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Nutritional Care in Amyotrophic Lateral Sclerosis: An Alternative for the Maximization of the Nutritional State

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1. Introduction

Amyotrophic lateral sclerosis (ALS) is characterized by progressive paralysis secondary to the impairment of the motor neurons, upper motor neuron and lower motor neuron. The most common symptoms and signs are atrophy and muscle weakness, fasciculations, cramps, hypertonia and hyperreflexia. In more advanced stages, decreased respiratory muscle strength, progressive loss of body weight and changes in food intake are observed (Nelson et al., 2000).
Several factors are inherent to the food intake in ALS, such as: lack of appetite, dysphagia, weakness, dyspnoea, and depression (Stanich et al., 2004; Nelson et al., 2000; Kasarskis et al., 1996; Welnetz, 1990; Slowie et al., 1983). ALS patients usually have rapid weight loss associated with reduced food intake, increased feeding time, fatigue, dehydration and depression (Wright et al., 2005). The combination of these factors may result in increased energy expenditure and therefore hypercatabolism.
Different studies confirm the correlation between the reduced Body Mass Index (BMI) and the decreased survival in subjects with ALS and the decreased food intake and decrease in tricipital skinfold (TSF) (Kasarskis et al., 1996; Desport et al., 2003; Desport et al., 1999; Desport et al., 2001; Heffernan et al., 2004; Slowie et al. 1983). They also show a high percentage of weight loss, greater than 15% (Mazzini et al. 1995), and prevalence of malnutrition.
Dysphagia, a common symptom with the disease progression, is a factor that makes difficult the maintenance of oral feeding, increasing the respiratory complications, with initiation of invasive ventilation, difficulty to move the patient for the outpatient care and depression (Mazzini et al., 1995).
In this context, taking the nutritiontal impairment experienced by ALS subjects into account, this chapter aims to discuss the key strategies of nutritional care of patients with ALS, with a tool for maximizing the nutritional status.

2. Amyotrophic lateral sclerosis and nutritional status

2.1 Food intake in ALS

Few studies on food intake in patients with ALS are available in the literature. Among these studies, Kasarskis et al. (1996) studies stand out, which found that 70% of the subjects

experienced energy intake below the RDA and 84% of the patients experienced protein intake above the RDA. Slowie et al. (1983) found, as well as Kasarskis et al. (1996), 70% of inadequacy for energy, using the 24-hour recall in patients with ALS. Stanich et al. (2004), found values above the RDA for lipids in most ALS patients chosen in their study.

Silva et al. (2007a and 2007b) analyzed the nutritional profile of patients treated in Dysphagia and Neuromuscular Outpatient Clinics of the Hospital das Clínicas of Unicamp – HC/UNICAMP. Interdisciplinary assessments were performed, revealing a low caloric intake of approximately 1600 kcal for men. In women, a low caloric intake (approximately 1700 kcal/day) was also observed.

In another study conducted by Silva et al. (2008a) the food intake was quantitatively and qualitatively assessed in ALS patients regularly followed at the neuromuscular outpatient clinic of the HC-UNICAMP. The foods most consumed daily were oil, rice, beans, French bread and milk. The food was found to be inadequate regarding energy, fiber, calcium and vitamin E. A significant difference was observed between patients with ALS of bulbar and appendicular predominance, whereas, in patients with higher appendicular manifestation, a higher energy intake ($p=0.02$) of saturated fat ($p=0.03$), monounsaturated fat ($p=0.04$) and polyunsaturated fat ($p=0.001$), as well as cholesterol ($p=0.001$) and fibers ($p=0.001$) was observed when compared with the ALS of bulbar predominance. A higher swallowing impairment observed in patients with bulbar predominance may have influenced the qualitative and quantitative intake. While feeding is impacted by the disease features, the per capita income of patients seems to have influenced the low qualitative consumption of food. Based on the results obtained, the authors suggested that guidance regarding the consumption of foods and preparations with a higher content of high-biological proteins, fibers, calcium, and vitamin E is necessary.

