

The application of aquatic resistance exercises in different diseases

Binhong Zhao

Lucton school Chongqing, Chongqing, 400000, China

dongkecun555@tzc.edu.cn

Abstract. Aquatic exercise is an active exercise that make full use of the physical and hydrodynamic characteristics of water in a water environment to achieve a similar strength increase effect as land training, while avoiding the aggravation of joint stress and muscle microdamage caused by repetitive training. It has been widely studied in the field of sports rehabilitation and public fitness, while its form is basically presented in the form of aerobic exercise or interval training, the aquatic resistance exercises are often ignored by people. Due to the influence of the physical characteristics of water, the main form of muscle contraction of athletes performing resistance training in water is similar to isokinetic contraction, and the force used by practitioners is proportional to the resistance of water, which increases the centrifugal load of muscles and greatly reduces the risk of sports injury. In addition to the athletes, aquatic resistance exercises also have certain benefits for other clinical diseases. In this paper, the application of this training in swimming performance, rheumatoid arthritis, postmenopausal osteoporosis and knee osteoarthritis was reviewed in order to improve the clinical understanding and promote its rational application.

Keywords: Aquatic Resistance Exercises, swimmer, Rheumatoid arthritis (RA), postmenopausal osteoporosis, Knee osteoarthritis (KOA).

1. Introduction

Resistance exercise refers to the body in the process of muscle movement to overcome resistance to achieve muscle growth and strength increase, which is considered to be a potential treatment method to improve muscle mass, especially type 2 fiber, and also a major way of strength training, it has been widely used in rehabilitation and sports medicine, the effect and safety is good. At the same time, as a part of comprehensive physical exercise, it can also play a role in preventing and treating chronic diseases to a certain extent. The formulation and use of correct and reasonable prescription involves different exercise effects, and it is necessary for professional sports people and the general public to arrange exercise and exercise reasonably and scientifically. Aquatic resistance exercise is one of them, the principle is mainly to combine the buoyancy of water with the anatomical characteristics of people, the use of physical methods and human joint movement of different types of training, for balance disorders, weight reduction and other land may not offer or difficult to complete the action provides feasibility. Meanwhile, compared with running, strength training or resistance training and other land training methods, it is also friendly to the bearing capacity of the joints, and the impact force is relatively

small, possibly because of the buoyancy of the water. For some elderly people, or disabled people, it is relatively safer [1,2].

At present, there are relatively few research on the application of resistance training in water. This paper will focus on the application status of aquatic resistance exercise in different diseases, in order to provide some theoretical basis for clinic.

2. The effect on swimmer

In order to perform well in the competition, swimmers need to have strong athletic ability and muscle strength. Muscle strength plays a vital role in improving swimming performance, especially the propulsion force generated by the resistance of the upper body in the water, and the impact on swimming speed cannot be ignored. Resistance training in water is a special quality training for athletes without destroying their water sense and technique, which aims to develop the athlete's strength and power endurance through added resistance, thereby improving the swimmer's performance. This special training way may increase the centrifugal load capacity of the muscles, the body to get this routine training cannot achieve the load action stimulus, after a period of time to adapt, and then stimulate, and then gradually adapt, repeated stimulation to adapt, and finally will be converted into improved ability and performance.

A number of studies have confirmed the positive effect on swimming performance, the standard deviation shows that the effect is different. In studies comparing the resistance suit and the resistance parachute, it was found that the improvement in the 50m, 100m and 200m freestyle tests was 3.2%, 5.1% and 7.5%, respectively, and the standard deviation was 0.32, 0.49 and 0.89, respectively. The research on resistance band training shows the same results, both were able to increase athletic performance (0.9% to 2.0%) [3].

However, this does not mean that swimmers do not need other forms of exercise, land training is also a key part, and the order of training before and after the two may have different effects. Some scholars have proposed that competitive athletes may benefit more from using both training sequences in one training cycle, land-water and water-land [4].

3. The effect on RA

Rheumatoid arthritis (RA) is a systemic autoimmune disease characterized by progressive joint destruction resulting in loss of function. The onset age is 40-60 years old; patients often present with symptoms such as morning stiffness, swelling, pain, and dysfunction of the joints. At present, the progress of clinical treatment of this disease is slow, and the degree of pain still affects the prognosis of patients. In addition to the application of anti-rheumatic drugs, non-steroidal anti-inflammatory drugs, biological agents, etc., functional exercise may also achieve satisfactory clinical effects, such as promoting the body metabolism, enhancing the body physiological function, reducing the pain, and restoring the joint function [5].

