



Taste changes in amyotrophic lateral sclerosis and effects on quality of life

Claudia Tarlarini¹ · Lucia Catherine Greco¹ · Andrea Lizio¹ · Francesca Gerardi¹ · Valeria Ada Sansone^{1,2} · Christian Lunetta¹

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Abstract

The primary aim of the study is to evaluate possible taste changes in a cohort of amyotrophic lateral sclerosis patients (pALS) with dysphagia, focusing on eventual psychological and quality of life (QoL) implications. The second aim is to evaluate the changes of QoL following the use of a specific device that provides food flavour. Thirty-two ALS patients were recruited and divided into two groups: subjects feeding only through enteral tube (ET) and subjects still eating by oral way (OW). A specific set of questionnaires was selected and adapted to investigate possible changes of taste and the impact on psychological status and QoL. Moreover, a specific device that provides food flavours in a safety manner was applied to all patients. We found a perceived reduction of taste in ALS patients, in particular in the ET group. All patients showed a strong interest in the preservation of taste, and its loss negatively related to their QoL. The use of the flavour device improved the perceived QoL showing no side effects, even in the ET group. For the first time, our study revealed changes in taste perception in a cohort of ALS patients and the negative consequences that these changes have on psychological status and QoL. Furthermore, the positive effects of the device used to provide flavours suggest a possible rehabilitative effect, which should be better evaluated and confirmed in further studies.

Keywords Amyotrophic lateral sclerosis · Dysphagia · Enteral feeding · Quality of life · Taste loss

Introduction

Amyotrophic lateral sclerosis (ALS) is a rare neurodegenerative disease involving motor neurons and characterised by relentless and diffuse paralysis, usually leading to death by respiratory failure in 3 to 5 years [1, 2].

ALS is often considered as a disease of losses that leads to severe dependency in the final stages. One of the most invalidating symptoms faced by the majority of patients with ALS (pALS) is dysphagia, also defined as an impairment of swallowing that disrupts the ability to take food or liquids safely and efficiently [3–5]. Nevertheless, dysphagia can be a cardinal symptom in many other diseases, highly affecting quality of life

(QoL). Indeed, among the general population, prevalence varies between 2.3% and 16% [6–12].

When dysphagia becomes severe, enteral nutrition (ET), a tube placed into the stomach to deliver formulas containing all essentials nutrients, is usually offered to patients because it may provide a safe and reliable route for nutrition [4, 13, 14].

One common negative feeling of patients receiving a dysphagia diet is that the food does not taste right. This aspect is even more problematic in patients receiving only ET, with reasonable consequences on psychological status.

The physical and psychological sensations of a good meal are arguably just as important as its nutritional content [15] and thus may have important consequences on patients' QoL. Indeed, among the many losses related to ALS, dysphagia may become deeply personal: this impairment can devastate the person's role and emotional balance in his/her own family and environment. Furthermore, the presence of dysphagia may not only mean that the person will not be able to feed orally but also cause a loss in taste perception.

Taste perception has shown to affect about 1% of the general population [16], although up to now no studies have explored the impact of this problem in an ALS population.

✉ Claudia Tarlarini
claudia.tarlarini@centroclinicinemo.it

¹ Neuromuscular Omnicentre (NEMO)-Fondazione Serena Onlus, Piazza Ospedale Maggiore, 3, 20162 Milan, Italy

² Neurorehabilitation Unit, Department of Biomedical Sciences for Health, University of Milan, Milan, Italy

The primary aim of the study is to evaluate whether taste perception changes in a cohort of pALS with dysphagia, focusing on eventual psychological and quality of life (QoL) implications. The second aim is to evaluate the changes of the QoL secondary to the use of a specific device that provides food flavours.

Materials and methods

Thirty-two subjects with ALS attending inpatients and outpatient facility at NEMO (NEuroMuscular Omnicenter) were recruited between July and December 2017. For each patient, a clinical assessment that included physical and neurological examination was conducted at baseline. All of the patients who did not display dysphagia, expressed as a score of 4 (as normal) on the sub-item for swallowing in the ALS Functional Rating Scale-Revised (ALSFRRS-R) [17], were excluded from the study. According to the route used in the nutrition, our sample was divided into two subgroups: patients feeding through ET and patients following a specific diet by oral way (OW).

A specific set of questionnaires was selected and adapted to investigate the impact of taste changes on the psychological status and on the QoL.

Subsequently, a specific device that provides selected flavours of natural meals obtained by molecular *cuisine* was created and used for this study. This device, previously tested in healthy volunteers, allows to perceive in a safety manner flavours without the need to swallow.

The device, containing the flavours chosen by each patient, was applied for 20 s on the tongue. Before and at the end of the test, each subject underwent the set of questions and questionnaires previously selected.

