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REVIEW ARTICLE

Dysphagia Associated with Cervical Spine and Postural Disorders

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Abstract Difficulties with swallowing may be both persistent and life threatening for the majority of those who experience it irrespective of age, gender, and race. The purpose of this review is to define oropharyngeal dysphagia and describe its relationship to cervical spine disorders and postural disturbances due to either congenital or acquired disorders. The etiology and diagnosis of dysphagia are analyzed, focusing on cervical spine pathology associated with dysphagia as severe cervical spine disorders and postural disturbances largely have been held accountable for deglutition disorders. Scoliosis, kyphosis–lordosis, and osteophytes are the primary focus of this review in an attempt to elucidate the link between cervical spine disorders and dysphagia. It is important for physicians to be knowledgeable about what triggers oropharyngeal dysphagia in cases of cervical spine and postural disorders. Moreover, the optimum treatment for dysphagia, including the use of therapeutic maneuvers during deglutition, neck exercises, and surgical treatment, is discussed.

Keywords Cervical spine · Oropharyngeal dysphagia · Scoliosis · Kyphosis–lordosis · Deglutition · Deglutition disorders

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The process of deglutition is an automatic response to the presence of liquids, semisolids, or solids in the oral cavity and is based on the manipulation of food. People generally are able to maintain a healthy condition of eating and drinking. On the contrary, the quality of life of those who experience swallowing difficulties is poor. The preparation and completion of swallowing are concluded in the oral, pharyngeal, and esophageal stages, and, as a consequence, unsuccessful or incomplete deglutition in any or all stages results in the condition known as dysphagia [1].

Dysphagia refers to a disorder that occurs at any stage of eating, starting from the detection of food in the buccal cavity up to the manipulation and swallowing of food of every consistency. Oropharyngeal dysphagia is caused by mainly structural or neuromotor abnormalities in the oral cavity, oropharynx, velopharynx, hypopharynx, and upper esophageal sphincter [2].

The most frequent causes of dysphagia are structural and functional disorders, lesions in the central nervous system (CNS) and peripheral nervous system (PNS), and psychogenic reasons. Oropharyngeal dysphagia has been reported as a complication of degenerative disorders, after surgery, respiratory disorders, chemoradiation, disorders in the metabolism that may lead to malnourishment and dehydration, and esophageal dysfunction. Finally, osteophytes of the cervical spine, malignancies, or simply dysphagia occurring in old age [3] due to normal age-related changes can cause deglutition disorders.

Apart from neurological disorders, chemoradiation for head and neck tumors is responsible for oropharyngeal dysphagia which is both a prevalent symptom and a side effect of prescription drugs and chemotherapy. Finally, dysphagia is often seen in the elderly [4]. From 40 to 70 % of stroke patients develop aspiration problems and silent aspiration occurs in 40 % of dysphagic patients [5].

According to a recent study, dysphagia appearing after a stroke resolved within 14 days in most patients [6].

Dysphagia can also be observed in patients suffering from cervical spine disorders such as scoliosis, kyphosis, lordosis, and vertebral degeneration with the presence of osteophytes and those with spinal cord injuries [7, 8]. Children suffering from craniovertebral abnormalities develop problems whose symptoms may include inability to thrive, weakness, basilar migraine, sleep apnea, scoliosis, cervical central cord syndrome, and dysphagia [9]. Therefore, all of these patients should be formally evaluated for dysphagia [10].

The purpose of this article is to present the available literature on the physiology of swallowing and the main pathologic factors that cause oropharyngeal dysphagia, especially those associated with cervical spine disorders, and to review the various diagnostic tools that help clinicians make accurate predictions about the severity of dysphagia and the recommendations of appropriate therapeutic techniques.

Pathophysiology of Swallowing

From a physiological and functional point of view, natural and unobstructed swallowing occurs in four distinct phases. The first phase is the preparatory phase during which the food is inserted into the mouth, melted, crushed, and mixed with saliva, and then situated on the tongue. The second phase, called the oral phase, transfers the bolus to the pharynx so as to trigger the swallowing reflex. Up until this point the process of swallowing is voluntary. The third phase is the pharyngeal phase during which the pharynx advances the bolus with a reflexive chain of movements. Finally, during the esophageal phase, the bolus is directed via primary and secondary peristalsis toward the stomach. The completion of these four phases guarantees effective swallowing. Dysphagia can occur in any of these four phases of swallowing [11].

Changes in swallowing are associated with the anatomy and physiology as well as a person's age. In addition, the coordination of respiration and swallowing ought to be checked as dysphagic patients interrupt the act of breathing while swallowing which may eventually give rise to aspiration [12].

To achieve effective swallowing, it is necessary to coordinate and control 50 muscle groups, 6 cerebral nerves (trigeminal, facial, glossopharyngeal, vagus, accessory, and hypoglossal), and 4 cervical nerves (C1, C2, C3, and C4) from the CNS. Injury to vertebral levels C2 and C3 may cause dysphagia, dysarthria, and tongue deviation due to hypoglossal nerve (HN) paresis, and impaired cough reflex from nerve-reduced innervation of laryngeal mucosa due to internal superior laryngeal nerve (ISLN) palsy [13]. Damage above C4 is not as common as in the lower cervical area; nonetheless, damage in the upper cervical structures can have severe consequences. The HN provides motor fibers for the extrinsic and intrinsic muscles of the tongue and, as a result, it is important in speech, deglutition, and airway protection [2].

