



Sarcopenia and swallowing disorders in older people

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Abstract

Aging is accompanied by several changes which may affect swallowing function. The beginning of these changes, termed presbyphagia, still captures a preserved swallowing function, although burdened by the consequences of the physiological aging process. Several stressors (including diseases and medications) can easily trigger the disruption of this (increasingly weak) equilibrium and lead to overt dysphagia. It is noteworthy that the swallowing dysfunction may be aggravated by the sarcopenic process, characterizing the so-called “sarcopenic dysphagia”, potentially responsible for several health-related negative outcomes. The assessment and management of sarcopenic dysphagia largely rely on the evaluation and integrated treatment of both constituting conditions (i.e., sarcopenia and dysphagia). The management of dysphagia requires a multidimensional approach and can be designed as either compensatory (aimed at producing immediate benefit for the patient through postural adjustments, swallowing maneuvers, and diet modifications) or rehabilitative. Interestingly, some evidence suggests that resistance training traditionally applied to tackle the lower extremity in sarcopenia may be simultaneously beneficial for sarcopenic dysphagia. If these preliminary results (discussed in the present review article) will be confirmed, the systemic beneficial effects of physical exercise will be indirectly demonstrated. This will also support the need of promoting healthy lifestyle in all sarcopenic individuals (thus potentially at risk of dysphagia).

Keywords Sarcopenia · Presbyphagia · Dysphagia · Sarcopenic dysphagia · Swallowing

Swallowing modifications with aging

Aging is accompanied by major pathophysiological changes that can negatively affect the individual’s functional status. In particular, the swallowing function may be altered by the age-related reduction of tissues elasticity, changes of head and neck anatomy, oropharyngeal disorders, decrease of oral moisture, and sensory (i.e., taste, smell) impairments [1, 2]. These alterations in the swallowing dynamics describe a condition called presbyphagia. Presbyphagia is characterized by a swallowing function that, although preserved, may present subtle signs of impairment. It is usually asymptomatic but tends to slowly worsen as the aging process advances. In its early phases, it does not compromise deglutition, but still increases the risk of developing a dysfunctional swallowing

[3, 4]. The clinical manifestations of presbyphagia are also frequently obscured and its detection delayed, because compensatory strategies (e.g., reduced or skipped meals, longer duration of meals) are gradually adopted by the individual [2, 4, 5].

In theory, presbyphagia can be differentiated in primary if only determined by the modifications typical of the aging process, or secondary when caused by specific diseases; e.g., neurological conditions, infectious diseases, and stroke [6]. Nevertheless, it is often difficult to clearly distinguish the effects of diseases from the underlying age-related modifications. Sometimes, acute diseases or side effects of medications (e.g., antipsychotics and antidepressants) may disrupt the homeostatic balance of the organism, leading to the onset of dysphagia, which can then subsequently complicate into aspiration pneumonia [2, 3]. Table 1 presents the main differences between presbyphagia and dysphagia.

Since swallowing disorders can be responsible for incident malnutrition (being triggers for reduced or altered intake of food and liquids), it becomes evident why presbyphagia and even more dysphagia are indicated as playing an important role in the vicious cycle of frailty in older persons

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Table 1 Main differences between presbyphagia and dysphagia

	Presbyphagia	Dysphagia	
Characteristics	Asymptomatic	Symptomatic	
	Swallow function normal (but highly vulnerable)	Swallow function impaired	
	Age related condition	Secondary to disease or medications	
	Paraphysiologic	Pathologic	
	Slower swallow	Aspiration	
	Prolonged duration of the meal	Food residue	
	↓ Taste and smell	Excessive throat clearing	
	↓ Lingual pressure	Coughing	
	↓ Bolus preparation	Hoarse voice	
	Chewing difficulty	Atypical ventilation periods	
	Sensory changes	Repetitive swallowing	
	Post-swallow residue		
	Consequences	Predisposition to dysphagia	Aspiration pneumonia
		Nutritional deficits	Infections
			Malnutrition
		Dehydration	

[7]. Their presence may indeed represent the biological substratum of the disabling cascade experienced by many frail individuals.

