

MRI ASSESSMENT OF CONUS MEDULLARIS TERMINATION (CMT) IN NORTH KARNATAKA POPULATION

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ABSTRACT: BACKGROUND: Conus Medullaris terminates commonly in the lower third of L1 vertebra; but a wide range of values has been reported in cadaver studies as well as in Magnetic Resonance Imaging (MRI) studies. There have been only a few reports on the influence of gender and age on Conus Medullaris Termination (CMT). **AIM:** To study the correlation between the level of Conus Medullaris Termination with age and gender in North Karnataka population. **MATERIALS AND METHODOLOGY:** A descriptive case control study was done in H.S.K. Hospital, Karnataka. Total 180 patients who underwent MRI scanning for various indications and who had normal MRI were studied for level of Conus Medullaris Termination. **RESULTS:** Most common level of Conus Medullaris Termination (CMT) overall was 4mm to 6mm above lower border of L1 vertebra; in males 4mm above lower border of L1 vertebra and in females 5mm to 6mm above lower border of L1 vertebra. There is a high positive correlation between the level Conus Medullaris Termination and age in males ($r=0.878$), in females ($r=0.879$) and also in male and female patients combined ($r=0.859$). **CONCLUSION:** With aging, level of Conus Medullaris Termination goes upwards. There is a high positive correlation between the level Conus Medullaris Termination and age in males ($r=0.878$), in females ($r=0.879$) and also in male and female patients combined ($r=0.859$).

KEYWORDS: Conus medullaris termination, magnetic resonance imaging (MRI), spinal cord, spinal anaesthesia.

INTRODUCTION: Conus medullaris is a tapering lower part of the spinal cord usually located between the 12th thoracic (T12) vertebra and the 3rd lumbar (L3) vertebra. Tuffier's line is another clinical landmark defined as a horizontal line connecting the superior aspect of the posterior iliac crests, used as a reference to localize 4th lumbar (L4) vertebra body before performing a lumbar puncture.¹ The level of termination of conus medullaris has been always remained as an area of interest. It is necessary to know the level of termination of medullaris in order to diagnose a low lying tethered cord in children² and also important in spinal anaesthesia. It is crucial to point out that in lieu of many publications of conus termination that one accepts that there is no one single normal position of the terminal cord but rather a normal range.^{3,4}

It is also known that the conus ascends from its early fetal location in the sacral canal to the eventual adult position.⁵ After the spinal cord tapers out, the spinal nerves continue to branch out diagonally, forming the cauda equina. It is widely accepted that the conus medullaris terminates in the lower third of L1 vertebra^{6,7} however; a wide range of values has been reported in cadaver studies as well as in MRI studies during life. There have been only a few reports on

ORIGINAL ARTICLE

the influence of gender on the Conus Medullaris Termination, and the influence of age has been studied scarcely.

There are several reports of damage to conus medullaris by lumbar puncture needle during lumbar anesthesia particularly in women. The correct position of these anatomic landmarks should be understood to execute these procedures safely and to minimize iatrogenic trauma. Recently, with the rapid development of MRI technology, the observation and measurement of conus medullaris position has become more accessible, accurate, and reliable. So the present study was undertaken with an aim to study the correlation between level of Conus Medullaris Termination with age and gender in living adult population in northern Karnataka.

MATERIALS AND METHODS: The present case control study was conducted in the department of radiology in S N Medical College and HSK Hospital and Research centre, Bagalkot, India during January 2010 to December 2011 (2years). The Study participants those who underwent MRI for various indications like backache, radiculopathy and trauma were included in our study. The patients whose MR images were reported as normal by the radiologist were included in the study. Whenever the anatomy was distorted as a result of pathologic changes, the MRI examination was excluded from the study. Patients with acquired diseases (e.g. tumour, infection, and ischemia) or spinal dysraphism (e.g. tethered cord, myelomeningocele, lipoma, diastematomyelia) were excluded from the study. A total of 180 magnetic resonance images (MRI) were reviewed on Philips achieva 1.5 T MRI computer system.

