

Equine masticatory organ

Part III

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The masticatory system, which is also referred to as the stomatognathic system, consists of the temporomandibular joints, dentoalveolar apparatus, dentodental junctions and the neuromuscular complex. This article presents the relations between various joints under both physiological and pathological conditions.

Key words: teeth, alveolar bone, molar teeth, temporomandibular joint, bone mineral dentistry

The shape of the buccal teeth in the horse provides an ideal surface for shredding and grinding of hard food particles. Soft cementum and dentine are the first structures to undergo attrition, hence they uncover sharp-edged particles of the enamel ledges. Fissures between the borders of the ledges grind the food in the central part of the oral cavity. The food is crushed by the tongue and adjoining laterally gingival margins and pushed backwards, where it is chewed. The teeth in one dental arch are closed laterally, they slide towards the medial-dorsal angle and next they are released enabling rotational, lateral movements of the mandible in relation to the dorsal dental arch. The food is formed into boluses which are moved backwards from the rostral to the caudal part of the oral cavity by circular masticatory movements. The boluses assume spindle-like shapes which supports the rostral-caudal theory of bur-like action. During successive chewing cycles the chewing surfaces are constantly replaced by coronary reserve. Thus the teeth are termed as “constantly growing” – hypselodontic, until complete protrusion of the tooth occurs [4, 6, 7].

The temporomandibular (*articulatio temporomandibularis*) joint is one of the main elements of the masticatory organ. Due to its double-layer structure enabling complex movements and combined action of both joints, the temporomandibular joint plays an exceptional role in the locomotor system of animals. In the horse, it is wider in its medial-lateral articular surface than in carnivorous animals and humans, which

enables better and larger side-to-side sliding motions. The temporomandibular joint connects bilaterally one movable bone within the skull – the mandible, with the base of the skull (figure 1).

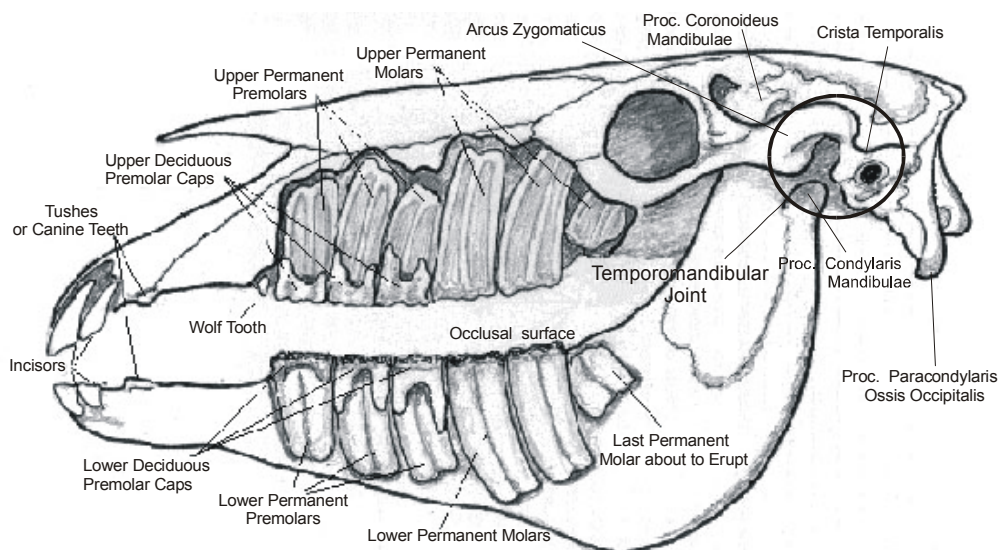


Fig. 1. Lateral view of a partially dissected skull

The temporomandibular joint includes the articular surfaces of the temporal bone (the fovea and the tuberculum), the articular surface on the condylar process of the mandible, the mandibular disc and the articular capsule with ligaments. The mandibular condylar processes form two-layer junction with the mandibular fossa of the temporal bone. This is a compound, incongruent, cylindrical joint. From the side of the temporal bone it is formed by the zygomatic process of the temporal bone (*processus zygomaticus ossis temporalis*) which contains the articular fovea, articular tuberculum and extra-articular tuberculum. From the side of the mandible there is the cylindrical condylar process (*processus condylaris*) which is separated from the temporal process by the mandibular notch. The articular surfaces of the fovea and the head of the mandible do not fit and do not contact each other directly (in physiological conditions) as they are separated by the articular disc, the shape of which is matched up to both articular surfaces. The articular disc (intraarticular cartilage) divides the joint into two parts: the superior temporal (*scala superior*) and the inferior mandibular (*scala inferior*) ones. The disc serves as a shock absorber which ameliorates the joint trauma and plays an important role in the complex motor mechanism of the joint. The collagen bundles in its medial part are compact and arranged horizontally while on the periphery they intertwine and form a fibrous ring [7, 8, 10].

