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## Physical therapy is an integral part of the surgical treatment of valgus deformity of the first toe

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*Objective.* Determining the effectiveness of physical therapy in the surgical treatment of valgus deformity of the first toe. *Methods.* The clinical material of the conducted study includes 38 observations, 34 patients (38 operative interventions, 4 patients — on 2 feet. In the control group (CG) there were 16 patients (16 interventions), and in the main group (MG) — 18 patients (22 interventions). All patients who participated in the study had the same diagnosis — hallux valgus II–III degree. All patients received the same type of surgical intervention — a variant Z-shaped osteotomy of the first metatarsal bone according to the Scarf method or Chevron, which was supplemented with osteotomy of proximal phalanges of the I finger to Akin method. Patients were examined with the Visual-Analogue Scale (VAS), the Physiotherapy Clinical Outcome Variables (COVS) Motor Skills Testing Scale, and the American Orthopedic Foot and Ankle Society (AOFAS) Scale (module 2) for the Clinical Evaluation of Foot and Ankle Diseases of the American Foot and Ankle Association. Rehabilitation of MG patients consisted of developed physical therapy (PT) program, which included 4 periods. Rehabilitation included not only massage and exercises for the muscles of the front part of the foot, but also a complex of rehabilitation methods aimed to restore the function of the muscles of both lower limbs, hips and buttocks. PT program for KG consisted only of morning hygienic gymnastics, classical massage and therapeutic exercises to restore function of muscles of the foot and lower leg. *Results.* Assessment of the condition of patients after the end of PT on the COVS scale helped to conclude that the patients of MG have significantly better indicators of general physical activity than patients of CG. Analysis of the obtained results according to the (AOFAS) Scale confirmed that patients of MG after using developed PT program have statistically better results. *Conclusions.* The developed PT program significantly accelerate the clinical recovery of function not only the front part of the foot, but also general working capacity of patients.

*Мета.* Визначення місця та ефективності фізичної терапії в хірургічному лікуванні вальгусної деформації I пальця стопи. *Методи.* Клінічний матеріал проведеного дослідження включав 38 спостережень, 34 пацієнта (38 оперативних втручань, 4 пацієнта — на 2 стопах). У контрольній групі (КГ) було 16 пацієнтів (16 втручань), а в основній групі (ОГ) — 18 пацієнтів (22 втручання). Всі пацієнти, які приймали участь у дослідженні, мали однаковий діагноз — hallux valgus II–III ступеня та отримали однотипне оперативне втручання — варіант Z-подібної остеотомії I плеснової кістки за методикою Scarf або Chevron, яка доповнювалась остеотомією проксимальної фаланги I пальця за Akin. Пацієнти обстежені за допомогою декількох шкал: візуально-аналогової (ВАШ), тестування рухових навичок та American Orthopaedic Foot and Ankle Society (AOFAS) (module 2). Метод математичної варіаційної статистики використовувався під час обробки отриманих результатів. Пацієнтам ОГ застосовані реабілітаційні заходи за розробленою програмою фізичної терапії (ФТ), яка включала 4 періоди. До реабілітації входили не лише масаж і гімнастичні вправи для м'язів переднього відділу стопи, але й комплекс методик, спрямованих на відновлення функції м'язів обох нижніх кінцівок із захватом стегон і сідниць. Програма ФТ для КГ складалася лише з ранкової гігієнічної гімнастики, класичного масажу та лікувальної гімнастики м'язів стопи та гомілки. *Результати.* Оцінювання стану пацієнтів після закінчення ФТ за шкалою COVS допомогло зробити висновок, що проведення програми ФТ пацієнтам ОГ сприяло отриманню значно кращих показників загальної фізичної працездатності, ніж в осіб КГ, у яких покращення результатів тесту не підтвердилося статистично. Аналіз отриманих результатів за шкалою AOFAS підтвердив, що в пацієнтів ОГ після застосування розробленої програми ФТ клініко-функціональний стан переднього відділу стопи статистично став кращим. *Висновки.* Ця програма ФТ дозволила значно прискорити відновлення клініко-функціональних показників не лише переднього відділу стопи, але й загальної працездатності. *Ключові слова.* Стопа, деформація I пальця, хірургічне лікування, фізична терапія.

