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Original Research Article

INFLUENCE OF SENSORIMOTOR TRAINING ON BALANCE AND PAIN PARAMETERS IN CHILDREN WITH HEMOPHILIA

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ABSTRACT

Background and purpose: Children with hemophilia often have intra-articular and intra-muscular bleeding which have a worse impact on postural stability and balance. Therefore, the purpose of this study was to investigate the effect of sensorimotor training on balance and perceived pain in children with hemophilia.

Subjects and Methods: Thirty hemophilic boys mean age (12.06±1.2) were divided randomly into two equal groups. Control group (n=15) received conventional physical therapy program and study group (n=15) received the same program in addition to sensorimotor training exercises. Baseline assessment included stability indices and perceived pain, was conducted at the beginning of the study and after 8 weeks of treatment program.

Results: There was no significant difference between both groups in the pre-treatment mean values of all measured variables. Significant improvement was observed in the two groups between pre and post treatment measured outcomes. Furthermore, the study group recorded significantly better improvement in balance and pain parameters compared with the control group.

Conclusion: Sensorimotor training could be an excellent supplement to regularly rehabilitation program used for children with hemophilia. It produces positive effects on balance and perceived pain parameters for these patients.

KEY WORDS: Sensorimotor Training, Balance, Pain, Hemophilia.

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INTRODUCTION

Hemophilia describes a group of sever congenital coagulation factor deficiencies. It is a lifelong genetic disorder with a prevalence of 1:10,000 birth and that of the most severe form of the disease to be approximately 6% per 1,00,000 Population [1]. Depending on the activity of coagulant factor VIII or IX in blood, hemophilia may be labeled as severe (<1% of normal), moderate (1–4%) or mild (5–25%) [2]. Hemophilia is characterized by recurrent haemarthroses inside the less muscular padding joints as knees, elbows and ankles joints [3].

Because immature cartilage is even more susceptible to spontaneous bleeding, most of hemophilic children experience repeated episodes of hemorrhage into their joints [4]. Intra-articular bleeding of synovial joints has a direct destructive effect on cartilage which triggers the joint degenerative process [5] and impact on the total motor development of children and youngsters [6].

Patients with hemophilia often used to have a sedentary lifestyle because of repeated uncontrollable hemarthroses with subsequent synovitis and arthropathy, which is the major complication of hemophilia. The chronic characters of hemophilic patients include musculoskeletal pain, muscle imbalance [7], reduced joint range of motion [8], and articular instability [9].

Balance performance is complex and multi-dimensional, involving not only the ability to maintain a static stance, but also the ability to maintain equilibrium under a range of dynamic conditions[10]. Few of studies have addressed the impact of musculoskeletal disorders in hemophiliacs on balance impairment or fall. Results showed that patients with hemophilia displayed a worse balance and proprioception compared with healthy normal subjects [10-13].Authors hypothesized that because proprioception information is transmitted from receptors found in all tissues of the synovial joint, repeated joint bleeding into the target joint could be a contributory cause of impaired proprioception in patients with hemophilia. As the muscular function comprises not only the static control of the joint and the dynamic control of movement, but also the proprioceptive input to the central nervous system (CNS) .So further possible mechanism induced proprioception deficit in hemophilic patients may be related to the intramuscular bleeding and lower muscle strength [14, 15].

Conservative physical therapy management of hemophilic patients focused primarily on increasing flexibility and muscle strength with minimum joint stress to reduce risk of trauma and further bleeds[16] . Yet, to date and to our knowledge, there are no studies on balance improvement approaches for children with hemophilia. In the past few years, it has been suggested that sensorimotor training contribute to reflective activation of the deep postural muscles and challenge the sensorimotor system to restore normal control of individual segments during dynamic tasks[17-19]. Although many therapists and clinicians reported successful treatment cases, the exact effect and validity of sensorimotor interventions is still discussed with contradicted results [20-22]. Therefore, this study aimed to investigate the feasibility and efficacy of sensorimotor training on improving balance performance and pain in children with hemophilia.