Among 180 MR images 78 were of male patients and 102 were of females. All images showed images of the spine from level Th10 to S5. The level of conus medullaris terminus was defined by the junction between the conus medullaris and the cauda equina. For calculation purpose a horizontal line was drawn through lower border of L1 vertebra and level of conus medullaris was measured in millimeter from it. If it was proximal to line, it was measured as plus and if it was distal to line, it was measured in minus. The mean, median, mode and range, as well as standard deviation and 95% confidence interval, were then from these numerical values.

RESULTS: Most of patients had MRI scanning of spine for Backache (61.22%), Radiculopathy (26.66%) & Trauma (14.44%). Among males Radiculopathy (64.86%) and backache (33.33%) were most common indications where as in females backache (74.51%) and trauma (25.49%) were most common indications for MRI spine (Table 1).

The precise termination of conus was determined in 180 patients who had MRI scanning of spine. There were 78 (38.78%) males and 102(61.22%) females in the study group, with an age range of 12 to 86 years. Overall mean age with standard deviation was 54±16years. Mean age with standard deviation in males and females was 51.74±15.75 years and 56.34±15.64 years respectively (Table2).

Table 3 provides conus positions these data represented graphically in figure 1. In our study most common level of Conus Medullaris Termination (CMT) overall was 4 to 6 mm above lower border of L1 vertebra. The mean conus termination position was at 4.66mm above the lower border of L1 vertebra. (Figure 1) The termination of conus medullaris in males was 4 mm above lower border of L1 vertebra and in females 5 to 6 mm above lower border of L1 vertebra.

ORIGINAL ARTICLE

The range span extended from 5 mm below the lower border of L1 vertebra to 14 mm above the lower border of L1 vertebra. Mean level of Conus Medullaris Termination was at 3.83mm in males and at 5.29mm in females. (Figure 2 and 3).

DISCUSSION: It is important to appreciate the possible range of positions of the conus medullaris for several reasons. According the practical point of view, it is important to be aware of location of conus termination when performing either diagnostic or therapeutic lumbar puncture. The findings in our study suggested that level of termination of Conus Medullaris (CMT) varies with age. As age increases the level of CMT goes upwards. Most common level was 4 to 6 mm above lower border of L1 vertebra. There is a strong positive correlation when analysis is done in both sexes combined ($r=0.859$). This can be explained with embryology of neural axis. In fetal life spinal cord lies upto sacral segments of vertebrae; however due to differential growth of neural axis and vertebral column, cord ascends relatively to higher vertebral level. At birth, CM lies at L4-5 disc and later ascends to lower border of L1. In old age there is age related atrophy of brain and spinal cord; this fact may be attributed to relative higher position of cord in older individuals. Whereas in a study Kim and collaborators showed a negative correlation between old age and the position of conus medullaris however, they did not report any sexual dimorphism in old ages.⁸

In the present study level of termination of Conus Medullaris (CMT) in males, varies with age. As age increases level of CMT goes upwards. Most common CMT level in males was 4 mm above lower border of L1 vertebra. There is a strong positive correlation ($r=0.878$) which depicts that level of termination of conus medullaris shifts upwards with the increasing age.

Also the level of Conus Medullaris Termination (CMT) in females varies with age. As age increases, the level of CMT moves upwards. Most common level of termination in females was 5 to 6mm above lower border of L1 vertebra. There is a strong positive correlation ($R=0.879$) seen among age and level of conus medullaris termination. In present study Conus termination was slightly lower down in females as compared to males which is in accordance with the study done by Windisch G et al.⁹

Our results are consistent with the study done Thomson¹⁰ in which showed that the position of the conus medullaris is from the lower border of T12 and the upper border of L3. Consistently, Saifuddin et al³ showed that the tip of the conus medullaris is between middle segment of T12 and upper segment of L3 with a median position at the lower segment of L1. The variation in conus positions followed a normal distribution. Another study by Soleiman J et al¹¹ showed that mean Conus Medullaris termination (CMT) level was at the level of the middle third of L1. The range span extended from the lower third of T11 to the upper third of L3. Also the CMT displayed a small but significant positive correlation with age. A Study by Kesler H et al¹² in Pennsylvania, USA on termination of the normal conus medullaris in children showed that the CM terminates most commonly at the L1-2 disc space. Some of earlier studies shown a small subset of patients with CM extending more caudally.^{13,14}

In our study we used patients with low back pain, trauma and radiculopathy as our study population. Further studies can be studied in healthy individuals in another trial to determine conus medullaris position.

