

## Anterior Cervical Spinal Surgery for Multilevel Cervical Myelopathy

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**Background:** In multilevel spinal cord compression caused by cervical spondylosis, surgeons face the choice of performing a posterior route as a laminectomy or laminoplasty, or an anterior route as multiple adjacent interbody decompressions or corpectomies. The anterior cervical operation is not considered by some clinicians because of concerns about complications and the complexity of multilevel anterior cervical surgery.

**Methods:** In this retrospective study, 14 patients with multilevel cervical spondylosis who were operated on via an anterior route were enrolled to evaluate the complexity, safety, and clinical results. The collected parameters were operation time, blood loss, hospital days, and early and late complications for evaluating the operative complexity, radiographic follow-up for evaluating fusion, graft problems, implants problems, and the recovery rate using the Japanese Orthopaedic Association score (JOA score) for evaluating the operative results.

**Results:** The mean operation time was 363.4 min, and blood loss was 431.4 ml. An early complication was noted in 1 patient with combined deep vein thrombosis and a pulmonary embolism. Late complications were screw breakage in 1 patient and screw loosening in 5 patients. The mean duration of follow-up was 21.9 months. The mean recovery rate of the JOA score was 38.8% post-operatively and 51.9% at the final follow-up. The fusion rate was 100% in this series.

**Conclusions:** Anterior cervical decompression and fusion for multilevel stenosis requires a longer operation time than posterior procedures; however, the clinical results are satisfactory.

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**Key words:** multilevel, myelopathy, cervical spine, anterior fusion.

Posterior decompression by a laminectomy or laminoplasty and anterior decompression by a discectomy or corpectomy are surgical methods for treating cervical myelopathy.<sup>(1,2)</sup> In 1 or 2 disc levels of stenosis, an anterior discectomy or corpectomy is

the preferred method. The main pathology originates from the disc, and available satisfactory fusion results are good reasons for selecting the anterior route in treating oligosegmental lesions. A laminectomy is usually considered only if the pathology is

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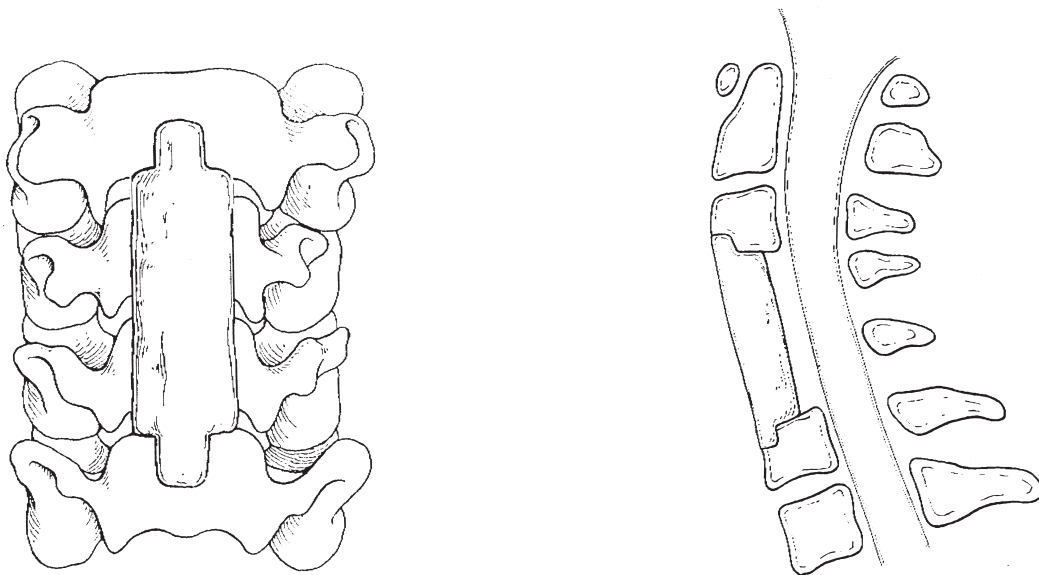
located posteriorly.<sup>(3,4)</sup> Facing multilevel stenosis, a higher incidence of pseudarthrosis may occur if multilevel interbody fusion is performed following discectomies. To avoid the risk of pseudarthrosis from multilevel anterior interbody grafting, posterior decompression by a laminectomy or laminoplasty without the need for fusion may be considered. If preoperative kyphosis or instability is present in patients with multilevel cervical stenosis treated posteriorly with a laminectomy or laminoplasty, the deformity and instability can be aggravated by the operation.<sup>(5)</sup> A subtotal corpectomy and strut graft fusion were introduced in the 1950s. This technique is considered useful due to its advantages of effective neurologic decompression, and feasible correction of kyphosis and instability.<sup>(2)</sup> However, problems of long operation times, extensive blood loss, and complications of the bone graft such as collapse, breakage, or nonunion are of great concern in patients with multilevel cervical stenosis treated anteriorly. In this study, we retrospectively assessed the operative complexity, complications, and outcomes of subtotal corpectomies or multilevel discectomies in patients with multilevel cervical myelopathy.

