Chapter 8: The mouth and related faciomaxillary structures

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The mouth is not only the province of the sister speciality of dentistry, but has enormous social importance to man. All creatures eat to live, but humans have transformed this energy acquiring necessity into the focus of much of their social life.

The development of conceptual thought and the ability to express this through speech is what has most separated the human being from the rest of the animal kingdom. The physiological complexities of speech, as with eating, demand the attention of the speciality. Diseases of the mouth will interfere with these most vital activities.

To the otolaryngologist, therefore, the mouth is not only the route to the pharynx and beyond, but increasingly a meeting ground for the disciplines of oral and maxillofacial surgery, dental surgery and speech therapy. A thorough knowledge of this region, combined with an understanding of modern practices, is therefore essential.

The mouth or oral cavity extends from the lips and cheeks externally to the pillars of the fauces internally. Its boundaries are the lips anteriorly, the cheeks laterally, the hard and soft palate superiorly and the floor of the mouth inferiorly.

The mouth is divided into the vestibule outside the teeth, the alveolar arches, and the oral cavity proper within the dental arcades, which contains the tongue.

Developmental anatomy

The primitive oral cavity or stomatodeum is first apparent in the four-week old embryo as a slit-like space, bounded by the brain above and the pericardial sac below. The buccopharyngeal membrane at the back of the cavity forms a thin septum between the stomatodeum and the foregut, which later breaks down so that the mouth cavity becomes continuous with the developing pharynx. The branchial arches originate from a number of mesodermal condensations in the lateral wall and floor of the pharynx. Between the arches, successive clefts on the pharyngeal aspects are matched by corresponding clefts in the overlying ectodermal surface.

Within these mesodermal condensations, differentiation produces a cartilaginous bar and branchial musculature together with a branchial arch artery (Paten, 1953). Each arch receives an afferent and an efferent nerve to supply the skin, the musculature and the endodermal lining of the arch concerned. In addition, each arch receives a branch from the nerve of the succeeding arch. The branch from its own arch is known as the post-trematic branch and the second branch from the succeeding arch is called the pre-trematic branch. The mandibular division of the trigeminal nerve is the post-trematic nerve of the first branchial arch. The pre-trematic nerve to the first arch is represented by the chorda tympani branch of the facial nerve.

The facial nerve itself is the post-trematic branch of the second arch, while the pre-trematic branch of this arch is derived from the tympanic branch (Jacobson's nerve) of the
glossopharyngeal nerve. The glossopharyngeal is the post-trematic nerve of the third arch. The nerves of the remaining arches (fourth and sixth) are derived from the vagus and accessory nerves by their superior and inferior (recurrent) laryngeal branches and from the pharyngeal branches.

By the sixth week of embryonic life, the two mandibular processes, which have arisen from the lateral aspect of the developing head, have met and fused in the midline, to form the tissue of the lower jaw. Meanwhile, the maxillary processes develop as buds from the mandibular process, and grow forward on each side of the face beneath the developing eyes to make contact with the lower ends of the descending nasal processes.

The fusion of the maxillary processes both creates the primary palate and separates the primitive nasal cavity from the primitive oral cavity. The inwardly directed extensions of each maxillary process produce tissues which later will form the nasal septum and secondary palate, and which will fuse following the descent of the developing tongue (Kraus, Kitamura and Latham, 1966; Sperber, 1976).

**Anomalies of development**

Normal development depends upon the crucially timed convergence of tissue processes from different origins. Failures result in anomalies along the lines of normal fusion. The most common of the orofacial clefts is that of the secondary palate, followed by lip clefts and then clefts of the primary palate. The embryological basis for these is failure of fusion of the palatal shelves of the maxillary process, and the medial and lateral limbs of the frontonasal process, respectively. Failure of the tongue to descend in consequence of abnormal embryonic head flexion has been postulated as a cause, although genetic factors do play a part in some cases (Poswillo, 1975). Less common clefts are oblique facial clefts, midline clefts and congenital macrostomia or microstomia, which represent failures in the earlier stages of development.

Other common abnormalities, such as developmental cysts and fistulae, result from the entrapment of epithelium along the lines of fusion, and these include nasolabial, nasoglobular, median alveolar and median palatal cysts which usually do not present until adult life.

**Development of the tongue**

The tongue develops in two parts: the anterior part arises from the mandibular arches, in the form of paired eminences and, from a midline structure, the tuberculum impar in the floor of the mouth; the posterior part is derived from the hypobranchial eminence of the third visceral arch which grows forward over the second arches to become continuous with the anterior part of the tongue. The V-shaped sulcus terminalis lies posterior to the site of union of the two parts. At the apex of this V, just behind the row of circumvallate papillae, there is a small median pit in the dorsum of the adult tongue, the foramen caecum. This is a vestige of invagination from the floor of the pharynx which gives rise to the thyroid gland. By using the foramen caecum as a landmark, it becomes apparent that the mucosal covering of the body of the tongue arises from the first arch tissue and thus its sensory innervation is by the lingual branch of the trigeminal nerve, which is the nerve to the first arch.
The sensory innervation to the part of the tongue posterior to the sulcus terminalis is derived from the third arch and hence its innervation is by the glossopharyngeal nerve.

Trapped between these two parts of the tongue is some tissue from the second arch, and this tissue is innervated by the nerve to the second arch, the seventh or facial nerve. In fact, the function of the nerve supply is gustatory and served by the chorda tympani branch of the facial nerve.

During the early part of its development, the tongue lies partly within the nasal cavity, and a delay in its descent may impede the uniting of the palatal folds, thereby producing clefts in the secondary palate.

