Swallowing and ageing

Review Article

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Article received on March 11, 2023.
Accepted for publication on May 22, 2023.

Abstract

Swallowing disorders, including dysphagia, are highly prevalent in the elderly and are associated with significantly negative outcomes, including malnutrition, dehydration, pneumonia, reduced quality of life, and caregiver burden. Although oropharyngeal dysphagia is responsible for such complications, it is often not detected and treated. The elderly and caregivers often are unaware of their dysfunction.

Understanding the physiology of normal swallowing and swallowing disorders in the elderly is essential, as well as distinguishing between functional changes in swallowing in the elderly and dysphagia.

In addition to numerous screening tools and clinical evaluation protocols, videofluoroscopy and videoendoscopy of swallowing are considered the gold standard for the diagnosis of oropharyngeal dysphagia.

The primary goal of dysphagia intervention is to reduce the morbidity and mortality associated with respiratory infections and poor nutritional status, promoting safe and adequate nutrition and hydration with minimal complications.

Keywords: oropharyngeal dysphagia, aging, presbyphagia.

Introduction

Aging is a relevant phenomenon because of its implications in the physical, emotional, and social domains. Structural and functional changes occur during the aging process; however, these should not be considered diseases, and it is important to distinguish between aging and conditions more prevalent in older age groups[1].

The understanding of the physiology and advancements in the evaluation of swallowing and its disorders in older adults remains undervalued by the general population and the medical community. Oropharyngeal dysphagia (OPD) is characterized by difficulty in bolus transfer from the mouth to the stomach. OPD is a clinical condition with a high prevalence, affecting up to 13% of the

adult population aged 65 years and over and approximately 50% of institutionalized adults[2].
The prevalence of many diseases that cause dysphagia increases with age, and changes related to aging per se can contribute to dysphagia[3]. For both reasons, the global prevalence of dysphagia is increasing in aging societies.
The advances in the instrumental evaluation of swallowing help determine the specific anatomical and physiological changes. Nevertheless, the dysfunction and etiology of the condition may remain unknown if the basic understanding of the physiology of swallowing and the changes that occur with aging is lacking[4].
Common disease states such as depression, cognitive impairment, dementia, and behavioral changes can delay the recognition of dysphagia in older people.
Thus, the difficulty in diagnosing dysphagia in this population is multifactorial, and its management includes numerous medical and technical specialties. Notably, although this is an eminent problem in healthcare, OPD is only marginally integrated into the graduate training of the Portuguese healthcare professionals who work with these patients.

Anatomy and Physiology of Swallowing

Safe and effective swallowing involves the coordinated participation of multiple structures that transfer food from the mouth to the stomach. This mechanism encompasses three stages: the oral, pharyngeal, and esophageal phases [5].

Oral Phase

The oral phase begins with the entry of food into the mouth and is divided into two sequential moments—the oral preparatory and propulsive phases—both voluntary.
The oral preparatory phase mainly involves the preparation of the bolus and reduction in the size of the food particles through the production of saliva and adequate coordination between the lips, mouth, mandible, and tongue movements for chewing. When food is present in the mouth, the prevention of premature pharyngeal entry with maintained nasal breathing results from the concerted action of the orbicularis muscle of the lips and the palatoglossus muscle that seal the oral cavity anteriorly and posteriorly, respectively[5].
The onset of the oral propulsive phase occurs after chewing and bolus formation, with posterior mobilization of food through the movement of the tongue pressing against the hard palate and subsequent initiation of the pharyngeal phase[5].

Pharyngeal Phase

The pharyngeal phase starts when the bolus comes in contact with the isthmus of the fauces and, unlike the previous phase, is totally a reflex phenomenon. This phase lasts for one second, and the speed of bolus transport is 30–40 cm/s. In this phase, there is a sequence of events in which the aerodigestive route becomes an exclusively digestive one: trigger point, closure of the soft palate, elevation and laryngeal anterior propulsion, laryngeal closure, propulsion, and opening of the upper esophageal sphincter (UES). Finally, all the previous events are sequentially inverted to reconfigure the aerodigestive tract[5].

Esophageal Phase

This phase starts when the bolus passes the UES and enters the stomach. This reflex process includes the following phases: entry into the esophagus, UES closure, onset of esophageal peristalsis, opening of the lower esophageal sphincter (LES), and passage to the stomach[5].

