Early experience with endoscopic revision of lumbar spinal fusions

Lynn B. McGrath Jr., MD;1 Karthik Madhavan, MD;2 Lee Onn Chieng, BS;2 Michael Y. Wang, MD;2 and Christoph P. Hofstetter, MD, PhD1

1Department of Neurological Surgery, University of Washington, Seattle, Washington; and 2Department of Neurological Surgery, and The Miami Project to Cure Paralysis, University of Miami Miller School of Medicine, Miami, Florida

Approximately half a million spinal fusion procedures are performed annually in the US. It is estimated that up to one-third of arthrodesis constructs require revision surgeries. In this study the authors present endoscopic treatment strategies targeting 3 types of complications following arthrodesis surgery: 1) adjacent-level foraminal stenosis; 2) foraminal stenosis at an arthrodesis segment; and 3) stenosis caused by a displaced interbody cage.

A retrospective chart review of 11 patients with a mean age of 68 ± 15 years was performed (continuous variables are shown as the mean ± SEM). All patients had a history of lumbar arthrodesis surgery and suffered from unilateral radiculopathy. Endoscopic revision surgeries were done as outpatient procedures, and there were no intraoperative or perioperative complications. The cohort included 3 patients with foraminal stenosis at the level of previous arthrodesis. They presented with unilateral radicular leg pain (visual analog scale [VAS] score: 7.3 ± 2.1) and were severely disabled, as evidenced by an Oswestry Disability Index (ODI) of 46 ± 4.9. Transforaminal endoscopic foraminotomies were performed, and at a mean follow-up time of 9.0 ± 2.5 months VAS was reduced by an average of 6.3. The cohort also includes 7 patients suffering unilateral radiculopathy due to adjacent-level foraminal stenosis. Preoperative VAS for leg pain of the symptomatic side was 6.0 ± 1.6, VAS for back pain was 5.2 ± 1.7, and ODI was 40 ± 6.33. Endoscopic decompression led to reduction of the ipsilateral leg VAS score by an average of 5, resulting in leg pain of 1 ± 0.5 at an average of 8 months of follow-up. The severity of back pain remained stable (VAS 4.2 ± 1.4). Two of these patients required revision surgery for recurrent symptoms. Finally, this study includes 1 patient who presented with weakness and pain due to retropulsion of an L5/S1 interbody spacer. The patient underwent an endoscopic interlaminar approach with partial resection of the interbody cage, which resulted in complete resolution of her radicular symptoms.

Endoscopic surgery may be a useful adjunct for management of certain arthrodesis-related complications. Endoscopic foraminal decompression of previously fused segments and resection of displaced interbody cages appears to have excellent outcomes, whereas decompression of adjacent segments remains challenging and requires further investigation.

http://thejns.org/doi/abs/10.3171/2015.10.FOCUS15503

KEY WORDS endoscopic spine surgery; revision; arthrodesis surgery
been developed as a minimally invasive approach for ef-
stenosis. In addition, fully endoscopic foraminotomy has
established as a viable method of treating lumbar spinal
has been shown to result in good clinical outcomes.2,8,12
fectively decompressing stenotic lumbar foramina, and
first described in 1997 by Foley et al.,
is increasing. Endoscope-assisted lumbar discectomy was
demonstrated the anatomical effectiveness of endoscopic
Cadaveric studies have been undertaken and have further
demonstrated the anatomical effectiveness of endoscopic
foraminotomies in achieving foraminal decompression.6
The purpose of this study was to investigate the utility
of endoscopic foraminotomy for highly targeted revision
surgery in selected patients with persistent radiculopathy
following lumbar fusion surgery.

Methods
Patient Population
Our prospective database of 80 endoscopic spine pro-
cedures was screened for patients who had undergone pre-
vious lumbar arthrodesis surgeries. All patients who un-
derwent endoscopic decompressive procedures performed
within the levels of the previous arthrodesis procedures
or at an adjacent level were included in the current series.
Thus, our report includes a total of 11 patients with unilat-
eral lower-extremity radiculopathy following lumbar ar-
throdesis surgery. Patient demographic data, operative de-
tails, clinical outcomes, complications, and radiographic
imaging were reviewed. Outcomes were measured using
the visual analog scale (VAS) and Oswestry Disability In-
dex (ODI) scores. Seven patients suffered from unilateral
symptomatic foraminal stenosis adjacent to an existing
fusion construct, 3 patients presented with symptomatic
foraminal stenosis at the level of an existing arthrodesis
surgery, and 1 patient had radiculopathy due to a displaced
interbody cage.

