

EVALUATION OF PHYSIOTHERAPY EFFECTS USING SPECIFIC TESTS IN DUCHENNE MUSCULAR DYSTROPHY – A CASE STUDY

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Abstract. Currently, patients with Duchenne muscular dystrophy manage to reach the fourth or fifth decade of life due to advances in the management of different specialties that are involved through evaluations and anticipatory therapies based on a type of suitable approach for identifying specific medical complications as early as possible. The progressive decrease in muscular strength that affects the cardiovascular, respiratory and musculoskeletal systems needs to be constantly managed. The purpose of this case study is to observe to what extent physiotherapy contributes to the modification of North Star Ambulatory Assessment (NSSA), NM-Score and Vignos Scale in a 27-year-old patient with Duchenne muscular dystrophy. NSAA is used to monitor disease progression and treatment effects but also to measure various motor skills. The NM-Score classifies functional abilities into three main motor domains. The Vignos Scale measures lower limb function. The scores obtained in the initial assessment were 11/34, 2/4, 1/4, 1/4 and 3/10, and the functional recovery treatment was carried out over a period of 6 months. Specific, non-specific and complex physiotherapy methods were used with the main objectives of improving joint range of motion, gait and balance, reducing muscle contractures, increasing endurance and promoting independence in carrying out daily activities. The final assessment showed improvements in all scores, so the objectives were accomplished. Along with the other medical specialties that help dystrophic patients improve their quality of life, physiotherapy plays an important role because movement is the key to a healthy and long life.

Keywords: Duchenne muscular dystrophy, North Star Ambulatory Assessment, NM-Score, Vignos Scale.

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Introduction

Duchenne muscular dystrophy (DMD) is an X-linked recessive neuromuscular disorder located at the p21 level and caused by the absence or insufficient production of dystrophin. For this reason, the muscle fibre becomes fragile, leading to the destruction of muscle cells (Tyagi et al., 2020), therefore the disappearance of muscle function and tissue, and the accumulation of connective and adipose tissue results in the disease-characteristic pseudo hypertrophy.

Duchenne dystrophy mainly affects men, because the mutant allele cannot balance with the normal allele as in the case of females. The incidence is 1 in 3,500 live male births (Gaina et al., 2021) and 1 in 50 million female births (Duchenne UK, 2017).

Mutations can be de novo, deletions, duplications, microdeletions, insertions, etc. Referring to the reading frame, the phenotype shows (in around 90% of cases) a genetic modification that results in an out-of-frame or in-frame mutation (Elhawary et al., 2018). The characteristic symptoms of Duchenne muscular dystrophy are observed between 2 and 5 years of age, with the lower limb muscles being affected first and then the upper limb muscles. Muscle weakness finally affects the respiratory and cardiac muscles (Kourakis et al., 2021). Gowers' Sign appears before the age of 8 due to weakness of the gluteus maximus muscle.

Because of progressive muscle weakness, the patient is wheelchair-bound, where scoliosis will begin to develop due to paraspinal muscle hypotrophy (Archer et al., 2016). Duchenne muscular dystrophy also affects the central nervous system through intellectual disability and delayed language development (Birnkrant et al., 2018a). Recent studies have described dystrophin as the protein that gets involved in the myelination process during postnatal brain development (Aranmolate et al., 2017). Duchenne muscular dystrophy is divided into five stages: pre-symptomatic, early ambulatory, late ambulatory, early non-ambulatory, late non-ambulatory (Solichin et al., 2021).

Complex treatment uses corticosteroids to improve muscle function and strength, physiotherapy to prevent contractures, joint stiffness and deformities, and surgical method to resolve spinal and lower limb deformities (Birnkrant et al., 2018b). Corticosteroid administration has been shown to be effective in developing muscle strength and decelerating disease progression, with positive effects on increasing independent ambulation and cardiac protection, reducing the onset of scoliosis and delaying respiratory muscle weakness (Khadilkar et al., 2018).

Paraclinical investigations will monitor scoliosis and vertebral fractures with the help of radiological examinations. Progressive scoliosis can be resolved by posterior fusion performed when the patient has not reached the end of bone growth and the Cobb angle has not exceeded 20 degrees within 6 months (Ward et al., 2018).

