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Effectiveness of Aquatic Therapy in Cardiac Rehabilitation

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Abstract

Cardiovascular diseases (CVDs) are the leading cause of death globally, accounting aapproximately 18.6 million deaths per year that accounts to around 33% of the deaths worldwide are caused by CVDs and >75% of these deaths take place in low and middle-income countries causing a burden on countries worldwide. The cause of such a large number of deaths is due to physical inactivity, substance abuse, overweight and obesity, unhealthy diet which give rise to a wide range of cardiovascular diseases. CR improve cardiac function, relieve symptoms like angina and breathlessness, prevent progression of atherosclerotic changes, improve the functional capacity, change the natural history of disease, reduce hospital admissions, substance abuse cessation, promoting a healthy lifestyle and physical activity. Aquatic therapy has proven to be a well-tolerated method for exercise rehabilitation protocols in preoperative and postoperative phases of CR. As there is very little exploration done in this recently advanced field of rehabilitation, there is a need to study the topic in depth so that we are able to set up better evidence based practise and develop highly efficient and effective exercise programmes for better capacity building and restoring a person to his/her activities of daily living post cardiac surgery.

Keywords: Cardiovascular diseases, Cardiac rehabilitation, Aquatic Therapy

Abbreviations:

AW- Aquatic walking, TW- Track walking, CAD-Coronary Artery Disease, CT- Continuous exercise Training, HIIT- High Intensity Interval Training, S.W.E.A.T- Shallow Water Aerobic Exercise Training, FMA- Fugl-Meyer Assessment, BBS- Bergs Balance Scale. BMI- Body Mass Index, WAET- Water Aerobic Exercise Training, HR- Heart Rate, CHD- Chronic Heart Disease, LVD- Left Ventricular Dystrophy, LVEF- Left Ventricular Ejection Fraction, AqEx- Aquatic Exercise, mPAP- Mean Pulmonary Artery Pressure, mPCP- Mean Pulmonary Capillary Pressure

Introduction

Cardiovascular diseases (CVDs) remain the leading cause of mortality worldwide, accounting for approximately 18.6 million deaths annually and nearly one-third of global deaths. The rising prevalence is largely attributed to physical inactivity, obesity, unhealthy diet, smoking, and other lifestyle-related factors. This growing burden highlights the need for effective cardiac rehabilitation (CR) strategies.[1]

Cardiac rehabilitation is defined as a comprehensive, multidisciplinary program designed to improve the physical, psychological, and social functioning of patients with cardiovascular disease. It aims to enhance cardiac function, reduce symptoms, prevent disease progression, improve functional capacity, and

promote long-term lifestyle modification. CR typically includes four phases: acute inpatient care, early outpatient supervised training, structured exercise training, and long-term maintenance. [2]

Exercise training is a cornerstone of cardiac rehabilitation. Traditionally, land-based aerobic exercises such as walking and cycling are prescribed. However, aquatic therapy has emerged as a promising alternative modality.

Aquatic therapy involves therapeutic exercises performed in water, utilizing properties such as buoyancy, hydrostatic pressure, and viscosity. Buoyancy reduces gravitational stress on joints, facilitating safer movement with less musculoskeletal strain. Hydrostatic pressure enhances venous return, increases central blood volume, improves early diastolic filling, reduces heart rate, and may improve stroke volume and ejection fraction. Physiological benefits of aquatic exercise include: Improved peripheral circulation, enhanced oxygen delivery to working muscles, reduced heart rate response, increased flexibility and muscle strength. pain reduction and muscle relaxation. These properties make aquatic therapy particularly suitable for cardiac patients with comorbid conditions such as obesity, osteoarthritis, or reduced mobility.[3] This study aimed to find the effects of Aquatic therapy in various cardiovascular diseases to incorporate in cardiac rehabilitation.

Review of Literature

Jong-Young Lee, Kee-Chan Joo, and Peter H. Brubaker did research on "Aqua walking as an additional exercise modality during cardiac rehabilitation for coronary artery disease in older patients with lower limb osteoarthritis in older patients with lower extremity osteoarthritis" in 2017. The purpose of this study was to compare the effects of aqua walking (AW) and normal over-ground walking on coronary artery disease (CAD) and cardiorespiratory fitness in older people with lower limb osteoarthritis. Sixty patients with limited ambulation owing to lower limb osteoarthritis who had had percutaneous coronary intervention for CAD were recruited in a single study. They were randomly assigned to one of three groups: the AW, treadmill/track walking (TW), or the non-exercise control group (CON). Before and after 24 weeks of medically supervised exercise instruction, assessments were taken. There were significant changes in percent body fat and total cholesterol levels. Over the course of 24 weeks, there were significant differences in percent body fat, total cholesterol level, resting heart rate, and cardiorespiratory fitness expressed as VO2 peak. The TW and AW groups, on the other hand, showed no significant differences in these modifications. AW appears to be a feasible alternative to over-ground walking for cardiac rehabilitation in elderly people with CAD and osteoarthritis. [4]