**Development of the mandible**

The mandible is formed in the lower or deeper part of the first visceral arch. It is preceded there by Meckel's cartilage which represents the primitive vertebrate mandible. The dorsal end of this unbroken rod of cartilage gives rise to the malleus of the middle ear, but Meckel's cartilage itself plays little direct part in the development of the bony mandible. A band of dense fibrocellular tissue on the lateral side of Meckel's cartilage undergoes ossification and traps the associated mandibular arch nerves. Thus the inferior alveolar nerve comes to lie in the inferior dental canal after entering the mandible through the mandibular foramen, and the mental nerve to the lower lip and chin exits through the mental foramen. The two bony halves are united anteriorly by connective tissue, but bony union of this suture takes place before the end of the first year of life. All of Meckel's cartilage, except for the sphenomandibular ligament, the malleus and the malleolar ligament, disappears.

**Surface anatomy**

**The lips**

The lips are covered externally by skin and internally by mucous membrane. The vermilion border of the lips is a characteristic of the human species, and the red zone in the upper lip protrudes in the midline to form the tubercle. From the midline to the corners of the mouth the lips widen and then narrow. In the midline of the upper lip is the philtrum and the corners of the lips, known as the commissures, lie adjacent to the canine teeth. The skin surrounding the lips in the adult male is hirsute, a secondary sexual characteristic. At rest, the lips are highly closed together when they are said to be competent.

**The oral vestibule**

The oral vestibule is a slit-like space between the lips and cheeks, and the teeth and alveolus. When the teeth are occluded, the vestibule is a closed space which communicates with the oral cavity proper only in the retromolar regions. The reflection of the mucosa from the alveolus to the lips and cheeks is the fornix of the vestibule. The upper and lower labial frenula are consistent folds of mucosa running from lip to the alveolus.
The cheeks

The cheeks extend from the labial commissures anteriorly to the ascending ramus posteriorly, and are bounded superiorly and inferiorly by the upper and lower vestibular sulci. Yellow granules on the mucosal surface are ectopic sebaceous glands known as Fordyce granules. The parotid salivary duct drains into the cheek opposite the maxillary secondary molar tooth. In front of the pillar of the fauces, a fold of mucosa containing the pterygomandibular raphe extends from the upper to the lower alveolus.

The palate

The palate is divided into the bony anterior hard palate and the mobile posterior soft palate. Immediately behind the anterior teeth, the mucosa of the hard palate shows the distinct prominence of the incisive papilla. Extending posteriorly to this is the midline raphe and the irregular folds of bound mucosa known as the palatal rugae. The junction of the hard and soft palate can be discerned, without palpation, by the change of colour from the pink of the hard palate to the yellow-red of the soft palate. In the middle of the free posterior edge of the soft palate is the uvula.

The floor of the mouth

The floor of the mouth is divided into two parts by the lingual frenulum which extends up to the base of the tongue. On either side of the frenulum are the sublingual papillae which mark the entry into the mouth of the ducts of the submandibular glands. On either side of this duct are the sublingual folds overlying the sublingual salivary glands.

The tongue

The tongue has both a dorsal and a ventral surface. The dorsal surface is divided by the V-shaped groove or the sulcus terminalis into the larger palatal and smaller posterior pharyngeal parts. Just anterior to these lie the large circumvallate papillae, while the remainder of the dorsum is covered with numerous white, conical elevations, the filiform papillae, between which are interspersed isolated reddish prominences, the fungiform papillae. On the posterolateral aspect of the tongue are the leaf-like folate papillae, which can cause much anxiety when first discovered by the cancerophobic patient.

The ventral surface of the tongue is covered by a smooth mucous membrane through which vessels are clearly visible. It is divided into two by the lingual frenulum, on either side of which are fringed folds of mucous membrane, the fimbriated folds (Liebgott, 1982).

Bony anatomy

Maxilla

The right and left maxillae are the principal bones of the facial skeleton and superior aspect of the mouth. Each maxilla consists of a body and four processes, the frontal, palatine, zygomatic and alveolar processes, the first three of which articulate with separate bones of
the same name while the alveolar process supports the maxillary teeth. In the midline, the two maxillae meet at the intermaxillary suture which is continuous with the suture between the two palatal processes.

Each maxilla is hollowed by the paranasal sinuses and contains the following foramina: the posterior superior dental, incisive, palatine canal (with palatine bone), nasolacrimal canal (with lacrimal and inferior turbinate bone), infraorbital groove, canal and foramen, and ostium to the maxillary antrum (Scott and Symons, 1977).

**Growth of the maxilla**

The maxilla develops in the fetal maxillary process as a membranous ossification. At birth, the infant maxilla differs from the adult maxilla in having small alveolar processes and rudimentary maxillary sinuses. Growth is by bone apposition, but the forward and downward growth of the mid-third of the facial skeleton also depends on endochondral growth at the *spheno-occipital synchondrosis*.

**The zygoma**

The zygoma is an important element in the facial buttress system. It is a paired bone, triradiating into a maxillary, frontal and temporal process. Clinically, this bone, the malus or malar bone, can undergo fracture dislocation following trauma. This may result in an inability to close the mouth because the coronoid process of the mandible impinges on the medially displaced zygoma. Reduction is achieved by passing an instrument under the zygoma from above using the fascia of the temporalis muscle as a guide.

**The palatine bone**

The horizontal plates of these paired bones articulate with each other and with the palatal process of the maxilla to form the posterior aspect of the bony palate.

**The mandible**

The mandible consists of a horizontal horseshoe-shaped component, the *body* of the mandible, and two vertical plates, the *rami*, which join the body at an obtuse angle. The two lateral halves of the mandible fuse in the midline soon after birth and the lower half of this forms the mental protuberance or chin. The upper border of the ramus carries two processes, the coronoid process anteriorly, and the condyloid process posteriorly, the latter of which articulates with the temporal bone at the *temporomandibular* joint.

The upper border of the mandible is the alveolar margin which contains the sockets for the roots of the mandibular teeth.

On the medial side of each ramus is the inferior dental foramen, opening into the inferior dental canal which runs through the body of the mandible to terminate laterally at the mental foramen.
On the medial aspect of the body of the mandible, the transverse mylohyoid ridge runs anteriorly almost to the genial tubercles at the midline (Berkovitch, Holland Moxham, 1977).