The external superior laryngeal nerve (ESLN) provides ipsilateral motor fibers to the cricothyroid muscle which rotates the cricoid cartilage, thus regulating the tension of the vocal cords. Injury to the ESLN results in inability to tense the cords, voice fatigue, and dysphonia. The "swallowing interneurones (INs)" nuclei are located in two medullary regions: (1) a dorsal region, including the nucleus of the solitary tract and the adjacent reticular formation, and (2) a ventral region corresponding to the reticular formation surrounding the nucleus ambiguus. The dorsal INs are involved in the initiation and programming of swallowing. The ventral INs receive their swallowing input from the dorsal neurones and are probably switching neurones that distribute the swallowing excitation to the various pools of motoneurones. The swallowing program can be triggered by inputs originating from either the peripheral reflexogenic areas or the supramedullary structures (cerebral cortex, basal ganglia, and hypothalamus) [9].

Under physiological circumstances the swallowing process is continuously modified by peripheral afferents (especially muscular) that adjust the force and the timing of contractions to the size of the swallowed bolus. In addition, an important operating feature of the programming network consists of a functional polarization so that the activity of the proximal portions of the swallowing tract inhibits that of the distal portions. This polarization implies the existence of inhibitory connections between interneurones, which could be responsible for the series of delays that are typical of the swallowing contractile sequence, by generating delayed inhibitions followed by postinhibitory excitation. Lastly, the sensitive messages that trigger and adjust the swallowing program are, at the same time, conveyed to higher nervous structures allowing the so-called "voluntary" swallow and the integration of swallowing into the ingestive act. Disruption of this central loop is likely the source of swallowing disorders (dysphagia) following injury to cortical or subcortical structures [14]. It is important to note that a patient may experience dysphagia in one of the four phases or in a combination of phases and even in all phases.

Etiology of Dysphagia

The causes of dysphagia have been reported on extensively and are attributed to structural disorders, central and peripheral nervous system diseases, and psychological reasons.

Oropharyngeal dysphagia is a complex symptom with severe complications. Dysphagia includes difficulty managing boluses in the oral cavity and pharynx which results in drooling, leaking, laryngeal penetration, aspiration, retention, regurgitation, painful eating, and the feeling of a know in the pharynx [15]. The presence of oropharyngeal dysphagia in patients who suffered a stroke is associated with malnutrition, dehydration, pulmonary compromise, and increased hospitalization [16]. Aspiration is defined as the passage of material below the vocal folds and is associated with infiltration pneumonia, respiratory insufficiency and possible death, while penetration is when material passes into the larynx but not below the vocal folds; it can be associated with hoarseness [17]. The main cause of aspiration after the swallowing reflex is pharyngeal stasis. Food left in the hypopharynx or posterior glottis can be sucked into the airway during breathing, either by gravity or by milking of the arytenoids. The residue can also result from reduced pharyngeal contraction or tongue-base movement [18]. Dysphagia may also result from an enlarged thyroid gland, cervical hyperostosis, or ingestion of caustic material [19]. It has been noted that in patients suffering from acute tetraplegia, dysphagia is prevalent in less than half of them [20, 21].

Anterior cervical spine surgery (ACSS) may cause direct or retraction trauma to the recurrent laryngeal nerve, superior laryngeal nerve, or glossopharyngeal nerve, which causes complications such as early dysphagia for less than 1 month, prolonged dysphagia for more than 12 months, and hematoma [22]. Orthopedic surgeons and spinal neurosurgeons usually resort to anterior cervical discectomy and corpectomy to achieve neurologic decompression. Oropharyngeal dysphagia is most commonly seen as a postoperative side effect of these procedures. Peripheral nerves are also at risk for injury usually from traction or direct pressure on the brachial plexus or ulnar nerve [16]. Although previous reports have identified dysphagia as a potential complication of anterior cervical spine surgery, the nature of postoperative dysphagia and the reasons why it develops after posterior cervical spine surgery are not clear [8].

In trauma patients with halo-vests, increasing severity of dysphagia from mild to moderate is associated with longer days on the ventilator, days in the intensive care unit, and hospital length of stay. Patients with cervical fractures treated with halo-vest fixation have a significantly high incidence of dysphagia and aspiration, especially those that have either increased traction or hyperlordosis, particularly in the hyperextended position [23]. Dysphagia in trauma patients treated with halo-vests for c-spine fractures is common, associated with worse outcomes, and difficult to predict. A halo-vest placed at the hyperextended neck position worsens dysphagia by narrowing the pharyngoesophageal junction causing a delay in the pharyngeal transit time of the bolus [23].

Anterior cervical osteophytes often cause oropharyngeal dysphagia that is relieved after resection of the osteophytes via an anterolateral, extrapharyngeal approach. Very often anterior cervical osteophytes are present in elderly people, especially in cases of diffuse idiopathic skeletal hyperostosis [24]. The surgical approach to treatment is recommended after other causes of dysphagia have been excluded [25]. Several possible explanations for dysphagia by osteophytes have been reported: (a) simple mechanical obstruction, (b) when they are located opposite a fixed point of the esophagus such as the cricoid cartilage (C6 level) resulting in direct mechanical compression of the pharynx and esophagus, (c) inflammation in the immediate vicinity of the osteophyte and inflammatory reactions in the tissues around the esophagus, (d) due to pain and cricopharyngeal spasm, and (e) disturbances of normal epiglottis tilt over the laryngeal inlet by the osteophytes at the C3–C4 level. Most probably, a combination of some or all of these conditions is responsible for dysphagia in the presence of osteophytes [14].

