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Magnetic Resonance Imaging (MRI): Choice of Modality in Assessing Terminal End of the Spinal Cord "Conus Medullaris"

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ABSTRACT

Introduction: The lowermost tapering end of the spinal cord is called Conus Medullaris (CM). It is important to recognize the level of CM termination, especially during diagnostic procedures like lumbar puncture, or to rule out the cause of any lower back pain. Magnetic Resonance Imaging (MRI) gives near-accurate information on the structures. The main objective of this study was to determine the level of termination of the spinal cord and correlate it with the patient's age and gender.

Methods: A retrospective study was conducted in the Radiology and Imaging Department at Gandaki Medical College, Pokhara, Nepal, from June 1 to September 30, 2023. MRI sagittal T1 and T2 weighted spin echo sequences of the lumbar spine from 91 adults (18–80 years) were analyzed to determine the spinal cord termination location.

Results: The position of conus medullaris varied between the T12 vertebral body and the L3 vertebral body. The average position was found to be the L1 vertebra, 7.13 ± 1.985 in females and 7.02 ±1.621 in males, Frequency and median were at 7, which corresponds to the L1 vertebral body. Likewise, the mean level of CM was at 6.94 ± 1.697 in 18-28 years, 6.76 ± 1.662 in 29-39 years, 7.13±1.746 in 40-50 years, 7.63 ± 2.419 in 51-61years, 7.18 ± 1.601 in 62-72 years and 8 ± 0 in 73-83 years.

Conclusions: The conus medullaris was observed to terminate between the T12 and L3 vertebral bodies. No statistically significant correlation was found between the vertebral level of the conus medullaris and age.

Keywords: *Infant; Spinal Cord; Spinal Puncture; Vertebral Body*

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INTRODUCTION

The spinal cord is a sensitive and important structure in the human body that begins from the area of the medulla oblongata and ends in the lower back in a tapering form called conus medullaris (CM). It is necessary to know the level of termination of Conus Medullaris during radiological procedures such as lumbar puncture to avoid unforeseen injury to CM and the nerve roots leading to complications like cauda equine syndrome, intramedullary hematoma, etc. The chances of spinal cord injury are high when the CM termination level is not well identified. MRI is one of the most advanced imaging modalities in medical science. It is both non-invasive and non-ionizing hence is regarded as one of the safest imaging modalities. The level of CM can be accurately identified in the majority of the midline, sagittal T1/T2 weighted MRI studies. Nevertheless, there is very little data published from our settings and environment. This reflects a clear gap of knowledge about the termination point of conus medullaris in the Nepalese people who have different body habitus.[1,2,3]

Filling this gap of knowledge by finding the termination point of CM among Nepalese through the termination point of conus medullaris in the Nepalese people who have different body habitus. This study aims to find the level of termination of conus medullaris among Nepalese people through MRI scanning of the lumbar spine. The outcome of this study when published will be helpful for the diagnostic aspect as well as in treatment procedures in the institution of the study and will be a reference for the treating clinicians.

METHODS

This retrospective study was conducted in the Department of Radiology and Imaging Gandaki Medical College, Pokhara, Nepal. MRI images from the period June 1st, 2023 to September 30th, 2023 were accessed from the database of the Radiology department after obtaining ethical clearance from the Institutional Review Committee of Gandaki Medical College (Reference Number:14/080/081-F). All the studies were performed on a 1.5 Tesla magnetic field strength Seimens Magnetom Essenza MR imaging system.

A purposive sampling technique (Total Enumeration Technique) was carried out, since there are very few studies with the defined prevalence of termination of CM among Nepalese people, we referred to other previous papers conducted in other Asian countries and they had sample sizes of less than 100.[4,7]

The study population comprised 91 individuals, 44 males and 47 females with a mean age of 41.91 years. MRI of all patients referred to the department of radio-diagnosis and imaging for Lumbar spine MRI were reviewed for the study, as well as whole spine screening comes under the routine departmental protocol for evaluation of the spine levels.

