DIAGNOSTIC CRITERIA OF FLATFOOT AND WAYS OF REHABILITATION THERAPY IN CHILDREN

Computer, roentgenologic, myographic, podometric, biochemical studies in 1427 children from 1 to 14 years old in 182 cases revealed the flatfoot; it had a straight proportional dependence from age and sexual differences. Suggested differential diagnostic table allows in short time to mark out the level of flatfoot on the base of taken results. Being reflected in scores, taken results are summed up, and, by general total, the level of flatfoot is determined.

Determination of oxiproline (collagen element) in urine serves as the confirmation of involution connective tissue at flatfoot. According to age changes of connecting tissue, a complex of conservative treatment, including physiotherapeutic means, TPE, plaster of Paris bandage, balneologic treatments, wearing insoles in shoes, taking multivitamin drugs, are offered.

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Introduction

Analysis of studies on flat feet in children shows that the given disease makes 12% in general pathology of osseous tissue and demands for improving diagnostics and correction (Kuchma, 2004). Due to the multifaceted problem of flat feet and its developing in a variety of forms, the problem must be solved at an early age (Yemelyanov and Strokina, 2007; Volkov and Dedov, 1980; Davidova et al., 2006).

Two directions appeal to be important in studying of the problem: a) timely diagnosis of prenosological deviations of health (risk group); and b) substantiation of medical rehabilitation appointments correcting actions (Nechvolodova and Shugalov, 1996; Belkevich and Gujanovsky, 1992).

At modern stage of development of orthopedics enough attention is paid to the problem of flatfoot disease, new multifunctional tools for the diagnosis and treatment of patients are carried out. The given interest of specialists promotes detailing of pathological manifestations and development of better diagnostic and therapeutic methods. Previously used methods are being replaced the more physiological and effective ones (Abdukodirov et al., 1989). Early revealing of flatfoot and coordination of taking therapeutic measures by adjacent specialists is one of the foremost among variety of means and ways to improve efficacy in diagnosis and treatment. The issue of the most promising direction remains fundamentally importan (Ivanov and Rilova, 2004; Yemelyanov and Strokina, 2007).

Bilateral pathological process, change the functions of muscles and ligaments, dysplastic disorders, changes in biomechanics of the musculoskeletal systemimpose strict requirements of the diagnostic and therapeutic nature. In such a context, the aim of the study appeals to diagnosis of flatfoot and ways of rehabilitation treatment.

Materials and methods

The study was conducted among 1427 children aged 1 year to 14 years, of which12.8% of cases (182) showed flatfoot signs of varying degrees. The incidence of disease was observed mainly in males - 100 children (54.9%), 82 to girls (45%).The incidence of flat feet (64.8%) is concentrated in children of 3-7 years of old.

Determining the flatfoot level required using the methods of computer plantography, myography, podometry (measurement of foot dome height, length, width, level pronation, abduction, adduction with the following calculation of Fridland (1960) index), and roentgenography. Biochemical studies included study of oxiproline in urine (colorimetric method) before and after taking treatment.

Results of discussion

Flatfoot in children was noted using generally accepted classification, results of computer plantography, podometry, and roentgenography.

Methods of computer plantography were used along with general accepted ways (examination, podometry, plantography, roentgenography, and electromyography). With this technique there were determined the length, large and small width of the foot in standing and sitting positions. Special computer program was used to interpret the received results and calculate flat feet degree for the right and left foot.

TABLE 1. PROGNOSTIC CLINICAL AND DIAGNOSTIC CRITERIA FOR DEGREE OF OF FLAT FEET

№	Clinical signs	Flatfoot		
		Mild level I	Middle severe level II	Severe level III
1	Foot length	According to age	According to age	According to age
2	Width of frontal transverse	Middle	Enlarged	Very interred
3	Width of back transverse	Middle	More than middle	Inclined
4	Height of foot dome	Middle	Reduced	Very reduced
5	Angle of dome inclination	300-400	150-300	00-150
6	Angle of sole inclination	50-100	100-200	20-300
7	Angle of ankle joint	1000-1800	1300-1500	1500-1800
8	Movement in joint arch supporting	Full	Some limited	Limited
9	Pain	Not	Severe	Constant
10	Reddening of sole	Not	Yes	Very noticeable
11	Fast fatigue	At long walk	Intermitted	Constant
12	Gait	Straight	Some unsteady	Steady
13	Change of bearing	Not changed	Forced	Bearing reduced
14	Correction with help, independently	Possible	Possible	Possible
15	Width of back transverse	Not	Not	Yes

During computer plantography there were taken into account the width of front and back transverse sections of the foot, direction of plantar straight line between 3-4 fingers, the size of a straight line running along the plantar surface of the fingerprint to the dome of the foot, passing on the medial part of it.

