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The Effect of Clinical, Radiographic and Functional Scores on the Total Score in the Evaluation of Congenital Clubfoot

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ABSTRACT

Introduction: The use of radical surgical treatments in treating congenital clubfoot is decreasing. Minimally invasive surgical treatment (MIST) is a way of treating congenital clubfoot, which is a kind of compromise between a radical surgical treatment and non-operational one. A few protocols of different authors McKay, Macnicol, Stevens, Meyer, G.W.Simons and Laaveg-Ponseti were used in the evaluation of the results. SCIENTIFIC OBJECTIVE:To determine the importance and role of groups of parameters (clinical, radiographic and functional) in the evaluation of the results in patients treated with the two methods (radical operation and MIST). **Subjects and methods:** This paper covers children who were treated for structural (idiopathic) form of PEVC. The testing is a prospective study and was conducted in two groups of patients. Group A (radical surgical treatment) – control group, where the total number of subjects was 50, out of which 35 male (70%) and 15 female (30%). The number of feet tested was 88. Group B (minimally invasive surgical treatment–MIST)–experimental group. The total number of subjects was 48, out of which 35 male (73%) and 13 female (27%). The number of feet tested was 84. For the analysis of the results, we used a questionnaire. The total number of parameters was fifteen, clinical, radiographic and functional, five parameters of each. Normal findings or measured value was determined by 0 points. The range of the total score (TS-a- *total score range*) 0-27 points, and the results were sorted out into the folowing categories: good result (0-5) satisfactory (6-11), poor (12-19) and deformity recrudescence (20-27) points. **Results:** The proportion of good results at 88 feet in group A was 0,477 as at 84 feet in group B it was significantly higher and came to 0,893. The difference between these proportions is statistically highly significant ($t = 5.84$, $p < 0.001$). Chi-square test ($\chi 2 = 30.083$ df = 1 N = 172, $p < 0.001$) indicated that there is a highly significant correlation between the method of treatment used and results of treatment. Good results of treatment in group A were observed in 48% and in group B in 88% of cases.The Charles Spearman nonparametric method showed that the rank correlation coefficients for the group A are positive, quite high (between 0.70 and 0.85), similar and statistically highly significant ($p < 0.001$).The influence of radiographic scores on the total score is the lowest, and clinical score on the overall score is the highest. Rank correlation coefficients for group B were also positive but somewhat smaller than in group A (between 0.55 and 0.75) and statistically highly significant ($p < 0.001$). It is possible to notice the difference here and say that the impact of functional scores on the total score is the highest and of radiographic score the lowest. **Conclusion:** Minimally invasive surgical treatment (MIST) gives better functional results in the treatment of congenital clubfoot than radical surgical treatment. The role of radigraphic parameters in the evaluation of the results of the treatment was the slightest regardless of whether the treatment was radical surgery or MIST. We believe that radiography for routine analysis of the results of treatment need not be used.

Key words: congenital clubfoot, treatment, results.

1. INTRODUCTION:

Congenital clubfoot (pes equinovarus congenitus PEVC) is a deformity of the foot and lower leg, segmental defects of bone–joint system in the developmental period. The most common issues that are the subject of discussion are related to: etiology, clinical classification, methods of treatment and evaluation of the results. In the last few years a radical surgical treatment is applied less. According to studies (1, 2, 3) search results away after radical surgery are weak and deteriorating in adolescence. Minimally invasive surgical treatment (MIST) represents a compromise between the radical surgical treatment and non-operative treatment and are increasingly being used.