**Keywords.** Foot, deformity of the first toe, surgical treatment, physical therapy

## Introduction

The main task of the conducted research is to determine not only the clinical and functional condition of the foot of patients who underwent an operation for *hallux valgus* deformity, but also their working capacity in general, with a further assessment of the effectiveness of the use of a physical therapy (PT) program.

The foot plays an important role in a person's life, professional and household activities, and sports. All its departments receive large static and dynamic loads related to support and movement. Functional disorders of the foot lead to significant limitations of the quality of life. Treatment of patients suffering from foot deformities continues to be a rather difficult problem of modern medicine and its component — orthopedics [1].

Any deviations in the anatomical structure of the foot lead to a violation of the load on its various departments, which cause a disorder of its functions and further development of various deformations [2].

One of the most common foot deformities is *hallux valgus*. Quite often, it has a combination with hammer-like deformation of the 2<sup>nd</sup> toe and lumbar flattening of the foot in the front part. According to information from the publications of various scientists, this pathology is diagnosed in adults under the age of 65 — in 15–25 %, after 60 — in almost 40 %. *Hallux valgus* deformity is 3–4 times more common in women than in men [3, 4].

Improvement of the methods of surgical treatment of patients with *hallux valgus* is relevant due to the significant prevalence of this disorder and a rather high percentage of dissatisfaction with the results of traditional treatment [5].

But in addition to surgical intervention, as the experience of a number of scientists shows, rehabilitation measures play a significant role in shaping the final result of treatment, which doctors often do not pay due attention to at all stages of the patient's stay in the hospital [6].

The few scientific studies on the operative treatment of *hallux valgus*, which contain data on the peculiarities of postoperative rehabilitation (hereafter we use the more modern term “physical therapy”), do not have sufficient scientific justification and systematicity [7]. This fact determines the necessity and relevance of research in this direction.

*Purpose:* to conduct an analysis of the long-term results of the use of the developed physical therapy under the conditions of surgical treatment of *hallux valgus*.

## Material and methods

The study was discussed and approved at the meeting of the Bioethics Committee of the State Establishment Professor M. I. Sytenko Institute of Spine and Joint Pathology of the National Academy of Sciences of Ukraine (Protocol No. 220 dated 18.11.2021).

The clinical material of the conducted research included 38 observations, 34 patients (4 subjects on 2 feet). There were 16 patients (16 interventions) in the control group (CG), and 18 cases (22 operations) in the main group (OG). Consent to participate in the study was obtained from all patients. In both groups, the age limits varied from 45 to 65 years, the average age was 55 years, the vast majority — 50–55 years (29 subjects, 76 %). Patients of both groups, for the most part, are of working age, which indicates the great social importance of the problem.

All patients who participated in the study had the same diagnosis — 2<sup>nd</sup>–3<sup>rd</sup> degree *hallux valgus* and received the same type of surgical intervention — a Z-shaped osteotomy of the first metatarsal bone according to the Scarf or Chevron method, which was supplemented with an osteotomy of the proximal phalanx of the first finger according to Akin [8].

They were assessed using the Visual Analogue Scale (VAS), the Physiotherapy Clinical Outcome Variables (COVS), and the American Orthopedic Foot and Ankle Society (AOFAS) Forefoot Clinical Assessment Scale (module 2) of the American Foot Orthopedic Association and Supracalcaneal joint.

Quality of PT with regard to the impact on pain syndrome was assessed with the VAS, which is a method of subjective pain assessment, used by most researchers of this issue. Simplicity and convenience are its undoubted advantages [9].