To ensure an objective evaluation of the effects of the patients' experience with the device, the neurologist, responsible of the flavour administration, was unaware of the answers given during the interviews before and after the test, and the psychologist administering the questionnaires was unaware of the patients' reactions to the device. The set of questionnaires included four sections, described as follows. Section 1 included a set of visual-analogue scales (VAS) to evaluate the degree of interest of pALS in the perception of flavours (score 0 corresponded to 'little' and 100 corresponded to 'a lot') and the degree of interest of ET patients in food and flavours (score 0 corresponded to 'little' and 100 corresponded to 'a lot'); we also evaluated the presence of excessive salivation (score 0 corresponded to 'little' and 100 corresponded to 'a lot') and/or gastric pyrosis (score 0 corresponded to 'not at all' and 100 corresponded to 'extremely').

Section 2 focused on the detection of taste and smell changes in pALS, through the use of a questionnaire on

chemosenses that measured the eventual loss or alteration of either taste, smell or both. This questionnaire was obtained starting from the 'Chemosensory Complaint Score' [18] that was translated in Italian and readapted for pALS. Particular attention was given to the answers at the first and second questions ('Did you notice any changes in your taste perception?'; 'Did you notice any changes in your smell perception?').

Section 3 evaluated the impact of dysphagia on the QoL of pALS, through the use of a questionnaire on QoL obtained from the already existing 'University of Washington Quality of Life Questionnaire-4' [19, 20] that was translated and readapted. In particular, the questionnaire investigated the importance of 11 different aspects on the QoL and was divided into two parts: the first one included the composite score of the two subscales 'Physical Function' (that included chewing, swallowing, speech, taste, saliva, appearance) and 'Social-Emotional Function' (that included anxiety, mood, pain, activity, recreation) with the score ranging from 0 (worst possible score) to 100 (best possible score); the second part included a single question that investigated the three most 'significant problems', as reported by patients [19, 20].

Finally, in section 4, a VAS was used in order to evaluate the ability to identify the chosen flavours presented through the device (0 corresponded to 'different' and 100 corresponded to 'identical') and the degree of pleasantness (0 corresponded to 'unpleasant' and 100 corresponded to 'pleasant'). The two additional questions on excessive salivation and gastric pyrosis were re-administered to evaluate possible side effects consequent to the device application. To better interpret our results, answers on the VAS for this section were arbitrarily divided into four classes: from 0 to 25, from 26 to 50, from 51 to 75 and from 76 to 100.

Statistical analyses

Statistical analyses were performed choosing a priori the questions to consider given the aim of our study. Data was described as appropriate by mean and standard deviation, median and interquartile range, number and percentage.

Descriptive analyses were performed through frequency analysis, in detail studying the frequency distribution using both numbers and percentages, and the central tendency of distribution, using mean and median as appropriate.

For each variable, the Shapiro-Wilk test was used to evaluate the normality of the distribution and Levene test to evaluate the homogeneity of variance.

Inferential analyses were made using Fisher exact test and Wilcoxon rank sum test as appropriate.

A p value < 0.05 was considered statistically significant.

Analyses were conducted using SAS 9.3 software.

Results

Table 1 shows demographic and clinical characteristics of patients involved in the current study.

The analyses of section 1 showed that food perception is an important issue in our patients, as demonstrated by the answers at the question ‘How much is flavour perception important for you?’: 24 out of 32 patients (75%) reported a score equal or higher than 75.

In addition, in the supplementary questions on food and flavour perception in the ET group, high scores in the majority of patients emerged, showing mean scores equal to 91.77 for food perception and equal to 87.92 for flavour perception.

Regarding section 2, it emerged that patients feeding through ET had a more severe loss in taste perception. In specific, 8 out of 11 patients (73%) with ET reported a significant loss in taste perception in comparison to the 21 patients still eating, of which only 5 (24%) stated changes.

In section 3, results on the total sample showed that the most compromising aspects on QoL were appearance, swallowing and speech, thus more than 50% of patients considered them as significant problems. Indeed, there was a significant difference in the perception of swallowing, speech, taste and chewing between patients feeding through ET and the rest of them. In particular, all of the patients feeding through ET (100%) considered swallowing as an important issue negatively influencing their QoL, while only 29% of patients still eating reported it as a problem, giving more importance to other aspects such as appearance (76%) and recreational activities (52%). In general, the composite score for the subscale ‘Physical Function’ was significantly lower in patients with ET (27.35 ± 16.26) in comparison to the rest of the sample (60.83 ± 23.08); the composite score of ‘Social-Emotional Function’ was instead similar in the two subgroups (59.54 ± 20.19 ; 57.86 ± 18.12).

Table 2 reports specific results for section 2 and section 3.

