

Anterior decompression and plate fixation in treatment of cervical myelopathy: A multicentric retrospective review



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ABSTRACT

Objectives: The aim of this study was to evaluate the results on anterior decompression and fusion with titanium mesh or expanding cage and plate fixation in patients with cervical myelopathy.

Methods: We conducted a retrospective multicentric review of 114 patients, 75 males and 39 females, with cervical myelopathy who underwent surgical treatment between July 2009 to December 2011. All surgeries were performed via a ventral approach. Based on the type of surgery the patients received, they were divided into 3 groups: group 1 consisted of 49 patients who received multilevel corpectomies and fusion with strut iliac bone graft and plates; group 2 consisted of 26 patients who received multilevel corpectomies and fusion with titanium expanding cage and plating; group 3 consisted of 39 patients who received multilevel corpectomies and fusion using titanium mesh with autologous bone graft and anterior plating.

Results: Decompression of the cervical spinal cord and grafting with plate fixation via a ventral approach demonstrated a high rate of improvement in neurological function with minimal complications. Fusion was documented radiologically in all cases. Eighty-three patients experienced a partial improvement and 41 had a complete recovery according to Nurick's myelopathy grading. Sixty-two patients were ranked as excellent, 48 as good, 4 as fair; unsatisfactory outcome was related to donor site complications.

Conclusion: Spinal decompression and fusion with titanium cages and plates appears to be a safe and effective alternative in patients with cervical spinal myelopathy.

Level of evidence: Level IV, therapeutic study.

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Introduction

Cervical spondylosis is a degenerative condition of the intervertebral discs and vertebral bodies resulting in cervical nerve root compression or spinal cord stenosis. This progressive condition may cause myelopathy and radiculopathy at one or more levels.¹ The management of cervical spondylosis may be medical, surgical, or both. Surgical management becomes necessary in those patients with neurological deficits, pain, and documented

compression of the spinal cord or nerve roots. The goal of surgery is to decompress the affected nerve roots and spinal cord.² MRI has established its place as the diagnostic modality of choice in various cervical problems.³ It also helps to take the more suitable treatment for cervical spondylotic myelopathy (Fig. 1). Cervical corpectomy is a common procedure for degenerative stenosis, trauma, instability, infection, deformity, and tumor. However, the choice about what kind of materials can be used during interbody fusion and reconstruction of bone defects after anterior discectomy or corpectomy is still controversial. Nonunion, malunion, graft dislodge, and graft collapse were also reported throughout the literature.⁴ Bone grafting techniques include iliac crest autograft, allograft, or fibular strut graft. Iliac crest autograft has been considered the best solution for graft material, but morbidity associated with harvesting has put the procedure into question.⁵ Autogenous fibula strut graft

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Fig. 1. MR: it determines the extent of the affected segments, the degree of canal stenosis, the magnitude of neural compression, and the nature of the compressing pathology.

harvesting can lead to significant donor-site complications.⁶ Efficacy of fusion with allograft bone has been controversial as to whether it has equivalent fusion rates to autograft.⁷ A vertebral body substitute has to guarantee stability, axial load-bearing resistance, a large interbody/bone interface to facilitate fusion and prevent migration, and to give the right height and sagittal alignment.⁸ Reconstruction with titanium mesh cages after cervical corpectomy has replaced autogenous tricortical bone grafts. Thanks to this procedure, we have no more complications correlated to autograft harvesting such as fracture and donor site pain. The use of titanium mesh cages has shown significant stability and low complication rates (no donor site complication will occur).⁹ Corpectomy with titanium cage reconstruction has been advocated because it provides a rigid biomechanical construct within the cage design itself. Corpectomy with titanium cage reconstruction allows for the use of local autogenous bone graft to obtain a high fusion rate without the associated donor site morbidity. The cervical vertebral body that was removed is replaced with a titanium cage packed with local autograft. The lateral walls of the vertebral body, as well as the prepared endplates, create an optimal condition through a three-sided cancellous bed for bony in-growth into the porous titanium cage.¹⁰ Treatments involving more than two levels of interbody fusion with the use of autograft or allograft were correlated to a significantly increased incidence of pseudoarthrosis and unsatisfactory outcomes. Zdeblick and Ducker¹¹ reported that the incidence of pseudoarthrosis and graft collapse was higher when using a freeze-dried allograft in two-level interbody fusion than autograft alone. Several series indicate a high rate of pseudoarthrosis (as high as 50%) for three-level procedures with the use of autograft, the same procedure has a higher failure rates with the use of allograft.¹²

Many authors have studied the use of subtotal corpectomy of the intervening vertebra (e) followed by strut fusion for multilevel degenerative disease and cervical kyphosis as an alternative procedure that decreases the fusion surfaces to only two with a lower nonunion rate.¹³ This procedure is not always possible due to the

impossibility to achieve an adequate decompression of the cord and roots. If autogenous graft is used, the donor site morbidity has been reported in up to 20% of patients,¹⁴ with symptoms including sustained pain, hematoma, muscle herniation and lateral femoral cutaneous nerve injury.

