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Effects of Therapeutic Exercise and Hydrotherapy on Pain Severity and Knee Range of Motion in Patients with Hemophilia: A Randomized Controlled Trial

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ABSTRACT

Background: Pain and limited range of motion (ROM) are the crucial subsequent results of joint hemorrhages in individuals with bleeding disorders and hemophilia. Exercise interventions are particularly recommended in treatment of such patients. The purpose of this study was to detect the influences of conventional exercise therapy and hydrotherapy on the knee joint complications in patients with hemophilia.

Methods: A total of 40 patients engaging hemophilia A were randomized into one of three groups: Therapeutic exercise ($N = 13$), hydrotherapy ($N = 14$) or control ($N = 13$). While the first two groups followed their specific programs for 4 weeks, routine life-style was maintained by subjects in the control group in this period. To evaluate the pain level and knee ROM the visual analog scale and standard goniometer were utilized, respectively. The outcome was measured at baseline and after completing the prescribed protocols. Data analysis was performed using one-way analysis of variance and Scheffe statistical tests ($P < 0.05$).

Results: Both experimental groups experienced more significant decreasing in pain level ($P < 0.001$) and knee flexion and extension ROM ($P < 0.001$) in comparison to the control group. Although the pain was significantly ($P < 0.01$) more alleviated in participants treated through hydrotherapy in comparison to exercise therapy, the difference in ROM improvement was not statistically significant ($P > 0.05$).

Conclusions: Using hydrotherapy in addition to usual rehabilitation training can result in beneficial effect in terms of pain and knee joint ROM. However, it appears that hydrotherapy is more effective in reducing pain.

Keywords: Aquatic therapy, hemophilia, knee range of motion

Original Article

INTRODUCTION

Bleeding disorders and consequent musculoskeletal injuries challenge the therapists involving in this field. Hemophilia A, B and Willberand disease are the most common congenital bleeding disorders. They affect different aging groups.[1] Hemophilia A and B

occur due to congenital X-linked inherited deficiency of clotting factors VIII and IX and while females are carriers of the trait, it happens commonly in males.[2,3] Bleeding disorders can be categorized into three groups; including mild, moderate and serve. In moderate and serve cases, minor traumas can result in intra-articular hemorrhage (hematoma). This hemorrhage may induce a vicious cycle of musculoskeletal deficit, which eventually leads to articular problems.[4,5]

Hemarthrosis is the most prevalence and degenerative manifestation of the hemophilia. Nearly 80% bleeding related to hemophilia are seen as hemarthrosis. Hemarthrosis usually appears around 12-24 months of age and continues through the life. Knee, elbow and ankle are the most frequent joints affected, although hip and shoulders are rarely involved, too.[5,6] Target joint is the one which has 3 or more bleeding episodes in a period of 3-6 months. Therefore, this joint is more subjected to bleeding and also articular degeneration.[7,8]

More bleeding within joints will induce hemophilic arthritis and joint tissue destruction as seen in rheumatoid arthritis. The present problem leads to invasive hypervascular synovial hypertrophy, chronic synovial inflammation, articular cartilage injury, bone hypertrophy and subchondral cysts.[9]

Articular disorders associated with hemophilia cause pain, joint instability, malalignment, muscular atrophy, impaired movement and dysfunction for patients.[5,6,10-12] There are three main treatment methods for patients with hemophilia: (1) Medications, (2) surgical intervention and (3) rehabilitation treatment.[13]

Mulvany *et al.* (2010) investigated the effects of a 6-week exercise program on symptoms of patients with arthritis related to bleeding disorders and hemophilia. They noted that using an exercise intervention in treatment of those engaging with bleeding disorders can increase knee, hip, ankle and elbow range of motion (ROM).[14] In another study, Harris and Boggio (2006) performed a systemic review for 46 patients with bleeding disorders and concluded that those who followed a regular exercise program would have better ROM in major joints in comparison to patients without any treatment.[15]

Review of the above studies and other evidences confirms that patients with bleeding disorders, especially hemophilia, can benefit from a regular supervised exercise program.[16] However, there is a lack of evidence regarding the effects of aquatic therapy as a therapeutic intervention on symptoms of patients with hemophilia. Then, the aim of this study was to investigate the effect of aquatic exercise therapy (AET) and land-based exercise therapy (LET) on pain severity and ROM of the knee joint in patients with hemophilia.

METHODS

Patients

This was a supervised quasi-experimental and perspective design study with a non-randomized pretest-posttest control group, which was performed in Tehran, Iran in May to June 2012. The research ethical committee in faculty of sports sciences and physical education in university of Isfahan confirmed the study to be performed. On the other hand, the control group received the rehabilitation treatment after finishing the study period in order to consider ethical approach.