**Growth of the mandible**

The ramus of the mandible is composed largely of bone, with the exception of the condylar process which differentiates into a cone-shaped mass of cartilage. This zone of cartilage beneath, and separate from, the articular cartilage persists until the end of the second decade of life and, but its continued proliferation and endochondral ossification, is responsible for the growth in length of the mandible. Damage to this cartilage will result in failure in growth of the mandible.

Renewed activity by this centre after completion of growth accounts for the prognathism of acromegaly. The change in width and general architecture of the mandible is produced by the remodelling process of resorption and apposition to which all bones are subject. During life the mandible changes in shape. At birth, there is a wide mandibular angle, the ramus is small compared to the body and the chin is poorly developed. By the end of life, if all the teeth have been prematurely lost, the mandible once again approaches its fetal form (Scott, 1967).

**Clinical aspects of the facial skeleton**

Trauma to the facial skeleton is common, and is usually the result of either a road traffic accident or violent assault. Many combinations of fracture of the mandible can occur but most fractures involve, either singly or in combination, the body, the ramus or the neck of the condyle of the mandible. Treatment of most fractures requires the application of intermaxillary fixation, although fractures distal to the tooth-bearing areas may require additional techniques. Injuries to the mandibular condyle should be mobilized early to prevent ankylosis of the temporomandibular joint.

Fractures of the maxilla and facial skeleton were classified by Le Fort at the turn of the century. Le Fort 1 fractures involve the maxilla alone, Le Fort 2 fractures involves the orbits, and Le Fort 3 fractures consist of a separation of the maxilla, nose and ethmoids from the base of the skull.

Severe disproportion between the mandible and the maxilla are between these and the face can be treated surgically by maxillary or mandibular osteotomies, a branch of maxillofacial surgery now called orthognathic surgery (Killey, 1971; Archer, 1978; Laskin, 1980; Mathog, 1984).

**The temporomandibular joint**

The mandible can be thought of as a single long bone, articulated at both ends. However, both joints must act simultaneously with movement, which is unique in the body.

The temporomandibular joint is a synovial articulation between the head of the mandible and the glenoid fossa of the temporal bone. The joint cavity is divided into two compartments by the intervening articular disc. The movement in the lower compartment is
that of a hinge joint, but in the upper compartment some anterior and posterior gliding up and
down the articular eminence occurs with wider degrees of jaw opening.

A strong joint capsule, which is strengthened laterally and medially by sturdy collateral
ligaments, is also present. The lateral ligament is called the temporomandibular ligament,
which not only prevents backward displacement of the condyle but which tightens at extreme
opening, thus preventing subluxation. Two accessory ligaments of the temporomandibular
joint are the sphenomandibular ligament, which runs from the spine of the sphenoid to the
lingula of the mandible, and the stylomandibular ligament, which runs from the styloid
process to the angle of the mandible; neither of these accessory ligaments, however, is
thought to contribute significantly to the stability of the joints. The articular disc or meniscus
is an important component of the temporomandibular joint. It consists of dense connective
fibrous tissue and is moulded to the bony joint surfaces, which makes it thinner centrally than
laterally, and it fills the gap produced by the disproportion between the head of the condyle
and the glenoid fossa. Some fibres of the lateral pterygoid muscle are inserted into the
anterior margin of the meniscus which is thus pulled forward with mandibular opening.
Failure of coordinated movement of the articular disc may, on wide opening of the mouth,
result in the head of the condyle slipping off the disc anteriorly, producing the familiar
symptom of the clicking temporomandibular joint. The posterior aspect of the articular disc
is rich in nerve endings concerned with proprioception in the joints (Sarnat and Laskin, 1980).

The movements of the mandible may be described as follows:

Protrusion. Both mandibular condyles move forward onto the articular eminences and
the teeth remain in gliding contact.

Retrusion (retraction). This is the reverse process.

Opening. This is partly a hinge movement and partly the result of the condyles being
drawn on to the articular eminences. The mandible rotates around a horizontal axis so that,
as the condyles move forward, the angles of the mandible move backwards and the chin is
depressed.

Closing. In this movement, the jaw may close in any number of positions. Closure in
protrusion with the heads of the condyles remaining on the articular eminences, so that the
lower incisors bite edge to edge with the upper incisors, is called incision. Closure with the
condyles in the most backward position in the glenoid fossa, so that the teeth meet in normal
occlusion, is called trituration.

Mastication requires side-to-side movements of the occlusal surfaces of the molar
teeth. The condyle remains in the posterior position in the glenoid fossa on the side to which
the chin is moving, and is held there by the tonic contractions of the muscle on that side; on
the other side, the condyle is drawn forward and then back by the muscles of mastication on
that side. The process is then repeated on the other side.
Myofacial pain dysfunction syndrome

Although the clinical symptoms associated with jaw dysfunction have long been recognized, it is only in the last 20 years that a condition previously referred to as Costen's syndrome or temporomandibular joint syndrome has been shown to be neither a primary joint disorder nor generally caused by occlusal abnormalities. Rather, it is now believed that masticatory muscle spasm is the primary factor responsible for the symptoms, for which the major causative factor is psychological stress.

The patient's symptoms are usually those of a unilateral dull ache in the ear or preauricular region that frequently radiates to the temple, to the angle of the mandible or the adjacent cervical region, or to the occiput. The pain is relatively constant but may be worse in the morning, and is exacerbated by use of the mandible.

The signs are four-fold. First, there is tenderness of the masticatory muscles to palpation; this can be elicited over the temporalis muscle but is most marked when the thumb is placed into the retromolar triangle and pressed upwards and backwards into the pterygoid muscles. Secondly, there is tenderness to firm palpation of the temporomandibular joint itself. Thirdly, there is limitation of mandibular movement and, fourthly, there is clicking of the joint. The latter two are lesser cardinal signs.

