

# The impact of aquatic therapy on the agility of a non-ambulatory patient with Duchenne muscular dystrophy

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## ABSTRACT

Duchenne Muscular Dystrophy (DMD) is a progressive disease. The inability to walk is common in early adolescence, and with the restriction to a wheelchair at this stage of the disease, the wheelchair becomes the patient's only form of locomotion. Their agility in the wheelchair is a key factor for the functional independence of these individuals. **Objective:** The objective of this study was to verify the impact of aquatic therapy on non-ambulatory children with DMD. **Method:** This study has a prospective, interventional, clinical character. The patient underwent ten sessions of aquatic therapy as an intervention, using the following assessment tools: EgenKlassifikation scale, zigzag agility test, oxygen saturation (SatO<sub>2</sub>), respiratory rate (RR), forced vital capacity (FVC), tidal volume (TV), minute volume (MV), peak cough flow (PCF), and maximal inspiratory (PI<sub>max</sub>) and maximal expiratory (PE<sub>max</sub>) pressures. The intervention protocol of aquatic therapy was defined focusing on the agility in maneuvering the wheelchair. **Results:** Improvement in agility was observed in moving wheelchair, maintenance of the EK scale score, and a decrease in TV, MV, and PCF. **Conclusion:** The results showed that for this patient, aquatic therapy may intervene positively in his mobile agility in the wheelchair.

**Keywords:** child, hydrotherapy, muscular dystrophy duchenne

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## INTRODUCTION

Duchenne Muscular Dystrophy (DMD) is a genetic disease, connected to the X chromosome, recessive, and characterized by the absence of the dystrophin protein. The incidence of DMD is approximately 1 in every 3,500 boys, making it the most common dystrophy in infancy.<sup>1-2</sup>

The first symptoms of the disease appear in infancy at around the age of three. The loss of deambulation occurs on average between 9 and 13 years of age, the incapacity to walk occurs at the beginning of adolescence, being attributed to a set of situations such as loss of muscular strength, respiratory complications, and weight gain.<sup>3</sup>

During the non-ambulatory phase, the children are restricted to wheelchairs, for it is frequently the only way of locomotion. Agility in the wheelchair is a fundamental factor for functional independence, and it is described as the capacity to change the direction of the body or its parts quickly. It is a neuromotor variable, characterized by quick to-and-fro and direction changes and shifting of the center of gravity of the whole body or part of it, such as movements that include changes in direction.<sup>4</sup>

Agility in a wheelchair provides mobility, comfort, and freedom, favoring the independence of the individual enhancing the functional capacity for the execution of daily activities.<sup>5</sup>

Many times, these individuals cannot perform certain activities on the ground, so the aquatic environment is a place favored for the physical properties of water, so through it we can facilitate the movements, and depending on the objective pursued, these patients experience an ease of functional movements, in addition to experiencing different postures.<sup>6</sup>

The present study aimed to verify the effect of aquatic physiotherapy on the agility of a child with a clinical diagnosis of non-ambulatory DMD.

### Presentation of the clinical case

This is an interventional, prospective, clinical case study with blind evaluator, developed in the aquatic physiotherapy sector of the Association for Assisting Children with Disabilities (AACD - Ibirapuera) that follows the ethical principles for human research, in accordance with resolution 196/96 of the National Health Council. It was analyzed and approved by the Ethics and Research Committee from AACD, with Opinion No. 10/2011.

The sample was composed of a 12-year-old male patient, diagnosed with DMD corroborated by data collected from his clinical history. The subject had not been able to walk for 2 years, was cooperative during the application of the evaluation instruments, was not participating in any rehabilitation program, and had no associated diseases.

Before the beginning of the study, the volunteer and the person responsible for him were duly informed about the procedures to be done. After they agreed to participate in the study, the person responsible signed a Free and Informed Consent form.

The subject was submitted to evaluations before and after the aquatic physiotherapy intervention protocol; during the evaluations and tests the subject was positioned in his wheelchair, which had no modification and/or adaptation for the application of the evaluation.

