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Multilevel Oblique Corpectomy Without Fusion

Our Experience in 48 Patients

Giovanni Rocchi, MD, Emanuela Caroli, MD, Maurizio Salvati, MD, and Roberto Delfini, MD

Study Design. The authors provide their results in performing multilevel oblique corpectomy for degenerative spondylotic myelopathy in 48 patients.

Objective. To demonstrate the efficacy and safety of the multilevel oblique corpectomy when applied in selected cases.

Summary of Background Data. The technique of multilevel oblique corporectomies for treatment of cervical spondylogenetic myeloradiculopathies allows anterolateral access to the cervical spine so that the spinal canal and conjugate foramen can be widened at more than one level, without the need for vertebral stabilization.

Methods. During a 7-year period, multilevel oblique corpectomy was performed in 48 consecutive patients for degenerative spondylotic myelopathy. The outcomes were analyzed according to the Japanese Orthopaedic Association classification modified to Western customs, and according to Nurick's scale 1 month, 1 year, and 2 years after surgery. Spinal stability was evaluated in all patients by plain radiograph films of the cervical spine, lateral views in flexion and extension, on discharge, 1 month and 1 year after operation.

Results. Significant clinical improvement occurred in 29 patients with a complete functional recovery in 22; moderate improvement was achieved in 12 patients; neurological status remained stable in 5, and it worsened in 2. All patients showed spinal stability.

Conclusions. Multilevel oblique corpectomy was found to be a safe technique that guarantees good results in terms of both regression of clinical symptoms and long-term spinal stability.

Key words: bone graft, cervical spondylosis, multilevel oblique corpectomy, spinal instrumentation, spinal stability. **Spine 2005;30:1963–1969**

Many techniques have been proposed for treatment of cervical spondylogenetic myelopathy: single or multiple subtotal corpectomy with bone graft, with or without osteosynthesis; multiple discectomy with or without intersomatic fusion; laminectomy; expansive open door laminoplasty.[1–27]

In cases where three or more levels are affected, the techniques most frequently employed are multiple corpectomy with autologous bone graft or one of the posterior routes (laminectomy, open door laminoplasty). The multilevel oblique corpectomy (MOC) technique, described by George *et al*,[28–31] offers a valid alternative in cases of cervical spondylogenetic myelopathy because good clinical results can be achieved without bone grafting or osteosynthesis instrumentation.

The purpose of this report is to analyze our experience with this technique.

From the Department of Neurological Sciences, Neurosurgery, University of Rome "La Sapienza," Italy.

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Address correspondence and requests for reprints to Emanuela Caroli, MD, Department of Neurological Sciences, Neurosurgery, University of Rome "La Sapienza," Via Meropia, 85, Rome, 00147 Italy; E-mail: manucarol2000@yahoo.it

Materials and Methods

Between January 1995 and December 2001, we treated 48 patients using the MOC technique. The following criteria for patient selection were strictly applied: myeloradiculopathy, confirmed by neurophysiological tests; radiological [computed tomography (CT) or magnetic resonance imaging (MRI)] picture of acquired stenosis of the cervical canal with somatic spondylosis involving three or more levels, accompanied by hard herniations and signs of compression, mainly anterior; absence of clear signs of preoperative instability on dynamic, plain radiograph films; and absence of preoperative lysthesis >2 mm between any two contiguous vertebral bodies. Patients with a verticalized spine were admitted to the study, but the technique was not performed when there was cervical kyphosis.

Clinical conditions were evaluated before operation and 1 month, 1 year, and 2 years after operation, according to the Japanese Orthopaedic Association (JOA) classification[32] modified to Western customs and also according to Nurick's scale,[33] which allows specific assessment of lower limb motor deficits.

We subdivided patients into 4 groups according to results:

Group 1: significant improvement (at least 2 grades on Nurick's scale, namely, complete functional recovery or intact lower limb motility, JOA score of 16 or 17).

Group 2: moderate improvement (variation of 1 grade on Nurick's scale, incomplete functional recovery).

