metatarsal bone was determined, which also corresponded to 10 mm. Considering the associated hallux valgus, it was necessary to determine

the length of the required shortening of the I metatarsal bone, equal to 10 mm.

SURGERY TECHNIQUE

Surgical intervention was performed using a pneumatic tourniquet in the lower third of the thigh. After three times treatment with antiseptic solution of the right foot with three projection incisions on the inner and dorsal surface, the metatarsal bones of the foot were accessed. Surgical treatment was initially performed to correct the hallux valgus, the standard steps of which were: medial exostectomy, release of the lateral aspect of the I metatarsophalangeal joint, and corrective scarf-osteotomy of the I metatarsal bone with a planned shortening by 10 mm. Bone fragments were fixed with a cannulated screw with a diameter of 2.5 mm and length of 22 mm. Additionally, an Akin osteotomy was performed on the first toe with fixation with a cannulated screw with a diameter of 2.5 mm and length of 22 mm.

Subsequently, from a separate 5.0 cm long projection incision in the second intertarsal space, access to the II–III metatarsophalangeal joint, proximal metadiaphysis of the II–III metatarsal bone was performed. Two transverse osteotomies of the II metatarsal bone were performed: the first one at the level of the distal metadiaphysis. To perform the second, a cylindrical graft was obtained by indenting 10 mm proximally and immersed in physiological solution. The fragments of the II metatarsal bone were juxtaposed and fixed with a cannulated screw. From the same accessible area at the level of the distal metadiaphysis, an osteotomy of the III metatarsal bone was performed, the fragments were separated along the axis, and a graft 10 mm long from the II metatarsal bone was inserted between them. Intramedullary fixation of all fragments of the III metatarsal bone with a cannulated screw was performed. Subsequently, from an additional 5.0 cm incision in the fourth intertarsal gap, access to the IV–V metatarsophalangeal joint, proximal metadiaphysis of the IV–V metatarsal bone was performed. Similarly, a cylindrical graft was harvested from the V metatarsal bone, measuring 10 mm. The fragments of the V metatarsal bone were juxtaposed and fixed with a cannulated screw. From the same accessible area at the level of the distal metadiaphysis, an osteotomy of the IV metatarsal bone was performed, the fragments were separated along the axis, and a graft 10 mm long from the V metatarsal bone was inserted between them. Intramedullary fixation of all fragments of the IV metatarsal bone with a cannulated screw was performed. Final control of osteosynthesis stability in osteotomized bones was performed, wounds were lavaged with antiseptic solutions; the wounds were sutured in layers (Fig. 4). Aseptic bandages were applied. Elastic bandaging of the lower extremities, immobilization of the right foot with an orthopaedic boot, and radiological control were performed (Fig. 5).



FIG. 4.
Patient S. External view of the right foot after the surgery



FIG. 5.
Patient S. X-ray of the right foot after the surgery (anteroposterior view)

POSTOPERATIVE CARE

According to the case management protocol after such surgeries, immobilization of the operated foot for 6 weeks in an orthopaedic boot with forefoot off-loading was recommended. No deviations in the patient's condition, clinical and laboratory parameters were observed during her treatment at the clinic, which allowed her to be discharged to the outpatient stage of treatment. The sutures were removed on the 14th day. After control X-ray radiography, immobilization was discontinued and walking was allowed with gradual increase of load, and courses of physiotherapy and lymphatic drainage massage were recommended. Suppression of postoperative oedema and restoration of foot bearing capacity allowed the patient to return to her normal lifestyle without any restrictions (Fig. 6, 7).



FIG. 6.
Patient S. External view of the right foot 1 year after the surgery

One year after the right foot surgery, the left foot surgery was performed according to a similar algorithm (Fig. 8–10).



FIG. 7.
Patient S. X-ray of the right foot 1 year after the surgery (anteroposterior view)



FIG. 9.
Patient S. External view of the left foot after the surgery



FIG. 8.
Patient S. X-ray of the left foot before the surgery (anteroposterior view)



FIG. 10.
Patient S. X-ray of the left foot after the surgery (anteroposterior view)

There were no abnormalities in the postoperative period as well, with restoration of left foot function (Fig. 11–13).



FIG. 11.
Patient S. External view of both feet: right foot – 2 years after the surgery, left foot – 1 year after the surgery (top view)



FIG. 12.
Patient S. External view of both feet: right foot – 2 years after the surgery, left foot – 1 year after the surgery (front view)



FIG. 13.
Patient S. X-ray of both feet: right foot – 2 years after the surgery, left foot – 1 year after the surgery (anteroposterior view)

RESULTS AND DISCUSSION

Brachymetatarsia is a rare congenital disorder in which there is absolute shortening of one or more metatarsal bones, with an incidence of only 0.05 % in the population [2, 4–6]. Shortening of the IV metatarsal bone is most often observed, and less often of the III metatarsal bone. The peculiarity of this clinical observation is shortening of both metatarsals on both feet, which is even rarer. Another feature was the combination of brachymetatarsia with hallux valgus, of which there are few references [14]. This phenomenon is not an aggravating factor, but increases the volume of surgical intervention. The surgical protocol for the treatment of patients with brachymetatarsia can be accomplished with two groups of techniques, which, without getting into the nuances, can be described as a one-stage increase in metatarsal length using auto-, allo-, or xenografts and fixation with spokes, screws, or plates, or as an increase in metatarsal length over time using EFA. Both of these groups seem to have their own advantages and disadvantages. However, the long period of fixation in EFA, a higher risk of infectious complications in the area of percutaneous elements, and limited mobility of the patient caused by difficulty in selecting and wearing shoes were significant arguments in choosing the treatment method.

CONCLUSION

A complete postoperative recovery of all the functions of both lower extremities, as well as satisfaction with the aesthetic result, allow us to conclude that it is acceptable to use this group of techniques with mandatory preoperative assessment of the necessary shortening and lengthening of the metatarsal bones, based on the parameters of the metatarsal formula of the forefoot deformity (anterior talipes), even in combination with other deformities.

Conflict of interest

The authors of this article declare no conflicts of interest.

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