COMPARISON BETWEEN THE MAXILLARY AND MANDIBULAR PERMANENT DENTITION OF HUMANS AND DOMESTIC ANIMALS

COMPARAÇÃO ENTRE A DENTIÇÃO MAXILAR E MANDIBULAR PERMANENTE DE HUMANOS E ANIMAIS DOMÉSTICOS

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Resumo

Introdução: Anatomia é a ciência que estuda a forma, arquitetura e estrutura dos seres vivos, sendo o ramo que explora as diferenças morfológicas entre as espécies denominado anatomia comparada. Dentre as estruturas que compõem o esqueleto axial, destacam-se os dentes. Objetivo: Comparar os dentes de humanos e animais domésticos (cães, cavalos e bovinos), destacando também as semelhanças estruturais entre essas espécies distintas em termos de quantidade, funções e formas. Metodologia: Foram utilizados esqueletos e peças anatômicas individuais do Laboratório de Anatomia Humana e Veterinária da Universidade de Franca (UNIFRAN - Franca, SP), além de livros de anatomia renomados da área e artigos científicos. Resultados: Os resultados foram apresentados de forma descritiva. Em termos de quantidade, os humanos possuem 32 elementos dentários permanentes, semelhantes aos bovinos; os cães possuem 42, e os cavalos possuem entre 34 e 38, todos compostos por coroa, colo e raiz. Os bovinos não possuem incisivos e caninos maxilares, e as éguas podem não possuir dentes caninos. Entre as várias espécies analisadas, os elementos dentários apresentaram diferenças em tamanhos, formas e quantidades de raízes. Em todas as espécies estudadas, os elementos dentários permanentes são responsáveis por agarrar, rasgar e triturar alimentos; adicionalmente, em algumas espécies animais, eles são usados para autodefesa, enquanto em humanos, eles influenciam diretamente na

estética facial e na fala. **Conclusão:** Com base nos resultados obtidos, reconhece-se que as semelhanças e diferenças anatômicas morfológicas entre os elementos dentários podem estar relacionadas aos aspectos funcionais e evolutivos, além dos hábitos comportamentais, tipo de alimentação e sexo dos indivíduos.

Palavras-chave: Anatomia comparada; Morfologia dentária; Trituração de alimentos; Adaptações funcionais; Dentição permanente.

Abstract

Introduction: Anatomy is the science that studies the shape, architecture, and structure of living beings, with the branch that explores morphological differences between species being termed comparative anatomy. Among the structures comprising the axial skeleton, teeth stand out. **Objective**: To compare the teeth in humans and domestic animals (dogs, horses, and cattle), while also highlighting the structural similarities across these distinct species in terms of quantity, functions, and shapes. **Methodology**: Skeletons and individual anatomical pieces from the Laboratory of Human and Veterinary Anatomy at the University of Franca (UNIFRAN - Franca, SP) were used, as well as renowned anatomy books in this specialty area and scientific articles. **Results**: The results were presented descriptively. In terms of quantity, humans possess 32 permanent dental elements, similar to cattle; dogs have 42, and horses have between 34 and 38, all composed of crown, neck, and root. Cattle lack maxillary incisors and canines, and mares may not have canine teeth. Across the various species analyzed, dental elements exhibited differences in sizes, shapes, and quantities of roots. In all studied species, permanent dental elements are responsible for grasping, tearing, and grinding food; additionally, in some animal species, they are used for self-defense, while in humans, they directly influence facial aesthetics and speech. **Conclusion:** Based on the results obtained, it is acknowledged that anatomical morphological similarities and differences among dental elements may be related to the functional, evolutionary aspects, beyond the behavioral habits, type of feeding and sex of individuals.

Keywords: Comparative anatomy; Dental morphology; Food grinding; Functional adaptations; Permanent dentition.

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1. Introduction

Anatomy is the science that studies the shape, architecture, and structure of living beings[1,2]. In this context, the part of anatomy that emphasizes the morphological differences between species is called comparative anatomy[3,4]. The comparison between similar and distinct anatomical structures relates to aspects related to the function and evolution of individuals; thus, it is believed that evolutionary processes explain the shape and functionality of each of them[5,6]. Thus, the similarity of anatomical structures that share a common ancestry is known as homology[6,7].