Images of patients with no sign of trauma, congenital anomaly, tumor, or other form of gross anatomical variation were selected for the study. Image of patients with a history of past spine surgery, kyphoscoliotic spine, spinal collapse or fracture, congenital spinal anomalies, Pott's spine, spinal cord pathology like tumors, syringomyelia, and myelomeningocele, Non-Nepalese patients, uncooperative patients, significant noise and distorted images of cases were excluded.

The tip point of the Conus Medullaris was considered the most distal point of the spinal cord that could be visualized in the sagittal T1/ T2 image (Figure 1). All scans were obtained while the patient lying in the supine position. The termination of the conus medullaris was identified on the sagittal plane and a line perpendicular to the long axis of the cord was drawn to identify its relation to the vertebrae level. This level was recorded as upper (U), mid (M), and lower third (L) of the vertebra or the intervertebral disc as per Saifuddin et al.[5]

All the cases were evaluated by a single radiologist to avoid observational bias. Statistical analysis was performed using the Statistical Package for Social Science (SPSS) version 24.0 for Windows, $p \leq 0.05$ was considered statistically significant.

Figure 1: *Sagittal T2 weighted MRI image taken from SIEMENS MAGNETOM ESSENZA 1.5 Tesla with an arrow pointing at the level of CM*

RESULTS

This study population comprised of 91 Patients 44 males (48.4%) and 47 (51.6%) females which was divided into different age groups. Among those 18 (19.8%) were of age group 18-28 years, 29 (31.9%) were of age group 29-39 years, 16 (17.6%) were of age group 40-50 years, 16 (17.6%) were of age group 51-61 years, 11 (12.1%) were of age group 62-72 years and 1 (1.1%) were of age group 73-83. The mean age of the population was 41.91 years.

The mean age of females was 41.98 ± 15.009 years and that of males was 41.84 ± 15.156 years. The vertebral bodies and intervening disc levels were assigned with sequential numbers starting at the upper third of T12 as 1 up to the upper third of L3 as 13. Analysis done for female data demonstrated following values of ending CM; 2.1% at the level of lower third of T12, 2.1% at the level of T12-L1 disc space, 14.9% at the upper third of L1, 17% at the middle third of L1, 36.2% at the lower third of L1, 6.4% at the L1-L2 disc space, 8.5% at the upper third of L2, 4.3% at the middle third of L2, 6.4% at the lower third of L2, 2.1% at the upper third of L3. Likewise, for males, 4.5% at the level of T12-L1 disc space, 11.4% at the upper third of L1, 20.5% at the middle third of L1, 36.4% at the lower third of L1, 6.8% at the L1-L2 disc space, 11.4% at the upper third of L2, 6.8% at the middle third of L2, 2.3% at the lower third of L2. The position of CM varied between a lower third of the T12 vertebral body and an upper third of the L3 vertebral body. Most of them end at the lower third of the L1 vertebrae (Table 1). The mean position hence derived was 7.04 in total, 7.13 ± 1.985 in females and 7.02±1.621 in males, mode and median were at 7 which corresponds to the lower third of the L1 vertebral body (Table 2)

In both males and females, the mean CM levels were found to be in the same segment. This gender difference was though not statistically significant for males and females as p=0.784 (Table 3). Likewise, among different age groups, the mean level of CM is also demonstrated (Table 4). However, the difference in the vertebral level of CM among different ages was not statistically significant as p=0.278, Likewise, the value of correlation coefficient r=0.115, showed a negligible correlation between the Vertebral level of CM and age (Table 5).

