Morphology and Morphometric of Bovine Digital Torus

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ABSTRACT

Background: Bovine lameness is an economic and sanitary problem with great losses. Digital torus are important in pathogenesis of hoof injuries preventing traumas and soft tissue compression. Objective: The study has established specific knowledge on zebu cattle, by means of morphologic and morphometric studies. For this reason, we determined length, width and height of abaxial, axial and intermediate torus of digits III and IV from thoracic and pelvic members of bovines at varied ages, gender, weights and management systems. Results: There was no statistical difference between dimensions of abaxial, axial and intermediate digital torus when comparing the groups and thoracic and pelvic members of these groups. In addition, there was no statistical difference between torus dimensions of III and IV digits. Collagen fibers type I were substantial for both members, prevailing at pelvic ones, in relation to type III. Although digital torus undergo through changes in morphology and composition in compliance with some factors, in this study there was no statistical difference between evaluated groups, maybe for being crossbred. Conclusion: Morphometrically, by applying statistical tests, there were no statistical differences among digital torus of the distinct groups, and nor between digits III and IV. Animal crossbred may explain such result. The various tissue types and arrangements led to state that their disposal were performed because of bovine locomotion.

INTRODUCTION

Bovine lameness is an important economic and sanitary problem with losses mainly in high-incidence flocks. Cattle digital diseases lead bovines not to perform regular activities and make them less productive, resulting in economic losses (Souza et al., 2006). Despite genetic improvement intensifies the best animal characteristics, these changes are not so beneficial for locomotion apparatus. The main factors that may cause podal diseases are nutritional, genetic and environmental, besides weight distribution difference. A percentage about 93% of locomotive problems are linked to hooves; from these, 92% in pelvic members, of which 68% are in digit IV, 12% in digit III and 20% in interdigital area and peripheral hoof (Dias & Marques Junior, 2003).

Hoof quality is determined by shape, anatomy and physiology of internal structures. Inside the corneous part of the hoof, chorion sole, associated to loose conjunctive tissue and digital torus, promotes the support mechanism. The torus may vary in thickness and size, acting in impacts deadening for distal phalanx and heel, wasting forces inside hoof and allowing mobility between distal phalanx and corneous capsule, and supporting animal weight (Räber et al., 2004).

Digital torus play an important role in hoof injury pathogenesis, preventing traumas and soft tissue compression, since hoof injuries generally originate from hurt tissue inside corneous protection (Räber et al., 2004). Therefore, bovine digital torus composition difference might be important for hoof disease appearance. In hoof asymmetry, in which natural digit concavity disappears and sole is plain or convex, impact absorption will mainly depend on suspension mechanism and digital torus. Digital torus is connected to internal part of hoof axial wall, establishing an additional support supplied by the connection with distal interdigital ligament (van Amstel & Shearer, 2006).

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III and IV from thoracic and pelvic members of bovines at varied ages, gender, weights and management systems.

MATERIAL AND METHODS

Twelve crossbred bovines without alterations in locomotion apparatus, of both genders and different ages were used. Divided into two groups: Group 1 - seven males, with average weight of 569.43±70.47 kg, from 30 to 36 months old, kept under confinement system on barren earth; Group 2 - five females, with average weight of 451.3±80.3 kg, from 40 to 48 months old, kept under extensive system. The Ethics Committee Animal Use (CEUA) of the Institute of Biological Sciences from the University of Brasilia (86551/2010) has approved the research.

After distal portion collection through metacarpal and metatarsal phalanxes, joint sections and hooves were removed to enable digital torus visualization. Secondly, they were immersed in 10% formaldehyde for 48 hours, and subsequently digital torus adjacent tissues were dissected, allowing their delimitation and measurement.

We determined length, width and height of abaxial, axial and intermediate digital torus from III and IV digits of the thoracic and pelvic member by using an electronic caliper model Starrett® 799. After measurements, we randomly collected three digital torus fragment, processed routinely for inclusion into paraffin, and cut into 4μm slices using a manual microtome (Leica RM 2125RT). Later stained with Gomori trichrome, in order to visualize conjunctive tissue, and Picrosirius red technique to differentiate collagen fibers through polarized light microscopy. Photomicrographs of random section of the fragment surfaces were obtained by optical microscope Olympus® BX51 coupled to an image capture and analysis program ProgRes® Capture Pro 2.5.

The Graph Pad Prism® 6.0 software was used to perform statistical analyses. By these analyses, average and standard error of average of the measures obtained from each group. The data were submitted to the Mann-Whitney U test adopting a 5% significance level all analyses.

