Introduction

Minimally invasive spine surgery: the greatest advance in medicine?

ROD J. OSKOUIAN JR., M.D.,¹ AND JUAN S. URIBE, M.D.²

¹Swedish Neuroscience Institute, Seattle, Washington; and ²University of South Florida, Tampa, Florida

A physician is obligated to consider more than a diseased organ, more even than the whole man—he must view the man in his world.

HARVEY CUSHING

In the past century, significant advances have been made in spine surgery, and in this issue of *Neurosurgical Focus*, we will review the myriad of treatment options currently available to treat spinal disorders. These minimally disruptive techniques and approaches to the spine have dramatically altered the natural history of previously difficult lesions and spinal conditions. Harvey Cushing would be proud of the work done in the fields of neurosurgery, radiology, engineering, physics, and orthopedics for the advancement of spine surgery.

In modern medicine, there are few advances that have had a more meaningful impact on patient outcomes than minimally invasive spine procedures. Patients presenting with painful radiculopathies and neural compression can be treated successfully with minimal access procedures and sent home the same day.

Sven Eicker and colleagues discuss their experience with extraforaminal lumbar disc herniations. Their minimal access microsurgical approach with the endoscopic technique seemed to produce less tissue trauma and instability, while providing significant improvement of functional outcomes.

Surgical management of tumors, fractures, and spinal deformities has significantly improved with these emerging technologies and techniques. Percutaneous pedicle screw fixation for spine fractures can be done with minimal blood loss, and patients can be mobilized immediately, resulting in a decrease in postsurgical complications. Flexion-distraction spine injuries, which are extremely unstable, classically consisting of a fracture line through all 3 columns, require surgical fixation to avoid neurological deterioration, help stabilize the spine,

and restore spinal balance. Historically, these injuries were all treated by means of the standard posterior open approach with instrumented fusion. Percutaneous pedicle screw fixation for these unstable spine injuries has been recently reported in the literature. Andrew Grossbach and colleagues report on their institutional experience of treating these fractures with both surgical techniques and review the current literature. Although it was a small prospective study, there was improvement in kyphotic angulation, and the authors found no significant difference in ASIA scores or the degree of kyphotic angulation between the percutaneous and open surgical groups. Percutaneous pedicle screw fixation appeared to have similar efficacy in the treatment of flexion-distraction injuries, and it allowed for reduced blood loss and tissue damage compared to open surgical techniques. Instrumentation systems have improved significantly in the past 10 years, and today's hardware allows surgeons to realign the spine and contour the rod to the spine.

How about treating spinal stenosis and spondylolisthesis with a minimally invasive interspinous fixation device? Nai-Feng Tian and colleagues found that there was a high incidence of heterotopic ossification after interspinous fixation.

Lateral approaches have been applied to treat spinal conditions, such as scoliosis, in recent years. The prior treatment deformity paradigms of shortening the spine by performing osteotomies posteriorly are utilized less. Scoliosis procedures can now be staged with multilevel lateral cages that lengthen the spine, correct the deformity, increase spinal balance, provide a more natural curve, and indirectly decompress neural elements. Armen Deukmedjian and coauthors reviewed their lateral approach for adult degenerative scoliosis. They provided useful data about patient selection for the application of lateral approaches for adult scoliosis surgery. Isolated lateral interbody fusions were deemed suitable for patients with preserved spinal pelvic harmony. Sagittal imbalance may be addressed with advanced lateral approaches, such as releasing the anterior longitudinal ligament.

Is there a role for minimally disruptive procedures in the treatment of intradural pathology? The article by Gandhi et al. eloquently describes utilizing a paramedian minimally invasive tubular retractor to access the spine and microscopic instruments to remove intradural pathology. Historically, intradural spinal lesions have been treated from a midline posterior approach using standard microsurgical techniques. The authors retrospectively reviewed their operative blood loss, length of stay, imaging characteristics, and outcomes.

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Cheng et al. assessed whether there was a difference in postoperative functional mobility and pain medication usage depending on whether patients had undergone open surgery or minimally invasive approaches. The authors were able to demonstrate that minimally invasive spine surgery resulted in improved functional mobility, decreased narcotic usage, and similar fusion rates in a comparison of open interbody fusion operations and minimally invasive procedures. Similarly, Silva et al. reviewed their collective experience with minimally invasive transforaminal lumbar interbody fusions, examining the surgical learning curve associated with minimal access surgery as well as the associated complications. Clark et al. present their technique to minimize radiation exposure for minimal access spine surgery. They were able to develop a low-dose protocol using a combination of low-dose pulsed fluoroscopy and digital spot images without compromising image quality, the accuracy of pedicle screw placement, or the efficiency of the procedure. Interestingly, Burke et al. describe two cases of lumbar nerve root anomalies identified through use of the minimally invasive technique. These anomalies are extremely rare, but when they are encountered they should be recognized in order to avoid nerve injury.

How about minimally invasive surgery for patients who are at higher risk for perioperative complications? Darryl Lau and coauthors present a retrospective review of their team's experience with minimal access fusions in obese patients. They looked at their minimal access perioperative outcome data and concluded that their overall complication rate, estimated blood loss, and length of hospital stay were less than for open surgical procedures.

What is the evidence for unilateral fixation in minimally invasive spine procedures? Do we really need to place hardware bilaterally? Choi and colleagues present their clinical results for unilateral pedicle screw fixation after lumbar interbody fusion. No studies to date have directly compared unilateral and bilateral percutaneous pedicle screw fixation after minimally invasive transforaminal lumbar interbody fusion. In the study presented in

this issue, patients were randomly assigned to either unilateral or bilateral percutaneous spinal instrumentation. The authors found that unilateral and bilateral procedures had similar short-term clinical results, but perioperative results were better with unilateral screw fixation. Interestingly, the long-term results were better with bilateral screw fixation, suggesting that bilateral screw fixation has biomechanical fixation advantages over unilateral constructs.

Dahdaleh et al. present outcome data for their prospective comparison of unilateral versus bilateral instrumentation for transforaminal lumbar interbody fusion. They found no significant differences in postoperative results on a number of outcome measures, but the average duration of follow-up was only 1 year.

Why use navigation in minimally invasive spine surgery? Does navigation really provide a benefit clinically or surgically? And does it really reduce your ionizing radiation exposure during surgery? Moses et al. thoughtfully reviewed the current literature on navigation and the various platforms available commercially. Spinal navigation clearly has limitations, and significant improvements are needed.

How about endoscopy? Is there a role for the rigid endoscope in the spine? Hickman and colleagues provided a unique and interesting application of the endoscope in the pediatric spine using the transnasal approaches to access the atlas and axis for odontoidectomies.

In summary, we had the difficult task of reviewing a large number of submissions for this issue and hopefully have selected an exciting collection for our readers. These insightful articles aim to illuminate new treatment options as well as provide an update for minimally disruptive options for the treatment of spinal disorders.

Onward and upward!

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Disclosure

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