SUBJECTS AND METHODS

Subjects: Thirty boys with mild to moderate hemophilia were selected from outpatient clinic, faculty of physical therapy, Abu El-Rish Paediatric Hospital, Cairo University, Egypt. Subjects were assigned randomly to two equal groups (control and study). Children in both groups were clinically and medically stable and their medical management included factor replacement therapy which determined by their hematologist. They participated in this study according to the following inclusive criteria: age 10-14 years, understood and followed verbal commands in both test and training, grade 3+ muscle strength for lower limb according to Kendall et al. [23].

Exclusive criteria included congenital or acquired skeletal deformities, cardiopulmonary dysfunction, advanced radiographic changes as bone erosions or destruction, bony ankyloses, joint subluxation or epiphyseal fracture, neurological condition affecting lower limbs, children who had bleeding in joints or muscles in the 2 weeks prior to assessment and treatment procedure.

Participants were assigned to two equal groups. Control group (n=15) received a conventional physical therapy program and a study group (n=15), received sensorimotor training in addition to a conventional physical therapy program fig 1. Following baseline assessment, children were allocated to corresponding group using a computer-generated randomized table. Allocation was concealed by random numerical sequence in sealed opaque envelopes. The parents of participants provided a consent form for their children to participate in the study as well as acceptance of the Ethics Committee of the Faculty of Physical Therapy, Cairo University was taken.

Methods: Dynamic balance parameter in the form of overall stability index (OSI), medial/ lateral stability index (MLSI), and anterior/ posterior stability index (APSI) and Perceived pain were evaluated using Biodex stability index and self-report faces scale respectively at baseline and after 8 weeks.

Balance measurement: Biodex Stability System (BSS) was used to assess the dynamic balance at the Balance Lab, Faculty of Physical Therapy, Cairo University. The BSS reliability been reported [24]. The BBS was calibrated before each measurement according to the manufacturer's manual. Dynamic balance test of BBS was used. It was performed on stability levels from 6 to 4. Certain parameters were fed to the device including: child's age, weight, height, and stability level.

Each child in the two groups was instructed to achieve a centered position on the platform once the platform with the two leg stance while grasping the handrails by shifting position of feet until it is easy to keep the cursor centered on the screen grid while standing in a comfortable, upright position .child then was instructed that the platform will now be released. Once centering is achieved on the unstable foot platform and the cursor is in the center of the display target, child was instructed to maintain position and the platform was stabilized. Then child's foot position on the foot platform grid was measured.

Three trials were done before testing for learning. After introducing feet angles and heel coordinates into BBS, the test began, the platform advanced to an unstable state, and then the child was instructed to focus on feedback screen directly in front of him. While both hands at the side of his body and asked to maintain the cursor in the middle of on the screen. The test duration was 30 s (sec.). The result was displayed on the screen at the end of each test including OSI, APSI and MLSI. The mean of the three repetitions was determined. A large Values was indicated that the child had balance difficulty and poor neuromuscular response [25].

Pain measurement: Pain intensity was measured using the self-report faces scale. Each children was asked to score their average pain experience using a self-report face pain scale which is valid and reliable and has good psychometric properties [26]. Measurement score was done pre-treatment procedure and after 8 weeks treatment for two groups.

Procedures: Patients in both groups received conventional physical therapy program for three sessions/ week on alternate days for 8 weeks in succession. This programme included the following:

- 1st and 2nd weeks: Gentle stretching exercises for tight muscles include biceps brachii, hamstrings, anterior tibial group and calf muscles bilaterally. It was done for 20 s stretch followed by 20 s relaxation and repeated five times per session for each muscle, 15 min.

