

## CASE REPORT

# Stimulated biofeedback training combined with conventional rehabilitation in a bilateral congenital clubfoot patient: a case report

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Ponseti method is the most commonly used method in treatment of congenital clubfoot, but still, there is a recurrence risk of deformity after treatment. The purpose of this case report was to investigate the effectiveness of stimulated biofeedback training combined with conventional rehabilitation on muscle strength, balance and foot posture in a patient with bilateral congenital clubfoot after walking age. The patient was a five-year-old girl with bilateral congenital clubfoot treated with Ponseti method on second day of birth but she was suffering foot posture and balance problems. The patient had included stimulated biofeedback training combined with conventional rehabilitation for 24-week. Her foot posture assessed by Foot Posture Index, balance assessed by Pediatric Functional Reaching Test and Balance Master System, muscle strength was assessed with the handheld dynamometer at the beginning, third month, and end of the rehabilitation program. Patient's foot posture and balance were improved after six-month rehabilitation, therefore physical therapy and rehabilitation could be effective in development of foot posture and balance of congenital clubfoot patients.

**Keywords:** Clubfoot, Biofeedback, Rehabilitation, Physical therapy, Balance.

## Bilateral konjenital pes ekinovaruslu bir hastada konvansiyonel rehabilitasyon ile kombine biofeedback eğitimi: vaka raporu

Ponseti yöntemi, konjenital pes ekinovarus tedavisinde en sık kullanılan yöntemdir, ancak yine de tedaviden sonra deformitenin rekürrens riski vardır. Bu olgu sunumunun amacı, bilateral konjenital pes ekinovaruslu bir hastada yürüme yaşından sonraki dönemde uygulanan konvansiyonel rehabilitasyon ile kombine stimülasyonlu biofeedback eğitiminin, kas kuvveti, denge ve ayak postürü üzerine etkinliğini araştırmaktır. Hasta doğumdan sonraki ikinci günde Ponseti yöntemiyle tedavi edilen bilateral konjenital pes ekinovaruslu beş yaşında bir kız olgu idi, ancak hastanın ayak postüründe ve dengesinde problemleri vardı. Hasta 24 haftalık konvansiyonel rehabilitasyon ile kombine stimülasyonlu biofeedback eğitimine dahil edildi. Hastanın ayak postürü Ayak Postür İndeksi ile, dengesi Pediatrik Fonksiyonel Uzanma Testi ve Balance Master Sistemi ile ve kas kuvveti el dinamometresi ile rehabilitasyon programının başında, üçüncü ayında ve sonunda değerlendirildi. Altı aylık rehabilitasyondan sonra hastanın ayak postürü ve dengesi gelişti. Bu nedenle fizik tedavi ve rehabilitasyon, konjenital pes ekinovaruslu hastaların ayak postürü ve denge gelişiminde etkili olabilir.

**Anahtar kelimeler:** Pes ekinovarus, Biofeedback, Rehabilitasyon, Fizik tedavi, Denge.

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Received: May 22, 2019. Accepted: August 26, 2019.



After developmental hip dislocation and scoliosis, clubfoot is one of the most common malformations and occurs approximately one to two of every 1,000 births.<sup>1</sup> Although clubfoot have various conservative and non-conservative treatment methods, its treatment is still controversial. Extensive surgical interventions such as repeated soft tissue releasing, arthrodesis, osteotomy are used in treatment but cause complications such as foot stiffness, ankle arthritis and low life quality.<sup>2</sup> Therefore, conservative treatments such as Kite method, Ponseti method and French Physical Therapy (FPT) have been proposed for the clubfoot treatment.<sup>1,2</sup> The use of the Ponseti method in treatment of clubfoot is a consensus.<sup>2,3</sup> However, recurrence of clubfoot can be seen in Ponseti method due to thickening of ligaments, retraction of tibialis posterior tendon and low adherence to orthosis.<sup>2</sup>

Stimulated biofeedback training is a method consist of biofeedback and stimulation cycles. For example, the patient is given biofeedback training for 10-second with muscle contraction while 10-second electrical stimulation is applied at the relaxation time of muscle. Biofeedback provides patients visual and auditory feedback by using their neuromuscular and autonomic activities.<sup>4</sup> Neuromuscular electrical stimulation is a therapeutic method that aims to improve muscle function with repeated contractions and one of the currents used for neuromuscular electrical stimulation is high voltage pulsed current (HVPC).<sup>5</sup> It has some advantages such as to be less painful, providing deeper penetration and stronger muscle contraction.<sup>6</sup>

To the best of our knowledge there is no study about the effectiveness of the physical therapy and rehabilitation practices applied to patients with clubfoot after walking age, which may direct the future results. The aim of this case report was to investigate the effectiveness of stimulated biofeedback training combined with conventional rehabilitation program on muscle strength, balance and foot posture in a patient with bilateral congenital clubfoot after walking age.

