

Swallowing Disorders Related to Vertebrogenic Dysfunctions

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1. Introduction

In recent years, a growing interest in functional gastrointestinal problems can be noticed. In Western Europe, there is prevalence of functional disorders of the gastrointestinal tract in nearly 40% of the population. In Great Britain, 8 to 10% of patients visiting general practitioners have gastrointestinal problems, and approximately 50% of these are functional disorders (Becker & Aroldo, 1990). In the United States, 14% of the population are treated annually for functional gastrointestinal disorders, and in 50 to 70% of patients sent to a gastroenterologist, no significant pathology is detected (Mathias & Clench, 1995).

One of the seldom explored disability symptoms related to functional gastrointestinal problems are swallowing dysfunctions that are difficult to verify and quantify. Swallowing problems are often underestimated and attributed to psychological problems or negative mechanical effects of spinal morphological changes. The aim of our overview is to describe in detail the relationship between clinical disability of locomotor system and functional dysphagia.

2. Functional disorders of the gastrointestinal tract

The digestive tube is one of the systems most affected in terms of functional disorders. Rich gastrointestinal tract innervation of mainly vegetative nerve fibers is closely connected with and thereby influences function and activity of the central nervous system.

Gastrointestinal tract disturbances can be divided into esophageal (chest pain, functional heartburn, functional dysphagia), gastroduodenal (functional dyspepsia, etc.), intestinal disorders (irritable bowel syndrome, functional constipation or diarrhea), functional abdominal pain, biliary disorders, and anorectal disorders. In terms of pathogenesis, functional gastrointestinal motility disorders, visceral hypersensitivity, and intolerance to certain food components have been cited as principal contributing factors. Although musculoskeletal changes occur in approximately 60% of patients with functional bowel disorders, relatively little research has examined vertebrovisceral functional relationships.

3. Anatomy and function of the esophagus

The esophagus is a muscular tube that can be divided into three anatomic areas: The pars cervicalis, pars thoracica, and pars abdominalis. It has two layers of muscles - the inner circular and outer longitudinal. The proximal portion of the esophagus consists of striated muscle, distal smooth muscle, and a middle part consisting of smooth and striated muscles.

In terms of nerves, the esophagus is innervated from the plexus esophageus that consists of a large number of nerves of different diameters covering the area from the nn. vagi via nn. laryngei recurrentes. Branches provide connections with four or five cranial ganglia of the upper section of truncus sympathicus. These are autonomous fibers with a smaller component of sensory fibers. Plexus esophageus is located on the surface of the esophagus and continues caudally to truncus vagalis anterior and posterior. Both front and rear truncus vagalis contain left and right vagus nerve fibers.

Afferent signals apparent during the swallowing reflex are directed from sensitive fibers of the trigeminal nerve, n. glossopharyngeus and n. vagus. Efferent arm is successively comprised of the nerve hypoglossal motor fibers, n. trigeminus, n. facialis, n. glossopharyngeus and the n. vagus.

In terms of functions, the esophagus can be divided into the upper esophageal sphincter, the muscle's own tube (body), and the lower esophageal sphincter. All these parts play an important role with the following functions: Transport and swallowing, removal of gastric contents, and prevention of tracheobronchial aspiration.

Swallowing is divided into three phases:

An oral phase, which is a voluntary act that proceeds as the food or liquid is shifted towards the larynx.

A pharyngeal phase in which the muscles of the larynx and pharynx close all openings except the Killian sphincter where the food is passed.

An esophageal phase. Shortly after the contraction of the pharynx, the upper sphincter of the esophagus flags at about 0.5 seconds and at this time it creates a primary peristaltic wave. In about two seconds, the lower esophageal sphincter is extended and then relaxed for 5 to 10 seconds. Relaxation is terminated with a contraction lasting about a tenth of a second. In addition to the primary peristaltic wave, there is a secondary peristaltic contraction that forces regurgitated food or liquid. During swallowing, the upper sphincter closes periodically.

In the first phase of the voluntary swallowing act, food is transported from the mouth into the pharynx by the tongue's pressure against the palate with lips and teeth together. The tongue and soft palate shape the food during this process. Cranial hyoid bone muscles raise the hyoid bone with pharynx. The bite of food then inches behind the isthmus faucium and the second phase begins.

