Modified Transvertebral Anterior Decompression without Fusion for Cervical Myelopathy

Keisuke Onoda, Daisuke Tanioka, Kazuhiko Kurozumi, Shoji Tsuchimoto
Department of Neurosurgery, Onomichi Municipal Hospital
Hiroshima, Japan

ABSTRACT

Transvertebral anterior decompression (TVAD), primary aim of which is to treat multi-level anterior spinal cord disorders directly, provides anterior decompression at a greater width to expose the nerve root and the vertebral artery. In this series, we have achieved good results using a modified method of the transvertebral anterior decompression (TVAD), i.e., by exposing the dura mater of the spinal cord at a shorter width without approaching laterally. We report the details of our surgical experience with modified TVAD for anterior spinal cord disorders presenting with myelopathy.

This procedure was performed on 28 patients with cervical myelopathy (with average age 65.0 years). These cases included cervical spondylosis, disc herniation and OPLL. The range of anterior decompression included 1 to 4 intervertebral spaces with an average of 2.3. The width of anterior decompression was 6 to 15 mm with an average of 10.5 mm. Surgical results were evaluated in accordance with the Neurosurgical Cervical Spine Scale (NCSS).

The average of preoperative score was 9.1, with the score being 12.1, the score remained at the same level one month later and one year after the surgery. The surgery was found to be efficiently reduce the symptoms, especially regarding the improvement of lower limb weakness. No instability was observed.

Modified TVAD has high potential for anterior decompression because this technique can be performed not only on the disc level, but also continuously on the vertebral body level. Furthermore, it may be unnecessary to extend the width of vertebrectomy to the lateral side for patients suffering from myelopathy.

Key word: transvertebral anterior decompression, myelopathy

Spinal Surgery 15 (3) : 183～190, 2001

Introduction

Modified Transvertebral anterior decompression (TVAD) is a method to directly eliminate disorders and to provide decompression in contrast to the conventional posterior approach, which has been performed so far to treat anterior spinal cord disorders such as multi-level cervical spondylosis, ossification of the posterior longitudinal ligament (OPLL), cervical disc herniation, etc. As well, this technique is superior to the conventional method in that there is no need to perform bone graft and fixation. This method

(Received: January 30, 2001, Accepted: August 14, 2001)
### Table

<table>
<thead>
<tr>
<th></th>
<th>a</th>
<th>b</th>
<th>c</th>
<th>d</th>
<th>e</th>
<th>f</th>
<th>g</th>
<th>h</th>
<th>i</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>58/M</td>
<td>S+H</td>
<td>4</td>
<td>12</td>
<td>5</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>82/F</td>
<td>S</td>
<td>3</td>
<td>14</td>
<td>9</td>
<td>12</td>
<td>12</td>
<td>8N</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>50/M</td>
<td>O</td>
<td>1</td>
<td>12</td>
<td>11</td>
<td>13</td>
<td>N</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>55/M</td>
<td>S+H</td>
<td>2</td>
<td>15</td>
<td>11</td>
<td>13</td>
<td>14</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>69/M</td>
<td>S+H</td>
<td>2</td>
<td>13</td>
<td>9</td>
<td>12</td>
<td>12</td>
<td>8N</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>83/M</td>
<td>S+H</td>
<td>3</td>
<td>12</td>
<td>7</td>
<td>11</td>
<td>N</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>83/M</td>
<td>O+</td>
<td>3</td>
<td>12</td>
<td>12</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>56/M</td>
<td>H</td>
<td>2</td>
<td>11</td>
<td>9</td>
<td>12</td>
<td>13</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>92/M</td>
<td>S</td>
<td>4</td>
<td>13</td>
<td>10</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>69/M</td>
<td>S+H</td>
<td>3</td>
<td>14</td>
<td>9</td>
<td>12</td>
<td>12</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>69/M</td>
<td>O+S</td>
<td>3</td>
<td>15</td>
<td>10</td>
<td>12</td>
<td>13</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>49/F</td>
<td>H</td>
<td>1</td>
<td>8</td>
<td>12</td>
<td>14</td>
<td>14</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>74/M</td>
<td>O+S</td>
<td>3</td>
<td>12</td>
<td>6</td>
<td>9</td>
<td>9</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>70/F</td>
<td>S+H</td>
<td>2</td>
<td>12</td>
<td>9</td>
<td>13</td>
<td>13</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>69/M</td>
<td>S</td>
<td>4</td>
<td>12</td>
<td>8</td>
<td>12</td>
<td>12</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>82/F</td>
<td>S</td>
<td>2</td>
<td>12</td>
<td>6</td>
<td>9</td>
<td>10</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>58/F</td>
<td>H</td>
<td>1</td>
<td>6</td>
<td>11</td>
<td>14</td>
<td>14</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>71/M</td>
<td>S+H</td>
<td>1</td>
<td>7</td>
<td>10</td>
<td>12</td>
<td>12</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>53/M</td>
<td>S+H</td>
<td>2</td>
<td>8</td>
<td>9</td>
<td>12</td>
<td>13</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>59/M</td>
<td>H</td>
<td>1</td>
<td>7</td>
<td>10</td>
<td>14</td>
<td>14</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>55/M</td>
<td>S</td>
<td>3</td>
<td>9</td>
<td>9</td>
<td>12</td>
<td>12</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>56/F</td>
<td>H</td>
<td>2</td>
<td>7</td>
<td>9</td>
<td>12</td>
<td>12</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>36/M</td>
<td>S</td>
<td>2</td>
<td>12</td>
<td>10</td>
<td>12</td>
<td>14</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>73/M</td>
<td>O</td>
<td>4</td>
<td>10</td>
<td>6</td>
<td>8</td>
<td>8</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>63/M</td>
<td>H</td>
<td>1</td>
<td>11</td>
<td>9</td>
<td>14</td>
<td>14</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>61/F</td>
<td>H</td>
<td>2</td>
<td>6</td>
<td>11</td>
<td>12</td>
<td>N</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>50/F</td>
<td>H</td>
<td>2</td>
<td>8</td>
<td>9</td>
<td>14</td>
<td>N</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>74/F</td>
<td>S</td>
<td>2</td>
<td>10</td>
<td>9</td>
<td>14</td>
<td>N</td>
<td>N</td>
<td></td>
</tr>
</tbody>
</table>

