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تشريح فلقات الحبل الشوكى فى الحمار

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بدراسة طول فلقات الحبل الشوكى فى الحمار وجد أن أطول الفلقات موجوده فى المنطقة العنقيه من الحبل الشوكى اما فلقات المنطقة الصدرية فأقل طول عن مثيلاتها فى المنطقة العنقيه . ويقل طول الفلقات تدريجيا من خلف آخر فلقة فطنيه حتى نهاية الحبل الشوكى . التضخم العنقى يمتد من الفلقة العقيه الخاسه الى الثامنة الصدرية ، اما التضخم القطنى فيمتد من الفلقة القطنية الثامنة الى الفلقة العجزية الأولى .

ANATOMY OF SPINAL CORD SEGMENTS OF DONKEY (EQUUS ASINUS)
(WITH 3 TABLES & TWO FIGURES)

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SUMMARY

The study of the length of the spinal cord segments revealed that the longest segments are found in the cervical region of the spinal cord, reaching its maximum at the third spinal cord segment.

The values of the segment length in the thoracic region are smaller than those of the cervical one, while in the lumbar region the segment length decreases in length from the last lumbar spinal cord segment caudad to the end of the spinal cord.

The cervical enlargement extends from C₅ through T₂, while the lumbar enlargement extends from L₂ through S₁. The transverse and dorsoventral diameters of the cervical and lumbar enlargement have the highest measurement along the whole spinal cord.

INTRODUCTION

A considerable literature has accumulated on the anatomy of the spinal cord: THIEL, (1941) on the dog; SISSON and GROSSMAN, (1953) on the horse; THOMAS & COMB, (1962) on the cat; SHARMA & RAO, (1971), on the buffaloe & SAMARMA, SINGH and DHINGER, (1973) on the goat. Although the donkey is an economically important animal in developing countries, nothing could be traced on the anatomy of the spinal cord.

MATERIAL AND METHODS

The spinal cord of 16 adult clinically healthy donkeys of both sexes and of different ages were exposed. The animals were bled and then injected with 10% formalin solution.

The method of THIEL (1941) on the dog for the measurement of the spinal cord segment length is adopted. He stated that the spinal cord segment length is the distance between the middle of two successive interroot spaces.

RESULTS AND DISCUSSION

A. LENGTH OF THE SPINAL CORD SEGMENTS

In the cervical region, the segment length increases gradually to reach its maximum at the third cervical spinal cord segment, from which the segment length decreases caudad to reach its lowest value at the first thoracic spinal cord segment. From the first to the fourth thoracic spinal cord segment the segment length increased slightly in gradual manner.

The values of lengths of the spinal cord segments from the fifth to the last thoracic spinal cord segments are approximately equal. From the last thoracic segment caudad the segment length decreases gradually.

The largest segment lengths are found in the cervical region, reaching its maximum at the third spinal cord segment. The segments from the second to the sixth cervical spinal cord segment are definitely the longest ones along the whole spinal cord and ranging from 3.39 to 7.78 cm.

In the cervical and thoracic regions the eighth cervical through the second thoracic spinal cord segments represent the shortest segments in the two regions ranging from 2.45 to 3 cm as from these segments the roots of the brachial plexus originate.

The values of the segment length in the thoracic region is smaller than those of the cervical one. On the other hand the shortest segment in the thoracic region is the first thoracic spinal cord segment (2.45 cm)

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while the longest one in the same region is represented by the last thoracic spinal cord segment (4.38 cm). This indicates that the segment length have a slight increase from the first till the last thoracic spinal cord segments.

In the lumbar region the segment length decreases from the first lumbar spinal cord segment caudal till the end of the cord.

The longest segments in donkey are those from the second to the sixth cervical spinal cord segments while in horse from the third to the sixth cervical spinal cord segments (SISSON and GROSSMAN, 1953) and in the midcervical segments of goat (SHARMA, ET AL. 1973). On the other hand the animals in which the longest spinal cord segments are located in the thoracolumbar region are these of the cat from the 11th thoracic through the first lumbar spinal cord segments, baboons from the seventh thoracic through the first lumbar spinal cord segments, rhesus from the sixth throacic through the second lumbar segments and in irus monkeys from the fifth thoracic through the second lumbar segments (THOMAS and COMBS, 1962, 1965).

