Segmental Anterior Decompression and Fusion for Multilevel Ossification of the Posterior Longitudinal Ligament

SUN QIZHI, MD; WANG XUELEI, MD; YANG LILI, MD; LIANG LEI, MD; CHEN LINWEI, MD; LIU YANG, MD; ZHANG YING, MD; YUAN WEN, MD

Abstract

Full article available online at ORTHOSuperSite.com. Search: 20120222-38

The purpose of this study was to evaluate the outcome of segmental anterior decompression and fusion for multilevel ossification of the posterior longitudinal ligament. Data were collected from 23 patients with multilevel ossification of the posterior longitudinal ligament. Average operative time and blood loss were 121 minutes and 201.6 mL, respectively. The Nurick score significantly decreased from 2.7±0.9 preoperatively to 1.8±0.9 at last follow-up (P<.01). The preoperative Japanese Orthopaedic Association score was 8.2, which significantly increased to 13.8 points at last follow-up (P<.01), with an improvement rate of 64.5%. The operation also significantly increased cervical lordosis (P<.01) from 7.7° preoperatively to 13.3° postoperatively. The fusion rate was 95.7% at 6 months postoperatively, and 100% at 12 months postoperatively. The loss of cervical lordosis and height of fusion segments were 1.2° and 0.9 mm at last follow-up, respectively. No hardware complications occurred. Cerebrospinal fluid leakage occurred in 2 patients, and hematoma occurred in 1 patient who needed an emergency operation. Segmental anterior decompression and fusion was generally effective and safe in the treatment of multilevel ossification of the posterior longitudinal ligament if indications were well controlled.

Dr Qizhi is from the Department of Orthopedics, No. 88 Hospital of China People’s Liberation Army, Dr Xuelei is from the Department of Orthopedics, People’s Hospital of Zhaoyuan, Shandong, and Drs Lili, Lei, Linwei, Yang, Ying, and Wen are from the Department of Orthopedics, Changzheng Hospital, Secondary Military Medical University of China, Shanghai, China.

Drs Qizhi, Xuelei, Lili, Lei, Linwei, Yang, Ying, and Wen have no relevant financial relationships to disclose.

The authors thank their patients for their permission to publish this article.

Correspondence should be addressed to: Yuan Wen, MD, Department of Orthopedics, Changzheng Hospital, Secondary Military Medical University of China, 415 Fengyang Rd, Shanghai 200003, PR China (sunqizhi2002@yahoo.com.cn).

doi: 10.3928/01477447-20120222-38
Ossification of the posterior longitudinal ligament of the cervical spine results in compression of the spinal cord, which causes myelopathy. Because conservative treatment is usually ineffective for severe myelopathy caused by ossification of the posterior longitudinal ligament, surgical treatment is usually chosen. For 1- or 2-level cervical ossification of the posterior longitudinal ligament, anterior diskectomy or corpectomy with fusion has been widely accepted. However, little agreement exists as to the best approach for multilevel ossification of the posterior longitudinal ligament. When ≥3 levels are affected by ossification of the posterior longitudinal ligament, contiguous multisegmental corpectomies and fusion are most frequently performed. A higher incidence of complications results from this surgical procedure, such as graft displacement, nonunion, and hardware-related complications, and increases as more levels are decompressed.\(^1\)\(^-\)\(^3\) Posterior decompression is an alternative choice to achieve spinal cord decompression. However, the possibility exists of progression of ossification of the posterior longitudinal ligament, postlaminectomy membrane formation, scar tissue in the spinal canal, kyphotic deformity, and cervical spine instability.\(^4\)\(^-\)\(^5\)

For better surgical outcomes and fewer complications, other anterior decompression techniques have recently been developed.\(^6\)\(^-\)\(^8\) Segmental anterior decompression and fusion for multilevel ossification of the posterior longitudinal ligament has been performed for many years in our hospital. We retrospectively reviewed the data of 23 patients with multilevel ossification of the posterior longitudinal ligament treated with segmental anterior decompression and fusion in our hospital between January 2003 and March 2006 to evaluate its result and feasibility.

