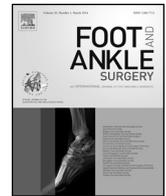




Contents lists available at ScienceDirect

Foot and Ankle Surgery

journal homepage: www.elsevier.com/locate/fas



The effectiveness of three-phase physiotherapy program in children with clubfoot after Ponseti treatment

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ARTICLE INFO

Article history:

Received 26 October 2020

Received in revised form 25 January 2021

Accepted 1 March 2021

Available online xxx

Keywords:

Clubfoot

Pes equinovarus

Physiotherapy

Rehabilitation

ABSTRACT

Backgrounds: Clubfoot is a foot disorder frequently seen. Although, there are several studies about the efficiency of physiotherapy in the treatment of clubfoot, physiotherapy programs may be more efficient if the treatment apply step by step similar to the logic of the serial casting progression of the involved foot. Therefore, the aim of this study was to determine the effectiveness of three-phase physiotherapy program in children with clubfoot.

Methods: Fifty-seven patients (37 males, 20 females; 7.26 ± 1.27 years) with clubfoot which had Ponseti treatment before were included. The ankle dorsiflexion (DF) and plantar flexion (PF) ranges of motion (ROM), one-leg standing time, sit-to-stand test, The Oxford Ankle Foot Questionnaire (OxAFQ) and treatment satisfaction were evaluated before and after treatment. A three-phase physiotherapy program was applied for 3 months.

Results: DF, PF, one-leg standing time, sit-to-stand test, treatment satisfaction and all parameters of OxAFQ except 'Emotional' parameter of OxAFQ-Children significantly improved after treatment ($p < 0.05$).

Conclusions: The three-phase physiotherapy program increased the ankle range of motion, improved functional status and treatment satisfaction in children with clubfoot. The three-phase physiotherapy might be a reasonable treatment for clubfoot. Although, there is a need for long-term studies to understand its effects on preventing relapse.

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1. Introduction

Clubfoot is a frequent congenital anomaly of the musculoskeletal system which is intervened the muscle as the bone deformity with a global incidence rate of 1 per 1000 live-births albeit some geographical variations [1]. Several hypotheses have been put forward to explain the etiology of clubfoot including a developmental arrest of the neuromuscular unit during intrauterine development, a compression effect in the intrauterine cavity due to inadequate space for the fetus, or genetic mutations, although none have been confirmed [2,3]. The foot is positioned in

supination, adduction, and varus when standing. Compared to normal feet, the smaller support area, muscular problems, and joint instability may impair balance in patients with clubfoot [4,5]. The Ponseti technique involving manipulation and casting has widespread acceptance with increasing rates of use for the management of clubfoot. This technique allows for easy correction of the anatomical deformation of the feet and reduces the need for surgery [6,7]. In the literature, there is a number of studies available about the efficiency of physiotherapeutic methods in the treatment of clubfoot patients [8–10]. The French method which contained daily stretching and strengthening exercises is one of the mostly known physiotherapy techniques [10–14]. The combination of Ponseti treatment with the French physiotherapy as described by Canavese et al. is the other physiotherapeutic option [15], although those methods reported a high risk of aggressive surgeries like posterior or posteromedial releases compared to Ponseti method. On the other hand, according to our clinical experiences, because of the nature of

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the clubfoot, physiotherapy programs may be more efficient if the treatment apply step by step similar to the logic of the serial casting progression of the involved foot [16]. Therefore, the aim of this study was to determine the effectiveness of three-phase physiotherapy program in children with clubfoot treated with Ponseti method previously.

2. Methods

2.1. Patients

A total of 62 patients (age, 7.26 ± 1.27 years) with clubfoot included in the study. The cases which have been diagnosed with clubfoot at the orthopedics department between February 2016 and March 2018 was included to study.

Inclusion criteria were as following: Having a diagnosis of unilateral congenital clubfoot, to be treated with the Ponseti method and not having received physiotherapy and rehabilitation in previous treatments.