In ALS, as in most neuromuscular diseases, changes can also be observed, which increase the muscle catabolism, directly impacting protein synthesis and mineral excretion. In the initial stages of the disease, according to the study conducted in 94 patients with ALS, it was observed no deficiency of vitamins E and C, but upon disease progression, clinical and biochemical manifestations of such deficiency were observed (Ludolph, 2006).

To estimate the dietary intake, some countries in Europe and Canada use as main practices the 24-hour recall, 3-day and 7-day food record. To estimate the energy requirements, professionals have used the equations of Schofield (1985) and Harris and Benedict (1919). To estimate the adequacy of macronutrients, the researchers used the standards of the Recommended Dietary Allowances (NCR, 1989), Department of Health (1991) and the Institute of Medicine (IOM, 2002; IOM, 2001; IOM 2000; IOM 1997).

To estimate the energy requirements, the most used equation was that of Harris and Benedict (1919) modified by Long; Schaffel; Geiger (1979).

According to Harris and Benedict:

$$\text{Men:} \quad \text{BMR*} = 66 + (13.7 \times \text{mass in kg}) + (5 \times \text{height in cm}) - (6.8 \times \text{age in years})$$

$$\text{Women:} \quad \text{BMR*} = 655 + (9.6 \times \text{mass in kg}) + (1.7 \times \text{height in cm}) - (4.7 \times \text{age in years})$$

*BMR = basal metabolic rate

Modified by Long; Schaffel; Geiger (1979):

VET* = BMR x activity factor x injury factor

*TEV = total energy value

The activity factor is considered as 1.2 for patients unable to walk and 1.3 for patients able to walk. The injury factor is considered as 1.1 for chronic diseases (Long; Schaffel; Geiger, 1979). Considering a higher energy expenditure (10-20%) for individuals with ALS (Piquet, 2006), some professionals also employ 35 kcal/kg current body weight.
For water intake, the estimation according to Thomas (2001) should be 30-35mL/kg, taking the age into account.

2.2 Anthropometry and body composition

The nutritional status can be evaluated through objective methods, such as: anthropometry, body composition, biochemical parameters and dietary consumption; or subjective methods, such as: physical examination and subjective global assessment. Anthropometry involves obtaining measures of body size, their proportions and the relationship with standards that reflect the development of adult subjects. The most used measures are weight, height, circumferences and skinfolds (Almeida et al., 2010; Silva et al., 2008b; Silva et al., 2008c; Stanich et al., 2004; Kasarskis et al., 1996; Slowie et al., 1983).

2.2.1 Weight (W)

For patients unable to walk, in the absence of a metabolic scale, the weight is measured using a wheelchair. Prior to patient's weighing, the wheelchairs are weighted and their weight is deducted at the time of calibration of the scale. In patients able to walk, the body weight is measured standing on platform type or digital scales (Silva et al., 2008b; Stanich et al., 2004). The weight can also be measured in chair scales, available in the market.

2.2.2 Height (H)

The height for individuals unable to walk is measured with the subject seated closest to the edge of the chair with his/her left knee bent at 90 degrees. The length between the plantar surface and the knee is measured with the help of a measuring tape. The height is estimated according to the equations proposed by Chumlea; Roche; Steinbaugh (1985), where:

$$\text{Men's height} = \left[64.19 - (0.04 \times \text{age in years})\right] + (2.02 \times \text{knee height in cm})$$

$$\text{Women's height} = [84.88 - (0.24 \times \text{age in years}) + (1.83 \times \text{knee height in cm})$$

2.2.3 Body mass index (BMI)

Usually, body mass-height ratio is used as an indicator of body mass index (BMI = body mass kg/height m²).
The BMI classification is described below:

