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Therapy Taping Method: Therapeutic Approach in Two Children with Duchenne Muscular Dystrophy

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Authors' contributions

This work was carried out in collaboration between both authors. Author CIM managed the literature searches, designed the study and the experimental process. Authors CIM and NMJ analyses the study performed, wrote the protocol and wrote the first draft of the manuscript. Both authors read and approved the final manuscript.

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Case Report

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ABSTRACT

Objective: To assess the effect of elastic bandage through the Therapy Taping Method on the execution of motor functions of children with Duchenne Muscular Dystrophy (DMD).

Methods: Two children with confirmed clinical diagnosis of DMD that visited the physiotherapy clinic at Metrocamp College were selected. Their degree of motor function was assessed by Motor Function Measure -20 Scale (MFM-20), performing then a month of physical therapy in the therapy pool without the use of bandage, in order to verify the primary functionality degree. After this period, the subjects were reassessed according to the mentioned scale, starting the application of the bandage technique in oblique muscles and quadriceps bilaterally, in conjunction with the treatment in hydrotherapy. The bandages were exchanged weekly, in a total of 24 weeks. The data was analyzed by comparing results before and after the treatment.

Results: The scores of the MFM-20 scale remained the same as the initial assessment after the

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hydrotherapy sessions without the use of bandage. However, there was an increase in scores after the combination of the use of elastic bandage with hydrotherapy.
Conclusion: The elastic bandage using the Therapy Taping Method allowed increased execution capacity of the motor activities of these children with DMD, slowing the development of symptoms.

Keywords: Duchenne muscular dystrophy; plasticity; bandage.

1. INTRODUCTION

Duchenne Muscular Dystrophy (DMD) is the most common form of muscular dystrophy in children, due to a coding error of the dystrophin protein, with progressive loss of motor function and independency [1]. Typically diagnosed in patients around the age of five, it can also be suspected earlier due to delays in developmental motor milestones, such as walking or language [2].

In healthy muscles, the dystrophin is located underlying the sarcolemma, parallel to the length of all myofibrils, attached to filaments of actin [3], beta-dystroglycan and alpha syntrophin [4]. The function of the dystrophin, associated with the previously mentioned protein complex, promotes a strong mechanical and elastic bond between the intracellular cytoskeleton and extracellular matrix, in order to send mechanical signs to muscle contraction.

In DMD, total or partial absence of dystrophin and its protein complex is observed, due to deletions, duplications, point mutations or other rearrangements [5], compromising the integrity of the sarcolemma structure, increasing the intracellular calcium entry, mitochondrial dysfunction, degradation of myofibrils, and apoptosis and necrosis, resulting in degeneration/regeneration [6].

Another pathophysiological hallmark of the disease is that the slower/more oxidative muscle fibers are more resistant to pathological processes of degeneration of dystrophin than the faster ones. The precise mechanism of this increased resistance is unknown, but factors such as differences in protein composition in the sarcolemma, oxygen transport and intracellular calcium dynamics can contribute to this important physiological phenomenon [7].

So far there is no cure for this disease, but drug treatments with the use of corticosteroids (slows the loss of muscle strength, stabilizes lung and motor functions and delays the onset of cardiomyopathy) [1,2] or adenosine monophosphate protein kinase (AMPK) which provides myogenesis to slow and oxidative fibers [8], and clinical trials such as gene therapy [9], allow a postponement of muscular degenerative process, with consequent maintenance and optimization of child functionality. The motor rehabilitation, despite not allowing the full return of the lost functionality and restoration of muscle strength, it allows the child with DMD, depending on the clinical stage in which physical therapy is started, maintain and even gain a better ability to execute motor activity in order to spare energy expenditure, thus prolonging the functional deterioration. Among the various methods and physical therapy techniques currently used, the use of therapeutic bandage may facilitate or inhibit a better motor response, according to the placement direction in relation to the muscle fibers [10,11], by stimulating mechanoreceptors present in the integument. They send sensory pressure information (static and dynamic) to regions of the somatosensory cortex, then plan a better motor response [12,13].

