Journal of Veterinary Research Advances
ISSN: 2582-774X

Research Article
Open access

Imaging of horn using computed radiography and computed tomography in cattle

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Received on: 11/01/2023 Accepted on: 21/04/2023 Published on: 30/04/2023

ABSTRACT

Aim: The study was aimed to evaluate the normal anatomical structure of horn using digital radiography and computed tomography in cattle.

Method and materials: Study was conducted on cadaver horns of cattle using X-ray diagnostic techniques; computed radiography and computed tomography and imaging of normal anatomical structures were evaluated.

Results: The study revealed that computed radiography and computed tomography techniques provided detailed information regarding anatomical structure of the normal horns viz; horn sheath, bony core, bony septa, connective tissue layer and pneumatic cavity.

Conclusion: Computed radiographic and computed tomographic evaluation revealed normal radiographic anatomical structures of cattle horn viz; horn sheath, bony core along with bony septa, connective tissue layer what are subjected to the diagnosis of various kinds of horn affections.

Keywords: Cattle Horn, Computed radiographic, Computed tomographic, Imaging diagnostics.

Cite This Article as: Bamniya Y and Kumar P (2023). Imaging of horn using computed radiography and computed tomography in cattle. J. Vet. Res. Adv., 05(01): 79-84.

Introduction

Cattle play a significant role in agricultural economy of country and occupy a unique position among the livestock. According to livestock census (2019), India has 35.93% (192.52 million) total cattle population, which produces 48% milk of the total livestock population. Rajasthan state has 7.3 % (13.9 million) of the total cattle population of the country. The overall contribution of livestock sector in the total GDP is nearly 4.11 percent and 25.6 of total agriculture GDP.

Cattle horns are important structure for the breed characteristic. Horns are weapons that are used by cattle in competitive encounters at the feed bunk, hay bale, shade tree, water trough, over breeding privileges or dominance and against man in offensive or protective situations (Hamdi *et al* 2013). The size and conformation of the horns depend on breed, age and sex. Both male and female cattle have horns, although the horns of female animal are smaller in size (Dyce and Wensing, 1971).

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The conditions which affect the productivity and lead economic loss to the farmer are supposed to be taken care of on priority. The production losses due the horn affections in cattle count a major share to the farmer (Rao *et al.*, 2014). The horns are prone to be affected like avulsion, fracture, overgrowth, sepsis, fissures and cancer (Singh and Kumar, 2012).

Utility of diagnostic imaging brings together science and technology to create a visual record of the interior body structures for biomedical research, clinical examination and medical preposition (Olsen *et al.*, 2007). Imaging techniques helpful to establish a standard database of normal anatomical, physiological and functional parameters that can be used for clinical and research purpose (Thomas and Pickstone, 2007). Diagnostic imaging has gone way beyond the production of images and now has options to display, post- process, record, store and also of transmission of images and finally application of Picture Archiving and Communication System (PACS). Thus, image production as earlier as the only option is now one of many facets of advanced imaging technology (Doi, 2006). Therefore, it was proposed to study the anatomical structure of normal horn using computed radiography and computed tomography.

Materials and Methods

The study was carried out on cadaver horns at CVAS, Navania, Udaipur. These horns were scanned with computed radiography and computed tomography. Computed radiography and computed tomography examination of samples were conducted at Med. Diagnostic Laboratory. Radiological examination in lateral views was carried out on normal horn using radiography machine (Allengers X Ray machine, mA 500). The horns were radiographed on lateral view using technical/exposure factors at 60kVp, 35 mAs and 90 cms FFD. The diagnostic images were interpreted and analysed.

The CT images were obtained with multi-slice CT scanner, which has high contrast spatial resolution and consequently better conspicuity of small structures. These high-quality images are attributed to the thin collimator (16 simultaneous slices at sub-millimetre collimator), high speed, decrease in noise and huge number of images generated at the same scanning time. The horns were extended and placed within the CT scanner machine (GE Healthcare 16 CT Scanner). A scout image (120 kV and 60 mA) was obtained for use in planning image acquisitions to ensure symmetry in positioning and inclusion of the entire region of interest. The acquisition settings were for soft tissue (window width = 350, level = 60), bone (width = 2000, level = 500), slice thickness of 2 mm and matrix size of 512. The horns were scanned in helical fashion (starting at a level of base of horn and continuing to the tip of horn). Computed tomographic images examined continuously series of sagittal and transverse manner. The diagnostic image was interpreted and analysed with DICOM file software i.e. RadiAnt software, 3D slicer and Sante software.

