Clinical and radiological outcomes in 153 patients undergoing oblique corpectomy for cervical spondylotic myelopathy

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Abstract
Objective. To document the clinical and radiological outcomes in a large series of patients undergoing the oblique cervical corpectomy (OCC) for spondylotic myelopathy. Materials and methods. We retrospectively analyzed our series of 153 patients undergoing OCC for cervical spondylotic myelopathy (CSM) over the last 10 years. A mean clinical follow-up of 3 years was obtained in 125 patients (81.7%), while 117 patients (76.5%) were followed up radiologically. Neurological function was measured by the Nurick grade and a modified Japanese Orthopedic Association score (JOA). Plain radiographs and magnetic resonance images (MRI) were reviewed. Results. Ninety-two percent were men with a mean age of 51 years and a mean duration of symptoms of 18 months. Sixty-one had a single level corpectomy, 66 had a 2-level, 24 had a 3-level, and two had a 4-level OCC. There was statistically significant improvement (p < 0.05) in both the Nurick grade and the JOA score at mean follow-up of 34.6 ± 25.4 months. Permanent Horner’s syndrome was seen in nine patients (5.9%), postoperative CSF radiculopathy in five patients (3.3%), dural tear with CSF leak in one patient (0.7%), and vertebral artery injury in one patient (0.7%). Of the 117 patients who were followed up radiologically, five patients (4.3%) developed an asymptomatic kyphosis of the cervical spine while 22 patients (25.6%) with preoperative lordotic spines had a straightening of the whole spine curvature. Conclusions. The OCC is a safe procedure with good outcomes and a low morbidity for treating cervical cord compression due to CSM. This procedure avoids graft-related complications associated with the central corpectomy, but is technically demanding.

Keywords: cervical myelopathy; complications; oblique corpectomy; technique

Introduction
Cervical spondylotic myelopathy (CSM) often requires surgical decompression when it results in progressive neurological deficits. Surgical approaches, either anterior or posterior, aim to widen the cervical canal and generally result in a good outcome. Discectomy and central corpectomy with grafting have been widely used through the anterior approach with or without anterior plating.1–5 From the posterior route, a cervical laminectomy with or without lateral mass screws/rods and laminoplasty are popular procedures among some spine surgeons.6–10 The choice between an anterior or posterior route depends on the location, extent and type of the compressive pathology, curvature of the spine, and presence of instability.

Since 1992, George et al.11 developed the oblique cervical corpectomy (OCC) through a lateral cervical approach as an alternative to the central corpectomy. Following a detailed cadaver dissection to familiarize ourselves with the anatomy and surgical technique, we have applied the OCC in the management of cervical myelopathy due to spondylotic disease since 2001. The main advantage of the OCC is that following the limited vertebral body resection no grafting or instrumentation is required thus theoretically preserving motion during flexion and extension. Despite its advantages, the procedure has not gained popularity primarily because of risk of vertebral artery (VA) injury and Horner’s syndrome.12,13 Here, we present a retrospective analysis of 153 cases operated by the OCC focusing on the surgical technique, clinical and radiological outcomes, and our complication rates.

Materials and methods
Between 2001 and 2011 we performed 153 oblique corpectomy procedures on patients with CSM. Patients with ossified posterior longitudinal ligament (OPLL) were excluded due to a fundamentally different pathophysiology, natural history, complication rates, and outcomes. Patients presenting with myelopathy underwent a detailed neurological examination, including assessment of functional status using the Nurick grading system14 and a modified Japanese Orthopedic Association score (JOA) scoring system for cervical myelopathy.15
Radiology
All patients had plain radiographs of the cervical spine in neutral, flexion, and extension. A preoperative magnetic resonance imaging (MRI) determined the extent of the cord compression. Patients were selected for an OCC when the number of levels of cord compression was ≤4 and if there was no spinal instability irrespective of spinal curvature. Cervical spine instability was defined as lack of anterior-posterior translation on flexion and extension plain radiographs. The number of levels of compression and T2-weighted intramedullary changes were noted on the MRI. Whole spine curvature was defined on lateral neutral radiographs in relation to a line joining the postero-inferior edge of C2 to the postero-inferior edge of C7. The spine was called lordotic when the posterior surfaces of the vertebral bodies were anterior to the line, straight when at least one body touched the line and kyphotic when the posterior vertebral margins crossed the line.