In a study performed by Elizabeth F. Nagle, Mary E. Sanders, Barry A. Franklin, for clinical and healthy populations who find that they may get comparable or higher fitness gains in less time, high-intensity interval training (HIIT) has emerged as an appealing alternative to standard continuous exercise training (CT) regimens. The study was performed in the year 2017. For certain individuals, land-based HIIT may not be the best option. Few studies have compared the cardio metabolic responses of an aquatic-based HIIT programme to a land-based HIIT programme, and none have looked at the acute responses and chronic adaptations of HIIT in an aquatic setting. When compared to constant-intensity or continuous AE regimens, shallow-water HIIT AE programmes have elicited comparable and, in some cases, stronger physiological responses. The sorts of workouts and how they are cued to effectively change hydrodynamic characteristics for increased intensities may be factors that explain why HIIT regimens elicit stronger cardio metabolic responses than CT protocols. Aquatic HIIT techniques like the S.W.E.A.T. system may be beneficial. For clinical and athletic populations, water HIIT protocols like the S.W.E.A.T. system may

be a helpful alternative to land-based HIIT regimens, potentially lowering the risk of musculoskeletal and orthopaedic issues. [5]

In 2018,So Young Lee, MD, Sang Hee Im, Bo Ryun Kim, and Eun Young Han conducted a Randomized Controlled Pilot Trial titled "The Effects of a Motorized Aquatic Treadmill Exercise Program on Muscle Strength, Cardiorespiratory Fitness, and Clinical Function in Subacute Stroke Patients" to see if a motorised aquatic treadmill exercise programme improved isometric strength of the knee muscles, cardiorespiratory fitness, and arterial stiffness. For four weeks of training, 32 patients were randomly assigned to either water therapy (n = 19) or land-based aerobic exercise (n=18). Isometric strength was measured using an isokinetic dynamometer. Cardiopulmonary fitness was assessed using a symptom-limited exercise tolerance test and brachial ankle pulse wave velocity. Motor function (Fugl-Meyer Assessment [FMA] and FMA-lower limb [FMA-LL]), balance (Berg Balance Scale [BBS]), activities of daily living (Korean version of the Modified Barthel Index [K-MBI]), and quality of life were also assessed (EQ-5D index). There were significant improvements in peak oxygen consumption, maximal isometric strength of the bilateral knee extensors and paretic knee flexors, FMA, FMA-LL, BBS, K-MBI, and EQ-5D after treatment in the aquatic therapy group. Only significant improvements in maximal isometric strength in the knee extensors and flexors were observed among the water treatment and control groups. A motorised aquatic treadmill was used for water-based aerobic exercise. [6]

Saleh A. Tarabily and Amira Moustafa conducted a study on Cardiovascular Reactions to Water Immersion in Diving and Non-Diving Humans. This study was done in 2019 for the purpose to assess the response of the vascular system to water immersion in divers and nondivers. Thirty healthy volunteers were separated into two groups: divers and non-divers (15 subjects each). Divers were trained in the water on a regular basis, whilst non-divers were trained seldom. All subjects were immersed in water for 30 minutes. After the immersion period, all individuals' heart rates, cardiovascular assessments, blood pressure (BP), bradykinin, histamine, LA, potassium, and magnesium concentrations were measured. When diving participants were compared to non-diving subjects, we discovered substantial decreases in heart rate and blood pressure, as well as significant increases in histamine, bradykinin, potassium, and manganese concentrations. In conclusion, divers have a better vascular system that adapts faster to water immersion compared to non-divers. [7]

Fariba Hossein Abadi, Gunathevan Elumalai, Mohansundar Sankaraval, Farizul Athir Bin Mohd Raml did research on the effects of aqua-aerobic activities on cardio vascular fitness and weight loss in obese college students in the year 2019. Because aquatic activities are safer than land-based workouts and allow for greater movement amplitude and energy expenditure in obese, middle-aged, and elderly persons, it is critical to determine the physiological effects of aqua aerobic exercise on health in obese students. The purpose of this study was to see how beneficial water aerobics training is for improving cardiovascular fitness (VO2max) and weight reduction (BMI) in obese college students. A total of 15 patients were chosen based on inclusion and exclusion criteria and a suitable sampling procedure. For 12 weeks, the experimental group engaged in water aerobic activity. After a 12-week exercise programme, there was a significant improvement in cardio-vascular fitness, weight loss, and BMI decrease. The findings show that aqua aerobic training significantly improves weight reduction and cardiovascular fitness markers in obese students. Aqua aerobic exercise, as a favourable exercise environment for the obese, can be recommended as a substantial intervention technique for weight loss and cardiovascular fitness development. [8]

