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ORIGINAL ARTICLE

Effects of subtalar arthroereisis in children, assessed on the basis of quality-of-life questionnaires

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Abstract

Introduction and Objective. Subtalar arthroereisis is a procedure commonly performed in children with flat feet. The procedure is performed when conservative treatment did not have the desired effect,or when the patient's abnormal symptoms are very severe and make it difficult for them to function normally in daily life. The aim of this study was to assess whether subtalar arthroereisis and physiotherapy improve the quality of life among children with flat feet.

Materials and method. The study comprised 79 patients (140 operated feet) diagnosed with a flat foot defect who underwent a subtalar arthroereisis procedure. A self-administered questionnaire and a shortened version of the standardised WHOQOL-BREF questionnaire were used in the research.

Results. The study confirmed that the patients' quality of life after surgery was high in all the areas regarding the somatic, psychological, social and environmental domains. In the group of children assessed 13–24 months after surgery. it was also found that rapid fatigue after exercise (30%±9%) and Achilles tendon contracture (7%±4%) were significantly reduced. The results of the study confirmed that subtalar arthroereisis contributes to a decreased demand for orthoses in children(9%±6%) and for orthopaedic footwear (11%±5%) than before surgery.

Conclusions. The employment of subtalars arthroereisis has a positive effect on the quality of life of children with flat feet. The surgery contributes to a reduction in pain and other abnormal symptoms that are associated with flat feet. In addition, physiotherapy performed after the procedure had a positive effect on the healing process and contributed to the improvement of the children's quality of life.

Key words

children, flat feet, subtalar arthroereisis, plano-valgus foot

INTRODUCTION

Flat feet can be identified by the visible lowering of the transverse and longitudinal arch of the foot and the outward deviation of the heel axis. When observing the patient, it can be seen that the foot rests on the ground along the medial edge, a condition known as excessive pronation of the foot. This deformity of the foot is associated with ligamentous weakness and inadequate muscle tone. Patients may complain of pain, contractures and more rapid muscle fatigue, they may have walking and/or balance problems, and sometimes, corns, calluses or abrasions may occur due to the abnormal loading of the limb [1, 2].

Subtalar arthroereisis is a minimally invasive procedure employed to treat flat feet in children. It usually takes between 10–30 minutes and is performed under general anaesthesia. During the procedure, the doctor makes a small incision (of about 1–2 cm) in the sinus tarsi. Then, the doctor performs a supination of the foot so that the implant can be properly inserted into the sinus tarsi. The implants are available in different sizes; therefore, it is very important that implants are properly fitted for each patient. The implant should restrict motion in the ankle joint but not cause excessive plantar flexion of the foot. Non-absorbable implants should be removed 2 years after surgery [3].

Bioabsorbable implants are also available. If these are used during subtalar arthroereisis, the child does not need to be operated on again after 2 years have elapsed. These implants are made of bioabsorbable poly-L-lactic acid (PLLA); examples include the Gianinni implant (from the group of edno-orthotic implants) [4, 5] and the calcaneo-stop screw [5].

The aim of physiotherapy is to improve the child's quality of life by correcting any postural deformity and reducing the accompanying symptoms, such as pain, muscle stiffness and contractures, mobility problems, or more rapid muscle fatigue. Appropriate treatment should be preceded by a thorough examination and diagnosis of the child by a physiotherapist or a physician. A correct diagnosis allows the selection of appropriate physiotherapeutic methods to achieve the best possible results for the patient. Numerous instruments can be used to evaluate children's feet. These include the plantocontourgraph, podoscope, pedobarograph mat and radiographs [6, 7, 8].

Several physiotherapy techniques are available for the treatment of flat feet and pes plano valgus in children. The most commonly used when working with the patient are corrective exercises the main goal of which is to restore normal foot function. In order to achieve the best possible results from physiotherapy, the types of exercises and their intensity should be determined individually for each patient [9].

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To combat undesirable symptoms, such as pain or increased muscle tension, physical therapy methods are useful and include electrotherapy, cryotherapy, laser therapy, etc. It is also helpful to combine physiotherapy with the use of supinating insoles, which are inserted into the child's shoes. Such insoles should be selected individually for each patient and yields the best possible results from the exercises [10].

Various types of questionnaires can be used to assess the quality of life. They include questions about the presence and severity of symptoms, problems with performing daily activities, general well-being, etc. Standardised general questionnaires can be used, such as the World Health Organisation's quality of life questionnaire (WHOQOL-BREF), which was validated into Polish by Jaracz K. et al. in 2006 [11] or the quality of life questionnaire SF-36 (SF-36) validated by Kłosiński M. et al. in 2014 [12]. Other questionnaires can also be used that focus on the assessment of the patient's foot, such as the American Orthopaedic Foot & Ankle Society (AOFAS) ankle and hindfoot assessment system [13, 14], or the Oxford ankle foot questionnaire for children (OxAFQ-C) [15, 16]. In addition, to evaluate subjective symptoms such as pain, visual analogue scales (VAS) can be used by the patient to indicate the severity of their pain. These scales can be numeric or descriptive [17, 18].