The second phase is involuntary reflex and begins as the soft palate makes contact with food or liquid. The soft palate rises and stretches along the upper pharyngeal constrictors closing the nasopharynx from the oral cavity. Mm. constrictores pharyngis (medius et inferior) shift the food, mm levatores rise up the pharynx with the larynx, the epiglottis is bending, and closes before the food passes the aditus laryngis.

In the next phase, which is a continuation of the swallowing reflex and is not considered a separate phase, the lower pharyngeal sphincter activity shifts the bite to the beginning of the esophagus, followed by transport due to esophageal muscle activity. Elevated pharynx and larynx return caudally. At the same time, swallowing ventilates the middle-ear cavity. Transport of food from the mouth into the upper esophagus is related to the coordinated relaxation of the upper esophageal sphincter, which is a consequence of inhibitory signals from the masticatory center through n. vagus. Sphincter tone can be influenced by local factors such as pH in the esophagus.

In the third phase, food is propelled by the coordinated peristaltic wave of esophagus muscles that move aborally at the rate of 3 cm/s when the lower esophageal sphincter is relaxed. Peristaltic wave speed is affected by many factors, especially by the temperature and volume of the swallowed food. If the interval between swallowing two mouthfuls is less than 10 seconds, swallowing is often not followed by a peristaltic wave.

The lower esophageal sphincter is a smooth muscle area with a length of 3 cm that separates the esophagus from the stomach. It prevents reflux of gastric contents back into the esophagus during swallowing and performs coordinated relaxation allowing the passage of food from the esophagus to the stomach. Its activity can be influenced by myogenic, neural, and humoral factors. The pressure increase is caused by gastrin, motilin, prostaglandin, and histamine. By contrast, a reduction occurs under the influence of cholecystokinin, secretine, glucagone, progesterone, neurotensin. The physiological significance of some of these substances is questionable.

The function of the esophagus is affected by autonomic innervation activity. The enteric system is relatively independent and regulates many functions of the digestive tube. Enteric system (myenteric and submucous) is under the influence of signals from CNS and receptors in the tube wall (mechanoreceptors, chemoreceptors, and thermoreceptors) (Bharucha & Camilleri, 2003, Bielefeldt & Gebhart, 2004).

The autonomic nervous system does not work separately from cortical and subcortical structures. The peripheral autonomic nervous system function is subject - to a large extent - to the regulations of the central nervous system (except the voluntary control), which provides a comprehensive and targeted response. Another function of the digestive tube modulation is the relationship between the enteric nervous system, central nervous system, and the immune system in the gastrointestinal tract. This can explain the influence of stress on the occurrence or worsening of symptoms in the digestive tract.

4. Differential diagnosis of swallowing disorders

Dysphagia is a symptom of numerous organic and functional disorders. Impaired swallowing can be high (oropharyngeal) or low (esophageal). Organic dysphagia is characterized by permanent dysphagia (stricture, tumor). Functional dysphagia is that one caused by motility disorders (usually spasms) and has the character of intermittent problems. With these distinct characteristics, patient's history is important in terms of a major or single base diagnosis. The causes of dysphagia are varied and numerous.

Obstructive swallowing disorders: Esophageal tumor, extramural compression, congenital abnormalities (stenosis, atresia), inflammation, trauma (burns, scars, foreign bodies).

Non-obstructive swallowing disorders: Neuromuscular diseases (pseudobulbar syndrome, bulbar syndrome, lower motor neuron dysfunction, neuromuscular disorders, muscle disease), autoimmune disease, achalasia, idiopathic spastic dysphagia, psychogenic and functional disorders.

The most common types of non-obstructive swallowing disorders are:

- Motility disorders in diabetic neuropathy, alcoholism, psychiatric illness.
- Scleroderma – an autoimmune disease that causes weakening of the esophagus tissues.
- Achalasia – with the loss of ganglion cells in the wall, increases the tone of the lower sphincter at first (loss of inhibitory stimuli), followed by the loss of peristalsis in the proximal parts of the esophagus with subsequent accumulation of food and dilation of the esophagus.
- Primary esophageal spasm with unclearly identified pathophysiology – diffuse spasms that block the transport of food and fluids through the esophagus, leading to an increase in lower esophageal sphincter tone and nonspecific motility disorders.
- Functional and psychogenic dysphagia – no signs of organic impairment, it may be associated with stress.
- Age-related changes in motor function of the esophagus.
- Inflammation associated with the use of drugs (pill esophagitis).
- Inflammation associated with gastroesophageal reflux.