## METHODS

Between September 1997 and March 2001, 17

patients with myelopathy caused by multilevel cervical stenosis from spondylosis and traumatic spinal cord injury without fracture underwent anterior cervical surgery at Chang Gung Memorial Hospital, Taoyuan, Taiwan. Either multilevel discectomies with interbody fusions or corpectomies with strut graft fusion were performed. One female patient with metastatic adenocarcinoma of the cervical spine and 1 male patient who suffered from gastric cancer 18 months after the operation were excluded from this study to prevent those conditions from influencing the findings. One patient who was a foreign laborer from Thailand returned to his country 3 months after the surgery and was excluded from this study due to inadequate follow-up. Therefore, 14 patients with complete follow-up records were included in this work. The levels on which the operations occurred were based on the neurologic deficits and correlated stenosis found in the magnetic resonance image (MRI) examination. "Multilevel" was defined as involvement of 3 or more disc levels.

The operation was performed through the right anterior neck using a single oblique incision along the medial margin of the sternocleidomastoid muscle. Multiple discectomies and interbody fusion with auto- or allogeneic grafts were performed on 5 patients. Multiple subtotal corpectomies and reconstruction by a single long spanning strut with a deep-



**Fig. 1** Grafting method used in this series. (A) A 5×5×5-mm peg was made on each end of graft. (B) A corresponding notch was made in the middle of the superior and inferior endplates. Lateral view of the graft position.

frozen fibula or ulna allograft were performed for the other 10 patients. The allogeneic strut graft was prepared using the hybrid technique, which consisted of autogenous cancellous chips taken from the corpectomies being used to fill in the medullary canal of the allograft. We made a 5×5×5-mm peg at both ends of the graft and correspondingly sized notches in the middle of the anterior portion of the superior and inferior endplates (Fig. 1). The graft was then secured into the space left after the corpectomy. The anterior cervical plate was augmented in all but 1 patient. All patients wore a Miami collar for protection for 6 weeks after surgery.

The operative time, blood loss, hospital days, and medical and surgical complications were recorded to assess the complexity of the operation. Complications were further divided into early and late groups. Outcomes were assessed both clinically and radiographically. Moreover, the clinical outcome was assessed using the Japanese Orthopaedic Association scoring system (the JOA score).<sup>(6)</sup> The JOA score was accessed preoperatively, postoperatively, and at the final follow-up by interview with a physician's assistant (Table 1). Nurick's classification<sup>(7)</sup> (Table 2) was used to classify the severity of the myelopathy before and after surgery. The recovery rate of the JOA score was calculated based on the equation below: (post-op (or final) JOA score-pre-op JOA score)/(17-pre-op score)×100%.

Concerning the fusion results, the correctability of the kyphosis and complications arising from the instrumentation were assessed based on radiographic studies (anteroposterior, lateral, flexion, and extension stress views) performed preoperatively, postoperatively, and at the final follow-up. The absence of a trabecular bridge crossing the contact surface between the graft and endplate, continuous radiolucency, or a significant change in Cobb's angle on the stress views were the criteria for fusion failure. Changes in Cobb's angle and the interbody height of the graft levels between before and after the operation were used to assess the correctability of the kyphosis with anterior surgery. Changes in the same parameters between the final follow-up and postoperatively were defined by both the loss of correction of the kyphosis and graft collapse. Complications of using an anterior cervical plate, such as screw loosening, breakage, malpositioning, and the plate backing out, were identified by the radiograms.