The questionnaire for the assessment of the ankle and ankle joint, validated into Polish by Boszczyk A. et al. in 2015, is the Foot and Ankle Outcomes Questionnaire. It consists of 25 questions and the score is presented in the range of 0–100 points, and can be used in both children and adults [19].

OBJECTIVES

The main focus of the study is to assess the quality of life in children after subtalar arthroereisis, and to evaluate the conservative treatment methods applied before and after surgery. In addition, the gender-dependent frequency of flat feet and the effectiveness of physiotherapy performed before and after surgery on the quality of life of the children are assessed. There is also an analysis of how the tarsal sinus arthroereisis procedure affected the incidence and severity of symptoms and the need for orthopaedic supplies among the children studied.

MATERIALS AND METHOD

A retrospective study was performed with a cohort of 79 patients, 61 of whom had surgery on both feet (comprising 140 operated feet of children). The study included children aged 9–17 years (55 boys and 24 girls, mean age 12.7). Patients underwent subtalar arthroereisis surgery in the Department of Orthopaedics and Traumatology for Children of the City Hospital Complex in Chorzów, Silesia, Western Poland, over a period of 3 years (2019–2021). The same surgical procedure was performed in all patients. Of the 140 procedures performed, none were a revision procedure. The exclusion criteria were concomitant neurological diseases, including cerebral palsy, genetic defect syndromes and malignant diseases, as well as the participant's age of 18 years at the time of surgery, and lack of parent or guardian consent to participate in the study.

The research protocol received a positive opinion from the Bioethics Committee of the Silesian Medical University in Katowice, Silesia (KNW/0022/ KB /233/19), as well as approval from the hospital director for the volunteer service. This made it possible to assemble the study group based on the patients' medical history.

All parents/legal guardians were contacted by telephone in January 2022 and were informed about the study, its purpose and research methods, and that participation was voluntary and anonymous. Due to Covid 19 pandemic restrictions, parents/legal guardians who had consented to the study were contacted by email. After obtaining consent to participate in the study, questionnaires were sent using SurveyMonkey – a survey creation software. In this way, patients' post-operative clinical effects, rehabilitation, and quality of life were assessed simultaneously at 3 intervals after subtalar arthroereis surgery: 6–12 months, 13–24 months, or > 25 months.

A survey form with 30 questions on demographics, disease, and quality of life was completed by each participant. Data on general characteristics, such as age, gender, hospital treatment, including surgery, perceived health status, number of diseases and current use of medications, and physiotherapy methods used before and after surgery, were also collected. The second questionnaire used in the study was the abbreviated version of the World Health Organisation's quality of life assessment questionnaire (WHOQOL-BREF), validated into Polish by Jaracz K. et al. It contained 26 questions for the assessment of the quality of life and health in the somatic, psychological, social and environmental domains. The score range for each question was from 1–5 points. Approval was obtained from the WHO for the questionnaire's use in the current study.

Statistical analyses were performed using the statistical software IBM SPSS Statistics 28. The statistical methods used included 1) the chi-square independence test, used to compare the proportion of observations in each condition, 2) the Wilcoxon rank sum test, used to compare the frequency of specific behaviours, and 3) a 2-factor analysis of variance, used to track the interaction between pre-operative and post-operative ratings and the time that had elapsed since surgery. The significance threshold was $\alpha=0.05$.

RESULTS

Analysis of the differences in the occurrence of flat feet revealed statistically significant differences: $\chi 2=11.05$; df=1; $p=0.001$. The condition occurred twice as often in boys as in girls. The subtalar arthroereisis procedure was also performed more frequently in boys (Fig. 1).

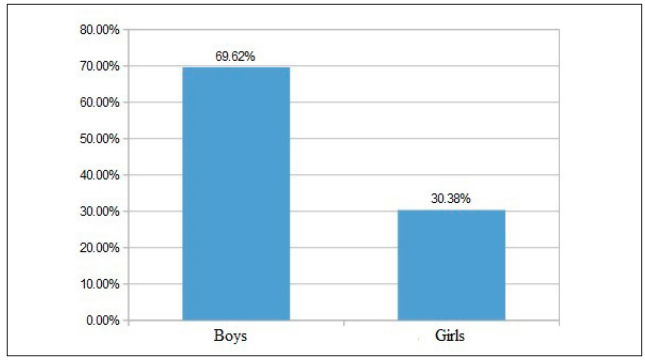

Figure 1. Prevalence of plano-valgus foot in children depending on gender in all examined children

The analysis distinguished between pre-operative and post-operative problems (Fig. 2). There was no statistically significant interaction between the time that had elapsed since surgery and the frequency of problems before and after surgery ($F(10,350)=1.01$; $p=0.435$). Statistically significant outcomes, such as movement problems and difficulties when walking, occurred more frequently in children after surgery (42%±11%) than in those before surgery (11%±8%), but this was seen only in the group assessed within the first 12 months after surgery. Similarly, scores for the rapid onset of fatigue after exercise were statistically significantly lower in children who were assessed 12–24 months after surgery (30%±9%) than in those before surgery (59%±9%). The outcomes regarding Achilles tendon contracture were also statistically significant and occurred less frequently in children who were assessed 12–24 months after surgery (7%±4%), compared with the outcomes before surgery (22%±7%).