In section 4, results showed that in general all of the patients appreciated the device providing flavours, thus no significant difference was identified between the two subgroups except for two items (Table 3). In detail, patients feeding through ET considered the essences as more pleasant; indeed, more than the 80% of answers ranged from 76 to 100 for each question. Even the remaining patients gave answers that ranged mainly from 76 to 100, although these were more homogeneous among the four classes and the percentage in the interval 76–100 was lower (between 46% and 76%). Regarding the similarity to essences, there were less answers that ranged from 76 to 100 in both subgroups even though this was the interval with more responders; results were in general more uniformed along the four classes and in four out of five questions patients with ET scored higher.

No significant difference emerged between before and after the device application in the patients’ salivation and gastric pyrosis. In general, all of the patients reported mild levels of saliva both pre and post test (50.95 ± 33.21 ; 56.32 ± 29.37 respectively; $p = 0.6218$) and an absence of gastric pyrosis (6.00 ± 12.94 ; 4.45 ± 8.53 ; $p = 0.8557$).

Discussion

Our results highlighted the strong interest of pALS in the preservation of taste perception. Indeed, taste loss is perceived negatively as debilitating and, as the disease progresses, it becomes more and more important in influencing the patients’ QoL. Dysphagia deeply affects personal life, impairing and devastating the person’s role and emotional balance in his/her own family and environment [21]. Our study has also shown that taste loss is a common feature in ALS patients, even in those with dysphagia without ET. A recent study [16] reported that the prevalence of taste problems in the general

Table 1 Demographic and clinical characteristics of our sample

| | Total sample ($n = 31$) | Patients with ET ($n = 10$) | Patients without ET ($n = 21$) | <i>p</i> value |
|--|---------------------------|-------------------------------|----------------------------------|----------------|
| Age; years, mean \pm std | 62.77 ± 11.39 | 60.23 ± 10.60 | 63.97 ± 11.80 | 0.3207 |
| Gender; male/female, n (%) | 19/13 | 6/4 | 13/8 | 0.9188 |
| Site of onset; bulbar, n (%) | 7 (22.58) | 2 (20.00) | 5 (23.81) | 0.5778 |
| Disease Duration [§] ; months, mean \pm std | 58.97 ± 41.88 | 76.26 ± 44.89 | 50.73 ± 38.78 | 0.0725 |
| Alsfrs-r total, mean \pm std | 16.00 ± 12.17 | 4.00 ± 2.36 | 22.32 ± 10.28 | < 0.0001* |
| Alsfrs-r bulbar, mean \pm std | 5.42 ± 3.36 | 2.90 ± 2.02 | 6.62 ± 3.23 | 0.0033* |
| NIV; yes (%), n (%) | 21 (67.74) | 9 (90.00) | 11 (52.38) | 0.0134* |
| Tracheo; yes (%), n (%) | 9 (29.03) | 6 (60.00) | 2 (9.52) | 0.0059* |

ET enteral tube, Alsfrs-r Amyotrophic Lateral Sclerosis Functional Rating Scale-Revised, NIV non-invasive ventilation

[§] Time from onset to evaluation

*Significant *p* value

Table 2 Answers to specific questions of sections 2 and 3

| | Patients with ET | Patients without ET | <i>p</i> value |
|---------------------------------------|------------------|---------------------|----------------|
| Section 2—chemosensory complaint | <i>n</i> = 8 | <i>n</i> = 9 | |
| Loss in taste perception (%) | 72.73 | 23.81 | – [§] |
| Section 3—UoW QoL questionnaire | <i>n</i> = 11 | <i>n</i> = 21 | |
| Pain (%) | 9.09 | 9.52 | 0.9787 |
| Swallowing (%) | 100.00 | 28.57 | < 0.0001* |
| Speech (%) | 90.91 | 42.86 | 0.0109* |
| Taste (%) | 54.55 | 4.76 | 0.0030* |
| Chewing (%) | 90.91 | 9.52 | < 0.0001* |
| Appearance (%) | 54.55 | 76.19 | 0.2515 |
| Activity (%) | 36.36 | 47.62 | 0.7120 |
| Recreation (%) | 45.45 | 52.38 | 0.7897 |
| Saliva (%) | 18.18 | 4.76 | 0.2661 |
| Mood (%) | 36.36 | 38.10 | 0.9981 |
| Anxiety (%) | 45.45 | 28.57 | 0.4424 |
| Physical function, mean ± std | 27.35 ± 16.26 | 60.83 ± 23.08 | < 0.0001* |
| Social-emotional function, mean ± std | 59.54 ± 33.25 | 57.86 ± 30.91 | 0.7497 |

ET enteral tube, UoW University of Washington, QoL quality of life

*Significant *p* value

[§] *p* value not calculated due to small sample size

population is 0.93% and it increases with age, with the highest prevalence among adults over 65 years old.