**Table 1.** Criteria Adopted by the Japanese Orthopaedic Association for Evaluation of the Results of the Operation for Cervical Myelopathy

I. Upper extremity function	
0.	Impossible to eat with either chopsticks or a spoon
1.	Possible to eat with a spoon, but not with chopsticks
2.	Possible to eat with chopsticks, but inadequately
3.	Possible to eat with chopsticks, but awkwardly
4.	Normal
II. Lower extremity function	
0.	Impossible to walk
1.	Needs a cane or aid on flat ground
2.	Needs a cane or aid only on stairs
3.	Possible to walk without a cane or aid, but slowly
4.	Normal
III. Sensory function	
A. Upper extremity	
0.	Apparent sensory loss
1.	Minimal sensory loss
2.	Normal
B. Lower extremity	
0.	Apparent sensory loss
1.	Minimal sensory loss
2.	Normal
C. Trunk	
0.	Apparent sensory loss
1.	Minimal sensory loss
2.	Normal
IV. Bladder function	
0.	Complete retention
1.	Severe disturbance
	(1) Inadequate evacuation of the bladder
	(2) Straining
	(3) Dribbling of urine
2.	Mild disturbance
	(1) Urinary frequency
	(2) Urinary hesitancy
3.	Normal

**Table 2.** Nurick's Classification

Nurick's score	Neurologic status
0	Root sign/symptoms, normal cord function
I	Cord pathology, gait intact/employed
II	Mild gait dysfunction/employed
III	Gait dysfunction/unemployed
IV	Moderate to marked gait dysfunction/ambulation with help
V	Marked gait dysfunction/wheelchair bound

## RESULTS

This investigation included 11 male and 3 female patients. The mean age was 59.1 (range, 35 to 77) years. Ten of the 14 patients had degenerative cervical spondylosis, and the other 4 patients had spinal cord injury without spinal fracture. Three levels of decompression and grafting were performed in 13 patients and 4 levels in 1 patient. All 14 patients had combined radiculopathy and myelopathy before surgery. The mean follow-up time in this study was  $21.9 \pm 11.4$  (range, 12 to 47) months.

### Operation

The mean operation time was 363.4 (range, 265 to 465) min. Estimated blood loss ranged from 120 to 1400 ml with an average of 431.4 ml. The hospital stay ranged from 5 to 14 days with an average of 10.7 days. The longest hospital stay was 34 days, and this was found in a 60-year-old male patient with multiple traumas. This patient experienced deep vein thrombosis and pulmonary embolism during his hospitalization, leading to additional hospital days to manage the complications. Consequently, this case was excluded from the average.

Nine patients (64.3%) received fibular or ulna allogeneic bone as the strut graft, while 5 patients (35.7%) received an autograft from their own anterior iliac crest for the multiple interbody fusions. An anterior cervical plate was applied in 13 patients. Moreover, 12 patients received Orion plate fixation and 1 received Caspar plate fixation.

### Radiography

The change between immediate postoperative and preoperative Cobb's angles was  $2.67^\circ$  of lordosis gain on average (range,  $-17^\circ$  to  $17^\circ$ ), and the change between the final and postoperative Cobb's angles was  $-4.94^\circ$  (range,  $-17^\circ$  to  $17^\circ$ ), so there was a loss of  $4.94^\circ$  of lordosis at the follow-up. The mean anterior interbody height was  $71.7 \pm 8.6$  mm preoperatively, which was corrected to  $73.7 \pm 9.4$  mm postoperatively. At the final follow-up, the mean anterior interbody height decreased to  $71.9 \pm 9.8$  mm. Moreover, the posterior interbody height was  $68.6 \pm 8.6$  mm preoperatively,  $69.7 \pm 9.1$  mm postoperatively, and  $69.0 \pm 9.4$  mm at the final follow-up. The mean correction of the anterior interbody height by surgery was 2.0 mm postoperatively, but ultimately declined

to 0 mm. Moreover, the mean correction of the posterior interbody height was 1.1 mm postoperatively, which was reduced to 0.1 mm at the final follow-up. This series demonstrates that anterior grafting techniques, either multiple interbody fusions or strut grafting, did maintain, but not effectively increase, the original interbody height and Cobb's angle. From a lateral view of the cervical spine, solid fusion was defined in all of the presented cases by bridging of the trabecular bone across the upper and lower interfaces between the graft and endplate. A fusion rate of 100% was achieved in this series.

### Complications

Complications were divided into early and late groups (Table 3). In the early complication group, a screw inserted into the inferior intact disc was noted on the postoperative radiogram of 1 patient, and revision was immediately performed. Another patient experienced deep vein thrombosis and a pulmonary embolism following surgery. But both problems were resolved smoothly by medical treatment. Additionally, a 54-year-old female patient suffered partial dislodgment of the bone graft. No special treatment was administered at that time, and the dislodgement of the graft eventually became insignificant during the follow-up. Incidentally, this female patient was the only one who did not receive implantation. No neurologic deficits or esophageal complications developed in any patient following surgery.