Operative procedure
A brief description of the operative procedure will be made here since it has been described in detail before.11 The patient is positioned supine with the head extended and turned slightly to the contralateral side. The skin incision is along the anterior border of the sternocleidomastoid muscle, the carotid sheath is retracted medially to expose the longus colli muscle on which lies the sympathetic chain that is retracted medially. The image intensifier confirms the vertebral level and the longus colli muscle divided transversely over the costotransverse bar and its medial half excised to expose the uncovertebral joints and the lateral portion of the vertebral body. The VA lies unprotected between two consecutive vertebrae but is protected above C6 in the foramen transversarium and also to confirm the adequacy of dural decompression in both axial and sagittal planes.12 The microscope is brought in and a diamond drill is used to thin down the costotransverse bar to the periosteum over the VA. A cutting burr is used to make a vertical trough, 8 mm wide in the vertebral body leaving about 3 mm of cortical bone to protect the VA laterally. The image intensifier confirms the vertebral level and the longus colli muscle divided transversely over the costotransverse bar and its medial half excised to expose the uncovertebral joints and the lateral portion of the vertebral body. The microscope is used to thin down the costotransverse bar to the periosteum over the VA. A cutting burr is used to make a vertical trough, 8 mm wide in the vertebral body leaving about 3 mm of cortical bone. The VA lies unprotected between two consecutive vertebrae but is protected above C6 in the foramen transversarium and also to confirm the adequacy of dural decompression in both axial and sagittal planes.12 The microscope is brought in and a diamond drill is used to thin down the costotransverse bar to the periosteum over the VA. A cutting burr is used to make a vertical trough, 8 mm wide in the vertebral body leaving about 3 mm of cortical bone to protect the VA laterally. Thus there is no actual manipulation of the VA. This drilling is continued along the entire craniocaudal extent of the corpectomy after which the microscope is repositioned to obtain an oblique view across to the contralateral side of canal. Using a smaller cutting burr, drilling is continued following the posterior cortical margin to the contralateral side. The posterior longitudinal ligament is opened with a sharp hook and then excised using rongeurs. Intraoperative ultrasound can be used to locate the VA between the foramina transversarium and also to confirm the adequacy of dural decompression in both axial and sagittal planes.12 A tube drain is left in-situ for 24 hours, the patient is mobilized the same day and allowed to go home after 2–3 days. During the initial period of the study a cervical collar was advised for 3 months but when we realized that spinal motion could be preserved with the OCC, we stopped advising the use of a cervical collar.17

Follow-up
Patients were advised to return for follow-up annually or to send us MR images and cervical spine lateral radiographs in neutral, flexion, and extension views. The majority of patients treated at our institution are residents of other states in the country. Although many returned for clinical and radiographical follow-up, the remaining were contacted through mail or telephone and were asked questions relevant to obtaining a clinical outcome through the JOA/Nurick grading systems. We obtained clinical follow-up in 125 patients (81.7%) and radiological follow-up in 117 patients (76.5%) with a mean follow-up of 34.6 ± 25.4 months (range, 6–117 months).

Statistics
Data were entered in Access software (Microsoft, Seattle, WA) and were analyzed using SPSS software, version 11.5 (SPSS, Inc., Chicago, IL). Means and standard deviations were computed for continuous variables. A paired t-test was used to compare means derived from the Nurick grade and JOA score of each patient. A Chi-square cross tabulation was done to assess the pre and postoperative Nurick score across various grades, as well as the pre and postoperative cervical spine curvature. A p value < 0.05 was considered significant.

Results
Of the 153 patients, 141 were men and 12 were women. Their mean age was 51.1 ± 10 years (range, 23–82 years). The mean duration of symptoms was 18.28 ± 26.7 months (range, 1–180 months). Sixty one had a single level corpectomy, 66 had a 2-level, 24 had a 3-level, and two had a 4-level OCC. There were no mortalities related to the procedure.

