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**Effectiveness Of Aquatic Therapy on Falls and Functional Activities in Postural Orthostatic Tachycardia Syndrome Subject - A Single Case Study**

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**ABSTRACT**

**Background Of the Study:** Postural orthostatic tachycardia syndrome (POTS) is marked by an abnormal increase in heart rate when moving to an upright position, making it difficult to stand for extended periods due to severe lightheadedness, weakness, and near-fainting. The cause of POTS remains unknown. The dizziness experienced by patients is due to insufficient blood flow to the brain. POTS affects about 0.2% of the general population, with an estimated 500,000 to 1,000,000 individuals in the United States living with the condition. It predominantly impacts women aged 15 to 50 years. Aquatic therapy, involving exercises performed in water, has shown benefits such as improving range of motion, initiating resistance training and weight bearing, promoting cardiovascular fitness, and enhancing relaxation for patients.

**Objectives:** The purpose of the study is to prevent falls and improve the functional activities after the aquatic therapy in individual with Postural orthostatic tachycardia syndrome.

**Subjects And Methods:** The study utilized a single case design and was carried out at the outpatient department of PPG College of Physiotherapy in Coimbatore. An 18-year-old female subject with postural orthostatic tachycardia syndrome participated, experiencing difficulties in functional activities and frequent falls. She underwent 12 sessions of aquatic therapy over three months. The outcome measures included the Short Falls Efficacy Scale for falls and the Vertigo Symptoms Scale for functional activities. Pretest and post-test values were recorded and analyzed.

**Result:** The statistical report indicates that the pretest and post-test values of the Short Falls Efficacy Scale and Vertigo Symptoms Scale demonstrate significant improvement in a subject with Postural Orthostatic Tachycardia Syndrome who underwent aquatic therapy. The pretest and post-test values for the Short Falls Efficacy Scale were 24 and 8, respectively. For the Vertigo Symptoms Scale, the pretest and post-test values were 31 and 14, respectively.

**Conclusion:** Thus, the study concluded that aquatic therapy resulted in statistically significant improvements in preventing falls and enhancing functional activities in a subject with Postural Orthostatic Tachycardia Syndrome.

**Clinical Implications:** Aquatic therapy has a significant effect to preventing falls and improving functional activities in subjects with POTS.

**Keywords:** Postural orthostatic tachycardia syndrome, Aquatic therapy, falls, functional activity, short falls efficacy scale, vertigo symptoms scale.

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## **1. Introduction**

Postural Orthostatic Tachycardia Syndrome (POTS) is characterized by an excessive increase in heart rate upon standing, leading to an inability to remain upright for extended periods.

**POSTURAL:** Pertaining to body position.

**ORTHOSTATIC:** Related to standing upright.

**TACHYCARDIA:** A heart rate exceeding 100 beats per minute.

**SYNDROME:** A collection of symptoms occurring together.

Under normal circumstances, the autonomic nervous system regulates heart rate and blood pressure to maintain a healthy blood flow regardless of body position. POTS typically triggers when a person transitions from lying down to standing. The syndrome predominantly affects women aged 15 to 50, with a prevalence of about 0.2% in the general population (Walter Rocca, Philip Low, et al). In POTS, the body fails to properly coordinate blood vessel constriction and heart rate response, leading to unstable blood pressure. Although POTS is life-changing, it is not life-threatening. One major risk for POTS patients is falls due to fainting, though not all patients faint, and for those who do, it may occur infrequently. Symptoms usually manifest when standing upright, marked by a heart rate increase of at least 30 beats per minute in adults or 40 beats per minute in adolescents within the first 10 minutes of standing. Symptoms may fluctuate over years, but with dietary adjustments, medications, and physical activity, most patients experience an improved quality of life. Significant illness such as viral infections like mononucleosis, severe infections, pregnancy, physical trauma like head injuries, and surgery can increase the risk of POTS. Autoimmune conditions like Sjogren's syndrome, lupus, and celiac disease also raise the likelihood of developing POTS. <sup>1</sup>

**1.1 Mechanism of injury:** Normally, standing causes gravity to pull about 10% to 15% of blood into the abdomen, legs, and arms, reducing blood flow to the brain and potentially causing brief light-headedness. However, leg muscles help pump blood back to the heart, and the autonomic nervous system activates rapid responses. The body releases epinephrine (adrenaline) and norepinephrine to increase heart rate and constrict blood vessels, ensuring more blood returns to the heart and brain. <sup>2</sup> In POTS, more blood pools in the vessels below the heart upon standing, prompting the release of additional epinephrine and norepinephrine. However, the blood vessels do not respond normally to these hormones, while the heart does, leading to an increased heart rate. This imbalance results in symptoms such as dizziness, fainting, and exhaustion. <sup>3</sup>