Along the whole length of the spinal cord, the longest spinal cord segment is C₂ in buffaloe (SHARMA and RAO 1971), C₃ in donkey, and C₄ in dog (THIEL, 1941). On the other hand the length of the spinal cord segments begins to decrease at the level of L₁ in donkey, L₂ in baboon, L₃ in cat, rhesus (THOMAS and COMBS 1962, 1965) and goat (SHARMA ET AL. 1973).

In the region of origin of the brachial plexus, the segment length decreases from C₈ to T₂ in the present work. However in baboon it include C₈ to T₃ (THOMAS and COMBS, 1965).

B. THE TRANSVERSE AND DORSOVENTRAL
DIAMETERS OF THE SPINAL CORD SEGMENTS

The spinal cord varies considerably in diameter from one region to another. In the cervical region (Table 2, 3 & Fig. 2) the first cervical spinal cord segment has a large transverse and dorsoventral diamters as it is considered the continuation of the medulla oblongata. The transverse and dorsoventral diameters from C₂ to C₄ are nearly equal and are the narrowest segments in the cervical region (Transverse diameter : 1.21 cm, dorsoventral diameter : 0.83 cm).

The cervical enlargement begins at C₅ to reach its maximum at C₈ then decreases gradually to T₂, and extends in the vertebral canal from the middle of fourth cervical vertebra to the middle of second thoracic vertebra.

However, GOL.ER (1957) noticed that in sheep the smallest diameter in the Pars cervicalis is found at C₃ while the cervical enlargement include C₆ - T₁ and the largest transverse diameter of this enalrgemetn is at C₇ and C₈ which reaches about 1.3 cm.

The transverse diameter of the cervical enlargement ranges from (1.28 - 1.66 cm), while its dorsoventral diameter ranges from (0.88 - 1.1 cm). The segment C₈ is the largest segment of this enlargement and its transverse and dorsoventral diameters are 1.66 cm and 1.10 cm. respectively.

The result of this investigation is similar to that obtained by McCCLURE, (1964) as well as DELLMANN and McCCLURE (1975) in dog in which the cervical enlargement for the nerves of the brachial plexus include the segments from C₅ to T₂, however THIEL (1941) mentioned that in dog this enlargement extends from C₆ to T₁.

Other authors noticed that the cervical enlargement is found in the caudal part of the cervical region. JANKOVIC (1953) recorded that the cervical enlargement includes spinal cord segments C₆ - C₇ in pig DELLMANN and McCCLURE (1975) found that the enlargement is shifted on segment caudally (C₇ - C₈) in pig while in cat it is shifted one segment cranially. Therefore in this animal the enlargement includes onyl C₅ - C₇ as found by SCHURMANN (195..). In cattle SEIFERLE (1939) recorded that the cervical enlargement includes C₅ - C₁.

On the other hand, some authors did not describe the relation between the cervical enlargement and spinal cord segments, and mentioned only the relation of this enlargement to the vertebrae. DELLMANN and McCCLURE (1975) found that the cervical enlargement in pig is located in the vertebral canal of the sixth and seventh

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cervical vertebrae, while in horse this enlargement begins gradually at the fifth cervical vertebra and subsides at the second thoracic vertebra as stated by SISSON and GROSSMAN (1953). CROUCH (1959) noticed that the cervical enlargement in cat is bounded by the fourth cervical vertebra cranial and the first thoracic vertebra caudal. In the donkey, it extends from the middle of the fourth cervical vertebra to the middle of the second thoracic vertebra.

