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Intra-Articular Injection, Computed Tomography and Cross Sectional Anatomy of the Metacarpus and Digits of the Cattle (*Bostaurus*) and Buffalo (*Bosbubalis*)

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Abstract: It has been the first trail to do intra-articular injection in cattle and buffalo as far as we know so, the purpose of the present study was to state the site of intra-articular injection of fetlock, pastern and coffin joints in these animals. Also to provide a detailed computed tomography (CT) and cross sectional anatomic reference of the normal metacarpus and digits for the cattle and buffalo, as well as to compare between metacarpus and digits in these animals to outstand a basis for diagnosis of their affections. Advantages, including depiction of detailed cross-sectional anatomy, improved contrast resolution and computer reformatting, make it a potentially valuable diagnostic technique. The fore limbs of ten healthy adult cattle and buffalo were used. Clinically relevant anatomic structures were identified and labeled at each level in the corresponding images (CT and anatomic slices). CT images were used to identify the bony and soft tissue structures of the metacarpus and digits. The knowledge of normal anatomy of the cattle and buffalo metacarpus and digits would serve as initial reference to the evaluation of CT images in these species. Intra-articular injection was done to clarify the joint of the digits.

Key words: Computed Tomography · Cattle · Buffalo · Metacarpus · Digits

INTRODUCTION

Lameness in dairy cattle is a major source of economic loss to the farmer [1-3]. Such losses include treatment costs, reduced milk production and fertility. Consequently, affected animals are culled more frequently [3].

The fetlock joint of cattle includes the proximal end of both proximal phalanges and the distal end of the third and fourth metacarpal bones. Dorsally, a prominent septum separates the lateral and medial joint pouches. Cartilaginous plaques within this pouch are localized below the synovial sheaths of the extensor tendons [4]. Communication between the lateral and medial synovial pouch in the distal palmar area of the fetlock joint exists in 98.9% of the examined cases so the fetlock joint in cattle has to be treated as a single compartment [5]. Proximal to the opening, there is a thin septum between the lateral and medial pouch.

A satisfactory diagnosis of most orthopedic problems could usually be achieved by the combination of a standardized lameness examination and a judicious choice of radiography and ultrasonography [6]. Inconclusive or incomplete findings on radiography or ultrasonography require the use of additional imaging modalities that may be useful in defining the anatomic origin of lameness, which is clinically localized at the digits [7]. In those instances, computed tomography (CT) could be a valuable complement [8-11]. CT allows cross sectional imaging without bone and soft tissue overlapping. Furthermore, three-dimensional rendering of the area of interest and multiplanar reformatting could yield better anatomical orientation of the area of interest and provide for more sensitive detection and characterization of disease extension [12, 13]. The available literatures do not provide detailed information about the places of the intra-articular injection of the joints of the digits using CT images.

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The aims of the present study were to specify the seat of intra-articular injection of the fetlock, pastern and coffin joints in cattle and buffalo, to describe images of normal anatomy and variations of the metacarpus and digit regions in healthy cattle and buffalo with relation to the rate of affections in these animals, finally to provide an atlas of detailed CT and cross-sectional anatomy of metacarpus and digits of the examined animals.

MATERIALS AND METHODS

Animals: The present work was carried out on the metacarpus and digits of twelve healthy adult cattle and buffalo (Six cattle of 5-7 years old and six buffalo of 5-7 years old), 4 males and 2 females of each species. The fore limbs were obtained immediately after slaughter, by disarticulating the carpometacarpal joints, cooled and imaged within 12 hours to minimize post-mortem changes.

CT Examination: The limbs were underwent consecutive CT scan using CT scanner [TOSHIBA 600 HQ, third-generation equip TCT, Japan] at Ahmed Faried Radiology Center, Benha, Egypt). The following images (three dimensions, lateromedial (Coronal) and contiguous transverse) were obtained. The acquisition settings were 120 kv, 130 mA and 1.5 seconds, thickness of 3 mm, pitch of 0.625, field of view of 45 cm and matrix size of 512×512 pixels. The images were started at the level of the base of the large metacarpal bone, 3cm distal to the carpal articulation and continuing 1cm distally in a row below the distal interphalangeal (Coffin) joint. Coronal and 3 D CT images were also obtained and the seats of intra-articular injection were determined on the coronal images.

Intra-Articular Injection: Injection of the colored latex was done to clarify the boundary of the joints of the digits. After the CT images were obtained, the limbs were frozen at -20° then sectioned transversely using an electric band saw, to correspond with the CT images. All sections were cleaned, photographed and used for the future studies.