The causes of POTS include

- Neuropathic
- Hyperadrenergic
- Autoimmune
- Hypovolemic
- Physical deconditioning

### **1.2 Symptoms of POTS:**

Postural Orthostatic Tachycardia Syndrome (POTS) is a condition that may develop either suddenly or gradually, characterized by symptoms that appear shortly after standing or sitting up and are often alleviated by lying down. Symptoms include dizziness or lightheadedness, fainting or near-fainting episodes, heart palpitations or a racing heart, fatigue, feelings of anxiety, shakiness, shortness of breath, chest pain, headaches, nausea, bloating, and a pale or purplish discoloration in the hands and feet when they are lower than heart level. These symptoms may worsen in specific situations, such as warm environments (e.g., hot showers, baths, or on hot days), prolonged standing (e.g., waiting in line or shopping), strenuous exercise, or during menstruation. Diagnosing POTS typically involves a variety of tests to assess the body's response to changes in posture and autonomic function, including a tilt table test, autonomic breathing tests, echocardiogram, and blood volume and hemodynamic studies to evaluate cardiovascular responses and blood flow dynamics.<sup>5,6</sup>

### **1.3 TREATMENT:**

Medical management of Postural Orthostatic Tachycardia Syndrome (POTS) may include medications such as pyridostigmine, midodrine, and beta blockers, along with physical management. Additional strategies focus on lifestyle adjustments, including regular exercise, proper diet and nutrition, and the use of medical compression stockings. Aquatic therapy offers a therapeutic option in early functional rehabilitation, leveraging the hydrostatic pressure of water to counteract gravity, enabling resistance training, cardiovascular exercises, weight-bearing, and relaxation with lower perceived exertion (RPE). Aquatic exercise is especially beneficial as it lowers heart rate, allowing patients to perform exercises that may be challenging on land. Contraindications for aquatic therapy include uncontrolled seizures, unstable angina, open wounds, infections, fever, hydrophobia, and deep vein thrombosis. The unique properties of water—density, specific gravity, hydrostatic pressure, viscosity, and buoyancy—enhance functional recovery by reducing injury risk and accelerating progress. The Vertigo Symptom Scale, a simple, equipment-free test, can assess functional capacity through a six-minute walk on

a flat surface, offering a straightforward measure of patient progress.<sup>7-11</sup>

## 2. METHODOLOGY:

**2.1 Study Design:** This study was a single case study.

**2.2 Case History:** The patient, an 18-year-old high school student, reported experiencing dizziness, achy bones and joints, tunnel vision, migraine headaches, fatigue, shortness of breath, palpitations, nausea, and fainting spells over the past several months. Referred by a pediatric cardiologist at Ashwin Multispecialty Hospital, she was directed to the physiotherapy department for rehabilitation. In the month before her physiotherapy evaluation, the patient estimated experiencing around 15 fainting spells without any warning symptoms, resulting in falls to the floor.<sup>12</sup> Following these episodes, she experienced migraine headaches, achy bones and joints, and fatigue lasting several days. No significant injuries were reported from these falls. Before her physical therapy referral, medical tests ruled out other causes of tachycardia, including endocrine abnormalities, adverse drug effects or interactions, kidney diseases, and other causes of autonomic dysfunction. The patient was assessed with the Short Falls Efficacy Scale to evaluate falls frequency and the Vertigo Symptom Scale to assess functional activities. She could only stand for 10 to 15 minutes at a time before fainting, limiting her to a very sedentary lifestyle and causing her to miss multiple days of school. Her current medications included Bystolic (a cardioselective beta-blocker), fludrocortisone (for fluid and salt retention), and Nuun tablets (an electrolyte supplement to replace sodium). She also wore lower extremity compression garments (40-50 mm Hg) to aid blood flow.<sup>13</sup> The patient's goal for physical therapy was to increase her standing time, walk independently at school to change classrooms and socialize with friends, and return to her previous recreational activities. The tools used for assessing falls frequency and functional activities were the Short Falls Efficacy Scale and the Vertigo Symptom Scale.