Screw loosening occurred in 5 patients, and screw breakage occurred in 1 patient in the late complication group. All these complications occurred with solid graft union, making further procedures unnecessary.

**Table 3.** Complications in This Series

	Complication	Number	Percentage
Early	Deep vein thrombosis	1/14	7.1%
	Pulmonary embolism	1/14	7.1%
	Implant malposition	1/14	7.1%
	Bone graft dislodgment	1/14	7.1%
Late	Nonunion	0/14	0%
	Screw breakage	1/14	7.1%
	Screw loosening	5/14	35.5%

### JOA scores and Nurick's grading

The development of neurological function

through surgery was evaluated based on the JOA score. The mean preoperative JOA score was  $11.7 \pm 2.6$ , which improved to  $13.5 \pm 3.1$  after surgery. The improvement reached  $14.1 \pm 2.5$  at the final follow-up. The immediate postoperative recovery rate was 38.8% (range, 0% to 100%), and the final recovery rate was 51.9% (range, 0% to 100%).

As for the myelopathy outcome as surveyed by Nurick's classification, 10 (71.4%) patients experienced 1 grade of improvement on the postoperative follow-up, 3 patients (21.4%) remained unchanged, and 1 patient experienced 1 grade of deterioration (Table 4).

**Table 4.** Perioperative Myelopathy by Nurick's Classification

Post-op \ Pre-op	0	1	2	3	4	5
0						
1	2	2				
2		3				
3			3	1	1	
4				2		
5						

## DISCUSSION

Patients with symptomatic cervical spondylosis usually present with radiculopathy such as arm pain, paresthesia, weakness, neck pain with or without involvement of the interscapular or shoulder regions, and myelopathy, such as spastic gait and limb clumsiness. A definite diagnosis can be achieved via cervical spine radiographic studies, myelography, computed tomography (CT), or MRI. For radiculopathy, conservative treatment such as a nonsteroid anti-inflammatory drug (NSAID) and antispasmodic medicine combined with physical therapy, can achieve improvement in most patients. Indications for surgical intervention in patients with radiculopathy are persistent or progressive arm pain, progressive neurologic deficits, or motor weakness without response to 3 months of conservative treatment.<sup>(8,9)</sup> Unlike radiculopathy, conservative treatment is less useful for myelopathy. In the presence of progressive deterioration of neurological function or interference with daily activities, surgical intervention is generally considered for patients with myelopathy.

If 1 or 2 levels of spinal cord compression are

caused by cervical spondylosis, surgeons generally select anterior interbody decompressions and interbody grafting by either an autogenous or allogeneic graft rather than posterior procedures. Spondylosis is a serial pathologic change originating from disc degeneration, and major pathologies, whether disc herniation or osteophyte, are always located around the disc, which are anterior to the cord. In such cases, the anterior approach can provide a good surgical route for direct decompression by discectomy and osteophylectomy. Furthermore, oligosegmental fusion can achieve a satisfactory likelihood of graft healing.