Comparison Between CT and Anatomical Images: Important anatomical structures were identified and labeled in two corresponding CT scans and cross-sections of the cattle and buffalo metacarpus and digits according to Nickel *et al.* [4], Getty [14], Nomina Anatomica Veterinaria [15] and Schaller [16]. Eight transverse slices from both CT and gross sections were chosen for publication. It worth to mention that, some structures present in the anatomical sections could not be seen on the corresponding CT images and vice versa.

RESULTS

The sites of intra-articular of distal joints, CT and cross-sectional of metacarpus and digits were performed. A 3D CT image of the distal part of the fore limb show the bones of the limb (Fig. 1), while a lateromedial CT image demonstrate the sites of intra-articular injection (Fig. 2). The present work also provided eight CT images and gross cross-sections of the cattle and buffalo metacarpus and digits (Figs. 3-10).

The fusion of the third and fourth metacarpal bones in buffaloes were clearly observed in the proximal and distal quarters of the shaft of the metacarpal bone, in contrast, such fusion was in the upper and distal fifth of the shaft in cattle (Fig. 3). The bony septum extended in the shaft of the metacarpal bone in buffalo more than that of cattle. The medullary cavity was divided in both buffalo and cattle by incomplete septum in the proximal and distal part of the shaft of the metacarpal bone (Fig. 4).

The suspensory ligament was conspious in both CT and gross sectional anatomy in the palmer aspect of the metacarpal bone and its shape varies from elongated and flattened in cattle to elliptical in buffalo (Figs. 3-5). Moreover, the superficial and deep digital flexor tendons were also visible clearly in the palmer aspect of the interosseus muscle and the fused metacarpal bones. The deep digital flexor tendon was recognized as an ovoid structure and appeared smaller in cattle. Each tendon was surrounded by a small rim representing its tendon sheath (Fig. 3&4). The extensor tendons appeared more clearly in the dorsal aspect of the metacarpal bones in the CT images of buffalo than that of cattle.

Intra-Articular Injection

Fetlock Joint: The intra-aticular injection of fetlock joint in both animals was performed through inserting 18 gauge needle from the medial or lateral aspect, almost 2 cm proximal to the level of the dew claw, in the triangular pouch bounded anteriorly by the large metacarpus and suspensory ligament posteriorly. The needle was directed medially and distally (Fig. 2A).

Pastern Joint: The intra-articular injection of the pastern joint was utilized through a dorsal approach via inserting the needle 1cm medial or lateral to the midline between the

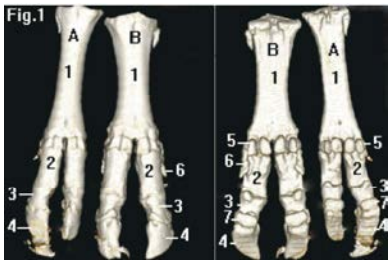

Fig. 1: 3 D CT image of the left metacarpus and digits in the cattle (A) and buffalo (B): dorsal (D) and palmer (P)view: 1- fused third and fourth metacarpal bone 2- first phalanx 3-second phalanx 4- third phalanx 5 proximal sesmoid bone - 6- fifth digit7- distal sesmoid bone

Fig. 2: Lateromedial computed tomography image of the bovine forelimb involved the surgical approach and showing the sites of intra-articular injection. The arrows A, B and C showing the sites of intra-articular injection of fetlock, pastern and coffin joint respectively.1- metacarpal bone, 2- fetlock joint, 3- proximal sesamoid bone, 4- proximal phalanx, 5- pastern joint, 6- middle phalanx, 7- distal sesamoid bone, 8- coffin joint and 9- distal phalanx

distal condyle of the first phalanx and the articular rim of the second phalanx. Two injections of both pasterns were conducted. The needle was directed distally and inward toward the midline (Fig. 2B).

Coffin Joint: While the joint is in a flexed position, intra-articular injection of the coffin joint was punctured through the dorsal aspect of the limb via inserting the needle 1 cm medial or lateral to the midline. Both coffin joints should be injected. The needle was directed distally and inward toward the midline (Fig. 2C). The horny material of the claw and the skin of the digit in cattle were thinner than those of buffalo.

