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Research Article

ORIGIN AND DISTRIBUTION OF BRACHIAL PLEXUS IN BEETAL GOAT (*CAPRA HIRCUS*)

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ABSTRACT

This study aimed to describe the origin and distribution of brachial plexus in beetal goats collected from local slaughterhouses. Standard procedures were opted for preparing the forelimb of the beetal goat for this study. The goat limbs were preserved in the 10% formalin solution for one week before the study of the forelimb plexus. In most specimens subjected to the present study, the brachial plexus of a beetal goat was derived from the sixth, seventh and eighth (C6-C8) cervical and first, second (T1-T2) thoracic spinal nerve. The suprascapular and subscapular nerves showed differences in origin, course and distribution compared to other animals. The external thoracic nerve received the number of intercostal nerves and formation of loops by pectoral and musculocutaneous nerves, with the median nerve showing differences from other animals.This study intends to increase the current knowledge of the nervous system anatomy of beetal goats and provides important information for veterinarians dealing withsmall ruminant animal species.

Keywords: Beetal, Brachial plexus, Goat, Innervation, Nerves

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Small ruminants, especially goats, can be a good choice of animal models for biomedical research, such as orthopedic and cardiac studies, due to their similarity to humans in most body structures, low maintenance expenses, and ethical acceptability (Kamali, 2024). The brachial plexus of animals is an ongoing topic of research interest among the scientific community. The brachial plexus is formed by anastomosis of the ventral primary branches of the last three cervical (C6, C7, C8) and first two thoracic (T1, T2) spinal nerves. The anatomical study of the brachial plexus of the goat is essential to provide preclinical knowledge about nervous disorders, either congenital, infectious,or due to brutal activities. A few investigators have studied brachial plexus in goats (Sultana *et al.*, 2011; Kamali, 2024). The present study aimed to elaborate on the morphological characteristics of the brachial plexus of Beetal goats and address knowledge gaps in the field of domestic small ruminants' neurology.

MATERIAL AND METHODS

From July 2023 to June 2024, four adult beetal goats' forelimbs, irrespective of sex, were collected from the slaughterhouses near Rampura Phul, Bathinda, and were utilized in this study.The beetal goat forelimbs were preserved by injecting a 10% buffered formalin solution through the axillary artery. These specimens were kept in a 10% formalin tank for one week before examining the forelimbs for their innervations. Major branches of the brachial plexus in the beetal goat have been shown in Fig. 1. The dissections were photographed with iPhone 14 Pro and labeled accordingly with Adobe Photoshop and Microsoft Office Publisher. Anatomical nomenclatures follow Nomina Anatomica Veterinaria (N.A.V., 2017). The prepared specimens of the beetal goat brachial plexus were preserved in the 10% formalin and used for undergraduate teaching.

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RESULTS AND DISCUSSION

The need for gross anatomical specimens remains unchanged in the era of artificial intelligence in veterinary anatomy (Choudhary *et al.*, 2023; 2024). The brachial plexus branches of the beetal goat were demonstrated in Fig. 1. The ventral branches of nerves originating from the brachial plexus primarily innervate the shoulder muscles. The brachial plexus in goatswas formed by the anastomoses of the ventral branches of the last three cervical and first two thoracic spinal nerves (C6, C7, C8, T1, T2). The following nerves were found in each of the animals under study: radial (n. radialis), median (n. medianus), ulnar (n. ulnaris), musculocutaneous (n. musculocutaneus), axillary (n. axillaris), thoracodorsal (n. thoracodorsalis), suprascapular (n. suprascapularis), subscapular (nn. subscapulares), long thoracic (n. thoracicus longus), lateral thoracic (n. thoracicuslateralis), cranial pectoral (nn. pectoralescraniales), caudal pectoral (n. pectoralescaudales), and brachiocephalic nerve (n. brachiocephalicus) as shown in Table 1 and Fig. 1. Of the abovementioned nerves, the radial nerve was the largest in the brachial plexus and innervated most muscles of the forelimb.

