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RESEARCH ARTICLE

The Effect of Aquatic Exercise Therapy on knee joint hemarthrosis in hemophilic children

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Abstract

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 aquatic exercise therapy on the knee joint complications in patients with hemophilia. Forty male patients with Rt knee joint bleeding were assigned randomly into two equal groups. Their ages were ranged from10-14 years old. The subjects were evaluated for the following parameters: The pain level and knee ROM and knee circumference, the visual analog scale, electronic goniometer and tape measurement were utilized, respectively before and after three months of treatment program. Subjects in the control group received selected physical therapy program in the form of (Range of motion, stretching exercises, strengthening exercises and proprioceptive training) whereas subjects in the study group received the same selected physical therapy program in water. The data were collected and analyzed using a paired and un-paired t-test to compare the difference between the results within each group pre test and post test and between the two groups. The results of this study revealed that there were significant differences ($p<0.05$) of all of the measured variables.

Introduction

Hemophilia is a group of hereditary genetic disorders that impair the body's ability to control blood clotting or coagulation, which is used to stop bleeding when a blood vessel is broken **(Douglas ,2007).** Haemophilia lowers blood plasma clotting factor levels of the coagulation factors needed for a normal clotting process. Thus when a blood vessel is injured, a temporary scab does form, but the missing coagulation factors prevent fibrin formation, which is necessary to maintain the blood clot. A haemophiliac does not bleed more intensely than a person without it, but can bleed for a much longer time. In severe haemophiliacs even a minor injury can result in blood loss lasting days or weeks, or even never healing completely. In areas such as the brain or inside joints, this can be fatal or permanently debilitating (**Wynbrandt et al., 2009).**

Hemorrhages may occur anywhere in the body but most often are in the joint cavities. Muscles are the second most common site of bleeding, particularly in the iliopsoas, gastrocnemius, and forearm flexor muscle compartment. Hemorrhages within muscles can be dangerous owing to the risk of nerve compression from the hematoma. Patients with hemophilia may also be susceptible to hematuria, mucous membrane hemorrhages, and central nervous system hemorrhages. Fortunately, central nervous system hemorrhages are uncommon, developing in approximately 3% of the hemophilic population, but they are the major cause of death from these bleeding disorders **(Buch et al, 2005).**

The major complications experienced by patients with haemophilia are recurrent bleeding episodes into the musculoskeletal system, not only into the joints (haemarthrosis) but also into the muscles (haematoma). Destruction

of the joint cartilage and irreversible chronic arthropathy are the long-term consequences of repeated haemarthrosis, causing severe and painful functional disability, loss of autonomy and altered quality of life. One of the major goals of medical treatment of haemophilia is to minimize joint structural damage by preventing haemarthrosis. This can be achieved by regular intravenous infusions of plasma-derived or recombinant concentrates of clotting factor VIII or IX, administered as either prophylactic therapy or on-demand therapy **(Lobet , 2010).**

The most typical manifestation of hemophilia is hemarthrosis. In severe hemophilia, 80 to 85% of bleeding events occur in joints. The most affected joints, especially in children, are the knees. Regular and/or intense hemarthrosis results in hypertrophy of the synovium (chronic hemophilic synovitis) and destruction of cartilage and bone (hemophilic arthropathy). If a single joint becomes the site of recurrent hemarthrosis, it is called a target joint. When the joint has not fully recovered between bleeding episodes, synovitis occurs and the joint becomes permanently swollen and warm. If the synovitis is not controlled, there is a progressive destruction of the cartilage, which ultimately results in hemophilic arthropathy and functional impairment **(Rosendal et al., 2007).**

Hemarthrosis can be divided into acute and subacute hemorrhagic events. An acute hemarthrosis is usually experienced as a burning sensation in the joint. Within a few hours, the joint becomes swollen, painful, and warm. The affected joint is held in a flexed position to minimize pain. The administration of clotting factor concentrate reduces the pain, but limitation of mobility disappears more slowly. The degree of inflammation and limitation of motion are related to the amount of blood in the joint and frequency of bleeding, again indicating the importance of early treatment with clotting factor concentrates **(Pia,2008).**