**Materials and Methods**

Between January 2003 and March 2006, clinical data of 23 patients with multilevel ossification of the posterior longitudinal ligament were collected in our department. All cases of ossification of the posterior longitudinal ligament extended 3 levels. Average patient age at operation was 58.4 years (range, 49-74 years). Segmental anterior decompression and fusion was performed in all 23 patients (15 men, 8 women). Mean duration of symptoms was 9.8 months (range, 3 days to 18 months).

All patients had preoperative plain radiographs, computed tomography (CT) construction, and magnetic resonance imaging (MRI) of the cervical spine (Figures 1, 2). Plain radiographs were taken immediately postoperatively, at 3, 6, and 12 months postoperatively, and yearly thereafter. Radiographs were taken in neutral lateral and extension–flexion positions. Solid fusion of the involved segments was achieved when segmental movement was <2\(^\circ\) on extension–flexion radiographs and ≤50% of the area of the outer surfaces of the implants were radiolucent. The cervical lordosis was measured as the angle between lines paralleled to the posterior aspects of the C2 and C6 vertebral bodies. The height of the fusion segments was measured at the midpoint of the adjacent upper and lower endplates. All radiographs were independently evaluated by 2 spine surgeons (Y.L., L.L.) and 1 radiologist (L.Y.). When a difference existed between the results of the 2 spine surgeons, the decision was made by the radiologist. The extent of ossification of the posterior longitudinal ligament was examined on sagittal MRIs.

**Surgical Technique**

The patients were placed in the supine position under general anesthesia, with their necks slightly extended. The cervical spine was exposed through a standard right-side anterior approach. The appropriate surgical level was confirmed by intraoperative radiographs. A combination of 1-level corpectomy and adjacent-level diskectomy was performed (Figures 1, 2). After disectomy and corpectomy, the ossification of the posterior longitudinal ligament was separated from the dura using a specialized microdissector. The head...
of the dissector was a hook with a narrow slot that was inserted under the ossification of the posterior longitudinal ligament from the nonossified ligament, rotated 90°, and slightly lifted. The ligament was cut off by scalpel along the slot. The ossification of the posterior longitudinal ligament was then meticulously separated using the microdissector and removed using a 1- to 2-mm Kerrison rongeur and microcurettes (Qing Niu; Zhangjiagang Sanxin Medical Apparatus & Instruments Co, Ltd, Jiangsu Province, China). If the ossification of the posterior longitudinal ligament was associated with the dural ossification, this portion of the dura was carefully preserved using the anterior floating method to prevent dural tears. Cage and titanium mesh were then used and filled with autologous bone fragments from the excised vertebrae to restore the bone defect. Anterior cervical plates were applied across the segments to be fused. All 23 patients were required to wear rigid cervical collars for an average of 4 weeks postoperatively.

Clinical Assessment
Perioperative parameters, including operative time and operative blood loss, were collected. The Japanese Orthopedic Association (JOA) score and Nurick scores were used to evaluate the neurological status. An improvement rate was calculated as improvement rate=(postoperative JOA score−preoperative JOA score/17−preoperative JOA score)×100%. Surgical outcome was defined by the improvement rate as excellent (improvement rate >75%), good (75%>improvement rate=50%), fair (50%>improvement rate=25%), and poor (improvement rate<25%).

Statistical Analysis
Student’s t test was used for comparison of paired data. A P value <.05 was considered statistically significant. Results are presented as mean±standard deviation (SD).

RESULTS
Radiological Findings
On sagittal images, ossification of the posterior longitudinal ligament extended 3 levels in all 23 patients. Bony fusion was achieved in 22 (95.7%) patients at 6 months postoperatively. At 12 months postoperatively, solid fusion was observed in all (100%) patients. No hardware complications occurred, and no recurrence or extension of ossification of the posterior longitudinal ligament occurred during the follow-up period. Mean cervical lordosis was 7.7°±2.5° preoperatively and significantly increased to 13.3°±1.5° postoperatively (P<.01). The loss of cervical lordosis and height of fusion segments at last follow-up were 1.2°±0.7° and 0.9±0.5 mm, respectively.

