RCMOS – Multidisciplinary Scientific Journal O Saber.
ISSN: 2675-9128. Sao Paulo-SP.
Year IV, v.1, n.1, Jan./Jul. 2024. | submission: 06/25/2024 | accepted: 06/27/2024 | publication:06/29/2024

DESCRIPTIVE OSTEOLOGY OF THE BOVINE SKULL

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SUMMARY
The bovine skull performs vital functions, protecting the brain and sensory organs, as well as providing structure and support for the head. Composed of several bones, such as the frontal, parietal, occipital, temporal, maxillary and mandibular, each one has a specific role. The frontal bone, for example, forms the forehead and part of the orbital cavities, while the occiput protects the back of the brain and articulates with the spinal column. The jaw, essential for chewing, is one of the most robust bones, supporting the molar and premolar teeth, essential for crushing fibrous foods. The nasal and maxillary bones form the structure of the snout and house the incisor teeth, important for grasping food. Studying the osteology of the bovine skull is crucial to understanding the functional anatomy and health of animals. Detailed knowledge about bone structure helps veterinarians and zootechnicians identify anomalies, fractures and bone diseases, in addition to being essential for surgical procedures and imaging diagnoses. This detailed anatomical information is usually found in specialized books rather than scientific articles. Therefore, this article aims to describe the osteology of the bovine skull, providing an accessible and practical reference for students and professionals in the field. An in-depth understanding of bovine cranial anatomy is essential to guarantee the well-being and productivity of animals, directly reflecting the efficiency of agricultural practices.
Key words: Anatomy. Bovine. Skull. Bone.

ABSTRACT
The bovine skull performs vital functions, protecting the brain and sensory organs, as well as providing structure and support for the head. Composed of various bones, such as the frontal, parietal, occipital, temporal, maxillary, and mandibular bones, each has a specific role. The frontal bone, for instance, forms the forehead and part of the orbital cavities, while the occipital bone protects the posterior part of the brain and articulates with the vertebral column. The mandible, essential for mastication, is one of the most robust bones, supporting the molar and premolar teeth, which are fundamental for grinding fibrous foods. The nasal and maxillary bones form the structure of the snout and house the incisor teeth, important for grasping food. Studying the osteology of the bovine skull is crucial for understanding the functional anatomy and health of the animals. Detailed knowledge of the bone structure aids veterinarians and animal scientists in identifying anomalies, fractures, and bone diseases, as well as being fundamental for surgical procedures and imaging diagnoses. These detailed anatomical informations are generally found in specialized books, not in scientific articles. Therefore, this article aims to describe the osteology of the bovine skull, providing an accessible and practical reference for students and professionals in the field. A deep understanding of bovine cranial anatomy is essential to ensure the well-being and productivity of the animals, directly reflecting the efficiency of agricultural practices.
Keywords: Anatomy. Beef. Skull. Cap.

1. INTRODUCTION

The skull is the most complex part of the skeleton, because despite appearing to be just one bone, or two (considering the jaw), the bone structure of the skull as a whole is made up of dozens of bones, around 16, including paired bones and odd. It performs several important functions, such as the protection of the brain and sensory organs (eyes, ears, nose), the muscular insertion for muscles of mastication and facial expression, the formation of the oral and nasal cavities, essential for breathing and eating, and communication, influencing vocalization and sound communication.

In domestic animals, the skull can be divided into two main parts: the neurocranium and the viscerocranium (or splanchnocranium). The neurocranium makes up the covering that protects the brain and meninges

brain structures, therefore being composed of bones that form the cranial cavity, while the viscerocranium forms the structure of the face, including the nasal cavity and the oral cavity, that is, it is composed of bones that surround the mouth, eyes and nose .

The bones of the neurocranium include thefrontal bone , which forms the dorsal part of the skull and the forehead; O parietal bone , located in the dorsal and lateral part of the skull; Otemporal bone , located on the sides of the skull and which contains the structures involved with hearing; Ooccipital bone , which forms the caudal part of the skull and contains the foramen magnum, through which the spinal cord passes; Osphenoid bone , located at the base of the skull and which contributes to the formation of the cranial cavity; and thepterygoid and ethmoid bones , located at the base of the skull, between the eyes, and which contributes to the formation of the nasal cavity.

The bones of the viscerocranium include thenasal bone , which forms the bridge of the nose; Otear bone , a small bone situated in the medial part of the eye socket; Ozygomatic bone , which contributes to the formation of the eye orbit and zygomatic arch; Ojaw bone , which occupies the side of the face and contains some of the teeth in the upper arch; O incisor bone which makes up the most rostral part of the skull; Opalatal bone , which forms the roof of the oral cavity, next to the maxillary and incisor bones, being the caudal part of the hard palate; Ovomer , which forms the ventral part of the nasal septum; and thenasal turbinates (or turbinates), which are bony structures within the nasal cavity that help filter and humidify inhaled air. Besides thejaw , a movable bone that forms the ventral part of the skull and contains the teeth of the lower arch.