Among the anatomical structures that make up the axial skeleton of individuals is the mouth composed of the oral cavity and its walls[3], as well as accessory structures such as the tongue, salivary glands, frenula and teeth[4]. The maxillary and mandibular teeth are considered paired, solid, mineralized structures[4,8], with roots housed and anchored inside the dental alveoli[9,10]. In this context, the periodontium is composed of structures that protect (gingiva) and support (cementum, periodontal ligament, and alveolar bone) the teeth[11-14]. Internally, the teeth are filled with dental pulp, which is composed of connective tissue, nerves, arteries, and veins. A small apical foramen opens at the end of each root and allows the free passage of vessels and nerves into and out of the teeth through the tooth canal[4,15]. Furthermore, each surface of the teeth is indicated by a descriptive denomination of fundamental importance in the clinical context; the tooth surfaces facing the vestibule of the mouth are the vestibular surfaces, which can be more precisely indicated by the expressions labial (facing the lips) and buccal (facing the cheeks). The surface adjacent to the tongue is the lingual surface[4,15,16].

Both in humans and domestic animals, dentition is classified as diphyodont[17], meaning that the first teeth to erupt (deciduous) are later replaced by permanent ones in adult individuals, and the timing of tooth replacement varies among species[3,4,5].

Regarding functions, teeth assist in food apprehension and grinding, and in some animal species, they are also used for defense against potential predators and for scratching the body[6,7]. In humans, besides the chewing function, the role in phonation and facial aesthetics is emphasized[17]. The quantity and shape of teeth can vary among different species due to dietary habits and type of diet[4-6]. In this regard, concerning heterodontia, they are classified into incisors, canines, premolars, and molars[4,7,16].

Given the functional importance of maxillary and mandibular teeth in the

quality of life and survival of individuals, the present work aims to compare such anatomical elements in humans and domestic animals (dog, horse, and cattle) regarding shapes, functions, quantities, and other particularities; emphasizing the structural similarities between species. This knowledge can help not only in teaching anatomy, but also in the development of dental techniques and in improving specific treatments for each species. In addition, it will help to understand dental functions and their implications for different types of food, communication, and defense, reinforcing the importance of comparative anatomy in the biological and clinical context. Furthermore, it must be considered that scientific articles addressing the topic are scarce and, furthermore, not all books in the area simultaneously emphasize the dental differences and similarities between humans and animals.

2. Methodology

The anatomical comparison between the teeth of humans and domestic animals (dogs, horses and cattle) was performed through direct analysis of the skeletons and individual anatomical specimens from the collection of the Human and Veterinary Anatomy Laboratory of the University of Franca (UNIFRAN - Franca, SP) regarding their shape, quantity and other homologous or distinct characteristics.

Only the skeletons and anatomical specimens of adult individuals were standardized, and damaged specimens were also excluded, to avoid interference in the evaluations, recommending three maxillary and mandibular samples from each species.

The comparison of the anatomical structures was based on information contained in renowned anatomy books in this area of specialty and in scientific articles, with the anatomical terms based on the Nomina Anatomica Veterinária[18] and the results presented descriptively.

Photographic images were obtained to record and illustrate these dental elements.

3. Results

A distinctive feature detected exclusively in horses was that the mandible is narrower compared to the maxila.

In all studied species, it was observed that maxillary and mandibular teeth share a common basic architecture, composed of crown, neck, and root (Figure 1).

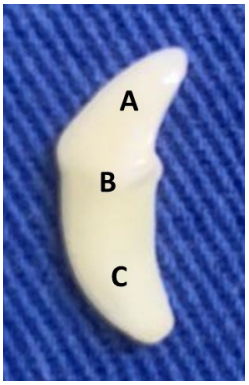

Figure 1 - Photographic image of a dental element, demonstrating basic architecture composed of crown (A), neck (B), and root (C).

Both in domestic animals and humans, the incisor teeth are located in the rostral segment of the maxillary and mandibular dental arches, followed laterally by the canines, and then the premolars and molars.

It was found that human dentition consists of 32 permanent dental elements, similar to cattle. In contrast, dogs have 42, and horses have 34 to 38 permanent teeth.

Regarding permanent incisor teeth, it was observed that humans have one central and one lateral incisor in each maxillary and mandibular antimer, totaling eight teeth (Figure 2).