Swallowing in Older Adults

Aging causes a progressive deterioration of the sensorimotor functions, including swallowing. Although numerous studies have shown physiological changes in swallowing with advanced age, there is strong disagreement regarding the definitions of normal and pathological swallowing.
Changes in the swallowing function are associated with normal aging, but older people

are often asymptomatic, with no evident clinical signs. Madhavan et al. [6] have suggested that these changes are associated with risk factors such as frailty and sarcopenia. Doty and Bosma [3] were the first to describe changes in swallowing in this age group through their study of electromyographic responses during swallowing in young and older individuals. They argued that swallowing, like locomotion, is subject to different levels of pharyngeal excitation and stimulation that decrease with aging. The prevalence of dysphagia in older people varies in the literature and depends on the context in which the studies are conducted. The prevalence rate range is 7–22% in healthy older individuals[7] and increase to 33% among people aged 80 years and over. Among older people hospitalized with acute diseases, prevalence varies between 35% and 55%; among those in care homes, it varies between 65% and 75% [8].

The changes during aging occur through three mutually complementary processes:

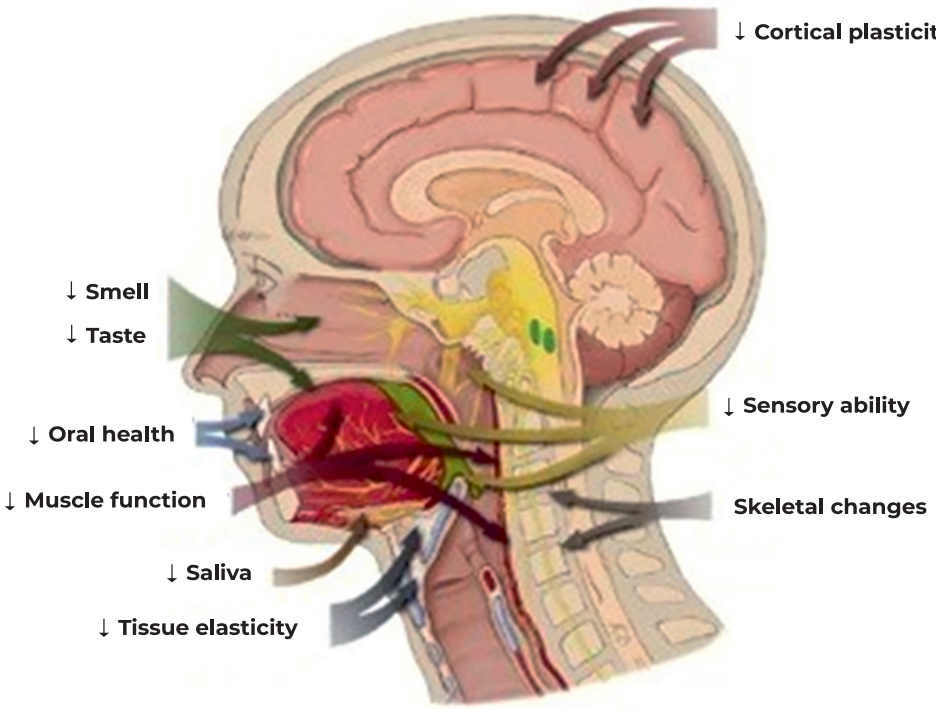
- The first process is inevitable, progressive, and irreversible; this physiological process entails a reduction in the body's ability to function
- The second process is related to changes secondary to diseases, surgical interventions, and accidents that occur throughout life
- Finally, changes caused by each individual's lifestyle (including eating habits, alcohol and tobacco consumption, degree of physical activity, and exposure to air pollution)

Evidence on changes in swallowing and its different phases continues to emerge as the functional and instrumental evaluation techniques become more refined.

Oral Phase

Decreased taste, smell, and oral sensitivity, tooth loss, reduced salivary flow, and xerostomia are the characteristics associated with age that affect the oral phase of swallowing (Figure 1). The consequences of diminished salivary flow include increased effort in chewing and processing foods, as well as decreased taste and difficult eviction of certain foods. There is a consensus about the fact that tongue strength decreases with age. Sakai et al. [9] suggested that in older individuals with suspected sarcopenia, lip and tongue

Figura 1
Changes in swallowing related to aging (adapted from Muhle *et al.*) [4]



strength are valuable independent indices for the diagnosis of sarcopenic dysphagia. Other authors [10,11] have stated that the reduction in oral ejection strength and atrophy of the geniohyoid muscle are significantly associated with aspiration in healthy older individuals. In addition to the decreased tongue strength, there is a reduction in the strength of the masticatory muscles (Table 1) [12].

Pharyngeal Phase

The pharyngeal response can also become slower with age, although this parameter was not significantly different between older people and young adults [13]. Martin-Harris et al. used a validated tool for assessing swallowing and concluded that the most affected parameters in this age group were anterior excursion of the hyoid, pharyngeal contraction, UES opening, and retraction of the base of the tongue [14].

Other factors that put healthy older individuals at risk of aspiration are atrophy of the pharyngeal muscles and reduction in pharyngeal pressure.