Progressive muscle weakness and ototoxicity of drug treatment underlie bone health disorders. Decreased physical activity will disrupt bone growth with effects on lower limb strength. Bone health management focuses on the use of calcium, vitamin D and bisphosphonates, which improve bone mineral density in most patients. The negative impact of fractures is reflected in prolonged immobilisation and decreased muscle strength (Apkon et al., 2018).

Regular physical exercise in Duchenne muscular dystrophy is necessary for good health, functional ability and participation in social activities, having a positive effect on quality of life (World Health Organization, 2020). There is uncertainty regarding the level, intensity and type of exercise that is most effective for patients with this disease. Recent studies have found that regular submaximal exercise can help prevent subsequent disuse atrophy and maintain strong muscles (Jansen et al., 2013). In addition to high-resistance training, intense eccentric muscular activity in which the muscle is stimulated and stretched may aggravate muscle damage and should be avoided (Birnkrant et al., 2018a). Careful management of rehabilitation therapies is primarily aimed at preventing contractures, which is critical for keeping the patient's motor function and autonomy (Skalsky & McDonald, 2012).

Physical activity in the rehabilitation programme should focus on muscle and joint stretching (4-6 times a week), where each position is held for 15 seconds and repeated 10-12 times in each session. Standing and walking are also suggested for the lower limbs (2-3 hours). Orthoses promote correct posture and body alignment (Iolascon et al., 2020). According to Voet et al. (2019), the impact of strength training and aerobic exercise training on muscle disorders appears to be harmless since no evidence of wear and tear has been observed, so regular involvement in sports and activities of daily living seems to be safe. Apart from traditional muscle training, neuromuscular electrical stimulation is commonly used in rehabilitation programmes because it activates fast-twitch fibres, but the disadvantage is that it can have damaging effects on uncontrolled muscle stimulation (Cudia et al., 2016).

Ordinary activities of daily living that are included in exercise therapy with cardiovascular fitness training, concentric and isometric contractions (low-resistance muscle activation) performed at least four times a week for 40 minutes per session and supplemented with massage and splints can significantly improve quality of life in patients with DMD (Lombardo et al., 2021). Targeted programmes that primarily involve dorsiflexion of the ankle, quadriceps and hip adductors, gluteal strength, but also breathing exercises, balance training (to minimise falls) and hydrokinetic therapy can be highly beneficial and have positive results in the independent daily living of individuals with DMD (Anziska & Inan, 2014).

Research purpose. The research aims to assess through specific tests how physiotherapy contributes to the functional recovery of the patient with Duchenne muscular dystrophy, as the basis for further more extensive studies.

Research objectives:

- to identify the importance of individualising the physiotherapy programme by adapting it through specific, non-specific and complex means;
- to find out through specific tests how the physiotherapy programme acts on the affected systems.

Research question. Can the use of an individualised and personalised physiotherapy programme using specific, non-specific and complex means stagnate or even improve NSAA, NM and Vignos Scale scores in patients with Duchenne muscular dystrophy?

Methodology

Case presentation

The patient (a 27-year-old woman) received the indication for physiotherapy at her last medical consultation at the Colentina Clinical Hospital, Neurology Department II, in 2018. Physiotherapy sessions took place three times a week at home and twice a week at the Lorentina Clinic in Târgoviște. Hydrokinetic therapy sessions were performed once a week in the same clinic. The patient followed the physiotherapy programme from December 2020 to May 2021, with initial, intermediate (after 3 months) and final assessments.

Inclusion criteria: Duchenne muscular dystrophy in early ambulatory stage (Grade 2); ability to climb/descend stairs even with relative difficulty; at least F3 in the upper limb muscles; absence of spinal or lower limb surgical interventions; presence of heel strike during

gait; normal cognitive status so as to understand verbal commands; consent to participate in the study.

Exclusion criteria: other types of muscular dystrophy; age up to and over 25-30 years; inability to maintain an upright position and walk; cardiovascular and/or respiratory system diseases that contraindicate exercise; presence of surgical interventions; refusal to participate in the study.

The symptoms that caused the patient to present to the Colentina Hospital were a decrease in brachial and crural muscle strength (at the proximal level), which progressively worsened.

