

Cervical Spondylotic Myelopathy Treated with Multilevel Oblique Corpectomy. A Review of 29 Cases.

Mohamed Sawan M.D., Khaled Anbar M.D.

Department of Neurosurgery, Cairo University

Abstract

Study Design: We reviewed our surgical experience and results in 29 patients operated upon by multiple oblique corpectomy without fusion for cervical spondylotic myelopathy.

Objective: To review the safety, efficacy and surgical experience of multiple oblique corpectomy in carefully selected 29 patients, through anterolateral corridor to the cervical spine without the need for vertebral fusion or stabilization.

Methods: Between March 2007 and April 2011, 29 patients have been treated with multiple oblique corpectomy technique for cervical spondylotic myelopathy. The functional status was assessed using the modified Japanese Orthopedic Association Score preoperatively and at 1,6,12 months postoperatively. Radiological Assessment was done preoperatively with MRI, CT scan and plain radiograph, and postoperatively on the following 1,6,12 months after surgery and routinely prior to discharge.

Results: Among the 29 patients (19 males and 10 females) with a mean preoperative duration of symptoms for of 11.7 months. Satisfactory significant recovery occurred in 20 patients, 5 patients had no clinical improvement and 4 patients had variable degrees of clinical deterioration. Only one patient showed an evidence of spinal instability postoperatively.

Conclusion: The multiple oblique corpectomy is a safe and effective technique in removal of the anterior compressing spurs to the spinal cord. No fusion is required regardless the number of the levels. The short recovery period, few complications rate with satisfactory significant outcome make this technique a better surgical option for cervical spondylotic myelopathy in selected patients.

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Key Words: corpectomy, cervical, spondylotic, myelopathy, multilevel

Introduction

Cervical spondylotic myelopathy (CSM) secondary to degenerative spinal changes causing canal stenosis and spinal cord compression is classically managed with anterior decompression at multiple disc spaces.^{5,28} Other various surgical treatment methods include: anterior subtotal corpectomies with strut grafting with or without instrumentation, multiple discectomies with or without Interbody fusions, anterior foraminotomy, laminectomy, and laminoplasty.²⁷ Though anterior corpectomy with fusion allows direct resection

of the offending pathology but it requires bone grafting and long period prior to bony fusion, while laminectomy or laminoplasty offers indirect posterior decompression without dealing with the anterior pathology.^{9,23,33} The multilevel oblique corpectomy (MOC) technique was originally described by George et al,^{10,11} offers a valid alternative in cases of cervical spondylotic myelopathy because good clinical results can be achieved without bone grafting with. This technique allows ventral surgical excision of the offending spondylotic bony spurs and bars while

eliminating the need for fusion^{10,11} As spinal reconstruction with grafting whether or not associated with anterior plating is technically challenging and several authors have reported associated postoperative Complications.^{2,6,14} This technique is safe and has led to good clinical results and long term spinal stability. The Purpose of this report is to describe the technique, to analyze our results and to demonstrate the efficacy and safety with this technique in an early series of 29 cases.

Materials and Methods

Between March 2007 and April 2011 29 patients have been treated with (MOC) technique for CSM. The diagnosis of CSM was based on clinical neurological presentation and radiological evidence of stenosis of the spinal canal and intervertebral foramina.

Those patients were clinically examined and we included the patients with clinical evident cervical myelopathy in the form of hyperreflexia, ankle clonus, positive Babinski, spasticity, progressive motor deficits, progressive sensory deficits, and sphincteric disturbances.

All patients had preoperative plain radiographs in dynamic, lateral, and antero-posterior views. Preoperative non-enhanced computed tomography, and magnetic resonance imaging (MRI) were done to all patients. Clinical examination and neurological evaluation were done before the operation and at 1, 6, 12 months after the operation on follow-up visits. The clinical preoperative symptoms and signs are gathered in table (1). Preoperative and postoperative functional status assessments were done using the Modified Japanese Orthopedic Association (mJOA) score.