Very often dysphagia and cervical spondylosis are seen at the same time but further investigation should be carried out to identify the true etiology of the dysphagia. Dysphagia usually interferes with swallowing in the pharyngoesophageal junction while osteophytes interfere with esophageal peristalsis [26]. With the use of fiberoptic endoscopic evaluation of swallowing (FEES), retention of solids in the pyriform sinus obstructed by an osteophyte can be seen [27].

Lesions in the cerebral area can impede voluntary mastication and the manipulation of the bolus in the oral phase. Cortical lesions in the precentral gyrus may cause contralateral impairment in oral motor abilities and contralateral compromise in pharyngeal peristalsis. Cerebral lesions affecting cognitive abilities can also cause swallowing problems [28]. As a result, early detection of dysphagia can help these patients overcome any swallowing problems and reduce the length of hospital stay, before psychosocial complications and others like dehydration, malnutrition, airway obstruction, aspiration pneumonia, and death develop [1].

Diagnosis of Dysphagia

In order to treat swallowing disorders, physicians and health clinicians first need to rely on the evaluation of the symptoms and problems that cause oropharyngeal dysphagia [20]. There are various screening tools used to accurately diagnose dysphagia. Their main objective is to differentiate the patients who are in danger of aspiration or penetration from those in whom drinking and eating can be deemed safe [29]. The early clinical evaluation of swallowing disorders can help find those at risk of aspiration so they avoid oral feeding, which may be detrimental to the patient [30].

The process of evaluation begins with screening procedures and then proceeds to a full bedside or clinical examination and then on to studies and/or procedures. Screening tends to identify the signs and the symptoms of oropharyngeal dysphagia, such as coughing, a history of pneumonia, particular diagnoses at greatest risk, and food squirting out of the tracheostomy, indicating aspiration, penetration, or the presence of residual food in the mouth. Bedside examination is significant insofar as it helps clinicians decide the degree of safety in oral feeding and can be instrumental in warning about the complications and results of the treatment used [1].

The bedside or clinical examination assesses the patient's (1) medical status, including nutritional and respiratory status; (2) information on the current medical diagnosis and past medical history, including awareness of the swallowing disorder, psychological status, and indications of the localization and the nature of the disorder; (3) anatomy, range, rate, and accuracy of the structures that participate in the swallowing process; (4) respiratory function and its relation to swallowing; (5) labial control in order to keep food in the mouth; (6) lingual control as it may affect the oral manipulation of food and the posterior transition of food through the oral cavity; (7) palatal function as it may affect the insertion of food into the nose during swallowing; (8) pharyngeal wall contraction, which may influence the movement of food through the pharynx and cause aspiration after swallowing; (9) laryngeal control since it may have an effect on airway protection and aspiration during swallowing; (10) general ability to follow directions and monitor and control behavior; (11) reaction to oral sensory stimulation, including taste, temperature, and texture; and (12) reactions and symptoms during attempts to swallow [12].

According to Halama [31], radiological esophagram, videofluoroscopy, flexible endoscopic examination, ultrasound examination, manometry, electromyography, scintigraphy, and 24-h pH monitoring are the main procedures for diagnosing dysphagia apart from a bedside examination. A fiberoptic endoscopic examination of swallowing (FEES) study is also used to accurately monitor swallowing problems.

The main radiographic procedure used in the study of oropharyngeal dysphagia is videofluoroscopy (VFS) of a modified barium swallow (MBS). Videofluoroscopy is the gold standard of exams at the physician's disposal used to establish and evaluate the mechanical consequences of oropharyngeal dysphagia and determine the structural and functional deficiency of the anatomy [24] involved in the swallowing process, and evaluate any disorders that have been afflicting the patient by administering different types of food, ranging from very liquid to solid. Moreover, the purpose of videofluoroscopy is to identify and evaluate treatment strategies that may immediately enable the patient to eat safely and/or efficiently [24] because swallowing is a dynamic and rapid process; thus, videofluoroscopy is particularly well suited to studying the physiologic function [13].

Videofluoroscopy can provide a quantitative measure of oropharyngeal disorders so the clinician can form a better idea about the severity of dysphagia [32]. However, although videofluoroscopy is a noninvasive test, use of it is limited because it requires a specially trained staff and a well-equipped laboratory [33]. There are certain cases in which videofluoroscopy is prohibited because of the nature of the patient's condition, e.g., those who are in the intensive care unit, those who cannot get into the right position during the examination or who are reluctant to cooperate, and those who are seriously ill and cannot undergo such an examination because the risk of aspiration might pose a serious problem [29]. In that case, FEES is the only tool that can be used to obtain comprehensive results about the patient's condition. FEES is performed with the patient sitting in the same position as when eating, while for bedridden patients the head of the bed is raised to 45° or more [29]. After the patient is positioned correctly, the flexible fiberoptic endoscope is inserted through the nasal cavity and liquid and semiliquid food with contrast is administered to monitor the passage of food throughout the digestive track.