## CASE

This study was performed in compliance with the *Declaration of Helsinki*. A girl with

bilateral congenital clubfoot was treated with Ponseti method on the second day of birth. She refused to use Ponseti night orthosis at the two years of age, therefore there has been a six-month interruption in the use of the orthosis. When she became four years old, she was referred to physical therapy program by a doctor because of foot posture and balance problems. The patient had included 45-minute/session, one-year conventional rehabilitation program with two sessions a week, and we have made some progress on the patient's foot posture and balance. After a while, the progressions we achieved with conventional rehabilitation reached a plateau. Therefore, we decided to apply an additional physiotherapy agent to the patient, and we planned the stimulated biofeedback training combined with conventional rehabilitation.

Before the study, the child and her family were informed about the purpose and method of the study and their approval were taken.

The foot posture assessed with the Foot Posture Index (FPI), the balance assessed by Pediatric Functional Reaching Test (PFRT) and Balance Master System (NeuroCom International Inc. Clackamas, OR, USA), the muscle strength was assessed with the handheld dynamometer (Lafayette, England®), at the beginning, third month, and end of the rehabilitation program. FPI is a quick and easy to use, reliable tool developed for the evaluation of foot posture. It consists of six criterion-based observations evaluating the rear-foot (talar-head palpation, supra/infra lateral curvature, calcaneal frontal plane position) and forefoot (prominence in the region of talo-navicular joint, congruence of the medial longitudinal arch, abduction/adduction of the forefoot on the rear-foot) posture. Negative values indicate that the foot is in supination and positive values indicate pronation of foot.<sup>7</sup> PFRT is a test developed to evaluate the balance of children. In this test, the child is asked to raise her/his arms 90° in standing position and reach the maximum distance that s/he can reach forward without losing her/his balance.<sup>8</sup> Balance Master System is a device providing real time and objective assessment of balance. It consists of force plate, computer and a software that transfers evaluations to the computer.<sup>9</sup> It has various assessment tests, and we used some of them. Weight-bearing squat test provides assessment

of lower extremities weight-bearing symmetry. Modified clinical test of sensory interaction on balance (MCTSIB) and unilateral stance (US) tests are used to assess body oscillations in both eyes open and closed condition. In the limit of stability (LoS) test, the patient is asked to reach points on the screen by sliding the center of gravity and without lifting the foot from the platform. Sit to stand (STS) test evaluates patients weight transfer time and sway velocity while they are standing up from sitting. Tandem test measures step width, walk speed and end sway during the tandem walking. Walk across test provides evaluation of normal walking step width, step length and speed.

The patient had included 45-minute/session, 24-week rehabilitation program with two sessions per week in an attempt to improve foot posture and balance. The rehabilitation program consists of 10-minute stimulated biofeedback training on left and right tibialis anterior and peroneal muscles with 10-second biofeedback +10-second HVPC cycles, and 25-minute conventional rehabilitation (such as foot posture exercises, balance, walking, muscle strength exercises and stair training). Foot posture exercise consist of plantar stretching, towel grip with toes, toe extension exercises and all of these exercises were performed in 10 repetitions. Balance exercises included bilateral and unilateral stance exercises on hard and soft surfaces in eyes open and closed conditions for 10 seconds. During walking exercises, the patient was asked to walk a distance of 15 meters 10 times while maintaining the posture of her feet. Hip extensors, quadriceps femoris muscle, hip flexors were given strength training against therapist resistance in 10 repetitions. During stair climbing exercises, the patient was asked to climb up and down the 10-step stair 10 times while maintaining the posture of her feet.