In a controlled study, 71 RA patients were divided into observation group (n=35) and control group (n=36) according to the odd-even date of treatment. The control group received routine nursing and joint function training. The observation group was given the water resistance training on the basis of the control group, training 30 ~ 60 minutes a day, at least 3 days a week. The mean hand grip strength, dysfunction, pain, fatigue score and morning stiffness time were compared before and after the intervention between the two groups. The results showed that the mean hand grip strength in observation group was significantly higher than that of the control group after training (9.32 vs. 8.09). Dysfunction (0 vs. 2), pain (2.17 vs. 3.25), fatigue score (3.1 vs. 4.6) and morning stiffness time (10 vs. 15min) were significantly lower than those in control group ($P < 0.05$, $P < 0.01$). Water exercise training may promote the secretion of brain endorphins, dopamine, morphine and opioid receptors, and thus play an analgesic effect; Resistance exercise may effectively improve the hand grip strength of RA patients, and then improve the degree of morning stiffness. Moreover, it is not limited by many conditions such as age, place and season, and has good feasibility [2].

4. The effect on postmenopausal osteoporosis

With the increase of population aging, osteoporosis has seriously threatened the health of middle-aged and elderly people, especially middle-aged and elderly women, and the prevalence of osteoporosis in women is 3 times that of men. It is estimated that by 2020, the number of patients in China will increase to 286.6 million, the number of hip fractures will reach 1,638,200, and the number of osteoporosis patients will rise to 533.3 million by 2050. Accelerated bone loss after menopause is associated with estrogen deficiency. There are no obvious symptoms in the early stage of osteoporosis in perimenopausal and postmenopausal women. With the progression of the disease, patients will have pain, bone deformation, osteoporosis fracture in severe cases, and psychological effects such as anxiety and fear may occur. Postmenopausal osteoporosis is the main cause of lumbar and leg pain in postmenopausal women and may lead to spinal deformation and vertebral compression fracture. As one of the new methods applied to the prevention and treatment of postmenopausal osteoporosis in recent years, resistance training may prevent bone loss and enhance bone density by imposing the large mechanical load on bones and joints [6,7].

A clinical study included 24 postmenopausal patients with osteoporotic low back pain (VAS \geq 3 points, an average age of 62.43 years old) and were randomly divided into three groups, A, B and C, 8 patients in each group. Group A received aquatic resistance exercises, Group B received magnetic therapy combined with aquatic resistance exercises, and Group C only received magnetic therapy(25 min) in lumbosacral area. The specific training content of aquatic resistance exercise :10min pool warm-up exercise, including hip, knee, ankle, wrist, waist, shoulder and other parts of the activity; 30min water training, including warm up walking in water for 5min, upper and lower limb joint activities in water, slow walking in water and relaxation activities for 5min. Subjects in group A and Group B were trained for a total of 45 minutes each time under the supervision of medical staff, twice a week, for a total of 3 months. The results showed that the VAS score of the three groups after intervention was significantly lower than that before training ($P<0.05$), and the decrease was more significant in the combined group ($P<0.01$). After intervention, the lumbar anterior flexion, posterior extension and lateral flexion of the aquatic resistance exercise group and the combined group were significantly increased compared with that before intervention ($P<0.05$), but the lumbar anterior flexion and posterior extension of the magnetic therapy group had no significant difference compared with that before the intervention ($P>0.05$). After the intervention, the bone mineral density and bone mass of the three groups were significantly increased ($P<0.05$); The bone mineral density of combined group was significantly higher than that of magnetic therapy group and aquatic resistance exercises group ($P<0.05$). It is further explained that the implementation of water resistance training for postmenopausal patients with osteoporotic low back pain is conducive to relieving pain, increasing the range of waist motion and strengthening bone density [8].

5. The effect on KOA

Knee osteoarthritis (KOA) is a clinically common degenerative joint disease that affects approximately 20% of the world's population. It is more common in women than men. The main clinical symptoms are knee pain and limited activity, and the symptoms gradually worsen with the increase of age, seriously affecting the quality of life and health level of patients. At present, KOA has become one of the important reasons for the incapacitation of middle-aged and elderly people in China, causing a huge burden on the medical and economic health of society. Resistance training is a common exercise therapy for relieving KOA, and research reports have confirmed that it can enhance patients' muscle strength, improve physical function, and reduce pain in KOA patients [9].

A randomized controlled study, 87 postmenopausal women with KOA randomly divided into an intervention group (n=44, participating in 48 supervised high-intensity water resistance training sessions over a 4-month period) and a control group (n=43, maintaining normal physical activity). The result showed that the resistance training significantly reduced fat mass (mean 1.17kg, 95%CI: -2.00~-0.43, $p=0.002$) and increased walking speed (mean 0.046m/s, 95%CI: 0.006~0.086, $p=0.002$). In the intervention group, body composition returned to the normal level after 12 months of follow-up, further prove the effectiveness [10].

A systematic review and meta-analysis of 32 randomized controlled studies (n=2200) evaluated the clinical efficacy of water training for chronic musculoskeletal disorders for the first time. The results found that compared with no exercise intervention, water training can indeed improve patients' pain, physical function, and improve patients' quality of life. Subgroup analysis showed that water training had significant effect on the treatment of osteoarthritis (SMD=-0.36, p=0.002) [11]. Similar studies have also found the relief for KOA pain from water training. While, the specific mechanism needs to be further clarified.