Statistical Analysis
Continuous variables are shown as the mean ± SEM.

Results
The current report includes a cohort of 11 patients,
which consists of 5 women and 6 men. The mean age was
68 ± 15 years. All patients had undergone previous lumbar
arthrodesis surgery. Approximately half of these patients
(n = 6) had 1-level fusion surgeries, and the remaining
had either 2-level (n = 4) or 3-level (n = 1) procedures.
All endoscopic revision surgeries were done as outpatient
procedures. There were no intraoperative or perioperative
complications.

Foraminal Decompression at Arthrodesis Level
In this study, 3 patients had symptomatic foraminal
stenosis at the level of their previous arthrodesis that was
causing radiculopathy. Preoperative imaging revealed that
all 3 patients had achieved successful arthrodesis at the
affected segment; however, unilateral collapse of the in-
tervertebral space led to foraminal stenosis (Fig. 1). Thus,
foraminal height was on average 9.2 ± 1.6 mm on the
symptomatic side compared with 13.4 ± 0.8 mm on the
contralateral side. The preoperative VAS score on the side
of the radicular pain was 7.5 ± 2.1. These patients had only
minimal complaints of contralateral leg pain or back pain.
However, a preoperative ODI of 46 ± 4.9 indicated that
these patients were severely disabled by their symptoms.
All patients underwent endoscopic foraminotomies (Fig.
2). At a mean follow-up time of 9.0 ± 2.5 months, the aver-
age VAS score for leg pain on the symptomatic side was
reduced by 6.3. Patients rated their leg pain on average as
1.0 ± 1.0. One patient had 4 weeks of transient postopera-
tive paresthesias, which completely resolved.

Foraminal Decompression at an Adjacent Level
Seven patients suffered from adjacent-level unilateral
symptomatic foraminal stenosis. Patients reported preop-
erative leg VAS of 6 ± 1.6 for the symptomatic side and
2.5 ± 1.3 for the contralateral side. In contrast to patients
with foraminal stenosis within the fusion construct, pa-
tients with radicular symptoms at adjacent levels also had
significant back pain (VAS 5.2 ± 1.7). These patients were
severely disabled, as indicated by an ODI of 40 ± 6.3.
Preoperative imaging revealed that the foraminal height
was smaller on the symptomatic side (8.8 ± 0.8 mm) when

FIG. 1. A: Example of unilateral foraminal stenosis at arthrodesis seg-
ment. Preoperative coronal reconstruction of an arthrodesis segment
with loss of intervertebral space height resulting in foraminal stenosis
(asterisk). B: Sagittal T1-weighted MRI study depicts an additional fo-
raminal disc bulge (arrow), which further aggravates foraminal stenosis.
Endoscopic revision surgery

compared with the nonsymptomatic side (14.5 ± 0.1 mm). Endoscopic decompression resulted in an average reduction of VAS by 5 for leg pain, resulting in a VAS of 1 ± 0.5 at an average of 8-month follow-up. The back pain VAS scores remained stable (4.2 ± 1.4). Two of the included patients required revision surgery for return of symptoms.

The first patient initially experienced complete relief of his preoperative leg pain. However, 6 months after the procedure he suffered recurrent symptoms due to a foraminal disc reherniation. Two months after a repeat endoscopic procedure, this patient was doing well. Another patient was pain free for 4 months before his symptoms recurred due to exacerbation of a segmental coronal deformity. He required a segmental stabilization performed via a far lateral approach. His radicular symptoms resolved and he is currently recovering from the procedure.

Decompression for Interbody Spacer Retropulsion

Finally, a 39-year-old woman who had undergone an L4–S1 transforaminal lumbar interbody fusion (TLIF) 9 years previously presented with right-sided posterolateral thigh and calf pain. The patient also had right-sided extensor hallucis longus weakness (3/5 strength on examination). Preoperative imaging revealed that the L5/S1 interbody spacer was displaced posteriorly. This caused severe lateral recess stenosis (Fig. 3A and 3B). The patient underwent an endoscopic interlaminar partial resection of the interbody cage (Fig. 3C–F), which resulted in complete recovery.

