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DESCRIPTIVE OSTEOLOGY OF THE EQUINE THORACIC LIMB

DESCRIPTIVE OSTEOLOGY OF THE THORACIC LIMB OF EQUINES

Gabriele Barros Mothé – Faculty of Medical Sciences of Maricá Camila
Anselmé Dutra – Universidade Estadual Norte Fluminense Aguinaldo
Francisco Mendes Junior – Universidade Santa Úrsula

SUMMARY
The equine thoracic limb performs vital functions that are fundamental for the locomotion, support and athletic performance of these animals. Composed of several bones, each bone structure has a specific and crucial role. The scapula, for example, connects the limb to the trunk and serves as an insertion point for muscles that facilitate movement. The humerus, being the long bone of the arm, is essential for the strength and mobility of the limb. The radius and ulna form the forearm, allowing flexion and extension movements necessary for walking, trotting and galloping. The carpal, metacarpal, phalangeal and sesamoid bones make up the structure of the wrist and fingers, essential for stability and distribution of body weight during locomotion. Studying the osteology of the equine thoracic limb is extremely important, as osteological problems, such as fractures, osteoarthritis or deformities, can compromise locomotion, cause pain and reduce the animal's performance capacity. Bone health and integrity are fundamental to the well-being and productivity of horses, especially in sports and work activities. Although this anatomical information is widely found in books, there is a scarcity of scientific articles that address equine osteology in detail and descriptively. Therefore, this article aims to describe the osteology of the equine thoracic limb, providing a more accessible and detailed reference for professionals in the field, contributing to a better understanding and management of the health of these animals. **Key words:** Anatomy. Equine. Arm. Bone.

ABSTRACT
The thoracic limb of equines plays vital roles that are fundamental for the locomotion, support, and athletic performance of these animals. Composed of various bones, each bony structure has a specific and crucial role. The scapula, for instance, connects the limb to the trunk and serves as an insertion point for muscles that facilitate movement. The humerus, being the long bone of the arm, is essential for the strength and mobility of the limb. The radius and ulna form the forearm, allowing the flexion and extension movements necessary for walking, trotting, and galloping. The carpal bones, metacarpals, phalanges, and sesamoids make up the structure of the wrist and fingers, essential for stability and weight distribution during locomotion. Studying the osteology of the thoracic limb of equines is of utmost importance, as osteological problems such as fractures, osteoarthritis, or deformities can compromise locomotion, cause pain, and reduce the animal's performance capacity. The health and integrity of the bones are fundamental for the well-being and productivity of equines, especially in sports and work activities. Although this anatomical information is widely found in books, there is a scarcity of scientific articles that address the osteology of equines in a detailed and descriptive manner. Therefore, this article aims to describe the osteology of the thoracic limb of equines, providing a more accessible and detailed reference for professionals in the field, contributing to a better understanding and management of these animals' health.

Keywords: Anatomy. Equine. Arm. Cap.

1. INTRODUCTION

Horses are large animals that perform a variety of functions, from sporting and recreational activities to agricultural and transport work. Their unique anatomical characteristics allow these animals to perform fast and precise movements, essential for running, jumping and other athletic activities. The efficiency and performance capacity of horses are closely linked to the integrity and functionality of their musculoskeletal system, especially the thoracic limbs.

The equine skeleton is made up of a complex structure of bones that provides support, protection and mobility. The thoracic limb, in particular, is fundamental for locomotion and the distribution of body weight during movement. This limb is made up of bones such as the scapula, humerus, radius,

ulna, carpal bones, metacarpals, phalanges and sesamoids. Each of these bones plays a specific and crucial role in the biomechanics of equine movement, allowing for flexion, extension, shock absorption and stability.

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 equine 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 bones of the equine thoracic limb, 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 Scapula

In horses, the scapula is a flat, triangular bone, classified as a flat bone. This bone is essential in the anatomy of horses, making up the shoulder girdle and playing a crucial role in locomotion. Located at the top of the back, the scapula connects the forelimbs to the trunk, providing a sturdy base for limb articulation. Its structure is specially adapted to support the insertion of various muscles, tendons and ligaments, which are vital for the mobility and strength of the forelimbs. Furthermore, the equine scapula has specific characteristics, such as the presence of the scapular spine, which serves as an anchoring point for important muscles, such as the trapezius muscle and the supraspinatus muscle, contributing to the efficiency and power of these animals' movements.

