

Gross Anatomy of the Skull

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Bones of the Skull

Mandible

The mandible is the largest bone of the face and is formed by paired hemi-mandibles, which fuse rostrally at the mandibular symphysis when the horse is approximately 2-3 months of age.¹ Each hemi-mandible is composed of a horizontal and vertical ramus. The horizontal ramus contains the alveoli of all the teeth in the lower jaw. The vertical ramus terminates with the coronoid process rostrally and the mandibular condyle caudally. The temporalis muscle inserts on the coronoid process; both of these structures are poorly developed in the horse (*vide infra*).

Between the incisors in the rostral aspect of the mandible and the cheek teeth in the horizontal rami of the mandible are the bars of the mouth. The canine (if present) is located in this area. The bars of the mouth can be injured by aggressive or over use of the bit causing osseous sequestra or spurs to form.² In the young horse, the ventral border of the mandible is wide and round, but as the horse ages, and eruption of the mandibular cheek teeth continues, the ventral border of the mandible takes on a sharper angled appearance. Eruption swellings or 'bumps' are often seen on the ventral border of the mandible of young horses as the permanent mandibular cheek teeth erupt.

Incisive Bone

The paired incisive (or premaxillary) bones form the rostral part of the upper jaw and contain the alveoli of the incisors. Caudally, the incisive bone becomes thinner and forms the rostral part of the hard palate. The thin suture line between the incisive bones and the maxillary bones is an anatomically weak area and a common site of facial fractures. The canines (if present) are situated caudal to this suture line.

Maxillary Bone

The paired, large maxillary bones extend from the incisive bone rostrally to the nasal bones dorsally and lacrimal bones caudally. The facial crest is a prominent ridge of bone on the lateral aspect of the maxillae. This crest continues caudally as the zygomatic process, which joins the malar and temporal bones to form the zygomatic arch. The ventromedial aspects of the maxillary bones join to form a horizontal shelf that provides rigid support of the majority of the hard palate. The alveoli of the canines (if present),

premolars and molars are embedded in the maxillae. The position of the cheek teeth alveoli is somewhat variable, but usually, the alveoli of the first two cheek teeth lie outside the sinuses, that of the 3rd and 4th cheek teeth lie within the rostral maxillary sinus, and that of the caudal two cheek teeth lie within the caudal maxillary sinus. Each alveolus is separated by transverse interalveolar bony septa. Eruption cysts or ‘bumps’ are occasionally seen on the lateral aspect of the maxillae of young horses when the permanent cheek teeth are erupting.

The Temporomandibular Joint

The temporomandibular joint is a synovial joint formed by the articulation of the squamous temporal bone with the condylar process of the mandible. The joint lies approximately 15 cm above the level of the occlusal surface of the cheek teeth. The joint cavity is large and is divided in two by an intra-articular disc. The joint is bound by a tight capsule and lateral and caudal ligaments. The equine temporomandibular joint has a wide range of lateromedial movement (allowing the medially directed ‘power stroke’) but limited vertical and rostrocaudal movement. Temporomandibular joint pain remains the subject of much controversy, and thus the kinematics and dissection of this joint have been the focus of several recent studies.³⁻⁵

Sinuses

The horse has 5 paired paranasal sinuses: the conchofrontal, sphenopalatine, caudal maxillary, rostral maxillary, and ethmoidal sinuses. Of these, the caudal and rostral maxillary sinuses are by far the most important with regard to the equine dentistry.

The rostral and caudal maxillary sinuses are contained within the maxillae and are usually separated by a thin bony septum, although this septum often breaks down with disease. The infraorbital canal traverses longitudinally through the maxillary sinuses. The alveoli of the 3rd and 4th cheek teeth are embedded in the rostral maxillary sinus, and the alveoli of the 5th and 6th cheek teeth are embedded in the caudal maxillary sinus. Consequently, sinusitis can occur secondary to disease of these teeth and classically results in a unilateral, malodorous nasal discharge. In a young horse, almost the entire maxillary sinuses are occupied by dental alveoli, but as the horse ages, and eruption of the reserve crown continues, the sinuses enlarge. The maxillary sinuses drain into the back of the nasal cavity via a slit like aperture, the nasomaxillary opening. The medial compartment of the rostral maxillary sinus is called the ventral conchal sinus. This compartment has poor drainage because its secretions must drain into the lateral compartment of rostral maxillary sinus before draining into the caudal middle meatus adjacent to the drainage angle of the caudal maxillary sinus.

Muscles of Mastication

As a result of the wide lateromedial range of temporomandibular joint motion associated with the power stroke of mastication, the masseter and pterygoid muscles are the most highly developed muscles of mastication in the horse. The powerful masseter muscle

originates from the full length of the facial crest and zygomatic arch and has wide insertions along the caudolateral aspect of the mandible. The superficial masseter muscle fibres run almost vertically whilst the deeper fibres run in a ventrocaudal direction. The masseter pulls the jaw to the ipsilateral side and also contributes to closure of the jaw. The medial and lateral pterygoid muscles have similar origins and insertions as the masseter and lie on the medial aspect of the mandible.⁶ The digastricus muscle originates on the occipital bone and attaches to the caudal aspect of the mandible and is small due to small effort required to open the jaw because of gravity. The temporalis muscle, whose function is jaw closure, is also small and poorly developed in the horse due to limited vertical opening of the temporomandibular joint. The muscles of mastication are all innervated by the trigeminal nerve.

