The mouth, stomach and intestines

Stuart W McDonald

Niall G MacFarlane

Abstract

Food is chewed into digestible portions in the mouth and swallowed – a complex reflex process involving several cranial nerves. The stomach homogenizes food, begins digestion and regulates the rate at which food enters the duodenum. Pancreatic juices containing powerful digesting enzymes are added and digestion is completed in the small intestine. The large bowel dehydrates the gastrointestinal contents.

Keywords Colon; digestive enzymes; gastro-oesophageal sphincter; intestinal secretions; small intestine; stomach; stomach acid; swallowing

Royal College of Anaesthetists CPD Matrix: 1A01

Learning objectives

After reading this article, you should be able to:

- understand how the stomach, small and large intestines function, and their relationship with each other
- have some knowledge of the various secretions (and their function) that enter the gastrointestinal tract along its course
- have some knowledge of the nature and size of the fluid shifts that occur along the gastrointestinal tract

Introduction

Food is chewed in the mouth and swallowed in boluses of a size appropriate to pass down the oesophagus and into the stomach. Lubrication with saliva makes them easier to swallow.

Chewing

Chewing involves the muscles which primarily move the mandible (Figure 1): masseter, temporalis and the medial and lateral pterygoids (all supplied by mandibular division of the trigeminal nerve). Their differential contraction not only opens and closes the mouth and protracts and retracts the mandible; but they bring about side-to-side movements. This movement occurs at the complex temporomandibular joint.

When the mouth opens and closes, the fulcrum of the movement lies, not at the joint, but at the mandibular foramen so that the inferior alveolar nerves and vessels entering the bone at this site undergo minimal stretch. The process of chewing, however, involves muscle other than those that are classed as 'muscles of mastication'. In particular, the tongue manipulates the bolus of food and pushes it between the teeth. Similarly, the buccinator muscle in the cheek and muscles of the lips (which are all muscles of facial expression and thus supplied by the facial nerve) ensure that food does not build up in the mouth and so a patient with facial palsy will have difficulty eating.

Stuart W McDonald *FRCS(Glas) is a Senior Lecturer at the School of Life Sciences, University of Glasgow, Glasgow, UK. Conflicts of interest: none declared.*

Niall G MacFarlane *BSc PhD is a Senior Lecturer at the School of Life Sciences, University of Glasgow, Glasgow, UK. Conflicts of interest: none declared.*

Swallowing

Swallowing is coordinated by the swallowing centre in the medulla. Liquids are swallowed by a backwards movement of the tongue. The right and left styloglossus muscle are well placed to facilitate this movement and the intrinsic muscle of the tongue will form a shape appropriate to this piston-like action. Solids are separated into boluses by the tongue being placed against the hard palate and food forced back into the oropharynx. The initial movement is voluntary, but as the bolus passes into the oropharynx a number of reflex contractions occur. The nasopharynx is closed off by the soft palate meeting the posterior wall of the pharynx. The superior constrictor muscle of the pharynx starts to propel the bolus. The glottis is closed and the larynx is elevated and moved anteriorly, out of the way of the bolus, and is covered and protected by the epiglottis. These effects are produced by intrinsic and extrinsic laryngeal muscles, but the protective movement of the epiglottis is passive as the bolus presses on it.

The whole process is coordinated with breathing. A peristaltic-type wave starts in the superior constrictor muscle and progresses to the middle and inferior constrictors, moving the bolus into the oesophagus. In the laryngopharynx, the bolus strikes the pharyngeal surface of the leaf-shaped epiglottis and is directed inferolaterally through the piriform fossa on either side. The piriform fossa is a pear-shaped recess and, along with the vallecula, the recesses between the tongue and the epiglottis are notorious sites for fish bones being lodged.

The oesophagus consists of skeletal muscle in the upper third, skeletal and smooth muscle in the middle third and smooth muscle alone in the lower third. The muscles are supplied by trigeminal, facial, glossopharyngeal, vagus and hypoglossal nerves. The upper oesophageal sphincter relaxes to receive the bolus and then closes, which prevents the swallowing of air. Food moves down the oesophagus by a peristaltic wave (this is an active reflex in the upper oesophagus, started skeletal muscle and lost if the vagus is cut).

In the lower oesophagus, peristalsis is mediated by the enteric nervous system and propels the food bolus towards the stomach at a slow rate (2–6 cm/s) and so it takes approximately 10 seconds for a food bolus to pass through the oesophagus. If the first peristaltic wave does not clear the food bolus from the oesophagus then its distension initiates further peristaltic waves until the food enters the stomach. Liquids drunk when an individual is erect will reach the stomach before the peristaltic wave.

