Comparative Utilization of Laminoplasty in the United States and Japan

William H. Waddell\textsuperscript{1}, Benjamin M. Weisenthal\textsuperscript{1}, Nicholas Golinvaux\textsuperscript{1}, Abigail L. Henry\textsuperscript{1}, Jacquelyn Pennings\textsuperscript{1}, John P. Wanner\textsuperscript{1}, Rishabh Gupta\textsuperscript{1,3}, Toshitaka Yoshii\textsuperscript{2}, Zhou Feifei\textsuperscript{4} and Byron F. Stephens\textsuperscript{1}

\textsuperscript{1} Department of Orthopedic Surgery, Vanderbilt University Medical Center, Nashville, USA
\textsuperscript{2} Department of Orthopedic Surgery, Graduate School, Tokyo Medical and Dental University, Tokyo, Japan
\textsuperscript{3} University of Minnesota Medical School, Minneapolis, USA
\textsuperscript{4} Department of Orthopedics, Peking University Third Hospital, Beijing, China

Abstract:

Introduction: Laminoplasty is a well-established technique used to manage cervical myelopathy (CM). Nevertheless, the degree to which United States surgeons have adopted laminoplasty from Japan to treat CM is less clear. The purpose of this study was to compare operative management strategies for CM in the United States (US) with Japan.

Methods: This study used a retrospective cohort of 16,084 patients from the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database and 389,872 patients from the Japanese Diagnosis Procedure Combination (DPC) database from 2007 to 2015. Patients with the following diagnoses were collected: spondylosis with myelopathy (ICD-19; 721.1, ICD-10; M47.12) and disk herniation with myelopathy (ICD-9; 722.71, ICD-10; M50.00). The proportion of surgeries between Japan and the US was compared using a linear regression model controlling for year.

Results: US surgeons utilized anterior procedures in 70% of cases compared to 9% in Japan (p<.001). In contrast, Japan had significantly more laminoplasties than the US (43% vs. 4%, respectively, p<.001). The percentage of laminoplasty in Japan (43%) relative to the percentage in the US (4%) was significantly different (p<.001). Accounting for increases in the number of total surgeries per year seen in the ACS-NSQIP and DPC databases, no specific surgery demonstrated a significant increase or decrease over the 8 years.

Conclusions: Japanese surgeons employ laminoplasty to treat CM approximately ten times more frequently than US surgeons who prefer anterior procedures.

Keywords: cervical, spine, laminoplasty, United States, Japan

Introduction

Laminoplasty originated in the 1970s as an alternative to laminectomy\textsuperscript{1}. Since its adoption, literature has been published establishing that laminoplasties offer equally robust clinical outcomes as other surgical techniques, including laminectomy and fusion and anterior cervical discectomy and fusion (ACDF), in treating cervical myelopathy (CM)\textsuperscript{2-8}. Laminoplasty also offers several unique advantages. It preserves cervical motion, avoids fusion-related complications, and is associated with reduced hospital stay, shorter operative times, less blood loss, and an overall lower complication rates\textsuperscript{4-7,10}. High healthcare costs make it imperative to stress the lower cost associated with laminoplasty compared to other options such as laminectomy and fusion surgery\textsuperscript{11,12}.

Given these benefits, laminoplasties are expected to become common procedures in United States (US) hospitals. Failure to adopt laminoplasty into routine clinical practice would warrant further investigation into reasons why. Given the paucity of literature examining the prevalence of surgical techniques to treat CM, this study aimed to assess the prevalence of laminoplasty in treating CM in the United States. Rates of laminoplasty for treating CM were then compared to those in Japan, a country with widespread adoption of
laminoplasty surgery, to provide context to the rate of laminoplasty usage in the US.

Materials and Methods

Data from the US were gathered from the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP). The ACS-NSQIP was started in 1999 after a successful trial in the Veteran’s Administration health system in 1994 and is available to participating hospitals in the US[11]. Data from Japan were gathered from the Diagnosis Procedure Combination (DPC) database. This is a nationally representative database in Japan comprising discharge and administrative claims data. It is used to track and analyze national trends in healthcare utilization in Japan[12].

In the ACS-NSQIP, preoperative, intraoperative, and 30-day postoperative variables are collected from medical records of patients undergoing major surgical procedures in inpatient and outpatient settings at eligible hospitals. A systematic sampling process is used to ensure that all cases have equal chances of being selected each day of the week[13]. The hospitals in the DPC are surveyed from July 1 to December 31 each year and numerous variables are collected; notably, for this study, the International Classification of Diseases (ICD-10 and ICD-9) and Current Procedural Terminology (CPT) codes were used[14]. As the data were collected without identifying factors, approval from the institutional review board was not required.

We used ICD-9 and ICD-10 diagnoses to collect an initial group of patients with cervical spine pathology from 2007 to 2015. Patients with the following diagnoses were collected: spondylosis with myelopathy (ICD-9: 721.1, ICD-10: M47.12) and disc herniation with myelopathy (ICD-9: 722.71, ICD-10: M50.00). This group of patients was subdivided by the type of surgery they underwent by collecting CPT codes for each case. This combination was used to exclude patients who underwent surgery for fractures or other traumatic injuries that would have limited the possible operative solutions. The following CPT codes were used: posterior laminectomy (63001, 63015, 63045, 63048); posterior discectomy (63020, 63035, 63040, 63043); posterior cervical fusion (22600, 22614); ACDF (22551, 22552, 63075, 22554, 22558); anterior corpectomy (63081, 63082); cervical disk arthroplasty (22856, 22858); and laminoplasty (63050, 63051).

