www.ijpm.ir

The Effect of Aquatic Exercise Therapy on Muscle Strength and Joint's Range of Motion in Hemophilia Patients

Mehdi Kargarfard, Mehdi Dehghadani, Reza Ghias[1]

Department of Exercise Physiology, School of Physical Education and Sport Sciences, University of Isfahan, Isfahan, Iran, [1]Health Center, University of Isfahan, Isfahan, Iran

Correspondence to:
Associate Prof. Mehdi Kargarfard, University of Isfahan, Faculty of Physical Education and Sport Sciences, Hezar Jerib Street, P.O. Box 81746 - 7344, Iran.
E-mail: kargar_m46@yahoo.com

Date of Submission: Oct 13, 2011

Date of Acceptance: Nov 14, 2012

How to cite this article: Kargarfard M, Dehghadani M, Ghias R. The effect of aquatic exercise therapy on muscle strength and joint's range of motion in hemophilia patients. Int J Prev Med 2013;4:50-6.

Original Article

ABSTRACT

Background: This study was to evaluate the effect of a period of aquatic exercise therapy on muscle strength and joints range of motion in hemophilia patients.

Methods: This was a semiexperimental, pretest, post-test study with a control group. This semi-experimental study comprised twenty men suffering moderate hemophilia were selected by convenience sampling method from patients of a referral hospital. They were randomly assigned to intervention and control groups of equal number. The hemophilia patients who were referred to Sayedo-Shohada Hospital enrolled in this study. Twenty men suffering moderate hemophilia were selected using convenience sampling method and then divided randomly into intervention and control groups (10 patients in each group). Subjects of aquatic exercise therapy group underwent activity in water in three sessions (45-60 minutes) per week for 8 weeks, while the control group was only under follow-up and during this period did not experience any effective physical activity. The patients' muscle strength and joint range of motion were evaluated through standard laboratory tools, using an isokinetic dynamometer (Biodex, Systems III) and a standard goniometer in the beginning and at end of the study. Finally, data was analyzed using analysis of covariance (ANCOVA).

Results: The strength of the muscles around the knee joint (to perform extension and flexion movements) increased significantly in the case group while the control group experienced a significant reduction of strength in left leg, but in right leg remarkable change was observed. Range of motion in all joints was improved in the case group, while the control group did not improve significantly.

Conclusion: The results showed that aquatic exercise therapy can be a useful method to improve joints' strength and range of motion in hemophilia patients in order to improve their daily functioning and quality of life.

Keywords: Aquatic exercise therapy, hemophilia, joint range of motion, muscle strength

INTRODUCTION

Hemophilia is a congenital genetic disorder. Hemophilia patients lack certain proteins in plasma which are responsible for blood clotting. Hemophilia type A or deficiency of coagulating factor 8 is the most common type of hemophilia and among every 10,000, one newborn is affected.[1-3] Severity of this disease depends on the level of clotting factor 8. If the amount of clotting factor 8 is between 5-40% of normal level, the person is affected with mild hemophilia and spontaneous hemorrhage rarely is seen in this group. In the moderate type, the amount of factor 8 is less than 5% and in severe type, this number reaches to less that 1% of normal level. Compared to healthy people, when these patients are exposed to injuries resulting from doing various kind of sports and physical activities, greater risk of bleeding within the joints, muscles and internal organs will threaten them.[4] Clinical signs of hemarthrosis may be swelling, increasing in skin body temperature, pain, muscle atrophy and reduction in the motion of joints.[1,4,5] Further studies have shown the joints damage and its decay. In addition, studies demonstrated that the most joint damages in hemophilia patients occurs in the knee joint which includes 50% of joint damages among these patients.[1] Furthermore, it is estimated that the prevalence of knee joint damage among patients with severe hemophilia is more than 80%. It means that more than 80% of those who are suffering from severe hemophilia endure knee joint damage.[3]