To evaluate the results of treatment a few protocols were used by several different authors. McKay (4) estimate is based on the allocation of 180 points for the normal foot. Eight parameters were evaluated: movements in the ankle joint, the strength of the triceps surae, the strength of long flexor of the hallucis longus muscle, pain in the ankle and subtalar pain. MacNicol (5) uses 12 parameters to evaluate treatment success: dorsiflexion (extention) in the ankle joint, the strength of the triceps surae, the strength

of the flexor hallucis longus, scar, subtalar pain, footwear and playing ... D.Stevens and S.Meyer () for normal foot allocated 100 points. Out of this number of points, points for a variable number of clinical, radiographic and functional parameters were deducted. Among the functional parameters we monitored: pain, aesthetics, walk, contact with the ground, dorsiflexion-extension, plantar flexion, eversion, inversion and static deformation. G.W.Simons (5) used radiographic parametres to evaluate the success of treatment. Laaveg-Ponseti (6) used clinical, radiographic and functional parameters. There are few publications, science papers, where the influence of individual groups of parameters on the overall results have been analyzed. For the result evaluation most authors have used analysis of clinical, radiographic and functional parameters. Few papers (7) analyze the effect of individual parameters and their role in the assessment of the overall treatment outcomes. The question asked is whether it is needed to keep track of all three groups of parameters in the analysis of the results.

2. OBJECTIVE

To determine the importance and necessity of the use of three groups of parameters (clinical, radiographic and functional) in the evaluation of the results in patients treated with the two methods (radical operation and MIST).

3. METHODOLOGY AND SUBJECTS

SUBJECTS

The paper covers children treated for structural (idiopathic) form of PEVC. It is a prospective study that lasted from 2007 until the end of 2013. The study was conducted in two groups of patients.

Group A–radical surgical treatment–control group. The total number of respondents was 50, out of which 35 male (70%) and 15 female (30%). Bilateral deformity was in 38 (76%), unilateral in 12 (24%) of patients. The age of children was 5-15.The total number of feet tested was 88.

Group B–minimally invasive surgical treatment (MIST)–experimental group. The total number of respondents was 48, out of which 35 male (73%) and 13 female (27%). Bilateral deformity was in 38 (79%), unilateral in 10 (21%) cases.The age of children was 3-7. The total number of feet tested was 84, table No. 1. The shortest period between treatment termination and examinig the results was five years and the longest 10 years for group A, and 5-7 years for group B. The average value for group A was 6.5 years and for group B 6.0 years.

Group	Number of subjects	Number of feet	Male	Female	Bilateral deformity	Unilateral deformity
A radical	50	88	35 (70%)	15(30%)	38 (76%),	12 (24%)
B MIST	48	84	35 (73%)	13(27%)	38 (79%)	10 (21%)
total	98	172	70	28	76	22

Table 1. Structure of groups A and B

METHODOLOGY

To analyze the results we used a questionnaire designed for this test. The parameters in our survey are a combination of parameters of the protocol used by: McKay, MacNicol, D.Stevens, S.Meyer, G.W.Simons and Laaveg-Ponseti (1,5,6) and our modification of individual parameters from the above mentioned protocols. The modified parameters are: pain in the foot, pace, support and range of motion in the talocrural joint.

The total number of parameters monitored was fifteen, clinical, radiographic and functional, five parameters of each. Normal findings or measured value was determined by 0 points. Assigning points to the parameters we got scores thus objectifying the success of treatment, i.e. expressed it numerically. By adding the scores of all 15 parameters, we obtained the total score (T.s.) for each foot. T.s. ranges from 0 to 27 points, and the results were categorized as follows: good result (0-5), satisfactory (6-11), poor (12-19) and deformity recrudescence (20-27points.) We determined the individual scores (clinical, radiographic and functional). Depending on the number of points scored, the results (clinical, functional and radiographic) were classified into three categories: good, satisfactory and poor. We analyzed three measurable clinical parameters: equinus, varus last part of the foot and adduction of the front foot. For the measurement we used a goniometer.The assessment of the success of equinus correction was made on the basis of the degree of extension of the ankle joint. 0 ° stood for the neutral position of the ankle joint. If the equinus is of 0 °–(- 20 °), it is fully corrected and extension is possible to (-20 °) = 0 points. From 20 ° to (-10 °) there is a lower degree of equinus to (20 °) and passive possible extension to (-10 °) = 1 point. From (45 °) to (21 °) (no neutral position can passively be achieved), the result was credited with two points. From (> 90 °) to (46 °), there is still equinus and passive correction is possible by (46 °),the result was credited with three points. The same values were used when evaluating varus correction success. If the value of adduction front foot ranged from 0 ° (fully corrected) and the possibility of passive adduction (-20 °) = 0 points, if it was (20 °)–(1 °) = 1 point and two points in case of > 45 °–21 °. To control the achieved correction we used two clinical parameters: the appearance of the outer edge of the foot and the presence of a posterior furrow.The outer edge in normal foot is flat. Its appearance reflects good performance of the heel varus correction, adduction and inversion of the front part of the foot. If it is flat = 0 points, if convex or concave = 1 point. Insufficient correction of the equinus and shortening of the Achilles tendon resulted in the creation of skin folds in the area of the posterior part of the heel, at the place of the Achilles tendon grip. If there is no such furrow or if it is shallow, equinus is well corrected, and the Achilles tendon is not shortened. If there is no posterior furrow = 0 points, and if there is one = 1 point.The scores we measured were clinical scores (Cs) and they ranged from 0 to 10 points. According to the number of points scored, results may be: good (0-2), satisfactory (3-5) and poor (6-10 points).