The maximum transverse diameter of the cervical enlargement in donkey is about 1.66cm and the dorsoventral diameter is about 1.10 cm. However in horse it is about 2.50 cm transversely and 1.20 cm dorsoventrally as reported by SISSON and GROSSMAN (1953). DELLMANN and McCURE (1975) mentioned that the diameter of the spinal cord in horse is greatest in the cervical and lumbar enlargements, being approximately 2 to 2.40 cm in adult horse. According to FLETCHER and KITCHELL (1966) the width of the spinal cord in dog is about 0.90 cm directly cephalic to the origin of the brachial plexus and increases to about 1.10 cm at the enlargement.

On the other hand the number of the spinal cord segments which enter in the formation of the cervical enlargement varies among domestic animals, being two segments in pig (JANKOVIC, 1953), three in cat (SHURMANN, 1951), four in dog (THIEL, 1941) and sheep (GOLLER, 1941) and sheep (GOLLER, 1957), five in cattle (SEIFERLE, 1939), and six in dog (McCURE, 1964, and DELLMANN and McCURE, 1975) and buffalo SHARMA and RAO (1971) as well as in the donkey.

The present work also shows that the thoracic spinal cord segments have a nearly equal transverse and dorsoventral diameters. They are narrower than those of the cervical and lumbar regions. This result is in agreement with that obtained in horse by SISSON and GROSSMAN (1953) in which the thoracic region of the spinal cord is fairly uniform in size. GOLLER (1957) found that the spinal cord in sheep has nearly the same transverse diameter (0.8 - 0.9 cm) from the second thoracic spinal cord segment till the fourth lumbar spinal cord segment.

The lumbar enlargement begins at L₂ and reaches its maximum at L₄ then decreases gradually to S₁, caudal to this the spinal cord tapers rapidly to form the Conus medullaris. This enlargement is located in the Canalis vertebralis from the second to the fourth lumbar vertebrae. The lumbar enlargement from L₂ to S₁ is shorter (12.40 cm) than the cervical enlargement from C₅ to T₁ (21.30 cm).

The transverse and dorsoventral diameters of both cervical and lumbar enlargements have the highest measurement along the whole spinal cord, but, the values in the cervical enlargement is higher than that of the lumbar one, and this is in agreement with that recorded by SISSON and GROSSMAN (1953) who stated that in horse the lumbar enlargement is narrower than the cervical one.

Although the lumbar enlargement is narrower than the cervical one, the former is clearer than the latter, because of the spinal cord segments that are located cranial and caudal to the lumbar enlargement are relatively narrower than the corresponding segments situated cranial and caudal to the cervical enlargement.

The lumbar enlargement is situated either in lumbar cord region or in lumbosacral portion. In the donkey, the lumbar enlargement extends from L₂ to S₁ i.e. in lumbosacral region as that described in sheep from L₄ to S₁ by McCURE (1964) or from L₅ to S₁ by FLETCHER and KITCHELL (1975). The last mentioned author added that in domestic animals the lumbar enlargement occurs in the last three lumbar and first two or three sacral spinal cord segments.

The lumbar enlargement was also reported to lie in the lumbar region of the spinal cord as stated by SEIFERLE (1939) in horse from L₂ to L₆ and in cattle from L₄ to L₆; THIEL (1941), in dog from L₅ to L₇; JANKOVIC (1954) in pig from L₄ to L₆ or from L₆ to L₇ as stated by DELLMANN and McCURE (1975).

The number of segments which enters in the formation of the lumbar enlargement vary among domestic animals. The above mentioned discussion shows that the number of segments in the lumbar enlargement were two or three segments in pig, three in cat, sheep as well as in cattle, and five segments in horse and donkey. In dog the number varies from three to six segments and this variation may be due to the species differences.

Some authors mentioned the relation of the lumbar enlargement to the vertebral column. It occupies the part of Canalis vertebralis from the third to the fifth lumbar vertebrae as in ox (RAGHVAN and KACHROO 1964) and buffalo (SHARMA and RAO 1971). However in horse the enlargement is located in the Canalis vertebralis of

fourth and fifth lumbar vertebrae (SISSON and GROSSMAN 1953) while the present work shows that in donkey the lumbar enlargement is situated in the Canalis vertebralis of second, third and fourth lumbar vertebrae. DELLMANN and McCLURE (1975) stated that in pig the lumbar enlargement is located within the sixth lumbar vertebra.