Medical history: from her mother's statements, the patient showed elevated liver cytolysis enzymes at the age of 6 months, which is why she was investigated with the suspicion of autoimmune hepatitis. At the age of 10, she had progressive gait disorders when climbing and descending stairs, being investigated with muscle biopsy and genetic tests that confirmed Duchenne muscular dystrophy in a clinic from Italy.

General physical examination: bilateral vesicular breathing with no added sounds or cough, normal cardiac appearance, bilateral peripheral pulse (BP = 130/70 mm Hg, HR = 78 bpm), mobile abdomen with pain-free respiratory movements.

Local physical examination: possible walking without support but with unstable and small steps, decreased brachial and crural segmental muscle strength at the proximal level, 3/5 MPA left, 4/5 MPA right, difficulty transferring from supine to sitting and standing, inconstant need for help, no coordination disorders, right patellar DTR - absent, left - diminished, DTR present bilaterally, symmetrically, without disturbances of subjective and myo-arthro-kinetic sensitivity, abolished vibratory sensitivity, asymmetric muscle atrophies (left > right) in the upper limb (deltoid, triceps, biceps) and gluteal muscles, normal speech, normal praxis.

Paraclinical examinations: CK: 1,078 IU/L; CK-MB: 51.7 IU/L, GOT: 47 IU/L, GPT: 43.8 IU/L, serum creatinine: 0.17 mg/dl. ECG: appendant pathway, sinus rhythm, no changes in ventricular repolarisation, T-wave flattened. Recommended treatment: hygienic-dietary regime with adequate hydration - at least 2 litres of fluid per day, physiotherapy, genetic counselling. There was no need to return for hospitalisation.

In the summer of 2022, the patient was suggested by a neurologist to have botulinum toxin injected into her Achilles tendon to relax it, and thus the tendon shortening would no longer have prevented her from carrying out daily activities. When she arrived at a medical recovery physician to get the injection, after consultation, she was advised not to have it done because of the risk for the tendon to shorten even more and the possible subsequent joint ankylosis. She was suggested to perform only the physiotherapy programme with the appropriate specific and non-specific means throughout her life.

Instruments and types of evaluation

The North Star Ambulatory Assessment (NSAA) is an internationally validated assessment scale that was specifically developed to quantify the ambulatory performance of patients with Duchenne muscular dystrophy. It consists of 17 items and is used to measure various motor skills and monitor disease progression and the effects of the treatment applied by using several clinical tests: standing, getting up from a chair, stepping up and down on a

box with the right or left foot, rising from the floor, running and so on. Scores range from 0 to 34, with high scores indicating good motor function. Each item is rated between 0 - unable to perform individually, and 2 - normally able to perform individually. The total score also shows a significant correlation with quality of life (Muntoni et al., 2019).

The NM-Score is a tool used in neuromuscular diseases from the age of 6, which classifies functional abilities into three main motor domains: standing and transfers; axial and proximal function; distal function. It measures the patient's motor performance at home, at work or in the school environment. Each domain is assigned grades from 1 to 4, where 1 indicates slight impairment, and 4 means very severe impairment; each performance is compared to that of a healthy person. (Vuillerot et al., 2013)

The Vignos Scale measures lower limb function and is significantly correlated with Duchenne muscular disease. Scores range from 1 to 10, where 1 means ability to walk and climb stairs without assistance, while 10 indicates that the patient is confined to bed (Lue et al., 2009).

Objectives

After the initial assessment, the physiotherapy objectives were established as follows:

- maintaining/improving joint range of motion within physiological limits;
- preventing the occurrence of / reducing muscle contractures;
- improving muscle tone and increasing exercise capacity within the limits allowed by the stage of the disease;
- supporting and promoting independence in carrying out daily activities;
- maintaining and improving gait and balance as much as possible.

Because the patient's home has stairs at the entrance to the house and the hallway, this obstacle will be used to preserve and even improve her gait but also to train her in order to achieve functional independence as part of the physiotherapy programme. Special attention will be paid to the prevention of falls.

NSAA, NM and Vignos Scale scores will be monitored again after 6 months of treatment.