Table 1 demonstrates the flatfoot prognostic diagnostic criteria developed using the computer and clinical data (Table 1).

TABLE 2. DISTRIBUTION OF PATIENTS BY THE LEVEL OF FLATFOOT AND SEX (ABS)

Level of flatfoot	Sex		General number
	Male	Female	
Mild level (I)	10	12	22 (23.4%)
Middle level (II)	24	19	43 (45.7%)
Severe level (III)	17	12	29 (30.9%)
Total	51 (54.3%)	43 (45.7%)	94 (100%)

TABLE 3. DISTRIBUTION OF PATIENTS BY THE AGE AND SEX (ABS)

Sex/age	1-3 years old (group 1)	3-7 years old (group 2)	7-14 years old (group 3)	General number
Boys	7	33	11	51 (54.3%)
Girls	5	26	12	43 (45.7%)
Total	12 (12.8%)	59 (62.8%)	23 (24.4%)	94 (100%)

Implemented studies discovered mild level of flatfoot in 22 (23.4%) children, middle level was in 43 (45.7%); severe level was in 29 (30.9%) patients, mainly in boys (Table 2).

According to Table 3, occurrence of flatfoot makes accent on 3-7 years old with majority of male contingent. In order to study age-related changes of flat feet the patients were divided into 3 groups by the general accepted distribution of the children by the age.

It is necessary to note that mild level of flatfoot in children under 3 years old is less evident, and often they are less seen by parents; this situation leads to late addressing to the doctor while the patients has already had manifested symptoms of more severe level. The marked reduction or limitation of motor abilities of the child should alert parents and persuade them to appeal for doctoral observation.

At 3-7 years old the signs of flatfoot are manifested with noticeable features - change of the gait, walking limitations, fast fatigue, complains on pain in different parts of the foot; change of the form of plantar surface and its passing redness are noted.

In the 7-14 age the severity of flat feet is noted not only the by restriction of motor activity, but also by change of its form, flattening of plantar surface, constant pains in various parts of the sole and back surfaces, permanent redness of plantar surface. The gait becomes "typing" without transferring foot "from heel to toe.

To establish the strength of connective tissue ligaments of the foot foundation it was conducted the study of the component of hyaluronic acid (HA) - hydroxyproline in urine. It is known that HA plays a key role in the intercellular interactions. Belonging to the group of sour glycosaminoglycans, high molecular linear polymers, HA is widely presented in human tissue, being important component of connective tissue. As "cementing" component of main connective tissue the HA influences on its penetrability, determines barrier and protective functions of extracellular matrix. Connective tissue proteins are quite diverse and include globular and fibrillar proteins, simple and complex in structure. Fibrillar proteins are collagen, elastin, reticulin. Collagen predominates and makes 25-33% of the total protein of connective tissue which is part of cartilage, tendons, ligaments, and other structural elements. In flatfoot closing of three-dimensional HA structure is disordered. There is a hypothesis that a violation of the regulation of metabolism is associated with HA functional changes in the thyroid and sexual glands, cortisone, adrenocorticotropic hormone. Catabolism of HA by hyaluronidase with enzymes which catalyze the hydrolases and depolymerization of these acids. It is a oxiproline that is non-essential amino acid and an indicator of the functioning of connective tissue.

The received data (Table 4) witness on increase of oxiproline release in children with flatfoot. Reliability of the results emphasizes the direct correlation of age and oxiprolinuria. In an earlier age (1-3 years), compensating changes in metabolic processes, proper medical tactics (combination of correcting bandages, massage, therapeutic salt baths coniferous, straighten posture, use of vitamin complexes, physical therapy), the process of involution of the connective tissue is very positive. In older ages (4-14 years), there is need for more extensive treatment measures, constant wearing of arch support insole.

Periodical course (4 times a year) use of multivitamin preparations, correcting massage, exercise, stimulating metabolic processes has a positive effect on the restoration of the plantar ligaments and the dorsum of the foot.