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 **(Wittmeier and Mulder, 2007).** 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 **(Mehdizadeh et al., 2009)** On the contrary, some scientists oppose inactivity and believe in treating hemarthrosis by physical activity, 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 **(Stewart et al., 2005 and Bonhause et al., 2005).**

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, 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 Therefore, treatment in the water or "water therapy" has attracted many patients recently **(Anderson et al., 2005).** Hence, this research investigates the effect of aquatic exercise therapy on pain and joint's dynamic range in a certain period of time in hemophilia patients

Subjects, Materials and Methods:

Subjects:

Forty boys with mild to moderate hemarthroses for Rt knee participated in this study. Subjects were divided into two groups; control and experimental groups. Boys were selected from the outpatient clinic of the Faculty of Physical Therapy, and Abu El-Rish hospital, Cairo University. They participated in this study according to these criteria Inclusion criteria their ages from 10-13 years, they were not suffering from respiratory or heart problems, they were suffering from unilateral knee affection.

Instrumentation:

- **Visual analogue scale:**

- **A digital uni dimensional Egyptian made electrogoniometer.**
- **Tape measurement**

Procedures:

Outcome measures:

All outcome measures were recorded pre and post intervention for both control and experimental groups for the affected knee. These were pain score which gained from visual analogue scale and knee ROM which gained from A digital uni dimensional Egyptian made electrogoniometer and knee circumference which gained from tape measurement.

Evaluative procedures:

1- The diagnosis of (hemarthroses): was based on orthopedist or orthopedic surgeon referral according to radiographic evidence of joint space narrowing, osteophyte formation.

2- Pain assessment: The patient marked on the line the point that they feel represents their perception of their current state. The **VAS** score was determined by measuring in millimeters from the left hand end of the line to the point that the patient marks. Measurement of pain score was done pre treatment and post treatment for two groups.

3- Range of motion of the knee joint Assessment.

A digital uni dimensional Egyptian made electrogoniometer was used to determine the ROM of the knee joint. Before starting evaluation the electrogoniometer was calibrated in three different angles which were (180, 90 and zero degree). This method of calibration was repeated each time the device was used.

Knee extension

Is the straightening of the knee joint resulting in an increase of angle, moving the lower leg away from the back of the thigh. So the angle of knee extension is remaining angle from full flexion to reach zero degree **(Polan, 1998)**

Subject preparation

All subjects were given the same full instruction about the procedures to be done. The subjects were asked to wear a short so most of the lower limb was bared skin.

Subject position

All subjects were allowed to lie in prone position with both feet out of the bed. Each subject was asked to maintain his trunk, both lower limb and pelvis completely supported on the bed.

Electrogoniometer position

The electrogoniometer was placed parallel to the lateral aspect of the lower limb with the axis parallel to the lateral articulation of the knee joint. The stationary arm of goniometer was placed parallel to the long axis of the femur along a line extending from the greater trochanter to the lateral femoral condyle, and the movable arm was placed to the long axis of fibula in line with the head of the fibula and the lateral malleouls. Two adhesive straps were used to stabilize each arm of the electrogoniometer to avoid any restrictions of the potentiometer movement as shown in (Fig 1&2).

Fig. (1): Application of the electrogoniometer with the knee extended.

Fig. (2): Application of the electrogoniometer with the knee flexed.

4- Knee joint swelling Assessment.

The child was in comfortable position (supine lying position) and the round measurement was done.

First the middle of the patella was determined then the knee circumference was measured at this level

Treatment procedures:
Control group
Range of Motion exercise

These exercises can be started as soon as bleeding has stopped.

- Sit with legs out straight (or lie on back). Exercise:

Bend hip and knee, and slide heel towards body. Then straighten knee by sliding heel away from body. Repeat several times.

- Sit on chair.

Support the weight of the affected leg with the other leg if necessary. Exercise: Allow the knee to bend as much as is comfortable, and then straighten the leg as far as possible.
Goal: Try to bend a bit more each time.

- Start: Lie on stomach.

