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Clinical Study

Dynamic changes in the spinal cord cross-sectional area in patients with myelopathy due to cervical ossification of posterior longitudinal ligament

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Abstract

BACKGROUND CONTEXT: Dynamic changes in the spinal cord cross-sectional area due to cervical ossification of the posterior longitudinal ligament (C-OPLL) are unknown, but dynamic multidetector-row computed tomography (MDCT) may be a useful tool.
PURPOSE: The purpose of this study was to evaluate the influence of dynamic factors on the spinal cord in patients with C-OPLL using MDCT during flexion and extension after myelography.
STUDY DESIGN/SETTING: This was a prospective cohort study.
PATIENT SAMPLE: Participants included 107 prospectively enrolled consecutive patients with C-OPLL and myelopathy.
OUTCOME MEASURE: The outcome measure was the extension/flexion ratio at the spinal cord cross-sectional area at the most stenotic cervical level (SCASL).
METHODS: Dynamic MDCT was performed, and the SCASL was measured. Patients were divided into the kyphosis group or lordosis group according to C2–C7 alignment. They were divided further into the K-line (−) group or K-line (+) group. The Japanese Orthopedic Association (JOA) score was used to determine myelopathy severity.
RESULTS: All patients with C-OPLL had myelopathy, with a mean JOA score of 10.7 and mean disease duration of 16.7 months. The average extension/flexion ratio at all disc levels was less than 100%, suggesting that the spinal cord was compressed more during extension. In the kyphosis group, the spinal cord was compressed slightly more during flexion than during extension. In the K-line (−) group, the spinal cord was compressed more during flexion, although C2–C7 alignment was slightly lordotic on average. Large changes in the spinal cord cross-sectional area during extension-flexion and disease duration significantly influenced the severity of myelopathy.
CONCLUSIONS: Dynamic MDCT was useful for evaluating dynamic changes in the spinal cord. At the most stenotic level, the spinal cord became narrower during extension at all disc levels. In the kyphosis group and K-line (−) group, it became narrower during flexion. Cervical flexion may induce greater spinal cord compression in patients with kyphosis and K-line (−).

Keywords: Spinal cord cross-sectional area; Multidetector-row computed tomography; Ossification of posterior longitudinal ligament; Cervical spine; Dynamic; K-line

Introduction

Ossification of the posterior longitudinal ligament (OPLL) is one of the main causes of cervical myelopathy [1]. Several studies have investigated the range of motion (ROM) and the space available for the spinal cord in patients with cervical spondylotic myelopathy (CSM) [2–4]. In these patients, spinal cords are likely to be compressed

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during neck extension [5]; however, the spinal cord cross-sectional area during flexion and extension in patients with cervical OPLL (C-OPLL) has not been elucidated. The pathogenesis of C-OPLL is complicated by static factors, such as the extent of ossification and dynamic factors, such as alignment, ROM, and spinal cord tethering. Radiography, magnetic resonance imaging (MRI), and computed tomography (CT) are not adequate to assess these factors completely. At our institution, Machino et al. [5] elucidated the influence of dynamic factors on CSM using multidetector-row computed tomography (MDCT) after myelography. MDCT was effective in evaluating the cross-sectional area during flexion and extension in cases of compression of the spinal cord.

Accordingly, this study aimed to elucidate the influence of dynamic factors on the spinal cord by using MDCT after myelography during cervical spine extension and flexion (dynamic MDCT) in patients with C-OPLL who had myelopathy.

Materials and methods

Patients

Between March 2002 and January 2012, we enrolled 107 consecutive patients (84 men, 23 women) with C-OPLL. The average age was 63.1±10.2 years (range, 38–82 years). All patients had myelopathy and were candidates for surgery. They underwent dynamic MDCT, which was performed during flexion and extension after myelography.

Dynamic MDCT technique and analysis

Patients were placed in the supine position on the CT table at maximum flexion and extension of the cervical spine after myelography (Fig. 1). A 64-line multislice CT system (Light Speed VCT; GE Healthcare Bio-Sciences, Piscataway, NJ) was used. Axial slices were acquired as parallel as possible to each disc level (Fig. 2). Of the axial slices, we determined the spinal cord cross-sectional area at the most stenotic cervical level (SCASL) in each case. The SCASL was measured twice, and mean data were used for analysis. To clarify changes in the SCASL, the ratio of the extension and flexion spinal cord cross-sectional area (extension/flexion ratio) was measured as follows: extension/flexion ratio (%)=spinal cord cross-sectional area on extension×100/spinal cord cross-sectional area on flexion. Accordingly, the patients were divided into the compressed at flexion group (extension/flexion ratio >100%) and the compressed at extension group (extension/flexion ratio ≤100%). The absolute of the gap between the SCASL in extension and the SCASL in flexion=|100–extension/flexion ratio| was also measured. The occupying ratio of the OPLL in the spinal canal at the most stenotic level (occupying ratio) was also measured as follows: occupying ratio (%)=thickness of OPLL×100/anteroposterior diameter of the spinal canal [6].

Evaluations

We assessed the C2–C7 ROM and local ROM by using dynamic MDCT and the Cobb method. To evaluate the influence of cervical alignment, the patients were divided into a kyphosis group (<0°) and a lordosis group (>0°) by assessing the C2–C7 alignment on a neutral lateral radiograph. The patients were further divided into a K-line (−) group and a K-line (+) group. The K-line is the line between the spinal canal midpoints at C2 and C7 on a neutral lateral radiograph. When the OPLL extended beyond the K-line, it was defined as K-line (−), but when it did not extend beyond the K-line, it was defined as K-line (+) (Fig. 3) [7,8].

Statistical analysis

Data are presented as the mean±SD of the mean. Statistical analysis was performed using SPSS for Windows,

Fig. 1. Supine position of dynamic multidetector-row computed tomography. Computed tomography scans during maximum flexion (Left) and extension (Right) after myelography. The pillow was under the head during flexion and under the higher back during extension. The height of the pillow was adjusted to each patient.