Treatments of this condition are various but most patients can be reassured that the majority of cases resolve spontaneously over a few weeks. Persistent problems require a dental opinion. Occlusal adjustments and the fitting of bite-raising appliances have been the mainstay of treatment. A very few cases may need referral to an oral surgeon for joint surgery.

The myofacial pain syndrome is commonly seen in otological practice, but the diagnosis should be entertained only after ear pathology has been eliminated following experienced examination.

Mandibular posture

At rest, there remains a gap of a few millimetres between the occlusal surfaces of the teeth, the so-called 'freeway space'. Following speech, mastication or swallowing the mandible returns to this physiological rest position. However, psychological states are known to interfere with this mechanism and the anxious individual with teeth tightly clenched is well recognized.

When establishing the occlusion of the edentulous patient for the provision of dentures, it is important to establish the physiological freeway space. An overopened occlusion on the denture produces discomfort and a 'horsey' appearance, whereas too great a freeway space produce overclosure, resulting in the sagging and falling of the soft tissues of the face, thereby mimicking or enhancing the ageing process of the face.

There has for some time been debate as to whether the temporomandibular joint is stress bearing (Hekneby, 1974). It is felt that most of the considerable stresses engendered by mastication are dispersed through the teeth and then through the well-recognized stress
pathway of the facial skeleton to the skull. Some of these forces, however, must be directed through the glenoid cavity and into the temporal bone itself.

**The muscles of mastication**

Although other muscles also act upon the mandible, the term 'muscles of mastication' is used to describe the temporalis, the masseter and the lateral and medial pterygoid muscles. These muscles all receive their innervation from the mandibular division of the trigeminal nerve, indicating their origin from the musculature of the first branchial arch.

The *temporalis muscles* are fan-shaped muscles which take origin from the lateral aspect of the skull up to the inferior temporal line. The muscle fibres converge towards their tendinous insertions on the coronoid process of the mandible.

The *masseter muscles* may be divided into superficial and deep parts. The superficial parts arise from the lower border of the zygomatic arch and pass downwards and backwards to be inserted into the lower half of the lateral surface of the mandibular ramus. The deep parts arise from the inner surface of the lower part of the zygomatic arch and pass vertically downwards to be inserted into the mandibular ramus above the insertion of the superficial parts of the muscle.

The *lateral pterygoid muscle* has two heads, each with a separate origin: the inferior head arises from the lateral surface of the lateral pterygoid plate, and the superior head from the infratemporal surface of the greater wing of the sphenoid. The muscle fibres are inserted into the neck of the condyle and into the disc and capsule of the temporomandibular joint.

The *medial pterygoid muscle* also has two heads. The anterior head arises from the pyramidal process of the palatine bone and the posterior head from the medial surface of the lateral pterygoid plate.

**Actions of the muscles of mastication**

The muscles of mastication, in conjunction with other muscles, such as the mylohyoid, buccinator and digastric, initiate the movements of the mandible. The movements may be summarized as follows, with the major actions of the muscle indicated:

*Elevation* is produced by the masseter, medial pterygoid and anterior fibres of temporalis.

*Depression* is produced by lateral pterygoids.

*Protrusion* is produced by the lateral and medial pterygoids.

*Retraction* is produced by the posterior fibres of temporalis.

*Lateral excursions* are produced by the medial and lateral pterygoids of both sides acting alternately (Jenkins, 1978).
Muscles of the cheeks and lips

The cheeks and lips contain some of the muscles of facial expression which are primarily muscles controlling the degree of opening and closing of the orifices of the face. The expressive functions of the facial musculature have developed secondarily.

The muscles of the face are all derived embryologically from the mesenchyme of the second branchial arch; and therefore, the motor innervation is that to the second arch, the facial nerve.

The muscle of the lip is the orbicularis oris, the fibres of which are divided into four parts which correspond to the four quadrants of the lips. Muscle fibres in the philtrum insert into the nasal septum. The range of movements produced by this muscle include lip closure, protrusion and pursing. The muscles which radiate from the orbicularis oris can be divided into the superficial muscles of the upper and lower lips.

Two muscles extend to the corner of the mouth, the risorius and the buccinator muscles. The risorius which lies superficial to the buccinator stretches the angle of the mouth laterally. The buccinator, which arises from the pterygomandibular raphe, inserts mostly into the mucous membrane covering the cheek, and its main function is to maintain the tension of the cheek against the teeth during mastication.

Numerous minor salivary glands line the inner surfaces of the lips and cheeks. The parotid duct pierces each buccinator muscle after passing around the anterior margin of the masseter muscle, with its orifice lying opposite the second upper molar teeth.

The soft palate

The soft palate is a fibrous aponeurosis, the shape and position of which is altered by the tensor palati muscles, the levator palati muscles, the palatoglossus and the palatopharyngeus muscles.

The tensor palati muscle arises from the scaphoid fossa of the sphenoid bone and from the lateral side of the cartilaginous part of the eustachian tube. The muscle fibres converge towards the pterygoid hamulus where they become tendinous, and bend at right angles around the hamulus to become the palatine aponeurosis. When the tensor palati muscles contract, the palatine aponeurosis becomes taut. The motor innervation is derived from the mandibular division of the trigeminal nerve.

The levator palati muscle takes origin from the petrous temporal bone and the medial side of the cartilaginous part of the eustachian tube. The muscle curves downwards, forwards and medially to form a muscular sling which, when acting against the stiffened aponeurosis, produces an upward and backward movement of the soft palate. The nerve supply to the levator palati is derived from the cranial part of the accessory nerve.

The paired palatopharyngeus muscles extend from the palate down the lateral pharyngeal walls, where they form the posterior pillars of the fauces to insert into the posterior border of the thyroid cartilage. The action of these muscles is to elevate the larynx.
and pharynx but they also arch the relaxed palate and depress the tensed palate. The nerve supply is from the cranial accessory nerve.

The paired *palatoglossus* muscles arise from the palatine aponeurosis and descend as the anterior pillar of the fauces to insert into the lateral margin of the tongue. Their action is to raise the tongue and narrow the oropharyngeal isthmus. They are innervated by the cranial part of the accessory nerve.

