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

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ABSTRACT

Introduction: To determine the frequency, comorbidities, and relationship between dysarthria and dysphagia in patients with traumatic spinal cord injury (tSCI).

Materials and Methods: A descriptive-analytical cross-sectional study was conducted enrolling 61 patients with tSCI from rehabilitation centers in Tehran Province, Iran between January and September 2024. Dysarthria and dysphagia were assessed using the Persian-adapted versions of the frenchay dysarthria assessment (FDA) and northwestern dysphagia patient check sheet (NDPCS), respectively. Logistic regression analysis was employed to evaluate the relationship 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 (odds ratio [OR]=9.69, P<0.05), even after adjusting for weight and sex.

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 results highlight the necessity of concurrent assessment and integrated rehabilitation approaches targeting both disorders to improve patient outcomes and quality of life.

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Introduction

Spinal cord injury (SCI) is a severe and acute medical condition characterized by disruption of 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). ntSCIs result from congenital abnormalities, genetic predisposition, 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 patients with SCI. Previous studies have shown that cervical SCI can lead to respiratory and bulbar dysfunction, 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, and 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 dysphagia onset and progression.

The comorbidity of these disorders has been reported at varying rates in 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 a 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, limited research has focused on patients with tSCI. This is particularly significant because 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, comorbidities, and relationship between dysarthria and dysphagia in patients with tSCI.

Materials and Methods

This descriptive-analytical cross-sectional study included 61 patients with tSCI from January 2024 to September 2024. Participants were selected through simple random sampling from patients referred to rehabilitation centers in Tehran City, Iran. The inclusion criteria included participants with a neurologist-confirmed diagnosis of tSCI, over 18 years of age, medically stable condition, and at least 3 months post-injury to ensure stabilization of neurological and functional symptoms. The exclusion criteria included individuals with a history of swallowing or speech disorders before 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 TBI based on neurologist-confirmed medical records.

Cognitive status was assessed using the Persian version of the mini-mental state examination, 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 before or during the assessment. 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.

Sample size

In the present study, the sample size was calculated based on the prevalence of dysphagia using the Equation 1:

1. $(Z_{(1-a/2)}^{2} \times P(1-P))/d^{2}$

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, sex, time since injury, and level of injury. Subsequently, the presence of dysarthria and dysphagia in eligible participants was assessed. Dysarthria was evaluated using the frenchay dysarthria assessment (FDA), and dysphagia was assessed using the northwestern dysphagia patient check sheet (NDPCS). The evaluator conducting these assessments was thoroughly trained to administer the FDA and complete 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.

The Persian version of the NDPCS was used for dysphagia evaluation [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 "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 of 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<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>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 tSCI participated in this descriptive-analytical cross-sectional study. The mean age of the participants was 42.98 years (Table 1). In 82% of the 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.

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).

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

Table 1. Baseline variables of study participants (n=61)

Variable (Unit)	Mean±SD	Min	Max
Age (y)	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

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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 than those without. Moreover, when controlling for age and sex, the strength of the relationship did not change significantly (Table 4).

Discussion

This study aimed to investigate the co-occurrence of dysarthria and dysphagia in patients with tSCI. According to the results of our study, among the 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 than that in similar studies on patients with SCI. In a prospective cohort study, the incidence of dysphagia in individuals with cervical SCI was estimated to be 30% [12], while another study reported an incidence of 7% [26]. Both 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's, 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, the prevalence of dysarthria ranges from 50.6% to 88%, and that of dysphagia ranges 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 design, sample size, and disease type studied. Our research specifically targeted patients with 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 dysarthria and dysphagia prevalence and severity. Methodological differences, including the tools used for assessment, diagnostic criteria, and inclusion of diverse patient charac-

Table 2. Frequency of dysarthria types and dysphagia among study participants (n=61)

Variables		No. (%)
Dysarthria	Ataxic	10(19)
	Flaccid	17(32)
	Spastic	8(15)
	Mixed	18(34)
Dysphagia	Present	30(49)
	Absent	31(51)

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Table 3. Classification of participants based on co-occurrence of dysarthria and dysphagia (n=61)

Groups	No. (%)
Without dysarthria and dysphagia	8(13)
Dysarthria without dysphagia	23(38)
Dysarthria with concurrent dysphagia	30(49)

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Table 4. Logistic regression results for the relationship between dysarthria and dysphagia

Variables	P	OR	95% CI
Crude	0.045	9.13	1.05-79.53
Adjusted for weight	0.045	9.29	1.05-82.00
Adjusted for gender	0.043	9.65	1.08-86.00
Adjusted for weight and gender	0.043	9.69	1.08-86.00

JMR

teristics, may also contribute to these discrepancies. Additionally, larger sample sizes in studies, such as those by Danesh-Sani et al. [33] provided more generalized estimates, whereas our study focused on a smaller group.

In addition to the prevalence of these two disorders, the present study examined their comorbidity rates. Among the participants, 49% were diagnosed with dysarthria and dysphagia, 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]. Our study not only identified a high comorbidity rate but also observed a strong correlation between dysarthria and dysphagia, with dysarthria being a significant predictor of dysphagia.

Several key reasons explain the comorbidity between dysarthria and dysphagia [14]. Both disorders result from damage to the central or peripheral nervous system, with significant overlap in the neural pathways controlling the muscles involved in speech and swallowing. Cranial nerves (CN), such as the vagus nerve (X), hypoglossal nerve (XII), and glossopharyngeal nerve (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 muscle weakness or paralysis shared between these processes. The muscles involved in producing sounds and words, such as the tongue, lips and pharynx, also play critical roles in swallowing. Weakness in these muscles can lead to difficulties in the oral and pharyngeal phases of swallowing, directly linking dysarthria and dysphagia. 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 tSCI, which often cause extensive damage to the nervous system, disrupt the control of muscles responsible for speech and swallowing, further contributing to the comorbidity of these disorders.

Conclusion

This study highlights the high prevalence and comorbidities of dysarthria and dysphagia in patients with tSCI. The findings underscore the strong correlation between these two disorders and identify 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 to enhance patients' quality of life.

Study limitation

One limitation of this study is its 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.

Ethical Considerations

Compliance with ethical guidelines

The ethical standards of the Declaration of Helsinki conducted this study. The University of Social Welfare and Rehabilitation Sciences Ethics Committee, Tehran City, Iran reviewed and approved the study protocol.

All eligible individuals were informed of the study's objectives, procedures, potential benefits, and risks before participation. 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 consequences.

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This study was extracted from master's thesis of Saeed Sheykh Chalandari, approved by the Department of Speech Therapy, School of Rehabilitation Sciences, University of Social Welfare and Rehabilitation Sciences, Tehran, Iran.

Authors' contributions

Conceptualization, data collection, analysis and writing the original draft: Saeed Sheykh Chalandari; Supervision, and methodology: Morteza Farazi; Data analysis, and investigations: Zahra Sadeghi; Data interpretation and statistical consultation: Mehdi Norouzi; Review and editing: Morteza Farazi, and Zahra Sadeghi.

Conflict of interest

The authors declared no conflict of interest.

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