From the surgical point of view for anaesthesia, the surgeon must know the relation of the beginning and the end of the lumbar enlargement to the vertebral column. The lumbar enlargement begins more cranially at the second lumbar vertebra as in donkey, more caudally at the sixth lumbar vertebra as in pig (DELLMANN and McCLURE 1975) or in between at the third lumbar vertebra as in ox (RAGHVAN and KACHROO, 1964) and buffalo (SHARMA and RAO 1971) or the fourth lumbar vertebra as in horse (SISSON and GROSSMAN, 1953). The end of the lumbar enlargement is located one vertebra before the last lumbar in the above discussed animals.

The present work reveals that the average measurements of the spinal cord at the maximum diameters of the cervical enlargement are 1.66 cm in width and 1.10 cm dorsoventrally. At the smallest part of the thoracic region the corresponding data are 0.99 cm. in width and 0.73 cm. dorsoventrally. While the maximum diameters of the lumbar enlargement are 1.56 cm. in width and 1.08 cm. dorsoventrally.

The contour of the graphs of both transverse and dorsoventral diameters of the segments of the spinal cord are essentially similar with the largest value in transverse diameter than the dorsoventral one. This result is similar to that recorded by HOLLINSHEAD (1958) who stated that in man the spinal cord is wider laterally than its depth in the anteroposterior direction.

The graphs (Fig. 1 & 2) shows that as the segment length increase the transverse and dorsoventral diameters decrease and vice versa.

In the cervical enlargement, the length of the spinal cord segment decreases (the segment length from C₆ - T₁ ranges from 2.40 - 5.39) while the transverse diameter and dorsoventral diameter increase as it ranges from 1.28 - 1.66 cm. and 0.88 - 1.10 cm. respectively. The middle of the cervical region from C₂-C₄ has an equal short transverse and dorsoventral diameters while their length represents the highest ones of the cervical region.

Also the length of the spinal cord segment from L₄ - L₆ is short (ranges from 1.6 - 2.5 cm) but their transverse and dorsoventral diameters are large as that range from 1.45 - 1.65 cm. and 1.07 - 1.08 cm. respectively.

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LEGENDS

- Fig. 1: Segment lengths. This figure indicates length measurements, the upper and lower steplike lines denote the ranges of individual measurements while the intermediate line shows the average of the measurements; Spinal cord levels are represented on the horizontal line and lengths in centimetre are indicated on the vertical.
- Fig. 2: Transverse and dorsoventral diameters of the spinal cord segments. Spinal cord levels are represented on horizontal line and lengths are indicated on the vertical.

Table (1): Spinal cord segment length (in cm).

S.L. ¹	Mean	Range	S.L.	Mean	Range
C ₁	3.97	3.00-4.90	T ₁₄	3.88	3.00-5.00
C ₂	6.50	5.75-7.10	T ₁₅	3.79	3.38-4.15
C ₃	7.78	6.68-8.55	T ₁₆	3.81	3.63-4.30
C ₄	7.56	6.70-8.15	T ₁₇	4.14	3.50-4.55
C ₅	6.85	6.10-7.35	T ₁₈	4.38	3.90-5.00
C ₆	5.39	4.60-6.20			
C ₇	3.80	3.20-4.40	L ₁	4.05	3.63-4.70
C ₈	2.80	2.50-3.65	L ₂	3.00	3.40-4.00
			L ₃	3.13	2.10-3.50
T ₁	2.45	2.20-2.70	L ₄	2.50	1.90-3.20
T ₂	3.00	2.75-3.30	L ₅	1.89	1.20-2.50
T ₃	3.58	3.00-4.00			
T ₄	3.94	2.35-4.92	S ₁	1.20	1.10-1.30
T ₅	3.93	3.20-4.35	S ₂	1.00	0.90-1.20
T ₆	3.59	3.20-4.00	S ₃	0.90	0.75-1.00
T ₇	3.78	3.35-4.20	S ₄	0.80	0.70-0.55
T ₈	3.50	2.80-3.85	S ₅	0.70	0.50-0.85
T ₉	3.68	2.90-4.45			
T ₁₀	3.71	3.00-4.05	Ca ₁	0.55	0.50-0.60
T ₁₁	2.57	3.22-4.00	Ca ₂	0.50	0.50-0.65
T ₁₂	3.92	3.40-4.58	Ca ₃	0.35	0.30-0.50
T ₁₃	3.73	3.35-4.50	Ca ₄	0.30	0.25-0.40
			Ca ₅	0.30	0.25-0.40