Group 3: no change in clinical status.

Group 4: clinical deterioration.

All our patients were studied by plain radiograph films of the cervical spine, lateral views in flexion and extension, on discharge and 1 month, and 1 year after operation.

Statistical analysis of the clinical outcome was evaluated using the Student *t* test. Statistical significance was assigned to probability values <0.05. Values are expressed as the means ± DS.

Surgical Technique. The MOC technique was described by George in 1993.[28,29] The approach to the spinal canal is anterolateral, preferring the side on which symptoms are more severe and osteophytes more marked, as documented by radiographic investigations. If the symptomatology is symmetrical, the side of the approach is the one with more marked radiological findings. When the approach is low, we prefer the left side

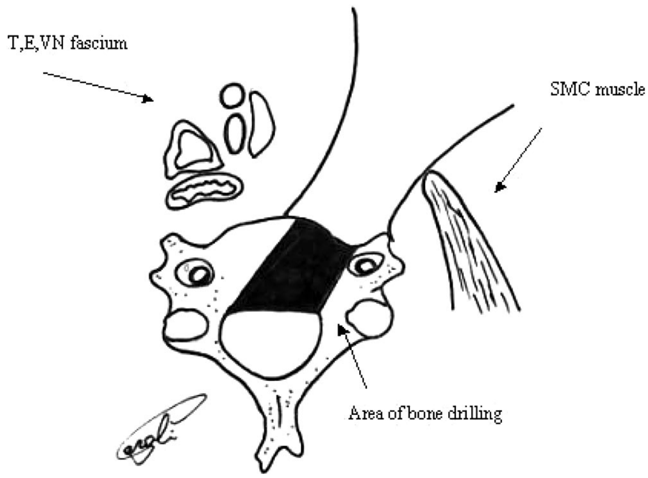

Figure 1.

to avoid involvement of the laryngeal nerve. George suggested that the spine should be approached from the side on which the vertebral artery (VA) is smaller. The vertebral arteries can be assessed by means of arterial echo-color Doppler sonography or magnetic resonance (MR) angiography, performed during preoperative MRI investigation. Once the side of the approach has been established, the patient is anesthetized and positioned supine with the head slightly extended and turned towards the controlateral side.

A skin incision is made along the medial edge of the sternocleidomastoid muscle (SCM) but must be extended to the tip of the mastoid process when it is necessary to reach C2–C3 and to the suprasternal notch to reach C7–T1. The platisma is cut to gain access to the anterolateral surface of the spine, passing through the lax cellular tissue lying between the SCM and the internal jugular vein. During this step, particular attention must be paid to the accessory nerve (XI cranial nerve), which should only be exposed for the higher levels (C2–C3 and/or C3–C4), and which should be gently retracted upwards, leaving it immersed in the cellular fat that surrounds it when possible. The SCM is reclined laterally, the neck vasculonervous system medially together with the trachea and esophagus, protected by a smooth spatula. The transverse processes are recognized with the finger. They are covered by the prevertebral muscles. Below the aponeurosis of the longus colli, the sympathetic chain must be identified, and then the aponeurosis may be cut longitudinally, medial to the sympathetic chain. The longus colli muscle is elevated from medial to lateral, and the longus capitis is kept in place when it is possible. The laterocervical sympathetic chain is exposed for a long tract so that it is not damaged in the displacement maneuver. The sympathetic chain is freed along the main trunk and is reclined gently with the aponeurosis to preserve the integrity of the thin rami communicantes (the communications between the sympathetic chain and the cervical nerve roots).

