Research Article

Dysarthria and Dysphagia in Traumatic Spinal Cord Injury: Frequency and Comorbidity in a Cross-Sectional Study

Saeed Sheykh Chalandari, Morteza Farazi*, Zahra Sadeghi, Mehdi Norouzi

Department of Speech Therapy, School of Rehabilitation Sciences, University of Social Welfare and Rehabilitation Sciences, Tehran, Iran

* **Corresponding author:** Dr. Morteza Farazi,
Department of Speech Therapy, School of Rehabilitation Sciences, University of Social Welfare and Rehabilitation Sciences, Tehran, Iran
Email: mfarazi@gmail.com
Tel: +989121405628

ORCID ID:
Saeed Sheykh Chalandari: 0000-0003-3697-0351
Morteza Farazi: 0000-0003-3733-1738
Zahra Sadeghi: 0000-0003-3966-4720
Mehdi Norouzi: 0000-0003-3966-4720

Article Info:
Received: 1 Jan 2025
Accepted: 21 Apr 2025

Citation: Sheykh Chalandari S, Farazi M, Sadeghi Z, Norouzi M. Dysarthria and Dysphagia in Traumatic Spinal Cord Injury: Frequency and Comorbidity in a Cross-Sectional Study. Journal of Modern Rehabilitation. 2025;19(3):?-?

Running title: Dysarthria and dysphagia in traumatic spinal cord injury

Abstract

Objective: To determine the frequency, comorbidity, and relationship between dysarthria and dysphagia in patients with tSCI.

Methods: A descriptive-analytical cross-sectional study was conducted, enrolling 61 patients with tSCI from rehabilitation centers in Tehran, Iran, between January and September 2024. Dysarthria and dysphagia were assessed using the Persian-adapted versions of the Frenchay Dysarthria Assessment (FDA) and the Northwestern Dysphagia Patient Check Sheet (NDPCS), respectively. Logistic regression analysis was employed to evaluate the association between these conditions, with odds ratios (ORs) calculated to quantify the strength of the relationship.

Results: Dysarthria was observed in 87% of participants, with mixed dysarthria being the most prevalent subtype (34%). Dysphagia was identified in 49% of participants, of whom 49% exhibited both disorders concurrently. Logistic regression analysis indicated that patients with dysarthria were approximately nine times more likely to experience dysphagia (OR = 9.69, $p < 0.05$), even after adjustments for weight and gender.

Conclusion: This study underscores the high prevalence and significant comorbidity of dysarthria and dysphagia in patients with tSCI, with dysarthria identified as a robust predictor of dysphagia. These findings highlight the necessity of concurrent assessment and integrated rehabilitation approaches targeting both disorders to improve patient outcomes and quality of life.
Keywords: Traumatic spinal cord injury, Dysarthria, Dysphagia, Comorbidity, Rehabilitation

Introduction

Spinal cord injury (SCI) is a severe and acute medical condition characterized by disruptions in sensory, motor, and autonomic functions (1). The prevalence of SCI is estimated at 906 cases per million in the United States and 681 cases per million in Australia and New Zealand (2, 3)

SCIs are categorized into two types based on their causes: traumatic spinal cord injuries (tSCIs) and non-traumatic spinal cord injuries (ntSCIs). Non-traumatic SCIs result from congenital abnormalities, genetic predispositions, acquired conditions, or other medical factors. Conversely, traumatic SCIs occur due to sudden and severe impacts on the spinal cord, typically caused by external trauma. The most common cause of tSCIs is motor vehicle accidents.

Both tSCIs and ntSCIs often result in similar complications. Respiratory complications are the primary cause of mortality during both the acute and chronic phases of SCI (4, 5). Additional complications include cardiovascular dysfunction, urinary and gastrointestinal issues, neurological bladder dysfunction, chronic pain, pressure ulcers, and osteoporosis (6-9)

In addition to these complications, dysarthria and dysphagia are commonly observed in SCI patients. Previous studies have shown that cervical spinal cord injury can lead to respiratory and bulbar dysfunctions, which are closely linked to speech and swallowing disorders. Dysphagia and dysarthria have been reported in patients with acute cervical spinal cord injuries (10-12). Dysarthria is a motor speech disorder caused by damage to the muscles or nerves responsible for speech production(13). This condition affects the physical aspects of speech, resulting in unintelligible, slow, or weak speech (14, 15). Similarly, dysphagia is prevalent in this group and is characterized by difficulty swallowing, affecting the passage of food, liquids, or saliva from the mouth to the stomach(10). Patients with dysphagia often exhibit disrupted reflexive oropharyngeal swallowing mechanisms, which increases the risk of aspiration, potentially leading to pneumonia and, in severe cases, death (11, 12)

Dysarthria and dysphagia are prevalent in conditions and injuries affecting the central nervous system. However, the relationship between these two disorders has not been thoroughly investigated. Research exploring this relationship suggests that dysarthria is a significant predictor of the onset and progression of dysphagia.

