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CHANGE IN THE SEVERITY OF CONGENITAL CLUBFOOT IN THE FIRST WEEK OF LIFE

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Background. Congenital clubfoot or congenital equino-cava-varus deformity of the feet is one of the most common pathologies of the musculoskeletal system in children. Numerous articles in global literature have been published about changes in clubfoot severity during treatment; however, there are very few reports on how the severity of foot deformities with congenital clubfoot changes during the first week of life in the absence of deformity correction.
Aim. To analyze changes in the severity of congenital clubfoot in the first week of life without any treatment.
Materials and methods. The study group included 28 newborns with idiopathic congenital clubfoot (a total of 40 feet). The severity of clubfoot was evaluated on days one and seven after birth using the Dimeglio and Pirani scores.
Results. During the initial examination of the newborns on the first day of life, the clubfoot severity recorded on the Pirani score was between 2 to 3 points and between 9 to 15 points on the Dimeglio score. Thus, in the first seven days of life in all patients who did not receive treatment, there was a significant increase in the severity of the equino-cava-varus deformity of the feet ($p < 0.05$). The results of this study confirm that the severity of congenital clubfoot increases in the first week of life. This necessitates the beginning of the correction of severe idiopathic clubfoot in the first days after birth.
Conclusions. The severity of congenital clubfoot during the first week of life significantly increased in all feet studied ($p < 0.05$: χ^2 higher than in the table). If left untreated in the first week after birth, the equinus deformity progresses followed by varus deformity, anterior forefoot reduction, and, to a lesser extent, rotation.

Keywords: congenital clubfoot; talipes equinovarus; Pirani score; Dimeglio score.

ИЗМЕНЕНИЕ СТЕПЕНИ ТЯЖЕСТИ ВРОЖДЕННОЙ КОСОЛАПОСТИ ЗА ПЕРВУЮ НЕДЕЛЮ ЖИЗНИ

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Обоснование. Врожденная косолапость или врожденная эквино-кава-варусная деформация стоп является одной из наиболее частых патологий опорно-двигательного аппарата у детей. В мировой литературе опубликовано большое количество статей на тему изменения тяжести деформации стоп в процессе лечения и практически отсутствуют сообщения о том, как меняется степень тяжести деформации стоп с врожденной косолапостью на протяжении первой недели жизни при отсутствии коррекции деформации.
Цель — проанализировать изменение степени тяжести врожденной косолапости за первую неделю жизни при отсутствии лечения.

Материалы и методы. В исследуемую группу вошли 28 новорожденных с идиопатической врожденной косолапостью (всего 40 стоп). Степень тяжести косолапости оценивали на 1-й и 7-й дни жизни по шкалам Димеглио и Пирани.

Результаты. При первичном осмотре новорожденного в первые сутки жизни у всех детей тяжесть косолапости по шкале Пирани составляла от 2 до 3 баллов, а по шкале Димеглио — от 9 до 15 баллов. Таким образом, за первые семь дней жизни у всех пациентов, не получавших лечения, тяжесть эквино-кава-варусной деформации стоп достоверно увеличилась ($p < 0,05$). Результаты нашего исследования показывают, что степень тяжести врожденной косолапости увеличивается в течение первой недели жизни. Это обусловливает необходимость начала коррекции тяжелой идиопатической косолапости в первые дни жизни ребенка.

Заключение. Тяжесть врожденной косолапости за первую неделю жизни достоверно увеличилась во всех исследованных стопах ($p < 0,05$; χ^2 выше табличного). В наибольшей степени за первую неделю жизни при отсутствии лечения прогрессирует эквинусная деформация, затем варусная деформация, приведение переднего отдела стопы и в самой меньшей степени внутренняя ротация.

Ключевые слова: врожденная косолапость; эквино-кава-варусная деформация; шкала Пирани; шкала Димеглио, новорожденные.

Congenital clubfoot, or congenital equinocavovarus deformity of the feet, is one of the most common pathologies of the musculoskeletal system in pediatric patients. According to the literature, the incidence is 1–2 per 1,000 live newborns [1].