- BMI < 16 kg/m²: severe malnutrition
- 16 - 16.9 kg/m²: moderate malnutrition
- 17.0 - 18.49 kg/m²: mild malnutrition
- 18.5 - 24.9 kg/m²: eutrophic
- 25.0 - 29.9 kg/m²: overweight
- 30.0 - 34.9 kg/m²: grade I obesity
- 35.0 - 39.9 kg/m²: grade II obesity
- >40 kg/m²: grade III obesity (World Health Organization, 1985)

Kasarskis *et al*. (1996) confirm the correlation between reduced BMI and decreased life expectancy. In studies carried out by Mazzini *et al.* (1995), 53% of ALS patients showed BMI < 20Kg/m² and 55% had weight loss > 15% of usual weight.

2.2.4 Arm circumference (AC)

The arm circumference is measured at the non-dominant arm extended along the body, measured at the midpoint between the acromion and the olecranon process, using a flexible, non-elastic, plastic measuring tape (Lohman; Roche; Martorell, 1991). Desport; Maillot (2002) uses the AC to calculate the arm muscle circumference (AMC) and monitor the nutritional status of patients with ALS.

2.2.5 Skinfolds

Tricipital skinfold (TSF) is determined along the longitudinal axis of the arm, on its posterior face, whereas its exact point of repair is the average distance between the superior lateral edge of the acromion and the olecranon.

Bicipital skinfold (BSF) is determined towards the longitudinal axis of the arm, on its anterior face, in the mid-point of the humeral biceps.

Subscapular skinfold (SCSF) is obtained obliquely to the longitudinal axis following the direction of the ribs, and located 2 cm distant from the lower angle of the scapula.

Suprailiac skinfold (SISF) is measured by slightly placing the patient's right arm behind, trying not to influence the attainment of the measure. This fold is obliquely individualized 2 cm above the anterior superior iliac crest, at the anterior axillary line.

To evaluate the AC and skinfolds, the reference standard used is the work of Frisancho (1981).

2.3 Classification of nutritional status

According to the Percentile Distribution Table, the percentage of adequacy for the abovementioned parameters is calculated by considering the 50th percentile (P50) as standard.

$$\% \text{ adequacy} = \text{studied parameter value} / \text{P50 value} \times 100$$

Values in Table 1 are used for the classification of nutritional status.

Parameters	Obesity	Overweight	Eutrophy	mild PEM[1]	moderate PEM	severe PEM
AC[2]	≥ 120%	120-110%	110-90%	90-80%	80-70%	≤ 70%
TSF[3]	≥120%	120-110%	110-90%	90-80%	80-70%	≤ 70%

[1]PEM: Protein-energy malnutrition; [2]AC: arm circumference; [3]TSF: Tricipital skinfold.

Table 1. Classification of nutritional status according to the parameters proposed by Blackburn; Harvey (1982) and Blackburn; Thornton (1979).

For the determination of the nutritional status, the anthropometric parameters are analyzed together. The values obtained according to the percentage adequacy are classified by Protein-Energy Malnutrition (PEM) Score. The PEM Score is the sum of all parameters of nutritional assessment in percentage adequacy divided by the number of parameters assessed (Blackburn; Harvey, 1982).

$$\text{PEM Score} = \frac{\%\text{ adq OW} + \%\text{ adq TSF} + \%\text{ adq AC} + \%\text{ adq AMC} + \%\text{ adq AMA}}{\text{Numbers of parameters}}$$

% adq OW = % adequacy from the optimal weight
% adq TSF = % adequacy of tricipital skinfold
% adq AC = % adequacy of arm circumference
% adq AMC = % adequacy of arm muscle circumference
% adq AMA = % adequacy of arm muscle area
The value obtained by PEM score allows for the classification of patients as:
Eutrophy: > 100%
Mild PEM: < 100% and > 80%
Moderate PEM: < 80% and > 60%
Severe PEM: < 60%

2.3.1 Percentage of weight loss (% WL*)*

The percentage change of usual weight or percentage of weight loss (% WL) is determined using the patient's usual and current weights, as per the following equation:

$$\%\ \text{WL} = \frac{\text{Usual Weight} - \text{Current Weight}}{\text{Usual Weight}} \times 100$$

The % WL highly reflects the extent of the disease. Patients with % WL values > 10% are classified as malnourished and above 10% severe malnutrition (Mahan; Escott-Stump, 2005).

