MRI Study of the Position of the Conus Medullaris in Patients With Lumbar Spinal Stenosis

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abstract

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Substantial data exist from cadaveric and magnetic resonance imaging studies regarding the position of the conus medullaris in normally developed adults. However, no large studies have documented the position of the conus medullaris in patients with diagnosed lumbar spinal stenosis. The goal of the current study was to determine the position of the conus medullaris within a living adult population with existing pathology of lumbar spinal stenosis. In a retrospective study, 234 patients (110 women and 124 men; mean age, 48.8 years) with diagnosed lumbar spinal stenosis had their T2-weighted, midline, sagittal, spin-echo magnetic resonance imaging studies compared to assess and confirm the position of the conus medullaris. A straight line perpendicular to the long axis of the spinal cord in the median sagittal sequence was subtended to the adjacent vertebra or disk space, and the position was defined in relation to the vertebra or disk space. The conus medullaris position was labeled in relation to the upper, middle, and lower segments of the adjacent vertebral body or the adjacent disk space and assigned numerical values from 1 to 12. The position of the conus medullaris in patients with lumbar spinal stenosis followed a normal distribution. The mean conus medullaris position was mainly within the lower third of the L1 vertebral body (ranged from the middle third of T12 to the upper third of L3). No significant differences existed between men and women with lumbar spinal stenosis. The conus medullaris position was found to be unaffected by the pathology of lumbar spinal stenosis.

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Figure: The vertebral body is divided into 3 parts. The disk space is viewed as an independent section. The spinal unit is divided into 4 segments. A straight line perpendicular to the axis of the spinal cord in the median sagittal sequence was subtended to the adjacent vertebra or disk space, and the position was defined in relation to the vertebra or disk space.
Substantial data exist from cadaveric and magnetic resonance imaging (MRI) studies regarding the position of the conus medullaris in normally developed adults. These studies have consistently shown the mean position of the conus medullaris to be between T12 and L2. A well-documented clinical complication of lumbar spinal stenosis is paralysis following epidural puncture. As such, determining the conus medullaris position is of great clinical importance. Until now, no large studies have documented the conus medullaris position in patients with diagnosed lumbar spinal stenosis. Conus medullaris position can be confirmed on midline, T2-weighted sagittal MRIs. The goal of this study was to determine the range of conus medullaris positions in a living adult population with pathology of lumbar spinal stenosis.

**Materials and Methods**

A retrospective review was performed of the MRIs of 234 patients (110 women and 124 men; mean age, 48.8 years) who underwent surgery for lumbar spinal stenosis between January 2008 and October 2010. All patients were required to meet the following criteria: no past or current history of tumor, trauma, or transitional vertebrae on the lumbar spine; no scoliosis or deformity; low back pain (including bilateral/unilateral radiating neurological signs such as scatica, parathesia, or numbness) or other clinical symptoms caused by lumbar spinal stenosis.

T2-weighted sagittal and axial spine echo MRI studies of the lumbar spine were performed on 234 consecutive patients using 3.0-T MRI machines (Philips Electronics, Amsterdam, The Netherlands). The parameters for scanning were as follows: repetition time, 3000 ms; echo time, 120 ms; field of vision, 220 mm; effective thickness, 4 mm; number of signal averages, 3. The tip of the conus medullaris was defined as the most distal point of the spinal cord that could be visualized on the sagittal sequence. In accordance with the method of Saifuddin et al, a straight line perpendicular to the long axis of the spinal cord in the median sagittal sequence was subtended to the adjacent vertebra or disk space using Mimics version 14.0 software (Materialise, Leuven, Belgium), and the position was defined in relation to the vertebra or disk space. Each vertebral/disk unit was divided into 4 segments. A vertebral body was subdivided into 3 equal portions (upper, middle, and lower third), with the intervertebral disk viewed as an independent section (ie, the spinal unit was divided into 4 segments).

For the purposes of statistical convenience, each potential conus medullaris position was assigned a number, such that the middle third of T12 = 1 and the upper third of L3 = 12 (Figures 1, 2). The MRIs of the 234 patients were viewed by the first author (Z.B.) and other experts. The average value and larger deviation data were then secondarily assessed by other experts. Statistical tests were performed, including analysis of variance and the Kolmogorov-Smirnov test of normal distribution. The data were then analyzed using SPSS version 19.0 software (SPSS, Inc, Chicago, Illinois). A P value of .05 represented statistical significance.

**Results**

The precise conus medullaris position was confirmed in 234 patients with lumbar spinal stenosis (Table). The range of positions followed a normal distribution. This was assessed statistically by the Kolmogorov-Smirnov test of normality (z = 6.19; P < .001). No significant difference existed in conus medullaris position between men and women (analysis of variance F value = 1.489; P = .326).