Procedure

Specific physiotherapy methods

Among the specific means of physiotherapy, exercise, postural therapy and massage will be used in this case study. Regarding exercise, Honório et al. (2019) suggest that a patient with Duchenne muscular dystrophy should perform at least 50 minutes of physical activity per day. Moderate-intensity exercise with elastic bands and light weights can also be implemented in the programme (Ashizawa et al., 2018). Active-passive, free-active and active-resistive exercises will be used in this programme, depending on the patient's muscle strength at a certain stage of the disease. The resistive force is less than the mobilising force, which involves isometric concentric work with maintenance of maximum 10 seconds. When passive exercise is applied, the patient will be asked to participate in the physiotherapy session through the somatosensory pathway and mentally when the session is not performed.

In this case, passive mobilisation is purely assistive. Regular stretching is also done for the triceps surae, tibialis posterior, hip and knee flexors and extensors, adductors, abductors and rotators.

Massage is used to stimulate skeletal muscles, improve joint range of motion and therefore walk, increase excitability, contractility and elasticity, as well as prevent atrophy with the help of stimulation techniques by gradually increasing intensity but gently performing them to break fibrous adhesions. In this regard, kneading, effleurage and friction are applied to the lower limbs. (Cordun, 1999)

Postural therapy helps prevent side effects in the spine, hips and knees or ankles due to muscle weakness or contractures. The standing position contributes to achieving a correct body posture, thus managing the muscle contractures as well. Short 30-minute periods or time blocks of 2 hours each with a 15-minute sitting break after an hour of standing and/or walking during the day were used. Because the patient spends a lot of time at school in a sitting position, the chair needs to meet the following requirements: the foot should make full contact with the floor and form a 90-degree angle with the leg, the back of the chair should be tilted to the rear at 10-15 degrees, the seat should be firm and have a depth at least equal to that of the thigh or even greater, and the arms of the chair should be at a suitable height and not too far apart to avoid causing hyperkyphosis or lordosis of the thorax when the elbows are resting on them.

Non-specific and complex physiotherapy methods

The immobilisation technique is one of the non-specific means used by the patient, which helps improve and prolong independent walking, i.e., reduce muscle contractures. The physician recommended fixed bilateral ankle-foot orthoses to be worn at night for Achilles tendon retraction. They were used three days a week, especially after hydrokinetic therapy and physiotherapy sessions to consolidate the effects at that level.

Swimming offers considerable potential for dystrophic patients because it reduces intra-articular pressure, does not overload the muscles, trains the cardiovascular and respiratory systems and participates in increasing the joint range of motion, the body benefiting from general relaxation and the facilitation of movement performance. All of this results in a better ability to maintain an upright position, the correction of bad posture and the improvement of gait (Yiu & Kornberg, 2015).

The hydrokinetic therapy programme took place twice a week on the days when physiotherapy was not done in order to avoid tiring the patient. After assessing the patient's ability, static exercises were combined with dynamic ones for muscle toning. Thus, cycling was applied for 3 minutes on the Aqua Bike, 2 sets x 5 repetitions. From the standing position, the patient performed abduction of the lower limbs, abduction combined with triple flexion of the lower limb, triple flexion of the lower limbs up to the maximum range of motion (with total or chest-level immersion), triple flexion of the right lower limb with an emphasis on thigh and leg flexion, extension of the knee joint with the left lower limb in front of the right at about 40 cm and slightly bent at the hip and knee joints, heel raising and lowering (it can be adjusted by reducing the space between the lower limbs and emphasising the posterior knee flexion while the heel is kept in contact with the surface of the pool);

finally, walking in the pool for 4 minutes, and every 2 minutes, the patient climbed a step with the right lower limb and then went down with the left leg and continued to walk.

Physiotherapy programme

Because the patient is a 27-year-old woman who is still in the early ambulatory stage, the physiotherapy programme is individualised and specific to her ability. Until now, no scientific study has addressed this kind of case from a physiotherapeutic point of view in which a *de novo* mutation occurring in a female may or may not have results for quality of life in the early ambulatory stage. The entire physiotherapy programme was based on research done so far on patients with the same pathology (Alemdaroglu et al., 2015; Heutinck et al., 2018), but the uniqueness of this case required a different approach in terms of objectives and means used, which were gradually introduced in the rehabilitation programme.