Each species of domestic animal has specific characteristics in its skull. In dogs, for example, there are variations, depending on the breed, such as the dolichocephalic skull (which is long and narrow, found in breeds such as the Doberman), the brachycephalic skull (which is short and wide, as in Bulldogs) and the mesaticephalic skull. (which has intermediate, proportional proportions, as in the Labrador Retriever). In cats, the skull is usually mesaticephalic, with a short, rounded face, but it can also be brachycephalic in some breeds, such as the Persian. In horses, the skull is long, with elongated nasal and jaw bones and a prominent sagittal crest on the dorsal part of the skull. And in pigs, the skull is short and wide, with short, robust nasal bones. Finally, in cattle, the protagonists of this study, among other characteristics that will be presented, the skull is massive, with wide and robust frontal bones,in addition to forming horns in some breeds.

Despite the importance of this anatomical information for veterinarians, students and other professionals in the field, there is a lack of scientific articles that address bovine osteology in detail. Much of the available knowledge is dispersed in veterinary anatomy books, which makes access to specific and detailed information difficult. Therefore, this article aims to describe the anatomy of the bovine skull bones, providing a more accessible and detailed reference for professionals in the field. By gathering and systematizing this information, we hope to contribute to a better understanding and management of the health and performance of these animals, facilitating more accurate diagnoses and more effective treatments.

2 THEORETICAL FRAMEWORK

2.1 Front

The frontal bone of BOVINE is a paired structure that forms the caudal and dorsal part of the skull, being notably wide and thick. Its surface is relatively flat and extensive, slightly convex, covering the frontal region (forming the animal's forehead) and giving the characteristic shape of the bovine head. Morphologically, the frontal bone is considered flat or flat, in addition to being internally pneumatic, that is, it forms hollow bone cavities to give more lightness to the skull which, in this region, are called frontal sinuses. Topographically, the frontal bone articulates with several other bones of the skull, including the parietal and occipital bones (caudally), the nasal bones (rostrally), the lacrimal and zygomatic bones (laterally), and the sphenoid bone (ventrally, at the base of the skull), forming a solid and resistant cranial structure. Your Its main function is to protect the brain and form the upper part of the orbital cavity, in addition to contributing to the structuring of the nasal cavity. In some cattle breeds, the presence of horns (a bony extension that projects laterally and caudally) is a significant difference in the frontal bone of this species in relation to other domestic animals.

The frontal bone of cattle has several anatomical features that perform essential functions both in protecting internal structures and in inserting muscles and supporting other parts of the skull. One of the most notable accidents is thecornual process , which projects laterally and serves as the base for the horns, characteristic structures of many bovine breeds. The horns that will develop at the site are

used by animals both for defense behaviors and in social interactions.

Adjacent to the cornual process is theintercornual bulge , a bony elevation located between the horns. This protuberance is particularly prominent in adult cattle and contributes to the structural strength of the skull, distributing the forces exerted on the horns during impacts or confrontations.

Osupraorbital foramen is another significant anatomical feature of the frontal bone. Located above the eye socket, this foramen allows the passage of the supraorbital nerve and blood vessels, which provide innervation and blood supply to the frontal region of the head. Associated with this foramen, thesupraorbital groove extends from it, forming a channel that facilitates the passage and protection of the nerves and vessels that go to the skin and muscles of the forehead.

Ozygomatic process of the frontal bone It is a lateral projection that articulates with the zygomatic bone, forming the caudal part of the orbit. Finally, also related to the ocular orbit, but specifically on its internal and dorsal surface, is thelacrimal gland fossa, a depression located on the inner surface of the frontal bone. This fossa houses the lacrimal gland, responsible for producing tears that lubricate and protect the ocular surface. The strategic location of this fossa ensures that the lacrimal gland is well protected and functionally efficient.

2.2 Parietal

The bovine parietal bone is a paired bone, located in the dorsal and lateral portion of the skull, thus forming the dorsolateral walls of the braincase. In cattle, the dorsal part of the parietal bone is covered by the frontal bone, making it only possible to see it laterally and caudally. It is also relatively quadrangular, with edges that articulate with different bones, including the frontal bones (dorsally), the temporal bones (ventrally), the occipital bone (caudally) and the other parietal bone in the midline of the skull. Its main function is to protect the brain, forming a significant part of the cranial vault, as well as providing attachment points for muscles that surround the head.