Standard radiographs were used for examining radiographic results. We measured Keats angles on standard AP radiography. By using AP radiography we measured: the angle talus–calcaneus (AP TC) and the angle talus–the first metatarsal bone (T-first MTB).The TK AP angle is

formed by lines that pull through the long axis of the talus and calcaneus plantar side. The reference value of the angle is from 20 ° to 40 ° and is used to evaluate varus correction. If the angle is within reference values = 0 points. If <20 ° or> 40 ° = 1 point. The angle of the first T-MTB is the angle between the longitudinal axis of the talus and the first metatarsal bone. By the analysis of this angle we estimate the performance of correcting adduction of the front part of the foot. If the reference value of this angle is 0 °–20 ° = 0 points. If it is negative or > 20 ° = 1 point.

On cephalometric radiography we measured: the angle talus–calcaneus (TC profile) and tibia-calcaneus angle (Ti-C profile). The Ti-C profile is the angle formed by the lines passing through the center of the head and body of the talus and the line that pulls through the plantar side of the calcaneus. This angle is used to evaluate success of the correction within the equinus of the foot. If the reference value of this angle is 35 °–50 ° = 0 points, and for values of <35 ° or> 50 ° = 1 point. The angle of the TK- profile is formed by the line passing through the longitudinal axis of the tibia and the line passing through the plantar side of the calcaneus. If reference values are from 60 °–90 ° = 0 points, if <60 ° or> 90 ° = 1 point. The analysis of this angle confirms the success of equinus correction.

In addition to the above mentioned angles we also defined the talo-calcaneal index (TC index). TC index = angle T-C (AP) angle + T-K (profile). If it is larger than 55 ° = 0 point, if it is smaller than 55 ° = 1 point.The estimated number of points for radiographic score (RTGS) ranges from 0 to 5. The results were classified into three categories: good (0-1), satisfactory (2-3) and poor (4-5 points.)

Functional results of the treatment were examined on the basis of: pain in the foot, walk and support, range of motion in the ankle joint and Schopart's joint and the function of the muscle triceps surae. From the medical history or hetero–anamnestic data we got information about pain and physical activities. The range of motion in the ankle joint was between 60 ° and 70 °. The lowest value needed for normal walk is 45 °. If the measured value of the reference interval ranged from 60 ° to 70 ° = 0 point, 35 °- 44 ° = 1 point, 24 °- 34 ° = 2 points. If <24 ° =3 points and in case of joint ankylosis (0 °) = 4 points. For the measurement we used a goniometer.

For testing functions of the triceps surae muscle we did a test of tip-toeing and examined the ability to walk on toes. 0 to 12 points were provided for functional score (FS), and the results ranged from being: good (0-2), satisfactory (3-6) and poor (7-12 points).

4. RESULTS

Results of the total score

The results defined as good in group A based on Us were 42 (48%), satisfactory 31 (35%) and poor 15 (17%), (N = 88). In Group B the good results were 75 (89%), satisfactory 9 (11%) and there were no poor results (N = 84), Table .2.A.Transforming satisfactory and poor results into undesirable (> 5) in group A, good results were 42 (48%) and undesirable 46 (52%). In group B good results were 75 (89%) and undesirable 9 (11%), Table No. 2 B.