6. Conclusion

Functional exercise is a way to prevent and cure some injury diseases and accelerate the recovery of limb function through limb movement. Water resistance training is a simple and effective way of home exercise rehabilitation, which uses the characteristics of water to allow patients to exercise in water, and the treatment method is not limited by age, place, season and other conditions. This exercise is conducive to relieving pain in patients with different diseases, improving the dysfunction, increasing the range of motion, improving the muscle strength, etc., and thereby improving the quality of life of patients. Compared with the traditional land training, this training can reduce the weight of the joint, reduce muscle tension, enhance the sense of security, whether it is for competitive athletes or middle-aged and elderly people who are inconvenient to go out at home, is one of the better choices.

After reviewing the literature, it is found that the current application of this training in diseases is not very much, and the mechanism of its role in different diseases is not completely clear. Some existing studies have low evidence-based quality and the intervention time is short, and it is impossible to comprehensively track the long-term exercise effect of follow-up patients. In the future, multi-center, large-sample longitudinal studies with stronger evidence-based value need to be further developed to further elaborate its effectiveness and safety and develop the individualized training programs based on patient needs.

In addition, even if this training method has the certain clinical efficacy and may prevent and cure chronic diseases, the elderly with chronic pain, fatigue and less social support still have less resistance training, and the participation rate is low. How to improve compliance of the patient will be a long-term issue.

References

- [1] Martínez-Rodríguez A, Cuestas-Calero BJ, Martínez-Olcina M, Marcos-Pardo PJ. Benefits of Adding an Aquatic Resistance Interval Training to a Nutritional Education on Body Composition, Body Image Perception and Adherence to the Mediterranean Diet in Older Women. *Nutrients*. 2021 Aug 6;13(8):2712.
- [2] Lu Jun, Zhong Qing-Ling, Luo Yan, et al. Effect of aquatic resistance exercises on hand, foot and joint function rehabilitation of patients with rheumatoid arthritis at home [J]. *Journal of Nursing*, 21,36(9):1-4.
- [3] Li Tianle. Effect of Resistance Training on Swimming performance: Based on systematic review method [J]. *Cultural and Sports Materials and Technology*, 2024(4):130-132.
- [4] Arsoniadis G, Botonis P, Bogdanis GC, Terzis G, Toubekis A. Acute and Long-Term Effects of Concurrent Resistance and Swimming Training on Swimming Performance. *Sports (Basel)*. 2022 Feb 24;10(3):29.
- [5] Xu J, Chen M, Yu Y, Tang L, Luo X, Cheng Y. Global research hotspots and trends in exercise interventions for rheumatoid arthritis over the past two decades: A bibliometric and visualization study. *Medicine (Baltimore)*. 2023 Nov 17;102(46):e36030.
- [6] Chinese Society of Gerontology and Geriatrics Osteoporosis Branch of obstetrics and Gynecology expert committee and Perimenopausal osteoporosis prevention and control training Department. Expert consensus on prevention and treatment of osteoporosis in perimenopausal and postmenopausal women [J]. *Chinese Journal of Clinicians*, 2019,48(8):903-908. (in Chinese)

- [7] Moreira LD, Oliveira ML, Lirani-Galvão AP, Marin-Mio RV, Santos RN, Lazaretti-Castro M. Physical exercise and osteoporosis: effects of different types of exercises on bone and physical function of postmenopausal women. *Arq Bras Endocrinol Metabol*. 2014 Jul;58(5):514-22.
- [8] Yi Chengli, Li Chunyan. Effect of underwater resistance training combined with magnetic therapy on postmenopausal patients with osteoporotic low back pain [C]// Chinese Society of Sports Science. Abstract collection of the 13th National Sports Science Conference -- Wall Newspaper Exchange (Sports Medicine Branch) (1).,2023:3.
- [9] Perruccio AV, Young JJ, Wilfong JM, Denise Power J, Canizares M, Badley EM. Osteoarthritis year in review 2023: Epidemiology & therapy. *Osteoarthritis Cartilage*. 2024 Feb;32(2):159-165.
- [10] Waller B, Munukka M, Rantalainen T, Lammentausta E, Nieminen MT, Kiviranta I, Kautiainen H, Häkkinen A, Kujala UM, Heinonen A. Effects of high intensity resistance aquatic training on body composition and walking speed in women with mild knee osteoarthritis: a 4-month RCT with 12-month follow-up. *Osteoarthritis Cartilage*. 2017 Aug;25(8):1238-1246.
- [11] Wang T, Wang J, Chen Y, Ruan Y, Dai S. Efficacy of aquatic exercise in chronic musculoskeletal disorders: a systematic review and meta-analysis of randomized controlled trials. *J Orthop Surg Res*. 2023 Dec 8;18(1):942.