- 3rd , 4th and 5th weeks (in addition): strengthening exercises in from of Isometric contraction for quadriceps, hamstrings, anterior tibial group, calf muscles triceps and biceps. It was done 5 s contraction then relaxed for another 5 s for five times per session[27].

- 6th , 7th and 8th weeks (in addition): Aerobic exercise in the form of 30 min treadmill training which consisting of 5 min of warm up exercise consisting of stretching exercise and walking forth and back then treadmill training was begun. Treadmill speed was done for all children in both groups as 75% of their comfortable speed during over ground walking and zero degree inclination for 20 min [28, 29]. The child was instructed to stop walking immediately if he felt pain, fainting, or shortness of breath. Finally, cooling down exercises for 5 min involving light stretch and walking inside the room were performed.

Patients in the study group received sensorimotor training program in addition to the conventional programme. Each child in the study group exercised through three phases: static, dynamic, and functional phase. Within each stage child' progress through exercises program in different postures, bases of support, and challenges to their center of gravity [30] . Sensorimotor training was performed 3 times per week for 8 weeks.

Data analysis: The primary outcome measure was pain during rest, stability indices (OSI, MLSI, APSI). The statistical analyses were conducted using the SPSS software, Version 24 (SPSS Inc., Chicago, Illinois). Statistical significance was set at $p < 0.05$. Data were summarized as mean and standard deviation. Test for normal data distribution was conducted using Kolmogorov-Smirnov test.

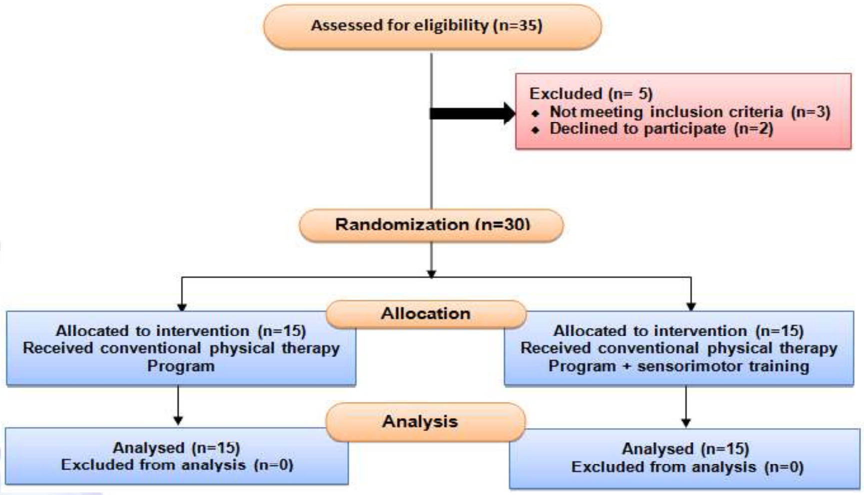


Fig. 1: Flow chart of the 35 participants through the study.

Table 1: Sensorimotor training program.

Phase	Duration	Exercise	Progressed by	Frequency
static	Week 1 and 2	1- Standing upright position for both lower limbs 2- Single leg stance for both lower limbs	Firm surface then soft surface Open eye then closed	30 sec , 10 repetition 10 sec, 10 repetition
dynamic	Week 3, 4 and 5	1-Forward stepping lunge exercise for both lower limbs 2. T-band kicks exercise (weight bearing for both lower limbs	Open eye then closed	3 sets of 10 repetition
functional	Week 6, 7 and 8	1-Walking exercise -Toe skipping with toes straight ahead then toes pointing outward and inward -Heel skipping with toes straight ahead then toes pointing outward and inward 2. Squatting exercise: for both lower limbs 3. Balance exercise on rocker and wobble board: (a) Anteroposterior rocking movement on rocker board b) Mediolateral rocking movement on rocker board c) Anteroposterior rolling movement on wobble board d) Mediolateral rolling movement on wobble	Open eye then closed against a wall and away from the wall sitting position then from standing position on both legs between parallel bars with eyes open, then eyes closed	20 meters 3 sets of 10 repetition 3 sets of 10 repetition

Two factor mixed model analysis of variance(ANOVA) was used to detect treatment effect between baseline and post-treatment values over a period of eight weeks (within groups variables) and for intra group comparison (control or study). Between-groups effect sizes for all variables were calculated using the Cohen d coefficient. An effect size > 0.8 was considered large, around 0.5 moderate, and < 0.2 small. All out outcome analysis were conducted according to intension to treatment principle.

