

## Spinal Muscle Atrophy: Clinical Cases

### Atrofia Muscular Espinhal: Casos Clínicos

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#### Abstract

Spinal muscular atrophy (EBF) is an autosomal recessive neuromuscular disease with genetic inheritance. EBF is classified into: type I - patients have symptoms up to 6 months of age; type II - after 6 months of age, symptoms begin; type III - it starts after 18 months of age. The objective of this study was to clinically characterize two brothers diagnosed with EBF. It is a clinical case study of two individuals, male gender, attended at Clínica Escola de Fisioterapia, at Universidade Estadual do Centro Oeste do Paraná- UNICENTRO, Campus CEDETEG. Selected by eligibility both were diagnosed with spinal muscular atrophy. The physiotherapy stages evaluation was carried out, which consist of anamnesis, functional examination, physical examination and respiratory evaluation. Patient 1, was diagnosed with EBF type IIIb at 16 years old, with reports of falls and weakness mainly in lower limbs, in the evaluation positive Gowers sign, anserine gait, hypotonic, MMSS areflexia and lower limb hyporeflexia, breathing pattern apical were found. Patient 2 was diagnosed with EBF type IIIa at 1 year of age, currently using a wheelchair for locomotion, on physical examination he had scoliosis with right convexity, deformities in the costal grid, decreased muscle strength in the upper limbs and lower limbs, mixed respiratory pattern. From the physical therapy evaluation performed on these patients, it could be noted that the weakness of the respiratory muscles is directly related to the clinical sign presented by both.

**Keywords:** Physiotherapy Specialty. Neuromuscular Diseases. Spinal Muscular Atrophy.

#### Resumo

*A atrofia muscular espinhal (AME) é uma doença neuromuscular autossômica recessiva com herança genética. A AME é classificada em: tipo I – pacientes apresentam sintomas até 6 meses de idade; tipo II – após os 6 meses de idade inicia-se os sintomas; tipo III – inicia-se após 18 meses de idade. O objetivo desse trabalho foi caracterizar clinicamente dois irmãos com diagnóstico de AME. É um estudo de casos clínicos de dois indivíduos, do gênero masculino, atendidos na Clínica Escola de Fisioterapia, da Universidade Estadual do Centro Oeste do Paraná – UNICENTRO, Campus CEDETEG. Selecionados por elegibilidade ambos diagnosticados com atrofia muscular espinhal. Foram realizadas as etapas da avaliação fisioterapêutica que consistem em anamnese, exame funcional, exame físico e avaliação respiratória. O paciente 1, foi diagnosticado com AME tipo IIIb aos 16 anos, com relatos de quedas e fraqueza principalmente em MMII, na avaliação constatou-se, sinal de Gowers positivo, marcha anserina, hipotônico, arreflexia de MMSS e hiporeflexia de MMII, padrão respiratório apical. O paciente 2 recebeu o diagnóstico de AME tipo IIIa com 01 ano de idade, atualmente utiliza cadeira de rodas para locomoção, no exame físico apresenta escoliose com convexidade a direita, deformidades no gradil costal, força muscular diminuída em MMSS e MMII, padrão respiratório misto. A partir da avaliação fisioterapêutica realizada nesses pacientes, pode-se notar que a fraqueza dos músculos respiratórios está diretamente relacionada com o quadro clínico apresentado por ambos.*