Sarcopenia and swallowing function

In the older persons, swallowing disorders can be aggravated by the sarcopenic process. Sarcopenia is an age-related condition characterized by the gradual decline of muscle mass and strength. It leads to a reduction in physical performance and represents a risk condition for several negative health-related outcomes [8]. Different from what commonly depicted, sarcopenia does not only affect lower extremities. In fact, the skeletal muscle decline occurring with aging is systemic and exerts detrimental effects beyond the mobility function. For example, it might be observed that sarcopenia is able to affect the respiratory function if the focus of the skeletal muscle evaluation would be moved to the muscular system devoted to breathing [9]. Consistently, sarcopenic muscles dedicated to the swallowing mechanism (e.g., tongue, geniohyoid and pharyngeal muscles) can determine altered deglutition and potentially expose the individual to the risk of adverse outcomes [10, 11]. In this context, a novel construct has recently been proposed to characterize the clinical impact that sarcopenia has on swallowing muscles contributing at the onset of dysphagia: the so-called “sarcopenic dysphagia” [12, 13].

Both sarcopenia and dysphagia are common conditions of advanced age. The prevalence of sarcopenia has been estimated as ranging between 1 and 33%; however, these figures largely depend on the adopted operational definitions, the

Table 2 EAT-10 questionnaire [17]

Items	Scoring
My swallowing problem has caused me to lose weight	0 1 2 3 4
My swallowing problem interferes with my ability to go out for meals	0 1 2 3 4
Swallowing liquids takes extra effort	0 1 2 3 4
Swallowing solids takes extra effort	0 1 2 3 4
Swallowing pills takes extra effort	0 1 2 3 4
Swallowing is painful	0 1 2 3 4
The pleasure of eating is affected by my swallowing	0 1 2 3 4
When I swallow food sticks in my throat	0 1 2 3 4
I cough when I eat	0 1 2 3 4
Swallowing is stressful	0 1 2 3 4

Each item is scored from 0 (no problem) to 4 (severe problem). A total score of 3 or higher indicates the presence of swallowing difficulties

setting, where research is conducted, and the frailty status of the studied individuals [14, 15]. At the same time, dysphagia seems to affect up to 13% of community-dwelling older adults and the majority of institutionalized patients [16]. The specific prevalence of sarcopenic dysphagia has not yet been estimated. This lack of information is probably due to the novelty of the concept, as well as (1) the limited attention paid to swallowing disorders in the elderly, and (2) the still inadequate tools for capturing the two components of this condition [11].

The assessment of dysphagia

The screening of dysphagia can be performed using simple tests designed to rapidly detect signs and symptoms of swallowing disorders [5]. One of the most commonly used is the EAT-10 test [17], considered a valid and solid self-assessment tool able for measuring the risk of dysphagia and identify individuals in the need of a (multidisciplinary) intervention. EAT-10 questionnaire (Table 2) is composed by 10 items, each one describing a specific risk condition to be scored from 0 (absence of the problem) to 4 (severe problem). A total score of 3 or higher indicates the presence of swallowing difficulties.

Bedside examination tests are also available to provide information about the patient’s capacity to swallow water and/or foods. The Toronto Bedside Swallowing Screening Test (TOR-BSST) [18] is a relatively quick and easy-to-use instrument (administration time about 10 min) that can be conducted by different healthcare professionals (e.g., nurses, dieticians, occupational therapists) for evaluating the swallowing of water. The Gugging Swallowing Screen (GUSS) [19] is another simple, stepwise bedside screening test. It

allows a graded rating of the swallowing function, separately evaluating non-fluid and fluid nutrition. It is used to assess the risk of aspiration and support recommendations for adapted diet. The volume–viscosity swallow test (V-VST) [20] is based on the sequential administration of boluses (from 5 to 20 mL) of three different viscosities (i.e., nectar, liquid, and pudding) for exploring both safety and efficacy of swallowing. The use of several viscosities is meant to better protect patients from possible aspiration by providing extra information compared to that coming from a simple water-based test.