Exercise: Bend knee and try to touch heel to buttocks. Assist with the other leg if necessary. Then straighten leg as far as possible.
Goal: Bend knee as much as knee could bend before the bleed.

Strengthening exercise

These exercise can be started as soon as bleeding has stopped.

- Lie on back with a roll under knee.

Exercise: Tighten the muscle at front of thigh, extend knee and lift heel. Hold for several seconds, and then relax. Repeat until muscle feels tired.

- Sit on a chair with knee bent.

Exercise: Extend knee, lifting the foot off the floor as far as possible. Hold for several seconds, then slowly return foot to floor. Repeat until
muscle feels tired.

- Stand with weight evenly on both feet.

Exercise: Squat down partway, keeping weight distributed evenly on both legs. Do not bend knees far enough to cause pain. Hold for several seconds. Return to upright position.

Proprioception

- Stand on affected leg.

Exercise: Maintain balance, practice until balance can be maintained
for 30 seconds.

- Stand on affected leg with eyes closed.

Exercise: Maintain balance with eyes closed as long as possible.

- Stand on affected leg on an unstable surface
(e.g., pillow, block of foam).

Exercise: Maintain balance, practice until balance can be maintained
for 30 seconds.

- Stand on affected leg on an unstable surface and close eyes.

Exercise: Maintain balance with eyes closed as long as possible.

Stretching exercise :

- Hamstring muscle

Lie on your back. Raise your right leg as high as you can keep your pelvis flat on the ground. Hold your lower thigh and encourage the leg to move toward your head. Flex your foot to stretch your calf too.

- Quadriceps

Start: Lie on back with affected leg close to the edge of the bed. Let the knee bend over the edge of the bed. It is preferable to let the foot rest on
the floor to start.
Exercise: Flex the non-affected thigh towards the chest, assisting with hands. Stop flexing as soon as there is a stretching sensation in the affected thigh. Keep thigh flat on bed. Slowly bend knee until stretch is felt in thigh. Hold, and then relax.

Study group

The same exercise program was done in water

Results

Descriptive data of both groups (control and study):

There were no significant differences between patients' characteristics (age, weight and height) between two groups of the study before treatment . control group the mean age, weight and height of the subjects was 10.560±1.110 Years , 33.410±3.129 kg and 1.441±5.023 meter respectively as shown in table (1), for study group the mean age , weight and height was 10.620±1.123 Years, 34.012±3.034 kg, 1.433±5.322 meter respectively as shown in table (1).

Table (1): Statistical analysis for age, weight and height between control and study group.

Items / Variables	$\overline{X}$	SD	T-value	P value
Age of control group (Years)	10.560	1.110	-0.269	0.789 (NS)
Age of study group (Years)	10.620	1.123		
Weight of control group (kg)	33.410	3.129	-0.977	0.331 (NS)
Weight of study group (kg)	34.012	3.034		
Height of control group (meter)	1.441	5.023	-0.289	0.456 (NS)
Height of study group (meter)	1.433	5.322		

1- Pain

There were significant differences of pain intensity between pre and post test in study group and also there were significant differences of pain score between post test of both control and experimental groups as shown in table(2) and Fig (3).

Table (2) Statistical analysis for pain intensity between control and study group pre- and post-the program

Pain	Pre	Post	MD	P value	Sig
Control	6.4±1.88	5.69±2.23	0.71	>0.05	NS
Study	5.95±1.76	2.8±1.32	3.15	0.005	HS
P-value	>0.05	<0.05			
Sig. (P<0.05)	NS	S			

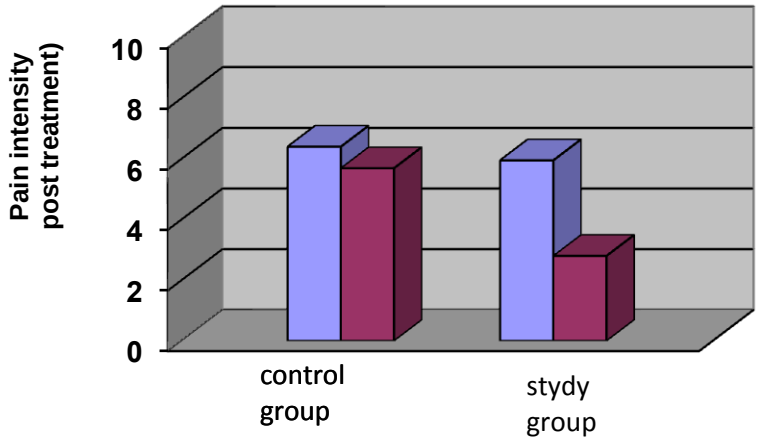

Fig (3) Showing pre- and post-treatment mean values of pain intensity in control and study groups

