



Hallux Valgus Deviation: Causes and Methods of Treatment

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Abstract

The purpose of this study is to test the minimally invasive method of surgical intervention with hallux valgus of the first toe in the elderly. The total number of operated and examined feet is 192 (182 in patients with bilateral valgus deviation and 10 with unilateral). The average age is 64.3±2.1 years. Overload on the first finger and the second and third metatarsal bones is completely absent after the operation, as well as overload on the first metatarsal bone ($p \leq 0.001$). The number of cases of overloads between the first finger and the first metatarsal bone in the postoperative period was halved ($p \leq 0.05$). In the proposed scheme of surgery, there is a significant improvement in the general condition of patients, in particular, biomechanical indicators of overload between different parts of the foot. After the operation, there was an increase in the longitudinal and a decrease in the transverse projection of the foot. Examination of the walking features of patients with bilateral hallux valgus showed the absence of pain after surgery, as well as a significant increase in the coefficient reflecting the rhythm of walking. This scheme of operation is simple in execution and methodology, and, at the same time, gives a positive result both in the short and long term. In addition, this operation is simple and cheap for patients compared to other methods of operations. The scheme of surgical intervention used on the head of the first metatarsal bone that we used allowed us to significantly improve the anatomical and biomechanical properties of the foot. The valgus deviation disappeared, gait parameters improved, and the load on both feet became more even. The consequence of the operation in the long term is a return to a normal lifestyle, wearing ordinary shoes, and an increase in physical activity. This type of surgery is most suitable for the elderly, as it is cheap and easy to perform, combined with a quick recovery.

Key words: *Hallux valgus, First toe, Metatarsal bones, Rhythmic walking, Biomechanical properties of the foot.*

Introduction

Violations associated with pathological changes in the motor and supporting functions of the foot can lead to not only disability, but also to disability [1]. As is known, among diseases of the musculoskeletal system, deformities associated with the fingers and toes can account for up to 9% of all cases [2, 3].

The number of cases of hallux valgus on the fingers and toes is quite large and varies widely in different groups of the population, from 1 to 80% of all cases of deformations of the musculoskeletal system [4, 5]. Hallux valgus deviation of the first toe can be found in varying degrees of severity in the majority of the population (within 20-65%) [6]. Signs of hallux valgus is intense pain, as well as a

clear deformation of one or more fingers [7, 8]. The consequence of this is the impossibility of wearing ordinary shoes that this person wore earlier, as well as a decrease in physical activity [9, 10]. Such widespread use determines the number of surgical interventions that reaches 250 around the world [11, 14].

At the same time, ubiquitous application found only 8-10 different methods [15, 17]. The urgent issue remains the price and time of such an intervention, which ultimately determines the effectiveness of the method of operation used [18, 19]. An operation for a patient with hallux valgus 1 toe should combine such characteristics as minimally invasiveness, cheapness and effectiveness.

For example, is greater efficiency in resection of the base of the phalanx or head of the metatarsal bone? What should be the volume of the resection and are the principles of bone preservation respected? The results of operations may have different meanings for segments of the population, for example, older people and young people whose life expectancy is much higher [20]. The operative method, however, remains the main method of normalizing motor activity in the long term and removing the hallux valgus deviation in the near term [21].

The process of rehabilitation and therapy with hallux valgus on the fingers of the extremities, including using surgical methods, remains relevant today. One of the priority tasks of postoperative rehabilitation is the restoration of biomechanical parameters and full motor activity of the patient [22]. Based on the foregoing, an urgent issue is the testing of surgical procedures with minimal consequences for the patient and maximum results of a return to physical activity in the postoperative period. A feature of this work is that we have selected elderly and senile age as a model group of patients.

This is due to the fact that this group accounts for the majority of cases of hallux valgus deviation of 1 toe, up to 75% of all cases of deviations [23]. This study is divided into 2 parts - the actual surgery, and postoperative rehabilitation, with the study of the changes that occurred in the parameters. The purpose of this study is to test a new minimally invasive method of surgical intervention with hallux valgus 1 toe in the elderly.

Material and Methods

Materials

The study was conducted in 2015-2019 on the basis of the orthopedic and traumatology department of the city polyclinic in Moscow, the Russian Federation. We analyzed the results of the clinic and the operation performed according to the new technique. Sample size, age and gender composition. The study included 101 people. Age ranges from 54 to 83 years, an average of 64.3 ± 2.1 years. The majority of the samples were women (Table 1), but no significant differences in age with men were found.