Sometimes, globus pharyngicus (hystericus) is classified as a functional swallowing disorders. Patients describe sensation of a lump in the throat with a characteristic absence of dysphagia. The food does not stick in the throat and fluids pass freely when swallowing, this condition can alleviate symptoms. Some studies suggest an increase in upper esophageal sphincter pressure or abnormal mobility of the hypopharynx. The occurrence of these problems is usually associated with psychosocial factors, especially depression and anxiety. Medical treatment usually does not bring relief, although patients may benefit from psychotherapy.

5. Vertebral dysfunction in relation to internal organ disease

Vertebral dysfunction is caused by a combination of morphological and functional disorders. The musculoskeletal system has passive components (bones, joints, ligaments) and active components (muscles, fascia). These components create static and dynamic spinal function. Vertebral disorders should not be considered as only morphological disturbances. Functional disorders of the intervertebral joints, movement problems, altered muscle tone status and abnormalities may also be classified as vertebral disorders. Morphological and functional disorders should therefore be considered simultaneously, as symptoms for both dysfunctions frequently appear together (Lewit, 2010)

Vertebrovisceral relations are determined by segmental somatic and autonomic innervation. Myotome, dermatome, viscerotome, and sclerotome are innervated in each spinal segment. Failure in one of the reflex arc sectors often causes dysfunction in parts or the entire segment. In terms of etiopathogenesis, two types of functional disorders are generated. If there is a primary spinal defect which reflexively induces changes in viscerotome, we can simply, although not precisely, refer to vertebrovisceral syndromes. Reflective changes in the spine lead to a number of significant clinical manifestations-primarily pain along with

other symptoms (Nansel & Szalazak, 1995). The musculoskeletal system can cause problems that mimic symptoms of visceral organ disorder.

We refer to viscerovertebral syndromes when there are primary defects in the visceral organ which can cause segment changes and changes in the functional state of the axial organ. The internal organ problems may cause changes, such as changes in muscle tone, tendons, fascia, subcutaneous tissue, and skin. Often it is difficult to establish a differential diagnosis that distinguishes the primary cause, and inaccurate or erroneous treatment could be the consequence.

In very broad terms, the four possibilities should be envisaged:

1. The spinal column (motion segment) is causing symptoms that are mistaken for visceral disease.
2. Visceral disease is causing symptoms that are interpreted as a lesion in some part of the locomotor system.
3. Visceral disease is producing changes in the locomotor system, such as movement restriction, etc.
4. A disturbance in the motion segment is triggering visceral disease or (more likely) is activating already latent visceral symptoms (hypothetical).

The first two points highlight the necessity for precise differential diagnosis and the problems associated with this. The spinal column with its motion segments can in fact produce symptoms that may mimic symptoms arising in the viscera. If such symptoms stem from the motor system, it is not surprising that drug treatment aimed at organic visceral disease fails. This causes frustration in many patients as the true cause of symptoms is not recognized (Nansel & Szalazak, 1995; Hülse, 1991).

If the mechanism causing visceral dysfunction is disturbed function of the motor system, better understanding of this would be of great practical interest, as more effective treatment by the technique of musculoskeletal (manual) medicine would be more widely applied.

Point 2 is the warning that pain perceived in the locomotor system may be a deceptive sign masking serious underlying visceral disease. This suspicion is strengthened if the symptoms of spinal segmental disturbance tend to relapse repeatedly without obvious cause. While the error in point 1 is more common, that in point 2 is all the more fraught with danger.

Point 3 is of major theoretical significance and demonstrates that visceral disease is actually one of the possible causes of dysfunction in the motion segment. Clinical experience teaches that certain visceral diseases are associated with characteristic patterns in the locomotor system. They are so specific that their recurrence is in all probability predictive of a recurrence of the visceral disease.

