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Clinical Study

Outcomes after cervical laminectomy with instrumented fusion *versus* expansile laminoplasty: A propensity matched study of 3185 patients

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ABSTRACT

The aim of this study was to compare reoperation, complication rates, and healthcare resource utilization of expansile laminectomies with instrumented fusion *versus* laminoplasty. Using the MarketScan database (Truven Health Analytics, Ann Arbor, MI, USA), we selected patients aged >18 years who underwent either cervical laminoplasty or laminectomy with fusion between 2000–2009. Propensity score modeling produced a matched cohort balanced for age, sex, comorbidities, and other relevant factors. A total of 3185 patients meeting our inclusion criteria also had 2 year follow-up available. Of these, 2927 (91.90%) and 258 (8.10%) had laminectomy with fusion and laminoplasty, respectively. Laminoplasty patients had significantly lower complication rates during index hospitalization (5.81 *versus* 9.62%, adjusted odds ratio [aOR]: 0.556, 95% confidence interval [CI]: 0.418–0.740, $p < 0.0002$), during 30 day (6.87 *versus* 11.12%, aOR: 0.568, 95% CI: 0.436–0.740, $p < 0.0002$) and 90 day (7.61 *versus* 11.78%, aOR: 0.593, 95% CI: 0.460–0.764, $p < 0.0002$) postoperative periods. They also had lower costs (United States dollars) during index hospitalization ($26,129 *versus* $35,483, $p < 0.0004$), and overall during the 2 year postoperative period ($77,960 *versus* $106,453, $p < 0.0001$). Two year reoperation rates were similar between both groups (9.77% *versus* 7.36%, $p = 0.20$). Our study suggests that cervical laminoplasty has significantly lower complication rates, similar long-term reoperation rates and lower healthcare resource utilization after 2 years than laminectomy with fusion.

1. Introduction

Laminoplasty and laminectomy with instrumented fusion have become popular surgical options for the management of multilevel compressive cervical spondylotic myelopathy (CSM) and ossification of the posterior longitudinal ligament [1]. However, no clear consensus has been established as to which procedure is preferred [2].

Proponents of decompressive laminectomy with instrumented fusion contend that it most optimally addresses the underlying pathophysiology. The decompressive procedure addresses the static factors, and the instrumented fusion eliminates the dynamic factors, halting the progression of spondylosis while reducing the risk of postoperative kyphosis. However, since fusion of the cervical spine results in alteration of normal cervical biomechanics, it leads to increased rates of adjacent segment disease (25–89%) [3].

Conversely, supporters of expansile laminoplasty assert that because the laminae are elevated *en bloc*, the risk of neurological injury from the violation of the spinal canal is avoided. Furthermore, it provides sufficient postoperative spine stability because it preserves the bony arch and the postoperative tension band, thereby reducing the incidence of postoperative kyphosis to 8–11% without subjecting the patient to the risk of greater instrumentation [4,5].

Several studies that have directly compared laminoplasty to laminectomy with fusion have suggested that laminoplasty may be associated with a lower incidence of perioperative complications [6,7]. However, these studies have been small, retrospective series insufficiently powered to draw firm conclusions. To our knowledge, no study has examined differences in postoperative complications between the two alternatives incorporating nationwide practice patterns.

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2. Methods

2.1. Data source

For the current study, we used the Commercial Claims and Encounters, Medicare supplemental, and Medicaid databases from 2000–2009 available as part of the MarketScan database (Truven Health Analytics, Ann Arbor, MI, USA). The MarketScan database captures patient-level data on clinical utilization (inpatient and outpatient), pharmaceutical claims, insurance enrollment, and costs, and links this data with detailed patient, provider and facility information. The MarketScan database is de-identified and compliant with the Health Insurance Privacy and Portability Act of 1996 and was used under Institutional Review Board approval.

2.2. Patient selection

The MarketScan database was queried for all inpatient admissions with an International Classification of Disease, Ninth edition, Clinical Modification (ICD-9-CM) code of 722.0, 721.1, 722.71, 721.0, 722.4, 723.7 and 723.0 and concurrent procedures of either a laminoplasty (Current Procedural Terminology [CPT]-4 codes 63050, 63051) or a laminectomy (ICD-9-CM code: 03.09, CPT-4 codes: 63045, 63048, 63020, 63035, 63015, 63001) and fusion (ICD-9-CM codes: 81.01, 81.02, 81.03, CPT-4 codes: 22600, 22590, 22595). Only patients 18 years and older at the time of the index hospitalization were retained for the analysis.