Table 1: Age and gender composition of patients

	Number of participants	Average age
Men	31	66.4±2.9
Women	70	62.2±2.0

Among the patients, almost all were admitted with hallux valgus on both feet (91 out of 101 people). The total number of operated and examined feet in this way was 192 (182 in patients with bilateral deviation and 10 with unilateral). During the initial diagnostics carried out by the orthopedist, the angle of the hallux valgus deviation ranged from 20-43 degrees. Moreover, the majority (88 patients) were diagnosed with

severe valgus deviation, with an angle of more than 21 degrees, that is, the third, most severe degree. Criteria for participation in the study. The study included patients who gave written informed consent to participate in the study and, in particular, to surgery according to the new method proposed by the authors of this article. The experiment involved patients with hallux valgus of the first toe (Fig. 1).

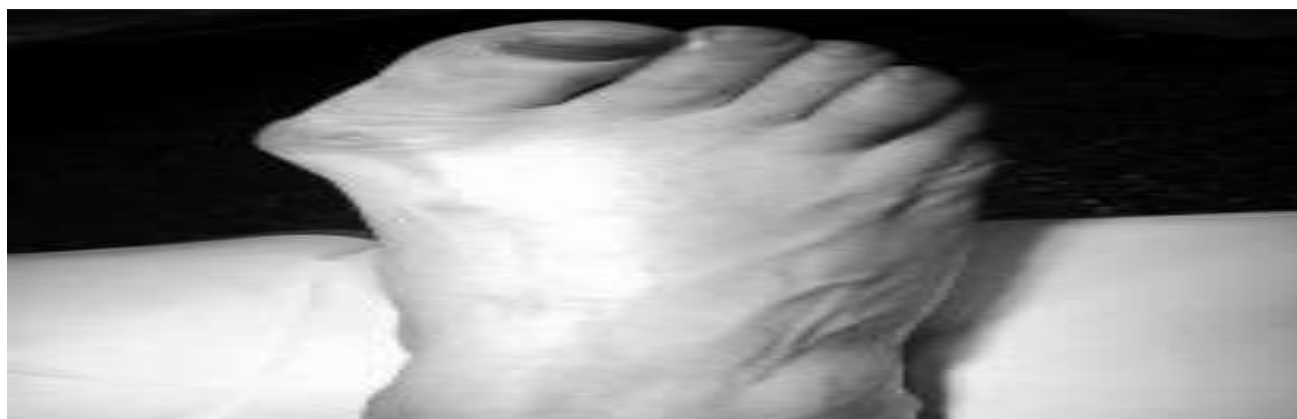


Figure 1: Photo of the right leg of a patient with hallux valgus

Exclusion criteria. This study did not include patients who had the following diseases. There are contraindications for surgical intervention, in particular, the presence of severe or local infection, the general condition of the patient that does not meet the standards for surgical intervention, and blood circulation below the norm in the area where the operation will be performed.

In addition to the above basic, there are secondary criteria for refusing surgical intervention: diseases of the cardiovascular system, various neurology (consequences of a stroke, etc.) as well as diseases of the musculoskeletal system of the lower limb, which led to the loss of its functioning. Also, patients who did not give written consent to participate in the surgical intervention of their own free will were not included.

Methods

Surgical Intervention

Patients underwent resection of the head of the first metatarsal bone with local anesthesia of the infiltration type, using a tourniquet. During the operation, an incision was made with a medical scalpel in the form of an arc, through the layers of the skin and fatty tissue. The incision was carried out in such a way as to obtain a bulge directed upward.

The beginning of the incision was on the side of the first metatarsal bone. In this case, the skin was separated so that it was directed in the form of a flap also upward. The extensor tendon of the first finger was sent to the holders. Bursa was excised so that the head of the first metatarsal bone was exposed. Then, using a linear incision in the medial plane, the first metatarsophalangeal joint was dissected. Then, the head of the first metatarsal bone was moved to the resulting wound. In this location, the medial part of the head was resected (Fig. 2).