Clinical Symptom / Sign	Patients' No. (N=29)
Disturbance of gait	20
Progressive motor deterioration	19
Progressive sensory deterioration	17
Unilateral or bilateral radiculopathy	6
Sphincteric (bladder/bowel) dysfunction	5
Spastic gait	19
pathological reflexes(hyperreflexia)	29
quadripareisis	20
upper limb sensory deficit	23

Table 1. Summary of preoperative clinical picture.

All the patients had evident anterior pathological compressive elements (osteophytic bar or spurs, pathological thickened calcified ligaments, degenerated hard discs) alone or in combination in some cases with posterior pathological compressing elements. Majority of patients suffered from loss of the cervical lordosis either in the form of straightening of the cervical spine or in some other cases in the form of variable degrees of kyphotic changes. In this study the straight or kyphotic spine in absence of radiological evidence of instability on dynamic radiographs were included.

Radiological exclusion criteria:

1) Cases with radiological evidence of soft disc herniation, explaining the symptomatic myelopathy or radiculopathy.

- 2) Cases with radiological evidence of instability to the cervical spine (preoperative listhesis 2mm or more movement between the posterior aspects of two adjacent vertebral bodies even if this degree does not increase on dynamic films as they may represent great potential for postoperative instability-angulation more than 5 degrees).
- 3) Patients with radiological evidence of anterior and posterior pathological compression while the cervical spine lordotic curve is preserved.

Surgical Technique:

Patients were placed in the supine position with slight neck extension and rotation 20 degrees to the opposite side. The side of our approach was chosen on the side with more offending pathology and

more clinically related symptoms. A skin incision is made longitudinally on the anterior border of the sternocleidomastoid muscle at the targeted levels of the vertebral bodies. When upper most cervical vertebra bodies were to be exposed, we extended our longitudinal incision to the tip of the mastoid process. Lower extension of the incision to the suprasternal notch was done to reach CV7-DV1 whenever was necessary. The subcutaneous tissue is incised with the same line of skin incision. The platysma is cut to reach the anterolateral aspect of the vertebral bodies. Sharp meticulous under vision dissection is conducted to ensure clear natural plane between the sternocleidomastoid and the carotid sheath. The sternocleidomastoid with the carotid sheath is retracted laterally while the esophagus, trachea together is retracted medially protected by a smooth spatula or with a blunt smooth retractor blade. Now between those 2 planes we can reach the anterolateral aspect of the vertebrae as we go deep with blunt dissection in the underlying fat tissue. We kept great attention in extremely high and low levels to identify and protect the spinal accessory nerve and thoracic duct when encountered.

Palpate the transverse processes by your finger while still covered with the prevertebral muscles. The surgical microscope is properly adjusted and introduced at this point. Great attention must be paid to identify clearly the sympathetic chain while still under the longus colli aponeurosis. Carefully incise the longus colli aponeurosis longitudinally medial to the sympathetic chain. The longus colli muscle is dissected from medial to lateral fashion and most of the cases we needed to resect the medial part of the longus colli muscle. The sympathetic chain with the aponeurosis is gently protected with a blunt spatula during this step. The longus colli muscle was coagulated and cut over the transverse process to avoid any unintended vascular injury to the vertebral artery. The remaining part of the longus colli and the sympathetic chain are minimally retracted laterally as one group with the aid of hand retractor under the longus colli protecting them. We were careful to minimize the manipulation and dissection of the sympathetic chain.

Proper level is identified with intraoperative fluoroscopy. Intervertebral disc at the pathological levels are incised and resected with a starting point between 5-10 mm away from the uncovertebral joint and removal is complete by reaching the edge

of the posterior margins of the vertebral bodies. We then start drilling at a point after leaving 4 mm edge of bone laterally. Vertically start drilling with a 8-10 mm width with the use of both cutting and diamond 4 mm burr with continuous generous irrigation to avoid the dangers of thermal damage. The first station here is to reach the posterior cortical bone of the vertebral bodies which can then be removed by diamond burr and meticulous dissection. Now the posterior longitudinal ligament has been reached. From this point we obliquely reorient the microscope and start drilling again in an oblique way from ipsilateral superior corner to the contralateral inferior corner.