As the scapula is a flat and triangular bone, it has three margins or edges, called the cranial, caudal and dorsal edges, in addition to three angles (“points”), the cranial, caudal and ventral angles.

Acranial edge of the equine scapula is the anterior margin, characterized by being thin and curved, extending from the cranial angle to the glenoid cavity. Acaudal edge , on the other hand, is the posterior margin, which is thicker, more robust and straight, which extends from the caudal angle to the ventral angle, offering insertion points for muscles. Adorsal edge , or base of the scapula, is the upper margin, which runs from the cranial angle to the caudal angle, and is often thick and rounded. Ocranial angle is the junction point between the cranial and dorsal edges of the scapula, characterized by a smooth and rounded curvature. In contrast, thecaudal angle It is the junction point between the caudal and dorsal edges, presenting a more accentuated, acute, robust, prominent and triangular curvature. Oventral angle , in turn, is the “tip of the triangle”, being the point of articulation of the scapula with the humerus.

The scapula, being a flat bone, has two distinct surfaces: the lateral surface and the medial surface. A side face is characterized by the presence of the scapular spine, while themedial face , also known as the costal face, is smooth and concave, as it is in contact with the ribs.

On the side face, thescapular spine it is the most prominent anatomical feature. This longitudinal bone structure, similar to a blade, runs the entire length of the lateral surface, dividing it into two regions: the supraspinatus fossa and the infraspinatus fossa. The spine of the scapula serves as an insertion point for important muscles and can be palpated externally. In the middle to proximal third of the scapular spine, there is a rough eminence known astuberosity of the scapular spine or spinal tubercle. Unlike other species, the equine scapula does not have an extension of the scapular spine, which is theacromion .

The spine of the scapula divides the lateral surface of this bone into two distinct regions, known as fossae. Asupraspinatus fossa , located cranial to the spine, is a depression that houses the supraspinal. This fossa receives its name due to the inclined and almost horizontal position of the scapula in the animal. poorly in anatomical position, causing the supraspinous fossa, despite being cranially, to be located above the spine. On the other hand, theinfraspinatus fossa It is located caudal to the spine. Considering the almost horizontal position of the scapula in the animal in an anatomical position, this fossa is below the spine, justifying its name. This depression accommodates the infraspinatus muscle.

At the end of the spine and fossae, there is a narrow region calledneck of the scapula . This area connects the blade or main body of the scapula to its distal end, functioning as a transition point between the wider, more robust and flatter body of the scapula and the region where the articulation occurs with the next bone of the thoracic limb.

The cavity located at the distal or ventral end, below the cervix, is calledcavity glenoid . This shallow depression, located at the "tip" of the scapula, articulates with the head of the humerus, forming the shoulder joint, also known as the glenohumeral joint. This joint is essential for the full range of movement of the forelimb.

Cranially to the glenoid cavity is thesupraglenoid tubercle , a rough bony prominence located above the cavity, which in the horse is quite evident. This tubercle is a strategic point for anchoring muscles and tendons.

On the medial surface, also known as the costal surface of the scapula, there is another fossa, this time not related to the spine of the scapula, therefore being calledsubscapular fossa . This is a wide, concave depression, with a generally smooth surface, that accommodates the subscapularis muscle. In different species of domestic animals, such as dogs, cats, cattle and horses, the subscapular fossa may vary in shape and depth. However, in horses, this fossa is notably deeper and wider.

Still on the medial surface of the scapula, there is theserratus face , a specific area where some of the serratus muscles are inserted. This region is characterized by a series of roughness or oblique lines that provide a robust anchoring surface for these muscles, such as the serratus muscles, among others.