Recently, scientists have turned to the nonsurgical method for the treatment and rehabilitation of hemarthrosis patients. They believe that the replacement of coagulation factor in the first stage of injury is very important.[1-4] Depending on the severity and location of bleeding, lack of motion and fixing the organ with brace and splint is necessary. This fixation of the limb should not last too long because it will lead to muscle atrophy; and on the other hand, it should last enough to bring about recuperation and to cure hemarthrosis.[1,2,4,6,7] On the contrary, some scientists oppose inactivity and believe in treating hemarthrosis by physical activity.[8,9] These scientists believe that inactivity, even in a short period time, can result in deleterious effects for the joints including complications such as changes in the place of joints, atrophy of joints, joints damage, ligaments weakness and muscle atrophy.[10,11]

Therefore, an appropriate physical training program should be considered to reduce the damages due to inactivity. Some experts believe that because of high risk of muscles and ligaments damage, isotonic and isokinetic exercise are not suitable for the start of treatment and the only way to start treatment is isometric exercises.[12-15] Gradually and by monitoring the recovery, active and resistive exercises will also be added.[1,2,4,6,7] Perhaps the main reason for using isometric exercises for the start of treatment is that in this kind of exercises, tension and the amount of muscle contraction is controllable. Therefore, the possible risk of damage and pain will be reduced.[4] Exercise therapy, by strengthening the muscles around the joint and reducing the pressure on it, is effective to reduce the pain and to increase the dynamic range. If these exercises are done in water (especially in warm water), the properties of water that cause resistance result in relaxation and reducing the pressure on the affected joint and induces the feeling of exhilarating. This sort of exercise will be easier; less damage will happen and better improvement of physical power, respiratory system, reduction of anxiety and depression can be obtained compared to exercising out of water.[16] Therefore, treatment in the water or "water therapy" has attracted many patients recently. Hence, this research investigates the effect of aquatic exercise therapy on muscles strength and joint's dynamic range in a certain period of time in hemophilia patients.

METHODS

This research was a semi-experimental study. Approval for this study was obtained from the Ethics Committee of University of Isfahan and Isfahan Hemophilia Society. From the hemophilia patients who referred to Sayedo-Shohada Hospital in Isfahan, 20 male patients with moderate hemophilia were selected through accessible sampling method. By randomization, half of these patients were placed in the experimental group and the rest were chosen as the control group. After completing the written consent form and gathering demographic data of the patients in both groups, by the standard isokinetic dynamometer, physical function tests were done (Biodex, Systems III) to evaluate the muscles strength and range of the extensor and flexor muscles dynamic of knee joints in both legs. Validity and reliability of this set to evaluate the muscle strength in all age classes, has been proved by previous investigations.[17]

To warm up the patients before the experiments, six contraction gestures were planed. Participants were asked to do six contraction gestures with their maximum power to extend and flex their knee joint. For extending and flexing the knee joint, the isokinetic power in an angular velocity of 1.04 radians per second (60 degrees per second) was measured. Range of motion for this action was measured at about 1.57 radians (90 degrees), so that at the beginning of the movement the person put his feet in a state of flexion (90 degree) and then extended the knee by his maximum power. For each joint, subjects did three consecutive extension and flexion with the maximum power and finally the maximum torque was recorded. The range of motion in six joints (knees, elbows and ankles) was measured. The position of subject at the time of measuring the range of motion was as follows.

Sitting for measuring the dorsiflexion and plantar flexion of the ankle, and prone to the back to measure the flexion and extension of the knee and elbow joints. Each joint was moved inactively to the maximum range of motion by the researcher and using a universal standard goniometer; the achieved angle was measured and recorded. After the primary tests, the participates in the intervention group underwent exercise therapy in water for 24 sessions; three times in a week and each time lasted about 40 - 60 minutes. In response to the principle of overload, the process of aquatic exercise therapy was planned by increasing the time and quality of the exercise for each session. Before planning the exercise therapy in water, a pulse meter was used to control heart beat of the subjects during the time of exercise. The sessions consisted of three sections as follows:

- Warm up: This section included progressive aerobic activity. Before beginning the exercise programs, subjects were asked to measure their heart beat in 3 consecutive days when they are relaxed (mornings in the bed and before doing any activity) and report it to the research team which was estimated to be around 50-74% of their maximum heart beat. This is approximately equal to the percentage of VO_2max with a standard deviation of 10; so, based on the estimated heart beat, age and severity of the disease, subjects were exercised.
- Main plan: This section consists of 10 simple movements in the water. Five movements specialized for the upper limbs and five movements for the lower limbs. One minute was considered for each movement. The subjects were asked to do movements with their maximum power. However, in case of pain, in order to maintain the health of patients, they were asked to do movements as far as the pain was tolerable.
- Cool down: In order to improve the joints' range of motion, some flexibility movements (for 5 minutes) were practiced by patients at the end of each session depending on the muscle and the joint da mage.

