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Review Article

Feasibility of Outpatient Cervical Laminoplasty

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Cervical laminoplasty was initially introduced as an effective alternative to laminectomy procedures but advances in surgical techniques and perioperative protocols have allowed its use to expand. As the utilization of ambulatory surgical centers continues to grow, so too will the transition of mandatory inpatient procedures such as cervical laminoplasty to the outpatient setting. Successful transition of such involved procedures requires a host of adjustments to facilitate this change. This article reviews the key aspects of our medical practice that have enabled us to find success in the outpatient setting and outlines the potential for successful transition of cervical laminoplasty.

INTRODUCTION AND BACKGROUND

Open laminectomy and laminoplasty have traditionally been used to treat symptomatic cervical spondylotic myelopathy (CSM). However, with the establishment of minimally invasive techniques for laminectomy (Boehm et al. 2003; Song and Christie 2006; Santiago and Fessler 2007; Minamide et al. 2017), there is growing interest in transitioning the procedure to the outpatient environment. Cervical laminoplasty was first introduced as an alternative treatment for CSM to avoid negative postoperative sequelae associated with laminectomy procedures such as lateral cervical spine instability and postoperative vulnerability to minor trauma (Hirabayashi et al. 1983; Guigui, Benoist, and Deburge 1998; Seichi et al. 2001; Mikawa, Shikata, and Yamamuro 1987).

Laminoplasty procedures generally include two types of techniques: "open door" or "french door". Hirabayashi first described the "open door" technique in 1978 whereby laminae are thinned bilaterally allowing for a hinging of the posterior arch on one side after transecting the contralateral lamina, followed by pushing the lamina and spinal process toward the hinged side, as if to open a door (Hirabayashi et al. 1983; Hirabayashi and Satomi 1988). The "french door" laminoplasty, originally described by Kurokawa in 1980 (Seichi et al. 2001; Kurokawa 1982), also thinned bilateral laminae but divided the spinous processes along the sagittal plane and laterally spread the spinal process halves and associated laminae.

The benefits of these early procedures were offset by a number of limitations. Among these were the cervical misalignment and loss of lordosis that were often associated with laminoplasty (Hirabayashi and Satomi 1988; Hukuda et al. 1988). These negative outcomes were thought to be related to the disruption of posterior paraspinal musculature that was necessitated by many of the approaches used at this time (P. Kim et al. 2007). Additionally, these procedures were associated with significantly higher levels of neck and shoulder pain compared with anterior fusion procedures, which similarly attributed pain with iatrogenic soft tissue and bone trauma (Hosono, Yonenobu, and Ono 1996). More recently, a less invasive approach, known as TEMPLA, was developed to preserve attachments of semi-

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spinalis cervicis and multifidus muscles to C2 and was observed to decrease rates of cervical misalignment and kyphosis, and improve range of motion and patient reported quality of life compared with its predecessors (Shiraishi et al. 2002; Kotani et al. 2009).

Use of cervical laminoplasty may have considerable advantages over other techniques such as anterior discectomy and fusion (ACDF). Use of a posterior approach can limit postoperative complications such as esophageal injuries, dysphagia, laryngeal nerve paralysis, and vascular injury, which have been associated with ACDF, particularly in the case of multilevel procedures (Beutler, Sweeney, and Connolly 2001; Wang et al. 2003). While anterior procedures such as ACDF may be limited by their ability to address more than 3 vertebral levels, cervical laminoplasty can be used to safely address spinal pathologies at 4-6 vertebral levels (Wang et al. 2003).

Laminoplasty also has direct benefits over other cervical procedures that utilize similar approaches such as laminectomy. Studies suggest that use of laminoplasty may be favored over laminectomy due to improved cervical spine stability (Kubo et al. 2002), reduction of postoperative kyphosis, and preserved range of motion (Manzano et al. 2012; Lin et al. 2019). Other reported advantages of laminoplasty include shorter operative times, decreased intraoperative blood loss (Lin et al. 2019), lower rates of postoperative nerve palsies, and decreased spinal deformity (Yuan et al. 2019; Ratliff and Cooper 2003), while achieving similar outcomes in terms of pain and physical function as cervical laminectomy (Lin et al. 2019). Additionally, opting for cervical laminoplasty over alternative procedures may facilitate preservation of dorsal dural coverage, which can offer safer parameters for revision (Weinberg and Rhee 2020). As an emphasis on improved patient outcomes continues to grow, use of minimally invasive (MIS) techniques and transitioning to the outpatient environment will only enhance the listed benefits to patients.

