Serial Changes in Signal Intensities of the Adjacent Discs on T2-Weighted Sagittal Images after Surgical Treatment of Cervical Spondylosis: Anterior Interbody Fusion Versus Expansive Laminoplasty

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Summary

Background. There have been many reports about newly developed degenerative changes in the adjacent segments after anterior interbody fusion. It is a controversial issue whether the adjacent-segment disease in patients treated by anterior interbody fusion is the result of progressive cervical spondylosis at the adjacent levels or is caused by the arthrodesis. The aim of this study is to clarify the difference in postoperative effect on the adjacent segments between anterior interbody fusion and expansive laminoplasty.

Method. This study included 14 patients who underwent pre- and postoperative MR images at 6 and 12 months. Seven patients underwent cervical interbody fusion and the other 7 patients underwent expansive laminoplasty. Disc degeneration was evaluated semi-quantitatively by calculating the degenerative index (DI) that is a ratio of the intensity in the disc to that in the upper cervical cord.

Findings. In the anterior interbody fusion group, the adjacent disc intensities decreased within 12 months (F = 20.42; P < 0.01). The pre-operative mean DI was 0.59 ± 0.16. The post-operative mean DIs were 0.56 ± 0.16 at 6 months and 0.47 ± 0.16 at 12 months. In the expansive laminoplasty group, the signal intensities of both the adjacent discs and the discs within the range of laminoplasty had no serial changes during the same period (DI = 2.67; P = 0.09).

Interpretation. Anterior interbody fusion had a significant influence on the adjacent discs even as soon as 12 months after surgery, but laminoplasty had no influence on them during the same period.

Keywords: Anterior interbody fusion; MR imaging; disc intensity; adjacent segment.

Introduction

It has been reported that newly developed degenerative change in the adjacent segments after anterior interbody fusion might occur occasionally [1, 2, 4]. It is a controversial issue whether the adjacent-segment disease in patients treated by anterior interbody fusion is the result of progressive cervical spondylosis at the adjacent levels or is caused by the arthrodesis [4]. It is difficult to assess radiologically the influence of the surgical intervention on the adjacent segments at the time of long-term follow-up because of the effects of ageing [11, 15] and natural history of cervical spondylosis cannot be distinguished [4, 9]. To clarify the influence of the surgeries on the adjacent segments, we investigated serial changes in signal intensities of the adjacent discs on T2-weighted images during the early postoperative period in patients treated by anterior interbody fusion or expansive laminoplasty.

Patients and Methods

Patient Characteristics

Between September 1997 and January 1999, 24 patients underwent cervical interbody fusion with iliac bone autografts or expansive laminoplasty with hydroxyapatite (HA) spacers. Of these 24 patients, 14 patients underwent pre- and postoperative follow-up MR images at 6 and 12 months and were selected for this study. Seven patients with single level spondylosis underwent cervical interbody fusion and the other 7 patients with multilevel spondylosis underwent expansive laminoplasty. The levels of fusion were C4–C5 in 3 patients and C5–C6 in 4. All patients had progressive myelopathy with documentation of spinal cord compression on neuroradiological imaging. The neurological state of the patient was evaluated according to the Neurological Cervical Spine Scale (NCSS) [8], a method of scoring motor function of the upper and lower extremities and sensory deficits. Using this scale, the maximum score is 14 (free of neurological deficits) and the minimum score is 3 (severely disabled with motor and sensory deficits).

Operation

The anterior interbody fusion with iliac autografts was performed via a left or right-sided transverse skin incision. Following discectomy, the superior and inferior vertebral cortical endplates were
partially decorticated. After preparation of the cavity accommodated to the autograft, the dorsal margin of the vertebral bodies was resected, including the osteophytes and other offending structures. The autograft was inserted using Caspar distraction device. The iliac bone autograft was harvested from the patient’s anterior iliac crest. All patients wore a Philadelphia cervical collar for 2 months postoperatively.