Throughout the study, those in the control groups did not experience any regular exercise. After 8 weeks of exercise therapy in water, the questionnaires were again given to the patients and physical examinations were also performed again to collect the needed information after the experiments to compare the results of two groups.

Statistical analyses

All values are presented as mean values ± SD. Nonparametric tests were used to avoid potential errors from non-normal distribution of data. Independent Student's t-tests were used to compare the differences in baseline values between the experimental and control groups. Paired samples Student's *t*-test was used to identify differences between pre- and post-study within both the experimental and control groups. Finally, in order to assess the effects of the program, analysis of covariance (ANCOVA) was used to make comparisons, between experimental and control groups, on posttest scores adjusted for differences in pretest scores. All the analyses were performed by using SPSS version 17.0 (SPSS Inc., Chicago, IL, USA). The significant level was set at $P < 0.05$.

RESULTS

The mean and standard deviation of some general characteristics of participants are presented in Table 1. Comparison of strength and range of motion for the experimental group before and after a period of aquatic exercise therapy is reported in Table 2. Analysis of covariance of strength and range of motion between groups at post-test is given in Table 3.

Table 1: General characteristics of the participants

	Experimental group	Control group
	Mean±SD	Mean±SD
Age (year)	22.90±7.60	18.10±6.26
Height (cm)	175±11.55	164±13.30
Weight (kg)	60.20±9	55.75±17.82
BMI (kg/m^2)	19.70±1.95	20.20±4.20

DISCUSSION

Because of the repetitious bleeding within the joints, hemophilia patients who are affected with hemarthrosis will lose their muscles strength and their range of motion by passing the time and this leads to inability to do the patient's daily function.[18] Swelling and joints pain leads to restriction of

Table 2: Strength and range of motion for the experimental group before and after a period of aquatic exercise therapy

Factors	Prestudy	Post-study	Paired samples *t* test		
	Mean±SD	Mean±SD	df	*t*	*P* value
Right knee extension peak torque NM	51.47±39	69.40±47.28	9	4.64	0.001
Right knee flexion peak torque NM	36.14±18.45	53.35±20.93	9	9.67	0.001
Left knee extension peak torque NM	55.60±44.12	72.16±48.74	9	5.58	0.001
Left knee flexion peak torque NM	34.70±19.26	49.90±24.80	9	7.25	0.001
Right knee extension (degree)	-6.90±9.11	-4±9.26	9	3.13	0.001
Right knee flexion (degree)	128.50±17.96	135±12.25	9	2.33	0.04
Left knee extension (degree)	-2.50±3.53	-0.5±1.60	9	2.45	0.03
Left knee flexion (degree)	138±7.84	140.5±6.43	9	2.32	0.037
Right elbow extension (degree)	-13.40±11.24	-5.50±7.62	9	4.38	0.002
Right elbow flexion (degree)	137.80±7.79	143.5±6.26	9	4.85	0.001
Left elbow extension (degree)	-14±10.74	-5.90±9.10	9	4.40	0.002
Left elbow flexion (degree)	134.50±9.49	141.50±9.14	9	3.85	0.004
Right ankle plantar flexion (degree)	43±6.32	49±6.85	9	3.90	0.004
Right ankle dorsiflexion (degree)	6.10±5.28	9.10±4.93	9	1.81	0.01
Left ankle plantar flexion (degree)	38±4.22	49.90±11.90	9	2.98	0.015
Left ankle dorsiflexion (degree)	5.80±5.63	8±4.92	9	2.51	0.034

Table 3: Strength and range of motion covariance (ANCOVA) analysis for experimental and control groups in post test