Molfenter, Lenell, et al. reported an increase in the pharyngeal volume with age, which, along with atrophy of the pharyngeal muscles, decreases hyolaryngeal elevation. Furthermore, reduced UES opening may be responsible for the presence of food residues after swallowing at the level of the valleculae and pyriform sinuses (Table 1) [15].

Esophageal Phase

Age-related changes have also been described in the esophageal phase, such as an increase in the duration and reduction in the esophageal peristaltic amplitude. In healthy older adults aged over 80 years, esophageal muscle weakness leads to the dysfunction of esophageal peristalsis and gastroesophageal reflux disease, predisposing these individuals to the risk of reflux-related aspiration (Table 1)[16].

The natural aging process leads to changes

Table 1
Changes in the swallowing phases in older people [12-17]

Oral Phase	
Changes	**Consequences**
- Loss of dental pieces/dental prosthesis maladjustment - Reduced production of saliva - Change in the oropharyngeal flora - Changes in taste and smell - Decreased strength of the masticatory muscles - Reduced tongue pressure and mobility - Reduced mandibular and maxillary bone tissue	- Difficulty in bolus preparation and its propulsion to the pharynx
Pharyngeal Phase	
Changes	**Consequences**
- Delay in the onset of the swallowing reflex - Decreased tonus of the pharyngeal and suprahyoid muscles - Decreased pharyngeal sensitivity - Delayed movement of the epiglottis - Delayed opening of the UES	- Increased duration of the pharyngeal phase - Reduced elevation of the hyoid - Retention in the valleculae and pyriform sinuses
Esophageal Phase	
Changes	**Consequences**
- Dysfunction of the upper esophageal sphincter - Decreased esophageal peristalsis - Esophageal dilatation - Dysfunction of the LES	- Bolus retention in the upper esophagus - Esophagitis - Laryngopharyngeal reflux

in the head and neck anatomy, as well as in several neural and muscular mechanisms, causing a loss of the functional reserve that can affect swallowing. However, swallowing in healthy older adults is not necessarily hindered; when these changes do not compromise safe swallowing, the phenomenon is called presbyphagia [18]. Nevertheless, it is difficult to establish the difference between what is deemed physiological swallowing in older people and the state in which these changes represent a disorder or dysfunction.

Consequences of Dysphagia for Health

Aspiration with subsequent aspiration pneumonia, malnutrition, and dehydration caused by a decrease in the ingestion of foods and liquids can result in reduced quality of life and increased risk of mortality.

a. **Aspiration pneumonia**
   Aspiration pneumonia occurs predominantly in older patients with a history of swallowing disorder. It accounts for 6–53% of all pneumonias, depending on the definition of aspiration pneumonia and the study. Several studies indicate that 5–15% of all community-acquired pneumonias are aspiration pneumonias [17]. Many authors have reported that patients with aspiration pneumonia were mostly older adults and had more severe disease and comorbidities than those with non-aspiration pneumonia.
b. **Malnutrition and dehydration**
   In older adults, the ingestion of foods and liquids is often reduced as a consequence of age-related changes such as anorexia of aging, chewing problems, or cognitive decline. Moreover, the loss of autonomy associated with the presence of neurological diseases in older adults increases the risk of malnutrition and dehydration [8].

Nutritional and/or therapeutic interventions are necessary to avoid or reduce these serious outcomes, the main objective being the provision of adequate amounts of energy and nutrients to minimize the risk of malnutrition and dehydration.

Screening and Clinical Assessment

Screening should be performed by a healthcare professional to identify patients at risk of dysphagia, along with referral to a multidisciplinary team that can conduct a clinical/functional and instrumental assessment. Notably, screening only identifies the disease and does not provide information on the severity of dysphagia or its best treatment. All patients with probable or previously confirmed dysphagia (positive screening results) should be considered for clinical evaluation of swallowing by a speech therapist, which entails a thorough clinical history, an evaluation of oral and motor function, and an assessment of the ability to ingest food. A clinical evaluation of these patients can help confirm dysphagia, determine its severity, and select the best management approach, be it an instrumental and/or individualized/personalized treatment. Thus, the assessment of swallowing requires a three-step process: screening (to identify the presence of dysphagia); clinical evaluation (to validate the presence of dysphagia and determine the best intervention); instrumental evaluation. Unlike clinical evaluation, instrumental evaluation is not necessary in all cases and can be restricted to patients with OPD or esophageal dysphagia[19].

Instrumental evaluation

Study of Swallowing by Videofluoroscopy

Videofluoroscopy (VFC) is the traditional gold standard for the diagnosis of OPD. VFC is a dynamic study that assesses the safety and efficacy of swallowing. It precisely measures the phases of swallowing and allows the selection and assessment of specific therapeutic strategies. The main videofluoroscopic signs of dysphagia are bolus penetration and aspiration, delayed or lack of coordination during the swallowing reflex, deficient preparation and propulsion, ineffective swallowing or presence of residues, and dysfunctional opening of the UES [20].