**2.3 Methods:** The objectives and necessity for the study were thoroughly explained to the PPG Group of Institutions, and permission was secured. Upon approval, the study was conducted at the PPG Group of Institutions in Coimbatore. The subject engaged in aquatic exercises, or physical exercises in water, for 12 sessions over 3 months. Each session lasted 45 minutes, five days a week, for 12 weeks.<sup>1</sup> The Short Falls Efficacy Scale and Vertigo Symptom Scale values were measured. After 3 months, post-test values were recorded, and pre- and post-test scores were documented.<sup>14</sup>

The aquatic environment maintained a water temperature between 80°F and 85°F. The pool was cleaned every three days by lowering the pH level to below 7.2 and shocking the pool with chlorine using pumps and filters until clear.<sup>15</sup> Initially, the patient performed exercises at a water depth of 3 feet 6 inches and progressed to a depth of 5 feet with the help of an aqua jogger vest. Although

deep-water exercises could have provided greater cardiovascular benefits, shallow-water exercises were introduced to alleviate the patient's anxiety about exercising in water. Given her frequent fainting episodes, the patient felt more comfortable in shallow water, close to the pool's edge.<sup>16</sup>

#### **2.4 Description of Experimental Intervention:**

1st AND 2nd WEEK

- Punches 30" x 4
- Butt kicks 30" x 4
- Reverse flies 30" x 4
- Skiers 30" x 4
- Jumping jacks 30" x 4

**PUNCHES:** Stand in a staggered stance with both fists guarding your face. Punch forward with your front fist while keeping the other hand in a defensive position.<sup>17</sup> Then, punch with the other fist, rotating your hip forward. Repeat the motion. This exercise improves balance and helps with posture.

**BUTT KICKS:** Stand tall and lift one heel towards your glutes while bringing the opposite hand up towards your shoulder, mimicking a running motion. Switch to the other side. This cardio workout builds muscle, boosts coordination, and improves balance.

**REVERSE FLYES:** Sit with knees bent and lean forward, allowing your arms to hang down beside your calves with elbows slightly bent. Slowly raise your hands until your elbows are level with your shoulders.<sup>18</sup> This exercise targets the rhomboid muscles in the upper back, balances shoulder strength, and supports the shoulder girdle.

**SKIERS:** Stand with feet together and knees bent, holding bent elbows next to your sides. Jump to one side with feet together, turning your hips and toes to the right. Then, jump to the other side, turning your hips and toes to the left. This exercise boosts circulation and works the cardiac muscles.

**JUMPING JACKS:** Stand upright with legs together and arms at your sides. Slightly bend your knees and jump into the water. As you jump, spread your legs to about shoulder-width apart and stretch your arms overhead. Jump back to the starting position and repeat. This exercise improves cardiovascular fitness.

3rd AND 4th WEEK

- Jump rope 1 min x 4
- Side to side jumps 1 min x 4
- Skiers 1 min x 4
- Jumping jacks 1 min x 4

JUMP ROPE: Keep your arms straight at shoulder height with your hands wider than your hips. Position your feet hip-width apart. Lift your knees to your stomach and keep the rope behind you when you land. This exercise is an excellent cardio workout that enhances breathing and improves coordination.<sup>19</sup>

SIDE TO SIDE JUMPS: Stand upright with your hands at your sides and feet hip-width apart. Jump both feet to the right, then to the left, quickly and repetitively. Continue this movement until the set is complete.<sup>20</sup>

#### 5th WEEK

- Punches 1 min x 4
- Reverse flies 1 min x 4
- Jumping jacks 1 min x 4
- Skiers 1 min x 4

#### 6th AND 7th WEEK

- Punches 1 min x 4
- Skiers 1 min x 4
- Jumping jacks 1 min x 4
- Run in place 1 min x 4
- Reverse flies 1 min x 4

#### RUN IN PLACE

Raise your right arm and left foot simultaneously, lifting your knee to hip height. Then switch to the opposite side, quickly lifting your right foot to hip height while moving your right arm back and your left arm forward and upward. Continue alternating these movements.<sup>21</sup>

8th AND 9th WEEK

- Reverse flies 1 min x 4
- Jumping jack 1 min x 4
- Run in place 1 min x 4
- Double knee tuck jumps 1 min x 4

DOUBLE KNEE TUCK JUMP: The person starts by pushing off with both legs, propelling themselves in a straight line. They then land on one foot (hop), quickly propel forward to land on the opposite foot (step), and finish by jumping from that foot to land with both feet (jump).

10th AND 11th WEEK

- Reverse flies 1 min x 4
- Jumping jack 1 min x 4
- Run in place 1 min x 4
- Double knee tuck jumps 1 min x 4
- Punches 1 min x 4 12th WEEK
- Jumping jacks 1 min x 4
- Double knee tuck jumps 1 min x 4
- Skiers 1 min x 4
- Reverse flies 1 min x 4

### 3.Results

The statistical report states that pretest and post test values of short falls efficacy scale and vertigo symptoms scale shows the significant improvement in subject with Postural Orthostatic Tachycardia Syndrome who receives aquatic therapy.<sup>22</sup> The pre and post test values of short falls efficacy scale is 24 and 8. The pre and post test values of Vertigo symptoms scale is 31 and 14.