Between the posterior border of the disc and the articular capsula there is a layer of loose connective tissue which is closely associated with the synovial membrane of the capsula. The fibrous membrane is common for the whole joint. The following ligaments are attached externally to the capsula:

a) the lateral temporomandibular ligament (*ligamentum temporo-mandibulare*) which strengthens the capsula and is attached to the base of the zygomatic process of the temporal bone, from where the fibres run backwards and downwards and attach to the lateral and posterior surfaces of the mandibular neck; this ligament in a horse is stronger and wider than in other animals, as the movements of the mandible in the lateral and posterior directions are much more extensive;

b) the sphenomandibular ligament (*ligamentum spheno-mandibulare*) runs forwards and downwards from the external portion of the sphenoid process, attaching to the internal surface of the mandibular branch, it restricts the posterior and lateral movements of the mandible;

c) the stylomandibular ligament (*ligamentum stylo-mandibulare*) runs from the anterior surface of the styloid process obliquely forwards and downwards to the posterior border of the mandible, it restricts forward movement of the mandible.

Injury to only one of the elements of the system impairs the function of other anatomical structures of the masticatory organ. Diseases of the temporomandibular joint are due to an external trauma associated with abnormal occlusion, neurogenic disturbances of the masticatory muscles causing dysfunction of the joint as well as inflammatory conditions of the periarticular tissues.

The muscular system of the masticatory organ is formed by two groups. The first one includes the masticatory muscles, the other contains muscles participating in lowering of the mandible while the hyoid bone is immovable. The masticatory muscles include:

1. The masseter muscle (*musculus messeter*) which is the largest and the strongest muscle from this group. It originates from the lower border of the zygomatic bone (pesteiniform process) and the zygomatic arch. Its fibres run ventrally and caudolaterally around the mandible. This anatomical arrangement enables lateral and circular movements of the mandible.

2. Medial pterygoid muscle (*musculus pterygoideus medialis*) raises the mandible in cooperation with the remaining muscles. It originates from the pterygoid fossa of the sphenoid bone, its fibres run downwards and backwards and are attached to the medial surface of the mandibular angle. It is responsible for strong impact of the tongue on chewing.

3. Lateral pterygoid muscle (*musculus pterygoideus lateralis*) is situated in the subtemporal fossa and consists of two bundles: the superior, attached to the articular capsula of the temporomandibular joint, and the inferior one, attached to the pterygoid fovea; contraction of the muscle on one side turns the mandible in the contralateral direction, contraction of both muscles causes forward movement of the mandible.

Medial and lateral pterygoid muscles support the masseter muscle in unilateral, horizontal closing movements of the jaws.

4. Temporal muscle (*musculus temporalis*) is situated in the temporal fossa and medial part of the zygomatic arch. It consists of a large number of fibres; the anterior fibres run vertically, the medial – obliquely and the posterior ones run almost horizontally. The horizontal bundles of the posterior part of the muscles move back the forwarded mandible, while the remaining bundles constrict causing elevation the mandible and approximating it to the upper jaw [6, 7].

The second group of muscles comprises the suprahyoid muscles which lower the mandible with a fixed hyoid bone:

1. Digastric muscle (*m. digastricus*) which extends in the intramandibular space. It is responsible for opening of the oral cavity.

2. Mylohyoid muscle (*m. mylohyoideus*) originates from the mylohyoid line of the mandible and is attached to the anterior surface of the body of hyoid bone, it extends from PM1 to the last molar. It is the posterior part of the transverse mandibular muscle (*m. transversus mandibulae*). It is responsible for the movements of the tongue. On chewing it raises the tongue and presses it against the palate.

3. Geniohyoid muscle (*m. geniohyoideus*) originates from the mental border of the mandible and is attached to the anterior surface of the body of hyoid bone. It pulls the tongue forwards.

The temporomandibular joints form a complex and compound system associated functionally with occlusion and the condition of dentition. Under normal conditions, the physiological movements of opening, closing, forward and backward movements of the mandible as well as chewing movements take place in both joints simultaneously.

From the point of view of mechanist, three kinds of movements are distinguished:

1. Hinged or rotatory movements – they consist in rotations of the head of the joint process in relation to the cartilage of the joint and take place at the lower level of the joint.

2. Sliding movements – they occur as a simultaneous forward and downward movement of the articular cartilage and the head of the articular process along the posterior surface of the articular tuberculum.

3. Complex movements are a combination of sliding movements of one articular process and rotatory movement of the second process about the vertical axis of the head.