*Passavant’s* muscle is a sphincter-like muscle which encircles the pharynx at the level of the palate. The contraction of this muscle forms a ridge against which the soft palate is elevated, and in this way the oropharynx can be shut off from the nasopharynx during swallowing and speech.

**The muscles of the tongue**

The muscles of the tongue are paired, and are grouped into an *intrinsic* and *extrinsic* set. The intrinsic muscle fibres of the tongue can be divided into three groups, namely the transverse, longitudinal and vertical. Their function is to alter the shape of the tongue and they are innervated by the *hypoglossal* nerve. The extrinsic muscles of the tongue are composed of four groups, namely the *genioglossus*, *hyoglossus*, *styloglossus* and *palatoglossus*.

The *genioglossus* is a fan-shaped muscle which arises from the upper genial tubercle and is inserted into the tongue from its tip to its root. When these muscles act together as a pair, they protrude the tongue.

The *hyoglossus* is a flat quadrilateral muscle arising from the greater cornu of the hyoid bone passing upwards to be inserted into the side of the tongue. When this muscle contracts, the side of the tongue is depressed.

The *styloglossus* arises from the styloid process and passes downwards and forwards to be inserted into the side of the tongue. The contraction of this muscle causes the tongue to be drawn upwards and backwards.

The *palatoglossus* arises from the aponeurosis of the soft palate and descends to the tongue as the anterior pillars of the fauces. Its action is to raise the tongue and narrow the oropharyngeal isthmus. In contrast to the other extrinsic muscles of the tongue which are innervated by the hypoglossal nerve, the palatoglossus is innervated by the cranial part of the accessory nerve.

**Blood supply**

The arterial supply of the head and neck is very rich and the major branches overlap and collateralize. In addition, a good cross-over exists in the midline so that the external carotid artery, which is the main supply, can be ligated without fear. The face is supplied by the facial artery which anastomoses with the vessel on the other side and also with the other vessels supplying the region - the superficial temporal artery, the infraorbital and mental branches of the maxillary artery and the nasal branch of the ophthalmic artery.
The maxilla and mandible are supplied by branches of the maxillary artery and the tongue by the lingual artery, both of which are branches of the external carotid artery.

The palatine derives its blood supply from the greater and lesser palatine branches of the maxillary artery.

The veins in the head and neck have few, if any, valves. This has the advantage of allowing bidirectional flow between deep maxillary veins and intercranial venous sinuses, but has the disadvantage of also allowing bacterial emboli from superficial septic foci to enter the cranial cavity by reverse flow.

The internal jugular vein is the largest channel, beginning at the jugular foramen as a continuation of the sigmoid dural sinus. Much of the drainage from the maxilla and mandible passes backwards, by way of the pterygoid plexus of veins, into the internal jugular system.

The superficial venous system is, however, quite variable, but the facial vein draining the superficial and anterior face usually joins with the retromandibular vein to form the common facial vein. This enters the internal jugular vein and finally drains into the brachiocephalic.

**Lymphatic drainage**

In general, the lymph from the anterior part of this region drains into the submental and submandibular nodes on the ipsilateral side and then into the deeper jugulodigastric node, whereas lymph from the posterior part drains directly into the jugulodigastric node.

The lymphatic drainage of the tongue, however, is a little more complex. Lymphatics from the anterior two-thirds of the tongue may be divided into the marginal and central vessels. The marginal vessels drain into the submandibular nodes on the same side; the central vessels at the tip of the tongue drain into the submental nodes and from further back into ipsilateral and contralateral submandibular lymph nodes. Lymphatics from the posterior third of the tongue drain directly into the jugulodigastric group of nodes.

The deep cervical plexus of lymphatic channels is the final common pathway for all head and neck drainage, terminating in the thoracic duct on the left and the junction of the internal jugular and subclavian veins on the right.

**Nerve supply**

The whole system, from the oropharynx forward, receives its sensory supply from the maxillary and mandibular division of the trigeminal nerve. The mandible, mandibular teeth, gingivae, and floor of the mouth and tongue are supplied by inferior dental, buccal, mylohyoid and lingual branches of the mandibular division.

The maxilla and maxillary teeth are served by the maxillary nerve, and by the infraorbital, pterygopalatine and anterior, middle and posterior dental nerves of the maxillary division.
The anterior hard palate is supplied by the nasopalatine nerve and the rest by the anterior and posterior palatine nerves from the maxillary division of the trigeminal nerve.

The anterior two-thirds of the tongue is supplied by the lingual nerve; the posterior one-third by the glossopharyngeal nerve.

The motor innervation of this region has been described previously.

The fascial spaces of the head

Within the head there are anatomical spaces bounded by fascial layers, muscle, bone, skin or mucous membrane. Contained within these spaces are vessels, nerves, lymphatics and lymph nodes, and filling the unoccupied space is loose connective tissue.

These spaces or potential spaces are important because they determine the spread of infection and, to a lesser extent, of neoplasms in these areas. The most important of these spaces are:

The superficial facial compartment, which is bounded superficially by the buccinator muscle, the facial surfaces of the maxilla and mandible, and the outer surface of the masseter muscle. It is limited above by the zygomatic arch, behind by the parotid compartment, and below by the lower border of the mandible. It communicates deep to the mandibular ramus with the pterygoid space. It contains the buccal pad of fat, the duct of the parotid gland, the facial artery and vein, the buccal lymph nodes, the mental and infraorbital foramina, branches of the trigeminal and facial nerves, and the muscles of facial expression.

The sublingual compartment, which is bounded by the lingual surface of the body of the mandible, the mucous membrane of the floor of the mouth and the upper surface of the mylohyoid muscle. It contains the submandibular salivary gland, the sublingual salivary glands, and the lingual and hypoglossal nerves.