- **S**: cervical spondylosis
- **H**: disc herniation
- **O**: ossification of posterior longitudinal ligament
- **N**: unknown

- **a**: Case number
- **b**: Age/Sex
- **c**: Pathology
- **d**: Range of anterior decompression (intervertebral space)
- **e**: Width of anterior decompression (mm)
- **f**: Neurosurgical cervical spine scale (presurgery)
- **g**: Neurosurgical cervical spine scale (one month after surgery)
- **h**: Neurosurgical cervical spine scale (three month after surgery)
- **i**: Neurosurgical cervical spine scale (one year after surgery)
may be more akin to "Antero-lateral partial vertebralctomy (ALPV)" Ohara et al [7], "trans-unco-discal approach" by Hakuba [2], "multiple oblique corpectomies without fusion" by George et al [1], "microsurgical anterior foraminotomy" by Jho [3], and "osteoplastic anterolateral vertebralctomy without fusion" by Takayasu et al [10]. The technique reported by Ohara et al [7] has a primary aim of achieving anterior decompression not only on vertebral bodies and discs anterior to the cord but also on the lateral side of the vertebral body until access to the nerve root and vertebral artery. In the present study, we performed anterior decompression only to the medial region of the vertebral body and disc in cases of cervical myelopathy and obtained satisfactory results. Based on the results of our present study, the usefulness of this technique will be described below with some review of the literatures concerned and brief discussion.

Materials and Methods

The indication for this type of surgery was multilevel lesions located anterior to the spinal cord (cervical spondylosis, disc herniation and OPLL). The levels treated with this procedure involved C3-4, C4-5, C5-6, C6-7 and C7-Th1. No instability was confirmed by the preoperative X-p study.

The cases under study included 28 patients (19 male and 9 female) to whom the method was applied. The age of the patients ranged from 36 to 92 years with an average age of 65.0 years (Table). The patient group included 5 very elderly patients with advanced ages of more than 80 years. The diseases of the patients included "spondylosis + disc herniation" in 8 cases, "spondylosis + OPLL" in 3 cases, spondylosis alone in 7 cases, disc herniation alone in 8 cases, and OPLL alone in 2 cases. Spinal canal stenosis was found in all cases. Symptoms included motor disorder in 28 cases (upper limbs in 28 cases; lower limbs in 21 cases), sensory disorder in 26 cases, and vesicorectal disorder in two cases. During the surgery, an incision of 6 cm was made on the anterior margin of the sternocleidomastoid muscle, and the vertebral body was reached using the conventional procedure for anterior fixation. The longus colli muscle was detached until the origin of transverse process was exposed. Under microscope, an air drill was used to create a groove of about 6 mm on the antero-lateral regions of vertebral bodies and discs, and posterior longitudinal ligament was confirmed. Then, vertebral bodies and discs were resected for a width of 6-15 mm. Next, the posterior longitudinal ligament was detached from dura mater by means such as the Kerrison punch and was extracted. It was confirmed that bulging and pulsation of the spinal cord were satisfactory. Drainage was retained, platyzma and skin were sutured, and surgery was completed. After surgery, only soft collars were used, and rehabilitation was executed from the early stage. Surgical results were evaluated in accordance with the Neurosurgical Cervical Spine Scale (NCSS) [4]. The scores ranged from 5-12 (with an average score of 9.1). Width of anterior decompression was measured under surgical microscope. The postoperative evaluation was performed according to the above scale over time. The postoperative instability was evaluated by the dynamic cervical X-p study.