Analysis of the difference in total scores between group A and group B

Total score A	Group A	Group B	Total score B	Group A	Group B
Good (0-5)	42 (48%)	75 (89%)	Good ≤ 5	42 (48%)	75 (89%)
Satisfactory (6-11)	31 (35%)	9 (11%)	Undesirable>5	46 (52.%)	9 (11%)
Poor (12-19)	15 (17%)	0	Total	88 (100 %)	84 (100%)
Recrudescence (20-28)	0	0			
Total	88 (100 %)	84 (100%)			

Table 2. A & B results of the total score

The proportion of good results with 88 feet in group A was 0,477, whereas with 84 feet in group B the proportion of good results was significantly higher, amounting to 0,893. The difference between these proportions is not random but statistically highly significant (t = 5.84, p <0.001).

Analysis of correlation of treatment results and methods used

The results obtained are shown in Table 3.

Groups	Treatment results		Total
	Good (≤ 5 points)	Undesirable (>5 points)	
A	42	46	88
B	74	10	84
Total	116	56	172

Table 3. Results of treating clubfoot per groups of patients (N = 172 feet)

For the above given contingency table 3 the chi-square test was carried out.Its results ($\chi 2$ = 30.083 df = 1 N = 172, p <0.001) indicated that there is a high correlation between treatment methods and its results . Good results of treatment in group A were observed in 48% of cases, while in group B good results were achieved in 88% of cases. This difference was not statistically random, but highly significant.

Analysis of the correlation between the total score with a clinical, radiographic and functional score

In this analysis, the non-parametric method of Charles Spearman was used. The results obtained are shown in table 4 for group A, and in Table 5 for group B.

Ord. No.	Variables	N	Spearman correl. coef.	p	Stat. signif.
1.	Total score Clinical score	88	0,85	<0,001	***
2.	Total score Radiographic score	88	0,70	<0,001	***
3.	Total score Functional score	88	0,80	<0,001	***

Table 4. The results of correlation analysis using the Spearman rank correlation coefficient for groups A. Note: * statistically significant up to 5%; ** statistically significant up to 1%; *** statistically significant up to 0.1%

The results of correlation analysis using the Spearman rank correlation coefficient for groups B are shown in Table No.5

Ord. No.	Variables	N	Spearman-ov koef. korel.	p	Stat. znač.
1.	Total score Clinical score	84	0,72	<0,001	***
2.	Total score Radiographic score	84	0,55	<0,001	***
3.	Total score Functional score	84	0,75	<0,001	***

Table 5. The results of correlation analysis using the Spearman rank correlation coefficient for groups B. Note: * statistically significant up to 5%; ** statistically significant up to 1%; *** statistically significant up to 0.1%

Among the 50 patients in group A , where the treatment of 88 feet was carried out by the use of radical surgery, the reported total scores, as indicators of treatment success, are related to clinical scores, radiographic scores and functional scores, i.e. their sum-total. In addition, among the 48 patients of the experimental group where clubfoot treatment of 84 feet was carried out by the use of minimally invasive surgical treatment the noted overall scores, as indicators of treatment success, were related to clinical, radiographic and functional scores. The less significant correlation of each of these three scores with the total score indicates less impact of that score on the overall success of treatment. Vice versa, the higher the correlation of each of these three scores with the total score,the greater impact of that score on the overall success of treatment..

The obtained rank correlation coefficients for group A were positive, quite high (between 0.70 and 0.85), similar and statistically highly significant (p <0.001). However, it can be said that the impact of the radiographic scores on the total score is the lowest, and of clinical score on the total score the highest. If this analysis included only 42 feet of patients in group A in which good results were achieved, we would be given smaller correlation coefficients (0.57 then 0.28 and 0.89), but the significance of the scores would remain the same.