2.3 Temporal

The bovine temporal bone is paired, classified as irregular and is located in the lateral portion of the neurocranium. Its shape is complex, with several projections and cavities that contribute to its multifunctional structure, accommodating and protecting, for example, essential components of the auditory system. In relation to its topography, the temporal bone articulates rostrally with the zygomatic bone, dorsally with the parietal bone, caudally with the occipital bone and medially with the sphenoid bone, in addition to articulating with the mandible, composing the only synovial joint present in the skull. It has several functions, but among the most important is the fact that it is the basis for the cartilaginous structures of the external ear, in addition to housing and protecting the structures of the middle and inner ears, such as the hearing ossicles: malleus, anvil and stapes. These transmit vibrations from the tympanic membrane through the middle ear cavity to the cochlea, in the inner ear. In the cochlea, receptor cells convert vibrations into nerve impulses that are interpreted by the brain as sound. Therefore, the temporal bone plays a crucial role in hearing and balance. Furthermore, it also helps protect the brain, provides insertion points for different muscles, including neck muscles, and also allows chewing movements.

The bovine temporal bone has different parts or portions and different anatomical features. A flaky portion The temporal bone is a thinner and wider area, which articulates with the parietal, frontal and sphenoid bones, and contributes to the formation of the skullcap. This portion provides an insertion surface for muscles and ligaments, in addition to participating in the protection of the brain.

In continuity, there are also the petrous and tympanic portions. However, in cattle, as well as in carnivores, these two parts fuse, making it impossible to distinguish them. In this case, the structure is called a petrous pyramid. In other species, thepetrous portion forms the dorsoventral closure of the bone temporal and includes the inner ear, with its structures such as the cochlea, vestibule and semicircular canals, vital for hearing and balance, skills crucial to their survival.

Atympanic portion , in turn, surrounds the middle ear cavity, where the auditory ossicles responsible for transmitting sound vibrations from the eardrum to the inner ear are located.

Other structures are found in the temporal bone, in its different portions. For example, theexternal auditory canal is a channel that extends from the outer surface of the skull to the eardrum, allowing sound waves to pass to the middle ear. This channel is essential for hearing, facilitating the entry of sound into the auditory system. Next and internally is thetympanic cavity , which is externally calledtympanic noise , a rounded protrusion at the base of the temporal bone, which protects the middle ear

and contributes to the amplification of sound waves. External to the tympanic sound, a pointed bony projection is called themuscular process .

Ozygomatic process of the temporal bone is a bony projection that extends laterally, articulating with the zygomatic bone to form the zygomatic arch. This structure is crucial for the insertion of masticatory muscles, such as the masseter, which are essential for efficient chewing of food.

Amandibular fossa , a depression on the inferior/ventral surface of the temporal bone, articulates with the condylar process of the mandible, forming the temporomandibular joint. This joint allows opening and closing movements of the mouth, essential for eating.

Located close to the mandibular fossa is theretroarticular process , a bony projection that provides additional support to the joint and serves as an insertion point for ligaments that stabilize the jaw.

2.4 Occiput

The bovine occipital bone is odd, that is, unique, and is classified as irregular. It is a strong structure to support the weight of the head, while protecting and connecting the structures of the central nervous system (brain and spinal cord), through a large opening, called the foramen magnum. This bone is located in the most caudoventral part of the neurocranium, in the nape region, with projections that allow connection with the spine, forming the important atlanto-occipital joint with the first cervical vertebra. In addition to this connection with the atlas, topographically the occiput also articulates with several other bones, such as the parietal bones (dorsally), the temporal bones (laterally) and the sphenoid bones (rostrally). Its function is to protect the caudal part of the brain, help form the base of the skull and allow the passage of the spinal cord from the skull to the spine. Additionally, it provides insertion points for neck muscles and ligaments, contributing to head stability and movement.

The most striking and visible anatomical features of the occiput are the foramen magnum, the occipital condyles and the jugular processes.

Oforamen magnum , a large opening at the base of the occipital bone, is the passage through which the spinal cord connects to the brain. This structure is vital for the continuity of the central nervous system and the transmission of neurological signals between the brain and the body. Youoccipital condyles , located on the sides of the foramen magnum, are rounded projections that articulate with the atlas, allowing the head to move.

Youjugular processes , also known asparacondylar processes , are bony projections that extend laterally from the occipital condyles. These processes serve as insertion points for muscles and ligaments that stabilize the atlanto-occipital joint and assist in head movements. These processes are particularly long in pigs, much shorter in ruminants and horses compared to pigs, and button-shaped in carnivores.

