 DOI: 10.18231/2394-2126.2017.0003

A magnetic resonance imaging study of the variations of position of conus medullaris and thecal sac in the adult population in Sikkim

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Abstract

Introduction: The termination of the spinal cord in human beings is cone shaped and is called the Conus Medullaris (CM). Thecal Sac (TS) is a membranous sac of dura mater containing the spinal cord, cauda equina and cerebrospinal fluid. The terminations of these vary in the population across the world, which carries therapeutic implications.

Materials and Methods: A retrospective descriptive study was conducted on all patients above 18 years of age undergoing Magnetic resonance imaging (MRI) of lumbosacral spine for low backache using Achieva 1.5 Tesla MRI (Philips, Netherland) to localize the levels of conus medullaris and thecal sac.

Results: The study population comprised of 91 individuals of which 63 individuals fulfilled the inclusion criteria. The position of conus medullaris varied between upper third of T12 vertebral body to L2- L3 disc level with a mean position at mid third of L1 vertebral body. The position of the thecal sac varied between upper third of S1 vertebral body to lower third of S3 vertebral body with the mean position at upper third of S2 vertebral body.

Conclusions The mean level of termination of the conus medullaris in our study was at the level of middle third of L1 vertebral body and the mean level of thecal sac in our study was at the upper third of S2 vertebral body. Knowledge of the position of CM and TS, the distances between the two in various population groups will be of practical value in day to day clinical practice.

Keywords: Conus Medullaris, Thecal Sac, Magnetic Resonance Imaging.

Introduction

The termination of the spinal cord in human beings is cone shaped and is called the Conus Medullaris (CM). In early fetal life the length of the vertebral canal and the spinal cord is same till the embryo length of 30mm, thereafter the vertebral column grows faster than the spinal cord.(1) CM is usually located at the level of lower third of T12-L3 in the adults.(1,2,3) Thecal sac (TS) is a membranous sac of dura mater containing the spinal cord, cauda equina and cerebrospinal fluid. TS is usually observed to terminate at the level of S2 vertebral body.(4) Studies have reported variations in the position of CM and TS in different races.(5) Such variations may contribute to compromise in safety of various diagnostic and therapeutic procedures. Often performed invasive procedures like lumbar puncture, myelography, spinal anesthesia, intrathecal injections of drugs may lead to unforeseen injury to CM and the nerve roots leading to complications like cauda equine syndrome, intramedullary hematoma etc.(6) Magnetic Resonance Imaging (MRI) is a good imaging modality which gives near accurate information on the various body structures. Identification of the level of CM can be accurately identified on majority of midline, sagittal T1 weighted MRI studies.(7) The present study is aimed at finding the range of CM and TS levels in living adult population of Sikkim using MRI.

Materials and Methods

A retrospective descriptive study was conducted on all patients above 18 years of age undergoing MRI of lumbosacral spine for low backache from February 2013 to July 2013. The study population comprised of 91 individuals of which 63 individuals fulfilled the inclusion criteria.

Patients with kyphoscoliotic spine , history of past spine surgery, spinal fracture or collapse, Pott's spine, congenital spinal anomalies like spinal bifida, block vertebra and hemi-vertebrae and cases of spinal cord pathology like syringomyelia, tumors, myelomeningocele, and tethered cord syndrome were excluded.

Using a Achieva 1.5 Tesla field strength MRI (Philips, Netherland) with slice thickness of 4mm and inter slip gap of 1mm for sagittal sequences we did a T2 weighted sagittal MRI sequence of the lumbosacral spine with the patient in supine position to localize the levels of CM and TS.

For easy identification, the vertebrae were divided into three equal segments as upper third, middle third and lower third followed by intervening vertebral disc levels. All the cases were evaluated by a single radiologist to avoid observational bias.

Statistical analysis was performed by SPPS software version 20 for windows.

Results

The study population comprised of 50.79% males and 49.21% females. The mean age of the study population was 44.38 years. The mean age of females was 45.09 years and that of males was 43.68 years. (Table 1) The position of CM varied between upper third of T12 vertebral body and L2- L3 disc level. To derive the mean of the CM position, each third of the vertebral body and the intervening disc level are assigned with sequential number starting at upper third of T12 as 1 upto the L2-L3 level as 12. Mean position hence derived was 5.73 in total, 5.56 in male and 5.90 in female, mode and median were at 6 which corresponds to the mid third of L1 vertebral body (Table 2). In both males and females, the mean CM level was found at the same segment however, in females it was located relatively lower as compared to males. This difference in gender was not statistically significant (p= 0.53).The position of the TS varied between upper third of S1 vertebral body and lower third of S3 vertebral body. To derive the mean of the TS position, each third of the vertebral body and the intervening disc level are assigned with sequential number starting at upper third of S1 vertebral body as 1 upto the lower third of S3 vertebral body level as 11. Mean position hence derived was 4.86 in total, 4.78 in male and 4.94 in female, mode and median were at 5 which corresponds to the upper third of S2 vertebral body. (Table 3) The mean TS level in both the gender were found at same segment however, in female it was relatively lower as compared to males. This difference in the TS level between the two gender was not statistically significant (p= 0.76).