There is no definite end point for horizontal drilling so in our study the extent of contralateral bone removal ended when the contralateral offending pathology previously shown on preoperative radiological studies has been successfully removed. Complete the removal of the posterior cortical bone. Now the bony work has been completed through removal of less than 50% of the vertebral body mass.

In patients having radiculopathy a wide foraminotomy has been done through removal of the hypertrophied uncovertebral joint as well as the anterior part of the foramen transversarium, while carefully protecting the adjacent parts of the vertebral artery. The contralateral foraminotomy can be done with changing the microscope angle after completion of the bony drilling of the vertebral body. The posterior longitudinal ligament has to be opened in a longitudinal way to ensure adequate decompression of the spinal cord. Sometimes when the posterior longitudinal ligament was thickened with calcific parts; though its separation from the dura was difficult we preferred to resect it to ensure complete release of the spinal cord. The drilled parts of the vertebral bodies frequently ooze and can lead to a postoperative haematoma with subsequent cord compression, which led us to the routine application of bone wax to complete haemostasis. We constantly left small sized suction drain prior to platysma closure. Skin is then closed with 4-0 intradermal absorbable sutures.

Results

Among the 29 patients operated upon, there were 19 males (65.6%) and 10 females (34.4%) with a mean age of 55.4 years (range 39-66 years). The mean preoperative duration of symptoms for all patients was 11.7 months (range 2-22 months). Progressive myelopathy was the predominant

symptom and sign in twenty patients, four of them presented with associated radiculopathy. The summary of significant preoperative clinical picture in 29 patients is shown in (table 1).

As a routine all patients preoperatively had a CT-scan, MRI, Plain dynamic radiographs. EMG/NCS

were done for patients with severe radiculopathy (Figure 1, 2, 3). The total number of levels compressed was 47 distributed among the patients as follows: CV2-3 in 2 cases, CV3-4 in 5 cases, and CV4-5 in 9 cases, and CV5-6 in 19 cases, and CV6-7 in 9 cases, and CV7-DV1 in 3 cases.



Figure 1. Preoperative plain radiograph with advanced spondylotic changes (with lost lordosis).



Figure 2. Preoperative MRI T2 showing advanced spondylodegenerative changes in the cervical spine.

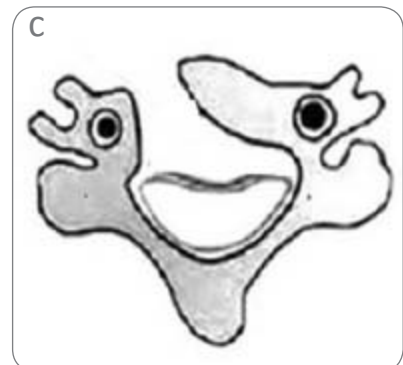
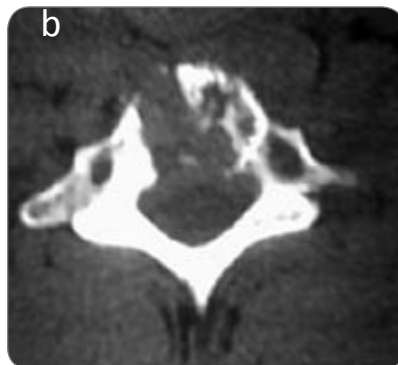
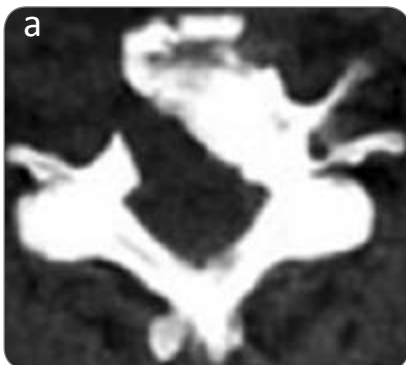


Figure 3. A- B Postoperative CT scan axial cut – Note the volume of corpectomy < 50% of the vertebral body. C- Diagrammatic drawing showing the extent of removal of the vertebral body.