Clinical
Table I describes the presenting clinical features—difficulty in walking was the most common presentation with a mean duration of 2.0 years (range, 0.9 and 14.4 months). The mean preoperative Nurick grade was 3.4 ± 0.9 and the JOA score was 11.6 ± 2.6. The mean postoperative Nurick grade and JOA score were 2.4 ± 0.9 and 14.4 ± 2.0, respectively. (p < 0.05)

Early postoperative improvement
Immediate subjective improvement in spasticity and paresthesia was seen in 111 patients (72.8%), 37 (24.4%) remained the same while five (3.2%) worsened. All five patients had a C5 radiculopathy. One of these worsened on the seventh postoperative day and was discovered to have a wound hematoma that required evacuation following which he improved to Grade III.

Table I. Summary of preoperative symptoms and signs in 153 patients.

<table>
<thead>
<tr>
<th>Symptoms and signs</th>
<th>Number of patients (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gait difficulty (Spasticity)</td>
<td>146 (95.4)</td>
</tr>
<tr>
<td>Paresthesia/sensory impairment</td>
<td>130 (82.4)</td>
</tr>
<tr>
<td>Posterior column dysfunction</td>
<td>98 (64.1)</td>
</tr>
<tr>
<td>Radicular pain</td>
<td>23 (15)</td>
</tr>
<tr>
<td>Bladder dysfunction</td>
<td>64 (41.8)</td>
</tr>
</tbody>
</table>
Clinical outcome at follow-up

Table II shows the clinical improvement across various grades in 125 patients with a mean follow-up of 35.9 months. All 13 Nurick Grade V patients improved to a better grade. Of these, 46.2% improved to Grade I or II and 53.8% improved to Grade III or IV. Of the Grade IV patients 22.5% remained the same, whereas 40% improved to Grade I or II, and 37.5% improved to Grade III. In the Nurick Grade III group 2/3rds improved to Grade I or II. Half of the Nurick Grade II patients improved to Grade I, while the others remained at Grade II. One of our patients, who had shown remarkable immediate postoperative improvement, returned with recurrence of myelopathy 4 years after OCC and underwent a repeat oblique corpectomy at a higher level.

Radiology

Preoperatively, the cervical spine was lordotic in 111 (72.5%) patients, straight in 32 (20.9%) and kyphotic in 10 (6.5%) patients. On pre-operative MRI, T2 weighted intramedullary signal hyperintensities were seen in 117 (76.4%) patients. Table III compares pre and postoperative spine curvatures in 117 patients (76.5%) with a mean radiological follow-up of 3 years. Those with a preoperative lordotic spine remained unchanged in 70.9%, straightened in 25.6%, and developed kyphosis in 3.5%. Twenty out of 25 (80%) patients with a preoperatively straight spine remained straight postoperatively while two patients developed an asymptomatic kyphosis. There was no increase in the kyphosis on follow-up in six patients with preoperative kyphosis in whom follow-up was available. The occurrence of kyphosis or straightening of the spine was not associated with neurological deterioration or a lack of clinical improvement. In the postoperative flexion and extension radiographs no abnormal sagittal plane translation to suggest instability was noted in any patient.

Complications (Table IV)

Dural tear with CSF leak occurred in only one case that resolved with bed rest and a lumbar subarachnoid drain for 5 days without requiring a re-exploration. The VA was injured during dissection of the longus colli in one case in the early part of the series—we have not had this complication in the last 140 cases. In this patient the bleeding stopped with pressure and no deficits were noted postoperatively. Temporary Horner’s syndrome in the immediate postoperative period was seen in 32 patients (21.1%) that improved in the majority by 6 months and permanent Horner’s syndrome was seen in only nine patients (5.9%). Five patients developed a C5 radiculopathy in the immediate postoperative period, four of which improved to normal in 6 months; one had persistent weakness with Grade III power at shoulder.