There are currently several brands of bandages, having as one of the first the Kinesio Taping®. The Therapy Taping Method (TTM) uses the Therapy Tex® bandage, recommending the use of the bandage for as much time as possible during 24 hours, which can influence motor behavior through neurophysiological effects, providing external support over the body or to an entire segment [14].

Thus, the purpose of this study was to investigate the influence of MTT in the execution of motor functions in children with DMD.

2. METHODS

2.1 Study Design

Case study, longitudinal, descriptive.

2.2 Study Local

Physical therapy clinic of the Metrocamp College.

2.3 Material Used

Therapy Tex® bandage, Motor Function Measure scale - 20 (MFM-20) Portuguese version (MFM-20-P) [15] score sheet.

2.4 Population Characterization

We selected two children with confirmed clinical diagnosis of DMD by muscle biopsy and genetic testing, that visited the physiotherapy clinic at Metrocamp College. Inclusion criteria was children without support of any addition, with the ability to understand simple orders (e.g. get up, pick up, sit down), aged up to six years, to enable the application of only the MFM-20-P scale, and that had not made use of any elastic bandage in any region of the body. The exclusion criteria was if the child aged seven or more during the research period, because it would be necessary to apply the MFM-32-P scale. Despite both scales having the same purpose, it has not been verified the reliability of the results in those individuals evaluated by MFM-20-P and subsequently by MFM-32-P. The children would also be excluded if they missed two consecutive weeks, due to the continuous treatment requirement of the bandage application protocol.

First, the children's degree of motor function was assessed by MFM-20-P scale, applied by a trained expert to scale application, performing then a month of physical therapy in the therapy pool without the use of bandage, in order to verify their primary functionality degree and its evolution with only conventional treatment. This treatment aimed for stretching the lower limbs (LL), upper limbs (UL) and trunk; concentric strengthening without external load; balance training in the standing posture; gait training. After this period the children were reassessed according to the MFM-20-P scale and the bandage Therapy Tex® was later applied by technique I in oblique and quadriceps muscles bilaterally. They were asked to attend the clinic to change the bandage and to continue the treatment in the therapy pool weekly, for a total of 24 weeks [6]. At the end of the proposed period, MFM-20-R scale was applied again. At the beginning of the treatment, the two children underwent muscle muscle resonance image (MRI) examination in order to do a topography of the intensity of the deposit of fat as well as the conditions of the muscle fibers.

2.5 Statistical Analysis

Data were arranged in tables for comparative and descriptive analysis of the results on both cases.

3. RESULTS

3.1 Case 1

Patient with 4 years old, second son of non-consanguineous parents, born by caesarean section at 38 weeks of gestation with meconium aspiration. According to mother's report, the patient showed delays in motor skills, when compared to the first child. At 12 months of age, the patient was referred to the pediatrician to investigate the clinical presentation, observing a level of creatine kinase (CK) above 2000 UL. During two years, the patient was accompanied for control of CK levels, always presenting levels higher than expected. At 3 years old, the patient was referred to Unicamp's Neuromuscular Diseases Clinic, where muscle biopsy was performed, and was submitted to genetic testing, confirming the diagnosis of DMD.

The MFM-20-P-scale data during the data collection period is described in Table 1.