ORIGINAL ARTICLE

CONCLUSION: The present study concludes that with aging, level of Conus Medullaris Termination shifts upwards. Anatomical landmarks vary according to age and gender, with a lower end of conus medullaris in women, so clinicians should use more caution on the identification of the appropriate site for lumbar puncture.

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ORIGINAL ARTICLE

Indication	Males		Females		Total	
	NO	%	NO	%	NO	%
Backache	26	33.33	76	74.51	102	61.22
Radiculopathy	48	64.86	0	0	48	26.66
Trauma	0	0	26	25.49	26	14.44
Trivial Trauma	4	5.13	0	0	4	2.22
Total	78	100.00	102	100.00	180	100.00

Table 1: Distribution of study subjects according to indication for MRI scanning

Age In Years	Males		Females		Total	
	NO	%	NO	%	NO	%
10-19	4	5.13	0	0	4	2.22
20-29	0	0	4	3.92	4	2.22
30-39	15	19.23	18	17.65	33	18.33
40-49	14	17.95	16	15.69	30	16.66
50-59	23	29.49	19	18.63	42	23.33
60-69	14	17.95	25	24.51	39	21.66
70-79	8	10.26	17	16.66	25	13.88
80-89	0	0	3	2.94	3	1.66
Total	78	100.00	102	100.00	180	100.00

Table 2: Distribution of study subjects according to Age group and gender

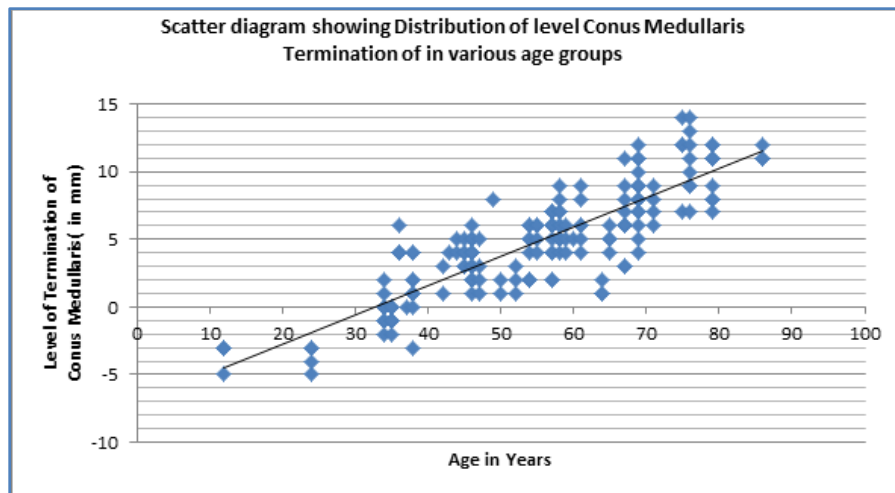
Level in millimeters	Males (Number)	Females (Number)	Total (Number)
14	1	1	2
13	0	1	1
12	1	6	7
11	2	7	9
10	1	1	2
9	5	5	10
8	3	6	10
7	5	7	12
6	8	14	22
5	5	14	19
4	11	11	22
3	5	5	10
2	9	6	15
1	4	7	11
0	5	3	8
-1	6	3	9
-2	1	1	2