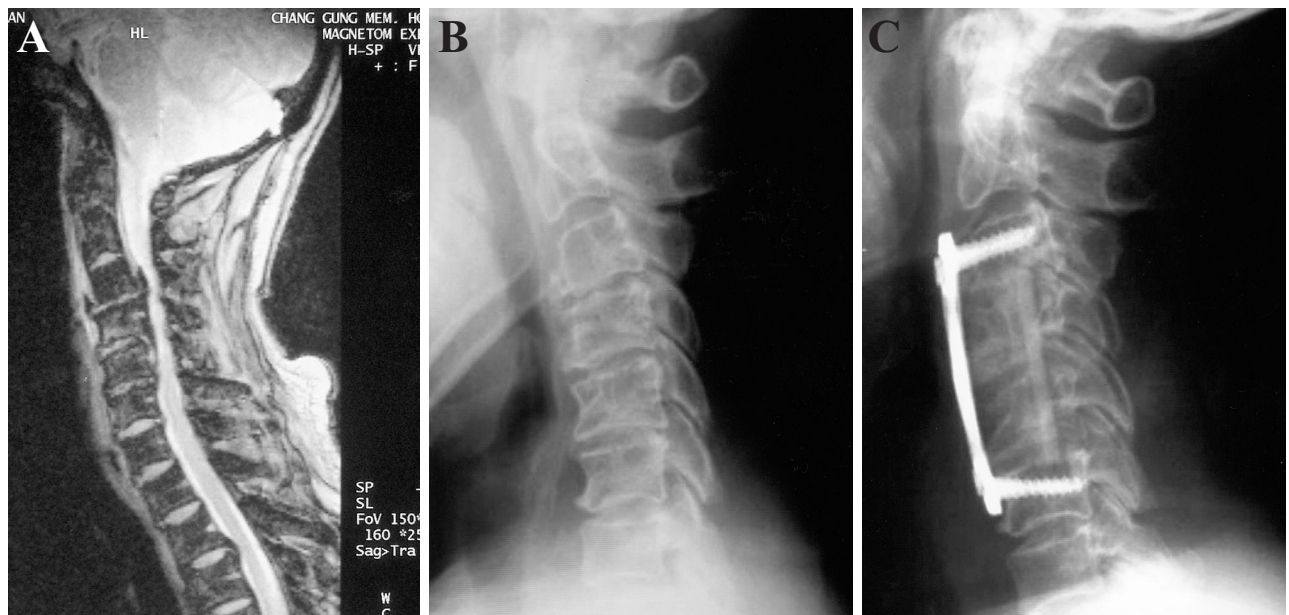
The issue of treatment choice for multilevel cervical spondylosis continues to be debated in the literature.<sup>(1,2)</sup> Optional procedures include posterior approaches, such as a laminectomy or laminoplasty, and anterior approaches, such as a corpectomy or adjacent multiple discectomies. Each of these procedures has its advantages and limitations. A laminectomy formerly was the standard posterior procedure. A laminectomy was routinely used in patients with radiculopathy and myelopathy arising from neurological compression. This procedure includes removal of the lamina and part of the facet joints if necessary to provide adequate decompression. However, loss of paraspinal muscle attachment to posterior elements (laminae and spinal processes), a partial facetectomy, and sacrifice of interspinous ligaments result in poor structural stability. Thereafter, posterior muscle weakness followed by chronic nuchal pain is likely to bother patients. The effect is increased as more levels are involved. After a multilevel cervical laminectomy, a patient may be prone to develop kyphosis. A laminectomy is initially performed to relieve cord compression from anterior structures; lordosis is necessary to allow the cord to fall away from the impinging anterior elements. The development of post-laminectomy kyphosis (more kyphotic than the preoperative Cobb's angle) will re-aggravate the neurologic symptoms on follow-up. For patients with preexisting cervical kyphosis or instability, a laminectomy is contraindicated owing to the increased deformity or instability resulting from this procedure.

Laminoplasty is another posterior procedure, which enlarges the spinal canal by opening the posterior elements without removing them. Laminoplasty has been demonstrated to achieve better mechanical

stability than a laminectomy for cervical multilevel decompression. Both the objective improvement in patient function and subjective improvements in strength, dexterity, sensation, pain, and gait tend to be greater in the laminoplasty group than the laminectomy group. Moreover, laminoplasty is preferable owing to significantly fewer complications and less functional impairment.<sup>(10)</sup> Nevertheless, even laminoplasty cannot completely prevent later kyphotic development.<sup>(10-12)</sup> To prevent post-laminectomy kyphosis, lateral mass plating and fusion are recommended in conjunction with posterior operations.<sup>(13)</sup> Lateral mass plating may be able to fix the preexisting instability and kyphosis to avoid an aggravated deformity. However, the correctibility of kyphosis is still questionable. In addition, lateral mass plating is not free of complications, nor is it technically simple. Nevertheless, laminoplasty is preferred for patients with multilevel cervical stenosis without kyphosis. Thereafter, posterior operations require a nonkyphotic alignment. Indirect decompression of the cord can be achieved by a laminectomy or laminoplasty for multilevel cervical stenosis in the presence of cervical lordosis; and laminoplasty is preferred to a laminectomy. Patients with preexisting

kyphosis are better treated by subtotal corpectomies to prevent aggravation of the kyphosis (Fig. 2). Besides, patients treated with laminoplasty more frequently manifest axial neck pain (40% vs. 15%), and more-severely lose their vertebral range of motion (ROM) (71%) than those treated with corpectomies (51%). The ROM is even more limited than in the laminectomy group, according to a comparative study.<sup>(2)</sup>