2.4 Bioelectrical impedance analysis

Bioelectrical impedance analysis (BIA) is a non-invasive technique that can be used to estimate body composition. The method uses low amperage current (single or multiple frequencies) that passes between two electrodes placed on the skin under the assumption that the current resistance (impedance) ranges on an inversely proportional basis to the fluid contained in the tissues and the content of electrolytes. BIA has a good correlation with body composition made with the isotope dilution, under controlled conditions (O'Brien; Young; Sawka, 2002).
In ALS, due to the limitations and difficulties during nutritional assessment, BIA has been a good tool in nutritional diagnosis. It is an easy, non-invasive technique, where fat-free and fat mass are obtained, in addition to the estimation of the degree of hydration. In 2003, the equation for BIA was validated in patients with ALS through cross-sectional and longitudinal studies, which was optimized at 50 kHz (Desport et al., 2003).

2.5 Dual-emission X-ray absorptiometry (DEXA)

The dual-emission X-ray absorptiometry (DEXA) is an invasive method that has become a popular measure for the assessment of body composition in developed countries (Madsen; Jensen; Sorensen, 1997; Tothill et al., 1996; Snead; Birge; Kohrt, 1993). This method allows the structural assessment of body composition, dividing the body mass by three basic components: mineral- and fat-free soft tissue, bone mineral content and fat (Laskey, 1996).
Some studies show the use of such technique in ALS patients (Tadan et al., 1998; Nau et al., 1995; Kanda et al., 1994), however Desport et al. (2003) emphasizes the equipment is

very expensive, and the fact that the patient remains in a horizontal position with his/her arms extended along the body for more than 10 minutes can be a problem for subjects with ALS.

In a study conducted by Rio and Cawadias (2007), it was discussed the main techniques adopted by nutritionists of some centers for the treatment of ALS in Europe and Canada for nutritional assessment of ALS subjects. The researchers found only 22% of nutritionists had more than 4 years of experience in ALS. Amongst the most used nutritional assessment methods were weight, % WL, BMI and arm circumference, used by 100%, 96%, 83%, and 9% of the professionals, respectively. The bioelectrical impedance, validated by Desport et al. in 2003, as well as DEXA, were not reported by the professionals from the centers investigated by Rio and Cawadias.

Analyzing the measures adopted by the relevant literature, in ALS, as well as in other diseases, the use of parameters such as weight, % WL and BMI, as well as skinfolds, BIA, DEXA and indirect calorimetry can also be observed (Rio; Cawadias 2007; Desport et al., 2003; Desport et al., 2001; Silani; Kasarkis, Yanagisawa, 1998).

3. Dysphagia and ALS

With the clinical progression of ALS, manifestations such as dysarthria (speech impairment), dyspnoea (breathing alteration), dysphonia (voice alteration) and dysphagia (swallowing alteration) are common. These manifestations occur as a result of progressive respiratory muscle dysfunction, caused by motor neuron degeneration of corticobulbar tract (Chiappetta; Oda, 2004).

In 17 to 30% of ALS patients, bulbar muscles, especially the muscle groups of the velum and tongue are the first ones affected, resulting in progressive dysphagia, and therefore difficulty in swallowing food and liquids (Calia; Annes, 2003; Mitsumoto; Norris, 1994; Gubbay et al., 1985).

The oro-laryngo-pharyngeal weakness affects the survival of subjects with ALS, especially because of the continuous risk of aspiration pneumonia and sepsis, and the inadequate food intake, which can result in malnutrition (Karsarkis et al., 1996).