The purpose of this study is to demonstrate that decompression of the cervical spinal cord and grafting with plate fixation through a ventral approach create a high rate of improvement in neurological function with minimal complications, also cervical corpectomies with titanium mesh or expanding cage may offer a viable alternative to previously described anterior cervical fusion technique.

Material and methods

We conducted a retrospective cohort study of 114 patients, 75 males and 39 females, with cervical myelopathy who underwent surgical treatment between July 2009 to December 2011. Their ages ranged from 67 to 73 years old. An independent observer extensively reviewed medical charts and radiographs. All patients included in this group had multi-level symptomatic degenerative disc disease, disc herniation, or stenosis of the cervical spine with clinical criteria of myelopathy and radiological criteria of cord compression.¹⁴ Myelopathy was diagnosed if abnormal reflexes such as clonus, positive Babinski sign or positive Hoffman sign were evident on physical examination or if the patient had a demonstrable disturbance of gait and hyperactive reflexes.¹⁵ The period between the onset of symptoms and surgery was variable from one to two years. Clinical status during postoperative follow-up was assessed by a score based on the criteria of neck pain, depending on drugs and ability to return to daily activities (Table 1). Neurological status was assigned according to Nurick's system (Table 2) and radiculopathy in motor or sensory function. Functional outcomes were evaluated by one of the authors with interviews either personally or by phone. Preoperative analysis included static radiographs, MRI, and CT scans. Postoperative analysis included static radiographs, flexion–extension radiographs, and three-dimensional CT (3D – CT) scans (Fig. 2). Surgery techniques were performed by three different surgeons at three different institutions (University of Sassari - Italy, Cantonal Hospital Fribourg - Switzerland; Santorso Hospital – Italy).

Table 1
Criteria of clinical outcome evaluation.

Pain	None = 0	No pain or mild ache which interferes with daily activities
	Mild = 1	Mild pain, but generally able to perform daily activities
	Moderate = 2	Pain tolerable but patient makes concessions for the pain, some limitations on daily activities.
	Severe = 3	Severe pain most or all of the time, serious limitations on activities.
Meds.	None = 0	
	Non-narc = 1	
	Narcotic = 2	
Return To Work	Full ret = 0	
	Modified = 1	
	No = 2	
Total (0–7)		
Definitions		
0–1 = Excellent (Satisfactory)		
2–3 = Good (Satisfactory)		
4–5 = Fair (Unsatisfactory)		
6–7 = Poor (Unsatisfactory)		

Table 2
Nurick's six grades of myelopathy.

Grade 0	Signs or symptoms of root involvement but without evidence of spinal cord disease.
Grade 1	Signs of spinal cord disease but no difficulty in walking.
Grade 2	Slight difficulty in walking not preventing full-time employment.
Grade 3	Difficulty in walking preventing full-time employment or the ability to do all housework, but not so severe as to require help to walk.
Grade 4	Ability to walk only with help or with the aid of a frame.
Grade 5	Chairbound or bedridden.

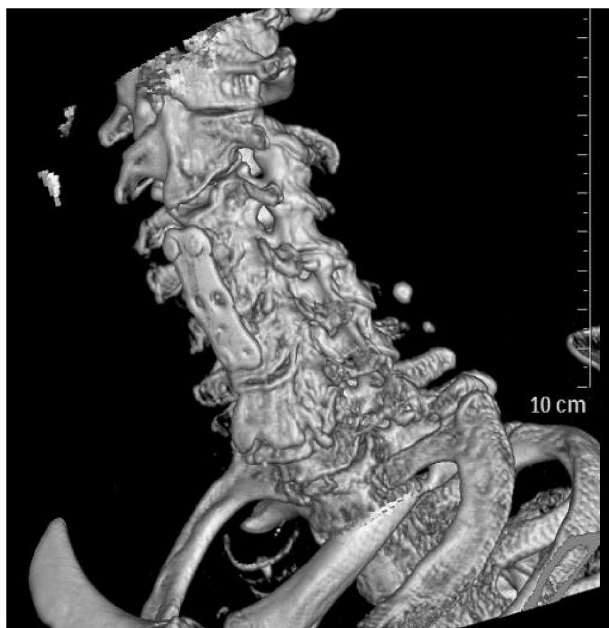


Fig. 2. Postoperative three-dimensional CT examination documenting the plate bringing the site of corpectomy and bone grafting.