Cervical spinal surgery by the anterior route is easier, and results are ensured for 1 or 2 levels. However, when decompression by a corpectomy or discectomy is performed on multiple levels, multiple interbody grafts or a single long strut graft are necessary to maintain or restore the lordotic alignment and stability. A corpectomy is designed to achieve direct decompression for lesions posterior to the vertebral body. In order to reduce the likelihood of failed healing with multiple interbody grafts following multiple levels of interbody decompression, a strut graft is applied to provide strong vertical support for the spinal column. An allograft or autograft is available for the bone graft. As described by An et al., higher rates of graft failure, pseudarthrosis, and collapse with interbody fusion were noted with allografts than



**Fig. 2** (A) A 68-year-old female patient who received a C3-6 laminectomy for myelopathy caused by OPLL, as revealed by an MRI study. (B) Post-laminectomy kyphosis which developed with aggravated myelopathy. (C) After the anterior operation, kyphosis was corrected by strut grafting and anterior plate fixation.

with autografts.<sup>(14)</sup> But autografts suffer more disadvantages in terms of donor site morbidity, including persistent donor site pain, infection, hematoma, iliac wing fracture, muscle herniation, and lateral femoral cutaneous nerve injury. The incidence of donor site morbidity has been reported in up to 20% of patients.<sup>(15)</sup> Fibular autografts suffer even more complications, including postoperative tibial stress fracture and decreased sensation in the first dorsal web space of the foot due to injury to the superficial and deep peroneal nerves.<sup>(16-18)</sup>

Interbody fusion is indicated for patients receiving a discectomy to achieve structural stability and maintain the neuroforamen. An autogeneic bone graft harvested from the anterior iliac spine is the graft of choice. The tricortical iliac bone has a cancellous part that can face the endplate and provides better fusion results. However, the chance of failed fusion at 1 or more surfaces increases in multiple interbody fusions, because twice the number of fusion surfaces exist for multiple grafting levels. The present series contained 5 patients using the anterior iliac bone for interbody fusion following multiple discectomies. To prevent a possibly higher pseudarthrosis rate, cervical plating was augmented in all of these patients. Fortunately, pseudarthrosis was not found around any graft surface in any of these patients.

A deep-frozen allogeneic ulna or fibula strut graft was used for the 10 patients undergoing multiple corpectomies. This investigation used the hybrid technique to overcome the disadvantage of a higher nonunion rate with allografts. The intramedullary canal of the allogeneic fibula was filled with morselized autogeneic cancellous bone saved from the corpectomies. The better osteogenic capability of the autogeneic cancellous bone can enhance the fusion process. In addition, a 5 × 5 × 5-mm notch was carved into the cancellous bone through the anterior portion of the respective superior and inferior end plates to receive specially prepared pegs at both ends of the strut graft (Fig. 1). This design also enhances osteogenesis in the notched area, and the major area of the endplate remains intact to prevent the graft from sinking into the subchondral bone.<sup>(19)</sup> This method was applied in all of our patients with strut grafting in the present study.

Because the pseudarthrosis rate and the time required for fusion may increase with the number of