A FEES study allows the imaging of the nasal cavity, the pharynx, the hypopharynx, and the larynx. It is administered in order to diagnose and affirm the suspicion of silent aspiration and inadequate bolus management and to select the appropriate compensatory and therapeutic techniques. The physician should be knowledgeable of the anatomy of the upper respiratory track, able to diagnose mechanical and neurogenic disorders, and possess the ability to comprehend behavioural disorders associated with dysphagia. The main advantages of FEES are that it is well tolerated, can be administered to bedridden patients, and can be repeated alongside therapy. Moreover, it provides clinicians with a clear picture of aspiration and with it they can monitor the effectiveness of therapy. On the other hand, it can cause patients to feel nauseous and in some cases it can lead to a heart attack following stimulation of the vagus nerve. In addition, neither the oral nor the esophageal stage can be depicted with FEES [11].

With bedside examination, videofluoroscopy, or FEES, the pulse oximetry test is carried out to determine the level of oxygen saturation. This test is a noninvasive way to perform the bedside swallowing test [34]. The oximeter probe is placed on the patient's finger, ear lobe, or forehead to monitor oxygen saturation during the administration of various consistencies of food containing barium and trace possible respiratory tract obliteration [11]. Although pulse oximetry during bedside evaluation offers inconclusive evidence [34] for predicting silent aspiration, it may be helpful if used in combination with other screening procedures [35].

Cervical Spine Kinematics-Biomechanics and Therapeutic Head and Neck Maneuvers to Improve Swallowing

Although many neck muscles contribute to stabilization and protection of the cervical spine, it is suggested that the deep cervical flexor (DCF) muscles (longus colli and longus capitis) are critical for the control of intervertebral motion and of cervical lordosis [36]. Therefore, any impairment of these particular muscles may cause problems in the swallowing process.

Modeling studies indicate that the activity of long strap-like superficial muscles (such as sternocleidomastoid) without concurrent activity of the deep muscles results in regions of uncontrolled segmental motion [33]. Recent data indicate that when people have neck pain, there are differences in the activity of the deep and superficial muscles of the cervical spine [28].

Several studies have reported the effects of head and neck positions on swallowing. Postures that compensate for difficulties in swallowing include the chin-down posture, head-back posture, head-tilt posture, and head rotation. The chin-down posture is an effective airway protection position for patients who exhibit a delayed initiation of pharyngeal swallow. Closure of the laryngeal vestibule during swallowing is important for the protection of the airways. Ekberg [37] described that flexion of the head enhanced closure of the laryngeal vestibule while swallowing, probably by altering the volume and shape of the laryngeal vestibule. The ability to protect the airways by tilting the epiglottis downward and blocking the laryngeal vestibule was studied with the head in different postures. Logemann et al. [34] reported that the incidence of aspiration decreased in patients with dysphagia related to cerebrovascular incidents when the patient flexed or extended the cervical spine. Patients with reduced tongue elevation or lateralization during videofluorography are instructed to tilt the head backward. Patients with delayed or absent reflexes are instructed to tilt the head forward. Patients with pharyngeal hemiparesis are instructed to tilt the head toward the stronger side and turn the body toward the weaker side.

Dysphagia and Cervical Scoliosis

Scoliosis is a three-dimensional [5] spinal deformity in which a person's spine is curved from side to side (more than 10° Cobb angle), which affects the morphology of the thorax and the mechanics of respiration [5], irrespective of age and gender. Scoliosis is typically classified as congenital, idiopathic, or neuromuscular. In the majority of cases, the causes of scoliosis are idiopathic and can be diagnosed by asking the patient to remove his shirt and bend forward to see if there is any prominence on the spine, then using a scoliometer, and then having weight-bearing full-spine X-rays taken. Cervical scoliosis may cause dysphagia, usually by damaging the patient's posture which causes constriction of the esophageal vestibule which may ultimately render the patient unable to swallow or severely disabled during the swallowing process. Sprengel's shoulder deformities can be accompanied with scoliosis and abnormal stature [38].

Klippel-Feil syndrome (KFS) (congenitally fused cervical vertebrae) coexists in approximately 53 % of cervical scoliosis patients. Approximately, one in two individuals suffering from KFS exhibit three main characteristics: short neck, low posterior hairline, and limited cervical range of motion. The most prevalent manifestation in patients with KFS is scoliosis [39]. The skeletal dysplasias are often associated with structural weakness and collapse of the skeleton [40].

From clinical observation of patients with unilateral neurological deficits of cerebral origin (e.g., infarcts, hemorrhage, traumatic brain injuries), the hemiplegic side of the cervical muscles is affected. The head is tilted to the healthy side and the shoulder of the healthy side is usually elevated compared to the hemiplegic side. These positionings lead to cervical spine curvature in the anteroposterior plane (i.e., scoliosis). Swallowing is more difficult with head and neck in this position as the mastication and deglutition muscles are in biomechanical dysfunction. It has been shown that isometric muscle exercises to strengthen the orofacial cervical muscles decrease the scoliotic deformity and the severity of dysphagia (anecdotal findings of our group). In patients suffering from severe scoliotic deformity of the cervical spine, there may be compression of the upper gastrointestinal tract and chronic progressive dysphagia may appear.