Surgical Outcomes
Six of 23 patients underwent an anterior floating procedure when ossification of the posterior longitudinal ligament was associated with dural ossification. Average operative time and blood loss were 121 minutes and 201.6 mL, respectively. No patient received blood transfusion. Mean follow-up for all 23 patients was 20.3 months (range, 12-30 months). The mean Nurick score significantly decreased from 2.7±0.9 preoperatively to 1.8±0.9 at last follow-up (P=.01). The mean preoperative JOA score was 8.2±0.9 points, which significantly increased to 13.8±1.33 points at last follow-up (P<.01), an improvement rate of 64.5%±13.68%. The surgical outcome was excellent in 6 (26.1%) patients, good in 15 (65.2%), and fair in 2 (8.7%).

Complications
In this series, complications included cerebrospinal fluid leakage leakage (n=2) and hematoma (n=1). Cerebrospinal fluid leakage leakage occurred after an intraoperative dural tear due to tight adhesion with the dura. No significant dural defect occurred in these cases because dural ossification was preserved by careful dissection. Cerebrospinal fluid leakage leakage stopped after approximately 1 week of conservative treatment of local pressure. The patient who sustained a hematoma recovered neurological function after an emergency operation.

DISCUSSION
Subtotal corpectomy and strut graft fusion were introduced in the 1950s. This technique is useful due to its effective neurologic decompression and feasible correction of kyphosis and instability.10 Anterior corpectomy decompression and fusion has been reported to be more appropriate for patients with ossification of the posterior longitudinal ligament, due to direct decompression and satisfactory results.11-13 If 1 or 2 levels of spinal cord compression are caused by ossification of the posterior longitudinal ligament, surgeons generally select anterior interbody decompressions and interbody grafting by an autogenous or allogeneic graft rather than posterior procedures.

However, when ossification of the posterior longitudinal ligament involves multiple vertebrae, performing anterior decompression becomes a challenge for spine surgeons. When anterior decompression is used in multilevel ossification of the posterior longitudinal ligament, the continuous 2 or 3 vertebral bodies are partially removed, and a longer-length autograft, allograft, or titanium mesh cage is packed with local corpectomy site derived and supplemented with a longer-length anterior plate. This procedure reportedly provides a poor fusion rate, and the failures increase as the number of decompressed levels increases.14-18 Some of the complications included vascular, esophageal, or neurologic injury.19,20 Vaccaro et al21 reported a high rate of early mechanical failure when they compared 3- and 2-level corpectomies, which were 50% and 9%, respectively. In 249 cases treated with corpectomy, Wang et al2 concluded that a longer-length graft was directly related to an increased incidence of graft displacement. A longer-length autograft...
or allograft increases the duration required for osteogenesis and creeping substitution along the graft. Mechanical failure can occur after autograft or allograft fusion and when a titanium mesh cage or anterior plate is used. Hee et al reported 19 incidences of plate-related problems in multilevel corpectomies. Sasso et al reported a 6% failure rate after fixed-plated 2-level anterior corpectomy decompression and fusion reconstruction and a 71% failure rate after 3-level fixed-plated anterior corpectomy decompression and fusion reconstruction.

Posterior decompression is an alternative choice for multilevel ossification of the posterior longitudinal ligament when anterior corpectomy decompression and fusion threatens complications and poor fusion rate. Posterior decompression mainly includes laminectomy and laminoplasty. A laminectomy is usually considered if the pathology is located posteriorly.23,24 The procedure includes removal of the lamina and part of the facet joints to provide adequate decompression. However, loss of paraspinal muscle attachment to posterior elements, a partial facetectomy, and sacrifice of interspinous ligaments results in poor structural stability and chronic axis pain. The effect increases as more levels are involved. After a multilevel cervical laminectomy, kyphosis may develop. The development of post-laminectomy kyphosis will reaggregate the neurologic symptoms on follow-up.

Laminoplasty is now being used more frequently to treat multilevel ossification of the posterior longitudinal ligament as another posterior procedure, which enlarges the spinal canal by opening the posterior elements without removing them. It has been demonstrated to achieve better mechanical stability than a laminectomy for cervical multilevel decompression. The objective and subjective improvements tend to be greater in patients who underwent laminoplasty rather than laminectomy. Laminoplasty is preferable due to significantly fewer complications and less functional impairment. Nevertheless, laminoplasty cannot completely prevent later kyphotic development.10,25 If preoperative kyphosis or instability is present in patients with multilevel cervical stenosis treated posteriorly with laminectomy or laminoplasty, the deformity and instability can be aggravated by the operation.26

Biomechanical studies and previous clinical studies suggest anterior corpectomy decompression and fusion combined with posterior stabilization.27 However, supplemental posterior stabilization adds a second significant surgery and risk, particularly in elderly and frail patients. The potential exists for a higher rate of infection, increased length of hospital stay, and increased costs. It also causes complications of posterior surgery, such as myofascial and axial neck pain.