2.3. Calculation of follow-up time

Pre- and post-operative follow-up times were calculated as the difference between the date of the index hospitalization and the start and end enrollment dates, respectively. If the latter date was not available, we used 1 January 2000, which is the first date in our data and 31 December 2009, which is the last date.

2.4. Explanatory variables

Patient sex and age at initial hospitalization were inherent elements gathered from the database. Comorbidities were tallied and used to calculate a Charlson comorbidity index score for each patient [8].

2.5. Postoperative outcome variables

Primary outcomes studied included length of hospital stay, total charges (reported in United States dollars), incidence of perioperative complications, and 30 and 90 day postoperative complications. The incidence of 30 and 90 day complications was assessed at any postoperative hospital admission using ICD-9 diagnosis codes. All charges were inflated to 2009 dollars using the medical care component of the consumer price index, accessible from the United States Bureau of Labor Statistics [9]. Complications included renal, cardiac, neural, venous thromboembolic, pulmonary, infectious and wound complications that occurred from the time of initial hospitalization to 30 and 90 days following discharge.

2.6. Reoperation

To evaluate whether a patient required a reoperation, all postoperative inpatient encounters were screened for an ICD-9-CM or CPT code corresponding to laminoplasty, laminectomy, fusion or refusion.

2.7. Complications

Complications associated with index hospitalization were complications that occurred during the index procedure hospitalization. Thirty and 90 day complication rates were evaluated by examining all surgery-related complications occurring within 30 or 90 days after surgery.

2.8. Healthcare resource utilization and costs

All cost estimates were based on patient-reported resource utilization (payer's perspective [direct costs]). Resource utilization was determined from institutional records. Cervical spine related outpatient visits, diagnostic tests (radiographs, CT scans, MRI and electromyography), devices (braces, canes, walkers), emergency room visits, and spine-specific medications (non-steriodal anti-inflammatory drugs, COX-2 inhibitors, oral steroids, narcotics, muscle relaxants, and antidepressants) were assessed. All instances of healthcare resource utilization at index hospitalization and then postoperatively were captured in the database. We evaluated the cumulative number of days spent in the hospital and associated costs for all hospitalizations occurring after the index procedure. In addition, we assessed the total treatment costs, which comprised the cost of the index hospitalization plus the cost of all postoperative healthcare resources use. All costs were inflated to 2009 United States dollars using the medical component of the consumer price index, accessed through the United States Bureau of Labor Statistics website [9].

2.9. Propensity score matching

Patients undergoing laminoplasty were matched 1:1 to patients undergoing laminectomy and fusion. The propensity score was computed as the probability of undergoing a laminoplasty using a multivariate logistic regression model that included all pertinent covariates. Propensity matching was performed using the greedy macro for propensity matching [10].

2.10. Statistical analysis

Multivariate models included pertinent variables such as insurance type, patient age, sex, and Charlson index as covariates in addition to the procedure group. Length of stay and cumulative days were analyzed with log-linear models. Cumulative services and cumulative prescriptions were analyzed with negative binomial models. Costs were analyzed with linear models on log-transformed variables. Reoperation and complications were analyzed with logistic regression. Covariate balance before and after matching was assessed using p values and absolute value of the standardized difference. We used the p value from two-sample comparisons using the non-parametric rank sum test for continuous variables and chi-squared or Fisher's exact test for categorical variables. We adjusted the p values to control for the false discovery rate in each table using the Benjamini and Hochberg's approach [11,12]. We used the software SAS 9.3 (SAS Institute, Cary, NC, USA) for data preparation and analysis.

3. Results

Our study identified 3185 patients in the MarketScan database who underwent a posterior cervical decompression and stabilization who were followed for at least 2 years between 2000 and 2009. Of these, 2927 underwent laminectomy with fusion and 258 laminoplasty. Complete patient cohort baseline characteristics are listed in Table 1.