Expansive laminoplasty was performed according to a modification of the midsagittal splitting method described by Kurokawa [6, 10]. Through a midline longitudinal incision, only one side of the paravertebral muscles was separated from the nuchal ligaments and their origin to expose ipsilateral laminae and spinous processes. The spinous processes were severed at the base using an air saw with a right-angled blade. The opposite paravertebral muscles, severed spinous processes and nuchal ligaments were retracted in a group to expose the laminae totally. Using an air drill with a diamond bar, splitting along the midline and drilling of the two gutters just medial to the facet joint were completed. After the laminae were opened, HA spacers were placed in the opening spaces and sutured with opened laminae and severed spinous processes. The HA spacer was made to be 40% porous and arch-shaped as designed by one of us (TG). It has a hilo lock on the top for fitting to the severed spinous processes and hollows of both sides for fitting to the opened laminae (Asahi Optical Co. Ltd., Tokyo, Japan). All patients wore a loose collar for 2 months postoperatively.

Imaging Studies

Postoperative lateral radiographs were obtained at 12 months. The index of curvature of the cervical spine (CCI) was calculated by the Ishihara’s method [7].

MR examinations were performed on a 1.5-T super conductive system (VISART and VISART/Ex, Toshiba, Tokyo, Japan) with a surface neck coil. All images were obtained using T2 weighted fast spin echo (T2W FSE) pulse sequences which are sensitive to disc degeneration the same as T2 weighted spin echo (T2W SE) sequences [13]. FSE imaging shortens the time for obtaining heavily T2 weighted sequences and has a higher spatial resolution than conventional T2 weighted imaging. For this sequence, the following parameters were used: 4500–5000/136 (effective TE), 160 x 256 matrix size, 4 mm section thickness with 1 mm intersection gap, and two signals were acquired. The field of view was 15 x 20 cm for sagittal images. Relative signal intensities were also measured using a region-of-interest (ROI) facility. The ROIs were placed in the discs (Id) and the upper cervical cords (Ic) in the midline sagittal images. Disc degeneration was evaluated semiquantitatively by calculating the degenerative index (DI = Id/Ic), (Fig. 1). Three times readings of signal intensity were taken in the discs and the upper cervical cords and the average of the readings was used. A total of 56 discs were evaluated and classified into 3 groups. Group I included the immediately contiguous discs cephalad or caudal to the site of the anterior fusion (n = 14), group Ia included immediately contiguous discs cephalad or caudal to the range of laminoplasty (n = 14) and group Ib included the discs within the range of laminoplasty (n = 28).

Statistical Analysis

Statistical analysis was performed using paired Student’s t-test to show differences between pre- and postoperative radiographic features. The serial changes of DIs in each group and the association between the serial changes of DIs and three groups were tested by repeated analysis of variance (ANOVA) with commercially available software (StatView 4.5 J; Abacus Concepts, Berkeley, CA). A p-value of <0.05 was considered statistically significant.

![Fig. 1. A postoperative T2-weighted fast spin echo image in a 66-year-old woman after the expansive laminoplasty (C3-7) using HA ceramic spacers. The regions of interest were placed in the discs and the upper cervical cord in the midline sagittal image](image)

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<thead>
<tr>
<th>Table 1. Clinical and Radiographic Characteristics</th>
<th>Anterior fusion (preop)</th>
<th>Laminoplasty (preop)</th>
<th>Anterior fusion (postop)</th>
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<tr>
<td>n</td>
<td>7</td>
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<tr>
<td>Age, y</td>
<td>48 ± 6</td>
<td>58 ± 20</td>
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<td>Sex (M/F)</td>
<td>5/2</td>
<td>5/2</td>
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<tr>
<td>NCSS</td>
<td>10.0</td>
<td>12.6</td>
<td>9.6</td>
<td>11.3</td>
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<tr>
<td>Mean CCI</td>
<td>15.2&lt;sup&gt;NS&lt;/sup&gt;</td>
<td>11.0&lt;sup&gt;NS&lt;/sup&gt;</td>
<td>8.8&lt;sup&gt;NS&lt;/sup&gt;</td>
<td>5.4&lt;sup&gt;NS&lt;/sup&gt;</td>
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<sup>NS</sup> Not significant; <sup>NCSS</sup> Neurological Cervical Spine Scale<sup>3</sup>;<sup>CCI</sup> index of curvature of cervical spine calculated by the Ishihara’s method<sup>7</sup>.

Results

Clinical and radiographic characteristics of each group are shown in Table 1. None of the patients treated by anterior interbody fusion had complications such as instability in the adjacent levels and pseudoarthrosis in the fusion level. None of the patients treated by expansive laminoplasty had severe kyphotic deformity during the follow-up period.

The serial changes of DI in the three groups are shown in Fig. 2. The DIs in the group I significantly decreased within 12 months after surgery (F = 20.42;