We chose our subjects from hospitals, clinics and hemophilic centers in three levels; mild, moderate, and severe. The inclusion criteria were as follow: (1) Diagnosis of hemophilia, (2) patient's tendency to participate in the treatment program for at least 4 weeks, 3 times/week, (3) impaired knee joint ROM and (4) age below 50 years. The last item was considered according to two reasons. First; patients older than 50 years have lower cardiopulmonary capacity,[17] so have limited ability to exercise in water. Second; the possibility of joint degeneration associated with osteoarthritis changes increased significantly in patients over 50 years.[13] As the purpose of this study was to assess the effect of rehabilitation treatment on joint arthritis associated with hemophilia, we did not allow these patients to participate in the study. Exclusion criteria were: (1) Surgery 6 weeks prior to starting the treatment protocol, (2) participation in any sports or other therapeutic exercises, (3) sever hemorrhage despite using clotting factors, (4) open wounds, (5) patient's sensibility to aquatic therapy.[14] Considering the exclusion criteria, only 43 individuals entered the study and 3 patients did not complete their own program due to personal difficulties. Therefore, the statistical analysis was conducted for 40 patients.

Demographic information of 40 patients, who completed a 4-weeek exercise protocol, is demonstrated in Table 1.

Measurements

Pain severity and flexion and extension ROM of the knee joint were evaluated using visual analogue scale (VAS) and standard goniometer, respectively at baseline and after 4 weeks.

Norkin and White approach was applied to measure knee joint ROM.[18] They reported the validity of this method as good to excellent. VAS assesses the patients' level of pain while they're in a relaxing position. This scale in numbered from zero to ten. While zero indicates no pain, ten shows that the patient feels sever pain.[19]

Exercise protocols

We described the procedure of all tests and treatment protocols for the whole subjects. The patients in the control group were requested to pursue their own life-style and not to attend in any exercise treatment. Management protocols for experimental groups can be visualized in Table 2.

All training principles such as time, frequency, overload and specificity were considered by the therapists. The exercises were simply designed and then were progressed to more complicated exercises according to the patient's status. We asked the subjects to take their clotting factor prior participating in the protocol. However, if the patient experienced discomfort during the exercise protocol, the program would be stopped. The water temperature was maintained approximately 27-35°C.

Statistical analysis

SPSS software, version 19, was used to analyze the data. We applied non-parametric tests to avoid potential errors from non-normal distribution of the data. To investigate between-group differences, one-way analysis of variance was utilized at $P < 0.05$.

RESULTS

The statistical analysis of data in Table 1 revealed that there was no significant difference in age ($P = 0.991$), height ($P = 0.878$) and weight ($P = 0.876$) between the three groups at baseline.

However, statistical analysis indicated a significant difference in pain intensity before and after 4 weeks between the groups ($F = 50.8$, $P < 0.001$). The pain was decreased significantly in both experimental groups in comparison to the control group ($P < 0.001$). On the other hand, the patients followed AET experienced more alleviation in pain intensity than those completed LET ($P < 0.01$) [Table 3].

Table 1: Demographic information of the participants

Group	*N*	Age (years)	Height (cm)	Weight (kg)
Exercise therapy	13	33.1 (10.5)	171.9 (9.1)	78.8 (12.8)
Aquatic therapy	14	33.4 (10.5)	170.3 (7.1)	78.0 (12.5)
Control	13	33.6 (9.2)	170.8 (7.9)	80.2 (7.4)

Mean (standard deviation)

Table 2: Therapeutic intervention programs

Phase	LET		AET	
	Time (min)	Description	Time (min)	Description
Warm up	5	Simple stretching exercises for muscles surrounding the knee joint	5	Coordinated and rhythmic movement of lower limb in water
Main part	30-45	Hamstring stretching, quadriceps strengthening: First isometric with progress to isotonic	30-45	Hamstring stretching, quadriceps strengthening: First isometric with progress to isotonic
Cool down	5	Gentle stretching exercising	5	Gentle stretching exercising

LET=Land-based exercise therapy, AET=Aquatic exercise therapy

Table 3: Pain intensity before and after intervention

Group	Pre-test			Post-test		
	Mean	SD	Min-Max	Mean	SD	Min-Max
LET	6.6	1.3	4.5-9.1	5.7	1.4	3.4-8.4
AET	6.9	1.3	4.7-9.2	5.2	1.3	3.1-7.6
Control	6.5	1.2	4.4-8.2	6.8	1.0	4.8-8.2

SD=Standard deviation, LET=Land-based exercise therapy, AET=Aquatic exercise therapy

The changes in flexion ($F = 53.9$, $P < 0.001$) and extension ($F = 31.4$, $P < 0.001$) ROM of the knee joint before and after therapeutic interventions were significantly different between the three groups. However, patients in both experimental groups gained more significant improvement in knee ROM in comparison to the control ($P < 0.001$). We also noted no significant difference between the two experimental groups for this factor ($P > 0.05$) [Table 4].

