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Magnetic Resonance Imaging based Determination of Conus Medullaris Position in Adults

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Abstract: The position of the conus medullaris was determined in 289 patients without obvious spine or cord pathology using midsagittal Magnetic Resonance (MR) images of the lumbosacral spine. In all patients, lumbosacral X-ray was evaluated for transitional vertebra to avoid misidentification of vertebrae on MR images. The mean location of the conus tip was at L_1 upper third, ranging from T_{12} upper third to L_2 middle third. The position was slightly higher in males than in females. Presence of transitional vertebra or degenerative joint disease did not have significant effect on the position of the conus.

Key words: Magnetic resonance imaging, lumbar spine, conus medullaris, transitional vertebra

INTRODUCTION

Conus medullaris is the cone shaped terminal part of the spinal cord that is usually located at the level of the lower third of T_{12} to L_3 vertebrae. According to the studies performed in various populations, position of the conus medullaris seems to differ somehow between different races (Demiryürek *et al*., 2002).

During invasive procedures such as spinal anesthesia, myelography and lumbar puncture for sampling of cerebrospinal fluid, considering the position of conus medullaris is necessary to avoid inadvertent injury to it. Iatrogenic injury to the conus medullaris and nerve roots in cauda equina leads to various complications including cauda equina syndrome as a result of chemical injury following intrathecal injection of various drugs like tetracain and lidocain, persistent anesthesia, sensory disturbance or pain in the territory of sacral, lumbar and even lower thoracic nerve roots, weakness and motor disturbance in lower extremities (unilateral or bilateral) and urinary symptoms such as poor bladder sensation, difficulty in initiation of micturition and urinary retention. Spinal cord trauma following lumbar puncture can produce syrinx or intramedullary hematoma (Reynolds, 2001). The site of cord termination can also be important in the degree of neurologic injury following fracture in lumbar spine.

The purpose of this study is to determine the level of the conus medullaris in a sample of adult population in relation to the thoracic and lumbar vertebrae, evaluate its age and sex-related variations, assess the influence of the presence of transitional vertebra on its position and compare the results with the other cadaveric and living subject studies in other populations.

MATERIALS AND METHODS

This is a descriptive cross-sectional study among 289 adult (between 20 and 73 years old) patients whom underwent MRI of lumbosacral spine as a work up for low back pain between January, 2007 and April, 2008. The study population consisted of 111 (38.4%) males and 178 (61.6%) females with the average age of 41.6 and 44.1 years old, respectively. Only patients who had lumbar X-ray before MRI examination were included in this study. Patients with kyphoscoliosis, history of previous spine surgery, spinal fracture or collapse, congenital spinal anomalies like spina bifida and cases of spinal cord pathology such as syringomyelia, tumor, myelomeningocele and tethered cord were excluded. We used T_1-weighted sagittal spin echo MRI sequences of the lumbar spine with the patient in supine position to localize the tip of the conus medullaris. Images were obtained at 1.5 tesla field strength (GE, Signa, USA) with slice thickness of 4 mm and interslice gap of 1 mm for sagittal sequences. Axial sequences were obtained as a pedicle to pedicle block angled to the disc space.

Each vertebra was divided into 3 equal upper, middle and lower segments. Vertebral segments and disc spaces were numbered consecutively from T_{12} upper segment

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Fig. 1: Midsagittal T_1-weighted MR image of lumbosacral spine shows the tip of the conus medullaris in relation to the vertebral segments. Each vertebrae is divided into 3 equal upper, middle and lower segments. Vertebral segments and disc spaces were numbered consecutively from T_{12} upper segment downward to L_5S_1 intervertebral disc

downward to L_5S_1 intervertebral disc, so these 2 parts were numbered as 1 and 24, respectively (Fig. 1). The numbers were used to describe the position of the conus medullaris in segmental number for statistical analysis. A horizontal line was drawn from the most distal part of the spinal cord on midsagittal image perpendicular to the longitudinal axis of the spine. The position of the conus medullaris was defined as the vertebral segment or intervertebral disc space that was determined by the line. All cases were evaluated by one radiologist. Presence of the transitional vertebra can leads to misidentification and false numbering of vertebrae on MR images so, we evaluated the lumbosacral X-ray of all patients before assessment of their MR images.