The mean operative time was 145 minutes (range 115-210 minutes). The mean preoperative (mJOA) score was 11.4 points, with ongoing improvement over the following 12 months after surgery. The postoperative mean (mJOA) score was 13.2 with a one year mean improvement of 1.8 points. Of our 29 patients; 21 patients (72 %) had satisfactory significant recovery (one point or more on (mJOA) score), while 5 patients (17%) had no clinical improvement (same preoperative points on (mJOA) score), and the last 3 patients (11%) showed clinical deterioration of variable degrees on the (mJOA) score (one point less or more) as compared to the preoperative score. We noticed

that 16 patient out of the 21 patients improved have reached their clinical improvement in the first 6 months after surgery. One patient (3.4%) presented with progressive neurological deterioration and difficulty in breathing related to airway compression post operatively due to compressive hematoma and underwent urgent surgical decompression and improved over the following 48 hours. Horner's syndrome postoperatively was detected in 1 patient attributed to intraoperative retraction or manipulation of the sympathetic chain. He was mildly affected and recovered completely within a period of 2 months later. Dural tear was encountered in 1 patient and primary

repair was done microscopically resulting in no cerebrospinal fluid leakage later postoperatively. Instability of the cervical spine postoperatively was noted in one case (3.4%), and was the reason for clinical deterioration, which required reoperation with bone graft and plate. No injury happened to the lymphatic canal. No vascular injuries were encountered in our series.

Discussion

Cervical spondylotic myelopathy due to degenerative spinal stenosis with cord compression is the most encountered cause of cervical spine dysfunction in elderly above 50 years.¹² In this condition the cervical spine is markedly affected with disc degeneration and arthrosis, the ligaments show pathological thickening with frequent calcifications which ends up in formation of osteophytic spurs and bars, all of these changes are the accused etiological pathology for the spondylotic myelopathy.^{26, 34} The surgical recommendations must be tailored for each patient according to the clinical condition and neuroradiological findings and nevertheless proper understanding by the patient for the realistic expectations for the outcome from the surgical intervention. The optimal surgical approach for such cases has always been controversial. Many approaches have been advocated in such surgical management from multilevel anterior corpectomy with fusion with or without instrumentation,²⁰ anterior decompression for multiple disc spaces,⁵ laminectomy with or without fusion,⁷ laminoplasty^{17,25} and finally microscopic multilevel oblique corpectomy without fusion.¹² In cases with multilevel anterior spinal cord compressive pathology the multilevel corpectomy with autologous bone graft harvested from the fibula or iliac crest with or without instrumentation is the most widely used approach.⁸ The main problem with this multilevel corpectomy with fusion with or without instrumentation has always been related mainly to the graft morbidity and pseudoarthrosis.²¹ In addition degenerative changes at the adjacent vertebral end plates,³³ instability due to pseudoarthrosis, osteophytic recurrence, and decrease the range of motion all add to the morbidity of this technique.²¹ Graft displacement is a frequently recorded complication.⁸

The multilevel oblique corpectomy without fusion allows anterior spinal cord decompression just as the common anterior corpectomies but with elimination of the need to use bone graft

and instrumentation, this is a main advantage in avoiding the bone fusion associated morbidity, instrumentation complications and the degenerative pathological changes in the adjacent vertebral levels.

Despite the great advantages of this technique it is still limited in the practice of neurospinal surgery field. Very few studies and reports have been published analyzing the clinical results of this technique.¹ In our 29 patient series the selection inclusion criteria were cervical progressive spondylotic myelopathy or radiculopathy due to anterior spinal cord degenerative spondylotic changes on multiple levels in a surgically fit patient, with strict clear absence of any evidence of instability in the preoperative radiological studies. Loss of the normal cervical lordosis either in the form of straightened or kyphotic cervical spine is an important criteria. Our inclusion criteria are matching those reported by Kiris et al., R Kemel et al., Salvatore et al., Giovanni et al., and George et al.^{10-12,19, 28} Our radiological preoperative exclusion criteria definitely matches all the reported series studies by Kiris et al., R Kemel et al., Salvatore et al., Giovanni et al., and George et al.^{10-12,19,27,28} We found no relation between the preoperative MRI high signal intensity T2 weighted images and the clinical results, same results concluded by R. Kemal Koc et al.²⁷

