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Clinical Study

The cost-effectiveness of interbody fusions versus posterolateral fusions in 137 patients with lumbar spondylolisthesis

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Abstract

BACKGROUND CONTEXT: Reimbursements for interbody fusions have declined recently because of their questionable cost-effectiveness.

PURPOSE: A Markov model was adopted to compare the cost-effectiveness of posterior lumbar interbody fusion (PLIF) or transforaminal lumbar interbody fusion (/TLIF) versus noninterbody fusion and posterolateral fusion (PLF) in patients with lumbar spondylolisthesis.

STUDY DESIGN/SETTING: Decision model analysis based on retrospective data from a single institutional series.

PATIENT SAMPLE: One hundred thirty-seven patients underwent first-time instrumented lumbar fusions for degenerative or isthmic spondylolisthesis.

OUTCOME MEASURES: Quality of life adjustments and expenditures were assigned to each short-term complication (durotomy, surgical site infection, and medical complication) and long-term outcome (bowel/bladder dysfunction and paraplegia, neurologic deficit, and chronic back pain).

METHODS: Patients were divided into a PLF cohort and a PLF plus PLIF/TLIF cohort. Anterior techniques and multilevel interbody fusions were excluded. Each short-term complication and long-term outcome was assigned a numerical quality-adjusted life-year (QALY), based on time trade-off values in the Beaver Dam Health Outcomes Study. The cost data for short-term complications were calculated from charges accrued by the institution's finance sector, and the cost data for long-term outcomes were estimated from the literature. The difference in cost of PLF plus PLIF/TLIF from the cost of PLF alone divided by the difference in QALY equals the cost-effectiveness ratio (CER). We do not report any study funding sources or any study-specific appraisal of potential conflict of interest–associated biases in this article.

RESULTS: Of 137 first-time lumbar fusions for spondylolisthesis, 83 patients underwent PLF and 54 underwent PLIF/TLIF. The average time to reoperation was 3.5 years. The mean QALY over 3.5 years was 2.81 in the PLF cohort versus 2.66 in the $PLIF_o$/TLIF cohort (p=.110). The mean 3.5-year costs of $54,827.05 after index interbody fusion were statistically higher than that of the $48,822.76 after PLF (p=.042). The CER of interbody fusion to PLF after the first

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operation was −$46,699.40 per QALY; however, of the 27 patients requiring reoperation, the incident (reoperation) rate ratio was 7.89 times higher after PLF (2.91, 26.67). The CER after the first reoperation was −$24,429.04 per QALY (relative to PLF). Two patients in the PLF cohort required a second reoperation, whereas none required a second reoperation in the PLIF/TLIF cohort. Taken collectively, the total CER for the interbody fusion is $9,883.97 per QALY.

CONCLUSIONS: The reoperation rate was statistically higher for PLF, whereas the negative CER for the initial operation and first reoperation favors PLF. However, when second reoperations were included, the CER for the interbody fusion became $9,883.97 per QALY, suggesting moderate long-term cost savings and better functional outcomes with the interbody fusion.

Keywords: Cost-effectiveness; Interbody; Lumbar; PLIF; TLIF; Spondylolisthesis

Introduction

Degenerative spondylolisthesis in the lumbar spine occurs when the cephalad vertebral body slips relative to the caudal vertebral body [1]. Symptoms may result from spinal stenosis and nerve root compression. Surgical management of this condition may entail decompression of the spinal canal followed by posterolateral fusion (PLF) with or without interbody. In a landmark publication, Suk et al. [2] found that the additional anterior stabilization of the vertebral column with an interbody reduces the incidence of nonunion, degree of slippage, and recurrence of deformity in patients with degenerative spondylolisthesis. However, more recently in a randomized clinical trial with 2-year follow-up, Høy et al. [3] found that the transforaminal interbody does not improve functional outcomes relative to PLFs. Moreover, the interbody fusion did not result in higher fusion rates.

In light of the conflicting studies [3–5], we sought to evaluate the cost-effectiveness of interbody fusions. We hypothesize that differences in reoperations between interbody and noninterbody fusions will have a significant impact on long-term expenditures. To study the impact of reoperation rates on health care utilities, we adopted Markov (state-transition) model in 137 patients undergoing lumbar fusion for spondylolisthesis. Posterolateral fusion and posterior/transforaminal lumbar interbody fusion/transforaminal lumbar interbody fusion (PLIF/TLIF) were compared according to quality of life adjustments and total expenditures, which in turn were used to calculate cost-effectiveness ratios (CERs).

Methods

On retrospectively reviewing medical records at a single institution, we identified all patients undergoing first-time instrumented lumbar fusions for degenerative or isthmic spondylolisthesis. All patients had either Grade 1 or Grade II spondylolisthesis. Patients with neoplastic, congenital, infectious, metabolic, and traumatic etiologies were excluded. Patients with previous fusions were also excluded. Patients who met the inclusion criteria were dichotomized into two cohorts: PLF cohort and PLIF/TLIF cohort. Interbody placement was limited to one intervertebral level. Although baseline characteristics between the two cohorts were similar (Table 1), the choice of interbody fusion was at the surgeon's discretion. Thus, the fusion decision is said to be retrospectively almost at random.

Within each cohort, variables were categorized into short-term complications and long-term outcomes (Table 1). The types of complications and outcomes that affect quality of life and/or cost utilization were determined a priori from the previously published reports, such as the SPORT (Spine Patient Outcomes Research Trial) trial. Short-term complications include durotomies, surgical site infections, and one or more medical complications (deep vein thrombosis, deep vein thrombosis, myocardial infarction, pneumonia, and/or pulmonary embolus). Long-term outcomes include bowel/bladder deficits, paraplegia, neurologic deficits (neurogenic claudication, radiculopathy, sensory deficit, and/or weakness), and chronic back pain. The remaining patients who experienced neither a short-term complication nor a clinically relevant long-term outcome were defined as no complication/outcome in Table 2.

Health-care utilities were approximated with quality of life adjustments that were previously calculated by Kuntz et al. [6] based on time trade-off values in the Beaver Dam Health Outcomes Study [7]. Quality of life adjustments are then reported as quality-adjusted life-years (QALYs) according to the length of each Markov cycle, wherein PLF_o and $PLIF_o/TLIF_o$ equal the initial operation, PLF_1 and $PLIF_1/TLIF_1$ equal the first reoperation, and PLF_2 and $PLIF_2/TLIF_2$ equal the second reoperation. Thus, the number of short-term complications and long-term outcomes were determined from our institutional series, whereas the quality of life adjustments in Table 2 were adopted from the Beaver Dam Health Outcomes Study [6,7]. The quality of life adjustments for the no complication/outcome group and the long-term outcome group were multiplied by 3.5 years for the initial cohort, 2.5 years for the first reoperation co-