**Palavras-chave:** Fisioterapia. Doenças Neuromusculares. Atrofia Muscular Espinhal.

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#### 1 Introduction

Spinal muscular atrophy (EBF) is an autosomal recessive neuromuscular disease with genetic inheritance. AME was originally described by Guido Werning and Johann Hoffmann between 1891 and 1900<sup>1</sup>, a century later, genetic advances allowed the identification and localization of the motor survival gene (SMN1) as the cause of the disease<sup>2</sup>. The homozygous mutation or deletion of the SMN1 gene is the cause by which it results in the development of AME, the determinant for AME clinical phenotype and its severity is defined by the SMN protein transcription, which is transcribed by the SMN2 gene, a copy of the SMN1 gene, which is located on chromosome 5q13<sup>3,4</sup>. Degeneration of motor neurons of the anterior horn

of the spinal cord results in progressive muscle atrophy and weakness<sup>5</sup>. AME is classified into three types, according to functional capacity: Type I – patients present symptoms up to 6 months of age and do not sit alone; Type II – after 6 months of age, muscle weakness begins, individuals sit, but do not walk; Type III – starts after 18 months of age, individuals can walk<sup>6,7</sup>.

AME type I (severe): It is characterized by early development time (0 to 6 months of age), showing lack of ability to sit without support and short life expectancy<sup>8</sup>. AME type II (chronic): Symptomatic about 6 to 18 months of life, however it may manifest before that. Some individuals can sit alone while others are only positioned, with this they can

develop scoliosis and contractures over the years, and the life expectancy of these individuals is around 10 to 40 years<sup>9</sup>. AME type III (juvenile): It is present after 18 months of age, however, the age at onset varies greatly<sup>10</sup>. The disease onset before the age of 3 is classified as type IIIa AME, whereas after this age it is defined as type IIIb AME. What differentiates both of them is the preserved ability to walk, and individuals with type IIIa are able to walk up to 20 years of age, however, type IIIb individuals of the same age remain capable of walking throughout life<sup>11</sup>.

AME is considered a severe pathology that affects 1 in 6000-10000 newborns. It presents clinical manifestations that occur early in the prenatal period through the reduction of fetal movements, at birth or before 6 months of life, in which the individual presents hypotonia to muscle palpation, global weakness of the proximal muscles of arms and legs that are usually the most affected, and eventually,<sup>12,13</sup> of trunk muscles, absence of active movements, absence of trunk and cervical control, evolving to severe respiratory and motor involvement.

Thus, this study aims to report clinically two brothers with AME diagnosis, who were attended at the Physiotherapy Clinical School, of Universidade Estadual do Centro Oeste do Paraná – UNICENTRO, Campus CEDETEG.

## 2 Case Report

The study was developed at the Physiotherapy School Clinic of Universidade Estadual do Centro Oeste do Paraná - UNICENTRO, CEDETEG Campus, in the city of Guarapuava-PR. The physiotherapeutic evaluation consisted of anamnesis, functional examination and physical examination in both individuals.

The physical evaluation instruments used were a goniometer of the brand (Arktus) to verify the range of movements of MMSS, MMII. Muscle strength was evaluated through the MRC-Medical Research Council scale (it evaluates 12 muscle groups, a total score below 48/60 designates significant weakness, and a total MRC score below 36/48 indicates severe weakness<sup>14</sup>), manual grip was evaluated through a dynamometer (Crown Manual 100 kgf), the special tests used were the EK-Engen Klassifikation questionnaires for functional AME evaluation (it is divided into 10 categories, each of them with four alternative, which provide partial scores between zero and three. A total score is obtained by the sum of the partial scores and varies between 0 and 30. The higher the degree of functional impairment, the higher the score obtained<sup>15</sup>), MFM – measurement of the gross motor function for neuromuscular diseases (it is composed of 32 items, divided into 3 dimensions: Dimension 1 – standing posture and transfers, with 13 items; Dimension 2 – axial and proximal motor function, with 12 items; Dimension 3 – distal motor function, with seven items. Each item is scored from 0 to 3, with zero not performing the movement or not maintaining the position, 1 performing partially, 2 performing slowly or

