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ANATOMIC TECHNIQUE: MANUFACTURE OF PLASTER MODELS MADE FROM THE CARPUS AND TARSUS OF EQUINE, BOVINE AND CANINE

Caroline Fernandes Possebon, Rubiele Müller de Vargas, Mayara Neves Mella, Orestes Cabeleira, *Gabriele Maria Callegaro Serafini and Cristiane Elise Teichmann

Veterinary Medicine of the Northwestern University the state of Rio Grande do Sul, Brazil

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ABSTRACT

In the practical classes of osteology the use of animals is routine, being that the obtaining of these materials, usually through donations of skeletons or dissections of *ex alive* animals. However, it is common some specimens to be scarce, making it difficult the progress of a classroom practice. With the purpose of increasing the osteological collection of Animal Anatomy Laboratory of the Veterinary Medicine Course, UNIJUI, the objective of this work was to develop alternative models of bones for use in the classroom. With this, models of carpus and tarsus of equine, bovine and canine with alginate and plaster from real bones were manufactured, representing faithfully every detail present in the original bones and maintaining the same quality of teaching.

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INTRODUCTION

For a better understanding of the biomechanics and of diseases that affect the locomotor system of domestic animals it is fundamental that the veterinary doctor has knowledge of the various structures present in it (Feitosa, 2008). In this sense, it is highlighted the bones of the carpus and tarsus, which make up the regions of the wrist and heel in the thoracic and pelvic limb of the animals, respectively. These structures are responsible for the dissemination of concussion, absorption of impacts and reduction of friction in contact bone surfaces (Machado *et al.,* 2011). The carpal bones are arranged in two rows: proximal and distal. The proximal row comprises the carpus radial, intermediary, ulnar, and accessory that articulate with the radio in horses and in other species with the radius and ulna. The distal row is composed by I, II, III and IV carpal articulated with the metacarpus. Both the rows are arranged from medial to lateral position. The arrangement of the bones varies in each species, being that in bovines the II and III carpals are merged and I is absent,in equines carpal I is inconstant and in the carnivorous the carpus radial and intermediary are merged (Dyce *et al.,* 2004). As well as the bones of the carpus, the tarsus is also arranged in rows, in this case, three: proximal row, middle and distal. The proximal row is composed by two large bones, the medial talus and the lateral calcaneus . The talus in equines articulates its proximal surface articulates with the tibia and in other species with the central bone. The calcaneus is located laterally to the talus, but extends a process similar to a shell, which overlaps the talus in its plantar surface. The largest part of the bone protrudes into the proximal tibial behind as a lever arm, ending with a thickening which represents the basis of the tip of the shank. Its distal end is articulated with the fourth tarsus bone. The middle row is composed only by the central bone of the tarsus. The distal row is formed by four bones, being these numbered in sequence middle lateral in tarsus I, II, III, IV. This composition is variable among species, in the carnivorous the tarsus I, II, III and IV are separated, in equines the tarsus I and II are merged, in bovines the tarsus II and III they are merged are merged and the tarsus IV is merged to the central bone of the tarsus (Dyce *et al.,* 2004). Given the complexity of the joint formation of these bones and importance to the

***Corresponding author:* Gabriele Maria Callegaro Serafini**
Veterinary Medicine of the Northwestern University the state of Rio Grande do Sul, Brazil.

locomotive system, it is important for the student to contact with such parts to improve the applicative, assimilative and understanding skills arising from the theoretical study, preparing him or her for an accurate diagnosis before a real situation (Cury *et al.,* 2013). To this end, the Discipline of Anatomy of Domestic Animals is of great importance in the course of Veterinary Medicine due to the fact that it provides the basic concepts for future application of this profession and challenge the student before the different studied species. Thus, the materials availability for use in the laboratory is essential for a better visualization and learning of theoretical content and also by the comparison of different anatomical aspects about each species (Freitas *et al.,* 2008). However, a challenge found when assembling a complete collection of osteology is the acquisition of all types of bones and in sufficient quantities. For this reason, the use of alternative models enables the manufacture of didactic material in a similar way of real dynamic structures (Freitas *et al.,* 2008). The confection of parts through biscuit, play dough, silicone, clay and plaster, for example, become powerful tools for the production of anatomical models, with relatively low cost and easy to acquire in order to be used in the teaching-learning process of the animal anatomy study (Machado *et al.,* 2017). In addition, with the goal of increasing the number of copies, the objective of this study was to prepare plaster models of the equines, bovines and canines' bones of the carpus and the tarsus, and use them in the practical classes of Anatomy of Domestic Animals in the course of Veterinary Medicine of the Northwestern University of the state of Rio Grande do Sul (UNIJUI).

MATERIALS AND METHODS

For the making of models in plaster, a specimen of the carpus and tarsus of bovine, equine and canine was used from the didactic collection of Animal Anatomy Laboratory of the Veterinary Medicine Course of UNIJUI. Thus, the process started with the preparation of a mold of each bone done in alginate; to this end, it was mixed the alginate powder with warm water until obtaining a homogeneous consistency, then this mixture was placed in a plastic container previously painted with Vaseline jelly and the bone was positioned in the same way covering approximately half of its height (Figure 1).

Figure 1 . Calcaneus bone partially covered with paste of homogeneous alginate for confection of the mold

It was waited until the alginate had a firm consistency and then a new mixture was made to cover the rest of the bone (Figure 2). After this second layer stiffened, one of the tips of the mold of alginate was cut for the guidance of which sides were overlaid, then the two halves were separated (Figure 3) and the bone was removed from the mold.