¹ Spinal cord segment length.

Table (2): Transverse diameter of the spinal cord segments (in cm).

T.D. ²	Mean	Range	T.D.	Mean	Range
C ₁	1.36	1.20-1.70	T ₁₄	0.99	0.90-1.10
C ₂	1.21	1.00-1.40	T ₁₅	1.03	0.95-1.20
C ₃	1.21	1.10-1.40	T ₁₆	1.06	1.00-1.20
C ₄	1.21	1.10-1.45	T ₁₇	1.06	1.00-1.25
C ₅	1.28	1.10-1.35	T ₁₈	1.06	0.90-1.30
C ₆	1.40	1.30-1.65			
C ₇	1.59	1.40-1.95	L ₁	1.15	1.00-1.35
C ₈	1.66	1.45-2.00	L ₂	1.21	1.05-1.35
			L ₃	1.36	1.20-1.55
T ₁	1.57	1.50-1.80	L ₄	1.48	1.40-1.60
T ₂	1.37	1.20-1.40	L ₅	1.56	1.40-1.60
T ₃	1.23	1.00-1.40			
T ₄	1.16	1.05-1.30	S ₁	1.40	1.20-1.50
T ₅	1.12	1.00-1.20	S ₂	1.14	1.00-1.40
T ₆	1.09	1.00-1.20	S ₃	0.88	0.80-1.00
T ₇	1.06	1.00-1.20	S ₄	0.68	0.60-0.80
T ₈	1.04	1.00-1.20	S ₅	0.58	0.50-0.70
T ₉	1.03	0.95-1.20			
T ₁₀	1.00	0.90-1.10	Ca ₁	0.50	0.40-0.60
T ₁₁	1.00	0.90-1.10	Ca ₂	0.40	0.30-0.60
T ₁₂	0.99	0.90-1.10	Ca ₃	0.35	0.30-0.50
T ₁₃	0.99	0.90-1.10	Ca ₄	0.30	0.20-0.40
			Ca ₅	0.30	0.20-0.40

² Transverse diameter of the spinal cord segments

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Table (3): Dorsoventral diameter of the spinal cord segments (in cm).

D.V.D. ^m	Mean	Range	D.V.D	Mean	Range
C ₁	0.85	0.70-1.00	T ₁₄	0.75	0.70-0.80
C ₂	0.83	0.75-0.90	T ₁₅	0.75	0.70-0.80
C ₃	0.83	0.70-0.90	T ₁₆	0.76	0.70-0.85
C ₄	0.83	0.75-0.90	T ₁₇	0.77	0.70-0.85
C ₅	0.88	0.80-0.95	T ₁₈	0.77	0.70-0.80
C ₆	0.95	0.80-1.05			
C ₇	1.05	0.95-1.15	L ₁	0.80	0.75-0.85
C ₈	1.10	0.95-1.15	L ₂	0.87	0.80-1.00
			L ₃	0.96	0.90-1.10
T ₁	0.98	0.85-1.10	L ₄	1.08	0.95-1.20
T ₂	0.88	0.80-0.90	L ₅	1.08	1.00-1.15
T ₃	0.80	0.70-0.85			
T ₄	0.77	0.70-0.85	S ₁	1.02	0.90-1.10
T ₅	0.76	0.70-0.85	S ₂	0.90	0.80-1.00
T ₆	0.72	0.70-0.80	S ₃	0.73	0.65-0.85
T ₇	0.74	0.70-0.80	S ₄	0.65	0.55-0.70
T ₈	0.72	0.60-0.80	S ₅	0.57	0.50-0.65
T ₉	0.72	0.55-0.80			
T ₁₀	0.73	0.60-0.80	Ca ₁	0.40	0.30-0.60
T ₁₁	0.74	0.60-0.80	Ca ₂	0.40	0.30-0.50
T ₁₂	0.73	0.65-0.80	Ca ₃	0.35	0.30-0.45
T ₁₃	0.75	0.70-0.80	Ca ₄	0.30	0.25-0.40
			Ca ₅	0.30	0.25-0.38