Finally, thecoracoid process It is a pointed, bony projection located on the medial surface of the scapula, behind the supraglenoid tubercle and close to the glenoid cavity. In the horse, this process is quite evident and prominent. It serves as an insertion point for ligaments and muscles, such as the coracobrachialis muscle, helping to move the thoracic limb.

2.2 Humerus

The humerus, being a long bone, is composed of three main parts: the proximal epiphysis, the diaphysis and the distal epiphysis. Aproximal epiphysis it is the upper extremity that articulates with the scapula, forming the shoulder joint. Adiaphysis is the long, central section of the bone, located between the proximal and distal epiphyses. A distal epiphysis is the lower extremity that articulates with the radius and ulna, forming the elbow joint.

This bone also has four distinct surfaces: lateral, medial, cranial and caudal. Aside face is the external surface of the bone, considering the median sagittal line of the body, while themedial face it is the internal one, less prominent in terms of visible anatomical features. Acranial face it is the frontal surface, facing the front of the animal, towards the head. Acaudal face , as the name implies, is the rear surface of the bone, facing the animal's tail.

The humerus has several crucial anatomical structures in all its parts and surfaces. At the proximal and caudal end of the bone, itshead , a spherical structure that articulates with the glenoid cavity of the scapula, forming the shoulder joint, classified as a ball and socket joint.

Just below the head is thelap anatomical, a narrow region that separates the head from the body of the humerus. This area is crucial for the insertion of various ligamentous structures and joint capsules that stabilize the shoulder joint.

In the proximal epiphysis, adjacent to the head of the humerus and on the cranial surface of the bone, are thelarger tubers It is smaller , as well as in other species; however, in the horse a third tubercle is found, between the other two, which is why it is calledintermediate or intermediate tuber . Ogreater tuber is a bony prominence located laterally, while the lesser tubercle is situated medially. Olesser tuber It is an important insertion point for the subscapularis muscle. Between these tubercles, at the proximal end of the humerus, is theintertubercular groove , an anatomical depression that serves as a channel for the passage of tendons and other structures towards the forearm.

Extending distally, thebody The humerus is the long, cylindrical portion of the bone, with a smooth, slightly curved surface, located between the proximal and distal ends. Internally, the body of the humerus contains the medullary canal, which houses the bone marrow.

Despite the smooth surface, the body of the humerus has specific prominences for the insertion of muscles. Adeltoid tuberosity , located on the lateral side of the body, approximately in the mid-shaft region, serves as an insertion point for the deltoid muscle, essential for shoulder flexion. This tuberosity is evident in all domestic species, but is particularly developed in horses.

On the medial surface of the body of the humerus, there is thegreater round tuberosity , a less prominent protuberance visible as a roughness. This area is an important point for muscle insertion

teres major, which helps with shoulder flexion.

Descending towards the distal epiphysis, there is thecrest of the humerus , a longitudinal elevation that also serves as support for the insertion of muscles and ends at theradial fossa , a depression at the distal end of the humerus, above the condyle.

At the distal epiphysis of the humerus, on the cranial surface, are the articular surfaces known collectively as the condyle. Ocondyle of the humerus is the distal portion that articulates with the bones of the forearm, dividing into two main parts: the trochlea and the capitellum. Atrochlea is the medial articular surface, in the form of a pulley, which articulates with the trochlear notch of the ulna. Ochapter it is the lateral surface, in spherical shape, that articulates with the head of the radius. Together, these structures allow movement of the elbow.

On the caudal surface of the distal epiphysis is theolecranon fossa , a deep depression that accommodates the olecranon of the ulna during full extension of the elbow, allowing a precise fit and facilitating the articulation between the humerus and the ulna. Above the olecranon fossa is thenutrient foramen , a small hole in the body of the humerus through which blood vessels and nerves pass, responsible for the nutrition and innervation of bone tissue.

2.3 Radius and ulna

The radius and ulna are two long bones located in the forearm. Between the two, the radius is the main bone in this region, responsible for supporting most of the animal's weight. It is a robust and slightly curved bone, which articulates proximally with the humerus and distally with the carpal bones.