Factors	Experimental group	Control group	Covariance (ANCOVA)	
	Mean±SD	Mean±SD	f	*P* value
Right knee extension peak torque NM	69.40±47.28	45.81±26	12.52	0.003
Right knee flexion peak torque NM	53.35±20.93	33.46±15.44	75.75	<0.001
Left knee extension peak torque NM	72.16±48.74	49.45±18.88	42.71	<0.001
Left knee flexion peak torque NM	49.90±24.80	31.35±14.24	79.62	<0.001
Right knee extension (degree)	-4±9.26	-6.50±6.69	14.53	0.001
Right knee flexion (degree)	135±12.25	133.50±17	14.53	0.004
Left knee extension (degree)	-0.5±1.60	-3.50±4.12	11.19	0.004
Left knee flexion (degree)	140.5±6.43	138.30±3.60	11.31	0.741
Right elbow extension (degree)	-5.50±7.62	-11.50±12.26	16.93	0.001
Right elbow flexion (degree)	143.5±6.26	133.70±4.85	30.72	<0.001
Left elbow extension (degree)	-5.90±9.10	11±6.14	17.15	<0.001
Left elbow flexion (degree)	141.50±9.14	135.20±6.26	17.28	0.001
Right ankle plantar flexion (degree)	49±6.85	39.70±5.85	19.43	<0.001
Right ankle dorsiflexion (degree)	9.10±4.93	8.30±7.10	4.04	0.061
Left ankle plantar flexion (degree)	49.90±11.90	35.50±7.62	12.45	0.003
Left ankle dorsiflexion (degree)	8±4.92	9±5.91	6.39	0.022

the joints movement.[19] After this inactivity, the patient uses less the joints and muscles which are around the painful joint. However, the pain itself also helps the development of this inactivity. Thus, after a while, the person will be affected with muscle atrophy and his muscle strength and joints' range of motion will decrease.[20] when we compare a hemophilia patient with a healthy inactive person, the difference in the amount of muscle strength is obvious. Compared to sedentary healthy people, hemophilia patients' muscle strength, especially in the lower limbs, is reduced.[21]

Therefore, researchers and specialists of hemophilia patients always recommend these patients to exercise and particularly suggest that they increase their muscle strength, so by the way of increasing their muscle's power, patients acquire more stability in their joints and it reduces their spontaneous bleeding.[3,22] One of the main aims for this research was to improve the joints of hemophilia patients by increasing their muscle strength around the joints. Results showed that among the experimental group, after a certain period of exercise therapy in water, significant improvement in the power of extending and flexing in both knees joint was observed. Koch and his colleagues[23] in their research about the effect of strength training program over two hemophilia patients reported significant increasing in muscles strength of these two patients. They stated that the increasing power and range of motion in these patients, was associated with reducing the times of bleeding. Although the training methods of subjects were different in our study, the results correspond to Koch and his colleagues findings. The Bernades *et al.*[24] results also showed that twice exercise in water during a 10-month period, can have a positive effect on limbs of hemophilia patients, which match to the results of our research.

Moreover, by performing a training program consisting of swimming, cycling, basketball and yoga three times a week and 30 minutes in each time, Koch and his colleagues observed a significant reduction in hemarthrosis in these patients and pursuant of the training program. A significant improvement in their range of motion was also observed. The result of other researches that had considered different exercise programs for hemophilia patients, all showed improvements in the strength and the range of motion in these patients.[24] Therefore, enough evidence that a proper physical activity can have a positive effect on the improvement of hemarthrosis symptoms is achieved.[6,25-27] The results of this study conform to this sort of researches, but the difference is that most related researches which have been carried out in the past were descriptive.

The interesting and distinguishing point of differences between previous researches and the presented study is the amount of time for exercise therapy which is substantially less than researches that have been performed before. It means that in a very short time, the same results have been obtained. Perhaps the reason of this matter is the differences in the environment or the intensity of exercises. For hemophilia patients, these results are very important from the economic and psychological points of view.