As far as children suffering from Chiari malformation type I are concerned, it has been observed that those aged 0–2 years commonly presented with oropharyngeal dysfunction (77.8 %), while children aged 3–5 years more frequently presented with syringomyelia (85.7 %), scoliosis (38.1 %), and/or headache (57.1 %) [40]. In addition, children with Chiari malformation or bony lesions at the craniocervical junction may develop oropharyngeal dysphagia and scoliosis [40, 41]. In many cases, halo traction and posterior occipitocervical decompression fusion successfully treat the dysphagia [42].

Scoliosis is a common complication in children with cerebral palsy (CP). In these patients, surgical correction carries a high risk of complications. CP is also associated with gastrointestinal dysmotility (such as delayed gastric emptying and gastroesophageal reflux) as well as dysphagia [43].

Adult patients with severe scoliosis secondary to familial dysautonomia developed oropharyngeal dysphagia and recurrent aspirations. Various imaging studies showed mechanical obstruction of the esophagus due to compression between the spine and the aorta [23]. For fetuses with myelomeningoceles, higher lesion levels were associated with dysphagia and scoliosis [44].

Dysphagia Following Cervical Spinal Cord Injury and Cervical Spine Surgery

Deglutition disorders are well-known complications of anterior cervical (AC) spine surgery and have been shown to persist for up to 24 months or longer. Lee et al. [45] reported that there is no universally accepted method of determining postoperative dysphagia. Daniels et al. [46] reported that the cervical plexus, ansa cervicalis, and all branches of the vagus are likely to be injured by the manipulation and retraction that is associated with AC spine injury.

Patients with injuries to the first or second cervical vertebra may have no sensory awareness of their swallowing difficulty. Occasionally, patients who have sustained a cervical spinal cord injury also exhibit problems in closing the airway entrance. Often, these problems are secondary to the reduction in anterior laryngeal movement. Problems with closure of the vocal folds occur infrequently in these patients and are usually related to direct laryngeal damage from the trauma or from the emergency airway management or are related to tracheostomy of more than 6 months, which can result in reduced vocal fold closure. These disorders may be exacerbated by the presence of a tracheostomy tube with the cuff of the tube inflated [44]. It has been noted that in patients suffering from acute tetraplegia, dysphagia is a prevalent symptom in less than half of them [21]. Although the relationship between dysphagia and tracheostomy is still not clear, many reports have commented that the presence of tracheostomy increases the risk of dysphagia in cervical spine cord injury patients through increased prevalence of chronic diseases or a change of organ function [47].

The incidence of dysphagia and dysphonia following an anterior approach to surgery and their effective treatment have been reported on extensively [48]. Dysphagia is a well-documented complication associated with anterior cervical discectomy and fusion (ACDF) and observed in as high as 50 % of cases by videofluoroscopic evaluation postoperatively. Riley et al. [49] found that dysphagia was present in 53.2 % of patients 1 month after ACDF, 19.8 % after 6 months, and 16.8 % after 12 months. At the same time, Bazaz et al. [50] found that dysphagia was prevalent in 50.3 % of patients 1 month after the procedure, 17.8 % continued to experience dysphagia 6 months after anterior cervical spine surgery, and 12.5 % still complained of dysphagia a year after surgery.

Dysphagia may result postoperatively from a variety of etiologies, including hardware displacement, pharyngeal edema, or vocal fold paresis. The patients who were surgically treated for cervical spine disorders by either an anterior approach or a posterior approach and who developed oropharyngeal dysphagia, the dysphagia was significantly higher during the first postoperative month and progressively decreased over time [51]. Anterior cervical plating results in significantly greater intraesophageal pressures when performed at C5–C6 compared to C3–C4. This holds regardless of whether the plate spans the distance from C3 to C6 (3-level plate) or the single C5–C6 level. In addition, the insertion of the cervical disc replacement seems to require less esophageal retraction and hence reduced intraesophageal pressure when compared to anterior cervical plating [52]. Patients in whom a posterior or combined approach was used had a disproportionately high rate of swallowing disorders [53].

Delayed pharyngoesophageal perforation is a rare complication following anterior cervical spine surgery. It is common for patients to spend weeks and maybe years suffering from less direct symptoms like dysphagia and neck pain [54]. Swallowing difficulties may ensue after esophageal injury due to surgical retraction [52]. Pharyngoesophageal diverticulum is a rare complication following ACDF. Such diverticula after ACDF surgery may have pathogenesis that is distinct from that of typical Zenker diverticula [55].

Oropharyngeal dysphagia after cervical surgery diminishes the patient's quality of life and may lead to inadequate caloric intake and subsequent malnourishment. Significant risk factors for dysphagia after cervical surgery include old age, a high-level injury, a complete injury, tracheostomy or use of a ventilator, and a multilevel operation. It remains unclear whether an anterior approach is a risk factor. The many reports that have examined the etiology of dysphagia after cervical surgery suggest that the causes of dysphagia are multifactorial [56].

Dysphagia and Cervical Kyphosis–Hyperlordosis

Lordosis and kyphosis are sagittal plane disorders of spinal alignment. Cervical lordosis is a Cobb angle normally between 20° and 60°. Hyperlordosis is excessive lordosis of the cervical vertebral column. Oropharyngeal stenosis is speculated to be closely related to dysphagia after O–C fusion or OSA as occipital–upper cervical alignment has an effect on the oropharyngeal space but not the lower cervical alignment. The O–C2 angle represents the upper cervical lordosis and the C2–C7 angle represents the middle–lower cervical lordosis [8]. The reduction of the O–C2 angle makes the mandible change position and adopt a posterior one, resulting in airway stenosis [57]. Postoperative dysphagia after ACDF was caused by oropharyngeal stenosis resulting from O–C2 fixation in a flexed position due to suboptimal alignment of the craniocervical junction [4].