The ulna, on the other hand, is a thinner and more elongated bone, located lateral to the radius. In horses, the ulna is incompletely and almost completely fused to the radius, especially in the proximal region, and becomes progressively thinner toward the distal end, ending in a point near the middle of the radius. This conformation is believed to be an adaptation for their faster mobility.

Together, the radius and ulna form the bony structure of the equine forearm, allowing the articulation and movement necessary for the animal's efficient locomotion.

The radius, like the humerus, is a long bone that can be divided into three main parts: the proximal and distal ends, known as epiphyses, and the central part, called the diaphysis. Aproximal epiphysis is the extremity that articulates with the humerus, while thedistal epiphysis articulates with the proximal row of carpal bones. Furthermore, the radius articulates laterally with the ulna.

The radius has four distinct surfaces: the cranial and caudal surfaces, and the lateral and medial surfaces, also referred to as lateral and medial margins or borders. Acranial face is smooth and facing forward, while thecaudal face it is rougher and faces backwards, where muscles and ligaments are inserted, in addition to having contact with the ulna. Amedial face is internally focused, and theside face turns externally.

At the proximal end of the radius, there are facets that articulate with the proximal end of the ulna and a large concave articular surface that joins the distal end of the humerus. This articular surface, called radio head , forms the elbow joint. The head of the radius is generally rounded and smooth, but not as rounded as the head of the humerus, and hasarticular foveae , which are depressions where the distal articular surface of the humerus fits.

Just below the radio head is theradio lap , a narrow region that connects the head to the body of the bone. Close to the neck, on the cranial surface, is theradium tuberosity , a bony prominence that serves as an insertion point for muscles and ligaments, being particularly important for the attachment of muscles essential for elbow flexion and stabilization of the limb during locomotion.

Descending towards the distal end, theradio body is the elongated and central portion of the bone, located between the proximal and distal ends. At the distal end, the radius has several facets and a pointed process calledtrochlea , a smooth, concave articular surface adapted to articulate with the bones of the proximal row of the carpus.

Now in relation to the ulna, the most striking anatomical characteristic of this bone is theolecranon , which forms the tip of the elbow. This robust and prominent structure is located at the proximal end of the bone and projects dorsally, serving as a powerful lever for the insertion of elbow extensor muscles, such as the triceps brachii muscle tendon. The olecranon fits into the olecranon fossa of the humerus, allowing flexion and extension movements.

At the proximal end of the olecranon, there is a rough protuberance calledolecranon tuberosity , which facilitates the fixation of muscles and other adjacent structures. Still in the olecranon, there is the trochlear notch , also known as the trochlear fovea, a concave, crescent-shaped articular surface located at the proximal end of the ulna. This notch articulates with the trochlea of the humerus, forming the

lation of the elbow and providing a smooth, congruent joint surface that facilitates smooth gliding between the bones during movement, while also making the joint secure and firm.

Above the trochlear notch, on the ulna, is theanconeal process , a beak-shaped bony prominence located at the proximal end of the bone. This process projects upward and backward, fitting into the olecranon fossa of the humerus when the elbow is in full extension. The anconeal process plays a crucial role in the stability of the elbow joint, preventing hyperextension and contributing to joint congruity. Its position and structure help distribute the forces transmitted through the elbow, protecting the joint from injury and excessive wear.

About theulna body , it extends to the carpus in all common species except horses. Its shape follows the straight or curved shape of the radius. Between the radius and ulna bones, aproximal interosseous space , with the distal not existing in horses, since in this species the ulna does not follow to the distal end of the radius.

2.5 Carpus

The carpus of animals, known as the “wrist”, is a complex structure made up of several small bones and joints that connect the forearm to the hand or paw. In mammals, the carpus is formed by two rows of bones: the proximal row and the distal row. There is considerable variation between species in the exact formation of the carpus, but a basic naming convention is maintained across species lineages. Thus, the bones in the proximal row have individual names, while the bones in the distal row are numbered, starting from the medial side and continuing laterally.

Atproximal row , the following bones are found: the radial carpal bone and the intermediate carpal bone, located in the medial part of the carpus, close to the radius; the ulnar carpal bone, located laterally, close to the ulna; and the accessory carpal bone, which protrudes backwards on the lateral surface of the carpus and also articulates with the ulna.