The statistical analysis was performed using SPSS 14.0 for windows software. One sample Kolmogorov-Smirnov test was used to evaluate pattern of distribution of the conus position among patients. For assessment of changes in the conus position with age we divided our cases into six age groups (20-29, 30-39, 40-49, 50-59, 60-69 and 70-79 years old). Kruskal-Wallis test was used for evaluation of the influence of transitional vertebra and age on the conus position. Differences with $p<0.01$ were considered significant.

RESULTS

The position of the conus medullaris was between T_{12} upper third and L_2 middle third with a mean of L_1 upper third. It did not reveal normal distribution (Kolmogorov-Smirnov test, $p<0.001$). The conus was located from T_{12} upper third to L_2 upper third (mean: L_1 upper third) in males and from T_{12} upper third to L_2 middle third (mean: L_1 middle third) in females. This difference was not statistically significant ($p = 0.012$). In different age groups, the mean position was variable ranging from $T_{12}L_1$ intervertebral disc to upper part of L_1 middle third and did not seem to be clinically significant.

Sacralization and lumbarization was noted in 56 (19.4%) and 15 (5.2%) cases, respectively. Presence of transitional vertebra did not have significant effect on the position of conus (Kruskal-Wallis test, $p = 0.017$). The position was between T_{12} middle third and L_2 upper third (mean: L_1 middle third) in patients with lumbarization, between T_{12} upper third and L_2 middle third (mean: L_1 upper third) in normal subjects and between T_{12} upper third and L_2 upper third (mean: $T_{12}L_1$ disc) in patients with sacralization. Degenerative joint disease in lumbar spine was noted in 109 (37.7%) cases without significant effect on the conus position ($p = 0.084$).

DISCUSSION

The importance of the conus position is during lumbar puncture and in cases with lumbar vertebral fracture. For lumbar puncture, Tuffier's line is used to determine the appropriate site clinically. Tuffier's line connects the highest parts of the iliac crests and is reported to be from L_3L_4 to L_5S_1 intervertebral disc (mean: L_4L_5 disc) (Kim *et al*., 2003). Therefore, knowing the probable site of the cord termination is important in preventing cord injury. A recent cadaveric study found no change in the conus position with spinal flexion and another recent MRI-based study reached variable results with this maneuver, so spinal flexion does not seem to be important in protecting the cord (Bauer *et al*., 2008). In cases of lumbar spine fracture, it is suggested that the amount of neural tissue in the spinal canal at the site of fracture is one of the determinants of the neurologic status (Saifuddin *et al*., 1998).

The position of the conus medullaris has been assessed in cadaveric studies. Thomson (1984) found the position of the conus between 5 mm above the lower border of T_{12} and the upper border of L_3 among 198 adult cadavers. It was lower in females than in males (Thomson, 1984). Using magnetic resonance imaging, the conus can be evaluated in living individuals. Some of the previous studies with MRI are mentioned here. Saifuddin *et al*. (1998) in a study with 504 adult cases without spinal deformity found the tip of the conus between middle third of T_{12} and upper third of L_3 with a mean position at the

lower third of L_1. The conus position was slightly lower in males than in females without statistical significance. They did not evaluate racial difference and they did not find any change in the conus location with increasing age (Saifuddin *et al*., 1998). Demiryürek *et al*. (2002) studied 639 patients and noticed the conus tip from $T_{11}T_{12}$ intervertebral disc space to the upper third of L_3. The conus was near one vertebra lower in females (mostly at L_1L_2 disc) than in males (mostly at $T_{12}L_1$ disc) that was statistically significant. They find no difference in the conus level related to increasing age (Demiryürek *et al*., 2002). Yasuhisa evaluated 602 patients and identified the peak of the distribution of the conus tip location at the middle third of L_1 (Arai *et al*., 2001). Soleiman *et al*. (2005) assessed 635 patients and reported the mean conus termination at L_1 middle third. They also reported a difference between females (mean: L_1 middle third) and males (mean: L_1 lower third) (Soleiman *et al*., 2005).