Malnutrition due to dysphagia, or other factors associated, such as muscle atrophy and diaphragm weakness, increases the relative risk of death almost eight times in ALS patients (Mitsumoto et al., 2003; Desport et al., 1999).

The involvement of the tongue muscles and lip orbicular muscles, upon ALS progression, triggers a decrease in pressure wave, pharyngeal peristalsis, and elevation and anteriorization of larynx, causing choking, even with saliva (Watts; Vanryckeghem, 2001; Strand et al., 1996).

In ALS, dysphagia for liquids is more common than for solids. The early escape, that is, when the food reaches the vallecula prior to initiation of pharyngeal swallowing, is more frequent with thin liquids and is the leading cause of tracheal aspiration. Pharyngeal residues are more commonly observed throughout the course of the disease. The pasty and solid consistencies may cause laryngeal penetration and tracheal aspiration after swallowing. Swallowing disorders occur due to the influence of oral transit, decreased movement of the tongue base, decreased elevation and anteriorization of the larynx and decreased pharyngeal contraction (Chiappetta; Oda, 2004; Logeman, 1998; Campbel; Enderby, 1984; apud Chiappetta, 2005).

In order to minimize respiratory and nutritional complications in the treatment of dysphagia, interdisciplinary assessment is extremely important, and the modification of the texture of foods is an alternative for the maintenance of the oral route.

3.1 Influence of viscosity

Food viscosity is one of the most important variables of swallowing. Thin liquids make difficult swallowing by patients with reduced laryngeal control, since they are quickly swallowed and do not maintain their shape inside the oral cavity, which can prematurely leak into the pharynx and, thus, penetrate the airways still open. To avoid such effect, the optimal viscosity must be determined so the swallowing may occur safety (Macedo & Furkim, 2000).

Viscosity influences many aspects of the assessment and management of dysphagia. It can be defined as the fluid resistance to the flow and is measured in Centipoise (ctps or cPs) (Silva et al, 2010).

There are different types of viscosity that can be easily achieved using commercial thickeners. These types can be classified in centipoise (cP) values (Table 1) as thin (1-50 cP), nectar (51-350 cP), honey (351-1750 cP) and pudding (> 1750 cP).

Classification	Viscosity (cP)
Thin	1-50
Nectar	51-350
Honey	351-1750
Pudding	> 1750

Source: ADA, 2002.

Table 2. Classification of viscosity, in centipoise (cP) values, according to the ADA (2002), for the nutritional care of subjects with dysphagia.

4. Nutritional therapy

Patients with symptoms of dysphagia limiting their intake of foods and liquids, hospitalized or at home, should be considered those at high risk of experiencing nutritional deficiencies and consequently should be treated.

Appropriate nutrition and hydration in patients with dysphagia are based on a complex balance between preparation, intake and absorption of foods and drinks (Steele & Lieshout, 2004).

When diagnosing the cause and severity of dysphagia, healthcare professionals can determine the texture of foods and the thickness of fluids for a safer swallowing by dysphagic patients, since the consistency of the diet should be individualized according to the type and extent of dysfunction. In case the recipe is not followed, the subject may face serious consequences for health (Silva et al, 2010; Macedo & Furquim, 2000).

Table 1 shows an example of a modified diet with restriction of "thin liquids" (1-50 cP) and solids for subjects with dysphagia and swallowing impairment.

