

DIAGNOSTICS

Postoperative Magnetic Resonance Imaging Assessment for Potential Compressive Effects of Retained Posterior Longitudinal Ligament After Anterior Cervical Fusions

A Cross-Sectional Study

Kingsley R. Chin, MD,* Gary Ghiselli, MD,† Vanessa Cumming, MBBS,‡ Christopher G. Furey, MD,§ Jung U. Yoo, MD,¶ and Sanford E. Emery, MD, MBA||

Study Design. A cross-sectional study.

Objective. To assess using postoperative magnetic resonance imaging whether the posterior longitudinal ligament (PLL) caused residual cord compression after anterior cervical decompression and fusion (ACDF) in a series of patients in whom the PLL was retained.

Summary of Background Data. There is a lack of data evaluating the postoperative compressive effects of the PLL in patients undergoing ACDF providing guidance as to whether to remove or retain the PLL during discectomy to facilitate adequate decompression.

Methods. Postoperative gadolinium enhanced magnetic resonance images were reviewed in a series of 33 patients who underwent ACDF for cervical radiculomyelopathy and who had persistent or recurrent postoperative symptoms. Patients with ossification of the posterior longitudinal ligament or with a herniated disc behind the PLL were excluded from this study.

Results. There were no cases of discernible compression by the retained PLL identified on the magnetic resonance image ($P < 0.001$) as assessed by 2 independent reviewers. Four patients underwent subsequent revision surgery unrelated to the PLL.

Conclusion. We were unable to demonstrate magnetic resonance imaging evidence to suggest that the retained PLL caused magnetic resonance imaging evidence to suggest that the retained PLL caused residual cord compression after ACDF in this patient cohort. Therefore we suggest that removing the PLL should be considered for reasons other than concern about residual compression.

Key words: postoperative magnetic resonance imaging, anterior cervical decompression and fusion, compressive effects of posterior longitudinal ligament. **Spine 2013;38:253–256**

Anterior cervical decompression and fusion (ACDF) is associated with good outcomes with variable techniques and implants.^{1–4} When performing ACDF, there is sparse data to provide direction as to whether to retain or remove the posterior longitudinal ligament (PLL) to facilitate decompression.⁵ Proponents of removal cite its continued compressive effects⁶ and that removal may assist with the elimination of sympathetic symptoms such as cervical vertigo postoperatively.⁷ Opponents think it is technically safer to retain the ligament and that there are biomechanical advantages.⁸ Some advocate routine inclusion of a transection or “opening up” of the PLL during anterior cervical corpectomy procedures.^{9,10} Retaining the ligament also provides some constraints to over-distraction of the disc space and facets during placement of an interbody cage. For uninstrumented fusions, there is reliance on the normal anatomic stabilizers such as the annulus, PLL, uncovertebral joints, facets, and ligamentous and muscular attachments to the bony elements.

In this study we used postoperative magnetic resonance imaging (MRI) to assess whether the PLL caused residual cord compression in a cohort of patients with ACDF in whom the PLL was retained intraoperatively.

MATERIALS AND METHODS

Patients

The sample comprised 33 patients (see Figure 1 for an example of patient preoperative imaging) who underwent ACDF

From the *Institute for Modern & Innovative Surgery (iMIS), Fort Lauderdale, FL; †Denver Spine, Greenwood Village, CO; ‡Less Exposure Surgery (LES) Society, Fort Lauderdale, FL; §University Hospitals Case Medical Center, Cleveland, OH; ¶Oregon Health & Science University, Portland, OR; and ||Department of Orthopaedics, West Virginia University, Morgantown, WV.

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Address correspondence and reprint requests to Kingsley R. Chin, MD, iMIS Surgery, 1100 W. Oakland Park Blvd. Ste 3, Fort Lauderdale, FL 33311; E-mail: Kingsleychin@gmail.com

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Figure 1. Preoperative sagittal T2 MR image showing advanced cervical spondylosis with multiple levels of stenosis from C3–C7. MR indicates magnetic resonance.

for cervical radiculomyelopathy and who had persistent or recurrent symptoms that prompted a postoperative MRI with gadolinium enhancement in each case. MRI was performed postoperatively to make an assessment of residual or new compressive lesions in patients with recurrent symptoms. The magnetic resonance (MR) images were independently retrospectively reviewed by 2 fellowship-trained orthopedic spine surgeons.