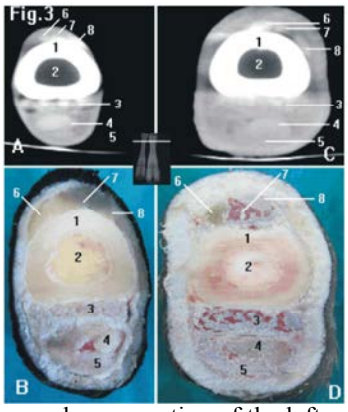

Fig. 3: CT image and cross section of the left metacarpal bone in the cattle (A&B) and buffalo (C&D) at the level of the proximal third of the large metacarpal bone, 4cm distal to the carpal articular surface as shown in the insert image. Dorsal is up and lateral is to the right of the viewer. 1-fused third and fourth metacarpal bone, 2-medullary cavity, 3-suspensory ligament(M. interosseous), 4-deep digital flexor tendon, 5-superficial digital flexor tendon , 6 and 7- medial and lateral tendons of common digital extensor muscle, 8- Tendon of lateral digital extensor muscle

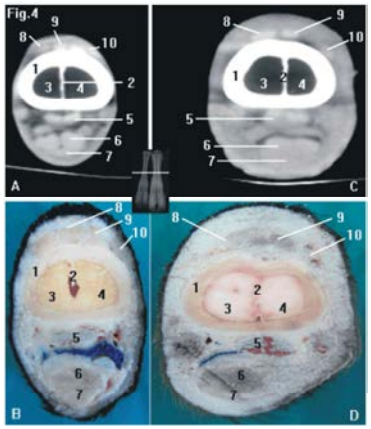

Fig. 4: CT image and cross section of the left metacarpal bone in the cattle (A&B) and buffalo (C&D) at the level of the distal third of the large metacarpal bone, 3 cm proximal to the fetlock joints shown in the insert image. Dorsal is up and lateral is to the right of the viewer. 1-fused third and fourth metacarpal bone, 2-bony septum 3 and 4-medullary cavities, 5-suspensory ligament(M. interosseous), 6-deep digital flexor tendon, 7-superficial digital flexor tendon , 8 and9- medial and lateral tendons of common digital extensor muscle, 10- Tendon of lateral digital extensor muscle, 11- extension of the fetlock joint pouch

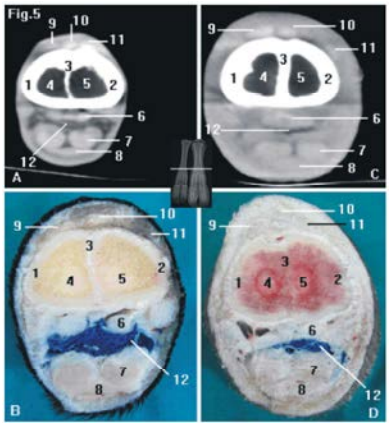

Fig. 5: CT image and cross section of the left metacarpal bone in the cattle (A&B) and buffalo (C&D), at the level just dorsal to the fetlock joints shown in the insert image. Dorsal is up and lateral is to the right of the viewer. 1-and 2-fused third and fouth metacarpal bone, 3-bony septum 4 and 5-medullary cavities, 6-suspensory ligament (M. interosseous), 7-deep digital flexor tendon, 8-superficial digital flexor tendon , 9 and10- medial and lateral tendons of common digital extensor muscle, 11- Tendon of lateral digital extensor muscle, 12- the fetlock joint pouch

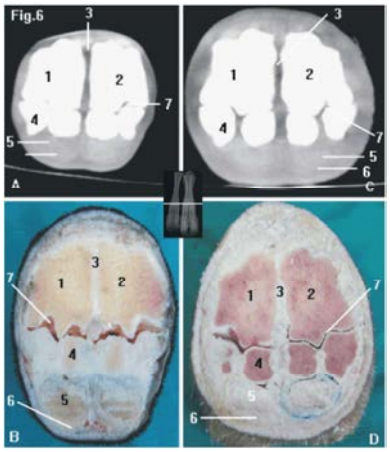

Fig. 6: CT image and cross section of the left digits bone in the cattle (A&B) and buffalo (C&D) at the level of the fetlock joints shown in the insert image. Dorsal is up and lateral is to the right of the viewer. 1- distal end of the third metacarpal bone, 2-distal end of the fourth metacarpal bone, 3-intertrochlear notch 4- proximal sesamoid bone, 5-deep digital flexor tendon, 6-superficial digital flexor tendon , 7- fetlock joint, 8- palmer ligament, 9- inter digital intersesmoiden ligament, 10-Manicaflexora