To determine the severity of clubfoot, the Pirani scale is widely used [2]. Six clinical indicators (three for the middle sections and three for the hindfoot) were expressed as scores on a scale from 0 to 3. Each symptom was assigned 0, 0.5, or 1 point depending on the severity (0 points means no deformity; 0.5 implies a medium degree of deformity; 1 is a severe deformity). The deformity severity was established by summing the points [2].

Another scoring system for congenital clubfoot is known as the Dimeglio classification [3]. It enables determination of the severity of clinical signs, namely the angle of equinus deformity, the angle of varus deformity, the angle of internal rotation of the foot, and the angle of adduction of the forefoot. Depending on the severity, each symptom is scored on a scale from 0 to 4 points (1 point for –20° to 0°; 2 points for 0° to 20°; 3 points for 21° to 45°; 4 points for 46° to 90°). Additional points are scored in the case of a pronounced skin fold, cavus, or atrophy of the lower leg (one point for each sign) [3].

A large number of articles have been published in the world literature that discuss changes in the severity of the foot deformity during treatment. However, there are practically no studies on changes in the severity of congenital clubfoot from the moment of birth to the start of treatment. There is still a discussion about the timing of the start of treatment. Some authors believe that correction of the deformity should be started immediately, on the first day of a child's life [4–8], while others consider the age of 1 month and older to be the best time to start treatment for clubfoot [9–11]. Ericson and Caprio note that if correction of clubfoot is started as soon as possible after birth, then it will be rapid, whereas if treatment is postponed, the foot will become more rigid in a few days [4].

This work aimed to analyze the change in the severity of congenital clubfoot in the first week of life if left untreated.

Materials and methods

The study included 28 newborns with idiopathic congenital clubfoot (a total of 40 feet), born from 2012 to 2014. The age of patients at the initial assessment ranged from 10 minutes to 24 hours. The severity ranged from moderate to severe. The initial rating on the Dimeglio scale was 9 points or more. The initial score on the Pirani scale was 2 points or more.

Feet with clubfoot in arthrogryposis and other systemic diseases were not considered. Parents of all patients signed a voluntary informed consent to participate in the study, as well as to the processing and publication of personal data.

On days 1 and 7 of life, six clinical signs were evaluated on the Pirani scale, namely curvature of the outer edge of the foot, medial fold, resistance of the talonavicular displacement, posterior (hucklebone) fold, position of the calcaneus, and the possibility of rear flexion of the foot. On the Dimeglio scale, the angles of equinus deformity, internal rotation of the foot relative to the knee joint, varus deformity, and adduction of the forefoot were measured, and the presence and severity of the hucklebone fold,

the transverse fold of the foot, cavus, and muscle atrophy were determined. All measurements were performed in the position of maximum foot correction using a digital goniometer GAM 220 MF Professional made by Bosch.

Correction of clubfoot in all pediatric patients included in the study was not performed in the first 7 days of life. Survey results for both scales obtained on day 1 of life were compared with the indicators obtained on day 7. The accumulation, systematization, and adjustment of the information obtained, as well as visualization of the results obtained were performed by using Microsoft Office Excel 2017 spreadsheets. Statistical processing was performed in the Statistica Base program, version 13.3 (StatSoft Inc.) for Microsoft Windows 10.

The sample was estimated as representative (the number of cases corresponded to the risk of error $p = 0.01$). Parametric and nonparametric statistical criteria were used. The mean values (M) and the mean square deviations ($\pm\sigma$) were calculated. The significance of differences in the average values was determined (at $t \geq 2$, the difference was considered significant, at $t = 2$, the reliability was at least 95%, with $p < 0.05$). A paired Student's t-test was calculated by comparing dependent samples (values of angles on days 1 and 7); the obtained value of the Student's t-test in all cases was more than critical; therefore, the differences were statistically significant. To assess the significance of the relationship between the two dependent samples, we used the conformity index χ^2, which in all cases was more than the tabulated one (statistically significant).

Results

The study included 15 boys and 13 girls; in 12 pediatric patients, the clubfoot was bilateral, and in 16 children it was unilateral (Table 1). A total of 40 feet were studied.

1. Assessment based on the Pirani score

At the initial examination on day 1 of life in all newborns, the severity of clubfoot based on the Pirani scale ranged from 2 to 3 points (2.87 ± 0.85), while on day 7 of life, it was 3–5 points (4.07 ± 0.96).