“To optimize exercise and PT interventions for patients with DMD, a type of precision exercise therapy could be envisioned, in which physical activity (monitored with an activity monitor), diet, exercise, and physical therapy interventions would be compared to a panel of biomarkers and a physical outcome (strength measure).” (Kostek, 2019, p. 9)

Joint range of motion and muscle strength in the upper limbs are within normal limits (a unique case for this pathology), but we took into account the progression of the pathology and worked on these segments so that no regression occurs. Regarding the lower limbs, the range of motion and muscle strength depended on the damage to the muscle groups and joints involved. Exercises in the physiotherapy programme start from the standing position, with the patient holding an abdominal wheel on both ends and rolling it out on the wall for 1 minute.

The upper limbs will initially perform free active mobilisations and then concentric active-resistive mobilisations, taking into account to avoid muscle fatigue and reduced coordination. There will be a 3-minute break between the upper and lower limb physiotherapy programme. The physiotherapist's hand represents a gradation of resistance according to the patient's muscle strength at that level. The lower limbs will perform stretching exercises, free-active mobilisations, as well as purely assistive resistive and passive exercises. These exercises will be integrated into daily life activities and the family members will be trained to help.

The functional rehabilitation programme includes 14 exercises that are performed by the patient within 50 minutes, with the most important being: sequential flexion of the phalanges, wrist, elbow and shoulder until the medial face of the arm reaches close to the earlobe, and then the physiotherapist puts progressive resistance in the opposite direction; flexion, adduction and internal rotation of the shoulder joint simultaneously with forearm supination (Figure 1); with the elbow bent at 90 degrees, the forearm and hand in supination and the phalanges flexed, the patient performs elbow joint extension simultaneously with forearm pronation and shoulder joint flexion; the patient holds with her hands the thigh that is flexed to the chest, the contralateral lower limb is extended, and the physiotherapist passively performs the internal rotation of the hip and abduction, holding for 10 seconds; the physiotherapist passively performs dorsiflexion and holds for 10-15 seconds; the patient's hip and knee joints are flexed at 90 degrees, and the physiotherapist passively performs adduction and external rotation of the hip joint, holding for 10 seconds (Figure 2); the patient performs plantar flexion and inversion against the physiotherapist's graded resistance, and then passive

dorsiflexion and eversion are performed by the physiotherapist (Figure 3); walking on the stepper for 3 minutes.

Upper limb exercises included 2 sets x 5 repetitions with a 5-second break between sets, and lower limb exercises consisted of 2 sets x 2 repetitions with a 5-second break between sets. The intermediate assessment was carried out by attaching a 0.5 kg sandbag to each upper limb at the distal joint during free-active and resistive exercises (except the abdominal wheel rollouts and phalangeal flexion and extension). The same thing was done for plantar flexion and inversion of the lower limb. Gradually, PNF (Proprioceptive Neuromuscular Facilitation) techniques (such as slow reversal, repeated contractions, contract-relax and agonist-contract) were also applied.

The physiotherapy programme was performed four times a week in two sessions (50 minutes per session at the clinic and 20 minutes at home only for the lower limbs), and the hydrokinetic therapy programme was carried out twice a week (40 minutes per session).



Figure 1. Flexion, adduction and internal rotation of the shoulder joint and forearm supination



Figure 2. Adduction and external rotation of the hip joint



Figure 3. Plantar flexion, inversion, dorsiflexion and eversion

Results

Following the final assessment, results were recorded for each type of test used.

The Vignos Scale was maintained at 3/10 points both initially and finally (Figure 4). The time difference between the initial and final assessment results is 3 seconds (25 initially and 22 finally) for climbing 8 steps.