Lucia Cugusi, Andrea Manca, Pier Paolo Bassareo, Antonio Crisafulli, Franca Deriu, and Giuseppe Mercuro in the year 2019 performed the study "Supervised aquatic-based exercise for men with coronary

artery disease: a meta-analysis of randomised controlled trials." The positive effect of traditional types of exercise on persons with coronary artery disease (CAD) has received a lot of attention. Recent research has shown that less well-known fitness activities can also have a positive impact on one's health. Aquatic-based exercise has been proven in studies to enhance cardiovascular fitness, risk profile, and muscular strength in both healthy and special populations. The physiological benefits found during acute and long-term exercise treatments have been attributed to the inherent characteristics of water. During immersion at the neck level, hydrostatic pressure redirects roughly 700 ml of peripheral blood centrally, increasing heart preload and stroke volume. Recent evaluations indicated that the haemodynamic alterations caused by AqEx are also well tolerated in stable patients with heart
failure (HF), providing the water is suitably warm. AqEx is also an appropriate activity for fragile and overweight adults who are unable to exercise effectively and safely with land-based exercise (LEx) due to concurrent disorders affecting mobility (i.e. musculoskeletal, neurological), as is commonly the case with cardiovascular patients. As a result, the primary goal of this study was to conduct a systematic review of the existing data on the effects of AqEx in persons with CAD. [9]

Marie-Claude Leblanc and Katharina Meyer did a research on "Aquatic therapy in individuals with impaired left ventricular function and heart failure" was conducted in 2008. Gravity is reduced to a lesser extent while immersed in water, and the water puts pressure on the body's surface. As a result, there is a shift in blood volume from the peripheral to the central circulation, resulting in significant volume loading of the thorax and heart. This research includes a review of the existing literature on water immersion, balneotherapy, aqua workouts, and swimming in patients with left ventricular dysfunction (LVD) and/or stable chronic heart failure (CHF). The central hemodynamic and neurohumoral effects of aquatic therapy will be demonstrated based on exploratory research. The following are the major findings: A favourable benefit of therapeutic warm-water tub bathing has been found in LVD and CHF, which is thought to be owing to afterload reduction produced by peripheral vasodilation generated by the warm water. In coronary patients with LVD, low-level water cycling causes the heart to operate more efficiently than low-level cycling outside of water. In individuals with a recent severe myocardial infarction, upright immersion to the neck resulted in transitory pathological elevations in mean pulmonary artery pressure (mPAP) and mean pulmonary capillary pressures (mPCP). Additionally, mPAP and/or PCP were greater during leisurely swimming (20-25m/min) than while supine cycling outside water at a 100W load. In CHF patients, neck-deep immersion resulted in a reduction or no change in stroke volume. Despite the fact that patients' haemodynamics are disturbed, they frequently maintain a sense of well-being during aquatic therapy. Based on these findings, therapeutic reasons for aquatic therapy are offered, as well as proposals for additional study. [10]

Elie Fiogbé, Rafaela Ferreira, Márcio Antônio Gonçalves Sindorf, Silvia Aparecida, Keiti Passoni de Souza, Marcelo de Castro Cesar, Charles Ricardo Lopes, and Marlene Aparecida Moreno conducted a randomised controlled trial titled "Water exercise in coronary artery disease patients, effects on heart rate variability, and body composition" in the year 2008. Water-based training regimens must be evaluated for effectiveness and efficiency before they can be prescribed as an option in cardiac rehabilitation for patients with coronary artery disease (CAD). Autonomic dysfunction is a significant physiological shift in these individuals that is highly related with poor outcomes, morbidity, and death. Given that the beneficial effects of physical training in CAD patients have traditionally been demonstrated with programmes involving land-based aerobic exercises, the purpose of this study is to assess the effects of water aerobic exercise training (WAET) on the autonomic modulation of heart rate (HR) and body composition in CAD

patients undergoing rehabilitation. Twenty-six male individuals with CAD were randomly assigned to one of two groups: a training group, which was subjected to the WAET, and a control group. The WAET consisted of three weekly sessions held on alternating days, for a total of 48 sessions. The examination of HR variability was utilised to investigate the autonomic regulation of HR, with R-R intervals recorded for 15 minutes at rest in the supine position, and body composition was assessed using bioelectrical impedance analysis. Only the training group participants improved in the HR variability indices; patterns without variation decreased and patterns with two different variations increased, Shannon entropy, and normalised conditional entropy, whereas the control group increased and normalised conditional entropy decreased. All body composition factors remained constant. The WAET protocol improved the cardiac autonomic modulation of patients with CAD and can be considered as exercise training strategy in cardiac rehabilitation programs. [11]

Discussion

Aquatic exercise-based cardiac rehabilitation provides significant physiological and functional benefits in both preoperative and postoperative phases. The hemodynamic effects of water immersion—such as improved venous return and reduced cardiac workload support cardiovascular efficiency while minimizing orthopedic stress. Aquatic therapy offers additional advantages including enhanced balance, reduced joint strain, improved patient comfort, and increased adherence. It is particularly beneficial for elderly patients and those with musculoskeletal limitations who may struggle with traditional land-based programs. Despite promising findings, further large-scale randomized controlled trials are required to establish standardized protocols and long-term outcome data.

Conclusion

Aquatic therapy is an effective and well-tolerated adjunct to conventional cardiac rehabilitation. By leveraging the unique physical properties of water, aquatic exercise improves cardiovascular function, functional capacity, and overall well-being in patients with cardiovascular disease. Given the global burden of CVD, incorporating aquatic-based exercise protocols into cardiac rehabilitation programs may contribute to reducing morbidity and mortality. Future research should focus on protocol standardization and long-term clinical outcomes to strengthen the evidence base.

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