The submandibular space, which is bounded by the body of the mandible, the lower surface of the mylohyoid muscle above and the superficial layer of deep cervical fascia below. It contains the superficial part of the submandibular salivary gland, the anterior belly of the digastric muscle and the submandibular and submental lymph nodes.

The parotid compartment, which is bounded by the posterior border of the ramus of the mandible, the styloid process and its muscles, the sternomastoid and the posterior belly of the digastric muscle. It contains the parotid salivary gland and its lymph nodes.

The pterygoid space, which is bounded by the ramus of the mandible and the deep surface of the masseter on the lateral side, the skull base above and the pharynx medially. It contains the pterygoid muscles, the pterygoid venous plexus, the maxillary artery and the mandibular division of the trigeminal nerve.

The parapharyngeal space, which is bounded by the pharyngeal wall and vertebral column medially, and the deep cervical fascia and sternomastoid muscle laterally. It contains
the carotid artery, the jugular vein, cranial nerves IX, X, XI, and XII, and the deep cervical lymph node chain.

The paratonsillar space, which is between the wall of the pharynx and the mucous membrane of the fauces, extends up into the soft palate.

Taste

Taste buds, which open directly on to the lingual surface of the tongue, are present in fungiform papillae which cover the anterior two-thirds of the dorsum of the tongue. These papillae are circular, red, between 1 and 4 mm in diameter and number between 20 and 60. These slightly raised fungiform papillae are surrounded by the more numerous filiform papillae which do not contain taste buds. Up to eight taste buds are present within these fungiform papillae, which also contain specialized pressure, tactile and temperature receptor.

Over the posterior third of the tongue, just anterior to the V-shaped sulcus terminalis, lie between 8 and 20 circumvallate papillae which project above the surrounding lingual tissue. Taste buds, in numbers up to 100, are present in both the papillae and the crypts which surround these papillae. In the bottom of the crypts surrounding the circumvallate papillae are the Von Ebner's glands, and encircling the opening of these glands are cilia which propel the secretions into the crypts. A few taste buds may be found on the palate and lips and have even been demonstrated in the upper third of the oesophagus (Henkin, 1976).

Taste buds are made up of between 20 and 50 cells, tightly joined together by desmosomal attachments. These cells are of epithelial origin and migrate into the bud; under neural salivary influence, they differentiate into one of three cell types which undergo constant renewal. All cell types have processes which extend up into the pore region of the bud, and nerves enter and leave the taste bud through its base.

For normal function, the taste bud receptors are exposed to the oral environment and are thought to respond to four primary stimuli: salt, sweet, sour and bitter. Differentiation of discrimination from within the various parts of the oral cavity has been observed, but the greatest number of buds respond to sweet stimuli.

Decreased taste activity is called hypogeusia and total loss of taste ability is known as ageusia. Abnormalities in the production of saliva, which is necessary for taste - such as occurs in Sjögren's syndrome, in the surgical removal of salivary glands, or after radiotherapy of the head and neck area - lead to a reduction in saliva flow and also to pathological changes in the taste buds.

Among the many pathological processes known to affect taste are vitamin deficiency, especially that of vitamins A and B_{12}, and zinc deficiency. Endocrine disturbances, such as hypothyroidism and Cushing’s syndrome, as well as numerous drugs, such as amitriptyline and some cytotoxic agents, have been implicated.

Damage to the facial nerve in Bell's palsy, or deliberate section of the chorda tympani during middle ear surgery, are well known to the otolaryngologist, but one of the commonest.
causes of altered or lost taste sensation is postcoryzal or postinfulenzal damage, which may be accompanied by a loss of sense of smell.

**Dental anatomy**

**Dentition**

Man has two generations of teeth, namely the deciduous and the permanent.

The deciduous dentition begins to appear in the mouth at about six months of age, and the complete set of 20 teeth has erupted by about two and a half years.

The permanent dentition starts to appear in the mouth at about six years and the last of the deciduous teeth is shed at about 13 years. The permanent dentition is not complete until the third permanent molar teeth (also known as wisdom teeth) erupt at about 18-21 years. The complete permanent set of teeth numbers 32.

The teeth of both dentitions are arranged in upper and lower arches, and in each arch the teeth are arranged symmetrically on either side of the median plane. The teeth are identified according to their anatomical location within each of the four quadrants. In man, the deciduous dentition has five teeth in each quadrant, comprising two incisors, one canine and two molars. The permanent dentition has eight teeth in each quadrant, comprising two incisors, one canine, two premolars and three molar teeth.

**Difference between the deciduous and permanent dentitions**

The deciduous teeth are smaller than their permanent successors and the crowns are more bulbous with less robust roots. The deciduous teeth are whiter than the permanent teeth, and the enamel is softer and more easily worn.

Each deciduous tooth is finally shed following the resorption of its root by the pressure of its erupting successor.

A dental shorthand is used for tooth identification. The deciduous teeth in each quadrant are labelled a to e and the permanent teeth in each quadrant are number 1 to 8.

The symbols for the quadrants are derived from an imaginary cross imposed upon the dentition when looking at the subject.

Thus the maxillary left second molar is /7 and the maxillary right deciduous first incisor is a/.

**Definition of terms in description of tooth form**

*Crown.* That portion of the tooth visible in the oral cavity.

*Root.* That portion of the tooth which lies within the alveolus.
**Occlusal surface.** The biting surface of a molar or premolar tooth.

**Incisal margin.** The cutting edge of the anterior teeth.

**Cusps.** The elevation in the occlusal surface of the teeth.

**Fissure.** Longitudinal cleft between cusps.

**Buccal surface.** That surface of a premolar or molar adjacent to the cheek.

**Labial surface.** That surface of canine or incisor which is positioned immediately adjacent to the lips.

**Palatal surface.** That surface of the maxillary teeth adjacent to the palate.

**Lingual surface.** That surface of the mandibular teeth adjacent to the tongue.

**Mesial.** That surface of the tooth that faces the median line.

**Distal.** That surface of the tooth that faces away from the median line.

**Chronology of tooth eruption**

**Deciduous dentition**

Lower incisors: 6-9 months  
Upper incisors: 8-10 months  
Upper and lower first molars: 12-16 months  
Deciduous canines: 16-20 months  
Upper and lower second molars: 20-24 months.