In turn, in the distal row, the carpal bones vary in number and shape between different species, but generally include four main bones, individual or fused, which articulate with the metacarpals, namely carpal bones I, II, III and IV. . In this row, the horse has the same carpals as cattle, II, III and IV, but separated, without fusion.

Furthermore, the carpal bones have at least four faces or surfaces: dorsal, palmar, lateral and medial. A dorsal side is the dorsal surface of the carpus, facing the animal's head, while thepalmar face it is the reverse surface, facing caudally and towards the ground. Aside edge is the outer margin of the carpus, facing outward from the limb, and themedial border is the inner margin, facing the center of the animal's body.

2.6 Metacarpus

In the hand, the bones are called metacarpals and can be single, double or multiple, depending on the animal species. The metacarpals are long bones that extend distally, lying between the bones of the distal row of the carpus (wrist) and the phalanges (bones that form the fingers). They are identified by numbers, starting from the medial to lateral side, with the thumb being metacarpal I, followed by metacarpals II, III, IV and V, present in some species, but not in all. The appearance of the metacarpal bones in animals is largely determined by the type of paw it has.

In horses, for example, the structure of the metacarpals is highly specialized. They have a simple paw with just one digit or finger. Therefore, they only have one large metacarpal bone supporting their weight in each paw. However, a horse actually has three metacarpal bones in each foot: one large metacarpal (also called the “cannon bone,” which is metacarpal III) and two small vestigial metacarpal bones (known as overbones). The overbones do not support any weight, they do not touch the soil and are incomplete. These vestigial metacarpals exist because, according to fossil evidence, the Ancestors of modern horses had multiple toes. Over many millennia, these three-toed animals became increasingly specialized for speed, and eventually the modern one-toed horse developed. The horse's large metacarpal bone is considered to be what remains of metacarpal bone III, and the small overbones on each side are designated metacarpal bone II and IV.

Aproximal epiphysis The equine metacarpus is the upper end that articulates with the carpal bones. A diaphysis , in turn, is the elongated and central part of the metacarpus, composed of compact bone, responsible for support and resistance. At the lower end, there is thedistal epiphysis , which is linked to

the phalangeal bones.

A dorsal side is the dorsal surface of the metacarpus, facing the animal's head, while the palmar face it is the reverse surface, facing caudally and towards the ground. A side edge is the outer margin of the metacarpus, facing outward from the limb, and the medial border is the inner margin, facing the center of the animal's body.

In horses, unlike cattle, the distal end is characterized by a unique articular surface called the trochlea , which also has a central protuberance called the sagittal crest .

2.7 Phalanges

After the metacarpals, there is the only equine finger, which is made up of three bones called phalanges. The phalanges are classified according to their proximity to the body: the proximal phalanx , also known as the long pastern bone, articulates with the metacarpus; The middle phalanx , known as the short pastern bone, is positioned between the other two phalanges; and the distal phalanx , popularly called the hoof bone, is the furthest bone from the axial skeleton and is covered by the hoof in this species.

Despite being small, most phalanges are considered long bones. Therefore, it is divided into proximal and distal epiphyses, in addition to the diaphysis. And it has four surfaces: dorsal, plantar, lateral and medial. A proximal epiphysis The phalanx is the upper end of the bone, which articulates with the distal epiphysis of the metacarpal or with the anterior phalanx, depending on the position of the phalanx in the digital sequence. A diaphysis The phalanx, or body of the bone, is the long, cylindrical portion that extends between the proximal and distal epiphyses. Already the distal epiphysis The phalanx is the lower end of the bone, which articulates with the subsequent phalanx or with the distal end of the limb, depending on the position of the phalanx.

A dorsal side of the phalanx is the surface facing the animal's head or back, while the palmar face is the surface facing the floor. The lateral and medial aspects of the phalanx are the outer and inner surfaces of the bone.