On the other hand, dogs have six maxillary incisor teeth and six mandibular incisor teeth (three in the right hemiarches and three in the left, termed central, middle, and lateral), totaling 12 teeth (Figure 3), with the maxillary ones having crowns composed of three well-defined cusps (intermediate, mesial, and lateral) and all with a single root

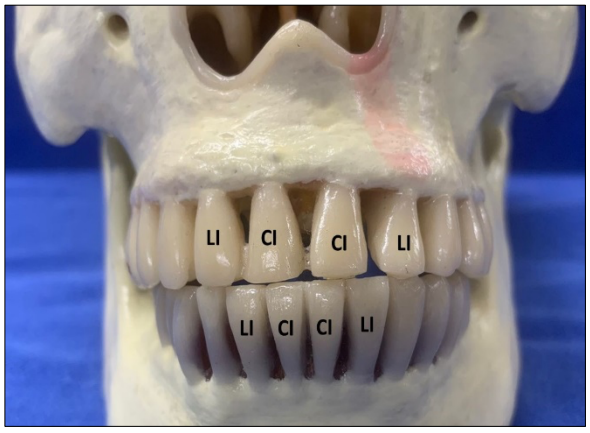

Figure 2 - Photographic image showing central (CI) and lateral (LI) maxillary and mandibular incisor teeth on the right and left sides in the human species.

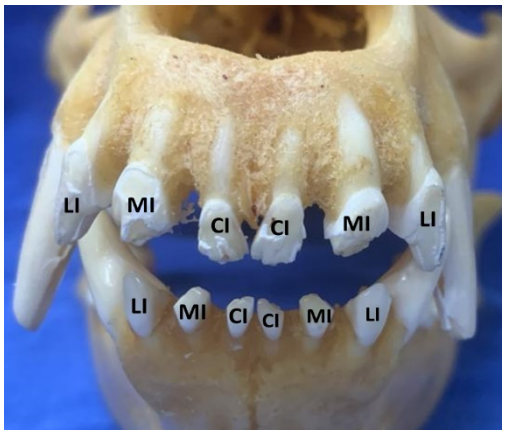

Figure 3 - Photographic image showing central (CI), middle (MI), and lateral (LI) maxillary and mandibular incisor teeth in the canine species.

Similar to dogs, horses have 12 permanent incisors (six mandibular and six maxillary) in each quadrant, which from medial to lateral are termed as central, middle, and corner incisors (Figure 4). Unlike other species, cattle do not have maxillary incisor teeth (Figure 5). Additionally, in this animal species, the three mandibular incisors on both the right and left sides have a spatula shape.

Incisor teeth have the function of grasping and cutting food; moreover, in the human species, they play a significant role both in aesthetics and phonetics.

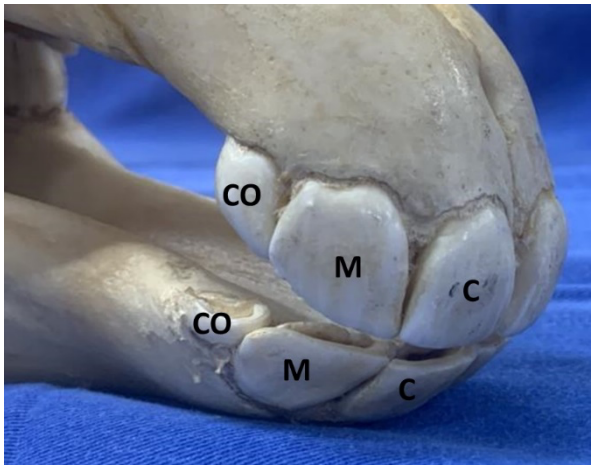

Figure 4 - Photographic image showing the right maxillary and mandibular incisor teeth in the equine species: clamps (C), middle (M) and corner (CO).