Pressure in the upper oesophageal sphincter is quite high (at around 60 cmH_2O). In the body of the oesophagus, the pressure

Please cite this article in press as: McDonald SW, MacFarlane NG, The mouth, stomach and intestines, Anaesthesia and intensive care medicine (2018), https://doi.org/10.1016/j.mpaic.2018.01.003

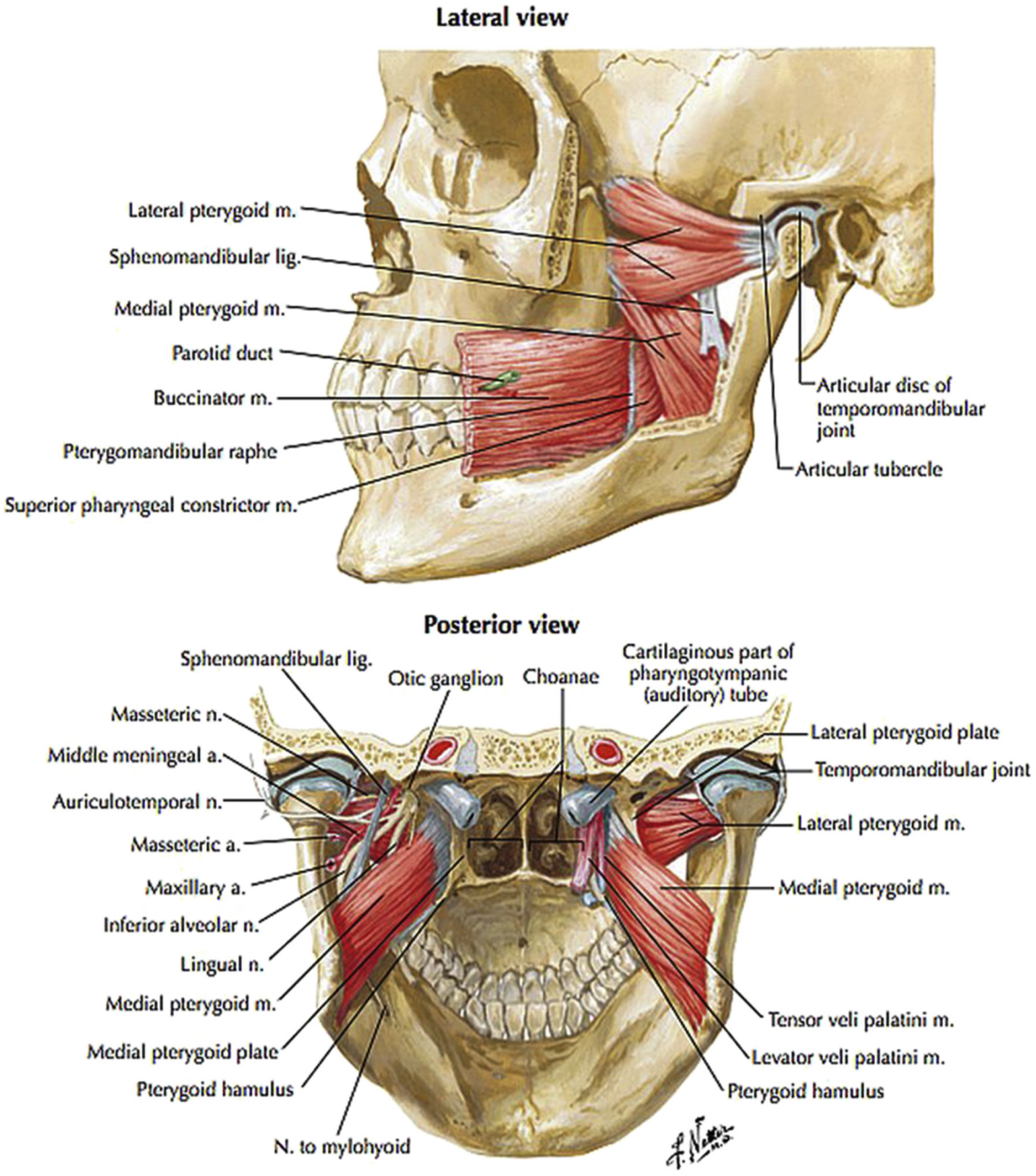

Figure 1 The anatomy of chewing.

will reflect the intrathoracic pressure and can vary, with ventilation, between −5 and −10 cmH_2O. The lower oesophageal sphincter is important for preventing regurgitation of acidic stomach contents, which could contaminate the respiratory tract. The lower oesophageal sphincter pressure is around +30 cmH_2O and the smooth muscle is tonically active but relaxes on swallowing.

Gastro-oesophageal sphincter

This has three components: (i) oesophageal smooth muscle is thicker at the sphincter than in the remainder of the oesophagus; (ii) the fibres of the diaphragm surround the sphincter and exert a positive pressure acting as a pinch-cock; and (iii) the oblique angle at which the oesophagus enters the stomach creates a flap valve that helps to close the stomach off from the oesophagus and prevent reflux (Figure 2). The smooth muscle sphincter is under neural control via the cholinergic fibres of the vagus; it relaxes to let food enter in response to nitric oxide and vasoactive intestinal peptide released from interneurons in the enteric system. The diaphragm is a skeletal muscle and swallowing is co-ordinated with respiration.

The stomach

Anatomically, the stomach is divided into five regions: cardia, fundus, corpus (body), antrum and pylorus; functionally, there are two: proximal and distal (Figure 2). The proximal region (cardia, fundus and proximal one-third of the corpus) acts as a reservoir; the distal region (distal two-thirds of the corpus,

Please cite this article in press as: McDonald SW, MacFarlane NG, The mouth, stomach and intestines, Anaesthesia and intensive care medicine (2018), https://doi.org/10.1016/j.mpaic.2018.01.003