with offsets, and 3 performing correctly. The partial and total scores of the dimensions are expressed as a percentage in relation to the maximum score of 96 points<sup>16</sup>), Barthel Index for the evaluation of functional independence (it is composed of ten items, which assess diverse aspects, such as ability to feed, dress, personal hygiene and movement. The partial scores obtained range from 0 to 10 or 0 and 15. The total score obtained range from 0 to 100. High values of the Barthel index indicate lower functional commitment<sup>15</sup>) and TUG (timed up and go test) for assessing functional mobility and dynamic balance in which it consists of getting up from a chair without the help of the arms and walking at a comfortable and safe pace at a distance of three meters, walking around, returning and sitting. At the beginning of the test, the participant remained with the back resting on the seat back and should return to this position at the end of the test<sup>17</sup>. For respiratory evaluation, the chest type, apical and xiphoid expansibility, diaphragmatic muscle strength, respiratory rhythm, respiratory pattern, expiratory flow through peak flow (Philips Respiromics), chest cytometry in axillary, xiphoid and basal regions were evaluated using measuring tape, chest symmetry, axillary and xiphoid force, Charpy angle, inspiratory and expiratory force which were evaluated through the Manovacuometry (Comercial Medica).

This is a case report of two male individuals, selected for eligibility both diagnosed with spinal muscular atrophy, which followed the norms recommended by the National Health Council (CNS) for research with human beings and the National Committee on Ethics in Research (CONEP), and all evaluated patients signed the free and informed consent form, approved by the Ethics Committee of Universidade Estadual do Centro-Oeste (UNICENTRO) opinion number 3.594.701.

### 2.1 Case 1

A 27-year-old male patient, A.R.J., was diagnosed with type IIIb spinal muscle atrophy at 16 years of age. The same reported that he suffered many falls and felt weakness mainly in the lower limbs, so he sought medical assistance. This patient has been receiving physiotherapeutic care since he was 15 years old. The same goes for supplementation with vitamins B12, Magnesium and Omega 3 and also makes use of Durabolim anabolic. In the functional exam, the patient presented a positive Gowers signal, and the patient's gait pattern is Anserine type. The patient also reported that he performs all the postural changes, but has difficulties due to muscle weakness. At the time of physical examination in May 2020, the patient weighed 63kg, with 173 cm height, blood pressure was 110/70mmHg, heart rate was 82 bpm, respiratory rate was 16 irpm and saturation was 98%.

Trunk range of motion (ADM) shows 45° flexion, 5° extension, 45° lateral flexion for both sides and 180° rotation for both sides. The range of movement of upper limbs is normal. He presents areflexia in the upper limbs and the

musculature is hypotonic. MRC was 44/60, being right side 22 and left side 22. In the lower limbs, the range of motion is reduced in the following movements: hip flexion (120° in the right and 125° in the left) as well as hip adduction (left/right 10°), dorsiflexion (15° in the right limb and 10° in the left) and plantar flexion (20° in both limbs). He shows hyporeflexia (patellar and aquileu reflex). There is also a difference in limbs length (91cm on the right limb and 93 cm on the left). In Engen Klassifikation scale, this patient scored 1. The Barthel index resulted in 100 points (independent) and the Timed Up and Go (TUG) test resulted in 12 seconds (with partial independence and low risk of falls). In MFM, the result was 100% indicating total independence.

In the respiratory evaluation, the patient presented normal chest, with normal apical, xiphoid and basal expansion, with normal anterior/posterior expansion. Dyspneic breathing rhythm when traveling at higher speed is necessary. The patient's breathing pattern is apical. Cytometry showed normal values (Table 1).

**Table 1** - Case 1 cytometry values, performed at the School of Physiotherapy Clinic, in 2019

Region	Inspiration/Expiration difference
Axillary	4 cm
Xiphoidian	7 cm
Abdominal	3 cm

Source: Research data.

Normolineal Charpy angle (Chart 2). In diaphragmatic evaluation, he presented grade 2 with normal tonus, normal expansibility and decreased strength. Manovacuometry showed respiratory muscle weakness and Peak Flow showed normal expiratory flow for the patient (Table 2).