Moreover, the overenlargement of cervical lordosis may cause posterior pharyngeal wall bulging which could reduce pharyngeal space and impair pharyngeal squeeze and laryngeal elevation [8]. The chances of severe dysphagia increase when the problem is localized in the C2–C7 angle. Cervical kyphosis (reversal of normal lordosis) may inhibit horizontal gaze function, impede activities of daily living, and induce disabling pain. At the end stage, a few patients may have difficulty breathing and swallowing [58]. Oropharyngeal dysphagia is an indication for surgery in patients with cervicothoracic kyphosis. Cervical kyphotic deformities can occur at any age and may be associated with thoracic or lumbar deformities [59].

Although the exact correlation between dysphagia and occipitocervical fusion is not clearly known, total sagittal alignment of the cervical spine is instrumental in avoiding these complications [57]. Carlos et al. reported that patients who experienced occipitocervical arthrodesis developed significant dysphagia. In addition, patients who have been in a fixed kyphotic position for a prolonged period of time may suffer from contractures of the suprahyoid musculature, causing biomechanical compromise in a relatively neutral position that is similar to that described by hyperextension under normal conditions [32].

Dysphagia also occurred as a result of compression at the cervicomedullary junction by a craniovertebral junction malformation with kyphosis and impingement of the pharynx by the tip of the odontoid process [55]. It is likewise important to recognize that infants and toddlers with "torticollis" must be suspected of harboring abnormalities at the craniovertebral junction (CVJ) border. Diseases such as Down's syndrome have a 14–20 % incidence of atlantoaxial instability. A wide variety of congenital, hereditary, developmental, and acquired anomalies exist at the CVJ either individually or in combination [40].

Dysphagia and Anterior Cervical Osteophytes

Osteophyte is the medical term for the overgrowth of bone tissue; the more common term is bone spur. Osteophytes are small round lumps that grow around joints; they are the body's attempt to compensate for bone and ligament degeneration resulting from an injury or age. Osteophytes are most often around the spine but they may be found on any bone in the body. In many cases, an individual with osteophytes may never suffer any symptoms; the vast majority of patients with cervical osteophytes are asymptomatic. However, in a small subset of patients this condition may lead to upper respiratory/digestive compromise that manifests as dysphagia and/or airway obstruction. Conservative medical therapy is usually sufficient, but patients with intractable disease may require surgical intervention, including tracheostomy, feeding tube placement, or osteophytectomy [60].

It has been reported that large osteophytes cause deglutition disorders due to neuromuscular dysfunction or mechanical obstruction as a result of the osteophytes [61]. Symptoms of osteophytes on the upper part of the vertebrae in the neck region include headaches, dizziness, and general neck pain. These osteophytes have been associated with serious complications. It has been found that anterior cervical osteophytes may be an uncommon cause of life-threatening dysphagia and potential lung aspiration, especially in elderly patients [18].

One of the most common causes of anterior cervical bony outgrowths is diffuse idiopathic skeletal hyperostosis (DISH) [36], a rare condition that causes dysphagia in 28 % of cases because of esophageal compression [62], and, occasionally, dyspnea [63] and ankylosing spondylitis (AS). Degenerative conditions and DISH may lead to osteophyte-associated dysphagia and/or airway complaints [60]. There was a high risk of the recurrence of osteophytes after surgical resection in patients with cervical DISH and dysphagia [64]. Patients with osteophytes of the cranial vertebrae of the cervical spine (C3/4/5) might complain about recurrent coughing and choking when drinking. The most frequent level of involvement related to dysphagia is C5–C6 followed by C4–C5, with C2–C3 being the least common level affected. This condition occurs more frequently in men than in women, and typically when they are in their 60 s. Anterior osteophytes, when large enough, may compress or displace the esophagus and/or the trachea and the patient may complain of dysphagia, odynophagia, dysphonia, a sensation of a foreign body in the throat, or a constant urge to clear the throat. Aspiration of liquids or solids, airway obstruction, stridor, and obstructive sleep apnea have also been reported as presenting symptoms of cervical osteophytosis.

Dysphagia caused by anterior cervical spine disorders is usually more severe with solids than with liquids. However, aspiration in these conditions may be greater for liquids than for solids [27]. Foreign body sensation may be caused by mucosal abrasion as food passes over a protruding osteophyte. Odynophagia may result from hypopharyngeal ulceration at a point of pressure between the posterior cricoid cartilage and a protruding osteophyte. Dysphonia or airway obstruction may result from laryngeal edema, arytenoid ankylosis, or vocal cord paralysis caused by an osteophyte at the cricoid level. Obstructive sleep apnea and stridor may result in impingement of the osteophyte on the laryngeal vestibule [27]. Seidler et al. [27] reported that osteophytes of the anterior face of cervical vertebrae cause a deglutition disorder. In addition, anterior cervical osteophytes accompanying DISH are most frequently asymptomatic. Large osteophytes, however, do cause swallowing disorders through a variety of mechanisms as outlined above [51].