According to the assessments improvements were observed in the foot posture, lower extremity muscle strength and balance after treatment. The patient's FPI scores at the beginning, third month and end of the rehabilitation were as follows: for right foot -11, -7, -3, respectively and for the left foot -7, -6, -3, respectively. There were no noteworthy changes in general muscle strength, but there was a relatively increase in ankle eversion and dorsiflexion force. According to the initial

evaluations there were a quite differences between lower extremities weight transfer percentages the at the 0°-30°-60°-90° squat positions and it was observed that the patient transfers the more weight to the left lower extremity. At the second and third assessments an improvement was observed in weight transfer symmetry, especially after the six-month rehabilitation, the patient was found to transfer approximately the same percentage of weight to both lower extremities. The relative improvement was achieved after six-month rehabilitation program in the MCTSIB and US tests. While the patient was not able to perform the LoS test before rehabilitation, she was able to perform this test in the second and third evaluations, and improvements in the stability limits were observed. In STS tests, improvements in weight transfer time, and sway velocity were observed. There was also a decrease in the step width during normal walking and tandem walking. In the PFRT, the patient could reach 12.2 cm before treatment and this value increased to 26.5 after treatment. The results of muscle strength, balance and foot posture evaluated before, at the third month and after the rehabilitation program have summarized in Table 1.

## DISCUSSION

A five-year-old girl with bilateral congenital clubfoot who was treated with the Ponseti method on the second day of birth was firstly taken to one-year conventional rehabilitation program but her development in foot posture and balance reached a plateau, then she taken to a six-month rehabilitation program consisting of stimulated biofeedback training and conventional rehabilitation. Patient's foot posture and balance were improved after combined stimulated biofeedback training and conventional the rehabilitation program.

Ponseti method is the most commonly used method in the treatment of congenital clubfoot. However, in this method, problems such as partial recovery or recurrence of the deformity could be seen.<sup>3</sup> Also, walking and balance problems could be seen in congenital clubfoot patients without depending on the method that have they treated (surgery, Ponseti method etc.).<sup>1,10</sup> Lööf et al. reported foot movement and

Table 1. Patient's foot posture, muscle strength, and balance results.

	Pre-rehabilitation	3 <sup>rd</sup> month of rehabilitation	Post-rehabilitation
<b>Foot Posture Index</b>			
Rear-foot			
Talar head palpation (R/L)	-2 / -2	-2 / -1	-1 / -1
Supra and infra lateral curvature (R/L)	-2 / -1	-1 / -1	-1 / -1
Calcaneal frontal plane position (R/L)	-2 / -1	-1 / -1	-1 / -1
Forefoot			
Prominence in the region of talonavicular joint (R/L)	-1 / -1	-1 / -1	0 / 0
Congruence of the medial longitudinal arch (R/L)	-2 / -1	-1 / -1	0 / 0
Abd/adduction of the forefoot on the rear-foot (R/L)	-2 / -1	-1 / -1	0 / 0
Total	-11 / -7	-7 / -6	-3 / -3
<b>Muscle Strength (kg)</b>			
Hip flexion (R/L)	3.7 / 3.7	3.9 / 4.1	3.7 / 3.9
Hip extension (R/L)	3.1 / 4.0	3.8 / 4.4	4.3 / 4.5
Hip abduction (R/L)	3.3 / 3.5	3.2 / 3.9	3.3 / 3.8
Hip adduction (R/L)	2.5 / 2.3	2.7 / 2.4	2.6 / 2.5
Hip internal rotation (R/L)	2.6 / 3.2	2.7 / 3.6	3.0 / 3.8
Hip external rotation (R/L)	2.4 / 2.4	2.2 / 2.1	2.9 / 2.7
Knee flexion (R/L)	4.0 / 3.9	4.0 / 4.1	3.8 / 4.0
Knee extension (R/L)	4.1 / 4.7	4.6 / 4.9	5.0 / 4.8
Plantar flexion (R/L)	4.9 / 4.7	5.2 / 5.2	5.2 / 4.7
Dorsiflexion (R/L)	2.7 / 2.9	3.3 / 3.4	3.9 / 4.9
Ankle eversion (R/L)	2.1 / 3.0	3.0 / 3.2	3.2 / 3.5
Ankle inversion (R/L)	2.9 / 2.8	3.0 / 3.1	3.1 / 3.0
<b>Balance Master</b>			
Weight bearing squat 0° (%) (R/L)	37 / 63	45 / 55	48 / 52
Weight bearing squat 30° (%) (R/L)	30 / 70	38 / 62	49 / 51
Weight bearing squat 60° (%) (R/L)	27 / 73	42 / 58	46 / 54
Weight bearing squat 90° (%) (R/L)	30 / 70	37 / 63	49 / 51
MCTSIB-sway velocity-EO (°/sec)	1.0	1.0	0.9
MCTSIB-sway velocity-EC (°/sec)	2.2	1.8	1.7
US-sway velocity-Left EO (°/sec)	1.9	1.5	1.5
US-sway velocity-Left EC (°/sec)	2.4	2.0	2.0
US-sway velocity-Right EO (°/sec)	2.2	1.5	1.4
US-sway velocity-Right EC (°/sec)	2.4	1.8	1.9
LoS-RT-complete (sec)	Fall	0.82	0.58
LoS-MVL-complete (°/sec)	Fall	6.5	6.2
LoS-EPE-complete (%)	Fall	81	83
LoS-MXE-complete (%)	Fall	93	93
LoS-DCL-complete (%)	Fall	66	70
STS-weight transfer time (sec)	0.13	0.16	0.15
STS-sway velocity (°/sec)	6.9	7.3	7.1
Tandem-step width (cm)	5.7	4.8	4.5
Tandem-walk speed (cm/sec)	12.2	14.9	11.2
Tandem-end sway (°/sec)	5.1	4.9	5.0
Walk across step width (cm)	20.9	13.8	11.5
Walk across step length (cm)	23.6	17.0	25.3
Walk across speed (cm/sec)	51.1	30.9	67.5
<b>Pediatric functional reach test (cm)</b>	<b>12.2</b>	<b>24.5</b>	<b>26.5</b>