Results and Discussion

Diagnostic imaging techniques have been observed useful non-invasive methods for the diagnosis of various diseases in animals. Among various diagnostic imaging techniques radiography is the first imaging modalities of choice when a bony or soft tissue injury is suspected (Raes *et al*, 2011). Computed tomography currently plays a prominent role in the diagnosis and evaluation of many diseases (Goncalves-Fetreira *et al*, 2001). The CT technique has been used for screening for disease, as well as for diagnosis, assessment of therapeutic effect, and detection of recurrent and metastatic disease and CT scans provided a great deal of anatomical information with a short scanning time (Miwa and Otsuka, 2017). The present study was carried out on cattle horns of different size and shape irrespective to breeds. X-ray diagnostic imaging of the horns was performed using Computed Radiography and Computed Tomography. Imaging of horns comprised of normal detailed structures of the specimens. Radiological anatomy of normal horns was detailed out by Computed Radiography and Computed tomography.

Radiographic images of horns were screened under fluorescent illuminator. Computed tomographic images of horn were analysed with the help of DICOM computer software. CT images were obtained to sagittal and transverse 2 mm slices for the analysis.

Computed Radiographic and Computed Tomographic images interpretations were based on the visualisation and analysis of the opacities on images. The X-ray images displayed a range of densities from white through various shades of grey.

Fig. 1: Radiographic images (lateral & AP views) of normal horn showing radiodense bony core with bony septa in trabeculae patterns and horn diverticulum was dark-greyish in appearance due to air occupied space.

