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Swallowing
Swallowing is a physiological phenomenon that occurs many times daily. Although it may be initiated consciously as a voluntary act during eating, most swallows occur subconsciously between meals, without apparent cerebral participation. Swallowing is a complex and complicated function that can be divided into four overlapping stages: oral preparatory, oral, pharyngeal, and esophageal. The first two are voluntary and the last two are involuntary. The act of swallowing is triggered by the contact of a liquid or solid with the soft palate, the dorsal or the pharyngeal surface of the tongue, or the laryngopharynx. The receptors in the oropharynx correspond to the glossopharyngeal nerve, those in the laryngopharynx correspond to the cranial laryngeal nerve, and those on the dorsal surface of the tongue correspond to the lingual nerve, a branch of the trigeminal nerve. The sensory nerve fibers conveyed by the cranial laryngeal nerve and the glossopharyngeal nerve terminate in the solitary tract and nucleus (NTS) in the brainstem. The solitary tract and nucleus constitute the main afferent system involved in swallowing, particularly the caudal part of the solitary system which receives the afferents of the cranial laryngeal nerve, or superior laryngeal nerve (SLN) in biomedical literature. The afferent fibers in the SLN appear to be the most potent in triggering swallowing. The major afferents for swallowing, the SLN fibers running within the solitary tract, are not connected directly to the cranial motor nuclei involved in swallowing - V, VII, IX, X, and XII - in the brainstem. The successive excitation of motor neurons which is responsible for the entire sequence of swallowing depends on an interneuronal network which organizes this activity through excitatory and inhibitory connections between neurons. This organizing system, which is obviously placed between the afferents and the motor neurons, represents the major component of the central pattern generator (CPG) for swallowing, the so-called "swallowing center". There are actually two CPGs, one in each side of the brainstem, for bilateral organization of motor activity in the bilateral swallowing muscles. The activity of the two CPGs during swallowing is coordinated via interconnections between them. Once activated, the CPG can trigger and organize the sequential swallowing pattern without feedback phenomena. However, its activity can also be regulated by peripheral afferent inputs that can control the entire motor sequence of swallowing. The motor neurons of cranial nerves V, VII, IX, X, and XII are located bilaterally in the brainstem. Motor neurons of the nucleus ambiguous innervate the muscles of the pharynx and larynx and the striated muscles of the esophagus. In the nucleus ambiguus the rostral-to-caudal sequence of the motor nuclei is: esophagus, pharynx, larynx. The nucleus ambiguus may be considered to be the main motor nucleus for swallowing, together with the hypoglossal nucleus for the tongue. The smooth muscles of the esophagus of the cat are innervated by the preganglionic neurons located within the dorsal nucleus of the vagus. The pharyngeal plexus - the glossopharyngeal nerves and the pharyngeal branches of the vagus nerves - distributes the motor supply to the pharyngeal muscles and of the two motor nerves supplying the innervation via this plexus, the pharyngeal branch of the vagus nerve is functionally more important than the glossopharyngeal nerve. The pharyngeal muscles are innervated unilaterally by both of the parent trunks of the pharyngeal plexus.