**Table 1:** Demographical Data

SI. NO	PATIENT DESCRIPTION	MEASURES
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1.	AGE	
2.	SEX	
3.	WEIGHT	

**Table 2:** Descriptive Analysis of Pre-Test And Post-Test Values Of Falls Using Short Efficacy Scale

SI. NO	OUTCOME MEASURES	PRE TEST	END OF WEEK 4	END OF WEEK 6	END OF WEEK 8	POST TEST
1.	Short efficacy scale	24	20	16	12	8

**Table 3:** Descriptive Analysis of Pre and Post Test Of Functional Activities Using Vertigo Symptoms Scale

S.NO	OUTCOME MEASURES	PRE TEST	END OF WEEK 4	END OF WEEK 6	END OF WEEK 8	POST TEST
1.	VERTIGO SYMPTOM S SCALE	31	27	22	18	14

#### 4. Discussion

Aquatic therapy for this patient was a joint decision made by the physical therapist and physician, considering the persistence of the patient’s symptoms despite medication, the documented benefits of aquatic therapy on compromised cardiovascular systems, and the patient's specific needs and preferences. MEYER K, LEBLANC M-C et al. The primary reason for selecting aquatic exercise was the principle of hydrostatic pressure and its impact on the cardiovascular system. CAMERON MH et al. Water pressure increases with depth, exerting a force of 22.4 mm Hg per foot of immersion. A person submerged to a depth of 48 inches experiences a force of 88.9 mm Hg. BECKER B et al. Since this pressure exceeds normal diastolic pressure, it enhances blood return to the heart. The effects of hydrostatic pressure, such as the upward shift of blood and the diaphragm, chest wall compression, increased right atrial pressure, and higher pleural surface pressure, begin immediately upon submersion. ALKATAN M, TANAKA H, MACHIN DR et al.

This enhanced the efficiency of the cardiovascular system, which could explain the patient's ability to tolerate not only standing in water but also exercising.<sup>23</sup> The outcomes in this case align with cardiovascular function changes observed after 8 to 12 weeks of aquatic exercise in recent studies involving different patient populations. ALKATAN et al. studied 48 sedentary adults with osteoarthritis, randomly assigned to either a land-based or aquatic-based exercise group. BAKER JR, AKKARI AS, PARK W et al. Participants engaged in a 12-week exercise program (20 to 30 minutes/day, 3 times/week) starting at 40 to 50% heart rate reserve (HRR) and progressing to 60 to 70% HRR. Both groups showed significant reductions in arterial stiffness and decreases in central systolic and peripheral pulses. The aquatic exercise group also demonstrated improved endothelial-dependent vasodilation, as measured by brachial flow-mediated dilation. This study suggests that aquatic therapy can positively affect vascular pliability and function, which may explain the patient's tolerance for water-based exercise in this case. In this study, an 18-year-old female participated in aquatic therapy for 3 months. Before starting therapy, she had been severely limited in her activities for a year and may have accepted this limitation. As her activity limitations and participation restrictions decreased during therapy, her expectations for participation in school and leisure activities likely changed. The patient was also nearing a significant life milestone, graduating from high school and starting college, which may have heightened anxiety about how POTS would affect her ability to fully engage in the college experience. During the 10th week of therapy, the patient missed several sessions due to a combination of symptoms. Patients with POTS often find it challenging to even get out of bed, making it difficult to attend physical therapy sessions. Ironically, the condition that necessitates physical therapy often makes attending sessions challenging. Despite these challenges, the patient was able to improve her activity tolerance and achieve the functional goals set for physical therapy. Before starting aquatic exercise, she was deconditioned and could not tolerate standing for more than 10 minutes on land. However, in the water, she was able to stand and participate in a moderate to vigorous interval training program for 30 minutes. The patient was very pleased with her outcomes and symptom reduction, attributing her symptom relief to the aquatic therapy program, which allowed her to return to her previous lifestyle. This case demonstrated that aquatic exercise positively affected the patient's ability to participate in school and leisure activities.<sup>24</sup> The patient also reported a reduction in symptoms, including no recent fainting spells, migraines, or body aches. This case suggests that aquatic therapy was an effective intervention for relieving the symptoms of POTS.<sup>1</sup>

### **5. Limitations:**

- The study has been conducted as a single case study.
- Only two parameters were assessed.
- The study only assessed falls and functional activities.

### **6. Conclusion:**

Thus, the study concluded that aquatic therapy had shown statistically significant improvement on preventing falls and improving functional activities in Postural orthostatic tachycardia syndrome subject.

## 7. Conflict of interest

No potential conflict of interest was reported by the authors.

## 8. Acknowledgement

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