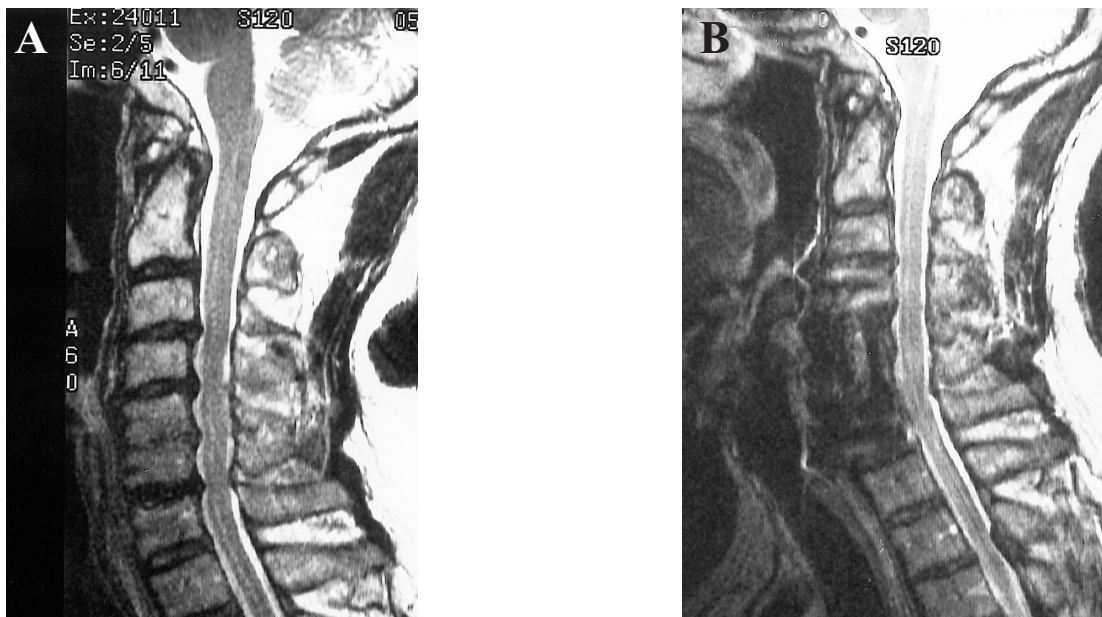
levels to be grafted, if a strut graft is used following multiple corpectomies, the duration required for osteogenesis and creeping substitution along the graft will increase with graft length, and it is even longer when using an allogeneic graft. To prevent nonunion, graft dislodgement, collapse, and breakage, anterior plate augmentation can effectively maintain the spinal alignment, prevent graft dislodgement, and increase the fusion rate in multilevel cervical operation by providing better graft immobilization.<sup>(11,20-24)</sup> Bicortical screw purchase is necessary to ensure rigid fixation for some old-generation cervical plates, while such as the Caspar plating system (Aesculap, Tuttlingen, Germany) which is a nonconstrained plate, otherwise screw loosening tends to occur with unicortical purchase.<sup>(22)</sup> Through modern plate designs of constrained systems, unicortical cancellous screw fixation with a locking design between the screw and plate can achieve rigid fixation, avoid risk of neurologic injury by bicortical screwing, and reduce screw loosening or the backing out of the plate, as with the Orion anterior cervical plating system (Danek, Memphis, TN).<sup>(24,25)</sup> In spite of the secure fixation provided by this constrained device, evidence from mechanical testing proved that this plate still serves as a load-sharing device rather than a load-shielding device, enabling successful graft consolidation as observed in this clinical study.<sup>(26)</sup> With concomitant anterior cervical plating, pseudarthrosis, delayed union, and graft collapse are decreased in multilevel fusions. Anterior cervical plate instrumentation was performed in 13 of the 14 patients in this study, with the Orion plate being used in the majority 12 of them. Although some late instrument complications developed later in follow-up, for example screw breakage and loosening, patients tolerated these complications well. We defined screw loosening as radiolucency around the screw. None of the patients with screw loosening experienced the screw backing out. We believe that the locking system effectively prevents the screw from backing out. None of the patients underwent further surgery for these complications, and the fusion rate in this study remained unaffected. The only patient without instrumentation in this study developed partial graft dislodgement. Fortunately, this patient eventually achieved bony union by longer brace protection.

This study was not designed to compare anterior

surgery with posterior surgery for multilevel cervical spondylosis. According to a literature review<sup>(27)</sup> of clinical results for patients who had nerve compression at 3 or more levels because of spondylosis, 92% of patients who had an anterior procedure, 86% of the laminoplasty group, and 66% of the laminectomy group had excellent or good results. The clinical outcomes revealed by the JOA score and the recovery rate of laminoplasty group were equivalent to those of the corpectomy group.<sup>(11,12)</sup> As a whole, clinical outcomes of the anterior procedure are superior to those of the laminectomy and equivalent to those of laminoplasty. In this study, anterior surgery indeed achieved satisfactory improvement and an adequate recovery rate according to the JOA score and was as good as other groups who had laminoplasty. Seventy-one percent of patients had at least 1 Nurick's grade of neurologic improvement after treatment. Because the major pathologies of canal stenosis from cervical spondylosis are located anterior to the spinal cord, anterior corpectomies or discectomies can directly remove them until the dura and neuroforamen are completely decompressed, which can be confirmed by direct vision and nerve-hook sounding. Adequate decompression of the spinal canal was also proven by the postoperative MRI

study (Fig. 3). As for the outcome of the sagittal curve provided by anterior surgery in this study, although the gain of kyphosis correction ( $2.67^\circ$ ) immediately after the operation might have been lost again ( $4.94^\circ$ ) during follow-up, anterior fusion by either a strut graft or multiple interbody fusions augmented by a plate can effectively prevent the deterioration of kyphosis.