Of course, the use of tests cannot replace the clinical judgment, which is based on a comprehensive assessment and multidimensional evaluation of the dysphagic signs and symptoms of the individual. It is important to define the presence, location, and severity of the impairment. It is crucial to record information about the person's medical history, oral and motor functions, and food intake [21].

Instrumental tools may be necessary to complement the clinical evaluation of dysphagia, confirm the diagnosis, and support the design of the intervention plan. They include videofluoroscopy and videoendoscopic evaluations, which provide dynamic imaging of the swallowing functions [5]. Unfortunately, since the availability of these techniques may vary across countries and settings, their use in every patient at risk for dysphagia is difficult to recommend.

All the above-mentioned tests, instruments, and tools are designed for the exploration of dysphagia. To date, none of them adequately consider the condition of presbyphagia. In particular, it is difficult to differentiate the “aged swallowing function” from the clear pathologic manifestation. Without adequately limiting the perimeter of the presbyphagia grey zone, the same borders of dysphagia might become arguable and vague.

The assessment of sarcopenia

In the literature, multiple operational definitions have been proposed over the years to measure sarcopenia. Overall, current recommendations indicate the need of combining a measure of appendicular lean mass with parameters of muscle function (i.e., strength and/or physical performance) [8]. Many techniques are available for the quantification of muscle mass (e.g., computed tomography, magnetic resonance imaging, dual energy X-ray absorptiometry, bioimpedance analysis, anthropometric measures) and function (e.g., handgrip strength, Short Physical Performance Battery, usual gait speed). Unfortunately, such variety and heterogeneity of measures and methodologies have affected over the years the possibility of reaching a universal consensus for a gold standard definition of sarcopenia. Moreover, the available techniques and tests substantially differ

in the capacity of being implemented in the routine clinical practice and properly support decisions across settings [22]. Despite these limitations, a growing consensus is emerging indicating sarcopenia as the combination of low appendicular lean mass (from DXA scan) and muscle weakness (as low handgrip strength) [23]. Just recently, the European Working Group on Sarcopenia in Older People (EWGSOP) released an update of the defining criteria for sarcopenia previously published in 2011 [8]. The new document seems to particularly enhance the role of muscle strength and function in the definition of the condition of interest. In the absence of a gold standard definition, it is perhaps safer to assess the skeletal muscle quantity in those with some physical/muscular impairment. In this way, the physical functioning will serve as entry criteria (or “red flag”) for conducting more in-depth and more expensive analyses of body composition [22]. These latter are not redundant, but clinically meaningful, because allow to differentiate the muscular impairment due to an organ-specific deficit from third factors.

Sarcopenic dysphagia: when the muscle decline determines a swallowing dysfunction

It is important to distinguish among presbyphagia, dysphagia, and sarcopenic dysphagia. Such distinction is crucial for personalizing interventions and improves the quality of care. We have already mentioned about the difference between presbyphagia and dysphagia. Sarcopenic dysphagia instead defines a clear causal pathway in the determination of the dysphagic symptom that is the muscle decline. The muscle loss here becomes the center of the clinical manifestation, where sarcopenia and dysphagia interact and generate detrimental synergies. It is not possible to disentangle a cause-effect relationship between them, because each can equally be the cause as well as the result of the other.

In 2013, diagnostic criteria for sarcopenic dysphagia were proposed [11]. They were based on five points:

1. presence of dysphagia;
2. presence of generalized sarcopenia;
3. results from imaging (i.e., computed tomography, magnetic resonance imaging, ultrasonography) consistent with the loss of swallowing muscles;
4. exclusion of causes of dysphagia other than sarcopenia;
5. sarcopenia represents the main cause of dysphagia but other causes may also exist (e.g., stroke, brain injury, neuromuscular diseases, head and neck cancer, and connective tissue diseases).