Children were younger than 3 years of age, non-idiopathic cases, who were bilaterally affected and had physiotherapy previously were excluded. All patients and their parents were informed about the study and written informed consent form was obtained from the parents of the patients. The study was approved by the Ethics Committee of Istanbul Medipol University (Number 2016/530) and was conducted in accordance with the Declaration of Helsinki.

2.2. Study design

This study was planned as a case series. The two physiotherapists were got in charge of the participants' process. The first physiotherapist (GL) evaluated the patients at the baseline and immediately after the exercise program. The second physiotherapist (DT) applied the exercise program to the patients.

2.3. Outcome measures

2.3.1. Range of motion

The pre-study and post-study ankle dorsiflexion (DF) and plantar flexion (PF) passive ranges of motion (ROM) were measured by goniometric measurement [17].

2.3.2. One-leg standing test

The one leg standing test is considered to be potentially useful for predicting functional deterioration [18]. In the present study, we used the one leg standing test in the eyes open condition.

2.3.3. Sit to stand test

The number of bilateral squats completed in 60 s is recorded [19].

2.3.4. The Oxford Ankle Foot Questionnaire for Children and Parent (OxAFQ-C/P)

OxAFQ is a child or parent-reported (or caregiver) self-report health status questionnaire. (The Oxford Ankle Foot Questionnaire for Children (OxAFQ-C) – A Guide to the Scoring System, Oxford University Innovation Limited 2011). In this study, children and their parents were individually questioned.

2.3.5. Treatment satisfaction

Treatment satisfaction levels were evaluated by means of a 10 cm visual analog scale and the family's statements. The participants were asked to sign in the scale about the treatment where 0 means that the subject is not satisfied at all and 10 means that the subject is highly satisfying.

2.4. Intervention

A three-phased physiotherapy program was applied for 45 min to all cases 2 times a week during 3 months by a physiotherapist (Fig. 1).

2.4.1. Three phases of physiotherapy program

2.4.1.1. First phase (month 1). Physiotherapist applied subtalar and talocrural joint mobilization in the supine position. The subtalar joint was mobilized in 2 directions with the therapist's hand holding the thumb in a way to support the medial malleolus, with mild traction and abduction with the other hand.

After that, Achilles stretching in subtalar neutral position and foot intrinsic and invertor muscle stretching were applied. Finally, parents/caregivers were educated about stretching exercises to do at home during physiotherapy process. The home exercise program included the plantar fascia relaxation massage, subtalar joint mobilization, active assistive dorsi flexion and eversion range of motion exercises, sensory stimulation to the tibialis anterior and peronous longus muscles (with balls, brushes, etc.). The home exercise program was recommended 4 days a week, 1 time a day with 15 repetitions.

2.4.1.2. Second phase (month 2). Subtalar and talocrural joint mobilizations were carried on during the second phase. Kinesio taping was used for fibularis longus and brevis muscles to stimulate muscle activation for involved foot in clubfoot (Fig. 2). At the end of the second phase, kinesio taping was performed bilaterally to involved foot and healthy foot for four times. Functional exercises including ball exercises, walking on different grounds and weight bearing were used.

2.4.1.3. Third phase (month 3). Standing on one leg without aid, standing on the edge of a stair with forefoot and standing on balance board exercises were used for balance and proprioception training. The exercises were applied bilaterally and unilaterally progressively. Strengthening exercises of tibialis anterior and peroneal muscles were used.

2.5. Statistics

The data were evaluated using the Statistical Package for Social Science (SPSS) version 21.0 software for Windows. We performed a power analysis to determine the sample size at the beginning of the study, using the Raosoft sample size calculator before the statistical analysis. All the variables cohered to the normal distribution ($p > 0.05$) according to the Kolmogorov-Smirnov test. An independent samples t-test was used to determine the

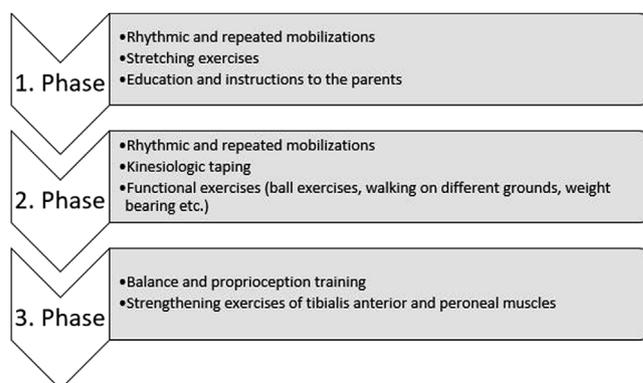


Fig. 1. A three-phased physiotherapy program.