Figure 2. Calcaneus bone completely covered by alginate for confection of the mold

Figure 3. Separation of both halves of the mold of alginate for removal of the calcaneus bone. Observe the size of the bone inside the mold

Subsequently, both alginate molds were filled with plaster (Figure 4) and their halves were joined together again, in accordance with the cutting done. For preparation of plaster, the powder was mixed with water at ambient temperature to form a homogeneous consistency. After the plaster solidify (approximately 20 minutes), the alginate mold was separated again to remove the plaster model of bone. With the help of a scalpel the excesses of plaster were removed giving the finishing touches to the workpiece (Figure 5).

Figure 4. Mold of alginate filled with plaster for confection of the calcaneus bone

Figure 5. Equine's calcaneus bone made with plaster

After each model of bone be prepared, they were painted with different colors for easy identification, assembled and glued with glue according to its anatomical position (Figure 6 and Figure 7). Five models were made of carpus and tarsus of each species (canine, bovine and equine). These models were used in the classes of Anatomy of the domestic animals of the Veterinary Medicine Course, UNIJUÍ.

Figure 6. Equine's tarsus bone made with plaster

Figure 7. Equine's carpal bone made with plaster

RESULTS AND DISCUSSION

Students of Veterinary Medicine of UNIJUÍ, as well as those of other institutions upon studying the Discipline anatomy of Domestic Animals, participate in lectures followed by practical classes. This didactic approach aims to facilitate and fix the learning, which in the case of osteology refers to the recognition of the bones, their accidents and anatomical position (Santos *et al.,* 2015). König and liebich (2011) reported that the acquiring of a thorough knowledge of the systemic anatomy is of extreme importance for students, because it provides the understanding of the general connection between structure and function of the animal body. Many are the techniques and ways to prepare didactic materials for use in practical classes of morphology (Silva *et al.,* 2011); and with the use of custom materials it is possible to make attractive and motivating classes, in which students are involved in the construction of their knowledge (Souza *et al.,* 2008). The anatomical models produced in the present study were with the external appearance very similar to the original bones, being possible the visualization of well modeled bone accidents and actual size. The use of specimens produced was well accepted by students during the practical classes. Consider the well finished replicas, allowing the identification of bone injuries and even confuse with genuine parts. Figueiró and Rothe (2014) also used the technique of models in alginate and plaster to reproduce beaks of birds in order to obtain approval or not of students as didactic material for practical classes. They concluded that the technique was satisfactory, where the majority of students considered the replicas of plaster equal to the true ones and being possible to distinguish the beaks of different species in the models.

Cabral *et al.* (2007) also concluded the effectiveness of using alginate and plaster in the production of dental arches of dogs in obedience to proposed by Herbert *et al*. (1998), who emphasized that the ideal model for the study should be an exact replica of the bone used and be free of bubbles. Alginate used in the manufacture of anatomic molds and also for orthodontic models is a material originated from a natural substance extracted from seaweed, called anhydro-beta-of-mannuronic acid or alginic acid. The dust from the material is composed of soluble alginate of sodium, potassium or triethanolamine, which when mixed in water, begins the process of alginate formation (Boa*et al.,* 2016). Plaster is a material used and studied in the whole world. It consists of hemihydrate calcium sulphate,originated from gypsum which is the mineral-compact of hardness and slightly soluble in water (Barbosa*et al.,* 2014). The main factors that elect the alginate and plaster as the main choice are the ease of handling, availability and low cost, since it is possible to reuse the models more than once (Boa*et al.,* 2016). These characteristics of both materials were also observed in the present study, especially the production in series, since that once made the mold of alginate, it can be used numerous times for confection of models in plaster.

According to Cabral *et al*. (2007), when used water cooled in the mixture of alginate, there is better handling, because the paste stiffness is faster and takes less time to dry. However, in the work herein, it was decided for warm water, especially in the confection of larger molds, in order to mix the paste without risk that it would harden before even putting it in the container. This fact occurred a few times when used cold water, which led to the material waste. In the case of plaster, some models may have cracks during the withdrawal process of the alginate model showing fragile when handling and easily broken, resulting in a shorter life. Some of the models developed for the present study suffered cracks on the withdrawal of the alginate mold , as for example, the calcaneus bone is a higher and wider bone than the rest, but during the development of the remaining bones there were no cracks or breaks. The manufacturedmodels were used during the first and second term of 2017 and continued during the animal anatomy classes. In addition to the use during the lessons, as well, are used in the schedules of extra-study class in the

laboratory. It was observed that only certain parts, when handled excessively and without careful showed cracks or they broke. Therefore, students are advised to handle with care the models and subsequently, they are stored in separate boxes.

Conclusion

The produced anatomical models of the equine, bovine and canine carpus and tarsus, were well accepted by the students in the practical classes of anatomy by the fact of being trustworthy to the actual model. It was possible to evaluate a greater dynamism in the classes, where the students, in addition to using the original bones, possessed an additional resource for studies. In addition, for the preparation of these models no sophisticated material or specialized people was necessary, leading to a low cost. With this, it was possible to increase the number of anatomic specimens within the laboratory, allowing to provide an anatomical piece for each student to handle and exercise their theoretical knowledge directly in the workpiece, contributing to the qualification of their learning.

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