



Early and staged endoscopic management of common pain generators in the spine

The current status of endoscopic spine surgery in surgical spine care

Endoscopic spine surgery has the potential to become the leading minimally invasive surgical technique for the treatment of common degenerative conditions of the spine. An increasing number of surgeons are recognizing its ability to alleviate patients' pain effectively, not just by reducing the size of the surgical incision to decrease surgical morbidity, but indeed decrease the measurable parameters of reduced blood loss, peri- and postoperative pain, and complications. Even when compared to the use of larger tubular retractors from traditional translaminar endoscopic decompression and microsurgical dissection techniques, transforming minimally invasiveness into an even less invasive transforaminal approach will allow for a more personalized and earlier interventional spine care model.

The benefits of endoscopic spine care are now more evident with analysis of long-term benefits of cost-effectiveness as well as safety. Over the last 40 years, open traditional spine surgery has established a well accepted track record that we use as a reference standard for comparison to new technologies as the cost of spine care is raising with decreased affordability unless rationed. When compared to endoscopic surgeries for most common and complex musculoskeletal conditions, current advances have only added to the costs to create an affordability crisis. For example, in patients with end-stage osteoarthritis of the hip or knee, the definitive treatment of the underlying disease can be successfully rolled into one treatment episode with good relatively long-term efficacy with joint replacement surgery. Such is not the case with the increased number of spine segments and multilevel spine segment involvement. Contemporary modern joint replacement technologies have performed so reliably well that patients can expect an average implant life cycle of 10 to 15 years before a revision may be necessary. In older patients, the implants may even outlive their carriers, and for many patients, the hip or knee replacement is a once-in-a-lifetime experience. Trying to roll-in surgical spine care into one such finite treatment episode with the intent of 10- to 15-year cycles is much more prohibitive and costly. In contrast to joint care, similar spine segment replacement and fusion is more expensive and functionally restrictive. This problem is illustrated by patients with treatable spine conditions considered too young, or for patients considered too old, or who have too many co-morbidities who often have to suffer due to the higher surgical risk of spine surgery.

The actual and recognized reoperation rates for open complex lumbar spine decompression and fusion surgery even in expert hands are reported at 20% to 25% within two years postoperatively from the index surgery—a number that is acknowledged by most contemporaries as too high (1,2). But is it really just the underlying disease whose natural history cannot be impacted any better or is it the way we treat it or both? Have we gotten tunnel vision by reducing the preoperative medical necessity criteria for spine surgery to image-based descriptors of stenosis, deformity, and instability? Are the repetitive cycles of spinal injections, physical therapy, and non-steroidal anti-inflammatory treatments that are demanded by our patients and payers before deeming surgical spine care medically necessary a waste of resources? A fresh look at the problem seems warranted given the increased scrutiny on spine care by payers, government, and patients who wonder how simplified innovative, less costly, more effective and reasonably durable treatments for common degenerative spine conditions can be implemented. Somehow these problems need to be tackled to meet the increasing demand for more simplified and reasonably durable treatments for our patients. In the opinion of the authors of this editorial, spinal endoscopy has the potential to be a big part of the solution of offering comprehensive spine care while eliminating the repetition of the less cost-effective options now available.

“Direct” visualization of painful pathoanatomy is the key to simplifying spine

The two main advantages of spinal endoscopy have mostly gone unnoticed by the majority of traditionally trained spine surgeons. First, the ability to reduce the surgical plan of care to STAGE the endoscopic treatment plan by focusing on one or two major pain generators in an otherwise complex problem. Second, the ability to directly visualize areas not just in the intervertebral disc but also in the epidural and foraminal space opens the door to analysis of pain generators residing within a spinal motion segment that can escape traditional spinal imaging. Traditional MRI reporting is mostly focused

on describing neural element compression by noting the presence or absence of stenosis. Rarely is the extent of stenosis described in objective, measurable parameters such as posterior disc height, or the height and width of the lateral recess or neuroforamen (3). Integration of routinely reported advanced imaging criteria into the clinical analysis of predictors of favorable outcomes with spine surgical treatments is restricted and illustrates the fundamental limitations of a purely image-based approach to identifying and treating pain generators accurately and successfully.

Currently, direct visualization of the painful spinal anatomy by introducing an endoscope into the intervertebral disc or the epidural space renders high-resolution video and images available not only for analysis but in the awake, yet mildly sedated patient allows direct correlation between intraoperatively visualized pathology and the pathophysiology of the patient's symptoms (4). Therefore, intraoperative surgical decision making may occur based on the patient's response to provocative or analgesic testing of suspected painful conditions, thereby correctly identifying and treating the primary pain generator. Described pain generators in the lumbar spine may range from (I) an inflamed disc, (II) an inflamed nerve, (III) a hypervascular scar, (IV) a hypertrophied superior articular process (SAP) and ligamentum flavum, (V) a tender capsule, (VI) an impacting facet margin, (VII) a superior foraminal facet osteophyte, (VIII) a superior foraminal ligament impingement, to (IX) a hidden shoulder osteophyte, and many others (5).