Additionally, VFC contributes significantly to the treatment of OPD by allowing the triage

of patients into several therapeutic categories: 1) patients with mild symptoms who require strategies mainly based on reducing the volume of the bolus and increasing its viscosity; 2) patients with severe symptoms who also need postural changes, increased sensory information, and swallowing maneuvers; 3) patients with severe dysphagia in whom oral feeding is contraindicated and who need an alternative feeding method[21].

Endoscopic Evaluation of Swallowing

Fiberoptic endoscopy of swallowing (FEES) allows the visualization of the laryngopharyngeal dynamics during the swallowing of differently dyed food consistencies. The two main objectives are as follows: (1) contribute to the diagnosis of the unknown underlying disease of OPD; (2) prescribe/outline a treatment and/or therapeutic plan for OPD[22].

The main advantages of this evaluation are as follows: (i) it can be performed at the bedside; (ii) there is no duration limit due to the absence of radiation; (iii) it allows biofeedback so that patients and carers can understand the functional changes and impact of the suggested adaptations and compensations on the function.

It is a useful tool for the detection of premature and/or late leakage into the laryngeal vestibule, presence of laryngopharyngeal residues, penetration, and aspiration. These findings allow the classification of the severity of dysphagia.

Premature leakage involves the transfer of the bolus to the pharynx before the swallowing reflex is triggered and is usually the result of deficient or incomplete glossopalatal closure.

Pharyngeal residues are usually the result of deficient bolus transfer from the mouth to the stomach.

Penetration/aspiration generally results from deficient closure of the airway, and its etiology varies. Its timing (before, during, or after swallowing) and the penetrated/aspirated amount are important findings for the classification of the dysphagia phenotype[23].

However, this method has limitations regarding the assessment of the pharyngeal and esophageal phases.

The two procedures complement each other. They are both used in older patients to determine the pattern or nature of the problem, test behavioral strategies, and detect changes in the volume and rheological characteristics of the bolus and their effects on swallowing. Therefore, they are considered "therapeutic" tests.

Obviously, during instrumental evaluation, the swallowing parameters should be interpreted differently when comparing young and older adults. In addition to the changes in the oral, pharyngeal, and esophageal phases previously described and visible on VFC and FEES, findings such as the whiteout phenomenon (moment of bolus transfer and movement of the pharyngeal structures during swallowing that are not visible due to the reflection of light from the fiberoptic endoscope on the laryngopharyngeal tissues) are more prolonged in older adults. Butler, Maslan, et al. reported that the bolus remains for a longer time in the valleculae and pyriform sinuses of healthy older adults aged 70–90 years and that this dwelling time increases with age[24].

Intervention

The main goal of the interventions for dysphagia is to reduce the morbidity and mortality associated with respiratory infections and poor nutritional status by promoting safe and adequate nutrition and hydration with minimal complications. Its aim is to recover physiological swallowing and maintain the patient's quality of life as much as possible. In terms of rehabilitation, exercise may play a role in reducing the risk of aspiration. However, we emphasize that not all changes in the muscle mass have an impact on swallowing, although muscle strengthening exercises, namely of the muscles involved in swallowing in older adults, may reduce the risk of developing dysphagia[25].

The compensatory strategies for dysphagia involve diet and/or behavioral modifications.

Compensation is primarily used to ensure the patients' safety when eating, whereas rehabilitation is used to accelerate the recovery process.

Conclusion

Swallowing disorders are underacknowledged in older adults, and this has a serious impact on their health. This is a poorly studied topic, and evidence from interventions remains weak. However, knowledge of the physiopathology of swallowing has been increasing, and a solid base is being built for further research on the efficacy of the currently available interventions, together with the development of new ones.

The challenge for the future is to promote the recognition and visibility of these disorders as an important clinical syndrome and provide evidence on the impact of an early and adequate intervention. Fostering the development and validation of interventions specifically targeted at older adults, insisting on the systematic investigation of the side effects of medications on the physiology of swallowing, and determining the impact of sarcopenia on swallowing can potentially improve the situation and prognosis of this fragile group of the population.

Conflicts of Interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

Data Confidentiality

The authors declare having followed the protocols in use at their working center regarding patients' data publication.

Protection of humans and animals

The authors declare that the procedures were followed according to the regulations established by the Clinical Research and Ethics Committee and to the 2013 Helsinki Declaration of the World Medical Association.

Funding Sources

This work did not receive any contribution, funding or scholarship.

Availability of scientific data

There are no datasets available, publicly related to this work.

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