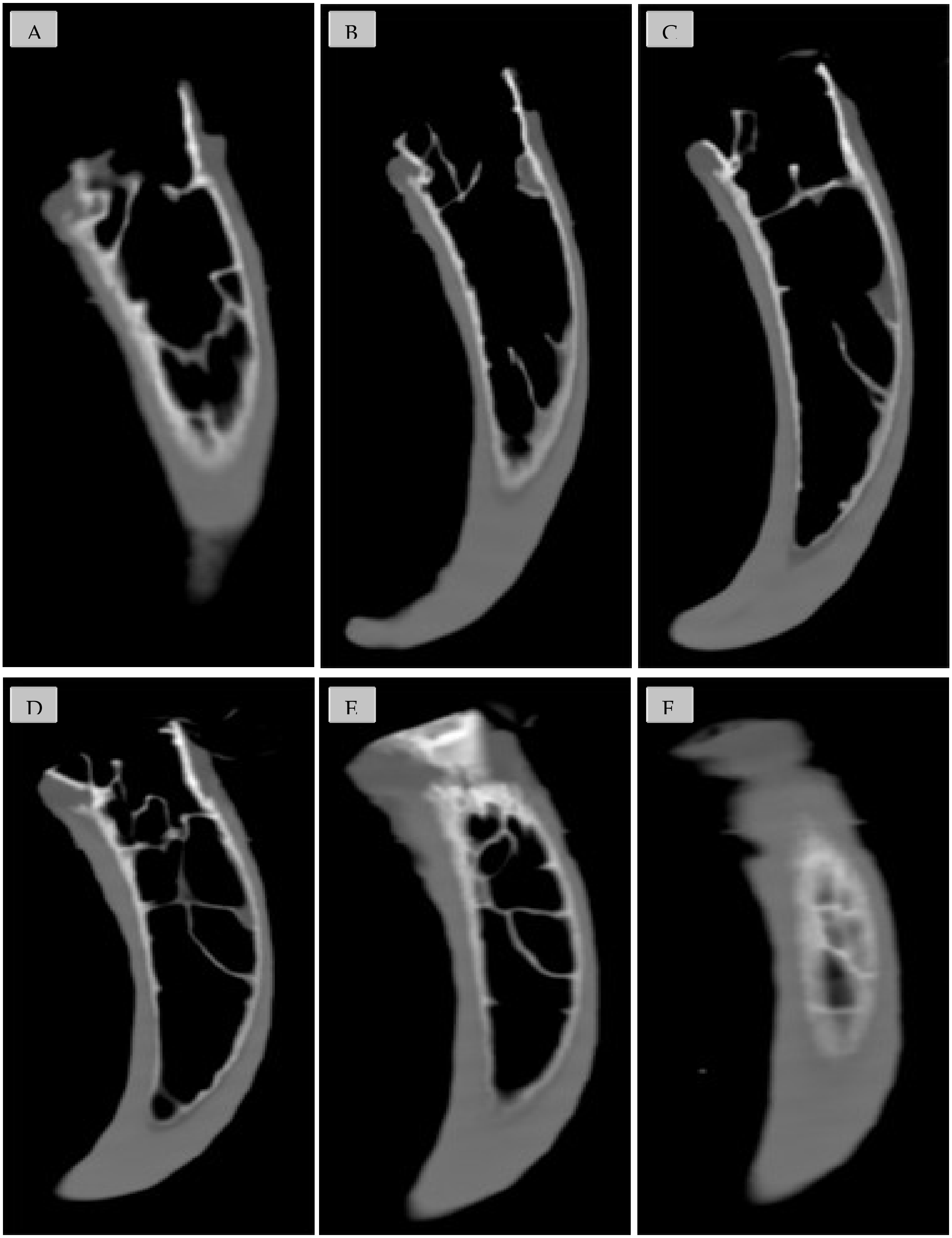

Fig. 2: CT images (sagittal slices) of normal horn indicating hyperdense white colour of bony core structure with bony septum showing complete osseous demarcation. In between horn sheath and bony core the thin layer of connective tissue appeared black (slices C&D). Bony septa were more dense visible at base horn in trabeculae pattern (slices D&E).