Treatment of Dysphagia

There is increasing social demand for the development of better rehabilitation treatment of dysphagic patients. Effective treatment of dysphagia can be achieved as part of the evaluation and successful management by an interdisciplinary team, beginning with the speech language therapist. To successfully treat oropharyngeal dysphagia, physicians have compensatory techniques, sensory awareness stimulation, consistency modification, and maneuvers at their disposal. Many of the existing screening tools focus on distinguishing patients who aspirate from those who do not, but the need has arisen for a more comprehensive tool that will also identify the stage of the disorder as well as patients with pharyngeal delay and a pharyngeal-stage swallowing problem [34].

For treating patients with dysphagia associated with cervical spine and postural disorders, physicians most commonly resort to modifying the food consistency and train the patients to perform orofacial and neck exercises if they are aware, cognitively intact, cooperative, and able to maintain a correct sitting position. Moreover, the clinician assesses voluntary cough, ability to manage excrement, absence of hoarseness and dysarthria, laryngeal elevation, oral hygiene, swallowing reflexes, and the anatomy and function of structures. Postural techniques can be used when there is reduced tongue movement and an inability to promote the bolus toward the posterior position. The purpose of the different head tilts (i.e., head back, chin up, chin down, head rotation) varies from blocking the airway to promoting the bolus backward with the aid of gravity. Infrequently, patients with cervical spine disorders are able to modify their head and neck position to facilitate deglutition due to internal (surgical) or external (bracing) immobilization.

Sensory awareness techniques are used for reduced oral sensation and delayed pharyngeal reflex with the aim of enhancing oral sensation and activating the pharyngeal reflex. Thermal tactile stimulation aims at activating the swallowing reflex with the use of a laryngeal mirror dipped in ice prior to the examination. This oral sensory awareness technique may include the use of cold lemon juice or crushed ice, both of which are used to treat reduced oral sensation, swallowing apraxia, and the inability to recognize food. To enhance sensory awareness, a spoon is used to apply force while pressing the tongue down, alternating between hot and cold boluses and supporting self-feeding with boluses that require chewing.

Swallowing maneuvers protect the airways and increase the function of the anatomical structures that participate in all stages of swallowing. The swallowing maneuvers are categorized as supraglottic, super-supraglottic, effortful swallow, Mendelsohn maneuver, Masako technique, and Shaker technique. The supraglottic swallow is designed for reduced late vocal fold closure and delayed pharyngeal swallow. The super-supraglottic swallow is designed for reduced closure of the airway entrance. The effortful swallow is used for reduced posterior movement in the tongue base. The Mendelsohn maneuver is instrumental in treating reduced laryngeal movement and uncoordinated swallow. The Masako technique is designed to improve the control, strength, and movement of the tongue base, reduce the food remnants in the pharyngeal wall, and reduce the risk of uncontrolled bolus flow to the pharynx. The Shaker technique is ideal for patients with reduced laryngeal elevation and reduced elevation of the hyoid bone. There are also some behavioral techniques that can be used to avoid aspiration when there are food remnants, including rinsing with water and multiple swallows [12] and changing the food consistency. The technique used is heavily dependent upon the results of the screening and evaluation process [65].

To date, many dysphagia diets have been developed and are available commercially to help bring back the pleasure of mealtime to dysphagia patients. Texture modification of food to make the food bolus easier to swallow with less risk of aspiration is one of the important elements of dysphagia diets [10]. Ice massage is widely used as a prefeeding technique to facilitate dry swallowing, to improve swallowing apraxia for initiating the swallowing action, and in daily swallowing training [66].

Preventive measures to avoid postoperative dysphagia include the preoperative use of steroids, the avoidance of extreme esophageal traction intraoperatively, the use of low-profile anterior cervical plates, and close monitoring of endotracheal tube cuff pressure [49]. Surgical treatment of dysphagia is rarely the treatment of choice. In case of persistent dysphagia due to postoperative hematoma following ACDF, drainage of the hematoma is the treatment of choice [16]. When dysphagia is caused by anterior osteophytes obstructing the esophagus, as in cases of DISH, then surgical excision of the osteophytes is indicated [67].

There are many surgical approaches that can be used when dealing with C3 pathologies. The anterior retropharyngeal approach is the most optimum one for the upper cervical spine. This approach is used mainly when the injury afflicts the hypoglossal and mandibular branch of the facial nerves and there is hypopharyngeal penetration [13]. The anatomical differences of the neurovascular structures (especially the left and right inferior laryngeal nerves) in the lower anterior cervical region with respect to the left and right side have led spine surgeons to opt for an anterior cervical (Smith-Robinson) left-sided approach as discussed below [13].

The management and treatment of dysphagia among geriatric patients is complicated by their cognitive decline, lowered immunity, malnutrition, and end-of-life decisions [68].

Discussion

Oropharyngeal dysphagia is one of the most common symptoms affecting people suffering from cervical spine disorders [16].

Dysphagia deteriorates not only the patient's health but also his quality of life and that of his immediate family. Much research has been conducted for diagnosing, evaluating, and suggesting multiple forms of treatment with the aim of offering the best possible therapy for the patient. The most prominent features of dysphagia are difficulty in swallowing, hoarseness, weight loss unaccountable by other causes, persistent coughing, a feeling of choking during swallowing, and aspiration pneumonia [12]. Thus, it is important for the clinician to be able to accurately identify the presence of dysphagia, and when dysphagia is attributed to injury rather than degenerative pathology, prompt diagnosis can ensure successful treatment.