During the first 7 days of life, an increase in the severity of clubfoot (a general score on the Pirani scale) by 1.5 points was noted for 16 feet (39%), by 1 point for 13 feet (33%), and by 0.5 points for 11 feet (28%).

Change in internal contracture when assessed on the Pirani scale. By day 7, the internal contracture of 31 feet (77.5%) out of 40 increased, namely 1 foot by 1.5 points (3%), 10 feet by 1 point (25%), 20 feet by 0.5 points (49%), and in the case of 9 feet (23%), internal contracture had not changed. Additional points (from 0.5 to 1.5) were scored in all feet.

Change in posterior contracture when assessed on the Pirani scale. For 7 days of life, the posterior contracture increased in 28 feet (70%) of 40, namely in 6 feet by 1 point (15%) and in 22 feet by 0.5 points (55%). In the case of 12 feet (30%), the posterior contracture remained unchanged.

Thus, when assessed according to the Pirani scale, an increase in the severity of clubfoot by day 7 of life was noted in all patients. At the same time, an increase in internal and posterior contracture of all feet occurred by more than 70% over the 7 days. Additional points (from 0 to 1) were scored in all feet.

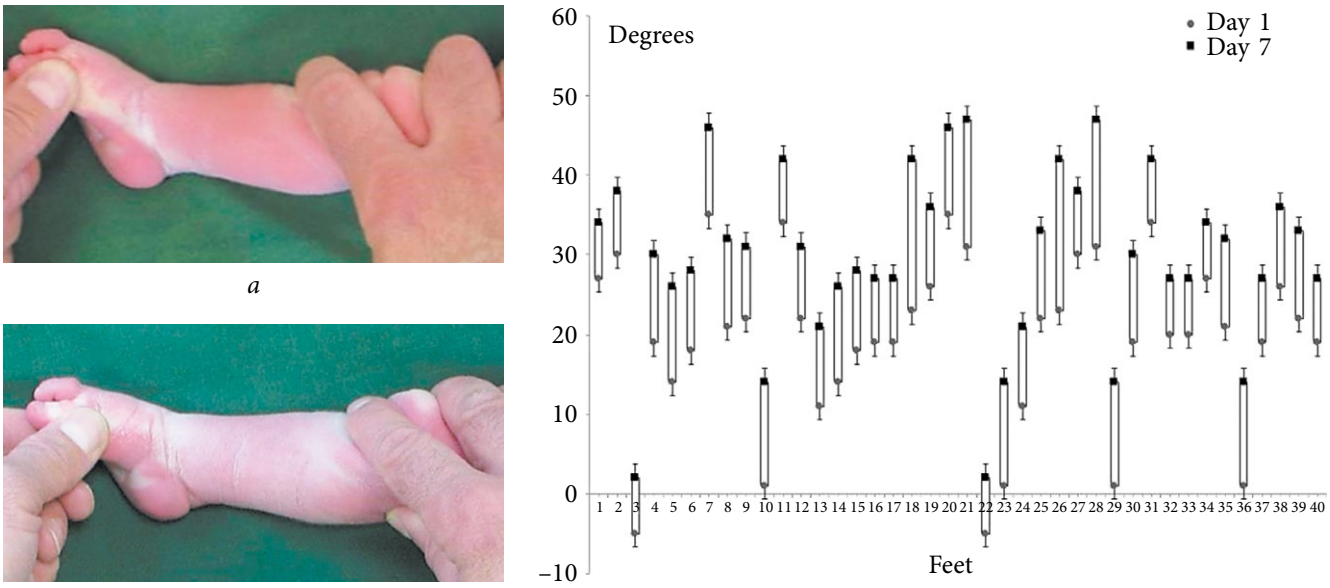
2. Assessment on the Dimeglio scale

When examined on day 1 of life, the severity of clubfoot on the Dimeglio scale was estimated from 9 to 15 points (11.4 ± 2.1). On day 7, an increase in the severity of clubfoot was noted in 10–17 points for all feet (13.1 ± 3.6), namely by 2 points in 12 feet (30%), by 3 points in 10 feet (25%) and 1 point in 18 feet (45%). It should be noted that all feet rated on day 1 of life as Dimeglio II were rated already as Dimeglio III on day 7 of life.

