

## REGARDING THE LENGTH AND EXTENT OF THE HUMAN MEDULLA SPINALIS

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Most of our modern text-books on human anatomy state that the spinal medulla is variable in length and in extent within the vertebral canal and that there is no definite relation between the length of the spinal medulla on the one hand and the length of the vertebral column and the height of the individual on the other. It was with these well known facts in mind that the study of this series of 234 cases was undertaken.

The observations about to be reported were made on the cadaver in the dissecting room. The material had been prepared for dissecting purposes by the method described by Professor Streeter in volume 5 of *The Anatomical Record*. During the regular course in Gross Anatomy as given in this department the superficial and deep muscles of the back are identified and removed thereby exposing the entire length of the vertebral canal. The neural arches are then removed. The cut pedicles of the vertebrae and the posterior root ganglia of the spinal nerves are exposed. The dural and arachnoid membranes are opened by an incision along the mid dorsal line bringing into view the spinal medulla and the root filaments of the spinal nerves. The relation of the neural segments of the spinal medulla with the vertebrae is readily determined.

Because of the impossibility to determine with accuracy, macroscopically, the lowest point to which the nervous elements of the spinal medulla extend and the beginning of the filum terminale, the attachment of the lowest root filaments of the fourth sacral nerve was taken as the lowest point in all measurements. To avoid error the number of ribs and vertebrae were taken in all cases. The cadaver was placed in the prone position on a

TABLE I

Shows the length of the medulla spinalis and its level of termination in the vertebral canal; measurements given in centimeters

EXTENT OF SPINAL MEDULLA	MALE, WHITE						FEMALE, WHITE						NEGRO						
	Cord lengths			Height of subject			Cord lengths			Height of subject			Cord lengths			Height of subject			
	Per cent	No.	Ave.	Extremes	Extremes	Ave.	Per cent	No.	Ave.	Extremes	Extremes	Ave.	Per cent	No.	Ave.	Extremes	Extremes	Ave.	
Middle of 12 T. vert.....	1.0	2	41.7	39 to 44	160 to 180	170.0								1	10	42.0			160.0
Lower border of 12 T. vert.	6.5	13	43.5	40 to 46	164 to 178	168.9	2	8	39.25	38 to 40	150 to 162	156.0	4	40	41.1	38 to 45	156 to 181	166.4	
Upper border of 1 L. vert...	15.0	30	44.5	41.5 to 47	159 to 182	171.5	4	16	40.6	38 to 44	152 to 164	160.5	1	10	41.0			172.0	
Middle of 1 L. vert.....	29.1	58	44.0	37 to 49	151 to 186	169.3	5	20	40.5	39 to 41	156 to 170	162.2	1	10	49.25			177.5	
Lower border of 1 L. vert....	20.1	40	45.3	39 to 52	149 to 196	170.6	6	24	40.75	40 to 45	151 to 166	155.5	2	20	45.5			171.5	
Upper border of 2 L. vert.	13.5	27	45.1	41 to 49	156 to 187	169.2	3	12	44.1	43 to 45	158 to 162	160.5							
Middle of 2 L. vert.....	13.5	27	46.2	40 to 51	135 to 187	167.1	4	16	45.0	44 to 47	160 to 172	169.0							
Lower border of 2 L. vert...	1.0	2	48.5	47 to 51	168 to 172	170.0	1	4	45.3			150.0	1	10	47.5			167.0	
Total.....	99.7	199	44.79			169.6	25	100	41.8			159.4	10	43	4.4			168.4	

flat table top. The length of the spinal medulla here given represents the distance between the lower border of the foramen magnum and the lowest filaments of the fourth sacral nerve roots.

By consulting table 1 it will be seen that these observations have been classified according to sex and race. In about 77 per cent of the white male subjects the lowest point of the spinal medulla was found to extend between the level of the upper border of the first and the upper border of the second lumbar vertebrae. In two cases the spinal medulla extended only to the middle of the twelfth thoracic vertebra and in two others it terminated on a level with the lower border of the second lumbar vertebra.

There is a gradual average increase in the length of the spinal medulla with the increase in extent down the vertebral canal. However, spinal medullae of average length may terminate high in the canal, as in one of our series where a spinal medulla 44 cm. in length extended to the level of the middle of the body of the twelfth thoracic vertebra. Short spinal medullae may extend relatively low in the vertebral canal, as in a case where a spinal medulla 37 cm. in length extended to the level of the middle of the body of the first lumbar vertebra. As a rule the long spinal medullae extend relatively low in the vertebral canal. A spinal medulla 50 cm. in length terminated at the level of the lower border of the second lumbar, and one 52 cm. in length extended to the lower border of the first lumbar vertebra. It will be seen also that the length of the spinal medulla and the height of the individual bear no definite relation to one another.