The longus colli muscle is retracted along the vertebral bodies and transverse processes at the decided levels. By retracting the longus colli muscle, the anterolateral surface of the vertebral bodies is clearly exposed. Before commencing trepanation with a high-speed air drill, the bone markers of the vertebral artery are identified. The uncovertebral joint and the medial portion of upper and lower transverse processes are the main landmarks for vertebral artery above the C6–C7 level. The beginning of the transverse processes of the cervical spine are exposed after the resection of the medial portion of the longus colli muscle. Once the medial portions of the transverse processes of the upper and lower vertebrae have been identified, the ipsilateral joint between them can be visualized. Before performing the drilling of the vertebral bodies, the vertebral artery must be visualized because it may present medial loops. To prevent injury to vertebral artery, a thin layer of cortical bone is left attached to the ligamentous tissue covering the medial portion of this artery. The vertebral artery is located anterior to the C7 transverse processes and beneath the longus colli. Therefore, for operations at the C6–C7 level, the longus colli is excised carefully under the operating microscope, and anterolateral surface of the disc is an important landmark.

The depth of trepanation should be estimated on the strength of preoperative CT-scan, proceeding obliquely with an angle from vertical between 40° and 45° until the posterior longitudinal ligament is visible. This makes it possible to remove the portion of the body and disc that extends from the lateral surface, anterior to the transverse processes, as far as the

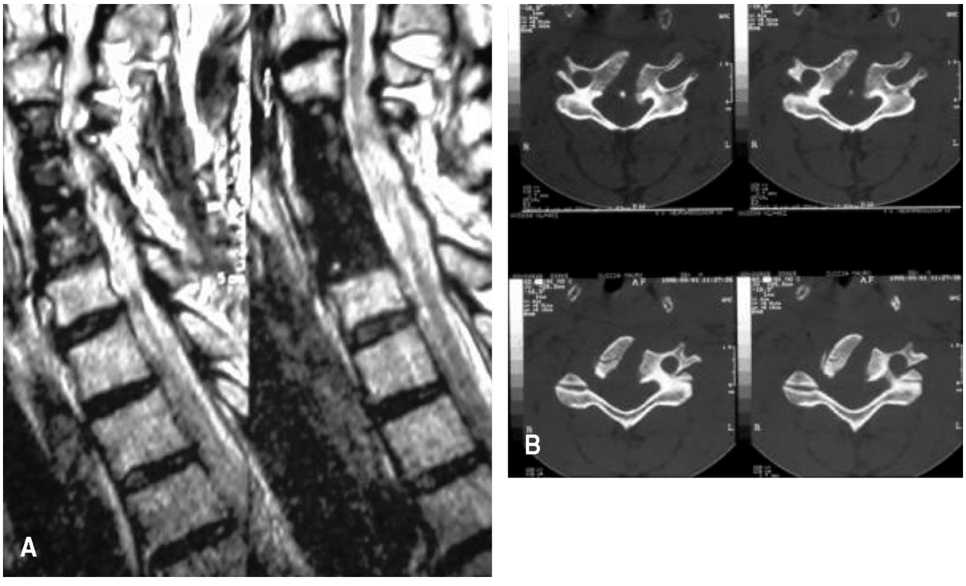

Figure 2.

Figure 3.

anterior surface of the vertebral body and obliquely in depth, as far as the posterior longitudinal ligament (Figures 1–3). The remaining portion of the vertebral bodies and discs is left in situ, preserving the anterior wall of the vertebral bodies and the remaining part of the discs. In the first phase, a cutting bur is used, changing to a diamond bur once the cortical bone has been identified below. The diskal part of the drilled segment is removed using discectomy forceps. In a case of radiculopathy, oblique corpectomy allows to open the intervertebral foramen fully. The bone underneath the VA has to be removed so as to control the nerve root from its junction with the dural sac up to its extraspinal segment.

The next step is extraligamental removal of the remaining osteophytes using curettes of different angulation and size. Removal of the osteophytes should be commenced from the side controlateral to the approach, until the controlateral pedicle is reached, because if it begins on the same side as the approach, the decompressed spinal cord tends to bulge into the spinal canal and makes it difficult to remove the controlateral osteophytes. It may be necessary to remove the posterior longitudinal ligament to permit re-expansion of the spinal cord, a procedure that may be laborious because of adherences between the dura mater and the ligament, which may be partly calcified. Once re-expansion has been verified, and effective hemostasis has been performed, the superficial planes are closed (plastima and subcutaneous) and an intradermal skin suture applied. It is advisable to leave suction drainage in the operative field for 24 to 36 hours. After surgery, the patient is mobilized early and use of a cervical collar is recommended for 4 weeks.