Between the condyles of the occipital and the jugular processes is a deepventral condylar fossa , which results in access to thehypoglossal nerve canal , as the site of passage of the hypoglossal nerve, which is responsible for the innervation of the tongue muscles. This canal is essential for the motor function of the tongue, which is crucial for feeding and vocalization. The other pit, thedorsal condylar fossa it is located dorsally to the foramen magnum, in the form of a plate.

In addition to these anatomical features, the following parts can be observed in the occiput: body or basilar part, the squamous part and the two lateral portions.

Abasilar portion of the occipital bone , also called the occipital body, located cranial to the foramen magnum, is fundamental for the articulation with the sphenoid bone and forms the caudal segment of the base of the skull. In this portion are, among other structures, themuscular tubercle (place of insertion of the head flexor muscles), thecaudal cranial fossa (with impressions for the pons of the brain and the medulla oblongata) and thejugular foramen (opening laterally at the limit with the tympanic sound). In pigs and horses, the sharp lateral gem of the basilar portion forms together with the petrous part of the deep temporal bonefissure petro-occipital, as well as the foramen lacerum. This portion is crucial for the stability of the skull and for the protection of the neurological structures that pass through this region.

Already theflaky portion , which forms the posterior/caudal part of the skull, is located above the foramen magnum, condyles and lateral portions, closing the skull at the back of the head. On its external surface there is almost always an acute delimitation, thenuchal crest , but in cattle and other ruminants there is only onenuchal line . The nuchal crest of horses, carnivores and pigs is easily palpable and represents, with the atlas, the orientation point for obtaining cerebrospinal fluid (cerebellomedullary cystena). From the nuchal crest, theexternal sagittal crest in the skull of horses and carnivores. And towards the base of the skull,

but wedge, it'sexternal occipital protuberance , whose main function is to be an attachment point for the nuchal ligament in ruminants and horses. Internally, the squamous portion is marked by shallow depressions caused by cerebellar impression or blood vessels. In ruminants and pigs there is also a internal occipital protuberance ; while in carnivores and horses there is the tentorial process, characteristic as a part of the bony cerebellar tensor. Therefore, the squamous portion is a broad surface that protects the cerebellum and other parts of the brain, in addition to serving as an insertion point for muscles and ligaments.

Alateral portion of the occipital bone , located on the sides of the foramen magnum, is responsible for articulating with the condyles of the atlas, the first cervical vertebra. This atlanto-occipital joint allows flexion and extension movements of the head, essential for the mobility and spatial orientation of cattle. In this portion, there are the occipital condyles and the jugular processes, already described.

2.5 Sphenoid

The sphenoid bone has a complex, symmetrical andIt is divided into two parts, the nuchal basisphenoid and the nasal presphenoid.Both the presphenoid and the basisphenoid are composed of the body and laterally the wings, resembling a butterfly or bat with outstretched wings, with several projections and central cavities that contribute to structuring the base of the skull.

In humans, these two bones fuse in the early stages of life, becoming a single sphenoid bone. In animals, they are initially kept separate through a cartilaginous suture, which later ossifies. Therefore, the sphenoid is seen as two separate bones.

It forms the ventral part (at the bottom) of the braincase and contains a depression, the pituitary fossa, which houses the pituitary gland, an important endocrine gland. Therefore, the sphenoid is located on the floor of the neurocranium, well rostral to the occiput (that is, in front of it, which is located caudally). It also articulates with other bones, including the ethmoid bone and temporal bones (laterally).

Obasisphenoid body , together with its wings, form the middle cranial fossa, including theturcica saddle . It contributes to the support of the brain andis fundamental to thestructural stability of the skull and for the protection of the neurological structures that pass through this region.

Continuing, thepresphenoid body , located anterior to the basisphenoid, is an extension that articulates with the ethmoid bone and also contributes to the formation of the base of the skull. This portion is essential for the structural integrity of the skull and for the protection of the nasal and orbital cavities. The external surfaces ofpresphenoid wings help form the bony portion of the orbital cavity (crucial for protecting the eyeball and for the insertion of muscles that move the eye) and theoptical channel (essential for the passage of the optic nerve to the orbital cavity), while its internal surfaces, together with the body of the presphenoid, help in the formation of the cranial cavity, mainly rostral.

The significant opening of the optical channel towards the orbit is calledoptic foramen , through which the optic nerve passes, which transmits visual information from the eye to the brain.

The function of the sphenoid bone is multiple: it forms part of the base of the skull, contributes to the cranial cavity and eye sockets, and houses important nervous and vascular structures. Additionally, the sphenoid provides insertion points for muscles that participate in chewing and eye movements.