The comorbidity of these disorders has been reported at varying rates across different studies. For example, the co-occurrence of dysarthria and dysphagia in stroke patients was reported as 31% in the study by Ghoreyshi et al.(16), 19% in Stipancic et al.(17), and 7% in the study by Lieuw et al. (18).

Additionally, a study found that dysphagia was associated with flaccid, spastic, and mixed forms of dysarthria (19). The severity of the relationship between dysarthria and dysphagia was highlighted in the study by Otapowicz et al., which concluded that the most severe forms of dysarthria were strongly correlated with dysphagia (20).

The relationship between dysarthria and dysphagia, as well as their comorbidity rates, has primarily been studied in patients with conditions such as Parkinson's disease, multiple sclerosis, myasthenia gravis, cerebral palsy, stroke, dementia, and traumatic brain injury. However, there is limited research focusing on patients with tSCI. This is particularly significant, as spinal cord

injuries, especially in the cervical region, can impair motor and sensory functions related to speech and swallowing.
This study aims to provide insights into the prevalence, comorbidity, and relationship between dysarthria and dysphagia in patients with tSCI.

Material and methods

Participants

This descriptive-analytical cross-sectional study included 61 patients with traumatic spinal cord injury (tSCI) from January 2024 to September 2024. Participants were selected through simple random sampling from patients referred to rehabilitation centers in the city of Tehran. Inclusion criteria required participants to have a neurologist-confirmed diagnosis of traumatic spinal cord injury, be over 18 years of age, have a medically stable condition, and be at least 3 months post-injury to ensure stabilization of neurological and functional symptoms. Exclusion criteria included individuals with a history of swallowing or speech disorders prior to the injury, those who had undergone nasal or oral intubation, individuals with cognitive impairments that prevented them from following instructions, and participants with a history or diagnosis of traumatic brain injury (TBI), based on neurologist-confirmed medical records.
Cognitive status was assessed using the Persian version of the Mini-Mental State Examination (MMSE), which has been validated for Persian-speaking populations (21). Individuals scoring below 24 out of 30, indicating potential cognitive impairment, were excluded from the study.
Additionally, since this was a cross-sectional study, withdrawal was only applicable prior to or during the assessment session. Any participant who declined to continue, was unwilling to complete the full assessment, or expressed discomfort with the procedures was excluded from further data collection
The study protocol was approved by the Ethics Committee of the University of Social Welfare and Rehabilitation Sciences. Informed consent was obtained from each participant or their first-degree family member if the inclusion criteria were met.

Sample size

In the present study, the sample size was calculated based on the prevalence of dysphagia using the following formula:
$(Z_{(1-a/2)}{}^2 * P(1-P))/d^2$
Considering a prevalence of 7% for dysphagia in patients with SCI, as reported by Hayashi et al.(22), assuming a Type I error rate of 0.05, and a precision (d) of 0.05, the sample size was estimated to be 55 participants, excluding dropouts. To account for a 10% dropout rate, the final sample size for this cross-sectional study was calculated to be 61 participants.

Procedure

In this study, baseline information was collected, including age, gender, time since the injury, and level of injury. Following this, the presence of dysarthria and dysphagia in eligible participants was assessed. Dysarthria was evaluated using the Frenchay Dysarthria Assessment (FDA), while dysphagia was assessed with the Northwestern Dysphagia Patient Check Sheet (NDPCS). The evaluator conducting these assessments was thoroughly trained in administering the FDA and completing the NDPCS.
The Persian version of the FDA was used to diagnose dysarthria by evaluating various aspects of speech affected by the condition, including articulation, voice, intonation, and prosody. This