2.8 Sesamoids

Finally, the sesamoid bones of the forelimb of domestic animals are small bones that form within tendons or ligaments, usually in areas where these tissues cross joints. They are essential for reducing friction, increasing the mechanical efficiency of tendons and protecting them against excessive wear. The presence and function of the sesamoid bones are vital to the health and performance of the forelimbs, allowing smooth movement and protecting tendon and ligament structures. They act as bearings on the joint surfaces, allowing muscles to apply powerful forces to the bones without wearing down the tendons due to constant movement over the joint. The sesamoids are named according to their proximity to the body: the proximal sesamoid is closer to the trunk, while the distal sesamoid (also called the navicular bone) is further away from the axial skeleton, both located in the joints between the metacarpals and the phalanges.

2. MATERIAL AND METHOD

This work consists of a narrative review of the literature on the bones and anatomical details of the equine thoracic limb. The bibliographic search was carried out in the PubMed, ScienceDirect and Google Scholar databases, using the following keywords: “Anatomy”, “Osteology”, “Bones”, “Arm”, “Thoracic limb”, “Equine” and “Horse ”. 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 horses. 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 equine thoracic limbs. The information obtained was organized and synthesized to prepare this literature review.

3. FINAL CONSIDERATIONS

Horses have unique anatomical characteristics that allow them to perform various functions, from sporting activities to heavy work. The integrity of the musculoskeletal system, especially the thoracic limbs, is crucial for the locomotion and performance of these animals. The member

Thoracic bone is made up of bones such as the scapula, humerus, radius, ulna, carpal bones, metacarpals, phalanges and sesamoids, each playing a vital role in the biomechanics of movement. Despite the importance of this information, there is a lack of detailed scientific articles on equine osteology, with most data only available in specialized books. This article sought to fill this gap by offering a detailed description of the bones of the equine thoracic limb. It is hoped that this contribution will facilitate access to essential information for professionals in the field, improving the understanding, diagnosis and treatment of osteological conditions in these animals.

REFERENCES

ALMEIDA, ID Methodology of scientific work. Recife: Ed. UFPE, 2021.

ASHDOWN, R.R.; DONE, SH Color atlas of equine veterinary anatomy. 2ed. Rio de Janeiro: GEN Guanabara Koogan, 2012, 360p.

CONSTANTINESCU, GM Clinical Anatomy of Small Animals. Rio de Janeiro, Guanabara Koogan, 2005, 400p.

GETTY, R. Anatomy of Domestic Animals. 5ed. Rio de Janeiro: Guanabara Koogan, 2vol., 1986, 2052p. 10.

INTERNATIONAL COMMITTEE ON VETERINARY GROSS ANATOMICAL NOMENCLATURE. Nomina Anatomica Veterinaria. 6ed. Rio de Janeiro: World Association of Veterinary Anatomists. 2017, 160p.

KÖNIG, HE; LIEBICH, HG Anatomy of domestic animals: [Text and Color Atlas]. 7ed. Porto Alegre: Artmed, 2021, 856p.

MATTOS, PC Types of literature review. Unesp, 1-9, 2015. Available at: https://www.fca.unesp.br/ Home/ Biblioteca/tipos-de-evisao-de-literatura.pdf

NICKEL, R.; SCHUMMER, A.; SEIFERLE, E. The Anatomy of the Domestic Animals. Volume 1: The Locomotor System of the Domestic Mammals. New York: Springer-Verlag, 1986, 499p.

ORSINI, PG; SACK, WO Rooney's guide to the dissection of the horse. 7ed. Ithaca: Veterinary Textbooks, 2003, 201p.

PEREIRA AS et al. Scientific research methodology. [free e-book]. Santa Maria/RS, 2018. Ed. UAB/ NTE/ UFSM.

PRODANOV, CC; FREITAS, EC Methodology of scientific work: Methods and Techniques of Research and Academic Work. 2ed. Ed. Feevale, 2013.

ROTHER, ET Systematic review x narrative review. Acta paulista de nursing, 20 (2), 2007. https:// doi.org/ 10.1590/S0103-21002007000200001.

SINGH, B. Textbook of Veterinary Anatomy. 5ed. Rio de Janeiro: GEN Guanabara Koogan, 2019, 872p.