Discussion

The number of arthrodesis surgeries has increased substantially during the last 10 years in the US.10 Given the aging of our population, an increasing number of procedures are carried out in patients of advanced age and with multiple comorbidities, which have both been shown to be associated with higher complication rates.4,11 Moreover, complication rates appear to correlate positively with increased complexity of instrumentation.13 The number of patients requiring revision surgery with extension of fusion constructs approached 10% at 2 years in the Spine Patient Outcomes Research Trial (SPORT) findings, and 29% of all patients will need to undergo further fusion surgery.1,9 This represents a large cohort of patients who often need additional fusion surgery, with significant associated morbidity. The challenge is compounded by the massive increase in the number of complex fusion opera-
tions being performed in the elderly, with an estimated 15-fold increase between 2002 and 2007. Revision surgery typically involves revision of instrumentation and/or extension of the fusion construct to additional levels.

In our current report we describe endoscopic revision as an alternative treatment strategy for selected patients who suffer from radiculopathy following arthrodesis surgery. Our results seem to indicate that highly targeted endoscopic decompression of nerve roots within a successful arthrodesis construct is feasible and may result in symptomatic relief. Our results for endoscopic decompression surgery within arthrodesis constructs mirror the results recently published by Telfeian. In his study, endoscopic foraminotomy performed in 5 patients at the segment previously treated with arthrodesis surgery resulted in a reduction of VAS by 6. The reduction of pain found in the current study was very similar. Moreover, we present a case in which a traversing nerve root was decompressed by partial resection of a retropulsed TLIF cage that was performed using the interlaminar technique. Given the very narrow working corridor of less than 10 mm between the spinous process and the pedicle screw, in our hands other surgical techniques would have not permitted safe resection of the protruded cage underneath the traversing nerve root without removal of the instrumentation. Given that decompression was carried out in these patients within a solid fusion mass, we anticipate that these results will be durable. However, a larger number of patients and longer follow-up times are needed.

As expected, treatment of adjacent-segment foraminal stenosis was challenging. While patients experienced reduction of their radicular pain, 2 out of 7 patients required further surgical interventions within our limited follow-up interval. One patient suffered from a recurrent foraminal disc herniation which required revision endoscopic discectomy. The other patient experienced recurrent radiculopathy due to progressive unilateral foraminal collapse following endoscopic foraminotomy; this patient required subsequent arthrodesis surgery. It is possible that segmental instability might have contributed to this rapid foraminal collapse following decompression. His preoperative flexion and extension lumbar radiographs displayed extensive segmental motion (segmental lordosis changed 12.8° between flexion and extension). Further studies should address whether certain static or dynamic radiographic parameters might be associated with a high failure rate following decompressive procedures for adjacent foramina. Moreover, longer follow-up times are needed to better define the durability of this intervention. It seems very likely that certain patients might be better candidates for immediate arthrodesis surgery.

Conclusions

As the number of complex fusion surgeries increases, especially in elderly patients with multiple comorbidities, there is a great need to develop new minimally invasive revision strategies. In the current report we propose that endoscopic decompression surgery within and adjacent to the segment of spinal arthrodesis may alleviate radicular symptoms in selected patients. We acknowledge that the results of the current study are limited due to a short follow-up time and a small patient cohort. However, given that the invasiveness and perioperative morbidity of the presented technique is dramatically less compared with typical revision surgeries, this technique warrants further investigation. Moreover, given the high failure rate of adjacent-level decompression, further studies of larger patient cohorts with long-term follow-up are needed to better define appropriate candidates for such a procedure. Nevertheless, our preliminary results suggest that endoscopic decompression might be a useful strategy for selected patients with unilateral radiculopathy following arthrodesis surgery.

References

Disclosures
Dr. Wang is a consultant for DePuy Spine, Aesculap Spine, joimax, and K2M. He is a patent holder with DePuy Spine. Dr. Hofstetter is a consultant for Johnson & Johnson and for InVivo Therapeutics.

Author Contributions

Correspondence
Christoph Hofstetter, Department of Neurological Surgery, University of Washington, 1959 N.E. Pacific St., Campus Box 356470, Rm. RR734, Seattle, WA 98195-6470. email: chh9045@neurosurgery.washington.edu.