No similar outcomes were observed up to 12 months after surgery and more than 24 months after surgery. As a significant effect, it was found that children from the group in which the period between surgery and the study was 25–36 months were less likely to have corns, calluses, and abrasions on their feet (11%±5%) than the children who were assessed before surgery (44%±9%); similar differences among the children in the other groups were not confirmed.

In summary, a main effect of surgery alone was found for the averaged measure of problems: $F(1, 350)=6.37$; $p=0.014$. Parents/guardians reported an average of 8% fewer problems in children after surgery (20%±5%) compared with their pre-surgery values (28%±5%). This difference increased with the time elapsed after surgery: 1) up to 12 months (before: 25%±5% vs. after: 22%±5%), 2) up to 24 months (before: 36%±5% vs. after: 24%±4%), and 3) up to 36 months (before: 24%±5% vs. after: 13%±4%). The results confirm that subtalar arthroereisis surgery had a positive effect on the reduction of symptoms, and that this effect was more frequent in the groups of children who were examined more than 12 months after surgery.

When comparing the demand for orthopaedic aids before and after surgery in the different groups of children, no significant effect was found: $F(4,134)=0.39$; $p=0.817$ (Fig. 3). Individual outcomes, such as the use of surgical footbeds and

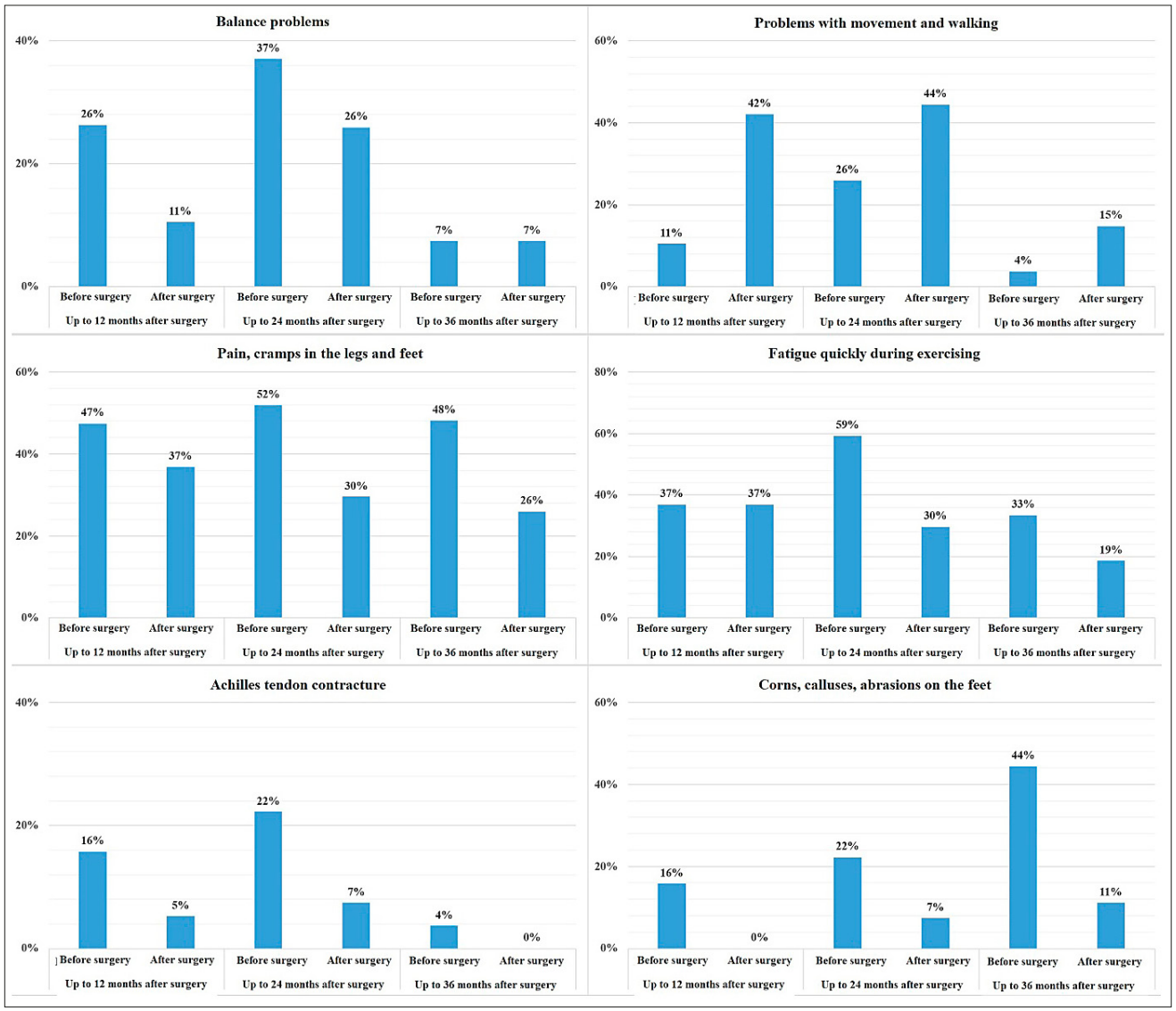

Figure 2. Incidence of symptoms associated with flat feet, i.e. problems with balance, movement and walking, calf pain/cramps, fatique quickly during exercising, Achilles tendon contracture and corns, calluses and abrasions on the feet in children assessed in3 groups (up to 12 months after surgery, 13–24 months after surgery and more than 24 months after surgery)

orthopaedic footwear, were statistically significant (p <0.05.). Regardless of the time that had elapsed since surgery, children were, on average, 44% less likely to need surgical footbeds after surgery (9%±6%) compared with the preoperative outcomes (53%±11%).The largest difference was observed in the period up to 12 months after surgery, whereas the effect gradually diminished in later periods as some children showed a renewed need for surgical footbeds. When the use of orthopaedic footwear was analysed, a significant decrease in this need was observed only among the groups of