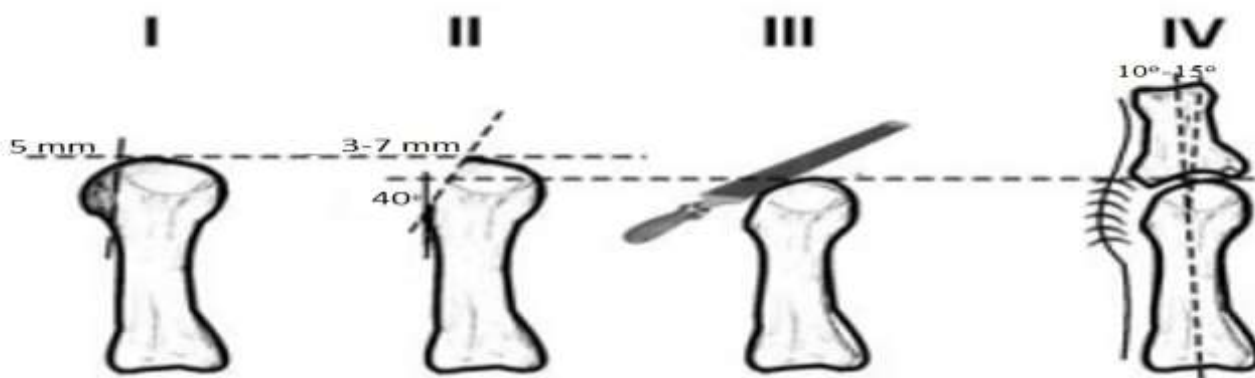


Figure 2: 4 stages of the sequence of resection of the head of the first metatarsal bone during surgery

This operation was carried out along with osteo-cartilaginous exostosis.

The displacement distance was 3.5-7.5 mm (Fig. 3b).

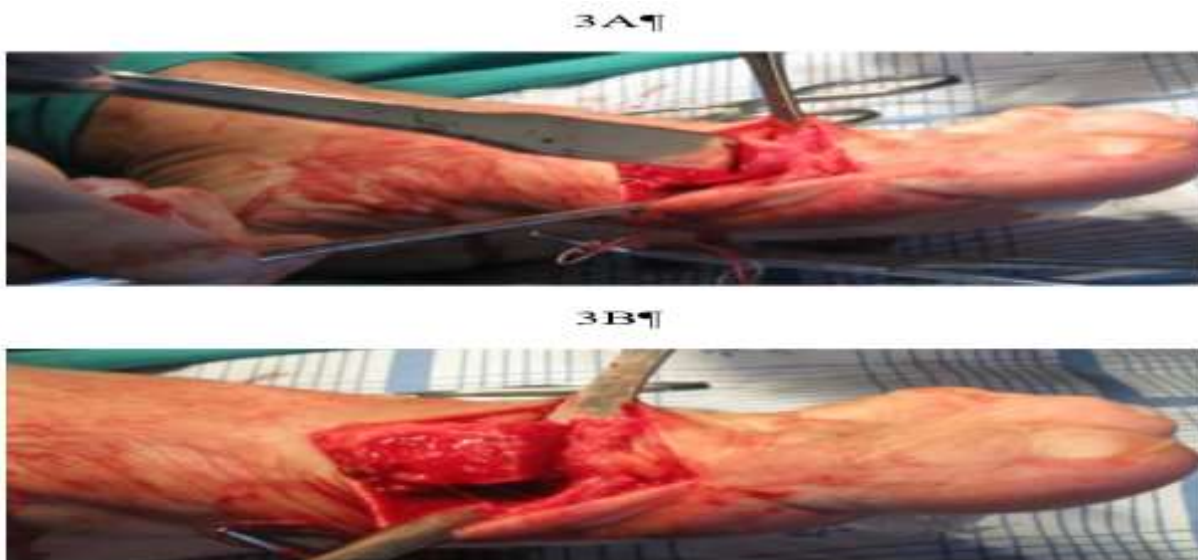


Figure 3: The operation processes. 3A - during the resection of the head of the first metatarsal bone, 3B - after the resection

Further, with the help of medical instruments (a chisel with a trench and a rasp), the head of the first metatarsal bone was processed from its lateral and lower surfaces. In the case of the growth of sesamoid bones to the metatarsal bone, they were separated. The joint capsule was attached to the periosteal part, while its edges were pulled together and, after that, the angle of the first finger was changed to values of 10-15 degrees using hypercorrection. The wound was completely sutured in all layers. At the end of the operation, an aseptic gauze bandage was applied so that it was fixed in the first interdigital space. This is necessary to correct 1 finger.