2.6 Ethmoid

The bovine ethmoid bone is unique. Its shape is complex and delicate, with a spongy structure that includes several laminae (such as the tectorial, paired orbital, orbital, basal, external, perpendicular, etc.) and cavities that house the ethmoid cells and contribute to its light but resistant structure. . It is located at the base of the skull, more specifically at the base of the nose, between the orbital cavities, and due to its topography, it articulates with several other bones, including the frontal bones (dorsally), the nasal and maxillary bones (rostrally), and the sphenoid bone (caudally).

Its function is multiple: it forms the upper part of the nasal cavity and contributes to the formation of the medial walls of the eye sockets. Additionally, the ethmoid helps form the ethmoidal turbinate from its laminae, the nasal cavity, and the nasal septum, which play a crucial role in filtering, humidifying, and warming inhaled air. It also houses part of the paranasal sinuses and the cribriform plate, through which the olfactory nerves, essential for the sense of smell, pass.

Asieve blade , also known ascribriform plate , is a perforated portion of the ethmoid bone that is located at the base of the skull, forming the end or roof of the nasal cavity. It is what separates the nasal cavity from the cranial cavity. This lamina is characterized by numerous small openings (foramina), through which the filaments of the olfactory nerve (cranial nerve I) pass, allowing the transmission of information.

sensory connections from the olfactory epithelium to the olfactory bulb of the brain. The integrity of the lamina cribriformis is vital for olfactory function, a sensory capacity essential for detecting food and perceiving the environment in animals.

In continuity, the medial lamina extends with an arched shape into the cranial cavity and divides the lamina cribriform through thecrista galli , in bothethmoid fossa , in which the olfactory bulbs are located.

In the ethmoidal labyrinth, the ethmoidal shells emerge from the roof and lateral laminae, which are normally in two rows (in the horse, in three).

2.7 Pterygoid

The bovine pterygoid bone is even and classified as flat. Morphologically, it is small and has a thin, laminar shape, with a structure that resembles a triangular blade. This bone is located at the base of the skull and topographically articulates with several others, being between the palatine bones (rostrally) and the sphenoid (caudally), forming the roof, that is, the lateral wall of the nasopharyngeal meatus.

The functions of the pterygoid bone include providing structural support to the nasal and oral cavities, the base of the skull and serving as an insertion point for muscles involved in chewing and swallowing, in addition to supporting part of the lateral walls of the pharynx, i.e. the animal's throat region.

Opterygoid body , the main portion of this bone, constitutes the structural base that articulates with the sphenoid bone and the palatine bone, contributing to the formation of the hard palate and the lateral wall of the nasal cavity.

Opterygoid hamulus, in turn, it is a bony projection that extends from the body of the pterygoid, at its free margin, and is especially prominent in horses.

2.8 Nasal

The bovine nasal bone is paired, long and slightly arched, forming the bridge of the nose and contributing significantly to the structure of the nasal cavity. It is located in the dorsal or upper part of the skull, topographically between the frontal bones (caudally) and the incisor bones (rostrally), articulating with both, in addition to connecting to the maxillary and lacrimal bones (laterally) and with its pair contralateral (medially). The primary function of the nasal bone is to provide structural support to the upper part of the nasal cavity, protecting internal structures and contributing to the shape and appearance of the nose. Furthermore, it plays a crucial role in the formation of the upper airways, facilitating the passage of air during breathing and allowing an important sense for animals, smell.

Considerable variety is seen in the size and shape of the nasal bones, depending on the species and breed of animal. In the case of pigs, in front of the nasal bone, there is still another bone, called the rostral bone. It is he who gives firmness to the nose of these animals, serving as an excavator to look for roots, for example.

Anasal suture is a fibrous junction that connects the nasal bones in the midline of the skull, located in the upper part, ensuring the firm union of the nasal bones, stability and resistance to the dorsal region of the nasal cavity.

Already thenasoincisive notch is an anatomical curvature located between the nasal bones and the incisor bones that contributes to the formation of the nostrils, allowing the passage of air to the internal airways.

2.9 Lacrimal

The bovine lacrimal bone is paired, relatively small. It has a quadrangular and thin shape, located in the medial portion of the orbit. Topographically, the lacrimal bone articulates dorsally and caudally with the frontal bone, medially with the nasal bone, ventrally and rostrally with the maxillary and ventral bone, and laterally with the zygomatic bone. Its main function is to form part of the medial wall of the orbit, contributing to the protection of the eyeball and housing the tear trough, which is essential for the tear drainage system, ensuring lubrication and cleaning of the ocular surface.

Olacrimal foramen is an opening located in the medial part of the eye socket, through which passes through the nasolacrimal duct, allowing tears to drain from the ocular surface into the nasal cavity.