Clinical validation of treatment protocols of such directly visualized pain generators may ultimately open the door for more simplified targeted therapies and surgical pain management rather than continuing to rely on aggressive surgical treatments of the end-stage of the disease. The recent development of axial back pain therapies grouped around ablation of the basivertebral nerve currently in clinical trials and is a prime example of a simplified targeted non-visualized procedure aimed at a clinically suspected pain generator. While this is a fluoroscopically guided ablation procedure, endoscopic imaging of the endplate as a pain generator is validated. Spinal endoscopy will likely produce more targeted treatments that are based on the direct visualization of validated pain generators, hence, allowing simplified surgical pain management procedures (6).

Why wait?

Traditional image-based decision making in spine surgery by its very nature focuses on treating the end-stage of the degenerative disease process of the spinal motion segment. With the relatively low sensitivity and specificity of advanced imaging studies such as MRI to pick up a painful spine condition (3,7-10), most patients are treated late in the disease process or not treated at all. However, is that really the smart play? Could it be more cost-effective to provide early intervention rather than waiting for the full-blown disease to materialize at which point the cost of treating it are out of control? Is it time to rethink clinical management protocols for sciatica-type back and leg pain for example to treat the seemingly minor conditions, such as annular tears, small extraforaminal disc herniations under the dorsal root ganglion, which can chronically inflame it and cause leg pain, or impaction syndromes of the facet joint complex, which can form painful highly inflammatory extradural and pedunculated synovial cysts? When asked that way, the current management approach to common degenerative spine conditions does seem somewhat outdated as no one today would leave heart disease or diabetes mellitus unmanaged until there is organ failure. The outcomes would be universally worse, and the costs higher. Therefore, could managing spine disease early on reduce the long-term disability associated with the disease? While it may not change the underlying disease process or alter its natural history too much it could certainly improve the patient's ability to coexist and cope with the problem in a more functional context since the associated symptoms have been significantly reduced—ideally with a small endoscopic outpatient surgical procedure. These questions are certainly worth looking into and need to be answered to position spinal endoscopy into the mainstream of spine care with the implementation of validated prognosticators of favorable outcomes with the procedure. Otherwise, it may continue to live on the fringes and be performed by few in niche practices.

Staged management

Organizing endoscopic spine care by grouping it around identified pain generators implies to ignore other structural problems which may be implicated in the symptoms by history and physical examination or by the advanced imaging studies such as MRI or CT scan. For example, exiting and traversing nerve root pain syndromes may not be symptomatic within the same lumbar motion segment at the same time. However, when they do, the surgeon can easily be confused in patients

with multilevel disease. Identification of the correct source level of axial facet joint pain in multilevel degeneration may even be more difficult in the absence of a radicular component. Therefore, many traditionally trained surgeons still implement the MRI or CT scan report as the surgical plan of care perhaps at least in part because coincidence between the radiologist's confirmation of compressive pathology and the surgical plan of care invites less scrutiny during the preauthorization process for surgery. However, is all that surgery inevitable? Sometimes the answer will never be clear-cut and recommending appropriate surgical spine care to a patient in pain is as much of an art as it is a science and relies heavily on judgment and clinical experience, which, when accumulated over many years, often results in less and less aggressive treatment recommendations by many skilled spine surgeons.

For the endoscopically trained spine surgeon, the question of what to treat and what to ignore is day-to-day bread-and-butter decision-making business. It requires attention to detail as well as precision in the diagnostic work-up to indeed arrive at a plan of care that will significantly reduce disability and pain and improve function in a way that is consistent with the expectation of the patient and the patient's family. The staged management approach has been developed and employed by both authors separate and jointly to arrive at the recommendation outlined in this editorial to stick with the endoscopic treatment of clearly identified pain generators which are limiting the patients functioning at the time when the spine care is delivered. The peer-reviewed data published by both authors jointly proves that this approach to endoscopic spine care results in favorable long-term clinical outcomes up to five years from the endoscopic index procedure and that early reoperations are uncommon (5). If additional treatments were needed due to the natural progression of the underlying disease process, the authors were able to manage new-onset of radicular and mechanical pain from within the same or an adjacent level successfully with another outpatient endoscopic decompression with or without a rhizotomy de-innervation procedure (11). Only a small subset of patients required an open decompression instrumented fusion procedure to control their symptoms, proving that the staged management approach to spine disease reduces disability, utilization, and cost in the long run. Should the staged management approach result in the uncommon scenario of undertreatment with unchanged, or reduced persistent symptoms due to failure to cure the fix is relatively straightforward: reanalyze and perform the additional surgical treatment necessary to overcome the patient's limitations. However, to unravel unintended consequences from surgical overtreatment is much harder, and in some cases, impossible, for which reason most patients are not dissatisfied with their surgeon's careful minimalist approach to treating their problem initially. On the contrary, patient satisfaction and motivation to work with their surgeon typically remain high even with persistent or partially resolved symptoms when shared decision making took place preoperatively.