^m Dorsoventral diameter of the spinal cord segments.

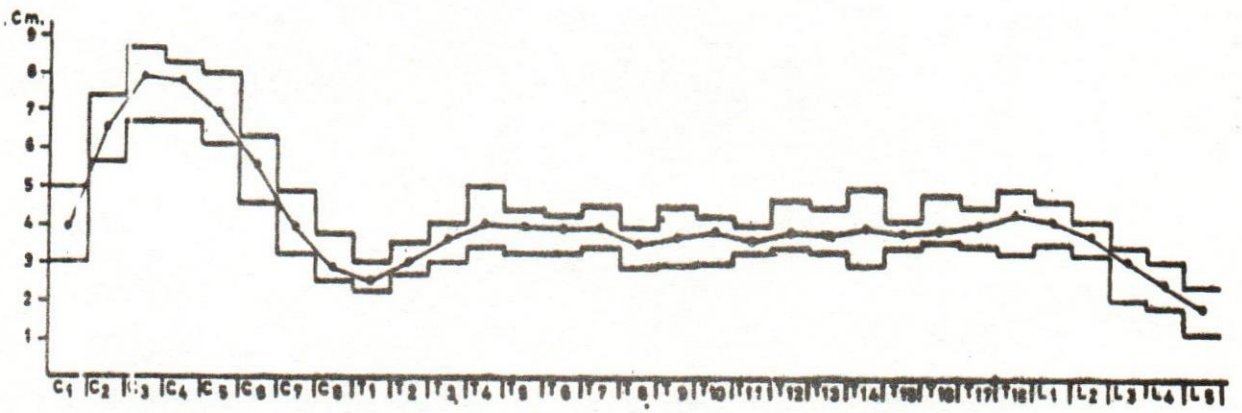


Fig. (1)

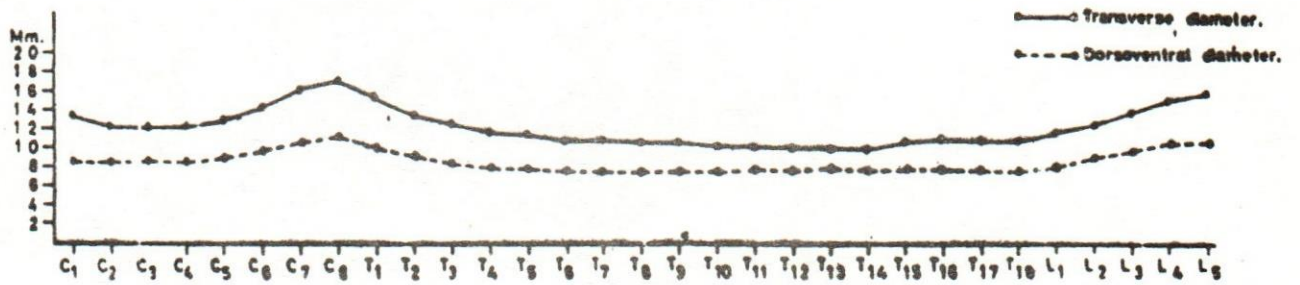


Fig. (2)