2- Knee flexion

There were significant differences of knee flexion between pre and post test in control and study groups and also there were significant differences of knee flexion between post test of both control and study groups as shown in table(3) and Fig (4).

Table (3) Statistical analysis for Knee flexion between control and study group pre- and post-the program

Knee flexion	Pre	post	MD	P value	Sig
Control	106.7±0.75	115.1±1.34	8.4	0.05	S
Study	105.5±1.2	123±1.4	17.5	0.005	HS
P-value	>0.05	<0.05			
Sig. (P<0.05)	NS	S			

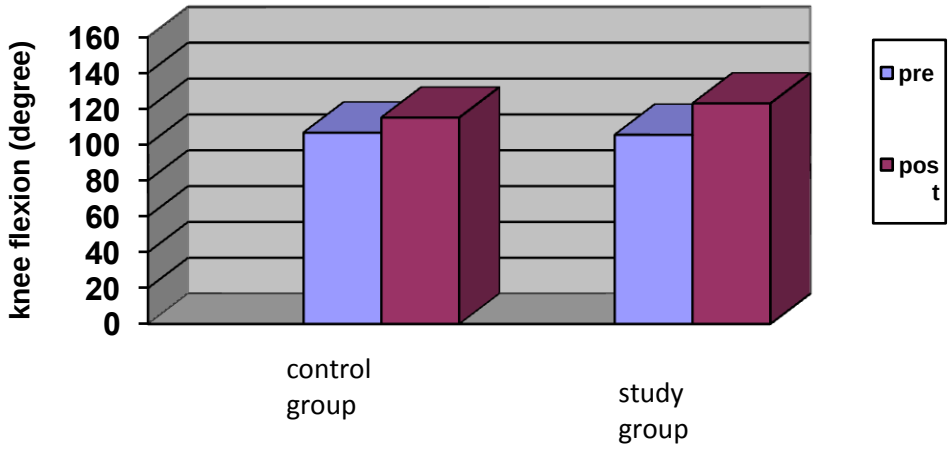

Fig (4) Showing pre- and post-treatment mean values of knee flexion in control and study groups.

3- Knee extension (degrees)

There were significant differences of knee extension between pre and post test in control and study groups and also there were significant differences of knee extension between post test of both control and study groups as shown in table(4) and Fig (5).

Table (4) Statistical analysis for Knee extension between control and study group pre- and post-the program

Knee extension	Pre	Post	MD	P value	Sig
Control	15.8±1.2	11.3±1.4	4.5	0.05	S
Study	14.9±0.93	8.7±1.01	6.2	0.05	S
P-value	>0.05	<0.05			
Sig. (P<0.05)	NS	S			

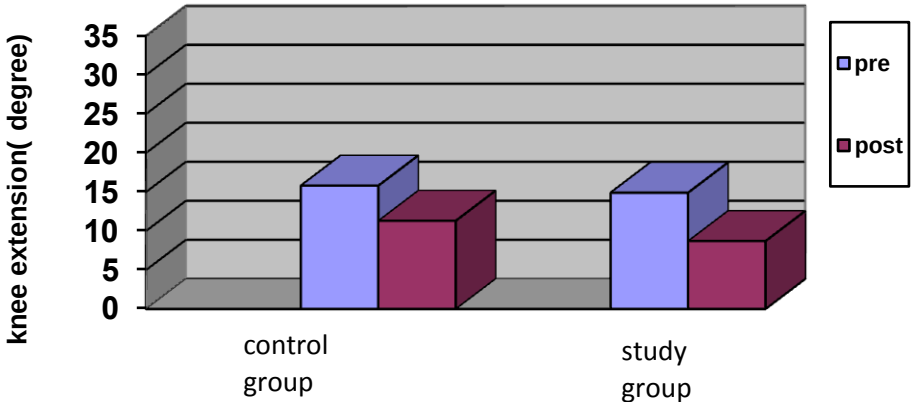

Fig (5) Showing pre- and post-treatment mean values of knee extension in control and study group.