Patients with ossification of the posterior longitudinal ligament or with a herniated disc behind the PLL were excluded from this study. The procedures performed on this sample of patients included 12 multilevel corpectomies, 19 anterior cervical decompressions and fusions, 1 single-level corpectomy, and 1 revision of a pseudoarthrosis and fusion. This yielded a sample size of 33 patients in whom the PLL was retained during these surgical procedures.

IRB approval was granted for patients involved in this study as part of a cohort of patients who underwent anterior cervical fusions.

Definition of Spinal Compression on MRI Postoperatively

Compression of the spinal cord on the MR image was defined as a record being made of the PLL touching or effacing the spinal cord as independently identified by either of the 2 observers.

Statistical Methods

Values are expressed as counts or means \pm standard deviation as appropriate. The prevalence of PLL compression on the MR image postoperatively was determined as the ratio of the number of abnormal MR images to the total number of MRI performed on the patients. Logistic regression was used to examine the relationship between potential predictors (age, sex, prior spine surgery) and the probability of having residual compression from the PLL. Data were analyzed using the Stata statistical software version 12 (Statacorp, TX). Tests were considered significant if $P < 0.05$.

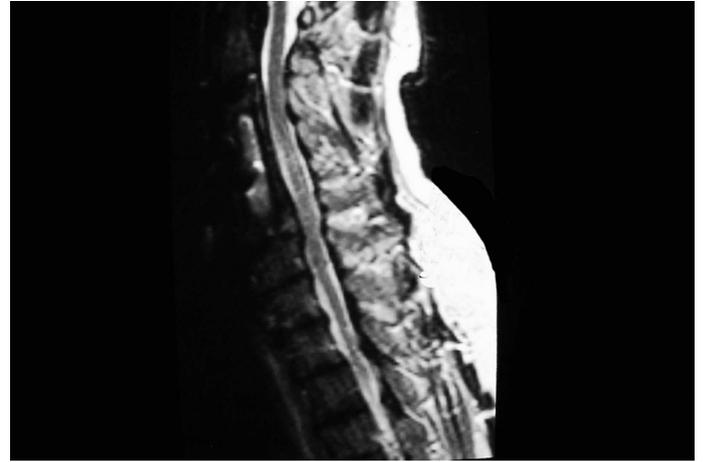


Figure 2. Postoperative sagittal T2 MR image shows the intact PLL with no compression from C3–C7. There is adjacent segment degeneration at C6–C7. MR indicates magnetic resonance; PLL, posterior longitudinal ligament.

RESULTS

Thirty-three patients were restudied after undergoing ACDF, with the PLL retained intraoperatively, of which 66% were female. These patients were included in this study. The mean age was 51.6 ± 13.1 years (range, 31–86).

MR image evaluation was performed to assess for residual or new compressive lesions in patients with recurrent symptoms at an average of 7 months (range, 0.3–53) postoperatively. The majority of patients who were advised to undergo postoperative MRI had specific complaints of either radiculitis or neck pain (32 of the 33 patients, 97%). One patient was involved in a motor vehicle accident postoperatively and therefore underwent MRI after that event (Figure 2).

There were no cases of the retained PLL interpreted as compressing the spinal cord identified on the MR image postoperatively ($P < 0.001$). There was agreement between the 2 observers' independent interpretations of postoperative PLL findings on the MR image in each case. Four patients underwent subsequent revision surgery. Two revision procedures were for C3–C4 ACDF, the third a C6–C7 ACDF repair, and the last revision was a C6–C7 ACDF after C4–C5–C6 ACDF as the first procedure performed. The first and last of the 4 revisions described were performed after the postoperative MR image made evident adjacent level disease, and the second and third were done after the MR image demonstrated pseudoarthrosis postoperatively. It was also noted that restoring disc height corrected PLL bulge in images of patients with disc herniation as the PLL was draped over the disc, and it therefore bulged prior to decompression.