Age of the patient in the study ranged from 39-66 years with a mean age of 55.4 years which is almost the same as the mean age of 55 years reported by Kiris et al.¹⁹ and very close to the mean age of 57.9 years reported by George et al.¹⁰ the mean age of 57.4 years reported by Giovanni et al.¹² and to the mean age of 58 years reported by Salvatore et al.²⁸ but slightly more than the mean age of 51.3 years reported by R. Kemal et al.²⁷

Of great value to our practice is the age factor for the patients. It is considered one of the predictors for the surgical outcome in cervical spondylotic myelopathy. We noticed that the majority of clinical improvement occurred in the age group below 53 years. A similar notice was reported by other authors^{1,27} they reported that the clinical postoperative improvement was in the age group of patients ≤ 50 years. George B et al.¹⁰ concluded that only age seemed to be a factor that was positively related with post operative results, the younger the age the better the chance of clinical improvement postoperatively. To the best of our knowledge no other reports in the literature

concerning this new technique have stated a statistically significant relation between the age of the patient and the surgical outcome.

The mean preoperative duration of symptoms for all patients was 11.7 months, which is different from the lower mean of 9.6 months reported by Salvatore et al.²⁸ and higher mean of 19.4 months reported by Giovanni et al.¹² We did not find a relation between the preoperative duration of symptoms and the postoperative clinical improvement. This result matches to those published George B et al.⁸ who conducted a statistical analysis about this relation and found no positive relation and also matches the results of by R.Kemal Koc et al.²⁷ who found that symptoms (more than or less than 1 year) was not statistically correlated with the results as in agreement with many other authors.^{15,24,29}

The functional assessment pre and postoperatively were done with the Modified Japanese Orthopedic Association Score (mJOA) for our patients which matches the functional assessment score used by Giovanni et al., Kiris, Talat et al., R.Kemal Koc et al., Salvatore et al., and George B et al.^{10-12,19,27,28}

The percentage of patients postoperatively who showed clinical improvement postoperatively in our series was (72%) which showing very close similarity to the (71%) post operative percentage of patients who showed clinical improvement published by Giovanni G et al.¹² The results published concerning the anterolateral decompression without fusion are limited, but compared to them our results are showing approximately close figures.^{13,31,32} Meanwhile our results are have shown less percentage of postoperative improvement compared to the (82%) reported in the study series by Bruneau et al.² and also less than the (86.6%) published by Salvatore et al.²⁸

We did not find a correlation between the preoperative severity of symptoms and the clinical outcome a finding similar to many published series^{2,8,10,12,28} but completely different from R.Kemal Koc et al.²⁷ who stated that the degree of postoperative recovery seems to be directly related to the severity of preoperative symptoms.

Our surgical approach was closely similar to the approach described with many authors but with few variations, one of them is that we did not retract the carotid sheath medially similar to the operative step published by George B et al.⁸ but other surgical techniques stressed on medial

retraction of the carotid sheath as published by Kiris et al.¹⁹ Giovanni et al.¹² Salvatore et al.²⁸ and by Bruneau al.² .We found that lateral retraction step is safer, faster and similar to the traditional anterior cervical approach. The longus colli muscle was routinely incised medial to the sympathetic chain and we kept manipulation and retraction on the lateral part of the longus colli with the overlying sympathetic chain minimal and this was more than enough for our exposure a step similar to that mentioned by George B et al.¹⁰ contrary to the description by Giovanni et al.¹² who mentioned that dissecting and exposing the sympathetic chain was an important step of the operation to ensure maximum protection.