Point 4 it would seem justifiable to assume that lesion in a motion segment of the spinal column may impair function in the corresponding internal organs. This is borne out by the vasomotor response in the whole segment to which pain is referred. In such cases we can see the disorder clearing up as soon as we treat the motion segment. Reactions of this kind have been noted particularly in connection with the cervicocranial syndrome, especially at the craniocervical junction, including disturbances of equilibrium. Similar phenomena have been observed in connection with certain cardiac arrhythmias. A motion segment dysfunction may activate latent disease in an internal organ. Multiple pathogenic factors

may also need to be considered in terms of their cumulative impact. As well as those that affect the locomotor system, other factors may be important in terms of their influence on the organism as a whole, for example infections, metabolic disturbances, diet, etc. None of these individual factors on its own would be sufficient to provoke disease but it is legitimate to refer to them as risk factors (Lewit 2010).

Motor system statics and dynamics are dependent on the physiological state of central regulatory mechanisms. Pain and stress play important roles. Chronic state pattern and disability severity are not represented with an individual musculoskeletal disorder, and the clinical picture is affected by the patient psychological condition. Vertebrovisceral relations are very complex. In many cases pathogenesis is due to more than one factor, and it is better to speak of disease with vertebrogenic factor (Lewit 2010).

In the medical literature the spinal column is mainly mentioned as a cause of dysphagia in the form of a possible mechanical obstacle causing compression of the esophagus by anterior osteophytes: they are believed to produce both dysphagia and dysphonia and even difficulty in breathing (Kodama et al, 1995; Krause & Castro, 1994, Richter et al., 1995; Valadka et al., 1995). Hughes (Hughes et al., 1994) even described patients in whom osteophytes caused dysphagia combined with apnea during sleep. Fuhrmann (Fuhrmann & Neufang, 1994) described similar cases due to disk protrusion. In such cases even surgical treatment was considered. Retropharyngeal hematoma, too, has been described, causing dysphagia and hoarseness (Shaw, 1995). Therefore it is mandatory to have the patient thoroughly examined clinically and by X-ray, ultrasound and esophageal endoscopy, etc.

6. Vertebral dysfunction and functional disorders of the esophagus

Vertebrovisceral relations are seldom explored as possible etiological factors of gastrointestinal tract functional disorders. Musculoskeletal changes occur in approximately 60% of patients with functional bowel disorders. Pain of the cervical and upper thoracic spine is often referred to as a focal point in terms of vertebrovisceral relationships. Functional dysphagia represents intermittent problem caused by motility disorders (usually spasm). In a patient group with evidence of spinal and thoracic, cervical dysfunctions and swallowing problems, functional dysphagia was quantified by measuring the dynamic esophageal scintigraphy detected with prolonged passage of marked fluid (Hep et al., 1999).

Disorders of the upper cervical spine are sometimes associated with the emergence of the swallowing difficulty termed globus pharyngicus, which is considered one of the functional disorders. In the past, the relationship between cervical spine disability, dysphonia, and globus formation was described. This relationship is a vertebrovisceral-induced impairment of the spine in the C 1- 4 segments. Globus is a typical syndrome for hyperfunctional dysphonia. Therefore, it is not accurate to designate or consider globus hystericus as a symptom of hysteria (Becker & Aroldo, 1990).

Functional dysphonia is associated with dysfunction of the upper cervical spine. Innervation of the vocal cords through n. laryngeus superior and n. laryngeus recurrens has no relationship with the disability of the spine but cervical spine changes have influence on a number of other muscles and thus affect the relative position of laryngeal cartilage and the tonus of vocal ligaments. They are innervating m. geniohyoideus of segments C1 and C2 (n. hypoglossus), followed by m. omohyoideus, m. sternohyoideus, m. thyreochoideus, and m.

sternothyreoideus, that are innervated mainly from segments C2 and C3. M. cricothyreoideus and m. laryngopharyngeus are also innervated by n. laryngicus cranialis of cervical segments C 1-4. The treatment using musculoskeletal (manual) medicine techniques lead to an improvement of laryngeal difficulties (Hulse, 1991).

Inclusion of functional dysphagia as a vertebrovisceral disorder is generally recognized, but this condition has not been studied extensively. This is because functional dysphagia borders with four fairly distant branches of medicine—gastroenterology, neurology, otorhinolaryngology, and musculoskeletal medicine. And an objective assessment of this disease is a complicated issue as well.