children assessed up to 12 months and 13–24 months after surgery. In the group assessed up to 12 months after surgery, the need decreased to zero (24%±11%) compared with the preoperative data. In contrast, the need for orthopaedic footwear was less frequently reported in the group assessed post-operatively at 13–24 months (11%±5%), compared with the preoperative results (33%±8%). No significant changes were noted in children in the group assessed more than 24 months after surgery. An analysis of the differences in orthotic use also revealed no significant differences before and after surgery. The results confirmed that surgery mainly had a positive effect on reducing the use of orthopedic insoles and orthotic shoes up to 24 months after surgery.

The results regarding the assessment of the children's quality of life, based on the 24 questions of the WHOQOL-BREF questionnaire, showed that the quality of life after subtalar arthroereisis was relatively high, and was above average on a measurement scale of 4–20 points. However, analysis of the results showed no statistically significant differences in the various domains regarding their quality of life: somatic (p=0.347), psychological (p=0.772), social (p=0.942) and environmental (p=0.812), depending on the time that had elapsed between the surgery and the study. (This means that the time period had no influence on the children's objective quality of life after subtalar arthroereisis). (Fig. 4). There were also no statistically significant differences in the 2 auxiliary questions from the WHOQOL-BREF questionnaire regarding the subjectively perceived quality of life (Fig. 5). Both the subjective quality of life (p=0.617) and level of satisfaction regarding health (p=0.830) were above average (M = 3). The results show that regardless of the time that had elapsed since the operation, a high quality of life and satisfaction with their health were found among the children (up 12 months, 13–24 months, more than 24 months after surgery).

When asked about the impact of physiotherapy on their quality of life before and after surgery (Fig. 6), about 60% of

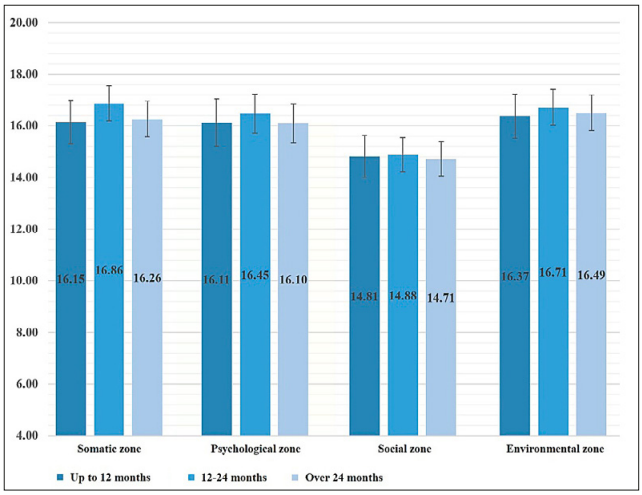

Figure 4. Somatic, psychological, social and environmental quality of life scores according to WHOQOL-BREF questionnaire assessed in 3 groups (up to 12 months after surgery, 13–24 months after surgery and more than 24 months after surgery)