TABLE 4. OUTCOME INDICES OF OXIPROLINE IN URINE
OF CHILDREN WITH FLATFOOT (M±M)

Age	Norm	Boys	Girls	P
1-3	35.52± 0.20	56.83± 1.6	47.89± 1.6	<0.05
4-7	36.76 ±0.16	51.46 ±1.4	65.21± 1.14	>0.05
8-11	58.82 ±0.15	76.47 ±1.3	90.04± 1.3	>0.05
12-14	63.93 ±0.22	76.93 ±1.2	92.88 ±1.2	>0.05

Carrying out complex treatment on suggested methods allowed significant correcting of the anatomic integrity of feet, improving its flexibility. Also, the oxiproline study revealed tendency to reduce its amount depending on sex and age peculiarities (Table 5).

TABLE 5. RESULT OF OXIPROLINE EXCRETION IN THE URINE AFTER COMPLEX TREATMENT

Age	Week I		Week II		Week III	
	Boys	Girls	Boys	Girls	Boys	Girls
1-3	55.06±1.55	46.39±1.55	46.18±1.3	38.91±1.3	42.62±1.2	35.92±1.2
4-7	51.46±1.4	65.21±1.4	47.79±1.3	60.55±1.3	40.44±1.1	51.24±1.1
8-11	76.47±1.3	90.04±1.3	70.58±1.2	83.11±1.2	64.7±1.1	76.19±1.1
12-14	76.72±1.2	92.88±1.2	70.32±1.1	85.14±1.1	63.93±1.0	77.4±1.2

Note:* p<0.05; **p<0.1; ***p<0.5

TABLE 6. DIFFERENTIAL DIAGNOSTIC TABLE FOR DETERMINATION OF FLATFOOT LEVEL IN CHILDREN (SCORES)

№	Parameters	Clinical signs			
		Average state	I level	II level	III level
		1	2	3	4
1	Pains	Not	From time to time	Often	Every day
2	Valgus position	Not	Marked	Expressed	Clearly displayed
3	Position of ankle bone	No marked	Slightly raised	Partly raised	Clearly expressed raised
4	Skin covering	Not changed	Pigmented	Mild callus formation	Hard callus formation
5	Arch supporting of ankle joint	Not changed	Limited	Pain limitation	Noticeable limilaxion
6	Angle between 1 toe and sole line	95^0-100^0	100^0-110^0	110^0-120^0	120^0
7	Distance of distal part foot's toes	Not	2^0-5^0	5^0-10^0	1ess10^0
		Roentgenologic indicators			
8	Sole line	25^0-28^0	28^0-30^0	-	-
9	Line of ankle bone	40^0	42^0	43^0-45^0	45^0-50^0
10	Sole angle	25^0-40^0	25^0-23^0	23^0-21^0	21^0-18^0
11	Index of ankle bone	13-18	12-10	10-16	6-0
12	Angle of foot dome	120^0-130^0	140^0	155^0	170^0
13	height of dome	55	39	25	Lower 25
		Indicators of computer podometry			
14	Height of dome	3.4-4.4	-	-	-
15	Fridland index (1960)	29-31	28-26	25-23	Lower 22
16	Pronation of ankle bone	6^0	7-8^0	9^0-10^0	11-15^0
		Plantography			
17	Footprint	18	36	54	72

Taken data were distributed per block with underlining clinical (Block 1), roentgenologic (Block 2), computer podometric (Block 3) and plantagraphic parameters (Table 6).

Results of received data sum up the scores per block. In case of receiving 18 scores the state of child is considered as compensated without signs of flatfoot. At the result ranging within 18-36 scores the state is estimated as 1 level of flatfoot. Score from 36 to 54 witnesses on presence of 2 level of flatfoot in the patient. The results exceeding 54 score are the signs of severe level of flatfoot.

Thus, on the base of carried out studies modern diagnostic, non-invasive, computer technologies and ways of determination flatfoot in children can be marked out, the evidence of that is determination concentration of oxiproline in urine. Developed differential diagnostic table also allowed determining the level of flatfoot in short time, using simple summing up the results of study in scores. The recommended conservative measures in treatment of different levels of flatfoot in children, including complex of physiotherapeutic, TPE, balneologic ways, wearing insoles in shoes, having multivitamin drugs allow to improve physiological correction of pathology, and, they will promote to psychological rehabilitation.

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