The extent of vertebral body removal by drilling did not exceed 50% of the vertebral bodies, we made sure to preserve large parts of the anterior surface and lateral pillars, as this will minimize the postoperative potential instability if further drilling is carried on, our findings matches other authors recommendations.^{3,4,30}

The ability to perform bilateral foraminal decompression from the oblique anterior cervical corpectomy approach remains a debatable issue. We find it easy to perform ipsilateral foraminotomy from this approach, and after finishing the drilling and by the aid of the microscope with adjusting the microscope angle in the most possible oblique view the contralateral foramen could be seen but decompression of the contralateral foramen was difficult and hazardous and to achieve this step further drilling and bone removal is required which eventually will affect the stability postoperatively. Our finding is similar to the results from R.Kemal Koc et al.²⁷ who stated that a bilateral radiculopathy cannot be treated in one stage and he preferred to perform discectomy and fusion with cages or corpectomy and fusion with instrumentation, also this opinion is supported by Salvatore et al.²⁸ who concluded that this surgical approach allows to completely decompress the intervertebral foramen and nerve roots completely on the ipsilateral side , and he believes that if the patient has bilateral radiculopathy then it is easier and more appropriately that bilateral foraminal decompression through a median corpectomy, a similar conclusion was published by Giovanni et al.¹² and viewed that bilateral radiculopathy cannot be treated in one stage because on the opposite side of the surgical approach, the drilling cannot go so far laterally.

We reported few post operative complications in our study. We had one single patient presented with progressive neurological deterioration and difficulty in breathing related to airway compression few hours post operatively due to compressive hematoma confirmed by urgent CT scan and underwent urgent surgical decompression, we found the source of haematoma was oozing from the vertebral body drilled surface due to inadequate waxing after drilling, and this patient improved later on within the following 48 hours. The incidence of this complication among the total number of operated patients was (3.4%), compared to the two patients among 101 patient (2%) incidence by George B et al.¹⁰ those two patients had reoperation, one recovered and the other improved but deteriorated again permanently. Notably, in the other published series no mention to this complication.

Among the 29 patients operated upon, Horner's syndrome postoperatively was detected in one patient (3.4%) attributed to intraoperative retraction or manipulation of the sympathetic chain, his affection was mild and completely resolved within a period of 2 months later. Our incidence is much less than the (30.7%) published by R.Kemal Koc et al.²⁷ also notably no permanent residual Horner's syndrome in our series compared to the (7.7%) published by R.Kemal Koc et al.²⁷ This can be attributed to the fact that we minimized intraoperative manipulations and dissection over the sympathetic chain, and also to the fact that we never went laterally than the level of the anterior tubercle of the transverse process during incision of the longus colli muscle. George et al.¹⁰ study has shown that Horner's syndrome had occurred in (57%) of the patients, while only (9%) experienced discrete residual Horner's syndrome. Giovanni et al.¹² reported that (29%) of patients have developed mild transient postoperative Horner's syndrome, whom they recovered in 2 months period later on, and only one case had residual Horner's syndrome.

Giovanni et al.¹² noticed that traction rather than dissection of the sympathetic chain is responsible for its functional damage, referring to the cases he operated upon and performed minimal retraction, while keeping dissection did not lead to post operative Horner's syndrome. In the largest published series by Salvatore et al.²⁸ this complication reported the least incidence among the patients (5.2%) as they stated that the incidence of this syndrome decreases significantly

with increasing experience and familiarity with the technique, and they experienced that gentle retraction without dissection can prevent this complication.

Dural tear was encountered in 1 patient (3.4%) and primary repair was done microscopically resulting in no cerebrospinal fluid leakage later postoperatively. R.Kemal Koc et al.²⁷ had a one case (3.8%) of unintended injury to the dura which leaked post operatively and was reoperated upon to deal with this complication. Kiris et al.¹⁹ mentioned a higher incidence (5%) of dural tear intraoperatively, one of the two cases he reported was repaired with primary suturing, the other was repaired with fibrin glue and a piece of muscle, and CSF fistula did not develop. It is our opinion that careful micro dissection of the posterior longitudinal ligament is the best way to avoid such an intended tears, and under vision excision should be performed routinely, unless there is pathological adhesions to the dura, then it is better to leave the adherent part in place as tear in such condition will be difficult to repair.

