OBSERVATIONS ON THE SPINAL NERVE ROOTS IN GOAT FOETUSES*

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ABSTRACT

The study on 52 goat foetuses revealed that each spinal nerve arose by dorsal and ventral roots, where the root emergence length was slightly greater in cervical, rostral thoracic and lumbar region of the cord in foetal goat. It decreased through sacral region. Ventral roots attached and originated over greater area than corresponding dorsal roots. The segments of enlargements had shorter lengths for root attachment and shorter interval between adjacent roots than other segments.

INTRODUCTION

A spinal cord segment consists of a portion of the spinal cord proper with all of its rootlets that join to form the associated pair of spinal nerves. Number of rootlets that forms a spinal nerve and the length of the cord segments vary from one level of the cord to the next. There is no clear demarcation between segments of the spinal cord except for the interval between root fibres of the adjacent nerves. Each spinal cord segment is numbered as per the attachment of the paired spinal nerves and the cord consists of as many segments, as there were pairs of spinal nerves. The distinct differences in the number of spinal cord segments between species reflected individual morphology and suited the functional requirements of the animal. Since the information about the attachment of spinal nerve rootletsin the caprine spinal cord is very scanty, this study was undertaken to elucidate the same during prenatal development in goat.

MATERIALAND METHODS

The study was conducted on 52 goat foetuses of different ages. Specimens were fixed by 10 per cent neutral buffered formalin. Root emergence length (REL) was measured as the extent of the dural surface occupied by the respective spinal nerve roots at the point of their emergence. Root attachment length (RAL) was the length of the cord to which the rootlets of each spinal nerve were attached, viz. distance from most rostral to the most caudal rootlet of both the dorsal and ventral roots of each spinal nerve. Inter root length (IRL) was the length of the cord surface devoid of rootlets, lying between the attachment of the roots of adjacent spinal nerves, viz. the distance between the most caudal and the most rostral rootlet of adjacent spinal nerves.

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RESULTS AND DISCUSSION

There were 36 pairs of spinal nerves in the foetuses under study: 8 cervical, 13 thoracic, 6 lumbar, 4 sacral and 5 coccygeal. According to Ghoshal (1975), the number of spinal nerves varied depending on the thoracic, lumbar and sacral vertebrae present in sheep and goat.

These spinal nerves had a common pattern of structure and were segmentally arranged. Each arose from the spinal cord by a dorsal root and a ventral root. The cervical nerve roots were shorter but nerve roots further became longer caudally. The dorsal roots had a small number of large coarse, rootlets whereas the ventral roots consisted of many small rootlets with less tensile strength. This was in accordance with findings of Thomas and Combs (1962) in cat.

Root Emergence Length (REL)

The emergence length of the dorsal and ventral roots of spinal nerves was measured in the last two months of gestation. The root emergence of the dorsal roots was always greater than that of the

ventral roots. So, the dorsal roots pierced the dura mater over a larger area compared to the ventral roots. Histological observations of Sanomiya (1927) indicated that there were more of glial tissues and a greater number of nerve fibres in the dorsal roots, which might account for this gross difference.

The root emergence length was slightly greater in cervical, rostral thoracic and lumbar regions of the cord. It decreased rapidly through the sacral region. The greatest root emergence length was measured dorsally at 8th cervical segment as 1.980 ± 0.020 mm at fourth and as 4.662 ± 0.078 mm fifth month of gestation. Ventrally, the greatest root emergence length was observed at first, second, third and eighth cervical segment as 1.050 ± 0.085 mm at fourth month and at third cervical segment as 3.554 ± 0.258 mm at fifth month of gestation.

In the thoracic region, dorsal root emergence length was greatest at first thoracic segment in fourth and fifth month. In lumbar region, the length was less variable at fourth month but in fifth month, fifth lumbar segment had the greatest length. In the sacral region, first sacral segment had the greatest length in both the age groups.

Ventrally, the same was true with first thoracic and first sacral segments, but it varied at the lumbar region. Greatest root emergence length was recorded at third cervical, first thoracic, fourth lumbar and first sacral segments in sheep (Rao, 1990). This observation is identical with those recorded in thoracic and sacral regions in the present study. Ventral root emergence length remained less variable in the thoracic region. This is in accordance with the findings of Sharma and Rao (1971) in buffaloes and Sharma et *al.* (1973) in goats.