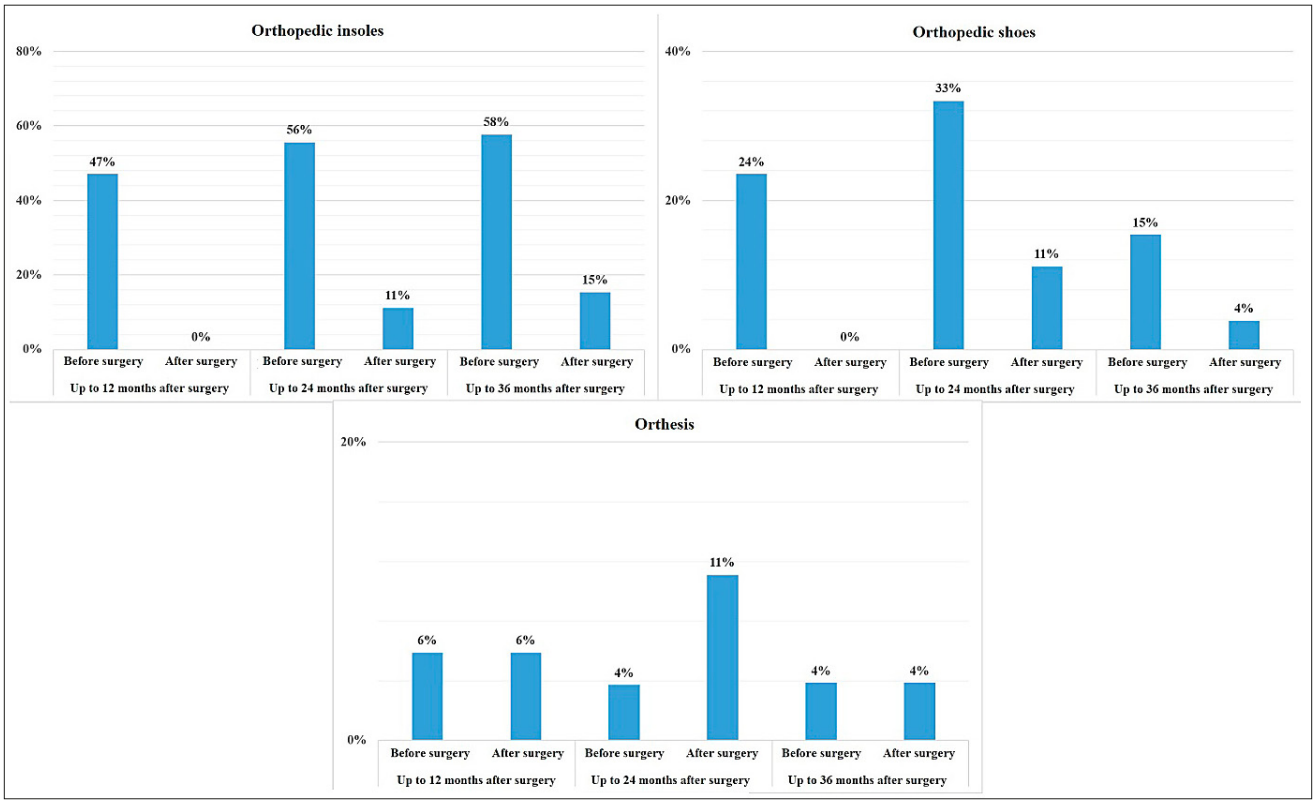

Figure 3. Assessment of the need for orthopaedic supplies, i.e. orthopaedic insoles and shoes, and orthoses, assessed in 3 groups (up to 12 months after surgery, 13–24 months after surgery and more than 24 months after surgery

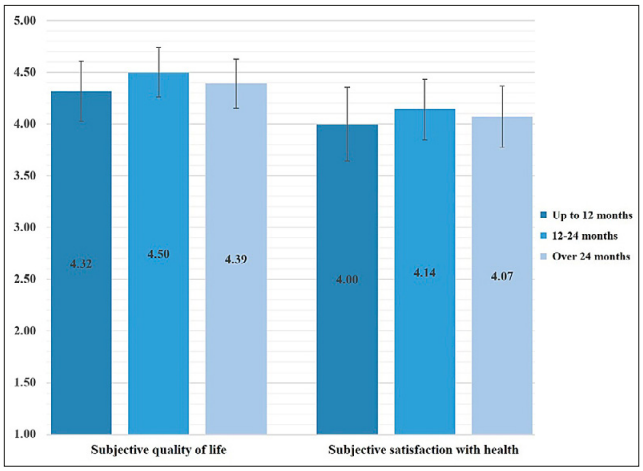

Figure 5. Evaluation of the supportive questions according to the WHOQOL-BREF questionnaire on subjective quality of life and subjective satisfaction with health assessed in 3 groups (up to 12 months after surgery, 13–24 months after surgery and more than 24 months after surgery)