To avoid these complications, discontinuous corpectomy with adjacent-level diskectomy has been successfully performed with no plate loosening or graft migration.17,28,29 A similar procedure, segmental anterior decompression and fusion for multilevel ossification of the posterior longitudinal ligament, has been performed for many years in our hospital. In this study, we investigated the clinical results and safety of segmental anterior decompression and fusion in cases of multilevel ossification of the posterior longitudinal ligament. The Nurick score, JOA score, and improvement rate revealed significant clinical improvements from preoperatively to last follow-up. Accordingly, radiologic evaluation revealed improvement in cervical lordosis. The fusion rate was 95.7% at 6 months postoperatively and 100% at 12 months postoperatively. No hardware complications occurred, and no recurrence or extension of ossification of the posterior longitudinal ligament occurred during follow-up. At last follow-up, the loss of cervical lordosis and height of fusion segments were minimal. Segmental anterior decompression and fusion can increase the inherent mechanical construct stability, facilitate reduction of kyphotic deformity, maintain the reconstructed alignment, and minimize the chance of terminal screw–bone interface degradation. In our study, 1 vertebral body was partially removed in the segmental anterior decompression and fusion, thus resulting in less blood loss and a shorter operative time compared with traditional anterior corpectomy decompression and fusion. No patient received blood transfusion, and average operative time was approximately 2 hours.

Complications occurred in 3 (13%) patients in the current series, including 2 cases of cerebrospinal fluid leakage and 1 case of hematoma. The incidence rate of cerebrospinal fluid leakage varied from 4.5% to 32%. Avoiding cerebrospinal fluid leakage depends on the preoperative identification of dural ossification and meticulous intraoperative dissection. In patients where removing ossification of the posterior longitudinal ligament was difficult, the floating method was an alternative choice, in which the ossification of the posterior longitudinal ligament was separated from the vertebral wall. Of the 23 patients treated with segmental anterior decompression and fusion in the current study, the floating method was applied in 6 patients. In our series, cerebrospinal fluid leakage resulting from dural tears occurred in 2 patients. However, the area of dural defect was limited, and cerebrospinal fluid leakage was cured by conservative treatment. The incidence of complications was less than that reported in other published series.21,30,31

The results of this study demonstrated the advantage of segmental anterior decompression and fusion, including significant Nurick scores, JOA scores, improvement rates, restoration of cervical lordosis, and height of fusion segments. However, the patients who underwent segmental anterior decompression and fusion were strictly selected in this series. The indications for segmental anterior decompression and fusion were (1)
no preoperative kyphosis or instability, (2) the absence of congenital canal stenosis, (3) no compression of the spinal cord from the rear, and (4) mild ossification of the posterior longitudinal ligament behind the leaving vertebrae body. If the surgeon is not satisfied with the decompression behind the leaving vertebral body, he or she should change the strategy intraoperatively instead of preserving the vertebral body. We also suggest using autografts for segmental anterior decompression and fusion. An et al.\(^3\) reported higher rates of graft failure, pseudarthrosis, and collapse with interbody fusion with allografts than with autografts. Iliac crest struts could be grafted for 2-level corpectomies, and a fibula-grafting technique was used for \(\geq3\)-level corpectomies.\(^{11,12,33}\) However, the traditional autologous bone graft has a high incidence of donor-site complications, including subcutaneous hematoma, wound infection, and chronic wound pain. In the current study, autologous bone fragments from the excised vertebrae were enough to complete the interbody fusion.

Based on the results of this study, segmental anterior decompression and fusion was generally effective and safe for multi-level ossification of the posterior longitudinal ligament. Good to excellent clinical outcomes can be achieved in segmental anterior decompression and fusion if indications are well controlled, with thorough decompression, autografts from the vertebral body, and reconstruction of the lordotic cervical posture.\(^5\)

**References**


29. Liam XF, Xu JG, Zeng BF, Zhou W, Kong WQ, Hou TS. Noncontiguous anterior de-


