Localizing tip of conus medullaris in hospital visiting adults using MRI

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ABSTRACT

Introduction: Generally, the spinal cord ends at the level between the first and second lumbar vertebrae. There are many studies published globally, yet no article has been published concerning this title in our settings. The objective of this study was to determine the tip level of conus medullaris by the Magnetic Resonance Imaging (MRI) in living humans in Nepalese population. **Methods:** Images of the MRI done between August 2019 to June 2021 were accessed through the database of the radiology department for defining the level of conus medullaris. The termination level of conus medullaris was rescored in relation to the upper, mid, and lower third of the adjacent vertebrae and the intervertebral disc. Input data was processed in Microsoft Excel which was later analyzed by SPSS 20.0. **Results:** Of the total, 202 study population, a higher number of spinal cords terminated at lower one-third of L1 vertebrae, accounting for 51 (females 26 and males 25) followed by L1-L2 intervertebral disc comprising only 35 (males 19; females 16). No significant differences in number existed between the two sexes having conus medullaris termination at both levels. Most of the cases who were in the age group of 40-49 years old, termination of CM was noted in L1 with the most common shape being the central type C, accounting for 38% (78/202). **Conclusions:** The conus medullaris was terminated mostly at lower one third of L1 vertebral body in our settings with no gender difference.

Keywords: Conus medullaris, magnetic resonance imaging, spinal cord, termination.

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INTRODUCTION

The spinal cord is a sensitive and important structure in human as it is the extension of the central nervous system (CNS) that begins from the area of medulla oblongata at the brain stem and ends in the lower back in a tapering form like a cone called as conus medullaris (CM). It has been observed that by birth, the level of CM termination is found at the level of L2 vertebral body or above.[1] There are various articles published regarding the termination of CM with respect to the vertebral level in live human beings and cadaveric.[2-3] Several studies revealed that the CM mostly terminates at the intervertebral level of L1/L2, yet there are other studies which elicited wide variety of termination from mid T11 to mid-L3.[4-5] It is clinically important to recognize the level of CM termination especially during the spinal anesthesia and during the diagnostic procedure like lumbar puncture. Damage to the spinal cord happens when the CM termination level is not well identified.[6] Nevertheless, there are no data published from our settings and environment. This reflects clear gap of knowledge about the termination point of conus medullaris in the Nepalese people which have different body habitus.

Filling this gap of knowledge by finding termination point of CM among Nepalese through cadaveric study could be expensive and invasive whereas magnetic resonance imaging (MRI) can make the study less expensive, more feasible and non-invasive. Already, ample

of study using MRI have been done in different population to find the level of CM and result have been satisfactory. Therefore, this study aimed to find the level of termination of conus medullaris among adult Nepalese through the MRI scanning of lumbar spine. Outcome of this study when published will be helpful for the diagnostic and treatment procedures in the institution of the study and will be reference for the clinicians.

METHODS

This was a retrospective study conducted in Pokhara Academy of Health Science (PoAHS) in Pokhara after obtaining ethical clearance from Institutional Review Committee (Ref. No. 73/078). MRI images of the last two years from August 2019 to June 2021 was accessed from the database of the Radiology department. Since there was no previous study with defined prevalence of termination of CM among Nepalese people, we referred other previous paper conducted in other Asian countries and in Nigeria which all had sample size of less than 200. Previous studies at similar sites in other countries found the prevalence to be 15% which gives us estimate of sample size to be about 196, while previous studies conducted in Nigeria, Korea, and Saudi Arabia used sample size 187, 177 and 179 respectively.[5,7,8] Therefore, we confined our sample size at 202.

MRI scans were reviewed by the consultant radiologists having more than five years of experience on MR spine reporting. Images of adult patients with no sign of congenital anomaly, trauma, tumor, or other form of gross anatomical variation were selected for the study. The images of patient file with the history of sciatica or low back pain were included in the study if it did not have any anatomical abnormalities. Patients with the history of low back pain (LBP), sciatica were enrolled in the study whereas patient with the history of trauma, vertebral fractures were excluded. All the MR Images were scanned by Philips 1.5 Tesla instrument (Digital Broadband Philips Multiva) with slice thickness of 5 mm in sagittal and 4 mm in transverse plane. The T1, T2 and Fat-saturated sequences of the images were viewed by OsiriX MD v.10.0.2 DICOM viewer software. All scans were obtained while patient lying in the supine position. The termination of the conus medullaris was identified on 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.[10] The shape of the conus medullaris and level of the vertebra on sagittal T2 weighted images are visualized. The shape of the conus medullaris in the MR spinal images were recorded as type A, type B and type C.[7] Type C is ventrally deviated, type B is central and type A is dorsally deviated conus tip. (Figure 1). Descriptive analysis was done to calculate the level of CM terminations (CMt) and the types.