In our 289 cases, we determined the position of the conus between T_{12} upper third and L_2 middle third with a mean of L_1 upper third. It was slightly lower in females than in males in contrast to the findings of Saifuddin *et al*. (1998) and Soleiman *et al*. (2005) in agree with the results of Demiryürek *et al*. (2002) although, this difference was insignificant. The mean position in different age groups was variable and clinically insignificant in agree with Saifuddin *et al*. (1998) and Demiryürek *et al*. (2002).

One setback to the previous studies is the potential error of vertebral misidentification in MRI-based determination of the conus tip in patients with transitional vertebra. Except the study conducted by Kim *et al*. (2003), in the above mentioned studies the presence of transitional vertebra was not considered in the assessment of the patients. We evaluated the lumbosacral X-ray in all cases to avoid this potential error. We did not find significant effect on the conus position from the presence of transitional vertebra or degenerative joint disease.

REFERENCES

Arai, Y., K. Shitoto, M. Takahashi and H. Kurosawa, 2001. Magnetic resonance imaging observation of the conus medullaris. Bull. Hosp. Jt. Dis., 60: 10-12. PMID:11759571.http://www.ncbi.nlm.nih.gov/entrez/utils/fref.fcgi?PrId=5993&itool=AbstractPlus-def&uid=11759571&db=pubmed&url=http://www.nyuhjdbulletin.org/Permalink.aspx?permalinkId=4a5f3d17-e7c2-4f18-8530-0ccf50407c5b.

Bauer, D.F., M.M. Shoja, M. Loukas, W.J. Oakes and R.S. Tubbs, 2008. Study of the effects of flexion on the position of the conus medullaris. Childs Nerv. Syst., 24: 1043-1045. PMID: 18431553. DOI: 10.1007/s00381-008-0640-6. http://www.springerlink.com/content/v237841302002363.

Demiryürek, D., Ü. Aydingöz, M.D. Aksit, N. Yener and P.Ö. Geyik, 2002. MR imaging determination of the normal level of conus medullaris. J. Clin. Imaging, 226: 375-377. PMID: 12427430. PII: S0899-7071(02)00451-5. http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6T5C-475334F-3&_user=10&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_version=1&_urlVersion=0&_userid=10&md5=955ed0871657a5b0ecc7a2884cdfb8da.

Kim, J.T., J.H. Bahk and J. Sung, 2003. Influence of age and sex on the position of the conus medullaris and Tuffier's line in adults. Anesthesiology, 99: 1359-1363. PMID: 14639149. http://www.anesthesiology.org/pt/re/anes/abstract.00000542-200312000-00018.htm;jsessionid=LrSTBmjPjmFh00RYSn0vG1yJpykgCrgTg5ZsHqsh9ZdMQqzj4218!-2060166207!181195629!8091!-1.

Reynolds, F., 2001. Damage to the conus medullaris following spinal anaesthesia. Anesthesia, 56: 238-247. PMID:11251431.http://www3.interscience.wiley.com/journal/121362510/abstract?CRETRY=1&SRETRY=0.

Saifuddin, A., J.D. Burnett and J. White, 1998. The variation of position of the conus medullaris in an adult population. Spine, 23: 1452-1456. PMID: 9670396. http://www.spinejournal.org/pt/re/spine/abstract.00007632-199807010-00005.htm;jsessionid=LrTXnKtJGrM8XLRz2QhD9yKkrJTNB18pHnmTqvm14Z7vvqn1vrgK!-2060166207!181195629!8091!-1.

Soleiman, J., P.H. Demaerel, S. Rocher, F. Maes and G. Marchal, 2005. Magnetic resonance imaging study of the level of termination of the conus medullaris and the thecal sac: Influence of age and gender. Spine, 30: 1875-1880. PMID: 16103859. http://www.spinejournal.org/pt/re/spine/abstract.00007632-200508150-00014.htm;jsessionid=LrVW2Bh9nydP56LYcVnmYGWLnD2W99F28vZ5Jf2F6wjvl0qm7KzT!116236564 7!181195628!8091!-1.

Thomson, A., 1984. Fifth Annual Report of the Committee of Collective Investigation of the Anatomical Society of Great Britain and Ireland for the Year 1893-1894. J. Anat. Physiol., 29: 46-48. PMID: 17232116. http://www.pubmedcentral.nih.gov/articlerender.fcgi?tool=pubmed&pubmedid=17232116.