The obtained rank correlation coefficients for group B were also positive but somewhat smaller than in group A (between 0.55 and 0.75) and statistically highly significant (p <0.001). Here we can notice the difference and say that functional scores affect the total score the most and radiographic score the least. If the analysis was to include only 74 feet of patients in group B where good results of treatment were achieved ,we would be given smaller correlation coefficients (0.48 then 0.67 and 0.63), but the significance of individual scores would remain the same.

DISCUSSION

Nowadays, we are witnessing attempts to find a uniform and optimal method of treatment of this congenital anomaly. According to previous research, no unique attitude regarding the treatment of congenital clubfoot has been defined yet. (Methods of treating congenital clubfoot partly depend on the field of specialty (pediatric surgeons, orthopedic surgeons, physiatrists) and on institutions dealing with the problem. Application of radical surgery treatment tends to decrease.

Based on our tests in group A, there were 42 (48%) good , 31 (35%) satisfactory and 15 (17%) poor results. These results were obtained on the basis of the total score involving radiographic and functional scores. In terms of functional parameters, foot pain and the range of motion within the ankle joint affected the functional score the most. Feet operated on are often non-elastic, hard with scars, painful in usual daily activities. Results of surgical treatment in the references vary. According to A. Di Meglio (9), good and excellent results were in up to 59%, 29% satisfactory, 12% poor, and repeated surgeries in up to 30% [12] of cases. Simons announces that 69% had good results, 23% satisfactory and 8% poor results. Mc Kay (10) states that there were 70% with good results, 22% satisfactory and 8% poor.

Minimally invasive surgical treatment (MIST) is a way of treating congenital clubfoot, which represents a compromise between radical surgery and non-surgical treatment. The basic element of this way of treatment is the Ponseti method . In our study we had 75 (89%) good results, 9(11%) satisfactory and no poor ones. Based on estimates of the treatment carried out by Ponseti in the period from 1999 to 2002 in Mulago Hospital clubfoot Clinics, out of 182 feet analized, there were 176 (97%) with good results and 6 (3%) with poor results. Kiyoshi Ikeda states that 95% of the results were either good or excellent by the Laaveg and Ponseti system, the system that includes morphological, radiographic and functional analysis (11,12,13).

Based on the results and statistical processing of the influence of individual scores on the total score it can be said that in assessing results in group A clinical score has the highest effect, and radiographic the lowest. In group B the greatest influence is given to functional scores and the lowest to radiographic ones. Radiographic scores in both groups are of least significance in evaluating the results of treatment. According to quotations from the references () and according to our opinion, the reasons for this may be: the lack of cooperation of children during x-ray treatment, different foot positions during x-ray, different presentation of bones on radiographs. Presentation of bone on radiographs and their shape depend on the age of the child. The precision of the drawing lines needed for measuring angles, is in inversely proportional relation with the appearance of bone. Clinical score in group A has the greatest impact on the overall score. Deformity is well corrected by radical surgical operation, but functional results are weaker compared with group B (t = 5.84, p <0.001). Feet operated on are more often painful and non-elastic. Functional scores in group B have the greatest importance in the assessment of treatment outcome, and radiographic has the smallest impact. When comparing radiographic scores between the groups, better results are obtained in group A (t = 2.31 p = 0.022). According to quotations from the references (14.15) radiological characteristics of feet treated with MIST spontaneously improve as the child grows up. Functional characteristics of feet treated with radical surgical operation tend to worsen during adolescence.

5. CONCLUSION

Treatment of congenital clubfoot with MIST has better clinical and functional outcomes than treatment with radical surgery. The role of radiographic parameters in the

evaluation of treatment results is the least significant, regardless of the treatment used, be it radical, surgical procedure or MIST. We believe that radiography for routine analysis of the treatment results is not to be used in all patients. The application of radiography should be assessed individually and thus reduce the exposure of children to X-ray radiation. Operative treatment cannot fully achieve the main goal of treatment, which is to get feet that allow normal movement, normal physical and mental development of the child that will not limit their professional careers. We believe that the application of MIST can significantly bring us closer to this goal.

CONFLICT OF INTEREST: NONE DECLARED

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