assessment covered reflexes (3 tasks), respiration (2 tasks), lips (5 tasks), palate (3 tasks), larynx (4 tasks), tongue (6 tasks), and speech intelligibility (3 tasks)(23). Based on the test results, the severity and type of dysarthria—including flaccid, spastic, ataxic, extrapyramidal, and mixed—were identified. The test duration was approximately 30 minutes.
For dysphagia evaluation, the Persian version of the NDPCS was used(24). It consists of five main sections: medical history, behavioral assessment, overall motor function, oromotor assessment, and swallowing assessment. The tool includes 28 items, each scored as either "safe" or "unsafe." An item is scored as "safe" if it indicates adequate performance in a specific aspect of swallowing or related behaviors, whereas "unsafe" indicates a problem or potential risk. The overall score is calculated from the total number of unsafe items, with higher scores reflecting greater impairment in swallowing function.

Statistical Analysis

All statistical analyses were conducted using SPSS software version 23. The prevalence and comorbidity of dysarthria and dysphagia were reported as frequency percentages, calculated based on the number of cases relative to the total. To investigate the relationship between dysarthria and dysphagia, logistic regression analysis was applied, and the effect size was assessed using the odds ratio (OR). The interpretive regions of OR were defined as follows: OR less than 1.31 indicated a negligible relationship, OR between 1.32 and 2.37 represented a small relationship, OR between 2.38 and 4.69 indicated a moderate relationship, and OR above 4.7 indicated a strong relationship (25). The significance level was set at 0.05.

Results

A total of 61 patients, comprising 24 women and 37 men, with traumatic spinal cord injury (tSCI) participated in this descriptive-analytical cross-sectional study. The mean age of the participants was 42.98 years **(Table 1).** In 82% of participants, the level of injury was in the cervical region; 13.1% had injuries in the thoracic region, and 5% had injuries involving both the cervical and thoracic regions.

Table 1. Baseline Variables of Study Participants (n = 61)

Variable (Unit)	Mean	Standard Deviation	Minimum	Maximum
Age (years)	42.98	5.06	34	53
Weight (kg)	77.79	8.05	64	98
Height (cm)	168.79	6.85	158	189
Body Mass Index (kg/m²)	27.08	3.52	18.48	35.65

cm = centimeters, kg = kilograms, kg/m² = kilograms per square meter

In this study, 87% of participants (53 out of 61) experienced at least one type of dysarthria, while no dysarthria was observed in 8 participants. The most common type of dysarthria was mixed, affecting 34% of participants, whereas the least common type was ataxic dysarthria, reported in 19%. Additionally, dysphagia was identified in 49% of participants **(Table 2).**

Table 2. Frequency of Dysarthria Types and Dysphagia among Study Participants (n = 61)

Variable		Frequency (n)	Percentage (%)
Dysarthria	**Ataxic**	10	19%
	Flaccid	17	32%
	Spastic	8	15%
	Mixed	18	34%
Dysphagia	**Present**	30	49%
	Absent	31	51%

Participants were categorized into three groups based on the presence of dysarthria and dysphagia: a group without dysarthria and dysphagia, a group with dysarthria but without dysphagia, and a group with both dysarthria and dysphagia simultaneously **(Table 3).** Accordingly, 49% of the participants were affected by both dysarthria and dysphagia, while 13% experienced neither disorder. Additionally, 38% of participants had one of the types of dysarthria without any dysphagia.

Table3: Classification of Participants Based on Co-Occurrence of Dysarthria and Dysphagia (n = 61)

Group	Frequency (n)	Percentage (%)
Without dysarthria and dysphagia	8	13%
Dysarthria without dysphagia	23	38%
Dysarthria with concurrent dysphagia	30	49%

Relationship between Dysarthria and Dysphagia

Based on the results of logistic regression analysis, a significant relationship was observed between dysarthria and dysphagia. Individuals with dysarthria were nine times more likely to experience dysphagia compared to those without dysarthria. Moreover, when controlling for age and gender, the strength of the relationship did not change significantly **(Table4)**.

Table 4. Logistic Regression Results for the Relationship between Dysarthria and Dysphagia

Variable	p-value	Odds Ratio (OR)	Confidence Interval (CI)
Crude	0.045	9.13	(1.05 to 79.53)
Adjusted for Weight	0.045	9.29	(1.05 to 82.00)
Adjusted for Gender	0.043	9.65	(1.08 to 86.00)
Adjusted for Weight & Gender	0.043	9.69	(1.08 to 86.00)

Discussion

This study aimed to investigate the co-occurrence of dysarthria and dysphagia in patients with traumatic spinal cord injury (tSCI). According to the results of our research, among 61 participants, 87% (53 individuals) were diagnosed with dysarthria, and 49% (30 individuals) experienced dysphagia. The most common type of dysarthria reported was mixed dysarthria (34%), followed by flaccid dysarthria (32%).