2.10 Zygomaticus

The zygomatic bone, also known as the malar bone, is paired. Topographically, the zygomatic bone is located in the lateral region of the skull and articulates rostrally with the maxillary bone, dorsally with

the frontal and lacrimal bones and caudally with the temporal bone. On both sides of the skull, the zygomatic bones join the temporal bones forming the zygomatic arches, which are easily palpable bony landmarks below and behind the eyes that form the widest part of the skull of dogs and cats, for example. Its main function is to form the lateral margin of the orbiteye and cheek prominence,providing structural support and protection for the eye. Furthermore, the zygomatic bone serves as an insertion point for masticatory muscles, playing a crucial role in jaw movement and chewing.

In pigs and carnivores, the bone orbit does not close completely, remaining open caudally; that is, the zygomatic bone meets the temporal bone but not the frontal bone. Therefore, unlike herbivores, such as cattle and horses, which have a completely closed orbit, forming a circle and adequately protecting the eye, eye protrusion is much more likely to occur in carnivores.

Among the anatomical accidents, thefrontal process of the zygomatic bone In cattle, it is a bony projection that extends towards the frontal bone, contributing to the formation of the lateral margin of the eye socket and providing an insertion point for facial muscles, essential for facial expression and chewing. Continuing, thetemporal process of the zygomatic bone It is another bony extension, but this time it projects towards the temporal bone, forming part of the zygomatic arch and serving as an anchoring point for masticatory muscles. Ozygomatic arch , resulting from the union of the temporal and zygomatic processes, is an arched structure that connects the zygomatic bone to the temporal bone, forming the lateral prominence of the face and playing a crucial role in protecting the eye orbit and supporting the muscles responsible for chewing and movement facials.

2.11 Jaw

The bovine jaw bone is even and pneumatic. It is located on the rostral and lateral portion of the face, forming a large part of the animal's face. Topographically, the maxillary bone articulates with the incisive bone (rostrally), the nasal bone (dorsally), the lacrimal bone, the zygomatic bone and the palatine bone (caudally), the latter being on the ventral surface and the others on the dorsal surface of the face, contributing for the formation of both the nasal cavity and the oral cavity. The jaw also houses the maxillary sinuses, in addition to supporting some of the teeth in the upper arch (in the case of cattle, all of them, since these animals do not have incisor teeth in the upper arch). This makes the jaw bone easier to chew and hold food. Furthermore, together with the palatine bones, the maxillary bones participate in the formation of the hard palate, separating the nasal and oral cavities, and also provide insertion points for facial and masticatory muscles that allow facial expression and chewing, respectively.

In relation to anatomical accidents, thefacial crest The maxillary bone is a bony prominence that extends along the lateral surface of the jaw, providing an insertion point for facial muscles and contributing to the conformation of the face. Already theinfraorbital foramen , located on the rostral surface of the maxillary bone, is an opening through which the infraorbital nerve and vessels pass, providing innervation and blood supply to the facial region. Youpalatal processes of the jaw are bony extensions that project medially to form the bulk of the hard palate, separating the oral cavity from the nasal cavity and providing a surface for the attachment of palatal muscles. Youdental alveoli These are cavities in the jaw bone that house the roots of the teeth, ensuring the fixation and stability of the teeth during chewing. In turn, theinteralveolar border is the region of the jaw bone located between the dental alveoli which provides additional structural support and contributes to the distribution of chewing forces.

2.12 Incisor

The incisor bone, also called premaxillary bone, is paired and classified as irregular, having a compact and robust shape, adapted to withstand chewing forces. It is located in the most rostral part of the face and topographically articulates with the maxillary (caudally) and nasal (medial and dorsum) bones.

sally). In all common domestic animals except ruminants such as cows, sheep and goats, The incisor bones house the upper incisor teeth. Therefore, its main function is to provide structural support for the incisor teeth, which in cattle are replaced by a dental pad, called the dental pulvinus, allowing the capture and cutting of food during feeding. Furthermore, the incisor bone contributes to the formation of the nasal cavity and the anterior opening of the oral cavity, playing an essential role in feeding and breathing.

Among the anatomical accidents, theincisor bone body It is the main and most voluminous portion of the bone, which supports the incisor teeth. Acleft of the incisors, or inter-incisive , is an opening located between the right and left incisor bones, allowing the passage of vessels and nerves and facilitating flexibility of the

anterior dental arch. Already thecleft palate is a longitudinal opening located on the palatal surface of the incisor bone, which articulates with the palatine bone and contributes to the formation of the hard palate. Ainteralveolar border is the region of the incisor bone located between the dental alveoli.

Opalatal process of the incisor is a bony extension that projects posteriorly to articulate with the palatine bone, forming part of the hard palate and separating the oral cavity from the nasal cavity. While thenasal process of the incisor is a bony projection that extends superiorly to articulate with the nasal bone, contributing to the formation of the anterior part of the nasal cavity.