RESULT

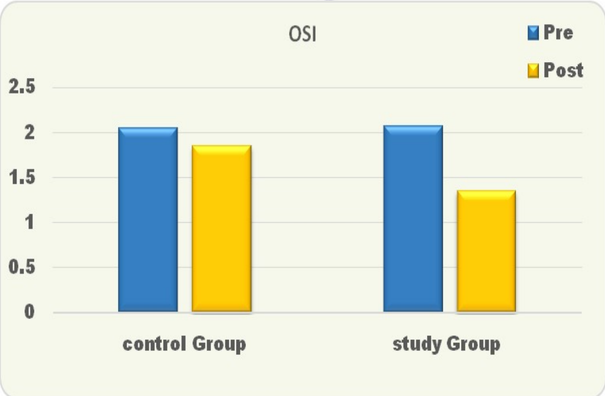
Thirty-five patients with hemophilia were assessed for compatibility with the eligibility criteria. Thirty met the eligibility criteria and agreed to participate in the study. Patients were randomly allocated to either control or study treatment groups. Demographic characteristics and baseline measurement of the two groups before treatment are shown in (Table 2). There was no significant difference between groups regarding patients characteristics and baseline measurements (P>0.05).

Table 2: Demographic data and baseline assessment of 30 participants.

patients characteristics	GROUP	Mean(SD)	p
Age (year)	Control Group	11.98 (1.31)	0.74
	Study Group	12.14 (1.24)	
Weight(Kg)	Control Group	40.96 (1.48)	0.3
	Study Group	38.32 (9.66)	
Height (cm)	Control Group	136.86 (1.64)	0.22
	Study Group	137.66 (1.87)	
OSI	Control Group	2.05 (0.22)	0.8
	Study Group	2.07 (0.18)	
APSI	Control Group	2.1 (0.25)	0.88
	Study Group	1.98 (0.33)	
MLSI	Control Group	1.44 (0.18)	0.67
	Study Group	1.40 (0.24)	
Pain	Control Group	6.6 (1.3)	0.23
	Study Group	7.2 (1.4)	

Comparison of the pre- and post-treatment values of the OSI score for each group revealed a significant reduction in OSI score in both group after treatment ($p < 0.05$). Post-treatment measurement comparison showed a significant difference between groups in favour of the study group (p=0.001) figure2.

Fig. 2: Mean and SD of OSI between groups.



The APSI and MLSI were significantly improved in both group post-intervention when comparing with the base line measurement table 3. Between groups analysis showed that there were a significant reduction in APSI and MLSI in favour of the study group at the end of treatment.

Data for pain scores at pre-and post-intervention for both groups are reported in Table 3 . There was no significance difference ($p > 0.05$) in pre intervention pain intensity between the groups (p=0.2). Pain intensity was significantly lower in post intervention compared to pre- intervention within two group. At post-intervention, the pain felt in the study group was less severe (p = 0.009) than the pain felt by control group.

Table 3: Mean (SD) for main outcomes for each group, mean difference (SD) within groups, mean difference and effect size between groups.