■ Results

Of the 48 patients, 35 were males and 13 females. Mean age was 57.4 years (range 36–74). Thirty-nine patients predominantly had myelopathy, and 7 of these also showed signs of severe radiculopathy. In the other 9 patients involvement was mainly radicular, but all patients had myelopathy. Thirty patients presented an antalgic contraction with decrease in the neck movements.

In all cases, radicular involvement affected $\geq$2 segments, as confirmed by neurophysiological studies. The mean duration of clinical history was 19.4 months (range 9–48 months).

Before surgery, all patients were submitted to CT-scan, MRI, plain and dynamic radiographs; patients with radiculopathy were also evaluated by EMG/ENG.

The number of segments involved was 4 in 4 patients and 3 in the remaining 44. The spinal segments most commonly affected were C4–C5 (41 patients) and C5–C6 (45 patients; Figure 4). Before operation, the mean score on Nurick's scale was 2.68. Mean preopera-

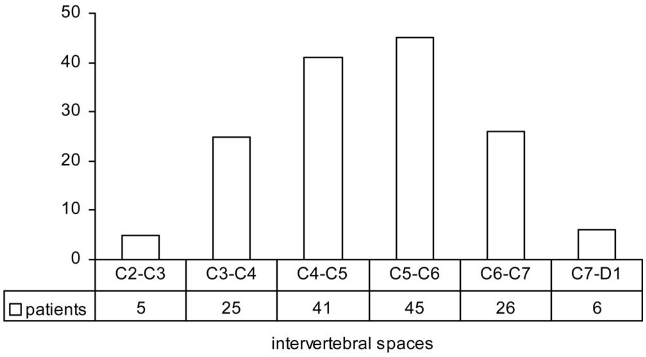

Figure 4. Rate of intervertebral levels involved.

tive JOA score was 12.3 points. One month after surgery, the mean score according to Nurick's scale was 1.73, making a mean improvement of 0.95 (DS ± 0.17). Mean JOA score was 13.8, making a mean improvement of 1.5 points (DS ± 0.47). At 1-year follow-up the mean score on Nurick's scale was 1.21, making a mean improvement of 1.47 (DS ± 0.14). One year after operation, the mean JOA score was 14.6, making a mean improvement of 2.3 (DS ± 0.23) in comparison to preoperative values.

Two years after surgery, the mean score of Nurick' scale was 1.18, making a mean improvement of 0.3 in comparison to 1-year follow-up value. At 2-year follow-up the mean JOA score was 14.8, making a mean improvement of 0.2 (Figure 5).

Patients were divided into 4 categories on the basis of outcome:

Group 1 – (significant improvement): 29 patients (60.5%). In this group, 22 patients made a complete functional recovery, making a cure rate of 45%.

Group 2 – (moderate improvement): 12 patients (25%).

Group 3 – (no change in clinical status): 5 patients (10.4%).

Group 4 – (clinical deterioration): 2 patients (4.1%).

The improvement rate (Group 1 plus Group 2) was 85%.

Among nine patients with prevalent radiculopathy, all were completely relieved from their preoperative radicular pain.

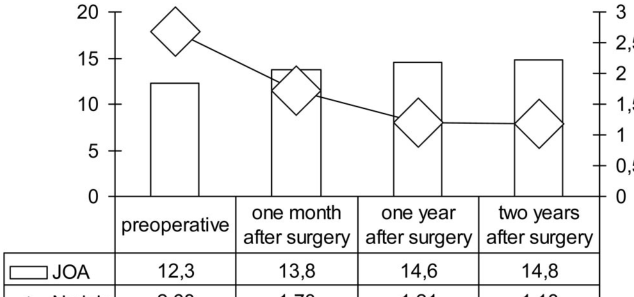

Figure 5. Clinical outcome before and after MOC.