The prevalence of dysarthria and dysphagia in our study was higher compared to similar studies in SCI patients. In a prospective cohort study, the incidence of dysphagia in individuals with cervical spinal cord injury was estimated at 30%(12), while another study reported an incidence of 7%(26). Both of these studies had larger sample sizes than the current study.

In studies examining the prevalence of these two disorders in individuals with stroke, the prevalence of dysarthria ranged from 16.5% to 69%, and dysphagia varied between 8.18% and 72% (18-20, 27, 28).

Compared to stroke patients, the prevalence of dysarthria and dysphagia was higher in patients with Parkinson, with rates ranging from 64% to 93% for dysarthria and from 59% to 86% for dysphagia (27-30). Similarly, in patients with Amyotrophic lateral sclerosis (ALS), the prevalence of dysarthria ranged from 50.6% to 88%, and dysphagia ranged from 36.3% to 54.2% (30-32). In a study by Danesh-Sani et al.(33), involving 500 individuals with multiple sclerosis, the prevalence of dysarthria was reported as 42.1%, and dysphagia as 26.6%.

The differences in the prevalence rates of dysarthria and dysphagia across studies may be attributed to variations in study designs, sample sizes, and the type of disease studied. Our research specifically targeted patients with traumatic spinal cord injury (tSCI), whereas other studies examined populations with conditions such as stroke, Parkinson's disease, and multiple sclerosis. These conditions differ in their underlying pathophysiology, which can influence the prevalence and severity of dysarthria and dysphagia. Methodological differences, including the tools used for assessment, diagnostic criteria, and the inclusion of diverse patient characteristics, may also contribute to these discrepancies. Additionally, larger sample sizes in studies like those by Danesh-Sani et al. (51) provided more generalized estimates, whereas our study focused on a smaller group.

In addition to the prevalence of these two disorders, the present study also examined their comorbidity rate. Among the participants, 49% were diagnosed with both dysarthria and dysphagia, while 38% had dysarthria alone, and 13% had neither dysarthria nor dysphagia. Similarly, previous studies on other central nervous system pathologies reported comorbidity rates ranging from 7% in the study by Lieuw et al.(18) to 31% in the study by Ghoreysi et al.(16). Importantly, our study not only identified a high comorbidity rate but also observed a strong correlation between dysarthria and dysphagia, with dysarthria recognized as a significant predictor of dysphagia.

Several key reasons explain the comorbidity of dysarthria and dysphagia(14). Both disorders result from damage to the central or peripheral nervous system, with significant overlap in the neural pathways that control the muscles involved in speech and swallowing. Cranial nerves, such as the vagus nerve (CN X), hypoglossal nerve (CN XII), and glossopharyngeal nerve (CN IX), play crucial roles in the movement of the tongue, pharynx, and soft palate, which are essential for both functions. Damage to these nerves can simultaneously impair speech and swallowing. Another major contributing factor is the weakness or paralysis of muscles shared between these processes. The muscles involved in producing sounds and words, such as those of the tongue, lips, and pharynx, also play a critical role in swallowing. Weakness in these muscles can lead to difficulties in the oral and pharyngeal phases of swallowing, directly linking dysarthria to dysphagia.

Moreover, motor coordination is a vital aspect of normal speech and swallowing. In mixed and flaccid dysarthria, which were most prevalent in our study, this coordination is severely disrupted, resulting in impairments in both functions (14, 16). Additionally, conditions such as traumatic spinal cord injury, which often causes extensive damage to the nervous system, disrupt the control of muscles responsible for speech and swallowing, further contributing to the comorbidity of these disorders.

Study limitation

One of the limitations of this study is the reliance on a non-probability sampling method, which may limit the generalizability of the findings to the broader population. Participants were selected based on convenience and availability rather than random sampling.

Conclusion

This study highlights the high prevalence and comorbidity of dysarthria and dysphagia in patients with traumatic spinal cord injury (tSCI). The findings underscore the strong correlation between these two disorders, identifying dysarthria as a significant predictor of dysphagia. These results emphasize the importance of simultaneous assessment of both conditions and recommend that rehabilitation interventions be comprehensively designed to address both disorders concurrently, with the aim of enhancing patients' quality of life.