According to literature, the most common causes of taste changes are drug use, zinc deficiency and oral and systemic diseases [16]. Among the systemic disorders, of particular interest are those that affect the central nervous system (CNS); evidence of taste changes has been shown in disorders such as stroke [22, 23], mild cognitive impairment, Alzheimer's disease [24], Parkinson disease [25] and major depression [26]. Conversely, no study has been conducted on taste perception changes in ALS.

For the first time, our study emphasises the weight of taste loss in pALS. During the past years, dysphagia has been analysed in terms of social and psychological consequences [21, 27], although the focus was the effect of dehydration,

malnutrition and respiratory infection on QoL and no space was given to taste changes during the disease course. Taste loss has been considered in elderly populations [28] presenting dysphagia but not specifically in ALS. Some studies considered changes in QoL after enteral nutrition [29, 30], but changes in taste were not reported.

Additionally, our study evaluated a possible solution to this problem through the use of a device containing food flavours. We demonstrated that the device was perceived not only as pleasant and similar to expectations, but also as safe; indeed, no side effects during the use of the device or in the following hours were reported, not even in patients with severe dysphagia and/or with a long history of compromised swallowing.

Alteration or loss of taste may change the perception of food in the mouth. The relationship between food intake and

Table 3 Overview of all of the answers to section 4, comparing the two subgroups

| | Similarity | | | Pleasantness | | |
|-----------------------|--|---|----------------|--|---|----------------|
| | Patients with ET (<i>n</i> = 11) Median [Q1–Q3] | Patients without ET (<i>n</i> = 21) Median [Q1–Q3] | <i>p</i> value | Patients with ET (<i>n</i> = 11) Median [Q1–Q3] | Patients without ET (<i>n</i> = 21) Median [Q1–Q3] | <i>p</i> value |
| Flavour of meal no. 1 | 90 [69.8–92.4] | 53 [48.6–66.8] | 0.0146* | 90 [90–100] | 70 [66.8–84.8] | 0.0555 |
| Flavour of meal no. 2 | 90 [66.7–98] | 80 [70–83.2] | 0.3699 | 100 [83.9–100] | 82 [69.6–91.4] | 0.2622 |
| Flavour of meal no. 3 | 86.5 [79.49–99.58] | 80 [65.4–83.6] | 0.1952 | 100 [91.94–100] | 83 [71.2–86.6] | 0.0116* |
| Flavour of meal no. 4 | 83 [75.1–96] | 92 [80.8–98.4] | 0.7154 | 100 [83–100] | 88 [83.8–100] | 0.5070 |
| Flavour of beverage | 80 [69.55–89.4] | 57 [41.64–76.68] | 0.1808 | 90 [80–91.88] | 65 [58.29–86.48] | 0.1400 |

ET enteral tube

*Significant *p* value

taste is complex and intriguing, with implications not only for nutritional status but also for psychosocial wellness, both areas of our interest. Indeed, on the one hand, the presence of food in the mouth initiates both mechanical and chemical stimuli via neural reflexes [31]; thus, an impairment in initial stages of digestion may compromise the gastrointestinal (GI) functions. On the other hand, in our clinical experience, one common complaint by patients receiving a dysphagia diet is that the food does not taste right. This may be due to the fact that increased viscosity decreases flavour and pureed food eliminates the need to chew, which breaks down food textures and increases the availability of flavour. However, it may also not taste right because of changes in the patient's own sensory system. Therefore, taste loss has a double importance: it may have consequences on GI functions, and it may play a key role in worsening the QoL of pALS, both investigated in the current study. Additionally, a possible solution to these problems may be a long-term use of our device: a constant stimulation of taste buds could avoid taste loss over time and could maintain active the digestive processes, preventing the appearance of GI dysfunctions. Taking into account our preliminary results, our belief is that the prevention of these manifestations and the preservation of taste perception may strongly impact, in a positive way, the patients' QoL.

However, this study presents some limits. First of all, further longitudinal studies should be conducted to confirm the long-term safety and efficacy of the device, in order to better observe changes in the patients' QoL and in GI functions. Secondly, this is a first observational study that presents some methodological limitations such as the absence of a group control or of a controlled setting. However, our wish is to be able to conduct a controlled study in order to confirm our conclusions and to do further investigation on pALS during their natural history of dysphagia.

In conclusion, to the best of our knowledge, for the first time this study sheds light on taste perception and its changes in pALS with moderate and severe dysphagia. Moreover, the use of a specific device that reproduces original food flavour, with a high level of fidelity, showed to have a good impact on QoL of pALS without significant side effects related to its use. Moreover, taking into account that dysphagia is a common feature of many diseases, our wish is that this study may draw attention on the importance of the evaluation of taste changes also in other diseases.

Compliance with ethical standards

All subjects or their caregivers gave written informed consent to the procedures previously approved by our medical ethical committees.

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