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OPTIMIZATION OF DIAGNOSTIC AND TREATMENT METHODS FOR PEDIATRIC FLATFOOT

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Abstract

Relevance. Flatfoot is a common orthopedic pathology in children, leading to gait disturbances, pain syndrome, and joint disorders. The lack of a unified approach to diagnosis and treatment necessitates the development of a comprehensive method that includes orthopedic correction, biochemical monitoring, and pharmacological support.

Objective. To evaluate the effectiveness of a comprehensive treatment for flatfoot in children, considering clinical and biochemical changes.

Methods. The study (2014–2024) included 88 children aged 1–14 years. Clinical, instrumental (X-ray, podometry, electromyography), and laboratory (urine analysis for glycosaminoglycans and oxyproline) methods were used. The main group received comprehensive treatment (plaster correction, physiotherapy, therapeutic exercises, massage, orthopedic insoles, pharmacotherapy), while the comparison group received traditional treatment.

Results. Grade II flatfoot was diagnosed in 52.3% of children, with the peak incidence at ages 4–7 (67.0%). Before treatment, glycosaminoglycan and oxyproline levels were elevated but normalized after therapy. Complete arch restoration was achieved in 66.0% of the main group compared to 36.2% in the comparison group. Instrumental methods confirmed improved biomechanics, and electromyography showed increased muscle tone.

Conclusion. The comprehensive treatment method significantly outperforms traditional approaches, especially in children aged 4–7 years. Its implementation will enhance therapy effectiveness and reduce the risk of complications.

Keywords: Flatfoot, children, orthopedic correction, biochemical monitoring, physiotherapy, glycosaminoglycans, oxyproline, rehabilitation, electromyography, prevention.

Introduction

Flatfoot is one of the most common orthopedic conditions in children, significantly affecting the musculoskeletal system and quality of life. Foot biomechanics disorders lead to gait abnormalities, rapid fatigue, pain syndrome, and may eventually cause joint pathologies in the lower limbs and spine. Despite the widespread nature of this issue, clinical practice still lacks a unified approach to early diagnosis and comprehensive treatment of this condition [1,3,5,9].

Traditional treatment methods for flatfoot include orthopedic insoles, therapeutic exercises, and massage. However, their effectiveness is limited in severe cases of deformity. Modern research

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highlights the need for a comprehensive approach that not only includes mechanical foot correction but also considers the biochemical aspects of pathogenesis related to connective tissue metabolism. In particular, changes in the levels of glycosaminoglycans and hydroxyproline in urine indicate collagen metabolism disorders, which require pharmacological correction and the use of biologically active substances [2,10].

Furthermore, the use of plaster casts in severe cases of flatfoot requires further improvement, considering possible side effects such as muscle atrophy, bone demineralization, and disruption of foot biomechanics. Optimizing immobilization duration and methods, as well as subsequent rehabilitation using physiotherapeutic techniques, remains a relevant area of scientific research [4,7].

Thus, the development and implementation of a comprehensive treatment method, incorporating orthopedic correction, biochemical monitoring, and pharmacological support, represent an important task in modern pediatric orthopedics. Conducting this study will not only enhance the effectiveness of treatment for children with flatfoot but also contribute to the development of new preventive measures aimed at avoiding complications in the future [8].

Research Objective

To develop and evaluate the effectiveness of a comprehensive treatment method for flatfoot in children, considering clinical and biochemical changes, to improve correction outcomes and prevent complications.

Materials and Methods

The study was conducted from 2014 to 2024 in medical and educational institutions, including the clinic of the Tashkent Pediatric Medical Institute. A total of 88 children aged 1 to 14 years with varying degrees of flatfoot were included. Clinical, instrumental, and laboratory methods were applied.

The clinical examination included the analysis of complaints, visual inspection, assessment of gait, foot biomechanics, and the severity of the deformity. Radiography was performed in two projections to determine angular parameters of the foot. Plantography and podometry were used to assess load distribution and calculate Friedland's index. Biochemical studies involved urine analysis for glycosaminoglycans and hydroxyproline using spectrophotometry. Electromyography was used to evaluate the tone and activity of foot and lower leg muscles.

The patients were divided into two groups. The main group (88 children) received comprehensive treatment, which included plaster correction (15–30 days), physiotherapy (paraffin applications, electrical stimulation, coniferous and salt baths), therapeutic exercise (TE), massage, orthopedic insoles, and pharmacological support (vitamins D3, B6, and calcium supplements). The comparison group (94 children) received traditional treatment, which consisted of therapeutic exercise, massage, and orthopedic insoles.

Statistical analysis included the calculation of mean values (M), standard deviation (m), Student's t-test, and correlation analysis. The study was conducted in compliance with ethical standards, with informed consent obtained from parents.

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Study Results

The results showed that the most common form of flatfoot in children was Grade II, diagnosed in 52.3% of patients. Grade I was found in 26.1% of children, while Grade III was observed in 22.7%. A gender-based analysis demonstrated that boys were more frequently affected than girls (57.9% vs. 42.1%), which may be due to greater physical activity and increased foot load.

Age distribution revealed that the highest incidence of flatfoot occurred in the 4–7-year-old group (67.0%), indicating a critical period for foot arch formation. Flatfoot was observed in 13.6% of children aged 1–3 years and in 19.3% of those aged 8–14 years, confirming the need for early diagnosis and timely correction.