The five criteria were indicated to support a definitive diagnosis (criteria 1–4 are met), a probable diagnosis

(criteria 1, 2, and 4 are met), and a possible diagnosis (criteria 1, 2, and 5 are met). Thus, it is evident as most of the geriatric patients fall under the latter category.

Interestingly, they do not include a direct evaluation of the swallowing strength. However, it has been repeatedly proposed that the reduction of the tongue strength evaluated by measuring the tongue pressure or the head lift may be considered as suggestive of sarcopenic dysphagia [11, 12, 24]. Unfortunately, the third criterion of this construct (requesting the imaging of swallowing muscles) is hardly applicable to the clinical routine, where function-driven evaluations are privileged. Moreover, the lack of operational criteria for defining the clinically relevant loss of swallowing muscle mass further makes the third point of arguable interest. After all, these two issues are common with the main limitations negatively affecting a widespread diffusion in the clinical setting of the sarcopenia definition (i.e., the assessment of body composition is seen as not sufficiently relevant for the clinical practice, and lack of widely accepted defining cut-points for poor muscle mass).

Treatment of sarcopenic dysphagia

The treatment of sarcopenic dysphagia should result in a rehabilitation program aimed at improving both conditions (i.e., sarcopenia and dysphagia). It should involve a multidisciplinary team (i.e., geriatricians, dietitians, speech language therapists, and nurses). It is pivotal to treat both conditions at the same time for promoting the initiation of a virtuous cycle, develop positive synergies, and quickly restore the normal function.

To date, the management of sarcopenia largely relies on physical exercise (resistance training exercises) coupled with adequate nutritional intake. In particular, it is necessary to provide the individual with an adequate protein intake in particular leucine enriched, essential amino acid. Vitamin D deficiency is very common among elderly, supplementation of this nutrient enhances muscle function and prevent falls [25, 26]. Several drugs for the treatment of sarcopenia are currently under development (in particular, myostatin inhibitors, testosterone, selective androgen receptor modulators, AMP-activated protein kinase agonists, insulin growth factor-1 analogues, ghrelin modulating agents, and activin-2 receptor inhibitors) [26, 27].

On the other hand, the therapy of dysphagia per se can be either compensatory or rehabilitative. Compensatory adjustments are intended to produce an immediate benefit to the patient and include postural adjustments, swallowing maneuvers, and diet modifications. Postural adjustments of the patient are relatively simple to obtain and reduce the risk of deviations of the bolus flow by applying biomechanical changes. Eating while maintaining an upright, 90° seated

position and keeping it for at least 30 min after the meal represent general rules for assuring a safe swallowing [27]. Swallow maneuvers are variants applied to the normal mechanism with the aim of improving the safety or efficiency of the function (e.g., Mendelsohn's maneuver, supra- and super-supraglottic swallow, effortful swallow) [28].

Diet modifications include changes in the consistency of solid and/or liquid foods. Solid foods may be modified into soft consistencies (e.g., pureed), and liquids may be thickened to render the swallowing process slower and safer [4, 28]. However, despite modifications of diet texture are common practice, their application varies quite a lot across clinicians, settings, and countries. Guidelines for standardized diet directions (including consistent terminology and practices) might be very helpful to federate clinicians in the management of swallowing disorders. For example, the American National Dysphagia Diet (NDD) [29] was developed by a panel of dietitians, speech language pathologists, and food scientists. Four levels of semisolid/solid foods were proposed to standardize the clinical approach:

- Level 1: dysphagia-pureed, that is homogenous, very cohesive, pudding-like substances, requiring very little chewing ability;
- Level 2: dysphagia-mechanical altered, that is cohesive, moist, semisolid foods, requiring some chewing;
- Level 3: dysphagia-advanced, that is soft foods that require more chewing ability;
- Level 4: regular, that is all foods with no specific modifications.