Where does it all come together?

The authors of this editorial are both accomplished and passionate endoscopic spinal surgeons who between the two of them have 44 years of operative experience. While their respective practice locations—the Desert Institute of Spine Care in Phoenix and the Center for Advanced Spine Care of Southern Arizona in Tucson—are only 112 miles apart and within driving distance in the state of Arizona, both surgeons have created separate clinical programs in their outpatient facilities—the Squaw Peak Surgical Facility (Anthony Yeung) and the Surgical Institute of Tucson (Kai-Uwe Lewandrowski)—to treat approximately 80% of patients with degenerative conditions of the spine, who have failed non-operative measures, surgically with a targeted outpatient endoscopic decompression or decompression fusion procedure. This illustrates that even in the most experienced hands, not every patient is best served with a small endoscopic procedure. In some cases, the extent of the degenerative disease with severe central stenosis, or multilevel lateral recess and foraminal stenosis with hypertrophied facet joints are too grave and can overwhelm the ability of the endoscopic procedure to produce meaningful improvements. Those patients are sometimes best treated with a primary index decompression fusion surgery where large sections of the spine can be appropriately reconstructed with attention to instability- or sagittal and coronal alignment correction.

Both surgeons have employed different philosophies and endoscopic techniques—the “*inside-out*” (Anthony Yeung), and the “*outside-in*” (Kai-Uwe Lewandrowski) in their vertically integrated outpatient spine care programs and eventually came to the same conclusion that treating the predominant pain generator is the most critical aspect of spinal endoscopy regardless of the individual surgical steps and techniques (12). The “*inside-out*” and the “*outside-in*” decompression techniques have converged mainly over the last several years facilitated by technology advancements. With lateral recess and foraminal stenosis being the most common clinically relevant indication for primary surgery and revision surgery after previous decompression employing

spinal endoscopy judiciously and skillfully is critical in achieving pain relief via complete decompression and adequate treatment of intraoperatively identified pain generators. Clinical judgment of appropriate patient selection and confidence in one's abilities will improve over time. Understanding the indications for the procedure, and its limitations will remain the key to a successful endoscopic outpatient spine practice.

Surgical pain management

Early and staged management of common degenerative conditions of the spine by focusing on validated pain generators may be summarized in the practice of "Surgical Pain Care." This approach integrates interventional into the endoscopic surgical procedures by tailoring the treatment based on the individual patient's symptoms and the functional context at the time when the spine care is delivered. Since the severity of these symptoms and their impact on each patient may vary a more personalized approach to spine care rather than the continued use of rule-based medical necessity criteria seems more appropriate. The latter may invite delivery of costly ineffective therapies and treatments, which ultimately do not lower the societal burden of spine care since the individual pain generator stemming from the underlying symptom causing cumulative disability is not addressed. Either one of these two approaches has short-comings. The authors are not suggesting to throw out established concepts of traditional open spine surgery. We are merely suggesting to integrate staged endoscopic Surgical Pain Care early on into existing spine care programs to lower disability and their direct and indirect cost with all of its hidden unintended consequences of repetitive treatments, the potential for failed medical pain management with the burden of opioid addiction, delayed returned to work and disrupted social reintegration.

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None.

Footnote

Conflicts of Interest: A Yeung designed and trademarked his inside-out YESS™ technique and receives royalties from the sale of his inventions. Indirect conflicts of interest (honoraria, consultancies to sponsoring organizations are donated to IITS.org, a 501c 3 organization). KU Lewandrowski has no conflicts of interest to declare. This manuscript is not meant for or intended to endorse any products or push any other agenda other than the associated clinical outcomes with lumbar endoscopic foraminoplasty. The motive for compiling this clinically relevant information is by no means created and/or correlated to directly enrich anyone due to its publication. This publication was intended to substantiate contemporary endoscopic spinal surgery concepts to facilitate technology advancements.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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