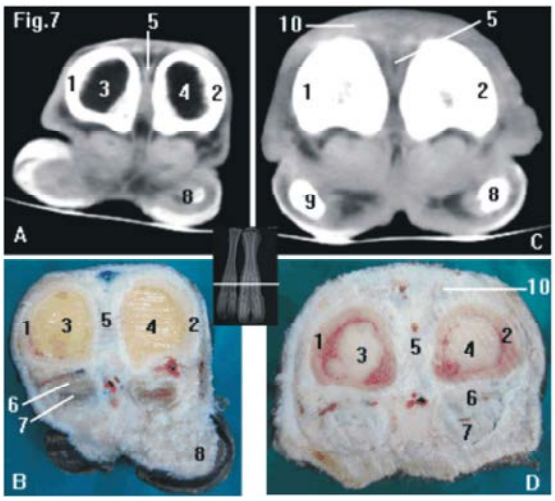

Fig. 7: CT image and cross section of the left digits bone in the cattle (A&B) and buffalo (C&D) at the level of the body of the first phalanxas shown in the insert image. Dorsal is up and lateral is to the right of the viewer. 1-proximal phalanx of the third digit, 2-proximal phalanx of the fourth digit, 3- and 4- medullary cavities, 5-proximal interdigital ligament, 6-deep digital flexor tendon, 7-superficial digital flexor tendon, 8- fifth digit, 9- second digit, 10- extensor tendons

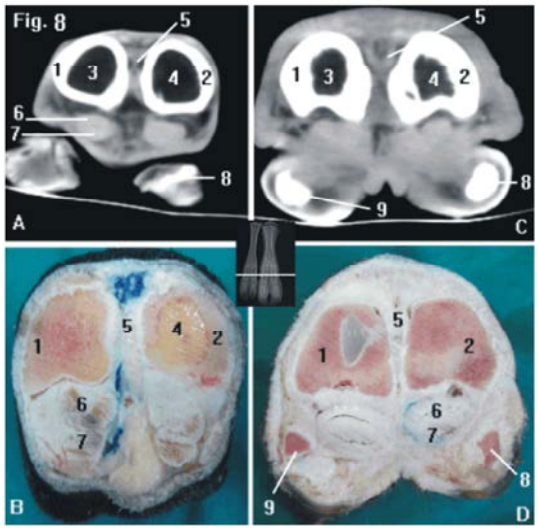

Fig. 8: CT image and cross section of the left digits bone in the cattle (A&B) and buffalo (C&D) at the level of the distal end of the proximal phalanx, just proximal to the pastern joint as shown in the insert image. Dorsal is up and lateral is to the right of the viewer. 1-proximal phalanx of the third digit, 2-proximal phalanx of the fourth digit, 3-interdigital ligament, 4-deep digital flexor tendon, 5- superficial digital flexor tendon6- fifth digit, 7- second digit

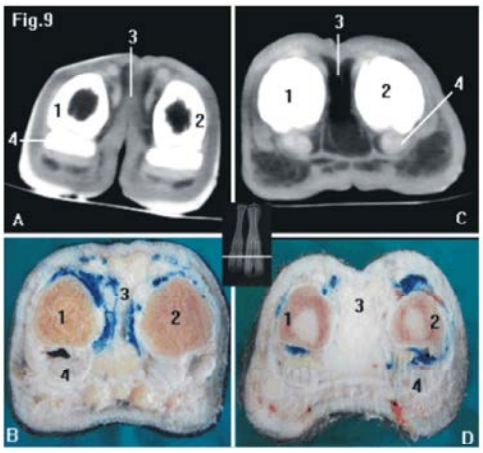

Fig. 9: CT image and cross section of the left digits bone in the cattle (A&B) and buffalo (C&D) at the level of the pastern joint as shown in the insert image. Dorsal is up and lateral is to the right of the viewer. 1-middle phalanx of the third digit, 2-middle phalanx of the fourth digit, 3-interdigital ligament, 4-deep digital flexor tendon, 5-adipose tissue 6- the colored latex injected in the pastern joint