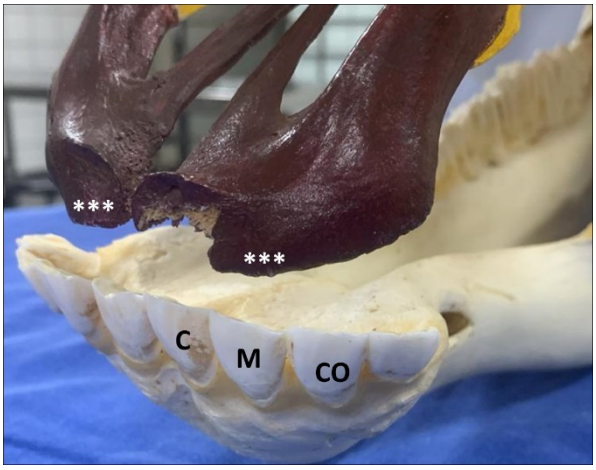

Figure 5 - Photographic image showing the absence of maxillary incisor teeth (*) in the bovine species and the left mandibular incisors: clamps (C), middle (M) and corner (CO).

Regarding canine teeth, humans have one tooth located in each hemiarch (Figure 6), with conical shapes and robust lateral surfaces with sharp points. Similarly, dogs also have four canine teeth, one in each dental hemiarch (Figure 7).

Figure 6 - Photographic image showing the left maxillary and mandibular canine tooth (Ca) in the human species.

Figure 7 - Photographic image showing the left maxillary and mandibular canine tooth (Ca) in the canine species.

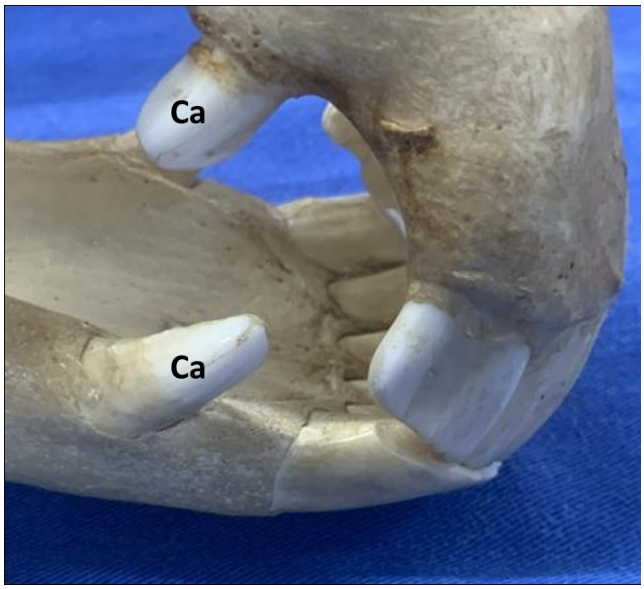

Figure 8 - Photographic image showing the right maxillary and mandibular canine tooth (Ca) in an adult male equine.

The equine species also has four canine teeth (two maxillary and two mandibular), present and developed in adult males (Figure 8) and typically absent or rudimentary in mares. These teeth are curved in shape, with a small crown.

Unlike other species, cattle do not have maxillary canine teeth, only one in each mandibular quadrant (Figure 9).

Among the functions of canine teeth, highlighted in all species studied, are chewing, piercing, and tearing of food; moreover, in animals, they are used for territory defense and dominance against rivals, while in the human species, they play a significant role in aesthetics and phonetics.

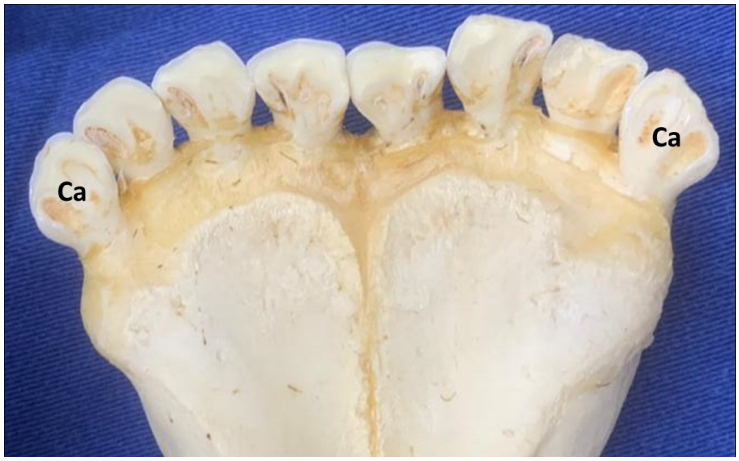

Figure 9 - Photographic image showing the right and left maxillary canine tooth (Ca) in the bovine

The humans have eight premolars in permanent dentition, with two in each maxillary and mandibular quadrant (Figure 10), with flat crowns and prominent ridges. The first maxillary premolars in humans have two roots: vestibular (larger) and lingual, while the second maxillary premolars have considerably flattened single roots with deep grooves, and the second mandibular premolars have a greater overall length than the first ones.