Meal	Food	Ingredients (Servings)	Viscosity (cP)
Breakfast:	Dried milk porridge	Milk: 100 mL Dried Milk: 25 g	910
	Mashed banana	1 unit – 90 g	2.900
Snack:	Thickened papaya juice	Water: 30 mL Papaya: 170 g	870
Lunch:	Spaghetti and basil soup (liquefied)	Spaghetti (125 g), vegetable oil (2 tablespoons), onion (1 unit), mashed garlic cloves (2 units), nut (60 g), chicken bouillon (70 mL), fresh basil leaves (30 g), salt to taste, grated cheese (1 dessert spoon).	2.440
	Thickened orange juice	Orange juice: 200 mL Thickener: 10 g	320
Snack:	Juice of fruits (papaya, banana and apple)	Cold fluid milk (10º) (200 mL), papaya (100 g), banana (90 g), apple (50 g)	1.090
Dinner:	Vegetable broth	Water (2 L), turnips (2 units), carrots (2 units), garlic clove (1 unit), onion (1 unit), arracacha (1 unit), bunch of watercress (1 unit), basil (to taste), salt (to taste), and a drizzle of olive oil, raw large potato (1 unit) 100 g	4.680
	Lemon Mousse		8.000
Supper:	Maize porridge	Milk: 100 mL Maize bran: 25 g	840

* Adapted from Peres, Manzano and Silva (2007).

Table 3. Modified diet with restriction of "thin liquids" (1-50 cP) and "solids" for subjects with dysphagia and swallowing impairment. Features: Soft, wet and liquefied foods. Liquid foods are all thickened. The example menu contains approximately 2,000 kilocalories.

Changes in viscosity of foods and fluids can be achieved with the help of commercial thickeners. The choice of thickening agent is critical to achieve a homogeneous and lasting consistency. The thickeners should interfere as little as possible with the sensory properties of liquids (Silva et al, 2010)

Several agents can be used as food thickeners. Such thickeners are mostly composed of polysaccharides (carbohydrates), such as gums and starches, in addition to pectins and cellulose derivatives. Among them, the modified starch is one of the most used, since the starch physically or chemically treated improves the properties of thickening, cohesion, stability, gelatinization, luster and taste of the natural starch. In addition, they can also maximize the nutritional and water intake, facilitating a wide variety of textures (Silva & Ikeda, 2009). Therefore, these modified starch-containing thickeners can be used to prevent dehydration of subjects with dysphagia (Ada, 2002). However, the commercial thickeners are very expensive (approximately R$ 40.00 BRL/200 g), which limits the purchase and adjustment of the correct consistency.

It is known that the intake may be maximized by adjusting the consistency of foods through simple and low-cost techniques, without using commercial thickeners that are very expensive (Silva & Ikeda, 2009; Whelan, 2001). Thickening of foods by using the own foods in several preparations so as to adjust the correct consistency is still unknown by many patients, caregivers and healthcare professionals, limiting the food intake, resulting in high rates of malnutrition, dehydration and pulmonary aspiration, and increasing the risk of death[32]. These techniques are designed for this population, especially regarding the amount of food in household measures necessary to achieve optimal viscosity, according to the ADA standard (Silva et al., 2006a).

In 2006, researches were conducted in order to develop a guide with recent literature survey, standardized preparations for patients with dysphagia, viscosities adjusted according to the ADA, chemical composition and photographic record for healthcare professionals, caregivers and patients with dysphagia, for a safe dietary intake (Silva et al., 2006b). Studies like this are still scarce for this population.

The poor knowledge of the fundamental physical characteristics of the consistency of the preparations is considered a limiting factor to adjust the viscosity, which does not ensure a safe intake. Figure 1 shows a photographic representation of a preparation of heart of palm cream with the consistency of pudding. Its main characteristic is the formation of a heavy cake, in which there is low adherence on the spoon surface, forming no continuous filaments.

Fig. 1. Photographic representation of a preparation (heart of palm cream) with pudding consistency. pH = 3.73; viscosity = 2000 cP; amount of water for dilution = 0 mL

Figure 2 shows a photographic representation of the same preparation with the consistency of honey, in which there is a formation of continuous filament with the base of the spoon forming a characteristic "V".

Fig. 2. Photographic representation of a preparation (heart of palm cream) with honey consistency. pH = 3.69; viscosity = 1080 cP; amount of water for dilution in 100 mL of the recipe with pudding viscosity = 14.23 mL

In the photographic representation of the nectar consistency (Figure 3), there is a formation of continuous filament thinner than the previous one, without a characteristic "V" at the base of the spoon.