Table 1

Distribution of pediatric patients by gender and number of feet ($N = 28$, $n = 40$, $p = 0.01$)

Gender	Bilateral clubfoot, number of pediatric patients (N)/ number of feet (n)	Left-sided clubfoot, number of pediatric patients (N)/ number of feet (n)	Right-sided clubfoot, number of pediatric patients (N)/ number of feet (n)	Total, of pediatric patients (N)/ number of feet (n)
Boys	8/16	2/2	5/5	15/23
Girls	4/8	3/3	6/6	13/17
Total	12/24	5/5	11/11	28/40



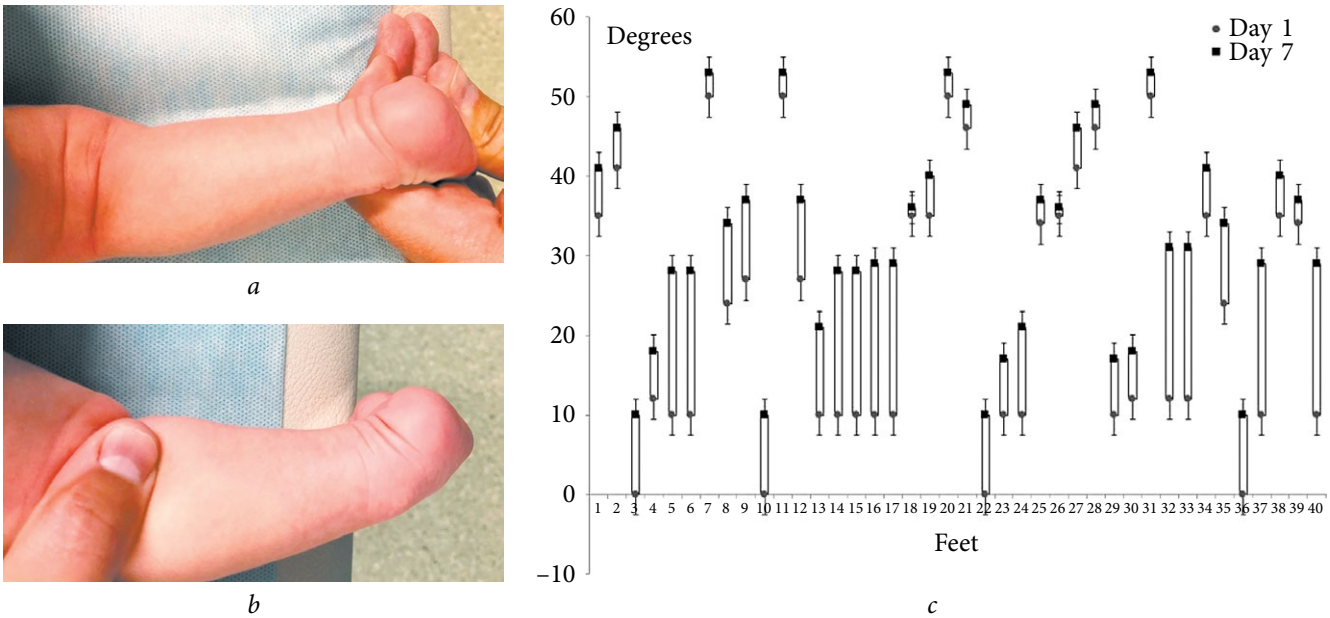
a *b* *c*

Fig. 1. Change in the angle of the equinus deformity: *a* — the angle of the equinus deformity upon examination on day 1 of life (23°); *b* — the angle of equinus deformity upon examination on day 7 of life (39°); *c* — graph of changes in the angle of equinus deformity for the follow-up period with demonstration of the increased bands and error bars for standard errors