Cases

<Case 1>

The patient was a 58-year-old man. He had experienced spinal cord injury at 10 years of age due to accident and underwent conservative therapy. His four limbs were in a state of severe spinal myelopathy. Spastic tendency was noted and the patient used a wheel chair. Vesicorectal disorder was also found. Magnetic resonance imaging (Fig.1) and axial CT (Fig.2) revealed severe cervical spondylotic changes and spinal canal stenosis at the C3-4, C4-5, C5-6, and C6-7 levels. To treat this case, modified TVAD was performed on 4 intervertebral regions of C3-4 - C6-7 (Fig.3). In anterior decompression at the levels of C3-4 and C6-7, we drilled out them using the distal groove space to spare the C3 and C7 cortex bone, creating a shape like a tunnel. The width of anterior decompression was 12 mm. The preoperative
Fig. 1 (Case 1)
Preoperative Magnetic resonance imagerings. Sagittal T1 (left) and T2 (right)-
weighted MR images revealing cervical spondylotic changes, spinal stenosis at the
C3-4, C4-5, C5-6, and C6-7 levels and mild myelomalacia due probably to chronic
spinal cord compression.

Fig. 2 (Case 1)
Preoperative computerized tomographic scans. Axial scans at the C4 (upper left), C5 (upper
right) levels revealing spinal stenosis resulting from spinal cord compression by the anterior
components (hard discs and osteophytic spurs). Postoperative axial scans at the C4 (lower left)
and C5 (lower right) levels demonstrating that the spinal cord was marked decompressed.

NCSS score was 5, while it was improved to 8 one
month later. Then, the patient could walk with the aid
of a cane and was discharged from the hospital. In the
examination performed one year after surgery, no sign
of instability was noted.

<Case 2>
A 82-year-old woman showed a moderate degree
of cervical myelopathy. Motor weakness of the left
upper and lower limbs was found, and she was using
a wheel chair. Based on the results of CT and MRI,
she was diagnosed as cervical spondylosis, and
modified TVAD was performed on 3 intervertebral
regions of C4-5 - C6-7 (Fig.4). The width of anterior
decompression is 14 mm. Her preoperative NCSS
score was 9, while it improved to 12 after one month,
and the patient could walk using a cane. MRI results
also recognized a space in anterior to the spinal cord
showing the state of decompression. There was no
evidence of instability in the cervical spine during the postoperative course.

Results

The range of anterior decompression included 1-4 intervertebral spaces (2.3 in average). The width of decompression is 6 to 15 mm, with an average of 10.5 mm. Postoperative evaluation in accordance with NCSS showed a score of 8-14 points one month after the surgery (9.1 in average). The average rate of improvement was 61.2%, and this was approximate to the postoperative results reported by Ohara et al [8]. Three months after surgery, average score was 9.2 with the rate of improvement of 63.3% showing satisfactory results. One year after the surgery, the score still remained at the same level (Fig.5). Motor function of upper limbs was 5.0 points in preoperative average score. One month after the surgery, this had risen to 4.2 points with a rate of improvement of 60.0%. In the improvement of motor function of lower limbs, the preoperative score was 3.4. One month after surgery, it had risen to 4.6 with a rate of improvement of 75.0%. Three month after the surgery, the score still remained at the same level. These results show that this technique is effective for the patients suffering from myelopathy caused gait disturbance. In the course of improvement, the motor function of lower limbs improved earlier than that of upper limbs. There has been no sign of instability in the cervical spine during the postoperative course up to now.

Regarding complications, disorder at the C5 nerve root was found in 3 cases, although the symptoms were transient. Also, transient Horner sign was seen in one case.

Discussion

In the anterior approach, the standard procedure is anterior decompressive fixation using bone graft from iliac bone, and this is regarded as useful. However, this procedure involves problems such as postoperative pain in the iliac region and requirement of external fixation. In the present procedure, the bone graft was not performed. Ohara et al. [8] reported from their experience in the long-term follow-up of 159 cases over an average period of 3.8 years that deformation of the cervical spine has appeared in only 2 cases (1.3%). Moreover, in one of these two cases, instability had been recognized before surgery. Also, in the average 3-year follow-up
study of 101 cases as reported by George et al [1], only 3 such cases were seen (3.0%). According to Ohara et al [8], deformation was found not later than 6th postoperative month. In our present experience, lateral components of the vertebral body such as Luschka's joint were preserved, and it was considered that deformation appeared less frequently, but we will perform careful observation of the course. In postoperative management, the patients need to wear soft collars for 2 weeks, and can walk from the next day of the surgery. This is particularly useful in the cases of elderly patients who should get rid of the bed earlier. In the present method, a surgical approach is made a parallel direction to the optical axis of the microscope. Further, we could get a wide operation field, because the consecutive vertebrectomy on the vertebral bodies and discs was made. Also, the surgery causes less bleeding and requires a shorter surgical duration. This method is less invasive and can be indicated for elderly patients in order to improve QOL.