We had 1 patient (3.4%) who had evidence of postoperative instability of the cervical spine, and was the reason for clinical deterioration in the form of increase axial neck pain and had a less score on the (mJOA) score than preoperative score. The case required reoperation with bone graft and plate. This patient had marked Kyphosis on the plain X-ray films preoperatively. Revision of his preoperative films has shown a poor selection as a candidate for this operative approach, as he had spondylodegenerative changes but mean while he had a well hydrated disc, the removal of which with drilling of up to 50% of the vertebral body markedly affected the stability postoperatively. Our results are closely to the (2.3%) incidence of instability reported by Salvatore et al.²⁸ and to the (2.9%) incidence of post operative instability reported by George B et al.¹⁰ who attributed the instability to the presence of congenital bone malformation in one case and to the next segment failure above the operated levels in the other case. Kiris et al.¹⁹ and Giovanni et al.¹² has reported a (0%) of instability with this technique in post operative radiological examination.

The anatomical position of the vertebral artery makes it possible to be injured, a well known fact for all neurosurgeons, but we have not face a single case of vertebral artery injury in our 29 patients operated upon. Our results are identical to the

results published by R.Kemal Koc et al., Kiris et al., Giovanni et al., and George B, Gauthier et al.^{10,12,19,27}

We found that the number of targeted levels was never a limiting issue during performing such technique, a finding that is agreed upon by George B et al.¹⁰ while many other authors changed their surgical approach from an anterior to posterior one, based only on the extent of involvement, even when the compressive spurs were anterior to the spinal cord.^{16,18}

Conclusion

The MOC is a safe and effective technique in removal of the anterior compressing spurs to the spinal cord. No fusion is required regardless the number of the levels. The satisfactory significant clinical outcome, short recovery period, and few limited complications rate make it a valid approach to the management of multisegmental cervical spondylotic myelopathy. This technique requires a learning curve to achieve adequate anatomical decompression, while preserving the integrity of the surrounding neurovascular structures. This technique saves the patient the problems of instrumentation, fusion. The preoperatively absence of instability, predominant symptomatology, and preservation of spinal stability are crucial pillars to the success of this technique.

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Address reprint
request to:

Mohamed Sawan, MD

Prof in Neurosurgery, Neurosurgery department,
Cairo University, Cairo, Egypt.
Email: mosawan@hotmail.com

الملخص العربي

الإزالة المائلة متعددة المستويات لجسم الفقرات العنقية، لمعالجة إعتلال النخاع الشوكي الناتج عن التيبس المفصلي الفقاري. خبرتنا الجراحية مع ٢٩ مريض.

الهدف: هو تقييم كفاءة وأمان وطريقة التدخل الجراحي، لمعالجة إعتلال النخاع الشوكي الناتج عن التيبس المفصلي الفقاري. تمت هذه الدراسة على ٢٩ مريض يعانون من إعتلال النخاع الشوكي الناتج عن التيبس المفصلي الفقاري.

الطريقة: تم إجراء تدخلات جراحية ميكروسكوبية للمرضى عن طريق عمل الإزالة المائلة متعددة المستويات لجسم الفقرات العنقية.

النتائج: تحسنت حالة ٢٠ مريض اكلينيكيًا في حين لم تتغير حالة ٥ مرضى وتدهورت الحالة الاكلينيكية بالنسبة إلى ٤ مرضى.

الاستنتاج: هذه الطريقة فعالة وآمنة في معالجة بعض الحالات المنتقاة من لمعالجة إعتلال النخاع الشوكي الناتج عن التيبس المفصلي الفقاري. الإختيار المناسب وإنتقاء الحالات قبل الجراحة مع مراعاة عدم وجود أعراض عدم ثبت للفقرات وفقدان التقوس الطبيعي للفقرات العنقية هو من أهم أسباب تحسن الحالات.