Surgical technique

All surgeries were performed via a ventral approach. In reason of the type of surgery the patients received, they were divided into 3 groups: group 1 consisted of 49 patients who received multilevel corpectomies and fusion with strut iliac bone graft and plates; group 2 consisted of 26 patients who received multilevel corpectomies and fusion with titanium expanding cage and plating; group 3 consisted of 39 patients who received multilevel corpectomies and fusion using titanium mesh with autologous bone graft and anterior plating.

Under general anesthesia, a standard anterior cervical dissection is performed with the patient in supine position. An oblique skin incision was done with suitable length along the anterior border of the sternomastoid muscle. Then dissection was carried-out in a standard way until exposing the vertebrae. An intra-operative X-ray evaluation confirmed the appropriate levels, and then a subperiosteal dissection is used to retract the longus coli muscles laterally to each side of the midline. Using curettage and pituitary forceps, the inter-vertebral discs above and below the corpectomy level were removed, and then by using rongeurs of different sizes, the vertebral body was removed until the posterior longitudinal ligament was exposed and excised. After an adequate decompression of the spinal cord and a clear determination of the gap, tricortical bone graft was taken from the iliac crest in group 1a and tapped into position; in group 2 a titanium expanding interbody cages were packed with autografts from the resected vertebrae

then were positioned into the corpectomy defect and expanded to recreate a contact between the inferior endplate of the superior vertebra and the superior endplate of the inferior vertebra; in group 3 titanium mesh were packed with the same autografts and positioned into the corpectomy defect. In all patients an anterior titanium vertebral plate was placed to bridge the entire construct, with screws placed into the superior and inferior vertebrae with variable angulation. An X-ray evaluations were performed to assess the final situation of the grafts, then plate and screws was tightened and finally a triple-layer closure over a suction drain was done.

Patients were immobilized in a hard-cervical collar for three months. Evidence of fusion was evaluated at three months, six months, and 12 months by flexion/extension radiographs. Fusion was considered adequate by the absence of brightness at the cage end caps and vertebral endplates, or by absence of instability on flexion/extension radiographs.

The Local Institutional Board approved this protocol in March 2010. Participation was purely voluntary and withdrawal from the study randomization was and will be allowed. The study was approved by the Local Ethics Committee of Sassari. Registration Identification: NCT01134211.

Results

Regarding on the relationship between the course of myelopathy and the postoperative clinical outcome, we found that some patients with rapid degeneration of symptoms and signs had better chance of improvement. Fusion was documented radiologically in all cases (100% fusion rate) with no pseudo-arthrosis. The complications after surgery in this study were relatively rare and included a superficial wound infection in one case and a screw and plate poorly positioned, in one case. No respiratory complication or recurrent laryngeal nerve palsy occurred in our series. Patients rated their overall quality of life after surgery as having improved greater than 50% compared to their situation before surgery. In our series, 83 patients underwent a two-level corpectomy, and 31 patients underwent a three-level corpectomy. Patients had a satisfactory clinical outcome in terms of pain reduction as evaluated post-operatively using Visual Analog Scale scores. All patients achieved an optimal decompression. Flexion and extension radiographs did not show any mobilization signs of the construct post-operatively in all patients. 73 patients experienced a partial postoperative improvement and 41 had a complete recovery, according to Nurick's myelopathy grading. Summing up the scores from the measured clinical outcomes of pain, medication and return to activity, 62 patients were ranked as excellent, 48 as good, 4 as fair; unsatisfactory outcome were related to donor site complications. In this study, no patients experienced any modification in sagittal angle, which indicated no significant instability. We used the axial CT and sagittal reconstructive CT scans to attempt to demonstrate bone growth. From the CT scan, we noticed that mature bony trabeculae across the interbody space (sentinel sign) were present, so this signs demonstrate at rue interbody fusion occurred. In all patients who underwent CT scan survey, exactly mature bony trabeculae bridging are all demonstrated (Fig. 3).

Discussion

Surgical treatment of cervical spondylotic myelopathy has focused on decompression of the spinal cord to stop neurological deterioration and to promote recovery. Cervical compression in myelopathy is predominantly due to the pressure on the anterior spinal cord with ischemia and deformation of the cord by the anterior herniated discs, spondylotic spurs or an ossified posterior longitudinal ligament.¹⁶ The purpose of placing a graft after



Fig. 3. We used CT scans to attempt to demonstrate bone growth. From the CT scan, we noticed that mature bony trabeculae bridging the interbody space (sentinel sign) were present, and it means true interbody fusion occurs.