The suprascapular nerve was enclosed in a common fibrous sheath with the subscapular nerve and originated from the craniodorsal division of eight cervical (C8) and first thoracic (T1); however, Sultana *et al.* (2011) reported

a few cases of suprascapular nerve origin from the C7 and T1 in black Bengal goat. In another study, no root from the last cervical was observed in the formation of the suprascapular nerve in sheep (Sisson *et al.*, 1975). The suprascapular nerve was divided into three branches supplying the M. supraspinatus and M. infraspinatus. The distribution of this nerve was similar to the observation of Atoji *et al.* (1987) in Japanese Serow (wild ruminant) and Sisson *et al.* (1975) in ox and Sultana *et al.* (2011) in black Bengal goat.

The subscapular nerves (*N. subscapularis*) were derived from the ventral branches of the C8 and T1. However, C7 fibers occasionally contributed to the formation of subscapular nerves in black Bengal goats (Sultana *et al.*, 2011). The origin of this nerve in Beetal goatspartially differed from the observation of Sisson *et al.* (1975) in ox. This nerve was narrower and smaller and divided into two branches. The cranial branch was again divided into two, and the caudal branch was divided into four. It ran with the thoracodorsal nerve and was ramified in the *M. subscapularis*.

The pectoral nerve was derived from the ventral branches of T1 and T2 and sometimes fibers from C8 spinal nerves in Beetal goat. In contrast, Atoji *et al.* (1987) in Japanese Serow reported that it originated from C8-T1 and received a thin fiber from the cranial division of C6-C7. This nerve formed a loop by the first thoracic root with the axillary artery. After that, it divided into 4 to 5 fine branches on the surface of the pectoral muscles and ended by supplying them. The distribution of this nerve agrees with that reported by Atoji *et al.* (1987) in Japanese Serow and McLeod *et al.* (1964) in ox. Theventral branches of C6 and C7 form the musculocutaneous nerve and form loops with the median nerve. This finding agreed with the observation of Sisson *et al.* (1975) in horse and dog but in ox, goat and sheep, the origin of the musculocutaneous nerve came from the ventral branches of C6, C7 and C8. The first loop was formed when it crossed the lateral face of the axillary artery andjoined with the median nerve. The second was formed ata short distance from the first loop and supplied fibers tothe pectoral and *M. brachialis* muscle. The findings agree with the observation of McLeod *et al.* (1964) in ox.

The median nerve (*N. medianus*) wasderived from theventral branches of C8 and T1, however, T2 also contributed to the formation of this nerve in black Bengal goat (Sultana *et al.*, 2011) and goat (Kamali, 2024). The median and ulnar nerves were enclosed in a common sheath. The median nerve ran laterally and descended alongside the axillary artery as soon as it crossed to the

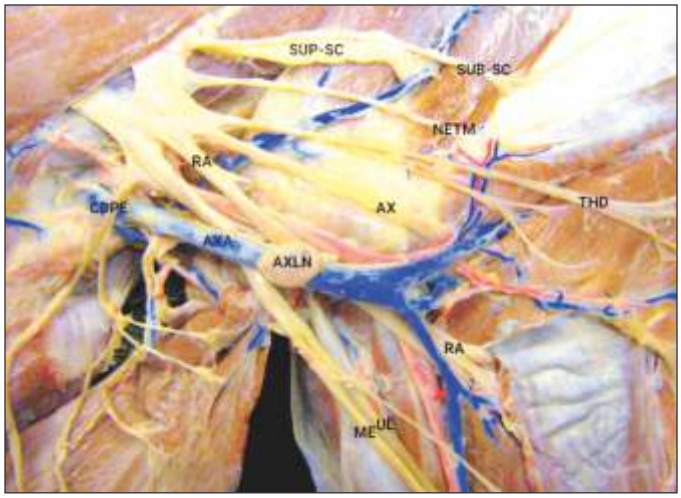

Fig. 1. Brachial plexus of beetal goat showing suprascapular (SUP-SC); subscapular nerve (SUB-SC); nerve to teres major (NETM); thoracodorsal nerve (TDN); axillary nerve (AX); axillary lymph node (AXLN); radial (RA), ulnar (UL) and median (ME); caudal pectoral (CDPE).