Table 1. Statistical Analysis of the Clinical Outcome

	Preoperative Versus 1 Month	Preoperative Versus 1 Year	One Month After Surgery Versus 1 Year
Modified JOA	$P = 0.03$	$P = 0.004$	$P = 0.18$
Nurick	$P = 0.018$	$P = 0.002$	$P = 0.07$

Statistical analysis of the outcome is shown in Table 1. Clinical improvement was statistically significant both 1 month and 1 year after surgery. The most significant clinical improvement occurred 1 month after surgery and a further improvement occurred at 1 year of follow-up. Two-years after surgery a not statistically significant clinical improvement occurred in comparison to 1-year follow-up improvement.

None of the 48 patients treated presented postoperative instability as documented by check neuroimaging. All the patients with preoperative limitation of the neck movements caused by an antalgic contraction reported a complete functional recovery within 5 months. The remainder of patients showed no significant variations.

A transient Bernard-Horner syndrome (BHS) was observed in 14 patients (29.16%), as a consequence of manipulation of the sympathetic nerve; in all but one of them, symptoms regressed within 2 months, and none of the patients continued to present a clinically significant BHS. The majority of BHS cases (11 cases) occurred in the first years of our experience.

Postoperative instability was not observed in any of the patients. There were no lesions of the vertebral artery and no cases of CSF leakage or infection.

Discussion

Cervical spondylosis represents the evolution of severe degeneration of the cervical intervertebral discs. It mainly affects over middle-aged patients and frequently requires surgical treatment. There is a gradual progression of diskarthrosis and ligamental alterations, which lead to the formation of margino-somatic spondylotic bars and osteophytes that constitute the anatomopathological substrate of the disease.[34,35] Neurological symptoms are secondary to compression of the spinal cord and/or cervical roots by osteophytes and hard disc herniations localized medially or laterally to it. Hypertrophy of the ligaments may also contribute to the reduced calibre of the spinal canal, thus amplifying the compressive effect of the spondylosis.

The MOC technique is indicated for acquired multisegmental stenosis from cervical spondylosis in which compression of the spinal cord and cervical roots is mainly anterior.[28–31] In other forms of stenosis, congenital or acquired, we believe that individual surgical solutions should be studied for each patient. The most widely used anterior multisegmental approach to 3 or more segments is the multiple corpectomy with autologous bone graft harvested from the fibula or iliac crest.[36–38] Although many authors have emphasized the clinical results that can be achieved using this technique, they also included approaches to one or two levels that undoubtedly present less technical difficulties and have a lower risk of complications. In case-series' principally comprising multisegmental approaches, clinical results do not differ significantly from those described by George *et al*, which are confirmed in the present study. On the contrary to laminectomy, execution of a multiple corpectomy requires a major surgery practice, similarly to MOC. In fact, a variety of lesions have been reported in connection with this approach, such as perforation of the esophagus, pharynx, and lesions of the nerve trunks in the neck.[39] Although complications arising from autologous bone harvesting have also been reported, the most common complications of corpectomy are displacement or unsuccessful fusion of the bone graft, which can lead to pseudarthrosis and late vertebral instability.[40–44] In many of these cases the disturbance appears months after surgery, in the absence of severe spinal instability, and the most common symptom is neck pain.[45] Lastly, particularly in multisegmental cases, there may be late modifications below and above the graft, caused by discarthrosis and osteophytes secondary to the local microtrauma that occurs at the interface between the bone graft and the vertebral body.[45] The use of metal plates may reduce the incidence of complications attributed to bone grafting, but this technique carries risks of its own.[42,46,47] Anterior somatotomy with bone graft, without plates, requires postoperative orthosis: in cases where ≥3 segments are affected, bed-rest and rigid cervical collar may be required or even application of a Halo-vest, with a consequent prolongation of hospital stay. In the past years, patients with involvement of 3 segments or more were treated by posterior decompression, because this technique is simpler than somatotomy. However, the results obtained using this approach are less encouraging than other techniques and are associated with a high incidence of vertebral instability and postoperative kyphotic spinal deformity.[48–53] Furthermore, it has a high regression rate, attributed to acceleration of the spondylotic modifications and consequent increase of anterior compression. The unsatisfactory overall results of decompressive laminectomy are partly attributed to the fact that this approach was also used for treating patients with prevalently anterior multisegmental compression in whom the posterior route does not ensure the desired amount of decompression. Plain radiograph films in lateral view can provide useful elements for selecting patients for posterior surgery: flattening or kyphosis of the cervical segment indicate that compression is mainly anterior whereas preservation or accentuation of lordosis indicates a prevalently posterior compression. The MOC technique, by preserving over 50% of the vertebral body and preserving two of the three columns described by Denis,[28–31] does not compromise spinal stability so that bone grafts or instrumental arthrodesis are not necessary.