**Discussion**

Large variations in conus medullaris position exist in normally developed adults, with extensive data available for cadaveric and live populations. Studies suggest that the conus medullaris reaches the adult position by 2 years of age and lies at an average position of L1 to L2. Thomson was the first to present data regarding the conus medullaris position after studying 198 adult cadavers in 1894. He also found that the position of the conus medullaris was lower in women than in men. The highest position of the conus medullaris was 5 mm above the lower border of T12, whereas the lowest was at the upper border of L3. In 1935, Needles studied 240 adult cadavers (107 Caucasian and 133 African of both sexes) and found that in 49% of the study group the cord terminated between the lower...
Conus Medullaris Position in Patients with Lumbar Spinal Stenosis | BA et al

Table

<table>
<thead>
<tr>
<th>Conus Position No.</th>
<th>Spinal Unit</th>
<th>Frequency</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Middle third of T12</td>
<td>7</td>
<td>3.0</td>
</tr>
<tr>
<td>2</td>
<td>Lower third of T12</td>
<td>15</td>
<td>6.4</td>
</tr>
<tr>
<td>3</td>
<td>Space of T12/L1</td>
<td>31</td>
<td>13.2</td>
</tr>
<tr>
<td>4</td>
<td>Upper third of L1</td>
<td>30</td>
<td>12.9</td>
</tr>
<tr>
<td>5</td>
<td>Middle third of L1</td>
<td>16</td>
<td>6.8</td>
</tr>
<tr>
<td>6</td>
<td>Lower third of L1</td>
<td>53</td>
<td>22.6</td>
</tr>
<tr>
<td>7</td>
<td>Space of L1/L2</td>
<td>37</td>
<td>15.8</td>
</tr>
<tr>
<td>8</td>
<td>Upper third of L2</td>
<td>9</td>
<td>3.8</td>
</tr>
<tr>
<td>9</td>
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</tr>
<tr>
<td>10</td>
<td>Lower third of L2</td>
<td>5</td>
<td>2.1</td>
</tr>
<tr>
<td>11</td>
<td>Space of L2/L3</td>
<td>16</td>
<td>6.8</td>
</tr>
<tr>
<td>12</td>
<td>Upper third of L3</td>
<td>7</td>
<td>3.0</td>
</tr>
</tbody>
</table>

*Mean conus position = 5.84 (just above lower third of L1) and SD = 2.17 (equivalent to half a vertebra).

third of L1 and the upper third of L2. Also, the position of the conus medullaris was consistently higher in men than in women of African descent.

Reimann and Anson2 devised a method of referring to the position of the conus medullaris in relation to the adjacent vertebral body or disk space. They summarized the previous studies (801 cases total) and surmised that the overall mean conus medullaris position lies within the lower third of L1. It was not reported whether these studies included specimens with spinal deformities. Saifuddin et al1 followed Reimann and Anson’s method to develop a measurement of conus medullaris positioning by MRI. Their results showed that the average value of conus medullaris position was 5.9 (equivalent to the lower third of L1) and the standard deviation was 2.0 (equivalent to half of a spinal unit). This method was used in the current study.

Recently, with the rapid development of MRI technology, the observation and measurement of conus medullaris position has become more accessible, accurate, and reliable. As such, increasing amounts of data pertaining to conus medullaris position in normally developed adults is available; however, no studies have reported on patients with lumbar spinal stenosis. No current data exist on whether the pathology of lumbar spinal stenosis affects the position of the conus medullaris. With an increasing geriatric population with lumbar spinal stenosis in China, it is clinically important to develop a better understanding of the pathology of lumbar spinal stenosis. One serious clinical complication of lumbar spinal stenosis is that patients may become paralyzed following epidural puncture, which has been well documented.4

The data in the current study showed no significant differences between men and women with lumbar spinal stenosis. The results are different from those of previous studies.7-11 It is possible that the ethnic differences in the samples may be relevant to the diverse findings of these studies.

In the current study, the data obtained from the MRIs displayed the conus medullaris position of normally developed adults to be within L1 or the intervertebral space of L1/L2. In patients with lumbar spinal stenosis, the conus medullaris position was 22.6% relative to the lower third of L1 and 16.1% relative to the space of L1/L2. The results indicated that the conus medullaris position of patients with lumbar spinal stenosis was mainly within the L1 vertebra. The data from the current study agree with previous data obtained from anatomical and radiological studies of normally developed adults.5-12 As such, the location of the conus medullaris may not change due to the pathology of lumbar spinal stenosis. Although change in the peripheral structure of the spinal cord can lead to lumbar spinal stenosis, the location of the conus medullaris will not change due to lumbar spinal stenosis pathology. Further study is needed to determine whether the conus medullaris position will change due to other diseases.

**Conclusion**

The current study showed that the conus medullaris in patients with lumbar spinal stenosis is mainly distributed in the lower third of the L1 vertebral body. The positions did not change due to lumbar spinal stenosis pathology.

**REFERENCES**


9. Boonpiirak N, Apinhasmit W. Length and caudal level of termination of spinal cord