However, this diet texture classification does not consider fluids. As well as this initiative, several countries have developed standards for diet texture and fluid modifications, but these descriptions vary quite a lot throughout the world and care settings [30]. In this way, the International Dysphagia Diet Standardization Initiative (IDDSI) was established to globally standardize terminology for diet texture and fluid modifications [31] and just recently a preliminary validation of a new scale, known as IDDSI Functional Diet Scale [32] was conducted. This scale (Fig. 1a) is composed by eight levels held in two matched pyramids according to the degrees of texture modifications. Each level of the scale is identified by a descriptive name (e.g., mildly thick, pureed), a color and a number.

It classifies dysphagia severity according to the degree of diet limitation. This scale aims to support diet texture prescription which may be derived using a matrix similar to a mileage chart (Fig. 1b). In this matrix, it is interesting to see that certain combinations of food and drink are not allowed (marked as N/A), since they represent errors of logic in the overlap zone of levels 3 and 4. Indeed, it is not logical to specify a food texture at level 3 (liquidized) while

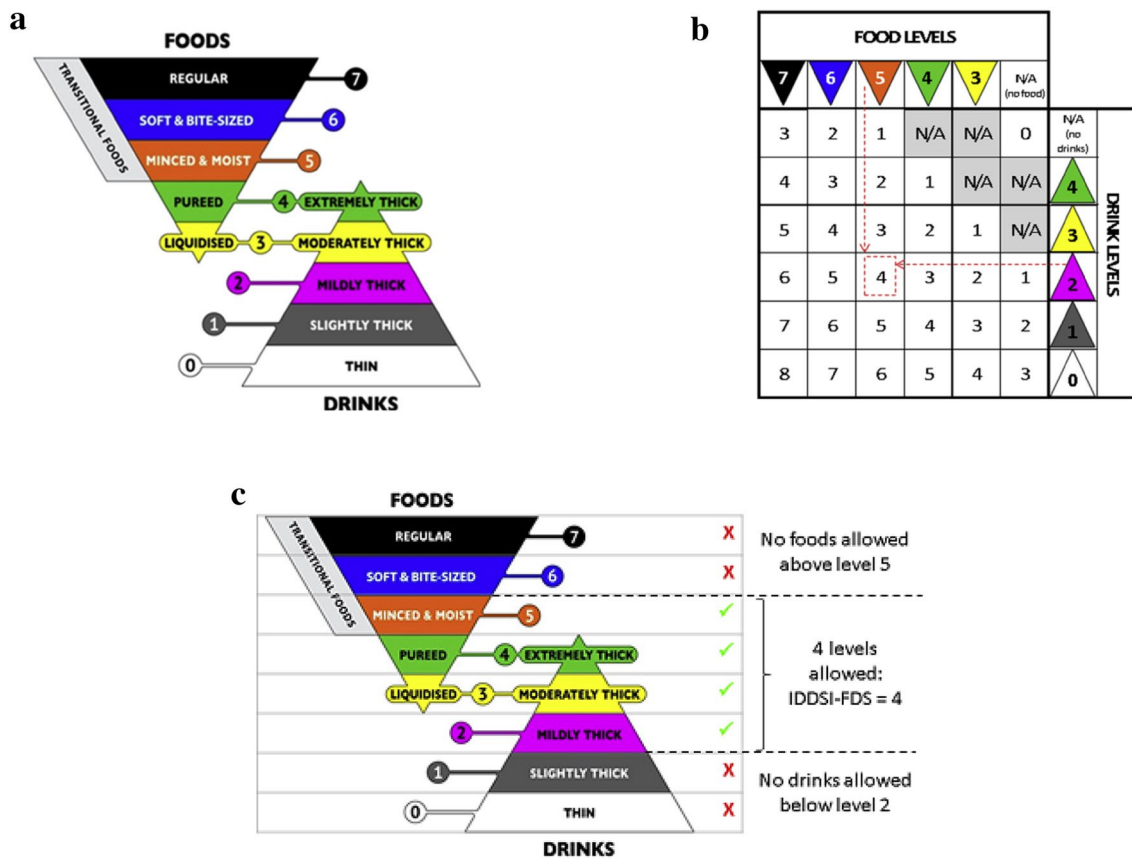


Fig. 1 IDDSI Functional Diet Scale [32]. Modified from Steele et al. [32] under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>)

permitting level 4 (extremely thick drinks). Figure 1c shows an example of a recommendation for level 5 (minced and moist foods) with level 2 (mildly thick liquids). In this case, the IDDSI Functional Diet Scale score would be 4, indicating that 4 levels of diet texture modification are permitted for the patient. The IDDSI framework has received a great consensus among various professionals and organizations around the world.

The swallowing rehabilitation is particularly useful in case of sarcopenic dysphagia, because of applying the beneficial effects of physical exercise to a specific group of dysfunctional muscles. It aims at (1) improving the physiology of the altered mechanism and (2) accelerating the recovery. It incorporates a wide spectrum of resistance training exercises (e.g., head raising exercises and tongue strengthening exercises) to train the swallowing muscles [12]. Evidence is still limited, but it seems that the improvement of systemic sarcopenia via resistance training may have a positive effect on the sarcopenic dysphagia.

It is noteworthy that sarcopenia preferentially affects type II rather than type I fibers. Although several contributors can determine dysphagia, the selective reduction of type II fibers occurring with sarcopenia might play a role by decreasing

