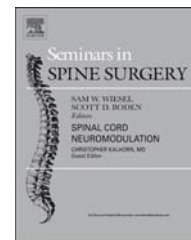




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Value in lumbar spine fusion: Minimally invasive versus traditional open surgery

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ABSTRACT

In the evolving healthcare climate, healthcare resource allocation will begin to favor surgical treatments that exhibit value through both clinical and cost-effectiveness. Lumbar pathology is extremely prevalent in the United States, resulting in a substantial portion of healthcare expenditure. Open lumbar fusions are an effective treatment for degenerative lumbar pathology; however, these procedures have exhibited extremely high and potentially unsustainable costs. Minimally invasive (MIS) techniques have previously demonstrated to reduce costs while maintaining or improving clinical effectiveness. The present review addresses the current literature comparing the values of open and MIS lumbar fusion techniques.

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1. Introduction

Healthcare facilities have historically been reimbursed with a fee-for service model. With the adoption of the Patient Protection and Affordable Care Act, the focus of healthcare has transitioned from volume-based to value-based reimbursement.¹ Value in healthcare is defined as the outcomes of an intervention per time-dollar spent, or essentially quality per cost.² This shift has garnered greater attention to the escalating costs of healthcare. Consequently, all healthcare stakeholders, including hospitals and patients, are aiming for more transparency and are carefully scrutinizing the value of their healthcare options.¹ Additionally, physician reimbursement has steadily become more reliant on a physician's ability to provide valuable care, focusing on effective interventions at reasonable costs.³ In order to improve the healthcare climate, further attention must be given to the value of costly, yet frequently utilized, healthcare interventions.

Spinal pathology is one of the most prevalent disease states worldwide, with a prevalence ranging from 60% to 90% in industrialized areas of the world.⁴⁻⁶ This prevalence results in

spinal diseases representing a significant portion of healthcare expenditure. In the 2010 Global Burden of Disease Study, low back pathology was ranked highest among 291 conditions in terms of indirect costs and disability, with 83 million disability-adjusted-life-years lost due to low back pain.⁷ Additionally, annual direct expenditure on spine care in the United States is estimated to approach \$100 billion, with surgical treatments serving as the most expensive interventions on a per-case basis.^{8,9} These costs are considered unsustainable, motivating a movement toward healthcare reform in the field of spine care.¹ However, these costs are often balanced by the costs saved by treating impairment and disability.¹⁰ As such, increasing value through improvement of outcomes and minimization of costs is crucial to maintaining the sustainability of surgical spine interventions.

Minimally invasive (MIS) spine surgery has been developed as a means of achieving healthcare value. Through theorized benefits resulting from minimal tissue trauma and shorter hospital stays, MIS techniques are thought to increase overall cost efficiency and value compared to traditional open techniques.¹¹⁻¹³ In this context, the purpose of this review is to

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compare the cost-effectiveness and value of MIS versus open techniques in the setting of lumbar spinal fusion.

2. Values and cost-effectiveness in spine surgery

In order to appropriately compare outcomes across a variety of different interventions and disciplines, a tool to measure health status improvements and cost is necessary. In this respect, Quality-adjusted-life-years (QALY) are typically utilized to provide a universal assessment of improvement achieved from an intervention.¹⁴ Cost per QALY is a cost-utility measurement that can assist in determining the overall value of an intervention and can be utilized for cost-allocation judgments amongst different surgical treatments.¹⁵⁻¹⁸

Despite the increasing necessity of value-based measurements in spine surgery, few studies have directly assessed the cost-utility of lumbar fusions.¹⁹ In order to appropriately analyze value and cost-utility in these studies, cost breakdowns, direct costs, and comparisons of benefits are required. In addition, indirect cost assessments are particularly useful.¹⁴ In the setting of spine surgery, these indirect measurements can aid in addressing productivity losses, time away from work, and overall disability.