Conflict of Interest

No conflict of interest

Ethical Considerations

This study was conducted in accordance with the ethical standards of the Declaration of Helsinki. The study protocol was reviewed and approved by the Ethics Committee of the University of Social Welfare and Rehabilitation Sciences, Tehran, Iran.

Prior to participation, all eligible individuals were informed about the objectives, procedures, potential benefits, and risks of the study. Written informed consent was obtained from each participant. Participants were assured of the confidentiality of their data and their right to withdraw from the study at any time without any consequences.

Author contributions

Saeed Sheykh Chalandari: Conceptualization, data collection, analysis, and original draft preparation.

Morteza Farazi: Supervision, methodology, and critical revision of the manuscript.

Zahra Sadeghi: Data analysis, literature review, and manuscript editing.

Mehdi Norouzi: Data interpretation and statistical consultation.

Funding

This study was conducted as the MSc thesis of the first author and was supported by the University of Social Welfare and Rehabilitation Sciences, Tehran, Iran.

Acknowledgments

The authors would like to express their sincere gratitude to the Clinical Research Development Center at Rofeideh Rehabilitation Hospital, Tehran, Iran, for their invaluable support, cooperation,

and assistance throughout the study period. We also extend our heartfelt thanks to the participants and their families for their willingness, cooperation, and patience, which greatly contributed to this research.

References

1. Myers J, Lee M, Kiratli J. Cardiovascular disease in spinal cord injury: an overview of prevalence, risk, evaluation, and management. American journal of physical medicine & rehabilitation. 2007;86(2):142-52.
2. Rahimi-Movaghar V, Saadat S, Rasouli MR, Ganji S, Ghahramani M, Zarei M-R, et al. Prevalence of spinal cord injury in Tehran, Iran. The journal of spinal cord medicine. 2009;32(4):428-31.
3. Singh A, Tetreault L, Kalsi-Ryan S, Nouri A, Fehlings MG. Global prevalence and incidence of traumatic spinal cord injury. Clinical epidemiology. 2014:309-31.
4. Winslow C, Rozovsky J. Effect of spinal cord injury on the respiratory system. American journal of physical medicine & rehabilitation. 2003;82(10):803-14.
5. Brown R, DiMarco AF, Hoit JD, Garshick E. Respiratory dysfunction and management in spinal cord injury. Respiratory care. 2006;51(8):853-70.
6. Sezer N, Akkuş S, Uğurlu FG. Chronic complications of spinal cord injury. World journal of orthopedics. 2015;6(1):24.
7. Hagen EM, Faerestrand S, Hoff J, Rekand T, Gronning M. Cardiovascular and urological dysfunction in spinal cord injury. Acta neurologica scandinavica. 2011;124:71-8.
8. Harkema SJ, Ferreira CK, van den Brand RJ, Krassioukov AV. Improvements in orthostatic instability with stand locomotor training in individuals with spinal cord injury. Journal of neurotrauma. 2008;25(12):1467-75.
9. Rekand T, Hagen EM, Grønning M. Chronic pain following spinal cord injury. Tidsskrift for Den norske legeforening. 2012.
10. Wolf C, Meiners T. Dysphagia in patients with acute cervical spinal cord injury. Spinal Cord. 2003;41(6):347-53.
11. Chaw E, Shem K, Castillo K, Wong S, Chang J. Dysphagia and associated respiratory considerations in cervical spinal cord injury. Topics in spinal cord injury rehabilitation. 2012;18(4):291-9.
12. Abel R, Ruf S, Spahn B. Cervical spinal cord injury and deglutition disorders. Dysphagia. 2004;19:5-94.
13. Knuijt S, Kalf JG, de Swart BJ, Drost G, Hendricks HT, Geurts AC, et al. Dysarthria and dysphagia are highly prevalent among various types of neuromuscular diseases. Disability and rehabilitation. 2014;36(15):1285-9.
14. Wang BJ, Carter FL, Altman KW. Relationship between dysarthria and oral-oropharyngeal dysphagia: the present evidence. Ear, Nose & Throat Journal. 2020:0145561320951647.
15. Simmons KC, Mayo R. The use of the Mayo Clinic system for differential diagnosis of dysarthria. Journal of communication disorders. 1997;30(2):117-32.
16. Ghoreyshi Z, Nilipour R, Bayat N, Nejad SS, Mehrpour M, Azimi T. The incidence of aphasia, cognitive deficits, apraxia, dysarthria, and dysphagia in acute post stroke Persian speaking adults. Indian Journal of Otolaryngology and Head & Neck Surgery. 2022;74(Suppl 3):5685-95.