Dysphagia
Dysphagia is difficulty in swallowing. The cause of neurogenic dysphagia is not always clear. It is difficult to demonstrate sensory loss in the pharynx by diagnostic tests, even though the clinical signs of such sensory loss are easily recognized when the sensory nerves are transected. In the same way, it is possible to study the clinical signs and characteristics of dysphagia following transection of the cranial nerves involved in swallowing. In muscular disorders causing dysphagia, such as the muscular dystrophy described in Bouviers, the diagnosis can be based on EMG studies and muscle histology. Neurogenic causes of dysphagia can be recognized because the resulting muscular dysfunction also involves other muscle groups, as in myasthenia gravis. The cranial
laryngeal nerve, or superior laryngeal nerve (SLN) in biomedical terminology, is the most important sensory nerve for triggering the swallowing action. The effect of unilateral or bilateral transection of the SLN on electromyographic activity in the hyopharyngeal, thyropharyngeal, and cricopharyngeal muscles was studied in 10 dogs during eating and during unilateral electrical stimulation of the NTS. In all dogs after unilateral (left or right) or bilateral transection, the sequence of activity in the pharyngeal muscles was disturbed in some swallowing actions during eating and during stimulation of the NTS. It was concluded that transection of the SLN modulates the central pattern generator for pharyngeal swallowing in dogs. Dysphagia was expected after transection of the SLN, but dogs continued to eat normally after unilateral transection. After bilateral transection one dog ate normally, but the second ate with reluctance, and the third did not attempt to eat at all, and in both of the latter two there fluid sounds in the trachea. The bilateral loss of sensation in the laryngeal mucosa and the consequent loss of normal triggering of swallowing may have allowed leakage of food and saliva into the trachea, with greater consequences than those of irregularities in the sequence of pharyngeal muscle activity. That one dog continued to eat normally after bilateral transection of the SLN suggests the possible existence of a compensatory mechanism. Muscular disorders causing dysphagia were studied in Bouviers and 14 dogs of various breeds. The Bouviers had a familial form of muscular dystrophy, while 2 of the 14 other dogs had myositis and 12 had a myogenic disease of unknown origin. Difficulty in swallowing was the sole clinical abnormality in all of the Bouviers; there were no other signs of muscle disease. In these Bouviers recordings of spontaneous EMG activity from of the tongue, the soft palate, the hyopharyngeal, thyropharyngeal, and cricopharyngeal muscles, and the cervical esophagus revealed a variety of abnormalities, such as fibrillation potentials, positive sharp waves, continuous potentials, and complex repetitive discharges. In the 14 dogs of other breeds the diagnosis of myogenic dysphagia was based mainly on the EMG findings, since biopsy or necropsy material was seldom available. Dysphagia and myasthenia gravis. Dysphagia can be one of the clinical signs in myasthenia gravis, a disease characterized by inefficient neuromuscular transmission secondary to a reduction in acetylcholine receptors on the postsynaptic muscle membrane. Two forms of the disease are recognized in dogs and cats, the acquired form being the most common. In cats, acquired myasthenia gravis can result in generalized weakness but it can also produce focal signs, including dysphagia and megaesophagus, without general weakness. Megaesophagus and dysphagia. Dysphagia may thus occur in both cats and dogs having the focal form of acquired myasthenia gravis. In cats megaesophagus may be a more prominent sign of myasthenia gravis and in dogs myasthenia gravis is recognized as one of the causes of megaesophagus. Central neurogenic lesions causing dysphagia are well known in humans and include cerebral or brainstem ischemic or hemorrhagic strokes, Alzheimer's disease, Parkinson’s disease, traumatic brain injury, and motor neuron disease. Both brainstem and cerebral neoplasms occur in dogs and cats and dysphagia may be one of the signs.

Obstructive disorders causing dysphagia. Obstruction of the passageway for food can cause dysphagia. The obstruction can be in the oropharynx or laryngopharynx, or in the area around the pharynx. The clinical signs of dysphagia are probably due to the physical size of the tumor but pain is certainly a factor. The pharynx is the passageway for air as well as for food and liquid and the clinical signs of obstruction in the pharynx often consist of dyspnea as well as dysphagia. Peripharyngeal masses are especially known for obstruction of the pharyngeal cavity. Pain causing dysphagia. Pain in the pharynx may be caused by sharp injuries, inflammation, or the growth of a tumor. That it makes swallowing difficult is evidenced by multiple rapid contractions of the pharyngeal muscles and profuse salivation. An extreme example of pharyngeal pain is found in the clinical signs of glossopharyngeal neuralgia. This uncommon but dramatic phenomenon is characterized by attacks of severe pharyngeal pain, causing the dog to scream and to salivate. Cramping of the neck muscles may also be observed. The attack lasts for several seconds but may recur many times daily

Diagnosis in dysphagia
**History and clinical signs.** “Difficulty in swallowing” may be mentioned spontaneously by the owner as a problem in a dog or cat. Questioning typically reveals that the animal takes a bite of food from the pan and attempts to swallow it but does not succeeding in emptying the pharynx, as is apparent from repeated swallowing actions. If the animal takes a quick breath of air between swallowing actions, food may enter the larynx and trachea, causing coughing. Dogs will try again and again, and will sometimes succeed in achieving a more adequate swallowing action. Although the dog’s attempt to drink from the water pan appears to be normal, the water becomes clouded with mucus and even after a prolonged effort, the level in the pan is scarcely changed. Emaciation is an important clinical sign and other signs include coughing, regurgitating, vomiting, and nasal discharge. **Plain radiographs** of the pharyngeal area are useful in the diagnosis in dysphagia when obstruction of the passageway for food is suspected. Masses and foreign bodies can be detected. The hyoid bone should be inspected carefully because a fracture of the bone or arthritic changes in its articulations can cause pain during swallowing and may cause dysphagia. Usually a laterolateral radiograph gives sufficient information. **Contrast videofluorography** to evaluate swallowing. For many years contrast videofluorography has been the gold standard for evaluation of patients with swallowing disorders. **Pharyngoscopy in dysphagia.** Pharyngoscopy is important in the diagnosis of dysphagia, to recognize and differentiate among lesions of the tongue, oral cavity, oropharynx, laryngopharynx, and nasopharynx. **EMG findings.** **Therapy in dysphagia** depends on the underlying disease.

**Reference:**