Fig. 3. Photographic representation of a preparation (heart of palm cream) with nectar consistency. pH = 3.71; viscosity = 240 cP; amount of water for dilution in 100 mL of the recipe with pudding viscosity = 42.88 mL

Figure 4 shows a photographic representation of the thin consistency of the same preparation; as the name implies, there is no formation of continuous filament, but only drops that fall from the spoon.

These alternatives are considered simple, low-cost and safe, and are extremely important to ensure a better quality of life for patients without dysphagia, without limiting the need for commercial thickeners, but guidelines concerning how to follow a correct preparation are still necessary. Currently, there are discussions on the improvement of the quality of

life and reduction of potential complications, through education/health promotion programs, including specialized procedures and orientation programs for caregivers (Santoro, 2008)

Fig. 4. Photographic representation of a preparation (heart of palm cream) with thin consistency. pH = 5.36; viscosity = 46 cP; amount of water for dilution in 100 mL of the recipe with pudding viscosity = 107.14 mL

Periodic and appropriate reassessments of the swallowing condition are critical aspects for the prevention/recovery from malnutrition. One study assessed the adequacy of the diet of elderlies admitted to nursing homes, where 91% of the patients had diets with a consistency below what they could tolerate safely. Both the nutritional status and the quality of life may be affected when patients are maintained on diets with inappropriate viscosity (Souza et al., 2003)

Patients with dysphagia may experience satiety quickly when they are given an extremely concentrated meal. Instead of providing three meals a day, these patients should receive smaller and more frequent portions (Silva et al., 2003). Of note, for patients with dysphagia, difficulty in performing the swallowing movements worsens when they are most tired. This is especially important for patients with diseases like Parkinson's, for which the medication effect can be reduced during the day, further reducing the patient's ability to swallow (Sachdev, 2005). The correct positioning of the patient may be of great help during meals, but it is important to follow the instructions of a speech therapist & audiologist.

If there is a high risk of aspiration or oral intake is insufficient to maintain the good nutritional status, the possibility of an alternative nutritional support must be considered. A soft and well tolerable tube can be inserted and radiologically guided. Percutaneous endoscopic gastrostomy is performed by inserting a gastrostomy tube into the stomach through a percutaneous abdominal route guided by the endoscopist and, if available, surgical gastrostomy is preferable (Ickenstein, 2003; Nguyen et al., 2006).

Therefore, the guidance on an individualized diet, precautions on the risk of aspiration, and appropriate choice regarding the route of access for feeding, help to prevent malnutrition in patients with dysphagia, where the care of a multidisciplinary team is required for the patient's welfare, as well as for a better quality of life. Nonetheless, the absence of detailed descriptions on the procedures for nutritional therapy makes unfeasible their efficient replication (Nguyen et al., 2006).

4.1 Nutritional support

Nutritional support may delay the weight loss and muscle atrophy. Researchers have shown the weight loss associated with bulbar changes (dysphagia and breathing) require early and specific nutritional support (Kasarskis *et al*., 1996; Slowie *et al*., 1983).

Constant muscle atrophy, characteristic of progressive diseases, may mask the increased metabolic demand. The increased baseline energy expenditure of patients with ALS occurs since the energies are focused on the maintenance of pulmonary ventilation (Stanich *et al*., 2004; Kasarskis *et al*., 1996; Nau *et al*., 1995; Shimizu; Hayashi; Tanabe, 1991).

In a study of ALS patients, under the oral nutritional supplementation program, there was a progressive decrease in body mass index (BMI) in patients with progressive bulbar palsy and preservation of such variables in ALS patients. The lean mass/fat mass ratio was maintained during the study for both groups. The nutritional status classification has not changed for 70% of the patients. The results showed that supplementation prevented the worsening of nutritional status, but was unable to correct the overall averages of adequacy (Stanich et al., 2004).