Table 2

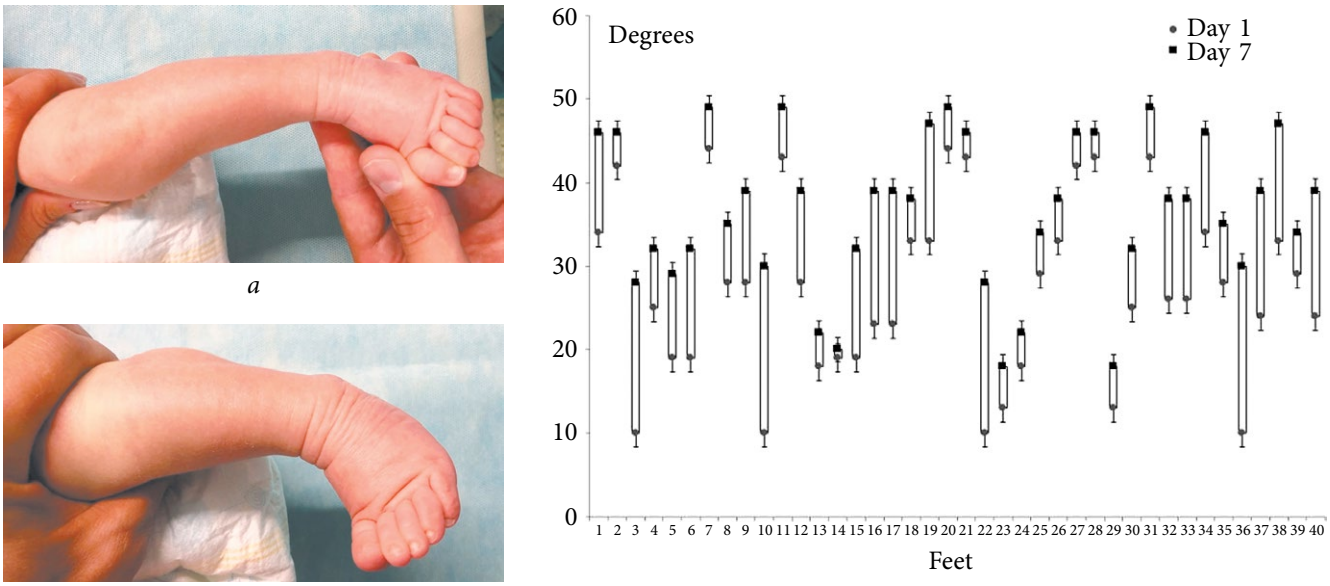
Change in the angle of equinocavovarus deformity ($n = 40$, $p < 0.01$)

Age	Equinus deformity	Varus deformity	Internal rotation	Forefoot adduction
	Angle, degrees (mean value)			
Day 1 of life	–5–35 (18.6 ± 9)	0–50 (23 ± 11.5)	10–44 (26.8 ± 7.9)	3–35 (18.2 ± 7.4)
Day 7 of life	11–47 (28.1 ± 10)	10–53 (32.3 ± 10)	18–49 (36.3 ± 7.2)	13–38 (24.5 ± 5.8)



a *b* *c*

Fig. 2. Change in the angle of varus deformity during the follow-up period: *a* — angle of varus deformity when examined on day 1 of life (26°); *b* — angle of varus deformity during examination on day 7 of life (37°); *c* — graph of changes in the angle of varus deformity during the follow-up period with demonstration of the increased bands and error bars with standard errors