Table 1: Demographic profile of study participants

Sex	Number	Mean Age in years	SD	Median Age in yrs.
Male	32	43.69	15.78	43.5
Female	31	45.10	14.46	42
Total	63	44.38	15.04	43

Table 2: Conus level in study participants

Sex	Number	Mean Conus level	SD	Median Conus level	Mode of conus level	Analysis (T-test)
Male	32	5.56	2.02	6	6	t=0.63, df =61 p= 0.53
Female	31	5.90	2.29	6	6	
Total	63	5.73	2.14	6	6	

Table 3: Thecal sac level in study participants

Sex	Number	Mean Thecal sac level	SD	Median Thecal sac level	Mode of Thecal sac level	Analysis (T-test)
Male	32	4.78	2	5	5	t=0.31, df =61 p= 0.76
Female	31	4.94	2.16	5	5	
Total	63	4.86	2.06	5	5	

Discussion

The position of CM and TS in human beings is seen to vary in population in different parts of the world. Various cadaveric studies and studies in the living humans have been carried out in different parts of the world to determine the position of CM and TS. However, very less data are available in this aspect from the north east India. Thompson in the year 1894 found that the spinal cord in females were longer than that of males in a study on 198 cadavers which corroborates with our study. It terminated between 5mm above the lower border of T12 & upper border of L3.[3,5,8-13] In another study McCotter reported in his series of 234 cases the level of CM to be between middle of T12 and lower border of L2 vertebral bodies.[11] Needles while examining 240 adult cadavers reported the position of CM to be between middle third of T12 and lower third of L3 vertebral bodies.[12] With the invention of Magnetic Resonance Imaging and its use in medical field, the location of CM and TS became possible in living population. Assessment by Saifuddin et al in 504 adults MRI scan of lumbosacral spine found that the CM was located between middle third of T12 and upper third of L3 vertebral bodies.[10] In another similar study by Demiryurek et al done on 639 patients undergoing MRI scan of lumbosacral vertebrae found the location of CM ranging from T11-T12 intervertebral disc space and upper third of L3 vertebral body.[5] A study by Maryam Rahmani et al found the CM level between upper third of T12 and middle third of L2 vertebral body.[14] However, in our study we found the level of CM varied between upper third of T12 vertebral body and L2-L3 disc level. The position of TS was also determined by various researchers in different populations. Soleiman et al on MRI studies found the mean TS level at the upper third of S2 and the range extended from lower third of L2 to upper third of S5 and was not affected by gender.[13] In our study, we also found the mean level of TS to be at the upper third of S2 vertebral body, however the level varied between upper third of S1 to lower third

of S3 vertebral body. Another study by Nasr Ay found the level of TS at the upper third of S2 in males and middle third of S2 in females.[15] However, in our study we found the mean level of TS at the upper third of S2 vertebral body in both the genders.

Table 4: Comparisons of our study with other studies

Previous studies	Present study
Thompson- Length of spinal cord in female > Male.	Same finding
McCotter- level of CM between Middle third-T12 to lower-third L1 vertebral body.	Level of CM between upper third of T12 vertebral body to L2- L3 disc level.
Needles- level of CM between Middle third of T12 and lower third of L3 vertebral bodies.	
Saifuddin- CM was located between middle third of T12 and upper third of L3 vertebral bodies.	
Demiryurek- the location of CM ranging from T11-T12 intervertebral disc space and upper third of L3vertebral body.	
Maryam Rahmani- the CM level between upper third of T12 and middle third of L2 vertebral body.	
Soleiman- Mean TS level at the upper third of S2 and the range extended from lower third of L2 to upper third of S5.	Mean level of TS at the upper third of S2 vertebral body, range extended from upper third of S1 to lower third of S3 vertebral body.
Nasr Ay- the level of TS at the upper third of S2 in males and middle third of S2 in females.	Mean level of TS at the upper third of S2 vertebral body in both the genders.

Conclusion

The mean level of the CM in our study was found to be at the level of middle third of L1 vertebral body with no statistically significant difference between the levels of CM between males and females. The mean level of TS in our study was at the upper third of S2 vertebral body. The difference of levels of TS between the genders were not statistically significant. Knowledge of the position of CM and TS, the distances between the two in various population groups will be of practical value in day to day clinical practice.

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