Discussion

CSM is a degenerative disease that results in neck pain, upper and lower limb numbness, paresthesiae and stiffness, gait difficulties, and bladder dysfunction. Men constituted the vast majority of our patients with only 8% being women. Apart from studies recruiting patients from Veterans Affairs clinics6 most reports from western literature indicate an equal gender distribution or a slight male preponderance.7,9 The low incidence of CSM in women from India is also noted in other series though the reason for this difference has not been elucidated.20,21 The mean age of 50 years in our cohort of patients is significantly lower than that seen in other series11,19,22 and is a finding supported by other series reported from India.3,21,23 The young age at presentation in our part of the world is not an isolated finding in CSM but also in other central nervous system diseases that present a decade earlier than in the western population24—it is unclear whether this finding is related to the lower life expectancy of our population. George et al.11 clearly mention that most of their patients, who had a mean age of 58 years, had hard, collapsed discs with probably partially fused spines. Age did not correlate with outcome in our series, a finding that is supported by most studies22,23,25 except for a few suggesting that older patients have a worse outcome26,27 and one that suggests a better outcome in elderly patients.28

Clinical outcomes using the central corpectomy

Central corpectomy provides an excellent ventral decompression of the cord but is inherently destabilizing requiring bone grafting with or without instrumentation.23,29-32 The majority of patients treated by the central corpectomy experience clinical improvement ranging from 57% to 86%—the remaining either reporting static neurological function or deterioration. The morbidity rates vary from 5% to 28%.29 Delayed deterioration following improvement has been documented in about 5% of CSM cases.31 Fusion related accelerated degenerative changes occurring in about 75% of cases at segments adjacent to the fused segment, although asymptomatic in the short term may be clinically relevant at long term follow-up.20 Central corpectomy over more than 2-levels tend to result in postoperative kyphosis and implant

Table II. Preoperative versus postoperative follow-up Nurick’s grade for 125 patients with clinical follow-up.

<table>
<thead>
<tr>
<th>Grade</th>
<th>0</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre op Nurick’s Grade</td>
<td>65</td>
<td>43</td>
<td>9</td>
<td>86</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>22</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>34</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>18</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>0</td>
<td>0</td>
<td>16</td>
<td>59</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table III. Preoperative versus postoperative spine curvatures in 117 patients with radiological follow-up.

<table>
<thead>
<tr>
<th>Postoperative cervical spine curvature (mean follow-up 36.4 months)</th>
<th>Lordotic</th>
<th>Straight</th>
<th>Kyphotic</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre op curvature</td>
<td>61</td>
<td>22</td>
<td>3</td>
<td>86</td>
</tr>
<tr>
<td>Lordotic</td>
<td>61</td>
<td>22</td>
<td>3</td>
<td>86</td>
</tr>
<tr>
<td>Straight</td>
<td>3</td>
<td>20</td>
<td>2</td>
<td>25</td>
</tr>
<tr>
<td>Kyphotic</td>
<td>1</td>
<td>4</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>65</td>
<td>43</td>
<td>9</td>
<td>117</td>
</tr>
</tbody>
</table>
Fig. 1. A), B) and C) Preoperative neutral, flexion, and extension radiographs of a 44-year-old man with CSM showing straightening of the spine. D) and E) Preoperative sagittal and axial MRI of the patient showing cord compression from C3-7 with myelomalacic changes at C6-7. F) and G) 5-year postoperative sagittal and axial MRI after a C4,5,6 oblique corpectomy showing adequate decompression behind C4,5 and 6 vertebral bodies with widening of the CSF spaces at these levels. There is some residual compression at the lower end of the corpectomy. H), I), and J) Postoperative neutral, flexion, and extension plain radiographs at 5 year follow-up showing no change in the sagittal curvature, maintained disc space heights, no instability on dynamic views, and preservation of segmental motion.
Table IV. Complications in 153 patients who underwent oblique corpectomy.