lateral side of the vessel in the axillary space. In the upper arm, it is passed down between the *M. biceps brachii* and *M. triceps brachii*, *M. brachialis*, anterior deep pectoral and skin by dividing into large and small branches.

The ulnar nerve (*N. ulnaris*) was derived from the C8 & T1 and gave off a craniomedial branch near the medial aspect of the shoulder joint, which, after dividing into three further branches, supplied *M. tensor* fascia antibrachii, fascia and skin of elbow. The radial nerve (*N. radialis*) was now the caudomedial aspect of the shoulder and proximal to the arm and gave off several branches to several branches to *M. triceps brachii* and tensor fasciae antibrachii.

The long thoracic nerve derived its fibers from the C8 and T1 components of the brachial plexus, which ran dorsoventrally between the M. Scaleniand united on the lateral surface of the M. Serratusthoracis and cervicis. This finding is supported by Atoji *et al.* (1987). The axillary nerve was found to derive from the ventral branches of the last cervical and first thoracic spinal nerves. These results partially disagreed with the report of Sisson *et al.* (1975) in horse, ox and dog where nofibers from first thoracic nerve joined to form this nerve. At its origin, it gave off a short branch to *M. subscapularis*, which again divided into three to four smaller branches. This nerve was found to have threebranches, which passed between *M. subscapularis* and *M. teres* major. The largest branch of it passed near the distal part of *M. subscapularis* and teres minor, turned upward behind the latter muscle over the medial surface of the *M. latissimus* dorsi and ramified in it by dividing into three branches. Some small fibers of this nerve supply superficial and deep pectoral muscles. This finding was

similar to the report in black Bengal goatgoatby Anam *et al.* (1984). The distribution of this nerve almost agreed with reports of Sisson *et al.* (1975) in ox, horse and McLeod *et al.* (1964) in ox.

The thoracodorsal nerve (*N. thoracodorsalis*) originated from the ventral branches of the C7 and T1 spinal nerve as reported earlier by Sisson *et al.* (1975) in ox. Sisson *et al.* (1975) reported the origin of this nerve from the seventh and eighth cervical in horse and pig. The nerve was divided into two branches at the distal part of *M. subscapularis*. The cranial branch was ramified by d being divided into f This result confirms the report of Anam *et al.* (1984) in the black Bengal goat.

The external thoracic nerve (*N. thoracis lateralis*), derived from the ventral branches of T1 & T2, passed downward and caudally, forming the loop with the radial and median nerves. It was divided into two main branches; one passed caudally over the ventral border of *M. serratus* ventralis. The other supplied *M. superficial* and deep pectoral dividing into many branches and sometimes it supplied *M. latissimus dorsi*. The former branch received intercostalnerve from second to fifth. The origin of the nerve agrees with Sisson *et al.* (1975) in horse and Anam *et al*. (1984) in theblack Bengal goat. However, the distributions of this nerve were almost similar to descriptions of Sisson *et al.* (1975) in horse, ox, goat, pig, dog and cat; Anam *et al.* (1984) in the black Bengal goat and McLeod *et al.* (1964) in ox.

CONCLUSION

This study was an overview of the formation and distribution of the brachial plexus and its derivative nerves in beetal goats. This information is essential for researchers conducting microanatomical comparative studies on the brachial plexus in different animal species. The results of our study may also be helpful for veterinarians dealing with small ruminants for surgery and treatment of nerve disorders. It will also be helpful for veterinary undergraduate and postgraduate students to understand the clear picture of the brachial plexus of Beetal goats.

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