Root Attachment Length (RAL)

In general, ventral roots originated over greater area when compared to corresponding dorsal roots. This is in accordance with the study by Thomas and Combs in cat and monkey (1962 and 1965 respectively) and Sharma and Rao (1971) in buffalo. Sharma *et al.* (1973) reported that this observation was true in goats in prelumbar segments. In the present study, the lumbar and sacral segments presented ventral root attachment length either greater than or equal to those at the dorsal aspect.

The maximum root attachment length was associated with the longest spinal cord segment, second cervical, dorsally in fourth and fifth month. It measured 2.444 ± 0.176 mm and 7.443 ± 1.060 mm respectively at fourth and fifth month. On ventral aspect it was at third cervical segment as 2.600 ± 0.191mm in fourth and second cervical segment as 7.571± 1.295 mm at fifth month of gestation. The root attachment length decreased after sixth lumbar segment towards the coccygeal region.

The minimum dorsal and ventral root attachment length were observed in the coccygeal region in both the age groups studied. In general, the ventral roots originated over greater area compared with corresponding dorsal roots.

A comparison between dorsal root attachment length and segment length at fifth month of gestation showed that both these parameters followed a similar pattern showing a relation between the two (Fig. 1). So there stands a relation between the root attachment length and segment length. Being greater in the longer ones and decreased in the shorter ones. So as stated by Sharma *et al.* (1973), the root attachment length contributes to the segment length.

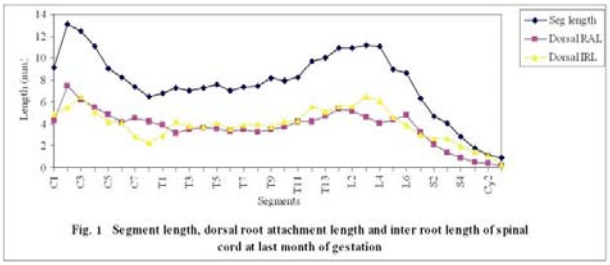

Fig. 1 Segment length, dorsal root attachment length and inter root length of spinal cord at last month of gestation

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The greatest root attachment length was recorded at third cervical segment in dogs (Fletcher and Kitchell, 1966), at second cervical segment through third cervical segment in buffalo (Sharma and Rao, 1971) and at third cervical segment in goats (Sharma *et al.*, 1973) and Sheep (Rao, 1990). In difference, Taluja *et al.* (1983) reported maximum RAL at seventh cervical segment in all age groups in goat foetuses. Taluja *et al.* (1999) also reported maximum RAL at fifth, seventh and eighth cervical segments in calves.

RAL increased from eleventh thoracic to first lumbar in fourth month and from eighth thoracic to first lumbar segments in fifth month of gestation in the present study. Sharma *et al.* (1973) reported that this second increment of RAL lay at eleventh thoracic to first lumbar dorsally in goats.

Inter Root Length (IRL)

The maximum IRL was noticed at second cervical segment in the fourth and fifth month as 4.500 ± 0.129 and 6.490 ± 0.643 mm respectively. A similar condition of maximum IRL was recorded at second cervical segment in goat foetuses (Taluja *et al.,* 1983), third cervical segment in sheep (Rao, 1990) and second cervical segment in calves (Taluja *et al.,* 1999; Parmar *et al.,* 2000).

Cervical enlargement region showed a decrease in inter root length in both fourth and fifth month (Fig. 1) rarely with, no measurable distance at eighth cervical segment. In the fifth month, lumbar enlargement region also showed a decrease in inter root length after sixth lumbar segment. Longest inter root length was at eleventh thoracic segment at fourth month and at twelfth thoracic segment in fifth month. Minimum inter root length was at first thoracic segment. Similar pattern occurred in camel (Gholami *et al.,* 1998).

The segments of cervical and lumbar enlargements had shorter length for root attachment and shorter interval between adjacent roots than the segments in other regions of cord in the present study. This is found true with the findings of Fletcher and Kitchell (1966) in dog.

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