Cervical spine disorders, including lordosis, hyperlordosis, kyphosis, scoliosis, and osteophytes, can result in swallowing problems whether or not there is also a head injury [58]. Scoliosis may cause dysphagia by damaging the patient's posture while constricting the esophageal vestibule. During anterior cervical spine surgery, the cervical plexus, ansa cervicalis, and all the branches of the vagus are traumatized by the manipulation and retraction. Lordosis and hyperlordosis may invariably cause dysphagia by reducing the retropharyngeal space and impairing pharyngeal squeeze and laryngeal elevation. Kyphosis compresses the cervicomedullary junction malformation. Finally, osteophytes trigger deglutition disorders due to neuromuscular dysfunction or mechanical obstruction.

Cervical spine disorders can have a degenerative or a traumatic cause and may be treated either surgically via an anterior or a posterior approach to relieve pressure on the structures that involve deglutition, or conservatively by therapy exercises and modifications to the head–neck posture and food consistency with a goal of improving the quality of life by alleviating pain. Lordosis, kyphosis, and scoliotic deformities with or without the presence of osteophytes are spinal alignment disorders that precipitate effective swallowing and may even cause difficulty in breathing in severe cases [59].

Patients with cervical degenerative or postural disorders who are suffering from dysphagia frequently have reduced range of motion of their cervical spine. For example, patients with ankylosing spondylitis and kyphotic posture cannot extend their neck and have limited flexion. Similarly, patients with cervical spondylosis and anterior osteophytes more or less have a rigid cervical spine with restricted mobile spinal segments, thus limiting motion in all planes, i.e., flexion extension, lateral flexion, and axial rotation. In such patients, the protective compensatory positions of the head and neck that are needed for safe deglutition cannot be sustained, adding to the problem of treating dysphagia.

The basic procedure for assessment of oropharyngeal dysphagia is based on the bedside examination, which involves watching the patient's general behavior, taking the medical history which may include a screening dysphagia questionnaire, and observing the patient's control of reflexes and ability to participate in the evaluation procedure. VFSS and FEES can be used to further evaluate dysphagia. Spinal alignment can be assessed by plain anteroposterior and lateral sitting or standing cervical radiographs [4]. The treatment used is based on the patient's general situation and the severity of his/her problems. Actually, the success of the therapy depends on the seriousness of the illness, the type and severity of dysphagia, and the individual's mobility, emotional and psychological situation, cognitive and respiratory condition, ability to follow instructions, and reaction to compensatory techniques. Moreover, it is absolutely necessary for the patient to have a very supportive environment to encourage him during treatment.

Swallowing therapy is usually designed to retrain muscle function, teach a new sequence of muscle activity, or stimulate increased sensory input. The strategy is oriented toward the patient's needs in order to select the most optimal therapeutic procedure. It consists of a number of compensatory techniques for the function and rehabilitation of dysphagia, modified food consistency, and some maneuvers appropriate in special circumstances [45].

Head–neck posture is vital in swallowing therapy; the patient must maintain a neutral head–neck alignment while in the sitting position. Chin-down posture, head-back posture, head-tilt posture, and head rotation are all effective in effecting the airway protective position. Isometric neck exercises to strengthen the neck muscles will give better support of the head and facilitate swallowing exercises, especially for patients with upper esophageal sphincter (UES) dysfunction [19]. The therapist should use every therapeutic method that has been proven to be most effective based on scientific knowledge; however, each method is different from one patient to another. Sometimes there is a need to combine therapeutic techniques and strategies for improved results.

Our study, incorporating all the published evidence, reveals a knowledge gap regarding the diagnosis and treatment of dysphagia in patients with cervical spine disorders. Most of the currently available studies are of low methodological quality and there was no available randomized clinical trial that focused on dysphagia and cervical spine disorders or postural disturbances. The paucity of the retrieved evidence did not allow for quantitative analysis. In addition, the mean follow-up time in the aforementioned studies was short, and as a consequence, the authors could not determine the long-term effects of cervical spine problems on oropharyngeal dysphagia. Our study indicates that, in the medical literature, there are no high-quality, consistent research findings on the incidence and treatment techniques of cervical spine disorders and postural disturbances.

Further research is needed in a prospective mode to answer the following questions: (1) what is the true incidence of dysphagia among patients with degenerative cervical spine disorders appearing in spinal departments, (2) what is the best treatment for patients with dysphagia and restricted range of motion of the head and neck, (3) what are the indications for surgical resection of anterior cervical osteophytes (in terms of osteophyte dimensions and severity of dysphagia) for the treatment of dysphagia caused by them, and (4) does cervical spine strengthening exercises benefit patients with dysphagia originating from cervical spine disorders?

Conclusions

Undeniably, there is a strong correlation between oropharyngeal dysphagia and cervical spine disorders necessitating interdisciplinary clinicians to accurately diagnose the type and severity of dysphagia and suggest the optimal treatment that includes rehabilitative nonsurgical and surgical intervention techniques. Because of the lack of high-quality evidence, further research is needed on cervical spine patients suffering from dysphagia.

Conflict of interest The authors have no conflict of interest to disclose.

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