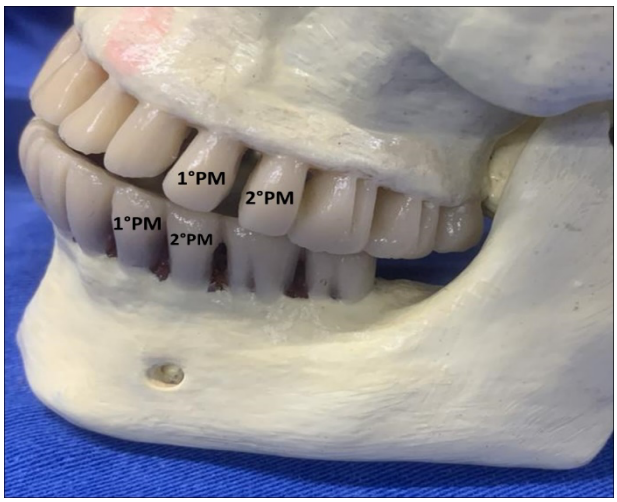

Figure 10 - Photograph demonstrating the first maxillary (upper) and mandibular (lower) left premolar (1° PM) and second premolar (2° PM) in the human species.

In contrast, dogs have four maxillary and mandibular premolars in each hemiarch, totaling 16 teeth (Figure 11); in this species, they form an irregular series of increasing size and complexity. The projections of the individual crowns align behind each other and form a discontinuous serrated cutting edge, resembling scissors. The first maxillary and mandibular premolars have a single root, the second and third premolars have two roots (biradicular), and the fourth maxillary premolar, also called the carnassial tooth, has three roots (triradicular) (Figure 12), which diverge providing greater dental fixation. The fourth mandibular premolar is biradicular.

In relation to premolars, it was observed that horses have 12 teeth (six mandibular and six maxillary) (Figure 13), and the prevalence of the first premolar (designated as wolf tooth) is higher at the maxillary level, possessing varied shape and size. It was also possible to identify that the second, third, and fourth premolars differ in shape between the maxilla and the mandible.

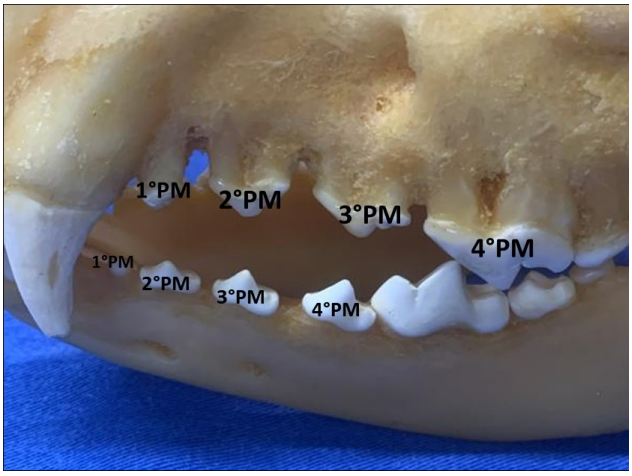

Figure 11 - Photographic image showing the first premolar (1° PM), second premolar (2° PM), third premolar (3° PM), and fourth premolar (4° PM) maxillary and mandibular teeth on the left side in the canine species.

Figure 12 - Photographic image of the maxillary fourth premolar (4° PM) tooth in the canine species, demonstrating the presence of three roots (triradicular).

Figure 13 - Photographic image showing the first premolar (1° PM), second premolar (2° PM), and third premolar (3° PM) maxillary and mandibular teeth on the left side in the equine species.

Similarly to horses, cattle have three maxillary and three mandibular premolars, totaling 12 (Figure 14), which have a crescent shape. In all species studied, including humans, premolar teeth function to grind and crush food, while the second premolars are solely for grinding.

