RELATIONS BETWEEN THE HUMP, *LIGAMENTUM NUCHAE* AND THORACIC VERTEBRAE IN *BOS INDICUS*

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SUMMARY.

The thoracic Vertebrae and the course of ligamentum nuchae and hump of East African zebu (*Bos indicus*) ranging from 5 months foetuses to 4 years old, were investigated. A comparison was made with 28 *Bos taurus* cattle 1-4 years old. The summits of the spinous processes of the 7th to 13th thoracic vertebrae in *Bos indicus* of both sexes and all ages are bifid and extremely tilted caudally, the terminal branches are covered by cartilage which furnish attachments to the funicular part of the ligamentum nuchae. In *Bos taurus* the summits are slightly widened into tubercles. In *Bos indicus* the tips of spinous processes of the 3rd, 4th, 5th and 6th thoracic vertebrae directed dorsad and slightly caudad are bordered by the two lateral portions of the funicular ligamentum nuchae. The inserting nuchal ligament form a concave face dorsally which in *Bos taurus* is convex. The spinous processes become shorter and flattened laterally towards the lumbar junction. The hump is composed of the rhomboideus cervicis muscle, adipose tissue type I, collagen and elastic fibres and lies between the first and the 9th thoracic vertebrae.

INTRODUCTION

Species variations in the skeletons and organs among domestic animals are a rule generally in known groups as equines, porcine, carnivores and ruminants. Despite the differences in sizes between sheep, goats and cattle the anatomy of the ruminants including the wild species is much similar, thus the basis for their categorical grouping. However, specific differences seem to exist among them. The vertebral columns of *Bos taurus* and *Bos indicus* particularly in the thoracic region and the course of the ligamentum nuchae vary to the extent of enabling their identification. This difference has not been reported and apparently seem to have escaped the detection by Veterinary Anatomists. Since zebu cattle is a model animal in most African Veterinary Colleges, it is essential to know these morphological variations. This article describes the structure and location of the hump, the origin, insertion and arrangement of the ligamentum nuchae, the morphology of the thoracic vertebrae and their relations in zebu cattle in comparison to those of *Bos taurus*.

MATERIALS AND METHODS

This study involved more than 200 *Bos indicus* and 28 *Bos taurus* species of cattle aged between 5 months foetuses to more than 4 years old adults. Dissections were performed to determine the nature of the hump, the origin, course and insertion of the nuchal ligament. Samples were taken from the hump fixed in formalin (10%, pH 7.2), processed for paraffin embedding and stained according to the standard histological methods.

RESULTS

The hump of zebu cattle is a dorsal enlargement covering from the first thoracic vertebra to the 9th thoracic vertebra. It is a continuation of the rhomboideus cervicis muscle, which originates from the nuchal ligament from the 2nd cervical (C2) to the 5th thoracic vertebrae (T5) and inserts in the craniomedial surface of the scapular cartilage. In the area between T 1 and T 9 it combines with adipose tissue, collagen fibres, the lamellar part of ligamentum nuchae and the thoracic intervertebral ligaments (see later). The laterocranial parts of the hump are united with the cervical branches of the trapezius. The trapezius thoracis is not completely separated from the cervical part but forms a base in the laterocaudal areas of the hump without attaching to it. Microscopically the

hump consists of striated muscles, collagen fibres, adipose tissue and some elastic fibres (Figure 1).

Figure 1. A section of the zebu hump composed of striated muscles (one side), adipose cells (the other) separated by collagen fibres. 160X.

There are thirteen thoracic vertebrae characterized by presence of cranial articular processes bearing the dorsally facing articular surfaces. Caudally are the caudoventrally facing caudal articular surfaces. The vertebrae bear short bodies, long dorsal spinous processes, cranial and caudal costal facets for articulation with heads of ribs and short transverse processes bearing facets for articulation with tuberculae of corresponding ribs.

In addition to the caudal notches the arches of the all thoracic vertebrae except the last bear transverse foramina on both sides. This is not present in the first thoracic vertebra of *Bos taurus* cattle.

The spinous processes are large and flattened laterally with sharp cranial and caudal borders. The fifth vertebra has a flat caudal border whereas in the sixth it is grooved in the terminal portion. The spinous processes of the 7th to 13th thoracic vertebrae terminate in two rounded or flat processes directed laterally, covered with hyaline and fibrocartilage (Figure 2). This bifid characteristic is typical of *Bos indicus* of all ages and sexes and forms a concave v-shaped longitudinal groove where the two lateral sections of the funicular part of the nuchal ligament are inserted.