Biochemical urine analysis before treatment revealed significant connective tissue metabolism disorders, manifested by elevated levels of glycosaminoglycans (GAG) and hydroxyproline. GAG concentrations exceeded the norm by 39.2% in boys and 51.7% in girls aged 1–3 years, by 64.7% and 51.2% in children aged 4–7 years, and by 62.8% and 72.9% in the 8–14-year-old group, respectively. The level of hydroxyproline in urine was also above normal by 24.5% in children aged 1–3 years, by 26.3% in those aged 4–7 years, and by 39.4% in children aged 8–14 years, indicating collagen fiber degradation.

After comprehensive treatment, most patients showed a significant reduction in GAG and hydroxyproline concentrations, indicating normalization of connective tissue metabolism and strengthening of the foot ligamentous apparatus. In the group that received only traditional therapy, such pronounced changes were not observed.

Clinical analysis of treatment effectiveness demonstrated that the comprehensive approach provided significantly better outcomes compared to traditional therapy. Complete restoration of the foot arch was achieved in 66.0% of patients in the main group, whereas in the comparison group, this rate was 36.2%. Improvement to Grade I was recorded in 17.0% of patients, to Grade II in 6.8%, while 10.2% showed no significant changes. In the group receiving traditional treatment, improvement to Grade I was observed in 24.4% of patients, 12.8% remained at Grade II, and 26.6% showed no positive dynamics.

The age-based analysis demonstrated that the best treatment outcomes were achieved in children aged 4–7 years, with full recovery recorded in 69.5% of cases, compared to 64.7% in the 8–14-year-old group. This finding highlights the high adaptability of connective tissue in younger children. Among children aged 1–3 years, the most significant biochemical normalization was observed; however, clinical treatment outcomes were less pronounced due to the ongoing development of the musculoskeletal and ligamentous system, requiring prolonged adaptation.

Instrumental diagnostic methods confirmed the effectiveness of the proposed approach. Radiographic analysis demonstrated a reduction in the longitudinal arch angle and normalization of the talocalcaneal joint in the main group, where the deformation angle decreased by 12–18%, indicating the restoration of proper foot biomechanics. Podometry and plantography showed a significant reduction in load on the medial foot and improved pressure distribution, suggesting enhanced ligamentous stability. Electromyography revealed increased functional activity of foot and lower leg muscles, reduced fatigue, and prolonged load retention time, indicating strengthened muscular support and restored shock-absorbing function of the foot.

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Thus, the comprehensive treatment of flatfoot in children demonstrated high effectiveness, ensuring not only the elimination of clinical symptoms but also the normalization of connective tissue metabolism, reducing the risk of further disease progression and complications. The most pronounced therapeutic effect was observed in children aged 4–7 years, emphasizing the necessity of early diagnosis and timely correction. The combination of plaster correction, physiotherapy, therapeutic exercises, pharmacological support, and orthopedic insoles yielded significantly better results compared to traditional methods, confirming the need for an integrated approach in pediatric flatfoot therapy.

Conclusion

The study results confirm the high effectiveness of a comprehensive approach in the diagnosis and treatment of pediatric flatfoot. Grade II flatfoot is the most common, with peak prevalence occurring between 4 and 7 years of age, indicating a critical period for foot arch formation. Biochemical studies revealed significant connective tissue metabolic disorders, reflected in elevated levels of glycosaminoglycans and hydroxyproline, indicating collagen structure degradation.

Comprehensive treatment, including plaster correction, physiotherapy, therapeutic exercises, pharmacological support, and orthopedic insoles, resulted in complete foot recovery in 66.0% of children, compared to 36.2% in the traditional therapy group. The best outcomes were observed in children aged 4–7 years, confirming the necessity of early diagnosis. Instrumental methods revealed a reduction in foot arch deformity, decreased medial foot load, and restored gait biomechanics. Electromyography demonstrated improved muscle function, tone, and resistance to stress. Biochemical indicators normalized, indicating strengthened connective tissue and reduced degenerative changes.

The obtained data support the recommendation of the proposed method as the most effective, especially for younger children. The implementation of a comprehensive approach in orthopedic practice will enhance treatment effectiveness, reduce relapse risk, and improve patients' quality of life.

Findings

The comprehensive approach to diagnosing and treating pediatric flatfoot demonstrated high effectiveness, ensuring foot deformity correction and normalization of connective tissue metabolism. Grade II flatfoot is the most common, with peak prevalence at 4–7 years, emphasizing the necessity of early diagnosis. Biochemical studies revealed increased levels of glycosaminoglycans and hydroxyproline, indicating collagen structure degradation.

Comprehensive therapy, including plaster correction, physiotherapy, therapeutic exercises, pharmacological support, and orthopedic insoles, led to complete foot arch restoration in 66.0% of patients, compared to 36.2% in the traditional treatment group. The best outcomes were achieved in children aged 4–7 years, confirming their high adaptability. Instrumental methods demonstrated a reduction in longitudinal arch angle, restoration of gait biomechanics, and decreased medial foot load. Electromyography recorded increased muscle tone and stress resistance. Biochemical indicators normalized, indicating strengthened connective tissue.

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The obtained data confirm that the comprehensive treatment method surpasses traditional approaches, not only eliminating clinical manifestations but also preventing disease progression. The developed methodology can be recommended for widespread use in pediatric orthopedics.

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