Table 1: Table showing ending vertebral level of CM among Males and Females of the study group

Vertebral Level of CM	Male %	Female %	Frequency	Percentage
T12-LOWER	-	2.1%	1	1.1
T12-L1	4.5%	2.1%	3	3.3
L1-UPPER	11.4%	14.9%	12	13.2
L1-MIDDLE	20.5%	17%	17	18.7
L1-LOWER	36.4%	36.2%	33	36.3
L1-L2	6.8%	6.4%	6	6.6

Vertebral Level of CM	Male %	Female %	Frequency	Percentage
L2-UPPER	11.4%	8.5%	9	9.9
L2-MIDDLE	6.7%	4.3%	5	5.5
L2-LOWER	2.3%	6.4%	4	4.4
L3-UPPER	-	2.1%	1	1.1
Total	100	100	91	100.0

Table 2: Table showing Mean, Standard Deviation, and Median of CM level between male and female

Gender	Mean	S.D	Median
Male	7.02	1.621	7
Female	7.13	1.985	7

Table 3: Table showing correlation and P value of Vertebral level of Conus Medullaris andGender

		Vertebral level of Conus Medullaris	Gender of Participant
Vertebral level of Conus Medullaris	Pearson Correlation	1	.029
	Sig. (2-tailed)		.784
	N	91	91
Gender of participant	Pearson Correlation	.029	1
	Sig. (2-tailed)	.784	
	N	91	91

Table 4: Table showing mean and standard deviation of CM level among different age groups

Age group	N	Mean CM level	S D
18-28	18	6.94	1.697
29-39	29	6.76	1.662
40-50	16	7.13	1.746
51-61	16	7.63	2.419
62-72	11	7.18	1.601
73-83	1	8.00	.
Total	91	7.08	1.809

Table 5: Table showing correlation and P value of Vertebral level of Conus Medullaris andAge

		Vertebral levelof CM	Age of theparticipant
Vertebral level of CM	Pearson Correlation	1	0.115
	Sig. (2-tailed)		0.278
	N	91	91
Age of the participant	Pearson Correlation	0.115	1
	Sig. (2-tailed)	0.278	
	N	91	91

DISCUSSION

The main aim of our study was to provide a base for a range of termination of the spinal cord (CM) in the normal population and to correlate the level of termination of the spinal cord with age and gender.

In our study we found that the position of CM varied between a lower third of T12 and the upper third of the L3 vertebral body which was almost similar to the findings of Preeti et al., Saifuddin et al. and Kwon S et al. where it varied between middle third of T12 to the upper third of L3 vertebra.[4,5,6]

Our study revealed the mean CM level to be at the lower third of the L1 vertebra, which is supported by the results of Preeti et al. and Saifuddin et al. but varied from the studies carried out by Kwon et al. and Sharma et al. as their result showed the mean level of conus medullaris to be at the middle third of L1 vertebra.[4,5,6,7]

There was negligible correlation between the vertebral level of CM and gender in our study which was similar to the studies carried out by Sharma et al., Sevinc et al., Rahmani et al., Preeti et al., and Saifuddin et al. whereas, the study of Demiryürek et al. found there was a significant statistical difference in Conus Medullaris levels between male and female study groups.[4,5,7,8,9,10]

Our study showed a negligible correlation between age and CM position in women and males, there was no significant correlation of conus position with age when the same variables were compared. However, in the study done by Karabulut O et al. there was a positive correlation between age and CM position in women and the difference was significant (p=0.036).[11]

The information on the level of CM termination differs between anatomy and neurology textbooks and the literature. The normal anatomical variation may be the reason for variations in results in the literature. Moreover, this is the first few articles done for the Nepalese population. However, a multicentric study with a larger sample size will verify it further.[12,13]

CONCLUSION

The level of Conus Medullaris in this study was found to range from the lower third of the T12 vertebral body to the L3 upper third vertebral body. The mean level of the CM was found to be at the lower third of the L1 vertebra. There was no statistically significant correlation between the vertebral level of CM and gender. Similarly, there was no statistically significant correlation between the vertebral level of CM with age. A large sample size study is recommended to suggest the exact variations and level of conus medullaris in the Nepalese population. This study will help provide the range of spinal cord termination that will be useful during procedures like lumbar puncture and spinal anesthesia.

CONFLICT OF INTEREST

None

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None

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