ORIGINAL ARTICLE

-3	4	2	6
-4	0	1	1
-5	1	1	2
Total	78	102	180

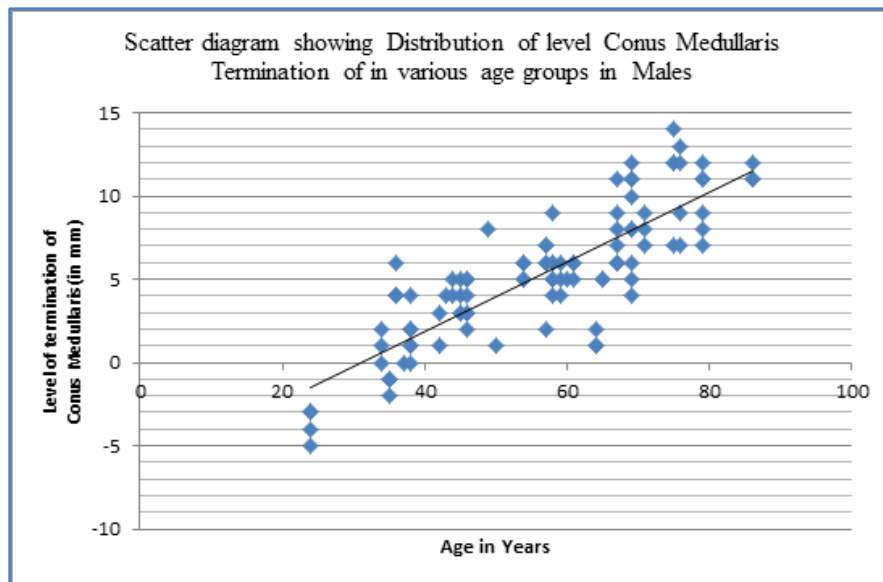
Table 3: Distribution of study subjects according to Level of termination of Conus Medullaris

Scatter diagram 1 showing distribution of level of conus medullaris termination in study population.



$$(y = 0.216x - 7.0763; R^2 = 0.739; r=0.859)$$

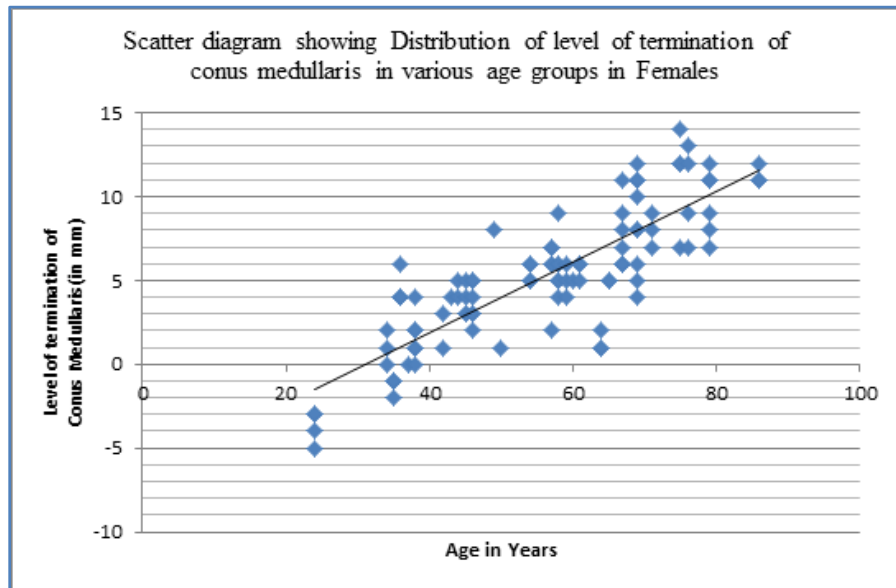
Scatter diagram 2 showing distribution of level of conus medullaris termination in males.



$$(y = 0.2168x - 7.4029; R^2 = 0.7706; r=0.878)$$

ORIGINAL ARTICLE

Scatter diagram 3 showing distribution of level of conus medullaris termination in females.



$$(y = 0.2103x - 6.5522; R^2 = 0.7008; r=0.879)$$

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