Taking into account that the definition criteria were the rapid recovery of functional capabilities not only of the front part of the foot, but also of the patient's working capacity as a whole, we used the COVS scale. It reflects indicators of general mobility that are used when assessing the functional consequences of a musculoskeletal injury in various settings (acute, inpatient/outpatient rehabilitation, and community settings). The COVS test consists of ten tasks and is evaluated with points from one to seven [10].

To characterize the clinical and functional state of the forefoot, we used the generally recognized AOFAS scale (module 2), which sums up the indicators of pain, function, and adaptation of the foot to a flat surface [11].

During the study, the degree of pain syndrome was assessed according to the VAS and motor skills were tested according to the COVS and AOFAS tests before and after the PT program, under the conditions of surgical treatment of *hallux valgus*.

The methods of mathematical variational statistics obtained during the research were used for data processing. They were compared by gender, age and volume of treatment of patients in both groups for scientific analysis.

The developed PT program for OG patients with *hallux valgus* included 4 periods in which different PT methods were used and different times of their use:

1 period — preoperative, its duration — 7–10 days. PT methods: hydrokinesiotherapy — thermal foot baths (water temperature 40 °C — 25–30 min) with active and passive finger movements; preparation of the skin of the foot; selection of an orthosis (Boruk orthosis-shoe) (Fig. 1) and teaching the patient to use it [12];

2 — early postoperative, its duration — 10–12 days. The first 2 days after the intervention — a high position of the operated limb, periodic cold compress on the foot. PT methods: kinesiotherapy — passive movements in the toes, active movements in the calcaneal-shin and knee joints, isometric tension of the shin and thigh muscles. Magnetotherapy. From the 3<sup>rd</sup> to the 4<sup>th</sup> day, dosed walking in Boruk shoes is recommended;

3 — late operative (outpatient), its duration — 15–18 days. PT methods: continuation of physical therapy — passive movements of the toes with independent soft development of movements in the finger joints and gradual transition to active movements (from 25–28 days after the intervention), active movements in the joints of the lower limb, walking in Boruk shoes. Lymphatic drainage massage. UHF



Fig. 1. Boruk orthosis-shoes

therapy and laser therapy to relieve swelling, reduce pain, and stimulate immunity;

4 — restorative (ambulatory), its duration — 15–25 days. PT methods: therapeutic gymnastics for the toes (holding small objects with the toes) and the calcaneus joint, along with elements of hydrokinesiotherapy (warm baths). Classic massage. From 40–45 days after the intervention, the use of everyday shoes with custom-made insoles is allowed.

PT program for CG patients involved a traditional set of measures, which consisted of morning hygienic gymnastics, classical massage, therapeutic gymnastics to strengthen the muscles of the foot and lower leg.

## Results

After completion of PT program (2.5 months after surgery), control testing of the patients' condition was performed.

The initial indicators of the first test of pain intensity in OG persons were ( $6.4 \pm 1.1$ ) cm according to VAS, and ( $5.9 \pm 1.3$ ) cm in CG. The difference did not reach a statistically significant level ( $p > 0.05$ ).

After PT program, the second pain intensity test according to VAS gave the following results, and in both groups of patients, the pain syndrome became less statistically significant ( $p < 0.05$ ). However, in OG patients it was ( $1.2 \pm 0.2$ ) cm, which was statistically significantly less ( $p < 0.05$ ) than in CG patients — ( $2.8 \pm 0.3$ ) cm (Table 1, Fig. 2).