In the presence of a hammer-like deformation of the second and third fingers, which was found in some patients (41 people), resection of the heads of the main phalanges was performed. In this case, the articular surface was processed so that it had an oval shape and smooth structure. The postoperative period. After 2 days after the operation, patients were allowed to take an upright position and try to move with a partial load on the operated leg, with the passage of standard physiotherapeutic procedures. Starting from day 3, more active therapeutic gymnastics was prescribed. Sutures were removed 10-13 days after surgery, depending on the rate of wound healing.

After 14 days, patients were allowed to walk in shoes with a hard sole, as well as with a special insole close to the transverse arch of the foot. In the shoe there was also a gasket necessary for the hypercorrection of the first finger.

Postoperative Studies of Motor Activity

To study the motor activity of patients, the Kistler platform was used, connected to a conductive moving track. Such a setup makes it possible to evaluate the biomechanical parameters of walking associated with its power and temporal characteristics. For the temporal characteristics of walking, the coefficient of rhythmicity of walking was used, which in a healthy person is in the range of 0.95-1.0. Data on the reaction of the

support, which are displayed as the total load on the leg, were also taken into account. In this case, the load on both legs is expressed in 100%, but in the process of walking for each leg there may be different values, which is associated with the features of walking of a particular individual. We used a podograph (Novel firm), which recorded data on the load distribution under the foot. When stepping on the sensor, the magnitude of the support reaction was recorded, as well as the average and maximum pressure on the sensor, the size of the foot in longitudinal and transverse projections. Separately, surveys of the localization of sites with overload on the sole of the foot were carried out.

Values exceeding three standard deviations of the pressure value on the support corresponded to this. 2 years after the operation, the patients underwent studies in which the degree of pain, as well as the state of the axis of the first ray, the amplitude of movements in the joints of the phalanges, especially wearing shoes, as well as everyday activity were indicated by points. We used a scoring system proposed by AOFAS (The American Orthopedic Foot & Ankle Society). This organization includes surgeons of the foot and ankle joint, who developed for patients a point scale of postoperative assessment of results in the long term.

Statistical Analysis

For calculations used the program Past v. 3.0 the tables show the mean values, taking into account the standard error of the mean (Mean \pm SE). Differences between patient parameters before and after surgery are significant at $p \leq 0.05$; differing significance levels are discussed separately in the text. To calculate the differences between the parameters, the Fisher t-test was used. Part of the data is given in%, since, in our opinion, it better reflects the qualitative changes that occurred with patients in the preoperative and postoperative periods.

Results

The load distribution before and after the operation was proven to significantly differ (Table. 2).

Table 2: Indicators of the load in the preoperative period and after surgery (%)

Transshipment location	Preoperative period	Postoperative period
1 st finger and 2 nd , 3 rd metatarsal bones	22	0
2 nd to 3 rd metatarsal bones	53	81
1 st finger and 1 st metatarsal bone	14	7

1 st toe	0	7
1 st metatarsal bone	11	0
5 th metatarsal bone	0	5
Total	100	100

So, in the postoperative period, the number of patients with overload of the second and third metatarsal bones increased by half ($p \leq 0.05$), with a decrease in foot. The load was redistributed in such a way that it shifted from the first load on the medial part of the finger to the heads of the second and third metatarsal bones, with a rare displacement to the fifth metatarsal bone. Overload on the first finger and the second and third metatarsal bones is completely absent after the operation, as well as overload on the first metatarsal bone ($p \leq 0.001$). The number of cases of overloads

between the first finger and the first metatarsal bone in the postoperative period was halved ($p \leq 0.05$). Thus, in terms of loads in our proposed operation scheme, there is a significant improvement in the general condition of patients, in particular, biomechanical indicators of overload between different parts of the foot. In the period after the operation, there was an increase in the response rate for the support by 0.5 times (Table 3, confidence levels are also given in the table), as well as the average pressure in the postoperative period.