**Table 2** - Respiratory Evaluation of case 1, performed at the School of Physiotherapy Clinic, in 2019

Breathing pattern	Charpy angle	Manovacuometry	Peak Flow
Apical	90° (normolineal)	133.7 cm H2O (PI <sub>max</sub> ) 137.4 cmH2O (PE <sub>max</sub> )	810 cm/l

Source: Research data.

## 2.2 Case 2

Patient 1, 14 years old, male, received the AME type IIIa diagnosis when he was 01 year old, since then has performed physiotherapy.

He reports that he walked independently until the age of 10, and currently uses wheelchair for locomotion. At the time of physical examination in May 2019, the patient weighed 32 kg, with 170 cm height, blood pressure was 110/60mmHg, heart rate was 76 bpm, respiratory rate was 18 irpm and saturation was 96%.

The patient presents scoliosis with convexity to the right and deformities in the costal grid. Trunk range of motion not evaluated due to deformity (Figures 1 and 2). In the upper limbs the range of motion is normal. He presents arreflexia in the upper limbs and the musculature is hypotonic. In the lower

limbs, there were reduced motion amplitudes in dorsiflexion (5° in the right ankle and 18° in the left ankle) and plantar flexion (20° in the left ankle and 40° in the right ankle). MRC was 34/60, being left side 17 and right side 17. He has lower limbs areflexia. In Engen Klassifikation scale, this patient scored 16. The Barthel index resulted in 40 points (dependent) and the Timed Up and Go (TUG) test was not performed in this patient due to locomotion. On the MFM scale, it was 70%, with compromised independence.

**Figures 1 and 2** - Trunk deformity of case 2 individual



Source: The authors.

The patient's chest is a kyphoscoliotic type. Reduced apical, xiphoidian, and basal anterior/posterior expansibility. Eupneic respiratory rhythm. Cytometry showed normal values (Table 3).

**Table 3** - Case 2 cytometry values, performed at the School of Physiotherapy Clinic, in 2019

Region	Inspiration/Expiration difference
Axillary	4 cm
Xiphoidian	3.5 cm
Abdominal	3.5 cm

Source: Research data.

The respiratory pattern of the patient is mixed and the angle of Charpy longilineal (Chart 4). In diaphragmatic evaluation, he presented grade 2 with normal tonus, normal expansibility and decreased strength. Manovacuometry showed respiratory muscle weakness and Peak Flow showed normal expiratory flow for the patient (Table 4).

**Table 4** - Respiratory Evaluation of case 2, performed at the School of Physiotherapy Clinic, in 2019

Breathing pattern	Charpy angle	Manovacuometry	Peak Flow
Mixed	<90° (longilineal)	143.3 cm H2O (PI <sub>max</sub> ) 103.45 cm H2O (PE <sub>max</sub> )	590 cm/l

Source: Research data.

## 2.3 Discussion

Respiratory muscle weakness is frequent in neuromuscular diseases and is directly associated with morbidity and mortality of these patients. Several complications may affect patients with AME, such as postural alterations, decrease in the range

of motion, changes in gait, motor and respiratory alterations, and basically all respiratory alterations are due to the fact that progressive respiratory muscle weakness occurs, as with other skeletal muscles that are affected by this disease<sup>18,19</sup>.

Respiratory complications are difficult to treat and often cause respiratory failure and death, where pulmonary diseases are the main cause of morbidity and mortality in patients with AME, particularly in patients with AME I and II, and may also occur, although in a lower proportion, in AME III. Immobility associated with AME increases muscle atrophy and may determine axial deviations and limbs deformities<sup>20</sup>. Types II and III, associated with higher survival, but also with increasing immobility and the use of wheelchair for ambulation<sup>21</sup>. Scoliosis is described in 50% of patients with AME, and it is more frequent in patients who have never performed gait or have lost capacity<sup>22</sup>. The findings obtained in the present study show respiratory alterations, due to postural maladjustment caused by spinal muscle atrophy, where there was a scoliosis generated by the evolution of the disease, in which the inadequate posture generated compression of organs and viscera, which was solved by surgical correction.