For an evaluation instrument, we used the Egen Classification Scale (EK), made of 10 questions and developed to quantify the degree of functional limitation of patients with DMD in the advanced phase. The score varies from 0 to 30, with 30 indicating greater disability.<sup>7</sup>

The evaluation of agility was made by the zigzag agility test, which is a course in a rectangle measuring 6 m by 9 m, where the child travels the distance in his wheelchair, making the direction changes (zigzags) at his top speed.<sup>8</sup>

At the beginning and end of the treatment, the Minute Volume (MV), the Flow Volume (FV), and the Forced Vital Capacity (FVC) were analyzed after being obtained through a *Ferraris Respirometer*, *Wright MK* ventilometer. The peak cough flow (PCF) was measured with the *Wright®* expiratory flow gauge, the oxygen saturation (SaO<sub>2</sub>) was verified by the portable finger pulse and oximeter type *Nonin Onix 9500®*. The Maximum Inspiratory Pressure (I<sub>p</sub>max) and the Maximum Expiratory Pressure (E<sub>p</sub>max) were measured through a *GeRar®* manovacuometer. The Respiratory Frequency (RF) was obtained by the quantification of the number of breaths made during 1 minute.

Three measurements of each one of the variables mentioned above were made, with the interval of one minute between them, with the highest reading being considered. The procedure was performed in a covered swimming pool heated to the temperature of 32°C, for 60 minutes

each session, totaling 10 sessions of aquatic physiotherapy.

The intervention consisted of a protocol of exercises focusing on agility in the wheelchair. At the beginning of the therapy, passive mobilization and exercises were practiced to improve the flexibility of the upper and lower limbs and trunk. Later, active exercises for the upper and lower limbs were practiced using only the water resistance, followed by respiratory exercises. Finally, there was training of the function placing a wheelchair inside the pool, where the patient touched the chair with immersion level at the xiphoid process.

For the data analysis, the Microsoft Excel program was used, with the best reading obtained during the evaluations and percentage to verify the pre and post-procedure data. It was confirmed that he maintained the EK scale scores, indicating that the subject did not show any modification in his degree of functional affliction for daily life activities, for he kept his same 12-point score in the pre and post intervention.

Observing the data (Table 1) obtained at the beginning and end of the proposed treatment, there was a significant decrease in the RF, MV, FV, and PCF variables. As for the SaO<sub>2</sub> and I<sub>p</sub>max, there was an increase compared to the pre-intervention period. The E<sub>p</sub>max and FCV did not change. In relation to agility (Figure 1) we noticed that after the intervention there was an increase in the speed of movement with the wheelchair.

## DISCUSSION

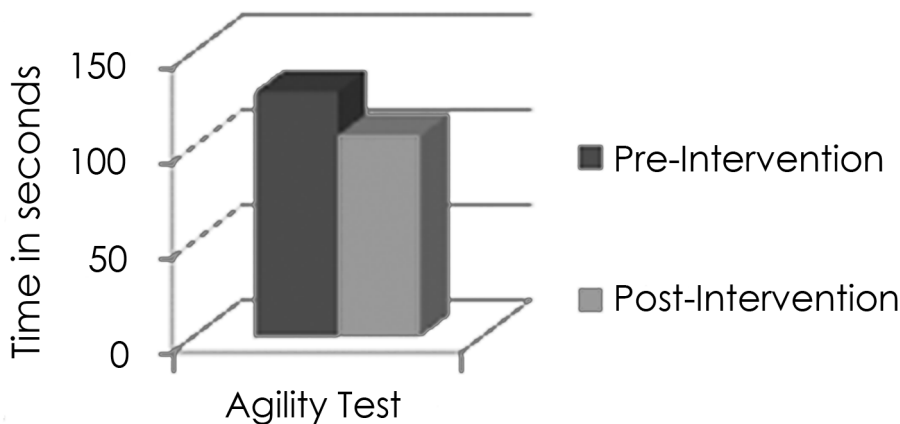
The results found for MV, FV, and PCF probably relate to the natural evolution of the pathology. Due to the inherent characteristics of DMD, we can consider that the classification adopted for improvement or maintenance of the data obtained indicates positive responses, since any worsening does not necessarily mean a negative effect, if this is slower than the one described in the natural evolution of the disease.<sup>9</sup> According to the literature, a progressive decline in pulmonary function almost always begins after the restriction to a wheelchair, with the association of increasing respiratory insufficiency and the inefficiency of the cough.<sup>10</sup>