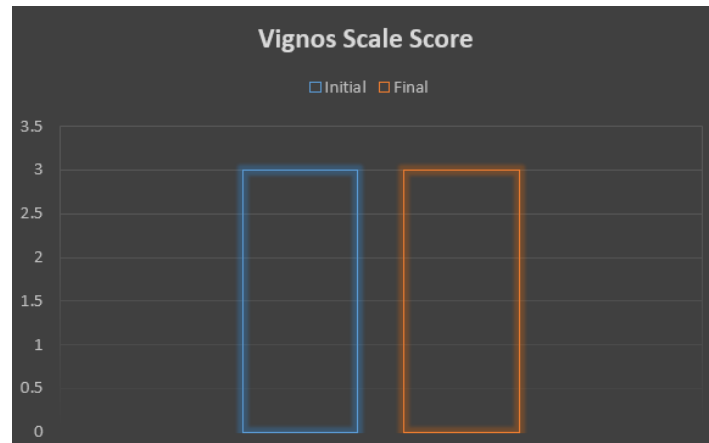


Figure 4. Graphical representation of Vignos Scale (before and after 6 months)

In first domain of the NM-Score, the values remained at 2/4 initially and finally, but the gait fatigue appeared after 150 m in the final assessment compared to the initial 130 m. The second domain kept its initial and final score of 1/4 with small improvements in the ability to carry the sandbag alone. Fatigue and decreased movement speed during daily activities (washing hair, dressing) occurred after a longer period in the final assessment compared to the initial assessment. In the third domain, the score was 1 in both assessments, but slight improvements were noted in the final one, with the patient being able to carry a full 500 g casserole in one hand compared to the initial 300 g and also peel vegetables more efficiently (Figure 5).

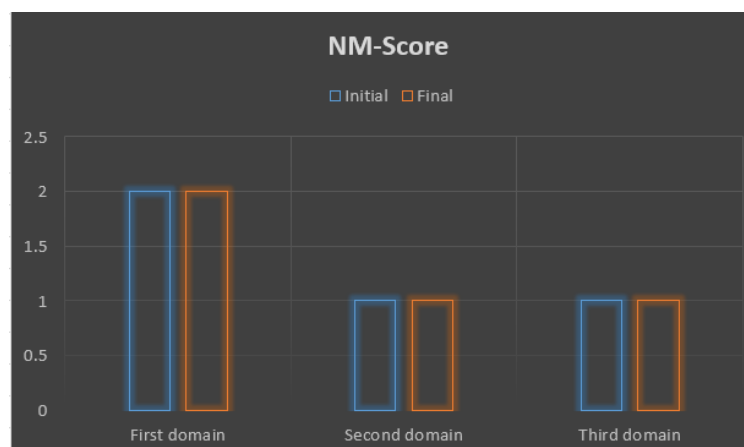


Figure 5. Graphical representation of NM-Score (before and after 6 months)

In the North Star Ambulatory Assessment (NSAA 2.0), the patient scored 11/34 points initially and 15/34 points finally. The difference in points represents the ability to stand on one leg – the support leg must be fixed, and the patient must climb and descend a 20 cm box step with the left lower limb (Figure 6).

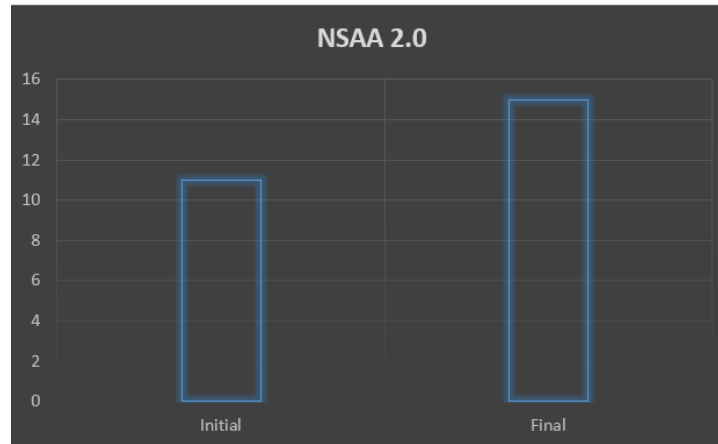


Figure 6. Graphical representation of NSAA 2.0 (before and after six months)

Thus, it can be established that the specific, non-specific and complex means used in the functional recovery treatment have contributed to achieving the objectives, while taking into account the limits allowed by the stage of the disease. The proposed physiotherapy programme can be the basis for further research.

Discussion

The aim of the study was to determine how physiotherapy would help the functional recovery of patients with Duchenne muscular dystrophy measured by particular tests, as the basis for further more extensive research.