Currently, there is no established method of direct or indirect cost and value measurement in spine care.¹⁴ Consequently, cost analyses and the measurements included can vary dramatically amongst studies assessing the value of surgical interventions.^{10,20-24} This inevitably limits the ability to determine the cost-utility of a variety of spine surgical techniques.^{10,16-18} A variety of studies utilize average costs or charge information to establish the cost-effectiveness of a procedure; however, these are not reflective of the true costs and values of an intervention.^{14,20,21} These charges are infrequently spine specific, which can lead to inaccurate estimations when different resources are used, and are often an overestimation of the actual cost being reimbursed.^{20,21} Despite this, there are a few high-quality studies that have determined the cost-utility (cost per QALY) of a variety of spinal interventions.^{16,17,21} Based on these analyses, comparison of outcomes, complications, and average costs can help infer the relative value of different interventions, including MIS versus open techniques.

3. Value of minimally invasive versus open lumbar spinal fusion

Surgical interventions for spinal pathology have exhibited favorable outcomes regarding cost-effectiveness and overall societal value.²⁵ Despite high costs, the improvement in quality of life resulting from spine surgical interventions often support the cost-utility of these treatments.^{10,25} Low back pathology is the most common and most expensive cause of work-related disability.^{26,27} Fritzell et al.¹⁰ reported that treating an individual with open lumbar fusion is less costly than utilizing conservative methods due to the indirect costs associated with reduced individual productivity.

However, previous studies have suggested that open lumbar fusions may not be cost-effective for certain spinal pathologies.^{16,21} Tosteson et al.¹⁶ reported that open lumbar fusions can cost up to \$258,200 per QALY gained, exceeding the \$100,000 per QALY threshold often utilized to determine whether a procedure is cost-effective. Theoretically, the value of lumbar fusion would improve if the surgical intervention resulted in reduced hospital costs and morbidity, as MIS lumbar fusions are theorized to do.¹⁴ These indirect improvements have been demonstrated in the evolution of other minimally invasive procedures. In a review of 2226 patients receiving either laparoscopic or abdominal hysterectomy, Bijen et al.²⁸ demonstrated that despite higher procedural costs, laparoscopic procedures are more cost-effective due to associated reductions in length of stay, complications, and overall indirect costs.

The effect of minimally invasive techniques on the perioperative outcomes of lumbar fusions when compared to traditional techniques has been extensively explored. Sidhu et al.²⁹ performed a systematic review of 7 studies comparing minimally invasive and open techniques for posterior lumbar interbody fusion (PLIF). The authors demonstrated that MIS PLIF exhibits decreased blood loss, decreased postoperative drainage, and a decreased length of stay when compared to open PLIF. Similarly, in a review of 154 patients undergoing open posterior lumbar fusion (PLF), open PLIF, or MIS transforaminal lumbar interbody fusion (TLIF), Patel et al.³⁰ identified decreased blood loss and rates of transfusion in the MIS TLIF cohort. Goldstein et al.³¹ when performing a meta-analysis of comparative studies involving open versus MIS TLIF/PLIF, further concluded that MIS techniques are associated with improvements in intraoperative blood loss and hospital length of stay. These improvements in perioperative parameters may indicate an overall increase in value of MIS lumbar fusion when compared to open techniques. Charges incurred for longer hospital stays, necessary laboratories, and transfusions may be reduced with MIS techniques, potentially improving the value of MIS lumbar fusions.

Minimally invasive approaches may also improve the value of lumbar fusion through the reduction of postoperative complications. Through the utilization of the Nationwide Inpatient Sample, overall complication rates have been noted to be 13.07% following open PLF in the setting of spondylolisthesis.³² Meanwhile, minimally invasive lumbar fusion techniques have exhibited much lower rates of overall complications, with some large studies reporting rates of 6.2% or lower, depending on the approach.³³⁻³⁵ Comparative studies between MIS and open techniques have also addressed complication rates. In a systematic review of 26 studies assessing outcomes of MIS compared to open PLIF/TLIF, Goldstein et al.³⁶ noted a trend toward fewer medical and surgical complications with the utilization of MIS techniques. The authors demonstrated decreased rates of specific complications including dural tears, nerve injury, hematomas, urinary tract infections, cardiac complications, and transfusions. Patel et al.³⁰ demonstrated similar results, with patients receiving the open approach experiencing higher rates of dural tears, wound infections, and screw malpositioning. The costs per in-hospital complication can vary substantially for spine patients, with reports ranging from

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