Studies on aquatic physiotherapy for this group of patients are scarce. Some authors observed significant alterations in the inspiratory and expiratory maximum pressures, and slight alterations in the readings

**Table 1.** Respiratory Parameters

Variables	Pre-Intervention	Post-Intervention	%
SaO <sub>2</sub>	93	96	3%
RF	35	25	-29%
IPmax	-40.00	-45	11%
EPmax	35	35	0%
MV	12.50	10.55	-16%
FV	0.567	0.519	-8%
FVC	2.950	2.950	0%
PCF	190	150	-21%

It shows the pre and post-intervention readings for the respiratory parameters



**Figure 1.** Zigzag agility test. It shows the time in seconds during the zigzag agility test at the pre and post intervention moments

for cardiac frequency and oxygen saturation levels. In this study there was also a slight alteration in the variables for inspiratory pressures and initial oxygen saturation when compared with the pre intervention readings. However, it is known that aquatic physiotherapy combined with low to moderate physical activity is not a physical overload for children with DMD.<sup>6</sup>

The results found in the current study regarding respiratory frequency and vital capacity corroborate the studies where it was concluded that physical exercises in a swimming pool offer good results in the physiotherapeutic treatment of individuals with DMD, since they contribute to maintaining the vital capacity and to diminishing the RF.<sup>11</sup>

Among the studies found, instruments based on the Pediatric Evaluation of Disability (PEDI) and Gross Motor Function Measure (GMFM) to verify the efficacy of aquatic physiotherapy in a child with DMD were used,<sup>12</sup> but in the present study we used the EK scale already standardized for this specific group. However, as it was not possible to observe progressive effects in the instrument of this

subject, we attributed this fact to the functional independence of the child, and we believe the instrument was not sensitive enough to detect agility in the wheelchair.

Aquatic physiotherapy, as the only form of intervention in the study showed a quantitative change in the agility of the subject evaluated, proving a decrease in his movement time while in the wheelchair. We believe that this is due to the disuse of his muscular system and functional capacity, in addition to the absence of low intensity physical activity. It is possible that the reduction of functional muscular mass in individuals with neuromuscular diseases combined with functional deficiencies are the result of disuse atrophy secondary to a sedentary life style and to muscular degeneration secondary to the disease.<sup>1</sup>

There is no evidence in the literature of studies verifying the agility of individuals with Duchenne muscular dystrophy. The individual who has the capacity to perform his activities independently shows a natural autonomy that can result in better life conditions.<sup>12</sup> Due to these factors, the improvement in agility

obtained in the study is a relevant factor during the functionality of these individuals.

In addition to the direct effects of muscular dystrophy, increasing with the effort required to perform activities, the fear of falling off the wheelchair, and the use of personal devices indirectly damage the body functions resulting in disuse. Low intensity physical training could oppose this secondary physical deterioration.<sup>2</sup> Aquatic physiotherapy offers the advantages of the water's physical properties, which many times facilitates active movement. Being considered as a low to moderate intensity therapy, it does not create any physical overload to children with DMD, and provides improvement of their functional capacity.

## CONCLUSION

This study shows that for this patient, aquatic physiotherapy can positively influence his agility in operating the wheelchair.

We observed that specific tests are fundamental to analyzing the treatment and through this work we sought to stimulate new studies, so we suggest an increase in the sample size. However, the data obtained in this study may be a reference for new studies on this non-ambulatory group.

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