Table 1. Values of D1, D2, D3 and total score of case 1 before and after the application of elastic bandage

	D1	D2	D3	Total score
1◦ evaluation	58.33%	87.50%	83.33	75%
2◦ evaluation after 1 month of hydrotherapy	58.33%	87.50%	83.33	75%
3◦ evaluation after the use of bandage – after 24 weeks (6 months)	62.50%	95.83%	91.66%	81.66%

Legend: D1 - dimension 1 refers to activities in the standing posture and transfer; D2 - dimension 2 refers to activities in the proximal segment of the limbs; D3 - dimension 3 refers to activities in the distal segment of the limbs

Table 2. Values of D1, D2, D3 and total score of case 2 before and after the application of elastic bandage

	D1	D2	D3	Score total
1◦ evaluation	37.50%	100%	83.33%	71.66%
2◦ evaluation after 1 month of hydrotherapy	45.83%	83.33%	83.33%	68.33%
3◦ evaluation after the use of bandage – after 24 weeks (6 months)	62.50%	95.83%	100%	83.33%

3.2 Case 2

Patient with 5 years old, first son of non-consanguineous parents, born by caesarean section, at 38 weeks of gestation. According to mother's report, the patient presented motor development within the normal range, and at 1 year and 4 months of age started showing early falls, and thereafter difficulty to walk long distances, to go up and down the stairs, and to run. At 4 years of age, the patient was referred to Unicamp's Neuromuscular Diseases Clinic, where muscle biopsy was performed, and was submitted to genetic testing, confirming the diagnosis of DMD.

The MFM-20-P-scale data during the data collection period is described in Table 2 above.

4. DISCUSSION

The use of elastic bandage has become fashionable in the rehabilitation area, especially in orthopedic and sporting conditions due to the massive advertising campaign seen at the Olympic Games in London in 2012. Therefore, scientific research has been done in order to verify the influence of this resource on musculoskeletal conditions regarding pain decrease, but such studies do not support its use due to the low methodological quality presented (non-homogeneous groups, flawed statistical analysis, uncontrolled intervention) [16].

Seen to question the bandage effect on motor rehabilitation, coupled with a lack of studies in patients with neuromuscular diseases, this research has allowed the start of the problem regarding the use or not in patients with a chronic and progressive disease.

In this pilot study we observed an increase in motor functionality scores in both cases after the start of bandage application. The lack of research in the neurological area hampered the analysis of found results, being analyzed at this time the possible physiological mechanisms of the bandage, as well as the stimulated muscular plasticity.

Sensory input of the body position and of the movement is captured by receptors present on the skin (mechanoreceptors), joints and muscles, sending this data to cortical regions via somatosensory inputs. The main muscular receptor is the neuromuscular spindle, but skin and joint receptors are also recognized as an important factor to inform position and movement. Thus, the elastic bandage allows stimulation of mechanoreceptors present in the integument, increasing the somatosensory input to the cerebral cortex [17,18].

The bandage would induce a pressure and a strain on the skin, activating mechanoreceptors [19] statically or dynamically (depending on the stimulated receptor type), providing continuous feedback to the brain as the movement or posture is running, resulting in a continuous muscular response [20].

Increased sensory information allows the muscle to maintain its state of proper tension during the performance, with no need for a permanent central control of regions such as the cerebellum or the pre motor cortex for constant movement planning and adjustment. Cortical and subcortical circuits that are usually requested to permanent motor control loads and other cognitive activities can decrease their activation when external stimuli that maintain adequate somatosensory information are added to the activity [21].

In our study, the bandage by MTT probably has facilitated a constant motor response in muscles that still presented preserved fibers without the deposition of fat or connective tissue. It is noteworthy that the two cases were of children in the early stages of DMD, under 6 years of age, in which the functional limitations include but are not always disabling, and there are still muscle fibers present (without degeneration and fat deposit and connective tissue, observed by muscle MRI). In advanced cases, due to the large deposit of fat and connective tissue, associated with muscle degeneration, there is no possibility of a suitable motor response due to the absence of a suitable effector (muscle), in spite of the information sent via cutaneous receptors for brain areas was intact.