The data from the DPC database in Japan were collected from the same ICD-9 and ICD-10 codes for myelopathy. As the DPC database did not distinguish between the different anterior procedures, ACDF, corpectomies, and cervical disk arthroplasty were grouped into one category. These CPT codes were grouped together for the subset of patients with a diagnosis of myelopathy who were gathered from the ACS-NSQIP to ensure an accurate comparison.

Patients were grouped yearly by the type of surgery performed. The proportion of surgeries between Japan and the US was compared using a linear regression model controlling for year. SPSS Version 25.0 was used for the statistical analyses.

Results

A total of 16,084 and 389,872 patients were identified in the ACS-NSQIP and DPC databases, respectively. In the US, ACDF was still the most performed surgery (9,864; 61%) to treat CM. In Japan, laminoplasty was the most performed surgery (165,494; 43%) to treat CM. The percentage of laminoplasty in Japan (43%) relative to the percentage in the US (4%) was significantly different (p<.001). Accounting for increases in the number of total surgeries per year seen in the NSQIP and DPC databases, no specific surgery demonstrated a significant increase or decrease over the 8 years. The percentage of anterior surgeries was approximately 70% in the US database (11,356) and 9% (31,412) in the Japanese database (p<.001) (Fig. 1). Although statistical significance was found, it should be noted that the DPC database enrolls a much larger cohort of patients than the ACS-NSQIP, based on the fact that 898 hospitals participated in the DPC compared to 183 hospitals in the ACS-NSQIP.

Discussion

Laminoplasty offers unique benefits over other surgical techniques in treating CM[5,6]. It preserves cervical motion, avoids fusion-related complications, is less expensive, and is associated with a reduced hospital stay, shorter operative time, less blood loss, and an overall lower complication rate[7-10]. Published meta-analyses have also compared clinical outcomes of laminoplasty to other surgical techniques. Results indicate that laminoplasty is highly comparable to laminectomy and fusion as well as ACDF in treating CM[11-14]. The unique benefits offered by laminoplasty are expected to result in a high proportion of patients with CM undergoing the procedure in the US. As such, the primary aim of this study was to assess the prevalence of laminoplasty in treating CM among US surgeons and to compare these rates to those in Japan, a country with high rates of laminoplasty.

Despite the established benefits, this study found a low utilization of laminoplasty the US. Of over 16,000 patients, only 4% underwent cervical laminoplasty to treat CM. In comparison, Japan had a 10-fold higher rate of laminoplasty use. US surgeons preferred ACDF to treat CM, with 61% of all patients with CM undergoing the procedure. Particularly noteworthy was the lack of increase in laminoplasty use in the US over the study period. Prior evidence evaluating surgical intervention usage for all cervical pathologies concurs with this trend, noting either no change or even a decline in the use of motion-preserving surgery over time in the US[15].

Few studies examine national trends regarding surgical management of CM in the US. Veeravagu et al. analyzed 35,962 patients with CM from 2006 to 2010 and reported

461
that 865 (2.4%) underwent laminoplasty, a finding similar to that of our study. Mesregah et al. analyzed 15,524 patients with degenerative CM, of whom 3.3% had laminoplasty. Three prior studies analyzed over 50,000 patients with CM from the Nationwide Inpatient Sample (NIS) from 2001 to 2010 and concluded that ACDFs comprised 63.3% of cases. Using the NIS database, Palejwala et al. examined patients from 2002 to 2012 and arrived at a similar rate of ACDF use. To our knowledge, this is the first study examining the relative rate of laminoplasty use in treating CM in Japan.

The low laminoplasty utilization among US surgeons may be because of a few reasons. First, although laminoplasty appears to offer equivalent clinical outcomes, its evidence quality is low to moderate. Disagreement on the best surgical approach coupled with low confidence inspired by current evidence might fail to motivate US-based surgeons to switch to laminoplasty from more established techniques. It is reasonable to assume that the high rates of laminoplasty in Japan are a function of the procedure being created there. Second, Japan has a higher rate of ossification of the posterior longitudinal ligament (OPLL) than the US, a major indication for laminoplasty. The prevalence of OPLL is still low in Japan and cannot account for the entire difference in surgical techniques; however, it is a contributing factor. Third, US doctors view laminoplasty less favorably than ACDF. Davies et al. noted that compared to their Japanese counterparts, US doctors are twice as likely to believe that laminoplasty is associated with higher complication rates than ACDF. Finally, the combination of the above variables likely creates a domino effect, where recent graduates from the US are less likely to incorporate laminoplasty into their clinical practice because of lower clinical exposure than their Japanese counterparts.

**Conclusion**

The purpose of this study was to quantify and compare the rates of laminoplasty and ACDF use in treating CM in the US and Japan. Results indicate laminoplasty is utilized at a significantly lower rate in the US than in Japan (4% vs. 43%). Given the unique benefits of laminoplasty, the results of this study should encourage spine surgeons to examine their own practice to ensure that they are achieving optimal results for patients, and to prompt institutions to analyze their training curriculum to ensure that residents receive proper exposure to laminoplasty.

**Conflicts of Interest:** Dr. Stephens has received consulting fees from Stryker Spine and Deupuy-Synthes. All other authors have no conflicts of interest to disclose.

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