As there was no evidence of residual or new compression caused by the PLL in this sample of patients postoperatively, there were also no relationships between the predictor variables and probability of having postoperative compression by the PLL. Logistic regression demonstrated no relationship between age, sex, or, prior spine surgery and the probability of having residual compression from the PLL.

DISCUSSION

The PLL although a narrower and weaker band than the anterior longitudinal ligament (ALL), does have some functional advantages. It runs along the posterior aspect of the vertebral bodies within the vertebral canal. It is broadest superiorly where it is continuous with the tectorial membrane, which is attached to the occipital bone on the interior aspect of the foramen magnum. It is attached to the intervertebral discs and the posterior edges of the vertebral bodies from the axis (C2) to the sacrum. The PLL also helps to prevent hyper flexion of the vertebral column and posterior protrusion of the nucleus pulposus of the disc. The ALL and PLL have similar composition, the PLL consisting of approximately 67% collagen and 6% elastin fibers.¹¹ The geometric and mechanical properties of human cervical spine ligaments are well described. The failure stress and Young's modulus were higher for the ALL and PLL than the ligaments of the posterior complex in the 2 groups.¹² Some biomechanical interpretations have implied that the PLL has better biomechanical properties as a stabilizer for cervical motion than the ALL in the lower cervical spine especially.¹³ The stabilizing benefits of the PLL are likely more advantageous for uninstrumented *versus* instrumented ACDFs because plate fixation adds substantial rigidity. In either case, retaining the PLL has the potential benefit of limiting over-distraction of the disc space and facets during interbody insertion. We believe these properties of the PLL speak to the advantages of retaining it during anterior cervical fusion whenever possible.

One clinical and radiological retrospective review examining the effect of resection of the PLL in anterior decompression for cervical spondylotic myelopathy¹⁴ was found, reporting general safety and advantages with removal of the PLL. Herewith, we have reported no compressive effects of the PLL postoperatively in patients with symptoms, as opposed to this earlier review comparing retained PLL and resected PLL patients' clinical states and imaging. The differences in the conclusions drawn between these 2 studies are due, consequently, to differences in study hypotheses and methodology.

Although the PLL should not be retained in procedures on the cervical spine where it is obviously causing compressive symptoms such as in the exclusion criteria described already (ossification of the posterior longitudinal ligament or herniated disc behind the PLL), we have herewith described a sample of patients in whom it has not been directly implicated in compressive effects preoperatively or postoperatively.

Because of low sensitivity, however, MRI should still be used cautiously for predicting free disc material posterior to the PLL. Visual or palpable examination of the PLL during surgery may be more accurate for this prediction.⁵ We would advise accordingly that these practices not be abandoned to rely on MRI alone to predict disc herniation. The data in this study have demonstrated that retention of the PLL during ACDF (Figure 2) is a safe practice.

CONCLUSION

We have demonstrated that a retained PLL following anterior cervical discectomy and fusion procedures does not cause

compression in patients undergoing MRI for recurrent symptoms. Technically, maintaining the PLL diminished the potential for dural tears and over-distraction of the discs and facets when cervical cages were inserted within the disc space. We suggest removal of the PLL only in cases where it is directly causing compression, such as in cases of ossification of the posterior longitudinal ligament or to retrieve a disc fragment posterior to the PLL.

➤ Key Points

- ❑ There is a lack of data evaluating the postoperative compressive effects of the PLL in patients undergoing ACDF.
- ❑ Postoperative gadolinium enhanced MR images were reviewed in a series of patients who underwent ACDF for cervical radiculomyelopathy and who had persistent or recurrent postoperative symptoms.
- ❑ There were no cases of discernible compression by the retained PLL identified on MR images as assessed by 2 independent reviewers.
- ❑ We suggest that removing the PLL should be considered for reasons other than concern about residual compression.

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