**Permanent dentition**

First molars: 6-7 years  
Central incisors: 6-8 years  
Lateral incisors: 7-9 years  
First premolars: 10-12 years  
Canines: 10-12 years  
Second premolars: 10-12 years  
Second molars: 10-13 years  
Third molars: 17-21 years.

Eruption times in the tables are approximate, and variations of up to six months either way are not unusual. The permanent dentition tends to be more advanced in girls than in boys.
The form of the teeth

The incisors

There are two incisors in each quadrant, upper and lower, in both deciduous and permanent dentitions. In each quadrant, the tooth nearest the midline of the dental arch is known as the central incisor and the second tooth as the lateral incisor. These single rooted teeth are adapted for incising and the incisal edge undergoes attrition with age. The upper incisor region is a common site for supernumerary teeth and the lower incisors are the most common teeth to exhibit crowding. A gap between the central incisors is called a diastema.

The canines

The name is derived from the Latin word for dog because in the dog this type of tooth is very prominent. The canines are less prominent in the human being but are still the longest rooted teeth and the crown has a sharply pointed cusp. They are the first teeth of the true maxilla, as both incisors are carried in the premaxilla.

The premolars

There are two premolars in each quadrant and they replace the deciduous molars.

The upper premolars have a larger buccal cusp and a smaller palatal cusp. The first premolar has two roots and the second premolar has a single root. The first premolar is the tooth most usually sacrificed to create space before orthodontic treatment. The lower premolars have a less prominent lingual cusp and are usually single rooted.

The molars

These teeth are adapted for crushing and grinding food and are multicuspid and multirooted. Upper molars have three roots and lower molars two, and they decrease in size from the largest first molar to the smallest third molar. This third molar or wisdom tooth is the most likely to be congenitally missing, and 25% of the population have one or more missing. In Caucasians, there is frequently insufficient room for the third molar to erupt so it may become impacted against the second molar in varied stages of eruption. The inability to clean the partly buried tooth, together with the sepsis that may ensue in the gingival pockets, produces discomfort in the young adult so that extraction is often necessary. The removal of these teeth, especially the mandibular impacted wisdom tooth, often requires a surgical approach because of the difficult access and the need to remove overlying bone. The apices of the roots of lower molars are usually in close relationship to the inferior alveolar nerve which may even occasionally perforate the root.

The roots of the upper molar teeth, especially those of the first molars, are in very close proximity to the antrum. When viewed from within the antrum, these roots can be seen as elevations of the antral floor.
Periapical abscesses on these molar teeth can therefore lead to sinusitis, although this is rarely seen in present times. Certainly, as part of the treatment of maxillary sinusitis, any carious teeth or infected roots should be appropriately treated.

The bone of the floor of the antrum, which lies between the roots of the molar teeth, is thin and is therefore commonly removed still attached to the roots during dental extraction. The iatrogenic production of oroantral fistulae is certainly more common than is generally recognized. Large oroantral fistulae should be dealt with by immediate surgical closure. However, many of the unrecognized oroantral fistulae heal spontaneously, and the most important determinant is the organization of a healthy blood clot within the socket. Sepsis within the clot will cause lysis and will produce a localized osteitis in the bone. This painful condition of 'dry socket' will predispose to the formation of an oroantral fistula.

Congenital absence of all teeth is known as total anodontia and absence of some of the teeth is known as partial anodontia, although a better term is 'hypodontia'. After the wisdom teeth, the most commonly congenitally absent tooth is the upper lateral incisor. Teeth which are found in excess of the normal number are called supernumerary teeth (Van Beek, 1983).

Dental occlusion

Dental occlusion is the relationship of the dental arcades, set upon their bony bases, to each other. There is a recognized ideal relationship of the upper and lower dental arches which is called normal occlusion.

The guidelines for assessing the occlusion are the comparative relationships of the first permanent molars and of the upper and lower incisor teeth. To a large extent, this relationship depends on the relative sizes of the maxilla and mandible. A small set back mandible will give a distocclusion or class II relationship. A large prognathic mandible produces the opposite effect, or mesiocclusion, more commonly called a class III relationship.

Superimposed upon these bony bases there may also be a relative dentoalveolar disproportion, more commonly known as dental crowding. In the class I malocclusion, the bony bases are in harmony, but there is a relative crowding so that individual teeth are forced out of the dental arch.

The position that the upper incisors finally assume depends also on a balance of forces between the tongue, which tends to push them outwards, and the lower lip which counterbalances and tends to pull them back. Any 'incompetence of the lips' to become securely sealed at rest may result in the upper teeth becoming proclined outside the control of the lower lip. This produces the characteristic deformity of class II, division I. Alternatively, any over-activity of the musculature of the lower lip will tend to retrocline the upper anterior teeth, producing the deformity of class II, division II.

Treatment of these malocclusions is by means of removal or fixed appliances. These apply light but continuous forces which move the teeth through the plastic bone. This form of treatment is called orthodontics.
Severe malocclusions may have a significant adverse effect on mastication; the majority of orthodontic treatments are, however, undertaken for cosmetic reasons during the early teens.

The development of teeth

A local proliferation of the oral epithelium in the seven-week embryo gives rise to the dental lamina. At intervals along its length, small round swellings develop which are the primitive enamel organs of the deciduous teeth. The primordia of the permanent dentition later develop by budding off from the deciduous enamel organs. Adjacent to the enamel organ, the mesodermal tissue proliferates to form a dense mass which becomes the dental papillae. The enamel organ becomes a bell-shaped structure with the dental papillae now in the hollow of the enamel organ. The inner aspect of the ectodermal enamel organ differentiates, and provokes further differentiation in the dental papilla, to form odontoblasts, and it begins depositing enamel upon the recently laid down dentine. The entrapped dental follicle differentiates into the dental pulp.