<table>
<thead>
<tr>
<th>Complications</th>
<th>Number of patients (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permanent Horner’s syndrome</td>
<td>9 (5.9)</td>
</tr>
<tr>
<td>C5 radiculopathy</td>
<td>5 (3.3)</td>
</tr>
<tr>
<td>CSF leak</td>
<td>1 (0.7)</td>
</tr>
<tr>
<td>Vertebral artery injury</td>
<td>1 (0.7)</td>
</tr>
</tbody>
</table>

Fig. 2. A 53-year-old man with cervical myelopathy, Nurick Grade II who underwent a C5 OCC. A and B) Pre and 3-year postoperative neutral sagittal MR images show the decompression of the cord after the C5 OCC. C) Preoperative neutral lateral cervical radiograph showing a lordotic spine. D, E, F) 3-year postoperative cervical lateral neutral, flexion, and extension radiographs showing maintenance of lordosis and no instability on the dynamic views.

failure prompting surgeons to do additional posterior stabilization in these cases.²

Clinical outcomes using the oblique corpectomy

The OCC has been adopted by other authors who have confirmed good results.²⁵,³³–³⁵ The main advantage attributed to this technique is the adequate ventral decompression without the need for bony fusion. Our cohort of patients were at least 5–10 years younger than those reported in western series¹¹,¹⁹,³⁴ and we included those patients with soft, non-collapsed disc spaces.¹⁷ The clinical improvement that we report (74%) is similar to what is observed in other studies with the OCC¹¹,¹⁹,²⁵,³⁴,³⁵ and the central corpectomy.²,³,²³,²⁹,³¹ Kiris and Kılıncer³⁴ found that 92.5% of the 40 patients who underwent an OCC for cervical spondylotic myelopathy improved at the 6-month follow-up examination according to the JOA score. Bruneau et al.³⁶ reported their results in the last 100 patients which showed improvement in 82% of their patients. In our series there was an improvement across all Nurick grades with the greatest changes seen in those with a poorer pre-operative function (Nurick Grades IV and V). Thus, even poor grade patients with CSM stand a good chance of improving after a corpectomy.²³

Whole spine curvature after oblique corpectomy

In their 40 patients, Kiris and Kılıncer³⁴ showed that sagittal alignment was well preserved at a mean of 59 months postoperatively showing neither a change of more than five degrees in lordotic angle nor instability. Chibbaro et al.¹⁹ report an average increase in spinal canal diameters by 67% with only 2% of
their patients going on to develop instability. We measured the whole spine curvature pre and postoperatively in 117 patients in whom complete radiological information was available. Of the patients who had a lordotic or straight spine preoperatively, only five patients developed an asymptomatic kyphosis at last follow-up. Thus, a quarter of lordotic spines straightened with no clinical worsening, while 80% of the straight spines did not have a change in curvature indicating a reasonable maintenance of sagittal alignment. None of our patients developed postoperative cervical spine instability. Preservation of segmental and whole spine range of motion following the OCC has been documented by us in another study.

Disadvantages of the oblique corpectomy

Major difficulties that may limit the popularity of the OCC are related to operating in the vicinity of the VA and mobilization of the sympathetic chain with a consequent Horner’s syndrome. In our series, Horner’s syndrome was most often found to be a transient deficit noticed in the immediate postoperative period and remained permanent in less than 6% of our patients, similar to that in other series. We have adopted a modification of the operative technique in the last few years by making a longitudinal incision in the longus colli sheath and retracting the sympathetic chain medially that has resulted in a further reduction in the incidence of this complication. Injury to the VA is a distinct possibility and occurred in the early part of our series during reflection of the longus colli muscle off the costotransverse bar.

Limitations of our study

Limitations inherent to this study include its retrospective analysis, although clinical functional grade was assigned prospectively. Thus, data pertaining to disability index and quality of life assessments such as the SF-36 questionnaire that may add to assessing clinical outcomes are lacking in this series. Secondly, we acknowledge that the lack of long-term follow-up in about 20% of our patients may be a drawback in the interpretation of these data. However, since the patients who were lost to follow-up had preoperative, operative, and postoperative profiles similar to the study group we may assume that they would have had similar outcomes. Nevertheless, reporting the immediate postoperative outcomes and complications adds to the limited literature available for OCC in CSM.

Conclusions

The multilevel OCC while providing good clinical improvement also preserves stability postoperatively without the need for instrumentation. It may be offered to patients with CSM who have predominantly ventral compression without instability, irrespective of the preoperative spinal alignment. Clinical improvement occurs in the majority of patients; however there is a high incidence of Horner’s syndrome. This technique is technically more demanding during the initial learning process.

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References