Fig. 2. Kinesio taping application for fibularis longus and brevis muscles.

differences in the subjects' demographic and clinical features. A paired samples t-test was used to determine the effects of the exercise program. A significance level of $p < 0.05$ was used.

3. Results

Total of 57 patients completed the treatment, 5 patients dropped out of the study because of various reasons such as difficulty accessing the clinic, or parents' program mismatch. The demographic and clinical features of the patients are shown in Table 1.

The mean age of the patients (37 males, 20 females) was 7.26 ± 1.27 years. The DF values, PF values, the one-leg standing time, sit-to-stand test and treatment satisfaction were significantly improved after treatment ($p < 0.05$). Significant differences were observed in all evaluation parameters of The Oxford Ankle Foot Questionnaire except 'Emotional' parameter of OxAFQ-Children after treatment.

The changes in outcome measures at the end of the exercise program are represented in Tables 2 and 3.

4. Discussion

The present study investigated the efficiency of three-phase physiotherapy program consisting of exercise, mobilization, and kinesio taping in children with clubfoot and the results demonstrated that the three-phase physiotherapy program increased the ankle range of motion, improved functional status and treatment satisfaction.

Although all of the basic conservative methods use common exercises such as stretching, there is lack of information about

Table 1
Demographic and clinical features of patients.

Demographic/clinic features	Patients (n = 57)
Age, years, mean \pm SD	7.26 \pm 1.27
Sex, F/M	20/37
BMI, kg/m ² mean \pm SD	15.7 \pm 6.24
Affected foot, R/L	23/34

Abbreviations. SD: standard deviation; F: female; M: male; BMI: body mass index; R: right; L: left.

Table 2
Comparison of ankle range of motions, functional tests and satisfaction before and after treatment.

	Pre-treatment mean \pm SD	Post-treatment mean \pm SD	p
Dorsiflexion ROM ($^{\circ}$)	15.71 $^{\circ}$ \pm 9.32 $^{\circ}$	24.74 $^{\circ}$ \pm 7.31 $^{\circ}$	0.017*
Plantarflexion ROM ($^{\circ}$)	35.71 $^{\circ}$ \pm 19.71 $^{\circ}$	47.41 $^{\circ}$ \pm 14.84 $^{\circ}$	0.023*
One-leg standing test (s)	26.57 \pm 10.19	87.85 \pm 15.36	0.018*
Sit-to-stand test	2.71 \pm 0.75	5 \pm 0.81	0.014*
Treatment satisfaction	3.14 \pm 0.69	7.27 \pm 1.11	0.017*

Abbreviations. ROM: Range of motion, s: second, * $p < 0.05$.

Table 3
Comparison of The Oxford Ankle Foot Questionnaire scores before and after treatment.

OxAFQ-C	Pre-treatment mean \pm SD	Post-treatment mean \pm SD	p
Physical	42.14 \pm 11.58	86.23 \pm 19.52	0.003*
School and play	68.75 \pm 21.44	75 \pm 18.96	0.007*
Emotional	62.50 \pm 16.21	64.33 \pm 10.48	0.223
Footwear	16.66 \pm 5.26	28.07 \pm 8.36	0.009*
OxAFQ-P			
Physical	29.16 \pm 12.53	83.33 \pm 17.24	0.001*
School and play	34.64 \pm 10.32	72.14 \pm 23.42	0.028*
Emotional	37.50 \pm 13.40	58.22 \pm 16.33	0.007*
Footwear	18.42 \pm 11.24	32.17 \pm 11.21	0.012*

Abbreviations. OxAFQ-C: Oxford Ankle Foot Questionnaire for Children, OxAFQ-P: Oxford Ankle Foot Questionnaire for Parent * $p < 0.05$.

standard protocols such as duration or intensity of stretching and strengthening exercises to guide other physiotherapists [20,21]. In present literature, family or caregivers of the patient are educated about basic stretching and strengthening exercises and generally, exercises are applied without physiotherapist supervision. In our study, the exercise protocol was clearly identified and applied by physiotherapist. It is the first strength of our study. Additionally, due to it is parallel to the progression of Ponseti method and the biomechanical improvement of the foot and lower extremity in children with clubfoot, the three-phase physiotherapy is a physiotherapy program which families and child can be easily adapt to.