Figure 1: Demonstrates the different shapes of tip of conus categorized as Type A, B and C; and the level of CMt with respect to vertebral bodies and intervertebral discs on T2 weighted sagittal Image

RESULTS

Of the total, 202 patients (103 females and males 99) with the mean age of 47.88 years and the range of age was between 11 and 83 years. The distribution of termination of conus medullaris was found to range from T12 to upper third level of L3 vertebrae (Figure 1). The most common termination level was L1 lower one third comprising 51 cases (26 females, 25 males) accounting for 25.24% which is then followed by L1-L2 disc interval accounting for 17.32% (16 females and 19 males). The least common termination level was noted at T12 upper one third and L2-L3 disc interval accounting just for 0.49%. (Figure 2)

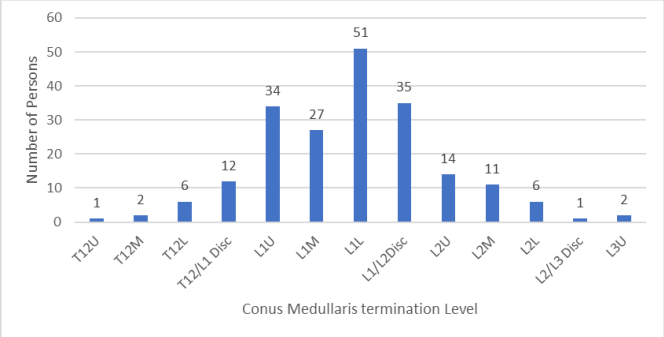

Figure 2: Distribution of CM termination level

It was found that most common shape of the tip of conus is central type accounting for 38% (78/202) followed by ventral (C) 37% and dorsal type (A) which accounts for 25 %.

DISCUSSION

MRI is the novel modality in the examination of spine. The high resolution and clarity in the images outweigh the study of conus medullaris by MRI compared to cadaveric study. [11]

Various studies concluded that the termination of CM lies between the levels of T12-L1 upto the level of L2 and L3.[9,10]

In the present study, there is slight dominance of female population comprising of 51% female and 49% male which is quite similar to the study conducted by Binokay et al.[11] where female population comprised of 85% of the sample size. The probable reason for number of females being greater than males is that females go a long distance to fetch water and bring that on their back in hilly areas of Pokhara resulting backache and they show up for MRI scan. Nevertheless, there was no significance in the cord termination between the genders and the most common age group included for this study was 40-49 years with varying level of cord termination.

Similarly, our study revealed that the termination of spinal cord was found at the level of upper third of T12 vertebrae to upper third of L3 vertebrae, which was quite similar to other study conducted by Saifuddin et al.[12] in 1998 and Mbaba et al.[5] in 2020, where termination of CMt was located between mid-third of T12 and upper third of L3.

The information on the level of CMt differs between anatomy and neurology textbooks and the literature. Mean levels of CMt were stated to be at the level of L1 vertebra in the 39th edition of Gray's Anatomy[13] and Gray's Clinical Neuroanatomy[14] which is consistent to this study where 51% of the total cases had CMt at the level of lower third of L1 vertebrae. The normal anatomical variation may be the reason of variations in result among the literature. However, we claim our result to be valid because it agrees with the reference book and most importantly this is the first article done for Nepalese population. However, multi-centric study with larger sample size will verify it further.

Similarly, with respect to the conus shape, centrally located conus tip (type B) was most common in our study accounting for 38%, which is quite similar to other study conducted by Myung-Sang et al.[7] in 2019, according to him type B conus tip was the most common in Korean Population accounting for 39.6% in his study. It is believed that type C conus experiences least bruises followed by type B and type C conus is bruised the most.[15,16]

CONCLUSIONS

The average level of termination of conus medullaris in this study population is at the level of lower one third of L1 vertebral body. There was no gender influencing factor for termination of spinal cord and we also believe that the differences in the shape of the conus are attributable to anatomical variations. A large sample size study is recommended to suggest the exact variations and level of conus medullaris in Nepalese population.

CONFLICTS OF INTEREST: None declared

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AUTHORS CONTRIBUTION

MT did conceptualization, definition of intellectual content, literature search, clinical studies, manuscript preparation, editing and review; SSP did the designing of the study, data acquisition, analysis and statistical analysis; MKS defined the intellectual content, did the clinical studies, and reviewed the manuscript; RP did the literature search, data analysis, statistical analysis and manuscript preparation; BBT did data acquisition, analysis, and statistical analysis manuscript preparation; SB did conceptualization, designing, definition of intellectual content, manuscript preparation, editing and review.

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