Table 3: Anatomical characteristics of the foot in the pre- and postoperative period

Indicators	Preoperative period	Postoperative period	Significance level of differences, $p \leq$
Support reaction	369±10	419±13	0.01
Average pressure per cm ²	2.7±0.1	3.3±0.1	0.05
Maximum pressure per cm ²	17.5±1.9	18.3±2.0	0.2
Longitudinal projection of the foot (in cm)	23.7±0.3	24.2±0.2	0.05
Transverse projection of the foot (in cm)	9.01±0.10	8.79±0.20	0.01

We associate this with an increase in body weight, as well as with a significant improvement in walking performance, as well as with the anesthetic effect after surgery. The maximum pressure indicators did not undergo significant changes. This is due to the fact that the lowering of the metatarsal bones in the direction of the sole has not changed. The observed significant increase in the longitudinal projection of the foot is associated with the operative correction of the hallux valgus deviation of the first toe

and the hammer-like deformation recorded in the second toe. In connection with the correction of cartilaginous exostosis, there was a decrease in the transverse projection of the foot. The result of the operation is an increase in the longitudinal and a decrease in the transverse projection of the foot. An examination of the walking features of patients with bilateral hallux valgus showed the absence of pain after surgery, as well as a significant increase in the coefficient reflecting the rhythm of walking (Table 4).

Table 4: Changes in power and time parameters of walking

Characteristics	Preoperative period	Postoperative period	T
Rhythm of walking, coefficient indicators	0.91±0.02	0.96±0.01	2.0
Leg pressure with hallux valgus (%)	48.5±0.9	49.4±1.1	2.5
Standing Load (%)	49.3±0.8	49.2±0.9	0.8

When walking, there was an increase in the load on the operated leg, which led to greater symmetry of the gait. At the same time, significant differences in standing before and after surgery were not observed. This is due to the fact that when standing, the main load falls not on the forefoot, where the operation

was performed, but on the back. An improvement in the condition of patients in the long term was recorded. After 2 years, in patients under 60 years of age, the condition improved by 14 points, while in patients over 60 years of age - twice as many points (at $p \leq 0.05$, Table 5).

Table 5: Results of scoring after 2 years

Age	Preoperative period	Postoperative period
Under 60	80	94
Over 60	41	83

From this we can conclude that the proposed operation is more effective for people over 60 years of age. At the same time, the final result - the number of points scored was higher in patients under 60 years of age. Most of them began to wear regular shoes and increased physical activity. For older patients, a change in lifestyle for the better was more noticeable, due to their lower social needs

Discussion

The choice of treatment tactics for hallux valgus deviation of the first toe may depend on the severity of the deviation, in particular on the angle of inclination of the head of the first metatarsal bone [24]. The favorable outcome of operations depends on the magnitude of this angle. Larger values suggest mandatory surgery [25]. On the other hand, for mild degrees of hallux valgus, physiotherapeutic procedures, such as psammotherapy, also show a positive result [26].

A hallmark of the hallux valgus is the presence of pain, the inability to wear standard shoes, difficulty in movements and their amplitude. All this can ultimately lead to a decrease in the quality of life, permanent disability [27]. Given the mass nature of this disease, a negative economic effect on society as a whole is also possible. Age-related features can have different consequences during surgery with a diagnosis of hallux valgus deviation of the first toe.

So, in young people, resection of the head of the first metatarsal bone is ineffective, because they have higher social requirements than older people. This includes faster rehabilitation after surgery, as well as a quick return to the usual way of life and the rhythm of physical activity [28]. As regards the resection of the metatarsal head resection used by us for elderly and senile individuals, there are differing opinions, up to the inefficiency of this operation [29]. This is due to some side effects, in particular, to the deterioration of the functioning of the first ray of the foot. At the same time, there is an

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opinion that partial resection of the head of the first metatarsal bone is more effective than resection of the phalanx of the first finger [30]. For the treatment of hallux valgus in the elderly and senile, there are a number of features [31]. These include the anatomical and functional age-related changes that occur in the foot, for example, deforming osteoarthritis of the small joints of the metatarsus and phalanx. There is a shift in the main load on the lateral edge of the foot, as well as a violation of the blood supply to the lower extremities.

Another characteristic feature is the observed rigidity of the foot deformity [32]. The operation scheme we tested is simple in execution and methodology, and, at the same time, gives a positive result both in the short and long term. For people of advanced and senile ages, who often cannot receive full medical care due to their low solvency, this operation is suitable because it combines simplicity (which allows a large number of operations) and low cost.

Conclusions

The scheme of surgical intervention used on the head of the first metatarsal bone used by us significantly improved the anatomical and biomechanical properties of the foot. The valgus deviation disappeared, gait parameters improved, and the load on both feet became more even. The consequence of the operation in the long term is a return to a normal lifestyle, wearing ordinary shoes, and an increase in physical activity. This type of surgery is most suitable for the elderly, as it is cheap and easy to perform, combined with a quick recovery.

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