Results:

Digital torus of abaxial, axial and intermediate (Figure 1) of III and IV digits from thoracic and pelvic members was convex structures disposed in parallel on plantar and palmar surfaces of solar distal phalanxes, extending from base middle third. Digital torus presented stretched shape with rounded extremities and edges. Macroscopically, there was a connective tissue wrapper externally to the digital torus, which was directly related to the hoof horny tissue plus an abundant fatty tissue (Figure 1).

Fig. 1: Palmar (a) and plantar (b) surfaces of distal phalanxes with abaxial digital torus (y), intermediate (m) and axial (x).

Histologically, connective tissue was organized in thick bundles of collagen fibers guided at different directions and disposed peripherally to fatty tissue, forming an increased amount of fatty tissue clusters. There was a large number of blood vessels in connective tissue near fatty tissue (Figure 2A). From polarized microscopy, collagen fibers type I and III were observed, in which type I presented in greater amount for both members, mainly in the pelvic ones, whereas type III were more evident in thoracic members (Figures 2B and 2C).

Fig. 2: Bovine digital torus. A- Conjunctive tissue (asterisk) with fatty tissue accumulations (arrow) and many blood vessels (incomplete arrow). Gomori trichrome. B and C - Digital torus of thoracic and pelvic
members, respectively, with abundant collagen fibers type I (asterisk) and scarce amount of type III (arrow). Picrosirius red polarized microscopy. Bar: 200 µm.

There was no statistical difference among dimensions of abaxial, axial and intermediate digital torus when comparing the groups (Graphic 1) and between thoracic and pelvic members (Graphic 2).

**Graphic 1:** Averages and average standard error gotten from abaxial, axial intermediate digital torus measures from groups 1 and 2. Without statistical difference (p≥0.05) among values.

**Graphic 2:** Averages and average standard error gotten of abaxial, axial and intermediate digital torus measures of thoracic and pelvic members from groups 1 and 2, respectively. Without statistical difference (p≥0.05) among values.

**Discussion:**

Ruminants have, due to absence of frog, an abundant bulb of horny substance, thin and soft, continuous with skin and composing great part of the ventral surface of hoof (Samuelson, 2007). Moreover, bovine lifting device differs from equines for having a less extensive lamellar chorion, in this way; torus has to support a greater body weight ratio (van Amstel & Shearer, 2006). Macroscopically, digital torus was formed by three-wrinkled dilation. With spongy appearance and cylindrical format, disposed in parallel to the deep flexor tendon muscle of digits, in proximal segment of the sheath connected to internal axial hoof wall coinciding with other studies (Räber et al., 2004; van Amstel & Shearer, 2006). In the evaluated animals, digital axial torus was
bigger, being the abaxial was distally situated to the axial one (Räber et al., 2004) and the intermediate torus was next to palmar/planar edge of the distal phalanx (Lischer & Ossent, 2002).

Cows with two or three lactations frequently present abaxial torus with fatty tissue slightly yellow, while in heifers it is white with conjunctive tissue deposition and a trend to present thicker structures than adult cows (Räber et al., 2004). This variation in the structure of the digital torus occurs according to age, with loss of conjunctive tissue in heifers, and fatty tissue deposition (Samuelson, 2007). For first calving heifers, there was greater predisposition to injuries, such as sole ulcers and white line disease, than second or third lactation cows, as lipid content of the torus is significantly larger in adult cows than in heifers (Offer et al., 2001). Although the adopted method does not allow evaluating the torus coloration due to formaldehyde 10% fixation; histologically, there was difference the amount of conjunctive and fatty tissues, which can be justified by the age difference of animals.

Conjunctive tissue provides support and structure and participates of defense and injury repair mechanisms (Samuelson, 2007). From conjunctive tissue constitution we found that, the digital torus of thoracic members have suffered constant remodeling, justifying the larger amount of collagen fibers of type III.

The digital torus suffers changes in morphology and composition due to factors as handling, raising system and animal age (Raber et al., 2004). There is a strong correlation between body score and digital torus thickness, in which the latest increases as the body mass enlarges (Bicalho et al., 2009). The contact area and pressure distribution average are affected by different types of floor and high ground abrasiveness that increases contact area, affecting force and pressure distribution; resulting in hoof wear (Telezhenko et al., 2008). However, animals with greater weight and under confinement system on barren earth (Group 1) presented similar torus dimensions to the animals with lesser body weight, but reared under extensive system (Group 2), without statistical difference. This fact can be explained by animal crossbreed, which have allowed higher adaptation in detriment of the Jersey and Gir (Ollhoff & Ortolani, 2001).

Conclusions:

Morphometrically, by applying statistical tests, there were no statistical differences among digital torus of the distinct groups, and nor between digits III and IV. Animal crossbred may explain such result. The various tissue types and arrangements led to state that their disposal were performed because of bovine locomotion.

REFERENCES