Hemophilia patients and generally all people who are looking for a result in doing exercises, tend to reach their aims in a possible minimum time. From the psychological point of view, observing daily or even weekly improvement will help to advance the planned aims of exercises. The cause of increasing strength of patients after a period of aquatic exercise therapy is not vague. Environment of water is very different with the environment of land and the forces which are imposed to a person due to the movements of water, acts as a counterpoise power and make the muscles powerful. Stronger muscles will lead to more stable joints. Therefore, the risk of injury and bleeding within the joints will be decreased. Physical activity results in the improvement of blood flow. Moving the muscles which are around the damaged joints causes more flow of blood towards them. The more blood flow around the damaged joint cause the retrieval and disposal of surplus substances and by this way flexibility of joints will be improved and the person's range of motion will increase. On the other hand, hydrostatics pressure which is caused by the floating of the organs or the body itself, results in physiological responses that is focused on the circulatory system, so that the produced hydrostatic pressure directs the flowing blood from lower limbs toward the upper part of the body and abdomen. Therefore, according to the Frank Starling principle, increasing in the returning speed of venous blood to heart causes increase in the beat quality and cardiac output.[28]

Moreover, covariance analysis test showed in this study that pre-test and post-test of the muscle strength and the range of motion between experimental and control groups have significant differences which demonstrate the results of a certain period of therapeutic exercise on the improvement of the power and range of the motion in hemophilia patients. On the other hand, without any intervention, the mentioned criterion in the control group remained almost constant during this period and even in some criterions, we observed decrease of functionality. This slight decreasing, (significant in some cases) can be the result of the progressive nature of hemophilia. It means that over time and without any preventive health care action, health condition of hemophilia patients will become worse. This research is one the few researches which have studied the effect of aquatic exercise therapy on the power and range of motion in hemophilia patients. One of the main aims of this study was to demonstrate logically the positive effect of aquatic exercise therapy on the improvement of patient's performance and its advantage to solve the musculoskeletal problems related to hemarthrosis. Till now, despite the recommendations by doctors and physiotherapist professionals, on the use of water environment for treatment of hemophilia patients, few researches have been carried out to examine these recommendations. Therefore, it is necessary to perform further researches in this field.

CONCLUSIONS

Finally, aquatic exercise therapy which was performed on hemophilia patients caused significant improvements in the muscles' power and the joints' range of motion. Because the muscles weakness and poor range of motion was are among the main problem of hemophilia patients, it is recommended that these patients do the exercise therapy in the water along with the other treatments procedures to improve their joints condition, strength and range of motion.

ACKNOWLEDGMENT

This study was supported by a grant from the University of Isfahan. The study group thanks all the patients who participated in the study, the administrative staff, physicians, nurses, aquatic coaches and other personnel at the Isfahan Hemophilia Society and Sayedo-Shohada Hospital in which the study was carried out.

REFERENCES

1. Mehdizadeh M, Kardoost M, Zamani G, Baghaeepour MR, Sadeghian K, Pourhoseingholi MA. Occurrence of haemophilia in Iran. Haemophilia 2009;15:348-51.
2. Wittmeier K, Mulder K. Enhancing lifestyle for individuals with haemophilia through physical activity and exercise: The role of physiotherapy. Haemophilia 2007;132:31-7.
3. Buzzard BM. Sports and hemophilia: Antagonist or protagonist. Clin Orthop Relat Res 1996;328:25-30.
4. Hilberg T, Herbsleb M, Gabriel HH, Jeschke D, Schramm W. Proprioception and isometric muscular strength in haemophilic subjects. Haemophilia 2001;7:582-8.
5. Tiktinsky R, Falk B, Heim M, Martinovitz U. The effect of resistance training on the frequency of bleeding in haemophilia patients: A pilot study. Haemophilia 2002;8:22-7.
6. Schoenmakers MA, Gulmans VA, Helders PJ, van den Berg HM. Motor performance and disability in Dutch children with haemophilia: A comparison with their healthy peers. Haemophilia 2001;7:293-8.
7. Smolander J, Blair SN, Kohl HW 3rd. Work ability, physical activity, and cardiorespiratory fitness: 2-year results from Project Active. J Occup Environ Med 2000;42:906-10.
8. Stewart KJ, Bacher AC, Turner K, Lim JG, Hees PS, Shapiro EP, *et al*. Exercise and risk factors associated with metabolic syndrome in older adults. Am J Prev Med 2005;28:9-18.
9. Bonhauser M, Fernandez G, Puschel K, Yanez F, Montero J, Thompson B, *et al*. Improving physical fitness and emotional well-being in adolescents of low socioeconomic status in Chile: Results of a school-based controlled trial. Health Promot Int 2005;20:113-22.
10. Mulder K, Cassis F, Seuser DR, Narayan P, Dalzell R, Poulsen W. Risks and benefits of sports and fitness activities for people with haemophilia. Haemophilia 2004;10:161-3.
11. Jones P, Buzzard B, Heijnen L. Go for It: Guidance on Physical Activity and Sports for People with Haemophilia and Related Disorders. Montreal, Quebec: World Federation of Hemophilia; 1998.
12. Anderson A, Forsyth A. Playing It Safe: Bleeding Disorders, Sports and Exercise. New York, NY: National Hemophilia Foundation; 2005.
13. Heijnen L. Rehabilitation and the role of the physical