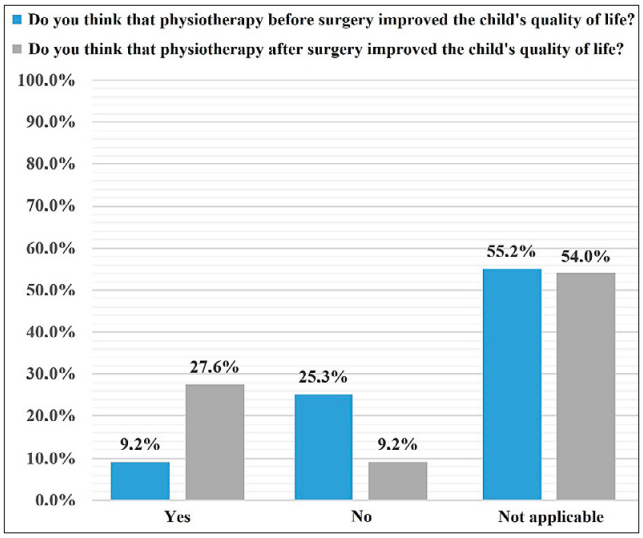

Figure 6. Evaluation of the effects of physiotherapy on the children's quality of life, based on the questions in the survey form

the respondents answered that the question did not apply to them, or they did not give an answer. The results for the remaining 40% of respondents showed that 25% of parents felt that physiotherapy did not improve their children's quality of life before surgery, while the ratio was reversed after surgery, when almost 28% of parents observed an improvement in their children's quality of life after physiotherapy.

In summary, physiotherapy before surgery did not have a positive impact on quality of life, while after surgery there was an improvement in the children's quality of life due to physiotherapy (Fig. 6).

DISCUSSION

The majority of patients in the study group were boys, a ratio that has been observed in many other studies [3, 4, 13, 14, 15, 16, 17, 18, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34], and could indicate that the flat foot defect is more common in boys than in girls.

The best results for the treatment were observed when the procedure is performed between the ages of 9–12 years. This finding was confirmed in the study by A. Mazzotti et al. Children who are operated on before the age of 9 years are more likely to show no long-term improvement, while only partial improvement is observed if the operation is performed when the child is older than 13 years [4]. H. Kubo et al. also confirmed in their study that the best results after subtalar arthroereisis are seen in children who are operated on between the ages of 9 -2 [31].

The impact of subtalar arthroereisis on the children's quality of life was confirmed in a study by G. L. di Gennaro et al., which aimed to compare the surgical and non-surgical treatment of children with flat feet. The non-surgical group consisted of 37 children (47 feet were analysed). In contrast, 21 children (34 feet) were in the operative group. All the children were between 9 and 17 years old. It was found that the patients in the surgical group demonstrated better results from treatment. G. L. di Gennaro et al. showed that surgical treatment was therefore superior to non-surgical treatment [20]. A study by Bing Li et al. also confirmed the positive effect of subtalar arthroereisis in the treatment of flat feet in children, when employed in combination with soft-tissue treatments. The study included 30 patients with flat feet (32 feet) aged between 8–12 years. The authors demonstrated that pain levels decreased, and the foot position improved after treatment [17]. A. Mazzotti et al. investigated the long-term effects of subtalar arthroereisis in the treatment of flat feet in children in which the average follow-up time of the patients was 180 months. The authors demonstrated that the long-term effects in children after subtalar arthroereisis surgery were satisfactory [4]. In another study, C. Faldini et al. investigated the quality of life of children after subtalar arthroereisis surgery. The authors used self-administered questionnaires in their study, which was conducted on 173 patients (average age 11.2 years). The authors demonstrated that the children's quality of life improved significantly after subtalar arthroereisis was performed. They also reported that the time needed before returning to physical activity after the procedure was 4.7 +/- 0.2 months [30].

To assess the impact of subtalar arthroereisis, the American Orthopaedic Foot & Ankle Society (AOFAS) maintain that the ankle and hindfoot scoring system is the most commonly chosen questionnaire. It was used in the studies by P. Megremis and O. Megremis [13], M. Elmarghanya et al. [14], S. S. Leonchuk et al. [3], G. Luigi di Gennaro et al. [20], B. Li, Wenbao He, et al. [17], S. Wang, Li Chen et al. [21], M. Ali Tahririan, S. Ramtin and P. Taheri [18], A. Bernasconia et al. [22], J. Hong, G. Dai, Q. Weng, and Yang Liu [27], A. Mazzotti et al. [4], L. Cao et al. [29] and Sakti P. Das et al. [32]. In addition, the Oxford Ankle Foot Questionnaire for Children (OxAFQ-C) was used by D. Ruiz-Picazo et al. [15], N. Martinelli et al. [16] and S. P. Das et al. [32], while the Foot Function Index (FFI) was used by B. Vogt et al. [23] and C. Faldini et al. [30].

Although subtalar arthroereisis is the most commonly performed surgery in children with flat feet, it is not the only procedure that can be performed to restore the correct alignment of the foot; another treatment method is lateral calcaneal lengthening (LCL). M. Ali Tahririan, S. Ramtin and P. Taheri presented a comparison of the effects of this treatment with those of treaed by subtalar arthroereisis. The authors demonstrated that although the functional and radiological outcomes were similar after both surgeries, there was greater parent/guardian satisfaction after subtalar

arthroereisis was performed in the child. This was probably related to the child's ability to start improving more quickly, and the shorter recovery process after this surgery [18].