DISCUSSION

In this study, we figure out that LET and AET can have beneficial effects on pain intensity in patients with hemophilia, although AET was more affective. However, flexion and extension ROMs of the knee joint were significantly increased in participants who completed their own therapeutic protocols; but no significant difference was indicated between them.

Articular pain in patients with hemophilia can be either acute or chronic. Acute pain occurs due to tissue destruction and intra-articular or intramuscular hemorrhage that can be too bothering. This pain induces articular contracture in a long period, resulting in subsequent muscle spasm and shortness of the joint tissues.[20]

Chronic pain may cause possible impairment of usual life-style, sleep habits and social status in such patients. In our study, the pain was as chronic. While there was no significant difference in pain level at baseline ($P = 0.901$), it was significantly different after 4 weeks.

In previous literature, the authors found no research regarding to the effect of AET on pain severity of hemophilic patients, but Varni (1981) used a progressive muscle relaxation exercise protocol for 3 hemophilic patients with chronic joint pain and concluded that this method can alleviate pain in these patients.[21] There is a similarity between the result of our study and the one for Varni. Muscle activation during exercise therapy will cause blood circulation improvement, reducing hypertension and more efficient oxygen flowing toward muscles and joints that eventually leads to reducing pain in hemophilic patients.[22]

Mechanism of more improvement in pain intensity by AET not familiarized yet.[23] However, we can contribute these beneficial influences to physical properties of water. Effects of hydrostatic pressure on the body during the immersion cause centralization of peripheral fluid. This results in various physiological responses such as increasing cardiac output and decreasing peripheral resistance.[24] Reducing edema, inflammation and improvement in contractile tissues activity are the results of this process.

Another reason for more reduction in pain level in patients following AET can be associated with water temperature. As using thermotherapy in treatment of individuals with bleeding disorders is contraindicated, our attempt was to avoid increasing water temperature and maintaining this in low level. The main physiological responses due to immersion in cold water include local hypovascularity and decreasing blood flow that can reduce the edema.[25] However, applying cryotherapy will induce antalgic effect, so can decrease pain in patients.[26,27] Despite the explained reasons, the placebo effects of AET should not be neglected. Hróbjartssonand Gøtzsche (2001) studied the placebo effects of AET and concluded that this approach has the main beneficial effects on subjective symptoms while no significant difference was indicated in objective symptoms.[28] As mentioned earlier, the subjective symptoms of (i.e., pain intensity) was significantly improved in subjects who finished the aquatic treatment intervention, but there was no significant difference in objective measurements (i.e., knee joint ROM) after performing therapeutic interventions in both experimental groups.

Table 4: Knee flexion and extension ROM before and after intervention (degree)

Group	Flexion ROM						Extension ROM					
	Pre-test			Post-test			Pre-test			Post-test		
	Mean	SD	Min-Max	Mean	SD	Min-Max	Mean	SD	Min-Max	Mean	SD	Min-Max
LET	102.8	24.0	59.8-130.2	110.0	24.0	67.2-134.7	−10.6	5.2	(−5.2)-(−21.0)	−8.7	5.0	(−3.0)-(−18.4)
AET	111.5	14.4	81.7-129.8	118.5	13.4	87.4-133.6	−9.1	5.4	(−4.1)-(−22.4)	−7.1	4.9	(−2.0)-(−19.8)
Control	106.1	21.7	69.4-130.7	105.5	22.2	69.4-131.6	−11.2	4.4	(−5.3)-(−20.4)	−12.1	4.1	(−5.3)-(−19.3)

ROM=Range of motion, SD=Standard deviation, LET=Land-based exercise therapy, AET=Aquatic exercise therapy

Despite what is assumed, the most important aspect of treating patients through AET is related to buoyancy, rather than water temperature. This unique property of AET will cause decreasing pressure exerted on the lower extremity due to weight bearing, thus encourages patients to continue their therapeutic program in a more effective way.[29] We believe that this principle is the reason for reducing pain and improving knee joint ROM in our study.

The authors also concluded that both AET and conventional LET can increase knee joint ROM in hemophilic patients, although no significant difference was indicated between the two methods. The results of our trial confirm the results of the study conducted by Harris and Boggio (2006).[15] They reported that performing exercise therapy by elders with hemophilia can significantly ($P = 0.03$) improve ROM in major impaired joints, in comparison to those without any exercise intervention.[15] In addition, Mulvany *et al.* (2010) indicated that 6-week exercise therapy supervised by a physical therapist can increase ROM in affected joints.[14]

CONCLUSIONS

Using AET in combination to conventional LET programs for hemophilic patients is a safe and suitable therapeutic intervention, without any side effects. This method especially is appropriate to reduce pain in these patients. Then, the authors suggest the therapists who access to aquatic centers to utilize this treatment approach in the rehabilitation program of patients with hemophilia.

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