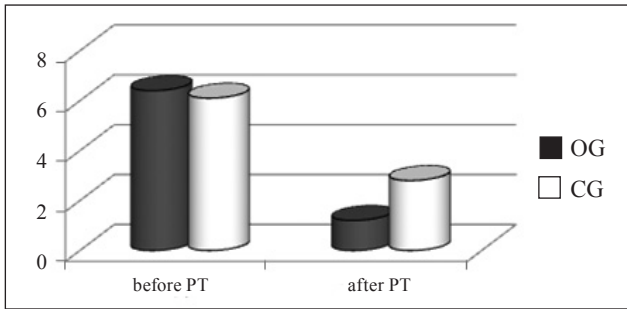
The analysis of the results of re-assessment of the condition of patients after the end of FT according to the COVS scale helped to conclude that the implementation of the FT program in OG patients contributed to obtaining significantly better results than in CG patients (Table 2, Fig. 3). Thus, in OG after FT the average indicator was ( $78.5 \pm 0.2$ ) points (before FT  $63.4 \pm 0.3$ ) ( $p < 0.05$ ), and in CG patients — ( $69.8 \pm 0.4$ ) score (to FT  $62.9 \pm 0.3$ ) ( $p > 0.05$ ). Therefore, in CG, the improvement of the test results was not statistically confirmed.

Assessment of COVS indicators showed that PT program resulted in an improvement of the level of functional skills and self-care ability of patients of both groups according to the COVS scale, but in OG patients they were statistically better than in CG patients ( $p < 0.05$ ).

After the completion of the program, an analysis of indicators was carried out according to the AOFAS scale. The total values according to the AOFAS scale (module 2) improved in patients of both groups ( $p < 0.05$ ), but when comparing the data between the groups, it was noted that the results were statistically better in OG patients than in CG patients (Table 3, Fig. 4).

**Table 1**  
**Time course of pain syndrome indicators in patients of both groups (cm)**

Group	Before PT	After PT	Statistical indicator in groups
OG (n = 18)	6.4 ± 1.1	1.2 ± 0.2	p < 0.05
CG (n = 16)	5.9 ± 1.3	2.8 ± 0.3	p < 0.05
Statistical indicator between the groups	p < 0.05		



**Fig. 2.** Comparative chart of pain intensity indicators on the VAS scale in patients of both groups (mm)

**Discussion**

One of the problems of orthopaedics today is the operative treatment of *hallux valgus* and subsequent rehabilitation of patients. For both orthopedists and physical therapists, the most important thing in this process is the quality of the surgical treatment and subsequent rehabilitation, as well as the time spent to obtain a positive result.

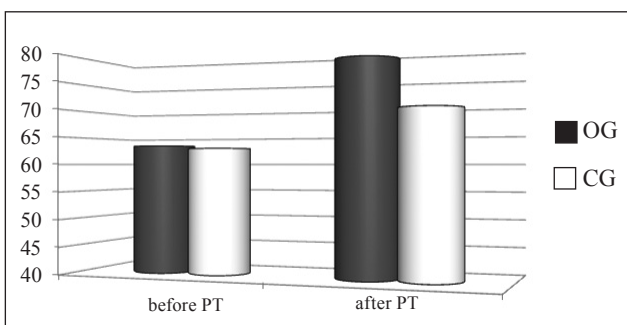
Analyzing the modern professional literature, we found out that today there are no uniform approaches to both *hallux valgus* surgery and rehabilitation methods after surgery. In general, specialized doctors are more concerned about surgical treatment methods than the issue of postoperative rehabilitation of patients, which is clearly shown in published sources [13]. The authors focus on surgical techniques and pay very little attention to recovery in the postoperative period, they write: “proper postoperative recovery, maintenance and protection of soft tissues of the foot with the help of special soft insoles

**Table 2**  
**Dynamics of indicators for assessing the level of functional and self-care skills of patients of both groups (scores)**