Other techniques that can be performed in the treatment of flat feet include Mosca heel-lengthening osteotomy, Grice extra-articular arthrodesis and triple arthrodesis. The effects of the use of the various techniques were compared with those of subtalar arthroereisis by A.G. Sterian et al. The authors also showed that improvement was recorded after treatment with each of these methods. The differences that emerged in their study were a significant reduction in the length of hospital stay and pain levels after subtalar arthroereisis, compared to the other surgical techniques studied [25].

Limitation and strength of the study. The major drawback of this study was the lack of a control group that would have allowed comparison of the effects of surgical treatment with those of conservative treatment over time.

A strength of the study is the use of the standardized and validated questionnaire WHOQOL-BREF which, however, contains questions on the general assessment of quality of life, and it would be worthwhile extending the study to include a questionnaire for direct assessment of the ankle and foot in children. Another plus of the study is the standardized study group. The children studied were operated on in the same hospital, by the same physicians, and with the same surgical technique. However, the disadvantage is that individual patient contact for the physical examination was not possible due to the restrictions imposed by the Covid -19 pandemic.

CONCLUSIONS

The subtalar arthroereisis procedure is more commonly performed in boys. It is used in the treatment of flat feet and provides an improvement in quality of life and a quick return to physical activity in children. The quality of life reported after the subtalar arthroereisis surgery was high in all areas studied, i.e. the somatic, psychological, social and environmental domains. After the surgery, the children were not as tired after engaging in sports as they were before the surgery, and the perceived contracture of the Achilles tendon decreased. The surgery had a positive effect on the decrease in these complaints, which was observed most strongly more than 12 months after surgery. In addition, the children needed surgical footbeds and orthopaedic footwear less often after the surgery than they did before the surgery. It was also evident that the physiotherapy performed after the surgery seemed to have a positive influence on the children's quality of life.

As for the research, a control group to compare conservative and surgical treatment, could not be obtained. It would be a good idea to extend the study to include a comparison with a control group to improve the quality of future studies.

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REFERENCES

1. Priyanka S, Murugan S. Anti Pronation Taping and Its Effect on Balance, Explosive Power and Agility of School Going Children with Flat Foot. Indian J Public Health Res Dev. 2020;11(7):934–939.
2. Lynn SK, Padilla RA, Tsang KW. Differences in Static- and Dynamic-Balance Task Performance After 4 Weeks of Intrinsic-Foot-Muscle Training: The Short-Foot Exercise Versus the Towel-Curl Exercise. J Sport Rehabil. 2012;21(4):327–33.
3. Leonchuk SS, Dyachkov K, Neretin AS, et al. Subtalar arthroereisis for treatment of children with flexible planovalgus foot deformity and analysis of CT data in long-term period. J Orthopaedics. 2020;22:478–484.
4. Mazzotti A, Di Martino A, Geraci G, et al. Long-term results of subtalar arthroereisis for the treatment of symptomatic flexible flatfoot in children: an average fifteen year follow-up study. Int Orthop. 2021;45:657–664.
5. Paoloa C, Giadaa L, Lisaa B, et al. Functional evaluation of bilateral subtalar arthroereisis for the correction of flexible flatfoot in children: 1-year follow-up. Gait Posture. 2018;64:152–158.
6. Carr II JB, Yang S, Lather LA. Pediatric Pes Planus: A Stateof-the-Art Review. Pediatrics. 2016;137(3):20151230.
7. Landorf KB, Radford JA, Hudson S. Minimal Important Difference (MID) of two commonly used outcome measures for foot problems. J Foot Ankle Res. 2010;3:7.
8. Balci P, Nohutlu ÖE, Bek N, et al. Does flexible taping effect contact area, time and total loading of foot in children with flatfoot? Develop Med Child Neurol. 2014;56:4.
9. Walkowska K, Siwiec S. Ćwiczenia krótkiej stopy (SFE) jako forma przeciwdziałania płaskostopiu u dzieci. In: Borowicz AM, Osińska M. Horyzonty współczesnej fizjoterapii. Poznań: Wyd. Wyższej Szkoły Edukacji i Terapii; 2016. p. 89–99.
10. Kuliński W, Zeman K. Fizjoterapia w pediatrii. Warszawa: Wyd. PZWL; 2014.
11. Jaracz K, Kalfoss M, Górna K, Bączyk G. Quality of life in Polish respondents: psychometric properties of the Polish WHOQOL – Bref. Scand J Caring Sci. 2006;20:251–260.
12. Kłosiński M, Tomaszewski KA, Tomaszewska IM, et al. Validation of the Polish language version of the SF-36 Health Survey in patients suffering from lumbar spinal stenosis. Ann Agric Environ Med. 2014;21(4):866–870.
13. Megremis P, Megremis O. Arthroereisis for Symptomatic Flexible Flatfoot Deformity in Young Children: Radiological Assessment and Short-Term Follow-Up. J Foot Ankle Surg. 2019;58:904–915.
14. Elmarghanya M, El-Ghaffara TMA, Elgeushya A, et al. Is subtalar extra articular screw arthroereisis (SESA) reducing pain and restoring medial longitudinal arch in children with flexible flat foot? J Orthopaedics. 2020;20:147–153.
15. Ruiz-Picazo D, Jiménez-Ortega P, Doñate-Pérez F, et al. Radiographic and Functional Results following Subtalar Arthroereisis in Pediatric Flexible Flatfoot. Adv Orthopedics. 2019;5061934.
16. Martinelli N, Bianchi A, Martinkevich P, et al. Return to sport activities after subtalar arthroereisis for correction of pediatric flexible flatfoot. J Pediatr Orthop. 2018;27:1.
17. Li B, He W, Yu G, et al. Treatment for Flexible Flatfoot in Children With Subtalar Arthroereisis and Soft Tissue Procedures. Front Pediatr. 2021;9:656178.
18. Tahririan MA, Ramtin S, Taheri P. Functional and radiographic comparison of subtalar arthroereisis and lateral calcaneal lengthening in the surgical treatment of flexible flatfoot in children. Int Orthop. 2021;45:2291–2298.
19. Boszczyk A, Błoński M, Pomianowski S. Translation, Cultural Adaptation and Validation of Polish Version of Foot and Ankle Outcomes Questionnaire. Ortop Traumatol Rehabil. 2015;2(6):175–187.
20. Di Gennaro GL, Stallone S, Olivotto E, et al. Operative versus nonoperative treatment in children with painful rigid flatfoot and talocalcaneal coalition. BMC Musculoskelet Disord. 2020;21:185.
21. Wang S, Chen L, Yu J, et al. Mid-term Results of Subtalar Arthroereisis with Talar-Fit Implant in Pediatric Flexible Flatfoot and Identifying the Effects of Adjunctive Procedures and Risk Factors for Sinus Tarsi Pain. Orthop Surg. 2021;13:175–184.
22. Bernasconia A, Iervolino C, D'Alterio R, et al. Midterm assessment of subtalar arthroereisis for correction of flexible flatfeet in children. Orthop Traumatol Surg Res. 2020;106:185–191.
23. Vogt B, Toporowski G, Gosheger G, et al. Subtalar Arthroereisis for Flexible Flatfoot in Children – Clinical, Radiographic and