![Graph showing rate of improvement over time after surgery](image)

**Fig.5**

Postoperative evaluation in accordance with NCSS showed the score of 8-14 points one month after the surgery (9.1 in average). The average rate of improvement was 61.2%. Three months after surgery, average score was 9.2 with the rate of improvement of 63.3% showing satisfactory results. One year after the surgery, the score still remained at the same level.

Although the symptoms were transient, pain in the C5 root was reported as a complication in 3 cases. The mechanism that develops this is not exactly known, but there are currently two different hypotheses, which are in striking contrast to each other. One [5] is that the pain occurs when decompression is insufficient, and the other [9] is that decompression is too extreme and the nerve root at C5, which is anatomically the shortest nerve root [6], is extended due to the forward movement of spinal cord. We agree with the latter hypothesis. Our twenty recent cases, decompression width at the level of the C5 nerve root was decreased to 11-12 mm, and this complication did not occur. However, further study should be performed to solve this problem.

In our present study, spinal canal stenosis was recognized in all cases. From the viewpoint of the increase of spinal canal volume, the posterior approach seems to be more useful, and this may be one of the best choices for surgery. According to the present method, however, decompression in the spinal
canal in the anterior approach can be achieved by continuously resecting not only on the disc level but also on the vertebral body level. To cope with the lesions causing spinal compression in the anterior direction, we considered that an approach should be made from the anterior direction in order to remove the lesions. This seems to be an essential therapeutic approach and will be helpful to achieve physiological improvement. In the present study, the range of anterior decompression was limited to 15 mm on the medial region of the spinal cord, but a remarkable effect in improving cervical myelopathy was noted. These results suggest that it may not be necessary to perform anterior decompression on the lateral side of the vertebral body, but that anterior decompression of the medial region only would provide satisfactory results.

References


Reviewer's comment:
Masakazu Takayasu
Department of Neurosurgery
Nagoya University School of Medicine
Nagoya, Japan

The authors demonstrated their results of the anterolateral cervical decompression without fusion for multi-level cervical myelopathy. The anterolateral approach for the cervical spine was reported long time before by Verbiest in 1968 and Hakuba in 1976. This approach was applied to multi-segmental cervical spondylosis and reported independently by Ohara and George in 1994. The best advantage of these methods was no need for long bone grafts or instrumentation, preserving postoperative neck movement. Limitations of this method are the need of learning skills for surgical orientation of antero-lateral cervical approach in the narrow operative field and the potential weakness of the cervical spinal column after partial resection, which may produce deformity of spinal alignment during long-term follow-up. I have reported a modified osteoplastic anterolateral vertebroplasty approach for multi-level cervical OPLL to widen the operative field, keeping postoperative cervical stability.

I congratulate the authors on the satisfactory results in 28 patients. Neurological improvement stayed for one year in their patients and improvement of the lower limb motor function was greater. Although the authors stated that wide decompression might be unnecessary, late neurological deterioration could occur after insufficient decompression, especially because there is a potential risk of deterioration of cervical alignment with this method. I am expecting to see the long-term follow-up results including cervical alignment in their patients.

Reviewer's comment:
Kyo Niijima
Department of Neurosurgery, Nakatsu Hospital
Osaka, Japan

Onoda, et al described an excellent paper, in which usefulness of multilevel anterolateral partial vertebrectomy for cervical myelopathy was dealt with. The operative procedure was originally performed by Hakuba (transuncondiscal approach) and modified and popularized by Ohara, George and Takayasu. The modification done by the present authors was likewise proved to be effective, although the follow-up term was yet only one year.

However, I do not agree with their opinion that “multi-level lesions located anterior to the spinal cord” are unexceptionally indicated to this surgery without further selection (page 185, line 23). In addition, some of the authors’ words could not be fully understood; for example, “It was confirmed that bulging and pulsation of the spinal cord (theca?)” (page 185, line 11) or “we drilled out them using the distal groove space (instrument?)” (page 185, line 41).

Concerning postoperative C5 radiculopathy, extensive vertebrectomy plus facetectomy would undoubtedly prevent the problem.