Fig. 4. X-ray examination documenting the plate bringing the site of corpectomy and bone grafting.

anterior cervical corpectomy is to maintain cervical height and to restore cervical lordosis allowing and promoting bony fusion and subsequent stability.¹⁷ The rationale for placing a plate over the graft and screwing it into the adjacent vertebral bodies increases the stability, decrease the incidence of graft dislodgement until bony fusion is reached, and also decreasing pseudo-arthrosis complications.¹⁸

Controversy remains as to the best method to providing anterior column support after bone removal. Use of autologous tri-cortical iliac bone has traditionally been considered the gold standard of graft material, but donor site morbidity is a concern.¹⁹ Allograft bone avoids the morbidity of harvesting, but fusion rate was not comparable to autograft (allograft strut grafts combined with anterior plates have given fusion rates as high as 86.6%).²⁰ Therefore, use of regional autograft bone would be ideal to avoid donor site morbidity and to promote fusion as much as possible (Figs. 4 and 5); in these cases, titanium mesh and/or titanium expanding cages allow the use of local autograft for graft material in cervical corpectomy surgery, thereby providing a good mechanical support. Expanding cages provide also a good distraction with theoretical restore of physiologic lordosis²¹ (Figs. 6–9). Complications of titanium mesh and expanding cages with autograft and anterior plates may include subsidence and kyphotic deformity^{22,23}; when using these devices, any over distraction maneuvers should be avoided.

Many factors have been shown to affect results of ventral cervical decompression surgery for cervical myelopathy including age, preoperative neurological condition, chronicity and the number of stenotic spinal segments.^{24,25} As regard the relationship between the duration of symptoms, signs and the clinical outcome, patients with a short time before surgery (up to one year) had much better chance of improvement than those patients with more than one-year of time before surgery. The relationship between the progress rate (course) of myelopathy and the clinical outcome showed that those patients with rapid progression of symptoms and signs had better chance of improvement. The rate



Fig. 5. CT examination documenting the plate bringing the site of corpectomy and bone grafting.

of graft and fixation related to complications increase as the length of the fusion increases.²⁶ The rate of fusion in our study was 100%, this may be explained by that we supplemented all our patients with a plate. Severity of dysphagia after anterior cervical spine surgery has been directly correlated with operative time.²⁷ All patients in this series encountered transient postoperative

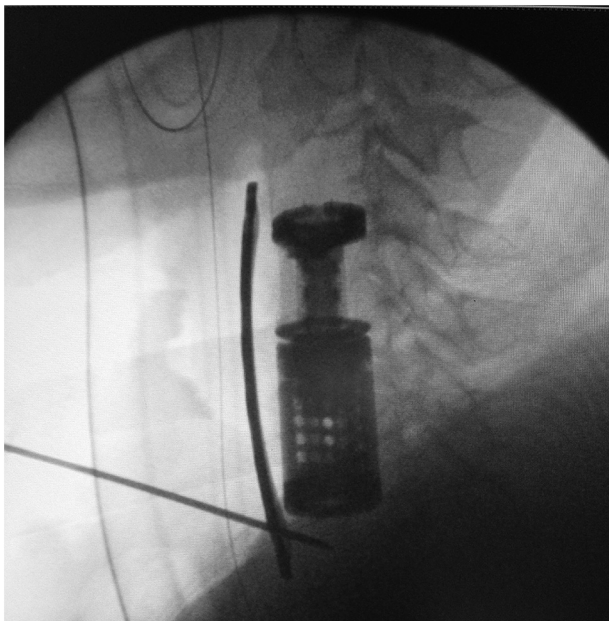


Fig. 6. In the group 2 titanium expanding interbody cages were packed with autografts from the resected vertebrae, positioned into the corpectomy defect and then expanded to make contact with the inferior endplate of the superior vertebra and the superior endplate of the inferior vertebra.



Fig. 8. Intraoperative images: three steps during the positioning of an expandable titanium cage. The cage is expanded into the defect.



Fig. 7. Intraoperative images: three steps during the positioning of an expandable titanium cage. Positioning into the corpectomy defect.



Fig. 9. Intraoperative images: three steps during the positioning of an expandable titanium cage. Interbody cage is packed with autografts from the resected vertebrae.

swallowing discomfort, but we do not consider this a complication as no patient required diet modification or a feeding tube. The percentage of complications is widely described in the literature, a recent article cited the complications of patients treated with anterior access during the cervical front surgery is the review written by Tasiou et al.²⁸ The number of complications was slightly lower than the statistics, probably due to a careful selection of patients to be treated and a standardization of the phases during treatment.

Conclusions

Decompression of the cervical spinal cord and grafting with plate fixation via a ventral approach demonstrate a high rate of improvement in neurological functions with minimal complications.

Better neurological outcomes are related to young patients, short duration of symptoms and signs, rapid course of myelopathy and better neurological function before surgery. Strut iliac bone graft combined with plating allows to a good stability with high rate of fusion. Cervical corpectomies with titanium mesh or expanding cage may offer a viable alternative to previously

described anterior cervical fusion technique. These treatments are reliable with excellent fusion rates and low rate of complications than the first described technique. The use of titanium devices (mesh/cage) avoids the harvest of strut iliac tri-cortical graft without complications at the bone donor site.

Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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