2.13 Palatine

The bovine palatine bone is a paired bone, with a shape that significantly contributes to the formation of the hard palate. Topographically, it is located in the caudal part of the oral cavity, extending to form part of the floor and lateral wall of the nasal cavity. The palatine bone articulates with the maxillary (rostrally), sphenoid and pterygoid (caudally) bones, among others. Its main function is to provide structural support to the hard palate, separating the nasal cavity from the oral cavity, which is essential for chewing and swallowing, in addition to contributing to breathing by maintaining the integrity of the upper airways.

Aportion or horizontal plate of the palatine bone is a bony structure that extends medially to form the posterior part of the hard palate, contributing to the separation of the oral and nasal cavities. Already the perpendicular portion or blade of the palatine bone It is a vertical extension that articulates with the maxillary bone and the sphenoid bone, forming part of the lateral wall of the nasal cavity.

Ogreater palatine foramen is an opening located in the horizontal portion of the palatine bone, through which the greater palatine nerve and vessels pass, providing innervation and blood supply to the hard palate and palatal mucosa. Ogreater palatine groove is a groove that extends from the greater palatine foramen, housing the greater palatine vessels and nerves and facilitating their passage along the hard palate. Caudal to the greater palatine foramina other smaller foramina are also visible, calledlesser palatal foramina . Finally, the mid palatal suture is the line of junction between the horizontal plates of the right and left palatine bones, providing structural stability to the hard palate and contributing to the integrity of the oral cavity.

2.14 Vomer

The bovine vomer bone is a unique bone, with a thin, flat and elongated shape that resembles a blade. There is a specialized mucosa (vomeronasal organ) that increases the olfactory sensitivity of animals through the capture of pheromones, thus functioning as an auxiliary olfactory organ, involved in reproductive, social and defense behaviors. Topographically, it is located in the midline of the skull, visible ventrally, forming the final part of the nasal septum, where it articulates with other bones of the skull, such as the ethmoid, sphenoid and palatine bones, helping to maintain the structure and stability of the nasal cavity. . Its main function is to divide the nasal cavity into two separate passages, facilitating the passage of air and contributing to the efficiency of breathing and smell.

Ablade or body of the vomer is its thin and elongated bone structure, located in the middle of the choanae and which extends vertically along the midline of the skull, contributing to the formation of the nasal septum and separating the right and left nasal cavities, playing a crucial role in supporting the nasal structure and dividing the airways. Already theschoanas These are openings located in the caudal part of the nasal cavity, on each side of the vomer and that allow communication between the nasal cavity and the nasopharynx, consequently breathing.

2.15 Nasal cavities, nasal septum and nasal turbinates

To thenasal cavities These are the cavities that extend from the nostrils to the cribriform plate of the ethmoid bone. It is divided into right and left sides by thenasal septum , a highly cartilaginous layer nosa, but which is ossified in its most caudal part. In horses, the septum extends the entire length of the hard palate, so that each nasal cavity communicates with the pharynx through a separate opening (choana). In other species (e.g., cattle and dogs) the caudal part of the septum does not join the palate and a single opening is shared between the two sides.

Inside the nasal cavities, close to the vomer, are the nasal turbinates, which are cartilaginous or ossified tubes, thin and covered by nasal mucosa, a soft and moist covering tissue.

They have a complex arrangement characteristic of each species. The nasal turbinates project into the nasal cavity and serve to increase the surface of the respiratory area.

Its shape forces the air inhaled through the nose to make many turns as it proceeds through the nose. nasal cavity. In this way, the nasal turbinates help to humidify and warm the air, in addition to trapping any small inhaled particles of foreign material so that they do not reach the lower airways. Therefore, its main function is to increase the internal surface of the nasal cavity, facilitating the humidification, heating and filtration of inhaled air, in addition to improving the efficiency of olfaction by directing the air flow to the olfactory region.

Classified by topography (and not by morphology), the nasal turbinates comprise a caudal system (of ethmoidal turbinates) constituting the lateral mass or labyrinth of the ethmoidal bone and a rostral (nasal) system in which the large dorsal and ventral nasal turbinates predominate (and a much lower average)

The numerous shells are separated by narrow slits, called meatuses according to their topography. In domestic animals there are three main ones: the dorsal, ventral, middle and common nasal meatuses.

The dorsal nasal meatus, located above the dorsal turbinate, is the passage between the roof of the nasal cavity and the dorsal nasal turbinate, and it is what leads directly to the bottom of the nasal cavity and channels air to the olfactory mucosa.