the strength of swallowing muscles (characterized by a greater percentage of fast twitch fibers) [33]. Resistance training has been shown to increase both type I and II fiber cross-sectional areas and whole-body muscle mass in older adults, leading to an increase in muscle strength [34]. In other words, physical exercise indeed resembles a systemic intervention that, although applied to lower extremities, may exert its beneficial effects to the entire organism (even to swallowing muscles) [35].

Other important recommendations include advice for promoting an improved control of the bolus flow (e.g., eating slowly; putting small amounts of food or liquid in the mouth; avoiding mixing aliments of different consistency in the same mouthful; alternating liquids and solids to “wash down” residuals; use of sauces, condiments, and gravies to facilitate cohesive bolus formation; and avoidance of crumbly and dry foods). Moreover, it is very important to maintain a good oral hygiene and periodically check the dental status (especially for preventing the development of edentulia). Nutritional status should be regularly assessed and monitored. Specific dietetic strategies should be considered for dysphagia rehabilitation as well as to guarantee the appropriate hydro-caloric intake to prevent malnutrition,

dehydration, and muscle decline. Furthermore, it would be interesting to see if the pharmacological interventions under development for the management of sarcopenia may provide beneficial effects on swallowing muscles (that is beyond the expected ones on lower extremities).

Conclusions

Sarcopenia and swallowing disorders seem to be closely related and represent major health concerns for older persons. Several stressors typical of the ageing process can easily disrupt the older person homeostatic balance and determine a deviation from normality into a frail swallowing function the so called presbyphagia, or even pathological (sarcopenic) dysphagia.

Healthcare professionals should be made more aware about the high (often hidden) prevalence of swallowing disorders in older persons, even those looking apparently healthy. A multidimensional approach is pivotal for the early detection of these disorders and preventing the onset of serious complications. There is the need of better defining the specific tools for capturing and measuring the different types of swallowing disorders. Further studies should also explore how sarcopenia affects the swallowing function, and whether treatments to manage lower extremity sarcopenia could exert positive effects in other muscular groups.

Compliance with ethical standards

Conflict of interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

Statement of human and animal rights The present article does not contain data involving humans or animals.

Informed consent For this type of study, formal consent is not required.

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