Pedobarographic Outcome Comparing Three Different Methods. Children. 2021;8:359.
24. Braito M, Radlwimmer M, Dammerer D, et al. Tarsometatarsal bone remodelling after subtalar arthroereisis. J Children's Orthopeadics. 2020;14:221–229.
25. Sterian AG, Ulici A. Quality of Life after Flatfoot Surgery in the Pediatric Population. J Med Life. 2020;13:356–361.
26. Hagen L, Kostakev M, Pape JP, Peterlein CD. Are there benefits of a 2D gait analysis in the evaluation of the subtalar extra-articular screw arthroereisis? Short-term investigation in children. Clin Biomechanics. 2019;63:73–78.
27. Hong J, Dai G, Weng Q, Liu Y. Interference Screw for the Treatment of Pediatric Flexible Flatfoot. J Foot Ankle Surg. 2020;59:1209–1214.
28. Arbab D, Frank D, Bouillon B, et al. Subtalare Screw Arthroereisis for the Treatment of Symptomatic, Flexible Pes Planovalgus. Orthop Unfall. 2018;156(01):93–99.
29. Cao L, Miao X, Wu Y, et al. Therapeutic Outcomes of Kalix II in Treating Juvenile Flexible Flatfoot. Orthop Surg. 2017;9:20–27.
30. Faldini C, Mazzotti A, Panciera A, et al. Patient-perceived outcomes after subtalar arthroereisis with bioabsorbable implants for flexible flatfoot in growing age: a 4-year follow-up study. Eur J Orthop Surg Traumatol. 2018;28:707–712.
31. Hagen L, Pape JP, Kostakev M, Peterlein CD. Pedobarographic changes during first month after subtalar extra-articular screw arthroereisis (SESA) operation of juvenile flexible flatfoot. Arch Orthop Trauma Surg. 2020;140:313–320.
32. Das SP, Das PB, Ganesh S, Sahu MC. Effectiveness of surgically treated symptomatic plano-valgus deformity by the calcaneo stop procedure according to radiological, functional and gait parameters. J Taibah Univ Med Sci. 2017;12(2):102–109.
33. Indino C, Villafañe JH, D'Ambrosi R, et al. Effectiveness of subtalar arthroereisis with endorthesis for pediatric flexible flat foot: a retrospective cross-sectional study with final follow up at skeletal maturity. J Foot Ankle Surg. 2020;26:98–104.
34. Giannini S, Cadossi M,, Mazzotti A, et al. Bioabsorbable Calcaneo-Stop Implant for the Treatment of Flexible Flatfoot: A Retrospective Cohort Study at a Minimum Follow-Up of 4 Years. J Foot Ankle Surg. 2017;56:776–782.
35. Kubo H, Lipp C, Hufeland M, et al. Outcome after subtalar screw arthroereisis in children with flexible flatfoot depends on time of treatment: Midterm results of 95 cases. J Orthop Sci. 2020;25:497–502.