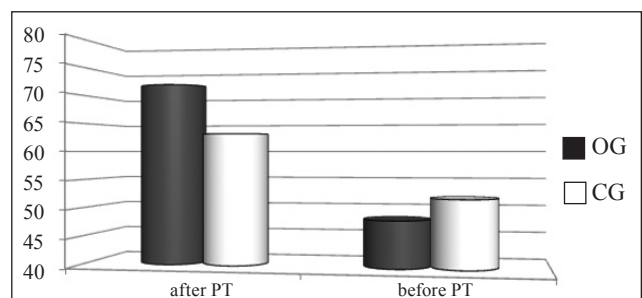
Test	Indicator			
	OG before PT (n = 18)	OG after PT (n = 18)	CG before PT (n = 16)	CG after PT (n = 16)
Sum of points (norm 83)	63.4 ± 0.3	78.5 ± 0.2	62.9 ± 0.3	69.8 ± 0.4
Statistical indicator in groups	p < 0.05		p > 0.05	
Statistical indicator between groups	p < 0.05			

**Table 3**  
**Time course of the total indicators of clinical and functional state of the forefoot of patients of both groups on the AOFAS scale (module 2) (points)**

Test	Indicator			
	OG before PT (n = 18)	OG after PT (n = 18)	CG before PT (n = 16)	CG after PT (n = 16)
Sum of points (norm 100)	48.2 ± 0.4	71.8 ± 1.2	51.9 ± 0.5	63.1 ± 2.4
Statistical indicator in groups	p < 0.05		p < 0.05	
Statistical indicator between groups	p < 0.05			



**Fig. 3.** Comparative diagram of indicators on the COVS scale in patients of both groups (scores)



**Fig. 4.** Comparative diagram of indicators of the clinical and functional state of the forefoot of patients of both groups according to the AOFAS scale (module 2) (points)

improved the further course of operated *hallux valgus*”. Effective return to active life and professional activities of patients can occur if the existing traditional PT methods are systematized into programs and supplemented with new technologies in order to accelerate and improve the quality of recovery processes.

We have developed and tested a complex PT program, which involves not only massage and gymnastic exercises for the muscles of the front part of the foot, but also has a whole complex of rehabilitation techniques aimed at restoring the function of the muscles of both lower extremities involving the hips and buttocks. It was divided into 4 periods — preoperative, early postoperative, late postoperative, and recovery. These periods included rehabilitation techniques — kinesiotherapy, hydrokinesiotherapy, different types of massage, and hardware physiotherapy methods.

In both groups of patients, the pain syndrome became less statistically significant ( $p < 0.05$ ). However, it is almost 2 times lower in OG patients than in CG patients. Assessment of the condition of patients after the end of PT according to the COVS scale helped to conclude that the implementation of PT program in OG contributed to obtaining significantly better indicators of general physical performance than in CG, in which the improvement of the test results was not statistically confirmed. The analysis of the obtained results according to the AOFAS scale also proved that the clinical and functional state of the forefoot was statistically better in OG patients after using the developed PT program than in CG patients. The developed PT program made it possible to significantly improve the clinical and functional indicators of not only the front part of the foot, but also the general mobility of OG patients.

Schuh R. et al. [14] and Polastri M. [15] provided the results of an analytical review of a large number of studies on this issue and stated that only 8 papers included the issue of postoperative rehabilitation, but they were about the use of kinesiotherapy: “postoperative rehabilitation, for the most part, is focused on stimulating both plantar pressure on the first beam and joint mobility”. In addition, some authors recommend: “to carry out sufficient mobilization, manual therapy, strengthening exercises for the joints of the lower limb and gait training”. It is also noted that: “terms of postoperative rehabilitation may vary depending on the surgical technique and be performed in an outpatient setting using appropriate footwear”. Concluding the discussion of the study, it can be stated that the developed complex program

of physical therapy is orderly (4 periods), includes various methods and does not contradict previously published findings.

## Conclusions

The complex PT program for patients with *hallux valgus* developed and applied in clinical conditions is a high-quality complex method of rehabilitation of such individuals. It makes it possible to significantly speed up the recovery of clinical and functional indicators not only of the front part of the foot, but also of the general working capacity of patients.

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

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## PHYSICAL THERAPY IS AN INTEGRAL PART OF THE SURGICAL TREATMENT OF VALGUS DEFORMITY OF THE FIRST TOE

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