In the literature, studies which conducted kinesio taping for ankle at different pathologies suggested that kinesio taping is an effective factor on biomechanics and the function of the lower limb [22]. For this reason, kinesio taping may contribute to improving the functional parameters in our study.

The children treated with the Ponseti method has shown multiple kinematic differences when compared to healthy controls in gait analysis, particularly, patients with clubfoot tend to have a decreased range of motion at the ankle, a decreased foot progression angle, and less power with ankle plantar flexion [23]. According to our results, ankle dorsi and plantar flexion range of motion were significantly increased after the treatment. Therefore, our physiotherapy program may be useful to improve gait behavior.

The functional activities (sit-to-stand test and one leg stand) and the school and play parameters of OxAFQ-C and OxAFQ-P significantly improved after treatment. Especially, our results showed similarity to the literature which suggested that congenital clubfoot with satisfactory treatment does not significantly impair athletic performance [24]. We concluded that with satisfactory treatment, the patient's sport and recreational activities will not be affected due to the reduction of the injury risk of the patient.

In contrast to the physiotherapy programs suggested in the literature [20], we progressively varied the exercise program in accordance with the progressive nature of the Ponseti method in

our study. This situation increased the patient's treatment satisfaction due to the increase in the patients' adaptability to the physiotherapy program. OxAFQ-C scale showed no significant improvement in the child's emotional state, but on the contrary, it showed significant improvement in the emotional state of the family. This is an important outcome because it is known that the cultural characteristics of the family and caregivers are effective in the treatment [25,26]. The physiotherapy program with the Ponseti method may have been satisfactory for the family/caregiver about the positive progress of the child. Also, this result supports a significant improvement in the treatment satisfaction outcome.

The common problem after treatment is a recurrence of deformity [1,27]. Although improvement is observed after Ponseti treatment in children diagnosed with clubfoot, the deformity may recur in the future [28,29]. Participants included in this study were also children who had received Ponseti treatment and were at risk of deformity recurrence afterward because in serial controls; a loose of dorsiflexion and an increase of supination have been detected. To avoid a recurrence of deformity, we used the physiotherapy program in addition to the original Ponseti method. According to our results, it can be said that the physiotherapy program in addition to the Ponseti method may prevent the recurrence of the deformity because it improves the functional status. In the present study, the outcomes examined at the before and after treatment. Therefore, whether being relapsing or not of deformity couldn't be evaluated. Also, there is a need to see the differences at three to six months after the three-phase physiotherapy program with the similar group in comparison with the Ponseti method without physiotherapeutic treatment protocol. Therefore, long-term follow-up studies are still required.

A second limitation of this study is that Dimeglio or Pirani scorings of the patients before treatment has not been evaluated. Future studies should compare Dimeglio or Pirani scorings of the patients before and after treatment to show the functional status or progress of the efficiency of the treatment much more clearly.

5. Conclusions

The three-phase physiotherapy program increased the ankle range of motion, improved functional status and treatment satisfaction in children with clubfoot in risk of relapse. The three-phase physiotherapy might be a complement treatment option for clubfoot after the Ponseti method. Although, there is a need for long-term studies to understand its effects on preventing relapse.

Financial disclosure

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflicts of interest

We would like to declare that all authors have made a significant contribution to the realization of this study and gave final approval of the content of the submitted version. None of the authors has potential conflicts of interest. Furthermore, no benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this manuscript. This manuscript will not be submitted for publication elsewhere.

Acknowledgements

The authors thank to all patients for participating in the study.

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