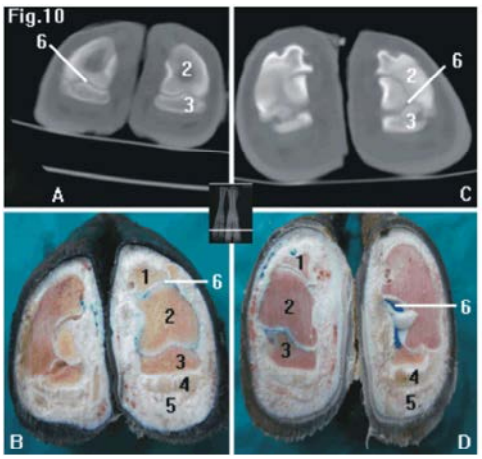

Fig. 10: CT image and cross section of the left digits bone in the cattle (A&B) and buffalo (C&D) at the level of the coffin joint as shown in the insert image. Dorsal is up and lateral is to the right of the viewer. 1-middle phalanx, 2-distal sesmoid bone, 3-distal phalanx, 4-deep digital flexor tendon, 5-adipose tissue 6- the colored latex injected in the coffin joint

Regarding to their physical densities, CT provided good discrimination between bones and soft tissues, while providing slight to moderate favoritism between the adjacent soft tissues. On CT images bone appeared hyperdense, while tendons, ligament and hoof were appeared on various grey scale. Medulla of the bone had a dark shade (Figs. 1-5). CT images clearly identify the phalangeal bones, proximal and distal sesamoid bones, superficial and deep digital flexor tendons and navicular bursa.

DISCUSSION

The state of the site of intra-articular injection of the distal extremity in cattle and buffalo is very important for treatment of joint disease. It worth to report that intra-artcular injection has been done for the first time, according to our knowledge. One injection either lateral or medial approach was utilized to puncture the fetlock joint in cattle and buffalo in the triangular space between metacarpus and suspensory ligament. Similar approach had been done in cattle indicating that communication between the lateral and medial synovial pouch in the distal palmer area of the fetlock joint in cattle has been existed [5, 17].

In the present study, the intra-articular injection of the pastern and coffin joint in cattle and buffalo was punctured through the dorsal aspect of the limb via inserting the needle 1 cm medial or lateral to the midline. Flexion of the interphalangeal joints significantly facilitates their puncture as the joint space increased. The joints were easily punctured either dorsomedially or dorsolaterally to avoid prick of the common digital extensor tendon. Similar results were obtained [18, 19].

Because of the observed thinner horny materials of the claw of cattle than that of buffalo, the prevalence of claw affections such as sole ulcers and abscess [3] was higher and take longer time in cattle than those of buffalo. Moreover, septic arthritis of the digit joints, mainly fetlock joint, was higher in cattle than that of buffalo due to thin skin and easily infects joints through traumatization [20, 21].

Our results revealed that the fusion of the third and fourth metacarpal bones in buffaloes was clearly observed in the proximal and distal quarters of the bone, while in cattle the fusion was in the upper and distal fifth. On the other hand, El-Shafey and Ahmed [22] reported that the fusion in buffalo was along the full length of the metacarpal bone.

Although, radiography is the standard imaging modality for the visualization of the region of the metacarpus and digits, it has its limitations because radiographs provide a two dimensional representation of a three-dimensional object and have a bad soft tissue

contrast. Ultrasound is often used in addition to radiography to avoid superposition of different structures. In addition, CT is a good complementary imaging modality, as it enabled the identification of both the exact and extends location of the lesion which is the paramount factor for prognosis [23, 24].

In the present study the CT images of the cattle and buffalo metacarpus and digits provides viable details structures corresponding to their gross anatomy. Similarly, CT provides good discrimination between bone and soft tissue architectures. In case of horse [25], in bovine [26], in small ruminant [27], in dog [28] and in human [29], thus the computed tomography (CT) has become an important diagnostic imaging modality in the diagnosis of the musculoskeletal disorders [13].

The present study served as a helpful reference that aid in CT imaging diagnosis of the cattle and buffalo metacarpus and digits disorders and determine the exact sites of the intra-articular injection of the joints of the digits in both animals. Knowledge about normal cross sectional anatomy of the cattle and buffalo metacarpus and digits is crucial for evaluation of CT scans.

CONCLUSION

The site of intra-articular injection of fetlock, pastern and coffin joints of cattle and buffalo is a key point information that could be reached simply and thus help in the approach of these joints in future clinical studies. CT allowed a full assessment of the metacarpus and digits of the examined animals as a valuable imaging technique for evaluation of both soft and bony structures. The images provided in this study can serve as a CT reference for the cattle and buffalo metacarpus and digits.

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