Another point to be considered in applying the bandage by MTT is the placement localization, that is, what muscle to be activated or inhibited. It is called *activation* the reactive force in the same direction as the contraction of the muscle in question, and called *inhibiting* the reverse situation. This does not mean producing a potential muscle action, but a pull on the skin overlying the muscle. In healthy subjects, the muscular contraction of the trunk always precedes the movements of the extremities, that is, to any appendicular function of upper or lower limbs, the anterior and posterior muscles of the trunk must be activated first in order to provide a stable axis so that distal structures can perform the move. However, in people with a muscle disorder such as low back pain, contraction of axial muscles occurs after the extremities movements, with motor recruitment delay [22].

Some studies, such as Bae et al. [23] & Voglar and Sarabon [24], have observed that after application of the bandage in cases of chronic lower back pain, muscular stem response was optimized by improving the early posture adjustment and motor disability, as described by Castro-Sánches et al. [25] and Paoloni et al. [26].

This postural adjustment delay reasoning can be used in the cases of children with DMD of our study. Therefore, the bandage application in bilateral oblique muscles may have allowed the activation of the trunk muscles in advance to the muscles of the extremities, thus allowing a better postural adjustment for execution of the requested activities.

We must also consider another important mechanism in the motor rehabilitation process, especially in cases of patients with neuromuscular diseases: The muscle plasticity. Skeletal muscle has a great capacity for regeneration after an acute or chronic event, activating muscle satellite cells and other structures such as mesenchymal progenitor cells (fibro-adipose progenitors - FAPs) [27]. In response to injury and appropriate external stimuli, eosinophils release IL-4 and IL-3 that activate FAP [28], and subsequently the satellite cells for the muscle fiber regeneration [29].

However, in muscles with advanced chronic degeneration such as dystrophies, the muscle regeneration process accumulates fibrous and adipose tissues, due to a lack of muscle plasticity in the muscle DNA's chromatin, not activating the ways which FAP expresses the myoblasts production, exciting the production of fibroblast / adipocytes, leading to a decrease in contractility and modifying the muscle metabolism [30].

Once more, it emphasizes the importance of applying the MTT DMD in the initial stage so as not to find advanced muscle degeneration, allowing activation of muscle plasticity.

Based on evidence that slow muscle fibers are rich in utrophin A (enables the most prolonged contraction - oxidative) and that in patients with DMD these slow fibers are more resistant to pathological processes of muscle degeneration, promoting phenotypic change in fiber muscle to slow and oxidative type can mitigate the degeneration process [31]. Such fibers modification was observed after resistance training in dystrophic patients, which modified the expression and type of fast muscle fibers to slower and more oxidative, which has a greater number of mitochondria and contractile proteins network such as troponin I (slow and with more myoglobin) [32] without negative consequences of muscle injury [33].

Thus, exercises at low intensity, aerobic activities, submaximal and functional strength may be beneficial especially in the early course of the disease [33-35], stimulating the mechanisms of muscle plasticity. The hydrotherapy practice may have promoted the transformation of muscle fibers, and associated with the use of elastic bandage allowed the muscle to receive constant and lasting stimuli 24 hours / day, increasing muscle plastic mechanisms.

In this pilot study, despite the limitation considering that the statistical analysis was not performed, we are able, therefore, to encourage the possibility that the MTT in DMD enables an extension of the proper muscle condition, delaying the loss of ambulation evident at around 8-10 years of age, since in both cases there was an increase score in the dimension 1 (D1) and in total score, which according to Vuilerot et al. [36], D1 values below 40% and total score below 70% are predictive of gait loss in 1 year.

We will be conducting a randomized study with a control group, with a larger number of individuals, acting isolated and in combination with bandage application, in order to analyze the actual clinical evidence of MTT in DMD.

5. CONCLUSION

In this initial study, there was an increase in the execution capacity of motor activities after the inclusion of elastic bandage in the physical therapy program. According to patient's mother's reports, there was a reduction of falls and in pain complaints after physical exertion.

CONSENT

All authors declare that 'written informed consent was obtained from the patient (or other approved parties) for publication of this paper and accompanying images.

ETHICAL APPROVAL

All authors hereby declare that all experiments have been examined and approved by the appropriate ethics committee and have therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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