17. Stipancic KL, Borders JC, Brates D, Thibeault SL. Prospective investigation of incidence and co-occurrence of dysphagia, dysarthria, and aphasia following ischemic stroke. American Journal of Speech-Language Pathology. 2019;28(1):188-94.
18. Lieuw D, Bipat R, Schraeyen K. First-ever stroke patients in Suriname show more communication disorders than swallowing disorders and these depend on age and length of stay in hospital. ACADEMIC JOURNAL. 2023.
19. Nishio M, Niimi S. Relationship between speech and swallowing disorders in patients with neuromuscular disease. Folia phoniatrica et logopaedica. 2004;56(5):291-304.
20. Otapowicz D, Sobaniec W, Okurowska-Zawada B, Artemowicz B, Sendrowski K, Kułak W, et al. Dysphagia in children with infantile cerebral palsy. Advances in medical sciences. 2010;55(2):222-7.
21. Foroughan M, Jafari Z, Shirin Bayan P, Ghaem Magham Farahani Z, Rahgozar M. Validation of mini-mental state examination (MMSE) in the elderly population of Tehran. Advances in Cognitive Science. 2008;10(2):29-37.
22. Hayashi T, Fujiwara Y, Sakai H, Maeda T, Ueta T, Shiba K. Risk factors for severe dysphagia in acute cervical spinal cord injury. Spinal cord. 2017;55(10):940-3.
23. Hijikata N, Kawakami M, Wada A, Ikezawa M, Kaji K, Chiba Y, et al. Assessment of dysarthria with Frenchay dysarthria assessment (FDA-2) in patients with Duchenne muscular dystrophy. Disability and Rehabilitation. 2022;44(8):1443-50.
24. Bakhtiyari J, Salmani M, Noruzi R, Sarraf P, Barzegar E, Mirmohammadkhani M. Translation, cross-cultural adaptation, validation and reliability of the northwestern dysphagia patient check sheet (NDPCS) in Iran. Iranian Journal of Otorhinolaryngology. 2018;30(97):97.
25. Olivier J, May WL, Bell ML. Relative effect sizes for measures of risk. Communications in statistics-theory and methods. 2017;46(14):6774-81.
26. Wing PC. Early acute management in adults with spinal cord injury: a clinical practice guideline for health-care providers. Who should read it? The journal of spinal cord medicine. 2008;31(4):360-.
27. Flowers HL, Silver FL, Fang J, Rochon E, Martino R. The incidence, co-occurrence, and predictors of dysphagia, dysarthria, and aphasia after first-ever acute ischemic stroke. Journal of communication disorders. 2013;46(3):238-48.
28. Perez-Lloret S, Nègre-Pagès L, Ojero-Senard A, Damier P, Destée A, Tison F, et al. Oro-buccal symptoms (dysphagia, dysarthria, and sialorrhea) in patients with Parkinson's disease: preliminary analysis from the French COPARK cohort. European journal of neurology. 2012;19(1):28-37.
29. Maeshima S, Osawa A, Miyazaki Y, Takeda H, Tanahashi N. Functional outcome in patients with pontine infarction after acute rehabilitation. Neurological Sciences. 2012;33:759-64.
30. Leder SB, Novella S, Patwa H. Use of fiberoptic endoscopic evaluation of swallowing (FEES) in patients with amyotrophic lateral sclerosis. Dysphagia. 2004;19:177-81.
31. Chen A, Garrett CG. Otolaryngologic presentations of amyotrophic lateral sclerosis. Otolaryngology—Head and Neck Surgery. 2005;132(3):500-4.

32. da Costa Franceschini A, Mourao LF. Dysarthria and dysphagia in amyotrophic lateral sclerosis with spinal onset: a study of quality of life related to swallowing. NeuroRehabilitation. 2015;36(1):127-34.
33. Danesh-Sani SA, Rahimdoost A, Soltani M, Ghiyasi M, Haghdoost N, Sabzali-Zanjankhah S. Clinical assessment of orofacial manifestations in 500 patients with multiple sclerosis. Journal of Oral and Maxillofacial Surgery. 2013;71(2):290-4.