In clinical practice, the use of supplements of vitamins, especially vitamin E, is common. The supplementation of this vitamin, with quantity still not defined, is expected to improve the nutritional profile of subjects with ALS (Borasio; Voltz, 1997). Oral supplementation with creatine monohydrate at 3g/day showed no improvement of nutritional status in ALS. However, the energy and protein supplementation is used by many professionals, and has proven to be efficient in the nutritional status of subjects with ALS (Rio; Cawadias, 2007; Heffernan et al., 2004).

Silva et al., (2010) evaluated the efficacy of oral supplementation with milk whey proteins and modified starch (70%WPI:30%MS), on nutritional and functional parameters of patients with ALS. Sixteen patients were randomized to two groups, treatment (70%WPI:30%MS) and control (maltodextrin). They underwent prospective nutritional, respiratory and functional assessment for 4 months. Patients in the treatment group presented weight gain, increased BMI, increased arm muscle area and circumference, higher albumin, white blood cell and total lymphocyte counts, and reduced creatine-kinase, aspartate aminotransferase and alanine aminotransferase. In the control group, biochemical measures did not change, but weight and BMI declined. The results indicate that the agglomerate 70%WPI:30%MS may be useful in the nutritional therapy of patients with ALS.

4.2 Alternative feeding in ALS

Different authors report the need for alternative routes of nutrition from the following criteria: vital capacity of approximately 50% of the expected value, presence of moderate to severe dysphagia and 10% reduction in body weight over the past three months. (Stanich *et al*., 2004; Mitsumoto *et al*., 2003; Albert *et al*., 2001; Silani; Kasarskis; Yanagisawa, 1998; Lisbeth et al., 1994).

Percutaneous endoscopic gastrostomy (PEG) is an option for the symptomatic treatment of patients with ALS (Miller et al., 1999).

When comparing the use of enteral nutrition via nasogastric tube and percutaneous endoscopic gastrostomy (PEG) in patients with ALS, there is a significant difference in the body mass index (BMI) of patients with PEG compared to those with a nasogastric tube, as well as a better social acceptance and, consequently, quality of life of the patients studied, supporting the use of this technique when oral intake is not safe (Mazzini et al., 1995).

5. Conclusions

This chapter was conducted to support the hypothesis of the thesis and gathers scientific information listing the main practices for assessment, from the nutritional point of view, in patients with ALS. The relevant literature available for consultation is limited. Studies on food intake, specific techniques for assessment of nutritional status, and the use of supplements are scarce. However, the follow-up of nutritional status by monitoring the anthropometric evolution, body composition and clinical signs, such as dysphagia, may improve the quality of life of subjects with ALS.

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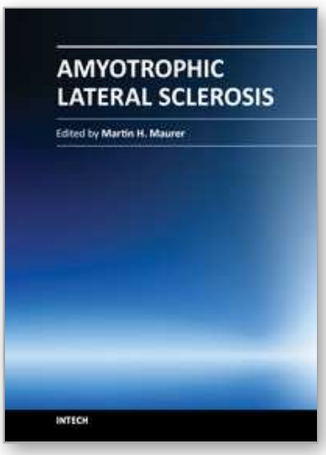

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Though considerable amount of research, both pre-clinical and clinical, has been conducted during recent years, Amyotrophic Lateral Sclerosis (ALS) remains one of the mysterious diseases of the 21st century. Great efforts have been made to develop pathophysiological models and to clarify the underlying pathology, and with novel instruments in genetics and transgenic techniques, the aim for finding a durable cure comes into scope. On the other hand, most pharmacological trials failed to show a benefit for ALS patients. In this book, the reader will find a compilation of state-of-the-art reviews about the etiology, epidemiology, and pathophysiology of ALS, the molecular basis of disease progression and clinical manifestations, the genetics familial ALS, as well as novel diagnostic criteria in the field of electrophysiology. An overview over all relevant pharmacological trials in ALS patients is also included, while the book concludes with a discussion on current advances and future trends in ALS research.

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