The small number of studies analysing the effectiveness of a physiotherapy programme based on specific and non-specific means has led us to the idea that, for the girl with Duchenne muscular dystrophy in the early ambulatory stage, this part should be analysed more thoroughly because, even due to the uniqueness of the case, we can adapt and improve the exercises according to the patient's capabilities.

According to Huijben et al. (2015), 30 minutes of low-to-moderate assisted bicycle training (first with the legs and after with the arms), five times a week for 24 weeks, had a positive effect on the Vignos Scale Score in the case of a 9-year-old girl with low levels of dystrophin, whose score switched from 3 to 4. This may happen because the mutations are different depending on muscle damage and joint stiffness, and this girl's young age might have had favourable effects on maintaining normal physical function. Since this study only used assisted bicycle training, we can say that more studies are needed to combine physiotherapy with this type of training.

Bulut et al. (2022) found that submaximal aerobic training added to a home-based exercise programme had significant effects on motor function, improving the NM-Score in all

domains. The programme consisted of 40 minutes of training (including 5 minutes of warm-up, 30 minutes of active exercise on a bicycle ergometer and 5 minutes of cool-down), 3 days a week for 12 weeks. The research patients were boys with a mean age of 7.9 years. After the treatment period, positive results were observed especially in the first domain, the general difference in all three domains being 2 points. Our study showed that the final scores remained the same as in the initial assessment, but with slight improvements. For this reason, we can say that both studies mentioned above have demonstrated that the bicycle ergometer can have benefits for the quality of life in Duchenne muscular dystrophy.

So far, no study has accurately explained the effects of physiotherapy on NSAA. In our study, following the analysis of this test, positive results were obtained for the ability to stand on one leg as well as climb and descend a 20 cm box step with the left lower limb.

The present study offers a new perspective on the possibility of applying specific and non-specific means of physiotherapy that, through individualisation and continuous adaptation to the disease stage and patient's capabilities, has managed to stagnate and improve the results of the three specific tests used. Future studies are needed to observe what types of exercise are best designed and most convenient to be used in Duchenne muscular dystrophy with a view to improving quality of life.

The limitation of the study consists in the singularity of the case that presents a mutation and implicitly a different symptomatology compared to other patients, which is why the kinetic programme applied may or may not have effects and results for other patients with similar symptomatology and implicitly for other types of mutations. Thus, this study can become a benchmark in terms of designing a kinetic programme for other patients.

In conclusion, we could say that (as far as we know) this is the only study using exercise in all its complexity for the whole body of a girl patient with Duchenne muscular dystrophy in the early ambulatory stage.

Conclusion

Duchenne muscular dystrophy is a severe, incurable condition that obviously affects the patient's quality of life. Symptoms can only be relieved if the management of different specialities has a synergistic action and applies a judicious treatment plan. The diagnosis is confirmed by clinical and paraclinical examinations. Following this confirmation, the physiotherapy programme will be part of the patient's life, so assessments must be performed periodically to determine the degree of disease progression.

The stage of the disease should be taken into account when designing the physiotherapy programme in order to avoid exercises that can lead to deterioration of the striated muscle fibre. The objectives must be quantifiable, individualised and continuously adapted to the patient's present capabilities.

After the initial assessment using the NSAA, NM-Score and Vignos Scale tests, the objectives of the kinetic programme were systematised as follows: improving joint range of motion, gait and balance; reducing muscle contractures, increasing endurance; promoting independence in carrying out daily activities. The functional recovery programme uses dynamic and static exercises - active-passive, free active, active resistive (concentric), isometric types, passive type, stretching, PNF techniques.

After six months of treatment during which specific, non-specific and complex means of physiotherapy were applied, the final assessment highlighted slight improvements in all specific test scores. The objectives of the treatment were met with the help of regular exercise, which would be the solution to slow down disease progression and increase life expectancy.

The physiotherapist should instruct both the patient and the family about the importance of continuing the physiotherapy programme throughout life and its role in improving quality of life.

How exercise manages to improve overall well-being, mental health, emotional health, vitality and the sense of social inclusion should be studied in the future, as the basis for further research.

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