When the formation of enamel is complete, the enamel epithelium extends below the cervical margin to become a two-layered structure called the sheath of Hertwig and this maps out the shape of the roots (Bhaskar, 1986).

When the structure of the crown is complete, the ameloblast layer will atrophy to become the reduced enamel epithelium protecting the ectodermal enamel from the mesodermal tissue in which it is buried. During eruption of the tooth, this epithelium finally unites with the epithelium of the alveolus, ensuring continuing epithelial contiguity of the mucosa in spite of the eruption of the teeth.

An abnormal proliferation of odontogenic epithelium, which does not produce teeth, may occur. The proliferations may remain cellular, resulting in an ameloblastoma, or may lead to the production of single or multiple masses of the calcified dental tissues arranged in irregular and haphazard ways. These are known as complex composite and compound composite odontomes, respectively.

Finally, areas of epithelial dental lamina which do not differentiate into enamel organs may lie entrapped and dormant within the alveolus. These are called the epithelial rests of Mallassez (Ham and McCormack, 1979). Later in life, cystic conditions may occur which originate from these remnants of the dental epithelium. Among these are cysts of eruption, dental cysts and dentigerous cysts.

Structure of the teeth

In the human being, each tooth is composed of three calcified tissues, namely enamel, dentine and cementum, and contains a centrally situated soft pulp, which is the nutritive and sensory organ of the tooth.

Enamel forms the outer covering of the crown. It is grey or bluish-white in colour - its colour being modified by that of the underlying dentine - and is semitranslucent. It is the
hardest substance in the body, so that it can well withstand masticatory stress, but is somewhat brittle. Enamel is highly mineralized, being 96% inorganic material, mainly in the form of hydroxyapatite crystals, 3% water and 1% organic matter. It has a crystalline prismatic structure, and each prism is the product of one ameloblast. It is ectodermal in origin, but no more enamel can be formed once the tooth has erupted.

Particular attention has recently been paid to the surface regions of enamel as it has been discovered that carious lesions within the enamel can be reversed and thereupon can reharden. Surface enamel differs both physically and chemically from subsurface enamel, in that the former is harder and less soluble. Surface enamel is rich in many trace elements, including fluorine, and it is believed that the fluoride ion incorporated in water supplies and tooth pastes has contributed to the rapid decline in the prevalence of dental caries in recent years.

Dentine, which forms the bulk of both the substances, and cementum, which covers the root, are both mesodermal in origin, that is living and capable of repair.

Dentine is composed of cells, the odontoblasts, and an intercellular substance. It is permeated by minute tubes, dentinal tubules, which contain the protoplasmic processes of the odontoblasts; the odontoblasts themselves always form a layer on the surface of the dentine. Dentine is a tissue highly sensitive to stimulation, as is commonly experienced, and although nerve fibres have been demonstrated in dentine, the odontoblasts themselves are believed to take part in the transmission of painful stimuli.

The pulp is composed of loose connective tissues richly supplied with blood vessels and nerves. The pulp is continuous with the connective tissue of the periodontal ligament and, functionally, is nutritive and sensory to the dentine. Any agent which opens up the dentinal tubules produces a reaction in the pulp. As the pulp is contained within unyielding walls of dentine, the hyperaemic and exudative changes accompanying inflammation lead to an increase in pressure inside both the pulp cavity and the vessels entering through the apical foramina, with the real risk of infarction of the pulp.

The periodontium

The periodontium is the unique attachment of the teeth to the bony bases, and includes the cementum of the tooth root, the alveolar bone and the intervening collagenous bundles of the periodontal ligament.

The most important elements of the periodontal ligament are the oblique fibres that pass from the cementum on the tooth substance to the lamina dura of the tooth socket. By the arrangement of these fibres, the tooth is suspended in its socket, and pressure upon a tooth is transformed into tension on the walls of the socket.

Teeth maintain their position in the arch because of a balance of the various forces acting upon each individual tooth. However, the plasticity of the alveolar bone means that teeth can move, as in eruption, or be moved by steady light pressure, and this property of the periodontium is the basis of orthodontics.
The alveolar bone, which houses the developing tooth germ and, later, the root of the tooth, is normal bone. When the teeth are lost, this bone is gradually resorbed; this process causes early problems with the fit of dentures and, with the reduction in face height, produces the ageing effect of the premature loss of the natural dentition.

The pink mucous membrane, immediately related to the teeth and firmly bound down to the alveolar bone, is called the gingiva. The gingiva follows the cervical margin of the teeth; with age, however, it physiologically moves toward the root, exposing more of the crown of the tooth, hence the expression 'getting long in the tooth'.

At the junction of the gingiva and the tooth, known as the gingival margin - representing the unique feature of a hard mineralized structure protruding through the surface integumentum of the body - there is a reflection of epithelium in close contact with the crown of the tooth which provides a seal at this point. Damage to this delicate seal, caused by the soft deposits of dental plaque and the calcific deposits of calculus or tartar, initiates and promotes the inflammatory process, resulting ultimately in periodontal disease, which is still the chief reason for tooth loss in adult life.

Age changes

With increasing age, the teeth undergo attrition; the enamel is worn away and the underlying dentine is exposed. The alveolar bone is progressively reduced and remodelled in those areas where the teeth have been prematurely lost. The edentulous mandible changes shape and the angle between the ramus and the body becomes more obtuse. The mental foramen comes to be closer to the upper border of the mandible where it is vulnerable to pressure.

Conclusions

As a result of changing attitudes in the UK, and of the increasing availability of innovatory methods of treatment, a greater percentage of the population are retaining their teeth for life.

Nevertheless, a substantial number of the senior adult population are edentulous and rely upon the prostheses of dentures to restore form and function.

Dental extraction is, however, still common practice and may occasionally be necessary in the course of surgical procedures undertaken by the otolaryngologist.

Surgical trainees would do well to acquaint themselves with the surgical techniques of exodontia.