Variables	Group				Difference within group		Difference between groups	
	Before treatment		After treatment		control	study	Control-study	Effect size
	control	study	control	Study				
OSI	2.05(0.22)	2.07(0.18)	1.85(0.23)	1.35(0.15)	1.33‡ (0.97)	1.86‡ (0.99)	0.50*	0.63
APS	2.1(0.25)	1.98(0.33)	1.79(0.23)	1.23(0.18)	0.19‡ (0.24)	0.71‡ (0.15)	0.56*	0.65
MLS	1.44(0.18)	1.40(0.24)	1.32(0.23)	0.82(0.17)	0.2‡ (0.18)	0.75‡ (0.3)	0.49*	0.6
PAIN	6.6(1.3)	7.2 (1.4)	5.86(1.18)	4.73(1.03)	0.11‡ (0.18)	0.58‡ (0.28)	1.13*	0.2

‡ Significance within group * Significance between groups

DISCUSSION

The purpose of this study was to investigate the effect of sensorimotor training on balance and perceived pain parameters in children with hemophilia. The results of the study demonstrate that children in the study group who had performed sensorimotor training showed greater significant improvement in post- training mean values of stability indices (OSI, APSI, MLSI) and pain severity compared with children in control group.

The difference of the post training values between the two groups could be attributed to improved posture and movement perception by the effect of sensorimotor training. Hertel suggested that sensorimotor training has the ability to enhance balance ability and improve of postural stability by improving mechanoreceptor function, which could lead to restoration of neuromuscular control of the joints [31]. This restoration of the neuromuscular feedback control may be a key factor that causes a positive outcomes in the study group.

Furthermore, it has been estimated that sensorimotor training could help to increase coordination between posture muscle groups and trigger the response to sensorial information. Also during sensorimotor training, patients progressed through exercises in different postures, base of support, challenges to their center of gravity, with and without visual input. So, each exercise program elicits automatic and reflexive muscular stabilization demanding the child to maintain postural control under a variety of situations [32, 33].

The study group showed more significant reduction of pain than the control group. The increased rate of joints and muscle bleeding in hemophilic patients is considered a real problem which lead to swelling, muscle spasm and pain in the affected area[34] .

Balance training rarely have been considered as a part of treatment program for children with hemophilia. Consequently, sensorimotor rehabilitation techniques for sensory deficiencies through promoting proprioceptive challenge have emerged in recent years and have received growing therapeutic attention [12].

Postural control is a complex skill based totally on the interaction of dynamic sensorimotor processes. Afferent information from somatosensory, vestibular and visual systems is incorporated according to the goals of the movement task and the environmental context. Postural stability includes coordination of movement strategies in order to maintain the center of body mass during both self-initiated and externally induced disturbances of equilibrium [35].

The findings of this study were similar to the results of Tsauo et al. who concluded that patients performing a set of eight-week sensorimotor training exercises produced better knee joint proprioception and self-reported functional difficulty score [36]. Also Lephart et al. suggested that sensorimotor training may help to improved quality of postural control by increasing of joint position-and motion perception, which in turn may alleviate postural specific musculoskeletal pain [37]. Moreover Gruber et al. reported that sensory motor training may increase proprioceptive input to the neuromuscular system for processing information of the proprioceptive system more appropriately[20]. Another study by Hwang et al. revealed that sensorimotor training makes patients capable of learning how to adjust muscles, thereby alleviating pain and improving muscle performance [38].

In contrast with the current study, Bruhn et al failed to demonstrat a significant difrence between sensorymotor training and strength training on poature stabilization [39]. Also our finding inconsistent with the finding of recent systematic review that appraise the effect of sensorimotor training on functional and balance in total knee replacement patients .The results showed that sensorimotor training induces equivalent improvement between intervention and control group [40]. Where this review based on six studies, generalization of findings should be made with caution, and was only feasible in patients with knee OA undergoing primary total knee replacement.

CONCLUSION

In this study, sensorimotor training appears to improve balance and pain intensity after eight weeks of application in children with hemophilia. This study may provide rational for adding sensorimotor training as part of a multifaceted exercise program for patients with hemophilia, particularly if there is a history balance impairment.

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Conflicts of interest: None

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