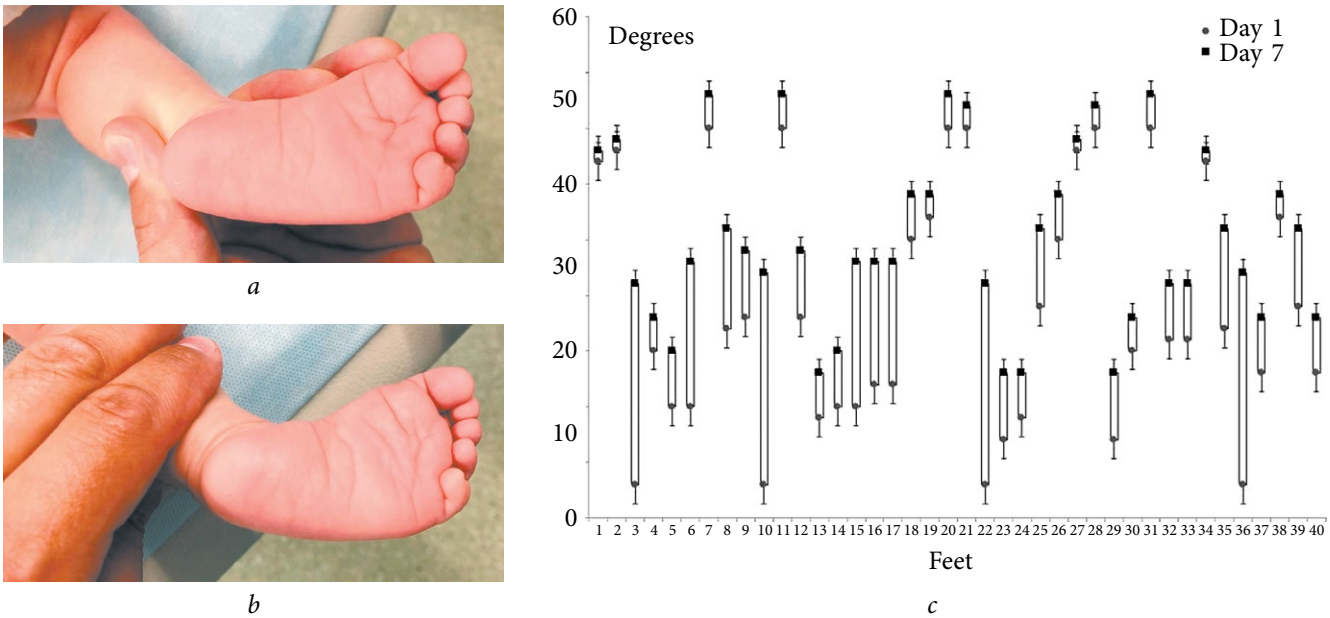


a *b* *c*

Fig. 3. Change in the angle of internal rotation during the follow-up period: *a* — angle of internal rotation during examination on day 1 of life (14°); *b* — the angle of internal rotation when examined on day 7 of life (26°); *c* — graph of changes in the angle of internal rotation during the follow-up period with demonstration of the increase bands and error bars with standard errors

Change in the angle of equinus deformity. When examined on day 1 of life, the angle of equinus deformity (AED) ranged from –5° to 35° (an average of 18.6° ± 9°). Over 7 days, the AED increased by 11°–15° in 14 feet (35%), by 16° and more in 4 feet (10%), and by 6°–10° in 22 feet (55%) (Fig. 1). Thus, in all cases (40 feet), an increase in AED was noted by 5° or more (Table 2). On average, the value of AED increased by 10.5° and amounted to 28.1° ± 10° (at $p < 0.01$).

Change in the angle of varus deformity. During examination on day 1 of life, the angle of varus deformity (AVD) was from 0° to 50° (an average of 23° ± 11.5°). On day 7, the AVD increased by 6°–10° in 14 feet (35%), by 11°–15° in 2 feet (5%), by 16° and more in 10 feet (25%), and by 5° and less in 14 feet (35%) (Fig. 2). Thus, for all feet, an increase in AVD from 1° to 19° was noted, on average, by 9.3° (32.3° ± 10° at $p < 0.01$) (see Table 2).



a *b* *c*

Fig. 4. Change in the angle of adduction of the forefoot during the follow-up period: *a* — angle of adduction of the forefoot upon examination on day 1 of life (18°); *b* — the angle of adduction of the forefoot during examination on day 7 of life (23°); *c* — graph of changes in the angle of adduction of the forefoot during the follow-up period with demonstration of the increased bands and error bars for standard errors

Table 3

Average severity of clubfoot on days 1 and 7 of life ($n = 40$, $p < 0.05$)

Age	Pirani scale				Dimeglio scale		
	Up to 2 points	Up to 2.5 points	Up to 3 points	More than 3 points	II	III	IV
	Количество стоп						
Day 1 of life	13	11	7	9	8	30	2
Day 7 of life	0	1	10	29	0	24	16

Change in the angle of internal rotation. On day 1, the angle of internal rotation (AIR) increased by 10°–44° (on average, 26.8° ± 7.9°). Over 7 days, the AIR increased from 6° to 10° in 12 feet (30%), from 11° to 15° in 8 feet (20%), 16° or more in 6 feet (15%), 5° or less in 14 feet (35%) (Fig. 3). For 26 feet (65%), the AIR increased by 11° or less. Thus, in all cases, the AIR increased over 7 days from 3° to 20°, on average, by 9.4° (36.3° ± 7.2° at $p < 0.01$) (see Table 2).