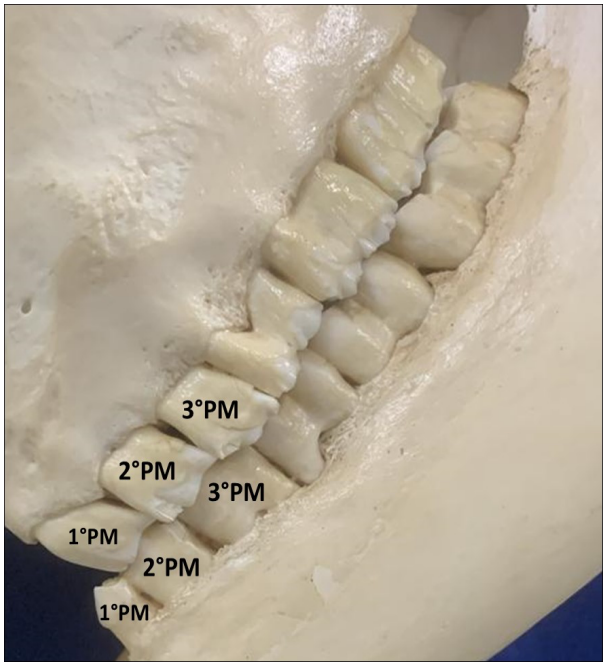

Figure 14 - Photographic image showing the first premolar (1° PM), second premolar (2° PM), and third premolar (3° PM) maxillary and mandibular teeth on the left side in the bovine species.

The humans have 12 permanent molar teeth (three in each dental hemiarch) (Figure 15), with large, flat crowns with prominent ridges. Similarly, horses (Figure 16) and cattle (Figure 17) also have 12 molar teeth (six mandibular and six maxillary), with a crescent shape. The second mandibular molars have roots similar to those of the first mandibular molars, but smaller. The third maxillary molars, also called wisdom teeth, are commonly absent unilaterally or bilaterally.

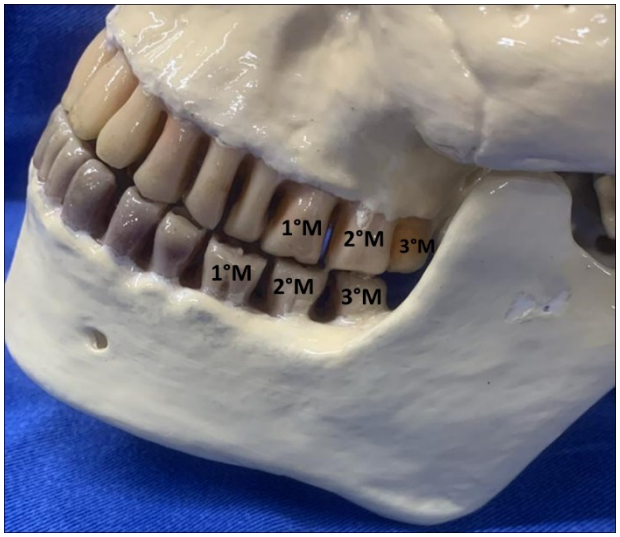

Figure 15 - Photographic image showing the first molar (1° M), second molar (2° M), and third molar (3° M) maxillary and mandibular teeth on the left side in the human species.

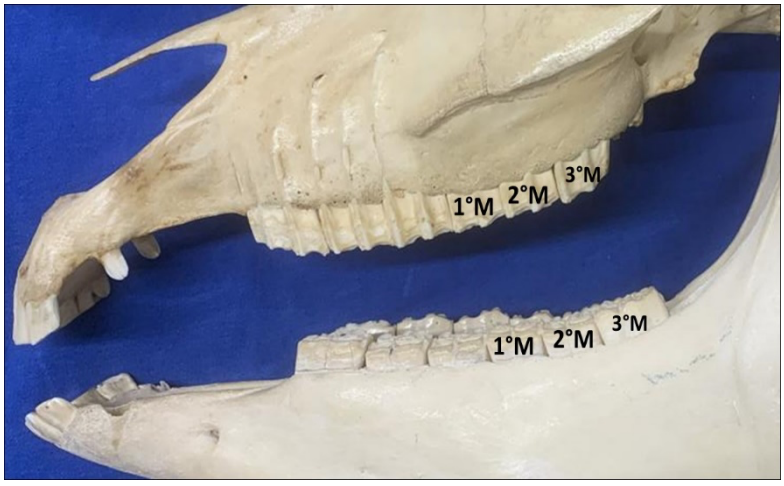

Figure 16 - Photographic image showing the first molar (1° M), second molar (2° M), and third molar (3° M) maxillary and mandibular teeth on the left side in the equine species.