7. Diagnosis of functional swallowing disorders

Conventional radiology, computed tomography, ultrasound scans, and magnetic resonance imaging facilitate visualization of gastrointestinal tract organ morphology, but these scans cannot precisely quantify their function. In the diagnosis of esophagus disease, fluoroscopy has been used with non-physiological contrast materials, and this is not a quantitative evaluation either. The use of endoscopy or manometry is an invasive way of investigating the organ condition. The use of nuclear medicine can quantify gastrointestinal organ function assessment by measuring the passage of isotope-labeled material (Russel et al., 1981). At the investigation of patients with dysphagia and normal manometric and endoscopic findings, 50% of them presented dysmotility when dynamic scintigraphy was used (Kjellen et al., 1984). A positive diagnosis of functional gastrointestinal disorders are a result of an expert gastroenterologist's work. Usually, this diagnosis is determined after exclusion of all other potential causes of dysfunction.

However, it is necessary to take into account the importance of psychological factors that may be the cause of motility disorders of the esophagus. Studies using sophisticated psychometric instruments, dealing with the importance of psychological factors in patients with painful esophageal motility disorders, identified a number of mutual relations. Groups of patients with esophageal spasm, with irritable colon, with benign abnormalities of the impaired esophagus were compared with a control set of healthy persons. Patients with esophageal motility and irritable colon had significantly higher scores than other groups with somatic anxiety and gastrointestinal susceptibility. This shows that certain patients tend to have a significant interest in the somatic function and have more frequent and severe gastrointestinal symptoms due to stress (Waterman et al., 1989).

When 50 referred patients with pathogenic esophageal manometry underwent a psychiatric examination, abnormalities were detected in 21 out of 25 patients with motility disorders of the distal esophagus. On the contrary, abnormalities were found in only 4 out of 13 patients with normal manometric findings. The most common findings were somatization disorders, anxiety, and depression. (Clouse & Lustman, 1983).

8. Treatment of esophagus functional disorders caused by vertebral dysfunction

In addition to patients with clearly defined pathomorphological esophageal changes, a group of patients without obvious morphological variations had functional spinal disorders. The positive effect of manipulation therapy to relieve pain of the spine and affected organs

has been known since the beginning of the twentieth century – originally cited in the works of Palmer and Still, and later referred to by Pikalov. (Pikalov & Kharin, 1994). In the past, it was found that somatic changes in the body caused by irritation are accompanied by an autonomic nervous system reaction that affects gastrointestinal system organs (Sato & Tera, 1976). The Beal study demonstrated a close relationship between changes in soft tissues and corresponding changes in the segmental innervation area (Beal, 1983, 1984).

Musculoskeletal (manual) medicine techniques can reduce pain and normalize the dysphagia. Using scintigraphy, this can be objectively measured. A significant relationship between dynamic scintigraphy and nonobstructive dysphagia/swallowing and spinal axis problems has been observed. Dynamic scintigraphy allowed for an objective treatment assessment (Vanaskova et al., 2001).

The effect of functional disorder treatment significantly influences psychological and emotional status of the patients. It is necessary to positively motivate the patient and then provide relaxation for both the body and the mind. From clinical practice and sports medicine we know that the use of methods of rehabilitation medicine can affect pain perception threshold, release tension and provide a feeling of well being by achieving stimulation of attention. Changes after therapy affect the function of the locomotor system, reflex actions, and internal organs. The effect of manipulative (manual) therapy in reducing anxiety and improving ability to solve numerical tasks were documented in the EEG records by Field and colleagues (Field et al, 1996).

9. Conclusions

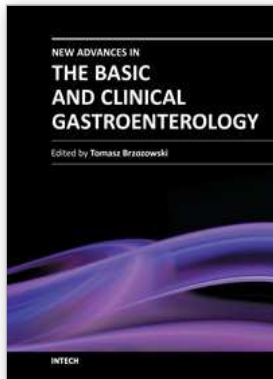
In functional swallowing disorders related to spinal dysfunctions, pharmacologic treatment often fails. Many patients become disappointed with the treatment failure and seeming inability of physicians to identify the cause of their discomfort. On the other hand, rehabilitation therapy focused on the musculoskeletal system can sometimes surprisingly and quickly treat patient ailments. The vertebrogenic mechanism of functional dysphagia is therefore not only of academic significance but of clinical importance as well. Swallowing disorders can be due not only to structural changes, but frequently to dysfunction of the spinal column and its musculature.

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