Changing the angle of adduction of the forefoot. At the initial examination of a newborn, the angle of the forefoot adduction (AFA) ranged from 3° to 35° (an average of 18.2° ± 7.4°). When viewed on day 7, the increase in AFA was from 6° to 10° in 8 feet (20%), from 11° to 15° in 4 feet (10%), 16° and more in 4 feet (10%), and 5° and less in 24 feet (60%) (Fig. 4). Thus, over the 7 days, AFA increased by 1°–19°, on average by 6.4° (24.5° ± 5.8° at $p < 0.01$) (see Table 2).

3. General assessment of clubfoot severity

On average, when assessed on a Pirani scale, the number of feet that scored 3 or more points increased from day 7 to 39. On the Dimeglio scale, an increase in the severity of deformity was also observed (Table 3). Thus, the severity of clubfoot when assessed by two different methods increased significantly ($p < 0.05$; χ^2 above those indicated in the table).

Discussion

If the fetus reveals equinocavovarus deformity during prenatal diagnostics, parents need to receive information about more than the possibilities of correction and prognosis of this pathology. "When and how will treatment start?" is the question asked most often by expectant mothers. Therefore, the timing of the start of correction remains extremely important.

Most authors consider it necessary to start treatment as early as possible. Ponseti noted that treatment of clubfoot should be started in the first week of life, as this approach takes advantage of the visco-elastic properties of the connective tissue that forms the ligaments, capsule, and tendons [5]. Hosalkar et al. in their Nelson Textbook of Pediatrics note that conservative treatment of idiopathic clubfoot should be started immediately after birth [6]. Mosca, in the latest edition of Lovell and Winter's Pediatric Orthopedics, recommends starting treatment as early as possible [7]. Ericson and Caprio, in a recent edition of Lange Current Diagnosis and Treatment Pediatrics, believe that if correction of clubfoot is started as early as possible after birth, then it will be rapid, whereas if treatment is postponed, the foot will become rigid in a few days [4]. The results of our study confirm the data from single publications in which the issue is discussed to some extent of the changing severity of clubfoot without treatment, namely how the severity of congenital clubfoot increases significantly during the first week of life.

In addition, it is known that the more severe the deformity, the longer it takes to correct. Sharma et al. report that the number of plaster casts required to obtain a complete correction is increased in cases when the initial severity according to Pirani is high [8].

Conclusion

The severity of congenital clubfoot of all the feet studied increased significantly during the first week of life ($p < 0.05$; χ^2 is higher than those specified in the table). Equinus deformity progresses to the greatest extent in the first week of life, if untreated, followed by varus deformity, anterior forefoot adduction and, to a lesser extent, internal rotation.

Thus, it can be argued that with age, the severity of deformity will increase, and therefore it is necessary to start conservative treatment as early as possible. In this regard, we believe that treatment for congenital clubfoot should be started as early after birth as possible. Moreover, the earlier the casting stages are started, the faster complete correction will be achieved. It is logical to assume that when starting treatment of a mild or moderate deformity, in most cases, it is possible to avoid surgical intervention, since the disease will not progress to a more severe degree.

Additional information

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Conflict of interest. The authors declare no obvious or potential conflicts of interest related to the publication of this article.

Ethical considerations. The study was conducted in accordance with the ethical standards of the Helsinki Declaration of the World Medical Association as amended by the Ministry of Health of Russia and approved by the ethics committee of the V.A. Almazov Scientific Research Center, Ministry of Health of the Russian Federation (Minutes No. 95 dated 14.05.2018). Patient representatives signed a voluntary informed consent to participate in the study and publish data without identification.

Contribution of authors

I.Yu. Kruglov performed examination of patients, collection of literature data and their processing, wrote all sections of the article.

N.Yu. Rumyantsev, G.G. Omarov, N.N. Rumyantseva took part in the examination of patients and writing sections of the article.

All authors made a significant contribution to the research and preparation of the article, read and approved the final version before publication.

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