The ventral nasal meatus is located below the ventral turbinate and is the main path for airflow leading to the pharynx and is located between the ventral nasal turbinate and the floor of the nasal cavity.

The middle nasal meatus is above the ventral turbinate and below the dorsal turbinate and communicates with the paranasal sinuses.

Finally, there is the common nasal meatus, which is the longitudinal space on each side of the nasal septum, that is, between the septum and the other turbinates. It communicates with all the other nasal meatuses.

In summary, the dorsal meatus leads directly to the bottom of the nasal cavity and presents air to the olfactory mucosa. The middle meatus normally gives access to the sinus system. The ventral and common meatus are the main airways leading to the pharynx. The relatively wide space at the junction of these meatuses is the route chosen for the passage of instruments, such as a gastric tube.

2.16 Jaw

The mandible, also called the lower jaw, is the largest and most robust bone in the head. It has a “U” shape, the sides of which meet in the midline, forming the mental or mandibular joint, which can be cartilaginous or fibrous, depending on the species, and are then called symphysis or synchondrosis, respectively. In the case of cattle, the joint formed is of the symphysis type, that is, cartilaginous. The mandible is located in the ventral part of the face and articulates caudally and dorsally with the temporal bone of the skull through the temporomandibular joint, forming the only movable joint in the skull. Its main functions are to support the lower teeth and thus play a crucial role in chewing, allowing opening, closing and lateralization movements of the mouth, essential for the efficient grinding of food.

Ohorizontal branch of the mandible or body is the elongated and lower part of the mandible that extends from the mental symphysis to the angle of the mandible, where the teeth are located. Already thejaw angle is the junction between the horizontal branch and the vertical branch of the mandible. In turn, thevertical branch of the mandible is the ascending portion of the mandible that extends from the angle of the mandible, vertically, contributing mainly to the articulation with the skull.

Amental symphysis is the cartilaginous junction in the midline of the jaw where the two halves of the jaw meet and fuse.Odental socket It is the bone cavity in the jaw that houses the roots of the teeth, ensuring the fixation and support of the teeth in the dental arch. While theinteralveolar border is the portion of the jaw located between the dental alveoli, serving as a transition area between the teeth.

Omental foramen is an opening located on the lateral surface of the horizontal ramus of the mandible, through which the mental nerve and vessels pass, providing innervation and blood supply to the chin and lower lip region.

The condylar process, with head and neck, is the superior projection of the vertical branch of the mandible that articulates with the temporal bone, forming the temporomandibular joint., essential for opening and closing movements of the mouth. Ocoronoid process it is another projection of the vertical branch of the mandible, but more cranial. Amandibular notch is the curvature between the condylar process and the coronoid process, allowing the passage of neurovascular structures and facilitating movement of the mandible. Omandibular foramen is an opening located on the inner surface of the vertical ramus of the mandible, through which the lower alveolar nerve and vessels pass, providing innervation and blood supply to the lower teeth. Amasseteric fossa is a depression on the outer surface of the vertical ramus of the mandible, providing

insertion for the masseter muscle, which is essential for chewing.pterygoid fossa , orpterygoid face , is a depression on the internal, medial surface of the vertical ramus of the mandible, serving as an insertion point for the medial pterygoid muscle, which assists in lateral movements and elevation of the mandible.

2. MATERIAL AND METHOD

This work consists of a narrative review of the literature on the bones and anatomical details of the bovine skull. The literature search was carried out in the PubMed, ScienceDirect and Google Scholar databases, using the following keywords: “Anatomy”, “Osteology”, “Bones”, “Skull”, “Head”, “Bovine” and “Ruminant” . However, although this information is widely available in books, there is a lack of scientific articles that deal in detail with the osteology of domestic animals, including cattle. Therefore, this article aims to describe the bones of the bovine thoracic limb, offering a more accessible reference for students and professionals in the field.

After selecting the studies, a critical reading and analysis of the contents was carried out, seeking to identify the main details related to the bones of the bovine skull. The information obtained was organized and synthesized to prepare this literature review.

3. FINAL CONSIDERATIONS

In summary, the bovine skull performs essential functions, protecting the brain and sensory organs, as well as providing structural support to the head. Composed of bones such as the frontal, parietal, occipital, temporal, maxillary and mandibular, each one has a specific function. The jaw, for example, is crucial for chewing, while the nasal and jaw bones form the snout and house the incisor teeth. The study of bovine skull osteology is fundamental for understanding the functional anatomy and health of animals, helping to identify anomalies, fractures and bone diseases, in addition to being essential for surgical procedures and imaging diagnoses. This detailed information is usually found in specialized books. This article aims to describe the osteology of the bovine skull, offering a practical and accessible reference for students and professionals, ensuring the well-being and productivity of the animals.

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