Dental Nerve Supply

Innervation of the dental structures is supplied by the trigeminal nerve, which exits the skull just below the ear. The nerve traverses rostrally and then divides into the ophthalmic, maxillary, and mandibular branches. The maxillary nerve enters the caudal maxilla ventral to the orbit via the maxillary foramen and runs through the maxilla in the infraorbital canal giving off branches to supply the maxillary cheek teeth. The nerve then exits the maxilla at the infraorbital foramen just rostral and dorsal to the facial crest. The mandibular nerve runs medially along the mandible branching into smaller nerves including the inferior alveolar nerve, which enters the mandibular canal on the caudomedial aspect of the mandible and innervates the mandibular cheek teeth. The mental nerve exits the mandibular canal via the mental foramen at the rostralateral aspect of the mandible just rostral to the mandibular cheek teeth and supplies the ipsilateral incisors and canine. Knowledge of the anatomical location of these nerves and foramen can be used when providing anaesthesia to dental structures to aid dental procedures.⁷

As yet there is little published information regarding pulpar innervation of hypsodont teeth, even though pulpar innervation has been well described in species having brachydont teeth. Pulpar nerves enter the tooth at the dental apex and consist of sensory fibres from the trigeminal nerve and sympathetic fibres from the cranial cervical ganglion. The sensory fibres are most abundant in the coronal pulp where they form a plexus.⁸ Sympathetic fibres supply vascular smooth muscle and regulate pulpar blood flow.⁹ These sympathetic fibres are also thought to regulate odontoblast differentiation,¹⁰ which may be an important function in hypsodont teeth given the need for odontoblasts to continue to lay down dentine throughout the horse's life to prevent pulpar exposure.

In species with brachydont teeth, pulpar pain is described as a dull ache, whereas dentinal pain is described as a sharp pain.¹⁰ Equids appear poor at showing obvious pulpar or dentinal pain. For example, horses with a dental fracture usually do not quid, a common sign of dental pain. The pain demonstrated by some horses after dental treatment (particularly radical reductions), however, may be an indication of dentinal pain, because open dentinal tubules and damaged odontoblasts have been observed microscopically after rasping.¹¹

Dental Blood Supply

Blood is supplied to brachydont teeth via the pulp and thus enters the tooth through the apical foramen. An extensive capillary network forms, particularly in the coronal aspect of the pulp. Blood is drained from the tooth via an intricate venous network that exits at the apical foramen.¹⁰

Vessels of note within the oral cavity include the greater palatine artery, which runs along the lateral border of the hard palate. This vessel communicates with both internal maxillary arteries, and thus, damage to this vessel, which sometimes occurs during extraction of a wolf tooth or maxillary cheek tooth, can result in severe haemorrhage.

Lymphatic System

Lymphatic vessels likely supply brachydont teeth via a route similar to that of the blood vessels but, due to the difficulty in distinguishing vascular and lymphatic vessels microscopically, the route of lymphatic supply remains speculative. Recently, lymphatic vessels have been immunohistochemically identified in the periodontium of equine maxillary and mandibular cheek teeth.¹² Lymphatic vessels were detected in all periodontal tissues, except for the dental cementum, and were most densely distributed in the gingiva. Two complementary lymphatic drainage pathways were proposed: a superficial lymphatic drainage via the gingiva that empties into the mandibular lymph nodes and a deeper lymphatic drainage via the mandibular and maxillary spongiosa that empties into the mandibular and retropharyngeal lymph nodes.¹²

Enlargement of the ipsilateral submandibular lymph node is often observed with periapical dental infection. The enlarged node must be differentiated from enlarged salivary tissue, which is also situated in the intermandibular space.

Salivary Glands and Ducts

Saliva is produced in the horse by paired parotid, mandibular, and sublingual salivary glands. The parotid salivary gland lies caudal to the horizontal ramus of the mandible, ventral to the ear, and is the largest and most significant salivary gland in the horse, producing up to 50 ml saliva per minute. This gland may swell to several times its normal size in some grazing horses due to an enigmatic condition termed idiopathic parotiditis. The parotid gland is intimately associated with several vital structures, including the jugular vein and carotid artery.⁴ The parotid duct crosses the ventrolateral aspect of the caudal horizontal ramus of the mandible with the facial artery and vein and enters the oral cavity just rostral to the first molar.¹ When performing a buccotomy, care should be taken to avoid damaging the duct where it traverses the mandible, to avoid development of a permanent salivary-cutaneous fistula at the site of injury.

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