therapist. Southeast Asian J Trop Med Public Health 1993;24:26-9.
14. Petrini P, Lindvall N, Egberg N, Blomback M. Prophylaxis with factor concentrates in preventing hemophilic arthropathy. Am J Pediatr Hematol Oncol 1991;13:280-7.
15. Koch B, Luban NL, Galioto FM Jr, Rick ME, Goldstein D, Kelleher JF Jr. Changes in coagulation parameters with exercise in patients with classic hemophilia. Am J Hematol 1984;16:227-33.
16. Stenstrom CH. Home exercise in rheumatoid arthritis functional class II: Goal setting versus pain attention. J Rheumatol 1994;21:627-34.
17. Dvir Z. Isokinetics: Muscle Testing, Interpretation and Clinical Application. New York: Churchill Livingstone; 1995. p. 45-55.
18. Heijnen L, De Kleijn P, Heim M. Functional kinesiology in haemophilia, an area yet to be explored. Haemophilia 1998;4:524-7.
19. Hicks JE. Exercise in patients with inflammatory arthritis and connective tissue disease. Rheum Dis Clin North Am 1990;16:845-70.
20. Cabrera M. Sport and Hemophilia, in Hemophilia Catalona. Barcelona: Hemofilia Catalona; 2003. p. 1-2.
21. Falk B, Portal S, Tiktinsky R, Zigel L, Weinstein Y, Constantini N, *et al*. Bone properties and muscle strength of young haemophilia patients. Haemophilia 2005;11:380-6.
22. Beardsley DS. Hemophilia. In: Goldberg B, editor. Sports and Exercise for Children with Chronic Health Conditions. Champaign: Human Kinetics; 1995. p. 301-10.
23. Koch B, Cohen S, Luban NC, Eng G. Hemophiliac knee: Rehabilitation techniques. Arch Phys Med Rehabil 1982;63:379-82.
24. Gomis M, Querol F, Gallach JE, Gonzalez LM, Aznar JA. Exercise and sport in the treatment of haemophilic patients: A systematic review. Haemophilia 2009;15:43-54.
25. Falk B, Portal S, Tiktinsky R, Weinstein Y, Constantini N, Martinowitz U. Anaerobic power and muscle strength in young hemophilia patients. Med Sci Sports Exerc 2000;32:52-7.
26. Hilberg T, Herbsleb M, Puta C, Gabriel HH, Schramm W. Physical training increases isometric muscular strength and proprioceptive performance in haemophilic subjects. Haemophilia 2003;9:86-93.
27. Querol F, Gallach JE, Toca-Herrera JL, Gomis M, Gonzalez LM. Surface electrical stimulation of the quadriceps femoris in patients affected by haemophilia A. Haemophilia 2006;12:629-32.
28. Barker KL, Dawes H, Hansford P, Shamley D. Perceived and measured levels of exertion of patients with chronic back pain exercising in a hydrotherapy pool. Arch Phys Med Rehabil 2003;84:1319-23.

Source of Support: Nil, **Conflict of Interest:** None declared.