Observations were made on a series of 25 females, in about 72 per cent of which the spinal medulla extended between the level of the upper border of the first and the upper border of the second lumbar vertebrae. As in the male series the short spinal medullae terminated as a rule at a higher level in the vertebral canal than the longer ones. In this group spinal medullae 38 cm. and 40 cm. extended to the level of the lower border of the first lumbar vertebra. As in the male series there was a gradual average increase in the length of the spinal medulla with its

extent down the vertebral canal and there also appeared to be no relation between the length of the spinal medulla and the height of the individual.

In the third group of 10 negro subjects the spinal medulla in 90 per cent did not extend below the level of the lower border of the first lumbar vertebra. As in the series of white subjects there is a gradual average increase in the extent of the spinal medulla down the vertebral canal with the increase in length of the former. A spinal medulla 42 cm. in length terminated at the level of the middle of the body of the twelfth thoracic vertebra, one 49 cm. in length reached to the level of the middle of the body of the twelfth thoracic vertebra, one 49 cm. long reached to the level of the middle of the first lumbar vertebra and a spinal medulla 47.5 cm. in length extended to the lower border of the second lumbar vertebra.

TABLE II.

*Shows the relative lengths of medulla spinalis and vertebral column*

NO. OF CASES	AVERAGE LENGTH OF VERTI- CAL COLUMN	AVERAGE LENGTH OF SPINAL CORD
	<i>cm.</i>	<i>cm.</i>
2	68	40.0
4	72	44.5
8	76	45.1
4	81	49.0

In 46 cases the length of the spinal column was also taken to determine if there was any definite ratio between the length of the spinal medulla and the vertebral axis. The length of the vertebral column was determined by taking the distance between the lower border of the foramen magnum, and the tip of the coccyx. By referring to table 2 it will be seen that the length of the spinal medulla is not in definite proportion to the length of the vertebral column in these cases, but that short vertebral columns were always associated with short spinal medullae and that long vertebral columns with long spinal medullae.

By comparing the results of this investigation with those of earlier reports it will be seen by consulting table 3 that the average length of the spinal medulla in the male (44.79 cm.) in our series

TABLE III  
*Gives comparisons between earlier observations and the authors cases*

OBSERVER	DATE	MALES						FEMALES					
		No. of cases	Av. height in cm.	Av. length of v. col. in cm.	Av. length of cord in cm.	Limits of variability of cord lengths	Limits of variability of cord lengths	No. of cases	Av. height in cm.	Av. length of v. col. in cm.	Av. length of cord in cm.	Limits of variability of cord lengths	Limits of variability of cord lengths
Pfitzner.....	1884	6			46.8			1			43		
Moorhead.....	1895	17	167.5	58.3	45	5 mm. above lower border 12 T. vert. to mid. 2 L. vert.	43.5 to 46.5	23	157.5	55.3	43.7	Mid 1 L. vert. to lower border 2 L.	39.5 to 47
Thompson.....	1895	115				Mid. 12 T. vert. to upper border 3 lumbar.		83				5 mm. below 12 T. vert. to 5 mm. below 2 L.	
Author.....		199	169.6		44.79	Mid. 12 T. vert. to lower border 2 L. vert.	37 to 52	25	159.4		41.8	Lower border 12 T. vert. to lower border 2 L.	38 to 47

<sup>1</sup> Moorhead's cases are included in Thompson's collective report.

is somewhat shorter than that given by Pfitzner and Moorhead; that the limits of variability of cord lengths is greater and that the limits of variability of cord levels in the vertebral canal are about the same as that of the earlier writers.

It will be seen, also that the average length of the spinal medulla in the female (41.8 cm.) is less than previously given and that the limits of variability of cord lengths and levels are nearly the same.

Finally, we conclude from the foregoing:

1. That there is no relation between the length of the spinal medulla and the height of the subject although tall individuals usually have a long spinal medulla and short individuals a short spinal medulla.

2. That there is no definite ratio between the lengths of the vertebral axis and the spinal medulla. However, short vertebral axes always enclosed short spinal medullae and long columns long spinal medullae.

3. The lowest point to which the spinal medulla was found to extend was to the level of the inferior border of the second lumbar. The highest level at which it was found to end was at the level of the middle of the body of the twelfth thoracic vertebra.

4. The average length of the spinal medulla for the male was 44.79 cm., for the female 41.8 cm. and for the negro 43.4 cm.

#### LITERATURE CITED

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