4- Knee circumference

There were significant differences of knee circumference between pre and post test in control and study groups and also there were significant differences of knee circumference between post test of both control and study groups as shown in table(5) and Fig (6).

Table (5) Statistical analysis for Knee circumference between control and study group pre- and post-the program

Knee circumference	Pre	Post	MD	P value	Sig
Control	29.5±3.12	28.55±4.94	0.95	<0.05	S
Study	30.66±4.94	27.46±4.38	3.2	<0.005	HS
P-value	>0.05	<0.05			
Sig. (P<0.05)	NS	S			

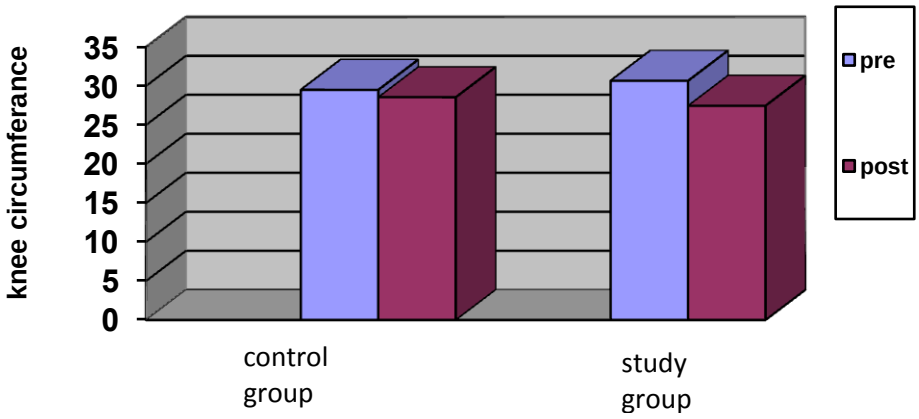

Fig (6) Showing pre- and post-treatment mean values of knee circumference in control and study group.

Discussion

The purpose of this study was to evaluate The effect of Aquatic Exercise Therapy on knee joint hemarthrosis in Hemophilic children. Forty hemophilic children were chosen from the outpatient clinic of the Faculty of Physical Therapy Cairo University. Subjects were divided randomly into two groups of equal numbers, control group which received selected physical therapy program and study group which received the same treatment program while in water for three successive months.

The pretreatment values of pain score, knee flexion, knee extension and knee circumference obtained from both groups revealed non significant difference and abnormal values of these variables. This may attributed to exposure of patients 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 **(Hilberg et al ., 2001).**Clinical signs of hemarthrosis may be swelling, increasing in skin body temperature, pain, muscle atrophy and reduction in the motion of joints **(Tiktinsky et al., 2002).**

The post treatment results of this study revealed an improvement in the mean values of the measured variables of the control and study group with superiority of study group and this may be due to

Reduction of pain may be contributed to the beneficial influences to physical properties of water, this come in agreement with **(Wilcock et al., 2006)** who stated that 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 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 **(Marossy et al., 2009)** However, applying cryotherapy will induce antalgic effect, so can decrease pain and sweeling in patients **(Hróbjartsson and Gøtzsche 2001).**

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. **(Gomis et al., 2009)** Therefore, enough evidence that a proper physical activity can have a positive effect on the improvement of hemarthrosis symptoms is achieved **(Falk et al .,2000 & Querol et al., 2006 and Schoenmakers et al., 2001)** The results of this study conform to this sort of researches.

Conclusion

This study concludes that The Aquatic Exercise Therapy with conventional physiotherapy is effective in improving knee joint hemarthrosis in hemophilic children

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