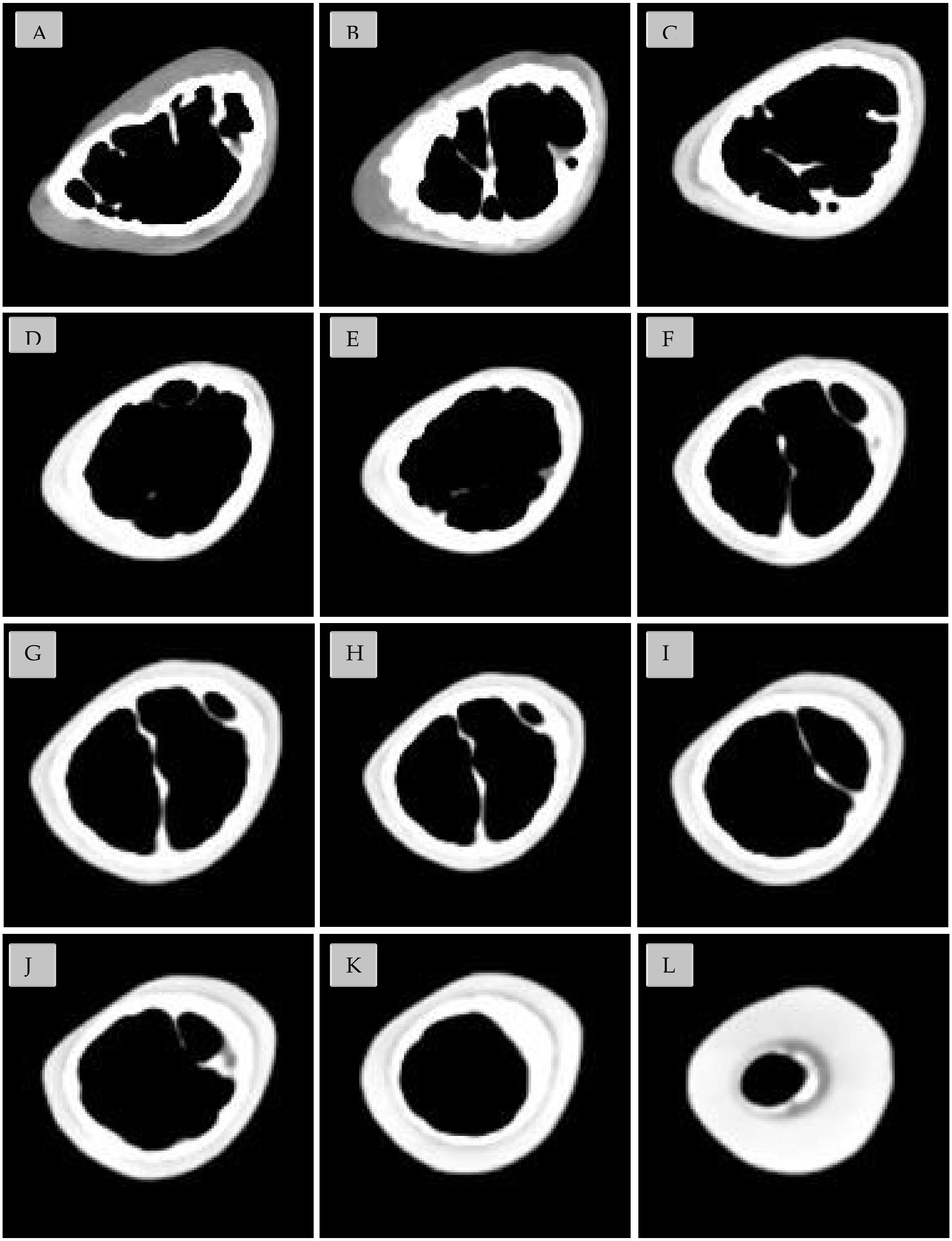

Fig. 3: CT images (Transverse slices) of normal horn from base to apex showing dense bony septa at base horn in trabeculae pattern (slices A to C) and Bony structure showing complete hyperdense osseous demarcation (slices A to L)

On X-ray image of horn, Radiopaque tissue appeared white however, radiolucent tissue appeared black. The resultant pattern of X-ray images was observed compilation of various opacities. In the radiographic images of normal horn, horn sheath had complete outer margin which appeared greyish. In between horn sheath and bony core, the thin layer of connective tissue appeared greyish black. Radiography of horns revealed radiodense bony core with bony septa in trabeculae patterns. Horn diverticulum was observed dark-greyish in appearance due to air occupied space (Fig. 1).

Shivaprakash (2008) also opined that radiographic technique could be the 100% reliable method for diagnosing horn affections in bullocks at an early stage when clinical signs were absent. Chauhan *et al* (1980) and Singh *et al* (1986) stated that radiography was important diagnostic tool for various horn disorders.

In present study, computed tomography decreased spatial resolution compared to radiographs, reduced anatomic superimposition and superior contrast resolution images to detect lesions throughout. Forrest (2018) and Hoskinson and Tucker (2001) also reported that CT technology provides images without superimposition of structures and better soft tissue delineation compared with radiography. Whereas, Nykamp and Randall (2019) elaborated the advantages and limitations of computed tomography (CT).

CT images of normal horn in thin plain manner revealed horn sheath which appeared grey in colour and hyperdense white coloured structure was bony core with bony septum showing complete osseous demarcation. In between horn sheath and bony core, the thin layer of connective tissue appeared black which was a combination of corium and periosteum. Bony septum was less visible at apex and horn pneumatic cavity is completely radiolucent black due to air space which provided negative contrast effect (Fig. 2).

In sagittal section images, horn sheath was outer margin of horn which appeared grey while bony core was hyperintense structure which appeared white in colour. Layer of connective tissue was clearly visible at apex margin while compared to mid and base of horn. Diverticulum of horn was observed as hyperattenuated trabecular pattern structure of bony septum with complete osseous demarcation adjacent to bony core (Fig. 3).

In present study, multiplanar reconstructed images have been evaluated for each CT study and the presumptive diagnosis was described based on the CT anatomy and variants (Schwarz and Saunders, 2011). Penninck *et al* (2001) also stated that CT was found very sensitive in detecting mineralization within soft tissues.

Conclusion

Computed radiographic and computed tomographic evaluation concluded normal radiographic anatomical structures of cattle horn viz; horn sheath, bony core along with bony septa and connective tissue layer. Computed tomography eliminates superimposition and provides detailed information of compact bony and soft tissues. These techniques found effective as diagnostic tool for the diagnosis various kind of horn disorders.

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