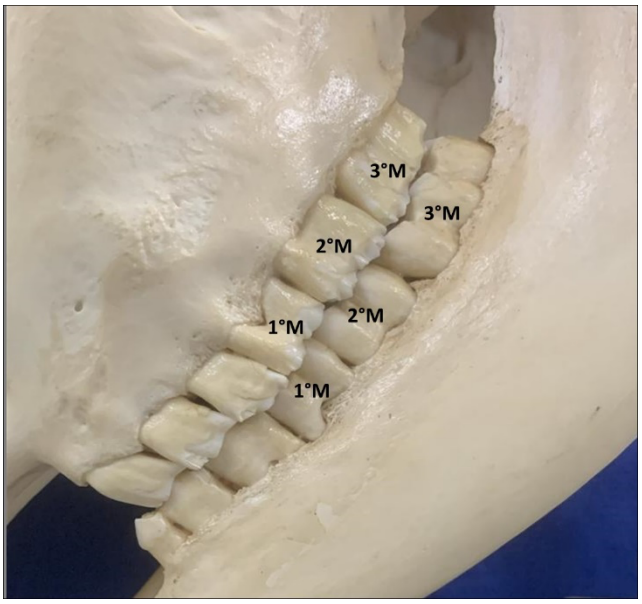

Figure 17 - Photographic image showing the first molar (1° M), second molar (2° M), and third molar (3° M) maxillary and mandibular teeth on the left side in the bovine species.

Unlike the other species established in this research, dogs have 10 permanent molar teeth (Figure 18) (two maxillary triradiculars in each hemiarch and three mandibulars, the first and second being biradicular and the third uniradicular). In humans, dogs, horses, and cattle, molar teeth serve the function of cutting and grinding food.

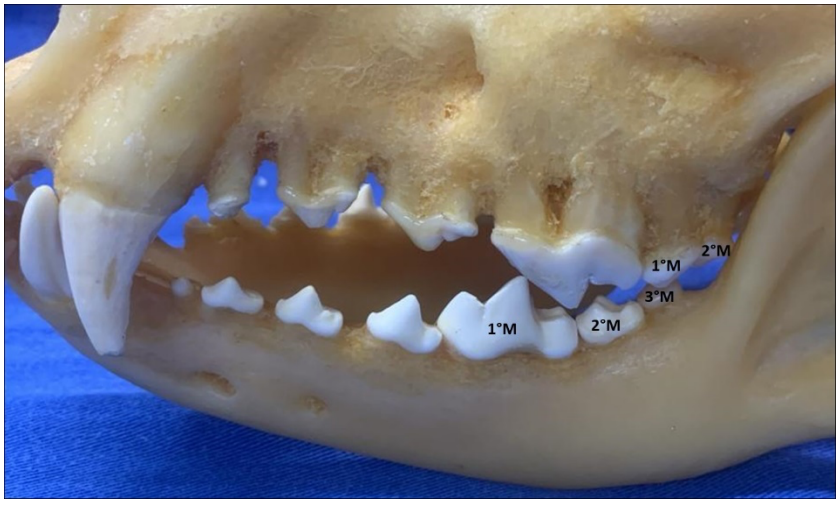

Figure 18 - Photographic image showing the first molar (1° M) and second molar (2° M) maxillary left, and the first molar (1° M), second molar (2° M), and third molar (3° M) mandibular left in the canine species.

5. Discussion

Costa, Farias and Leite[17] and Silva[19], reinforced the findings of this study on the mandibular shape of horses; the researchers classified the species as anisognathic. Additionally, in this species, the replacement and wear of the teeth associated with other modifications allow the animal's age to be estimated[4,19-21].

The common dental architecture among the species, composed of crown, neck, and root, coincides with descriptions in the scientific literature[5,6,12]. In this context, the crown is the exposed part of the tooth, which projects beyond the gum and is covered by dental enamel; the neck is the slight constriction located at the gum line, where the dental enamel ends; and the dental root is the part below the gum, covered by cementum, most of which ends in the alveolar socket6. Another similarity detected in humans, dogs, horses, and cattle was that the teeth are composed mainly of dentin12, both in the crown and in the root, whose composition is similar to bone, consisting mainly of hydroxyapatite[4,17].