Movements of the mandible are controlled by the muscular system and extracapsular ligaments, they also depend on the shape and action of the articular cartilage and inclination of the articular tuberculum as well as on the position of the occlusal surface.

The following muscles take part in closing of the jaws: masseter, temporal and medial pterygoid muscles. Opening of the jaws is accomplished by the contraction of the following muscles: lateral pterygoid, mylohyoid, geniohyoid and digastric muscles. Immobilization of the hyoid bone is responsible for a proper functioning of the muscles. Forward protrusion of the mandible is controlled by the lateral pterygoid muscles, while retraction of the mandible is accomplished by the horizontal bundle of the temporal muscles that cooperate with the muscles of the floor of the mouth.

Forward protrusion and retraction of the mandible take place on both levels of the temporomandibular joint.

In the first phase of movement, lower incisors slide over the palatal surfaces of the upper incisors, while the borders of lingual surfaces of lower molars slide over the lateral surfaces of the opposite teeth and the mandible moves in a rotational manner about the axis passing vertically through the neck, not leaving the acetabulum. The head of the mandible on the contralateral (balancing) side lowers down and moves forward, describing an arch towards the side, thus it moves about the peroneal axis passing through the middle of the head resting in the acetabulum and about the axis passing vertically through the same head.

The teeth rub against each other in such a way that the masticatory surfaces of the upper and lower molars occlude on the chewing side, while the borders of the buccal surfaces of lower molars meet the lingual surfaces of the upper molars on the balancing (supporting) side. The lateral movements of the mandible are controlled by the lateral pterygoid muscle, the movement to the right being controlled by the left lateral pterygoid muscle and to the left – by the right lateral pterygoid muscle. Simultaneous contraction of the muscle causes forward protrusion of the head of the mandible on the side of the contraction, thus it moves the mandible to the contralateral side.

Proper functioning of the masticatory muscles is closely associated with nerve supply. The mandibular branch of the trigeminal nerve supplies the skin and the oral mucous membrane. It also innervates the masseter muscle. Lower alveolar nerves enter the mandibular canal on the medial side of the mandible. Within the mandible they give off branches to the mandibular teeth and leave through the submental foramen. The teeth of the upper jaw are supplied by the long maxillary branch of the interorbital nerve which enters the infraorbital canal and gives off branches to the teeth. Leaving through the interorbital foramen, it gives off sensory branches supplying the upper lips, the nose and the vestibule of the nose. The infraorbital canal is closed together with the roots of the buccal teeth of the maxilla PM4, M1, M2, M3. Normally, molars in upper jaw are spaced wider than in the lower jaw, thus the grinding surfaces of the teeth do not match exactly each other (figure 2).

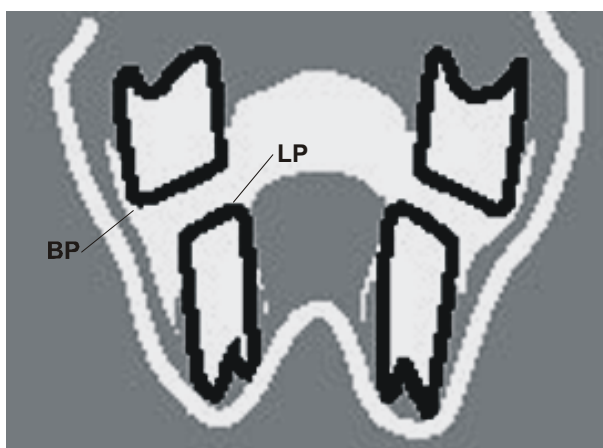


Fig. 2. Cross-section at the molars showing sharp enamel points.
(LP) – lingual points, (BP) – buccal points

On occlusion of the dental arches, every upper molar contacts its opposing tooth only in 3/4 of its surface, the buccal 1/3 of the grinding surface is free just as the lingual half of the grinding surface of the lower molars, such inclination of the grinding surfaces and lack of full cover on occlusion of the jaws predispose to the formation of a sharp external edge on upper molars and a sharp internal edge on the lower molars [1, 7, 11]. If the teeth are not hard enough and the lateral masticatory movements are limited, the edges become sharper and elongated, they are covered with sharp irregularities on the surface of enamel which on chewing may cut the cheeks and the tongue. This condition is manifested by slow chewing interrupted by removal of partly utilized food and its accumulation between the cheeks and the teeth, which in consequence leads to emaciation of the animal and decreased utilitarian fitness.

Despite differentiation in dentition, size, shape and replacement of teeth, horses with normal dentition are very rare. Inborn bite anomalies, deformities, injuries and premature falling off teeth are often met.

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