From the literature,<sup>(10-12,28)</sup> anterior cervical spinal surgery was associated with more complications than with either laminoplasty or a laminectomy. Complications can be classified as intraoperative and postoperative ones. Intraoperative complications include an esophageal tear, carotid or vertebral artery laceration, recurrent laryngeal nerve injury, and spinal cord injury. Experience by surgeons and knowledge of the anatomical structures of the neck can help lessen the chance of such problems occurring. Postoperative complications include hematoma formation, dyspnea and dysphagia from local edema, and graft-related complications, such as graft dislodgment, collapse, fracture, and pseudarthrosis. Donor site complications of hematoma, infection, nerve injury, or chronic pain may occur if an autograft is used. In addition, medical complications such as deep vein thrombosis or acute myocardial infar-



**Fig. 3** Multilevel stenosis in the disc areas (A) which was well decompressed by corpectomies and (B) which was proven by a postoperative MRI evaluation.



tion have also been reported previously.<sup>(10-12,28)</sup> The present series surprisingly revealed less surgery time and blood loss than in the literature. Notably, the blood loss was even less than in a laminoplasty group.<sup>(2)</sup> The patients in this series experienced few major complications. One patient developed deep vein thrombosis and pulmonary emboli, but anticoagulant therapy resolved these problems smoothly. The most-common complication in this series was screw loosening (35.5%), which was mild and clinically asymptomatic in all cases. One incident of screw breakage was noted during follow-up but did not cause structural instability or nonunion. The reported pseudarthrosis rate for anterior cervical multilevel surgery ranged from 9.7% to 26%.<sup>(17,29)</sup> Fortunately, this series contained no cases of nonunion as determined by the presence of trabecular bone bridging. However, the number involved in the present series was too small to draw any definitive conclusions. At least, we can conclude that the successful fusion rate using our grafting method and plate augmentation is sufficient to encourage further use of anterior surgery for cervical myelopathy. No major operative complications, such as esophageal tears, or carotid artery or vertebral artery injuries were encountered in this series.

In conclusion, long decompression and long fusion through the anterior route for cervical myelopathy by multilevel stenosis are an effective procedure, which is not as complicated as generally thought according to the experiences of this series. Objective improvement according to the JOA scores was obvious, and the union results were quite satisfactory. Although the corrected kyphosis tended to restore to the preoperative degree, no patient in the present series experienced worse kyphosis or deformity. The surgical time was not as long as expected, and blood loss and hospital stay were also acceptable. But this procedure has its limitations. For example, the approach by the C2-3 disc is difficult due to the mandible's position if decompression has to be performed on the upper cervical level. Whenever more than 6 cm of autologous fibular strut graft has to be harvested from a patient's own leg instead of the anterior iliac crest and an allogeneic graft is unavailable from a commercial source or bone bank in some countries or hospitals, graft harvesting will take more time and there will be higher risks of complications. For long canal stenosis by

ossified posterior longitudinal ligament (OPLL), anterior decompression is not recommended because of the high chance of a dura tear. Because the dura is pressed thin and tightly adherent to the OPLL, it is easily torn during decompression. However, for patients with myelopathy caused by multiple-level cervical spondylosis who have kyphosis or segmental instability, anterior cervical corpectomy reconstruction with an allogeneic strut graft in the hybrid preparation and anterior cervical plate augmentation is the preferred procedure and is highly recommended over posterior procedures.

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## 多節頸椎髓神經病變的前位手術治療

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- 背景：**對於多節頸椎椎管狹窄產生神經壓迫的問題，外科醫師常面臨選擇前位減壓與融合術或者後位椎板切除或椎板整型術的難題。手術方式上使用前位多節減壓與融合術來治療，由於手術複雜以及擔憂可能遇到的合併症，常是阻礙此法普遍化的因素。
- 方法：**本回溯性研究蒐集了14位病人接受前位長節減壓術（椎體切除術或多節椎間盤切除術）與骨融合術，加上骨椎板的固定治療，統計並記錄了此法的治療經驗。以手術時間、流血量、住院天數、急性合併症的發生來代表手術的複雜性；以Japaneses Orthopaedic Association score (JOA score) 恢復率與植骨融合成功率表其臨床滿意的程度。依此來衡量以前位手術的來治療多節頸椎狹窄的價值。
- 結果：**平均手術時間為363.4分鐘，術中流血量平均為431.4毫升。早期合併症中，只有1位病人同時發生了下肢靜脈栓塞與肺栓塞。後期合併症中有1位螺絲斷裂和5位螺絲鬆動現象，但皆無症狀。JOA score 術後與最後追蹤恢復率為38.8%及51.9%。植骨融合成功率達100%。
- 結論：**由本研究結果顯示，前位融合手術比後位手術所需時間較長，但是整體上臨床結果令人滿意。  
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**關鍵字：**多節，脊髓病變，頸椎，前位融合。

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