In general, motor unit diseases are associated with decreased bone mineral density (BMD) due to disuse.<sup>23,24</sup> For this pathological state, the immobilization/reduction of mobility and locomotion, which simultaneously condition a reduction in the forces applied to the bone by muscular contraction and severity, and the decrease in the bone remodeling threshold with consequent reduction in trabecular and endocortical BMD. The earlier the disease starts and the longer the survival, the worse the prognosis, in terms of the number of fractures and gait capacity, due to a cycle of immobility, reduction of BMD, pathological fracture and so on<sup>25</sup>.

When there is respiratory muscle weakness, there is a high incidence of ventilatory insufficiency, thus justifying the strengthening of respiratory muscles as a form of prevention<sup>18,19</sup>. In the present study, respiratory muscle weakness is shown by respiratory evaluation, with specific instruments, such as peak flow and manovacuometry, in which manovacuometry was decreased in individuals with spinal muscle atrophy III. In some studies, type III presented a higher expiratory peak, since it is a more heterogeneous group, composed of individuals who maintain ambulation, wheel-chair users and people with and without spinal deformities<sup>26</sup>. In the present report, one of the individuals obtained the expiratory flow without alterations, in which the same ambulates and does not present deformities.

Maintaining proper body alignment, preventing spinal compensation – especially in patients with scoliosis – benefits respiratory function. These results show this: statistically significant values were found in the patients' MV, VC, CFV, MIP, MEP and PEF when sitting in their chairs with postural adequacy than in the standard chair, without adaptation to suit the posture. Comparing the two situations, the postural

adequacy system resulted in an increase of 16% in MV, 30% in VC, 25% in CFV, 46% in MIP, 37% in MEP and 19% in PEF<sup>27</sup>.

Adaptations made specifically for the patient in his wheelchair provide better positioning and trunk stabilization, unlike the standard chair without postural fit. It is believed that the best biomechanical alignment offered by this resource positively influences the performance of the structures involved in breathing, contributing to minimize the possibility of a worsening of the respiratory function resulting from the sitting posture with mechanical compensation and blockages to the chest and abdomen, since such patients are already affected by progressive deterioration of the strength of the muscles involved<sup>27</sup>.

Because of the severity of muscle weakness and because they are always lying or rising very little, these patients have a limited ability to cough and clean secretions present in the lower airways. As a result, recurrent infections may occur, which exacerbate muscle weakness (mainly respiratory muscles) and may also result in atelectasis and pulmonary collapse<sup>20</sup>. The immobility of these patients leads to alterations in the range of movement of the joints, where it is decreased in one of the individuals in the case report, corroborating, for generalized muscle weakness generating hypotonia, joint and muscular contractures, postural maladjustments, and consequently impairing the gait of these individuals, who before could walk and after a while they started to use a wheelchair. Type III has a milder start with highly variable travel. Patients are able to walk without care for a significant period of time and have a life expectancy close to normal. The involvement is predominantly proximal, with involvement of the pelvic waist and later of the scapular waist. The disease can progress rapidly during adolescence, leading to disability in the second decade, while at other times it is limited to a discreet commitment of the proximal muscles of the limbs<sup>28</sup>.

As we have seen, spinal muscular atrophy is characterized by a hypotonia that generates a muscular atrophy, which directly influence the respiratory and motor impairment of patients presenting this pathology. We also suggest that the research be carried out with a greater number of samples, and that the evaluation and intervention of the individuals be performed.

### 3 Conclusion

Spinal muscular atrophy is characterized by a hypotonia, a condition that may lead patients to infections that may result in some respiratory complications such as atelectasis and pulmonary collapse. Thus, it is concluded that from physiotherapeutic evaluation performed in such patients, that the respiratory muscles weakness is directly associated to the clinical signs presented by both.



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