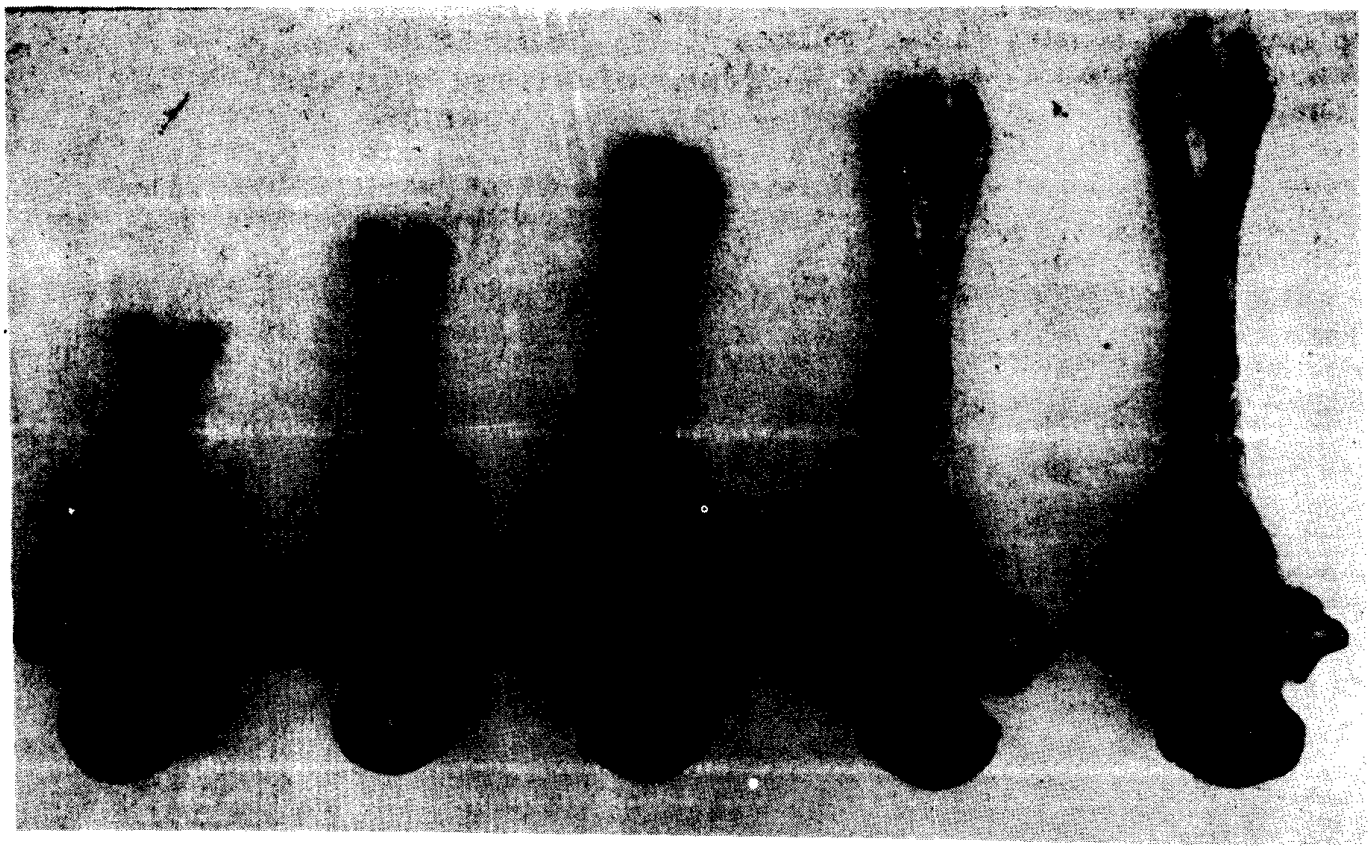

Figure 2. The 7th to 11th thoracic vertebrae of zebu cattle in decreasing size. Note the two terminal branches of the spinous processes.

Figure 3. The fourth (4) to 9th (9) thoracic vertebrae of a 60 cm crown rump length zebu cattle male foetus. The terminal branches of the spinous processes and the primary centres of ossification as the body and the arches are apparent.

The spinous processes of the 12th and 13th thoracic vertebrae are short and flat sagittally, in zebu cattle appearing as two perpendicular plates fused at the base, but single in *Bos taurus*. The spinous processes of all the thoracic vertebrae in both young and adult *Bos taurus* species are single and the joining parts of the ligamentum nuchae form a longitudinal convex area.

In both *Bos indicus* and *Bos taurus* the funicular ligamentum nuchae which originates at the nuchae crest of the occipital bone, broadens at the level of the second thoracic spine. On reaching the third spine it divides into two wide parts which pass caudally on either side of the spinous processes up to the sixth thoracic vertebra.

At the level of the 7th thoracic spine the two parts approach each other, initially running parallel, later unite and sink in the two branches of the spinous processes, terminating in the 2nd lumbar vertebrae. In *Bos taurus* they directly merge dorsally and fade away in lumbar region. Both the cranial and caudal lamellar parts of ligamentum nuchae blend with the hump at the summits of the thoracic spines. The deeper parts of the hump are thus more elastic than the superficial and lateral parts. The two plates of the cranial lamellar part originate from the funicular branch at T1 summit and spread to insert in the spines of C2 to C4. The single caudal branch originates from the cartilaginous ends of spinous processes of T1 and insert on dorsal spines of C5 - C7. Due to the differences in the mode of insertion of the nuchal ligament the back of *Bos indicus* species has a longitudinal groove caudal to the hump while in *Bos taurus* a ridge.

DISCUSSION

The zebu hump is composed of rhomboideus cervicis muscle bound superficially by the trapezius thoracis and deeply by the rhomboideus thoracis as also described by Heath (1978). In humpless *Bos taurus*, the trapezius muscle is wide, undivided flat and triangular while in humped cattle it is partially divided into cervical and thoracis parts the cervical branch is primarily attached to the hump. Because of this location, the hump tends to spread apart the lateral parts of the funicular part of the ligamentum nuchae. As a result the bifid characteristic of the thoracic vertebrae spinous processes in *Bos indicus* offers more firm insertion for the ligament. In Bos taurus breeds where the spinous processes are not bifid (Getty 1975; Popesko 1984), the lateral parts of the furnicular ligamentum nuchae unite dorsally to form a convex ridge.

Since the materials investigated covered all ages from embryonic, up to more than four years in both species and sexes with the thoracic spinous bifurcation being found in *Bos indicus* but not in *Bos taurus* it is concluded that this is a specific characteristic of the former. Bifurcations are found in foetuses as young as five months of age (Fig. 3).

Assuming this to be a result of two secondary centres of ossification at the distal end of the spinous processes as normally occurs for the vertebral arches, they would fuse with age. To the contrary the terminal branches are much wider, longer and tough in old animals.

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