To re-establish the calibre of the cervical canal by means of MOC, without compromising spinal stability, patients must be selected carefully. Of the 3 cases of postoperative instability described by George *et al*, two were attributable to the selection criteria not being correctly applied: in one case there was only a soft hernia and in the other there was a congenital anomaly of the facets with lateral instability, not identified on preoperative investigations. On the basis of this experience, we exclude all patients with a definite instability of the spine (slippage >2 mm between 2 adjacent vertebral bodies on dynamic films); we also exclude patients with preoperative listhesis >2 mm between two adjacent bodies, even when the degree of slipping does not increase on dynamic films, on the assumption of favoring an isthmic lysis with onset of late instability at this level. Clinical outcome of our series, as evaluated according to the score proposed by both Nurick's and JOA, was satisfactory. With respect to nerve root decompression, MOC allows to open fully the intervertebral foramen, so that patients with radiculopathy achieve good results. However, a bilateral radiculopathy cannot be treated in one stage because on the side opposite the surgical approach, the drilling cannot go so far laterally.

When the MOC technique is performed, it is necessary to check the bony markers of the VA before drilling. Injuries to the vertebral artery with this approach have not been reported until now. It must be emphasize that as a rule, the periosteal sheath surrounding the vertebral artery has to be preserved. The vertebral artery can then be gently displaced laterally and protected by a smooth spatula. For the operations at C6–C7 level, cure must be taken not to injure the vertebral artery while removing the medial portion of the longus colli muscle. We have not encountered any anatomic variations of the artery in our experience. In our series, there were no VA lesions, nor were there any cases of CSF leakage, infections or postoperative epidural hematomas. In 14 patients (29%), there was a mild, transient SBH, which did not last more than 2 months, except in one case. Most of SBH occurred in the first period of time in which we performed MOC. We think that traction rather than dissection of the sympathetic chain is responsible for its functional damage. In fact, in the last cases we have not observed SBH performing a long tract dissection and then a minimal traction.

Control radiological examination documented a spinal stability in all patients.

In conclusion, the MOC technique, although representing a major surgical performance, is a valid alternative for treating myelopathy from multisegmental cervical spondylosis. The clinical results achieved are comparable with those of other anterior approaches, but the incidence of early and late postoperative complications is lower. Because bone grafting is not necessary, the MOC is principally indicated for categories of patients with a low fusion rate, namely elderly and diabetic patients and long-standing smokers. This technique also allows early patient mobilization and tolerable postoperative orthosis. These results rely on strict, scrupulous selection of patients, and preservation of cervical spine stability is almost total (George *et al*, 98%; our series, 100%). Whenever the patient presents preoperative instability, even minimal, or a fixed listhesis >2 mm, a method of treatment employing osteosynthesis instrumentation should be preferred. In forms of stenosis of the spinal canal where compression is not predominantly anterior, indications for the MOC technique should be evaluated case by case.

■ Key Points

- Multilevel oblique corpectomy allows for widening of the cervical spinal canal and conjugate foramen via anterolateral access, without the need for vertebral stabilization.
- We have applied this technique to 48 patients with multilevel degenerative spondylotic myelopathy.
- This technique has resulted in good results in terms of both regression of clinical symptoms and long-term spinal stability.

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