The arrangement of teeth in incisors, canines, premolars and molars detected in all species was also scientifically reported by Konig and Liebich[4] and Costas, Farias and Leite[17]. In addition to the number of incisor teeth in humans being similar to those described by Martini, Timmons and Tallitsch[12] and Putz and Pabst[16]; these researchers also described the blade shape, with average sizes and only one root (single-rooted).

According to Konig and Lieich[4] and Baker and Easley[22], the absence of maxillary incisor teeth in cattle is replaced by the dental pulvinus, a soft structure responsible for assisting in the capture of food.

The number of canine teeth in humans coincided with descriptions in the literature[7,12]. In this species, these dental elements the longest, with single conical roots, which are the largest and most resistant, and their lengths correspond to almost twice that of the crowns[12]. In dogs, canine teeth also are well-developed, curved, and laterally compressed, with considerably long single roots[5,15]. Konig and Liebich[4], Silva et al.[20] and Baker and Easley[22] emphasized that equine canine teeth have a single, well-developed root[22], located in the diastema (toothless space between the corner incisor and the first premolar).

Silva et al.[20] described that in horses, as the wolf tooth (maxillary first premolar) normally does not have a mandibular opponent, it remains rudimentary and, due to a possible modification caused by pressure from the dental arch, this tooth can injure the gums, and due to discomfort, in some cases, its extraction is indicated, especially in animals that use a bit. According to Baker and Easley[22], the fibrous diet of horses can cause significant wear on the premolars teeth. Allen[23] and Pence[24], yet emphasized that the maxillaries premolars of horses have a layer of

enamel with complex undulation with two pulp horns, whereas the mandibular ones do not present this structure.

In humans, the first maxillary molars have three roots, two buccal (mesio-buccal and disto-buccal) and one palatal, while the first mandibular molar, the largest tooth in the arch, has two roots, one mesial (larger) and one distal (smaller)[6,7]. In this specie, the absence of maxillary third molars may be due to agenesis or being impacted in the maxillary bone due to lack of space or due to the sharper angle formed by the junction between the body and the angle of the mandible[16,17].

Costa et al.[17] explained that chewing carried out by the molar teeth exerts grinding actions on food due to its position in the arch, morphology, and the greater concentration of forces from muscle groups such as the masseter.

The absence of any dental element can lead to bone changes in the maxilla and mandible, as well as changes in the muscles of mastication and facial expression, giving the face an aged appearance, especially in humans[12,16]. In all species studied in this research, oral diseases can cause sensitivity leading to decreased appetite and, depending on severity, anorexia, as well as facial swelling, nasal discharge, coughing, sneezing, fever, tooth loss, among other local and systemic signs. Among the oral conditions commonly diagnosed in humans and dogs, periodontal disease (periodontitis) stands out, caused by compromise of the periodontium by bacterial plaque mineralizing into dental calculus (calculus)[1,10,11,13].

This research was based on skeletons and anatomical specimens; therefore, future investigations will be able to perform comparative analyses with imaging exams, including X-rays and computed tomography, aiming to elucidate with greater precision the possible anatomical variabilities in the dentition of the different species studied, as well as geometric morphometric methods. The study on the influence of genetic, nutritional and pathological aspects will also be able to elucidate the anatomical differences in both mandibular and maxillary teeth.

6. Conclusion

According to the established methodology and the obtained results, it can be inferred that humans, dogs, horses, and cattle have different quantities and shapes of permanent dental elements; however, the functions of grasping, tearing, and grinding food are similar. Additionally, some animal species use them for defense, and in humans, they also directly influence facial aesthetics and phonation.

The anatomical morphological similarities and differences among such anatomical structures may be related to the functional and evolutionary aspects, beyond the

behavioral habits, type of feeding (omnivores, carnivores and herbivores) and sex of individuals of the different species studied; however, future studies including imaging examinations and geometric morphometric methods may be able to more accurately elucidate these dental anatomical variabilities.

6. Conflict of Interest Statement

The authors declare that there are no conflicts of interest.

8. Acknowledgements

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