R/L: Right / Left. DCL: directional control, EC: eyes closed, EO: eyes open, EPE: endpoint excursion, kg: kilogram, LoS: Limit of stability, MCTSIB: modified clinical test of sensory interaction on balance, MVL: movement velocity, MXE: maximum excursion, RT: reaction time, sec: second, STS: sit to stand, US: Unilateral stance.

walking asymmetries in children with bilateral or unilateral clubfoot.<sup>10</sup> When our patient's results were examined, it was observed that the patient had asymmetries especially in balance and foot posture. We thought that one of the methods that can be used to prevent recurrence of the deformity and improve balance and gait may be the inclusion of patients in an individual-specific physiotherapy and rehabilitation. Our patient's improvement in balance and foot posture supports our aforementioned opinion. Advances in our patient's balance and foot posture may be derived from an increase in muscle strength or proprioceptive sensory input provided by exercises. Also, Dursun et al.<sup>11</sup> stated that children who received biofeedback training plus conventional exercise showed significant improvements, compared to children who received the just conventional exercise. In our case, the development that have reached a plateau after 1 year of conventional rehabilitation continued to progress after stimulated biofeedback training combined with conventional rehabilitation. In this regard, the results of our case report are consistent with the literature.

However, this was a case report and there is a need for comprehensive studies to understand effect mechanism of exercises in patients with clubfoot.

Another method used in the treatment of congenital clubfoot is FPT. This method has been developed as an alternative to Ponseti method and it is applied in the early postpartum period.<sup>1</sup> To the best of our knowledge there is no study about the physical therapy and rehabilitation in congenital clubfoot patients other than FPT. Therefore, we also did not find any studies about the effectiveness of the physical therapy and rehabilitation applied to the children with clubfoot after walking age. In this regard, we hope this case report will provide a basis for studies to investigate the effectiveness of physical therapy and rehabilitation in congenital clubfoot patients who can walk.

#### Limitations

Although congenital clubfoot is a very common malformation, only one case was included in the rehabilitation program, this was a limitation. However, in routine practice, the patients are not referred to a physical therapy

and rehabilitation program after being treated with methods such as surgery, Ponseti method and FPT. Therefore, our access to patients was very limited. We hope that this case report will provide a basis for studies to be done in this area and contribute to a greater proportion of congenital clubfoot patients to be referred to a physical therapy and rehabilitation.

#### Conclusion

This case report shows that physical therapy and rehabilitation could be effective in the development of foot posture and balance of patients with congenital clubfoot after walking age. More comprehensive studies are needed to investigate the efficacy of physical therapy rehabilitation in the treatment of patients with congenital clubfoot after walking age.

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**Acknowledgement:** *None*

**Conflict of Interest:** *None.*

**Funding:** *None.*

**Ethical Approval:** Informed consent was obtained from the case in this study.

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