Magnetic Resonance Imaging Observation of the Conus Medullaris

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Abstract
We examined the anatomical height and shape of the conus medullaris in 602 cases using magnetic resonance imaging. The peak of the distribution of the conus height was at the middle one-third of L1. The comparison of the conus level had no significant relationships with age or sex, but the juvenile group had more a caudal distribution of the conus level. The shape of the conus medullaris was classified into three types, and the type B was most frequently observed.

The position of the conus medullaris in the adult population has been described through the use of cadaveric study. These reports showed its mean level to be located at L1 and L2. The neurological symptoms in burst fracture or osteoporotic vertebral collapse of thoracolumbar junction are variedly. We suspect that the relationship between the vertebral body and the conus medullaris is related to the variation of these neurological symptoms.

The purpose of this study is to observe the anatomical height and the shape of the conus medullaris by sex and age group using magnetic resonance imaging (MRI).

Materials and Methods
The population investigated consisted of 602 patients who underwent an MRI examination in our department from January 1995 to August 1997. The sagittal T1-weighted image of the lumbar spine was reviewed in 288 female and 314 male patients ranging from 8 months to 84 years of age. Most patients were being examined for low back pain. A total of 501 cases were evaluated using the first generation technique (Toshiba MRT 50A with MRI of 0.5 tesla) and only the position of the conus medullaris was measured. We observed the axial and sagittal images, which had a slice thickness of 5 mm.

The remaining 101 cases were studied by a second-generation device (the Toshiba Visart hyper with 1.5 tesla) and in these cases we observed the shape as well. Using only sagittal slices we measured the shape of the conus medullaris.

The cases were divided into three groups according to age. Those in the first group were under 11 years of age and were defined as the juvenile group. The second group contained patients ranging from 11 to 70 years and this was designated as the young and adult group. The third group consisted of patients over 71 years of age and was designated as the elder group.

The position of the intervertebral disk or trisection of the vertebral body closest to the tip of the conus medullaris was recorded as the conus level (Fig. 1). In addition, we investigated the shape of the conus medullaris in those imaged by the second generation MRI. Type A was defined as the tip of the conus slant deviated to ventral, type B to central, and type C to dorsal (Fig. 2). Cases in which the shape was unclear were defined as “unclassified.”

Results
The level of the tip of the conus medullaris showed almost regular distribution from the T11/12 disk to the center of the L3 vertebral body, and the peak of the distribution of the conus height was at the middle one-third of L1. The mean level of the tip of the co-
nus medullaris was located at between the middle one-third of L1 and the distal one-third of L1. The comparison of the conus level had no significant relationships to age or sex (Fig. 3), but the juvenile group had a more distal distribution of the conus as compared to the young and adult group and the elder group. We used the chi-square test for the statistical analysis; a $p$ value of under 0.05 indicates significant differences (Fig. 4).

Concerning the shape of the conus medullaris in the second group, the results showed 14 (14%) could be classified as type A, 51 (50%) as type B, 31 (30%) as type C, and 5 (5%) remained unclassified.

**Discussion**

Reimann and Anson\(^1\) reported that the mean level of the conus medullaris was at the lower third of L1. Their study examined a total of 801 cadavers, including their own series of 129, but they did not report whether any of these subjects included spinal deformity.

They did not refer to the prevalence of lumbosacral transitional vertebrae. Wilson and Prince\(^2\) reported the MRI observation of the conus medullaris throughout childhood. They concluded that the conus medullaris does not ascend throughout childhood, and that the conus level of termination at L2-L3 or above is normal at any age. They reviewed 184 children ranging in age from newborn to 20 years (average: 9.2 years of age). Hamanishi and colleagues\(^3\) examined the distribution of the conus medullaris on the MRI using 109 normal Japanese adults who had no congenital spinal anomaly. The results showed the peak of the distribution to be in the middle third of L1 and that the position in elderly patient over 70 years of age is lower than it is in the younger population. They considered that the degenerative changes in old age (such as disk narrowing, kyphosis due to osteoporotic collapse) cause the shortening of spine and the relative descending of the conus medullaris. In accordance with this report, we divided the adulthood into two groups, namely under and over 70 years.

A recent study concerning the variation of the conus level in adults reported by Saifuddin and associates\(^4\) consists of 504 adult cases without spinal deformity. The distribution of the conus location in a large adult population was shown to range from the middle third of T12 to the upper third of L3. These investigators stated that the variation of the conus level helped to perform lumbar puncture and myelography, and also helped to explain the differences among observed neurologic injuries from burst fractures. Our study revealed the location

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**Figure 1** The position of the conus medullaris. The position of intervertebral disk or trisection of the vertebral body closest to the tip of the conus medullaris was recorded as the conus level.

**Figure 2** The shape of the conus medullaris. Type A was defined as the tip of the conus slant deviated to ventral, type B to central, and type C to dorsal.
The distribution of the conus level. The comparison of the conus medullaris had no significant relationships with age (A) or sex (B).

Figure 4 The distribution of the conus level. The juvenile group had more distal distribution of the conus compared with the young and adult group and the elder group. The location of the conus medullaris showed close to regular distribution with the peak level at the middle one-third of L1. The juvenile group had a more caudal distribution of the conus medullaris compared to the other groups. We classified the shape of the conus medullaris into three types, and the type B was most frequently observed.

We consider that the differences in conus shape are due to anatomical variations. We suspect that there is a relationship between the differences in shape and the various neurological conditions.

References