TRANSITIONING FROM INPATIENT TO OUTPATIENT

While major spine procedures have traditionally been performed in the hospital environment on an inpatient basis, a growing body of evidence supports the advantages of performing certain spine procedures in outpatient settings (Sivaganesan et al. 2018; Ban et al. 2016; M. C. Fu et al. 2017; Khanna et al. 2018; Purger et al. 2019; Sheperd and Young 2012; Adamson et al. 2016; Lied et al. 2013). A recent meta-analysis of comparative outcome studies of inpatient and outpatient ACDF found there was a 50% reduction in major morbidity, 80% reduction of reoperation within a 30 day window, and an equivalent 30-day and 90-day readmission or reoperation rate (McGirt et al. 2015). A similar finding was observed for both cervical disc arthroplasty and laminectomy patients, with no increase in admissions or readmissions within 30 days postoperatively (Chin, Pencle, Seale, et al. 2017; Yen and Albargi 2017). In addition to reduced surgical risks and morbidity, outpatient cervical procedures show equivalent patient satisfaction as inpatient procedures (Sheperd and Young 2012; Lied et al. 2013). Collectively, these reductions can translate to reduced costs for both the patient and provider (McGirt et al. 2015; Purger et al. 2018). One study demonstrated reductions of 30% in fees and nearly half the total cost of inpatient ACDF (McGirt et al. 2015; Purger et al. 2018). It is plausible that these benefits from transitioning to the outpatient setting could then carry over for cervical laminoplasty; however the transition is contingent on several key aspects.

For the transition to outpatient settings to be made successfully, patients must be amenable to discharge safely and without complication within 24 hours of their procedure. Patients undergoing posterior decompression using either cervical laminoplasty, laminectomy alone, or laminectomy with instrumentation can currently expect to stay in the hospital for up to 3 days postoperatively. One of the largest determinants of inpatient stay beyond the initial 24-hours postoperative period is the presence of preoperative comorbidities or chronic medical conditions (Kobayashi et al. 2019). In addition to these risk factors, lengthier operative times, larger blood loss, and increased postoperative pain must also be considered as other studies have implicated their contribution to an increased length of stay in other cervical spine procedures (Garringer and Sasso 2010).

While moving complex spine procedures such as cervical laminoplasty from hospitals to ASCs may previously have been unrealistic, the use of MIS has greatly broadened what is possible in terms of such transitions. The more recent adoption of MIS techniques in laminectomy procedures has prompted increased interest in their use for laminoplasty surgeries. MIS laminoplasty can mitigate operative complications by reducing operative and postoperative complications (Yeh et al. 2015) and minimizing the dissection of paraspinal muscles (Lin et al. 2019; Fang et al. 2016), while achieving similar or better patient outcomes (Minamide et al. 2017; Yeh et al. 2015) and near complete preservation of range of motion (Takebayashi et al. 2013).

CHALLENGES

Even though both outpatient surgery and advances in surgical technique provide a number of advantages, transitioning to the outpatient environment has its challenges. The main appeal of outpatient procedures is an efficient, uncomplicated encounter that maximizes the chances of same day discharge of patients. Achievement of this goal is largely predicated on maximizing operative efficiency. This requires an adept medical team familiar with the sequential steps of the procedure and postoperative management. These expectations take time to develop, requiring training and increased exposure. In addition to staffing challenges, standardization of surgical instrumentation can pose a problem when switching to the outpatient setting. Past studies have investigated advantages of this practice and reported both cost- and time-saving benefits to the practice, factors which are essential to an efficient procedure (John-Baptiste et al. 2016; Capra et al. 2019; Attard et al. 2019). To compound the standardization of instru-

ments, familiarity with MIS specific instruments is required to retain the benefits of reduced muscle dissection and operative efficiency. Lastly, although not entirely within the control of the surgical team, established protocols for operative or postoperative complications requiring hospital admissions is necessitated. While some facilities do allow for an outpatient procedure with access to inpatient facilities, ambulatory surgical centers are typically ill-equipped to accommodate stays > 24 hours for complications such as dural tears after laminoplasty.

Aside from the shortcomings surgical centers and staff can place on the transition to the outpatient space, ultimately the biggest challenge is selection of appropriate patients. Given the limited ability of outpatient centers to accommodate complications and extended length of stay, not all surgical candidates are suitable for outpatient surgery. When choosing patients to perform an outpatient posterior decompression, careful selection of specific patients that can safely endure an outpatient procedure is of the utmost importance.

STANDARDIZATION OF PROCEDURE

Standardization of all possible aspects of the surgical procedure is key to safe and efficient transition to the outpatient setting. This is important at nearly every point along the way from patient selection and counseling during clinical evaluations to post-discharge care and follow up. Identification of appropriate patients can be accomplished in a number of ways and published guidelines exist that recommend profiles best suited for the outpatient setting. To some, it may be surprising that the majority of patients can be eligible for outpatient procedures based on several criteria (Chin, Pencle, Coombs, et al. 2017). These include living within 30 minutes of a hospital (Mohandas et al. 2017), having a body mass index ⩽ 42 kg/m^2, a history clear of cardiovascular disease (Fleisher et al. 2014), an American Society of Anesthesiology score ⩽ 3 (Chin, Pencle, Coombs, et al. 2017; Mohandas et al. 2017; K.-M. G. Fu et al. 2011; Chin, Coombs, and Seale 2015), and a responsible adult available to help the patient for at least 24 hours postoperatively (Mohandas et al. 2017). Additionally, some patients may have significant anxiety about undergoing surgery as an outpatient and thus may not be good candidates for this setting, even if they might otherwise be suitable (Mohandas et al. 2017). Outside of this general profile, more specific considerations for spine surgery patients must also be addressed prior to the procedure. While ideal candidates will differ by institution, past studies of outpatient spine procedures have indicated that patients with better outcomes tend to have lower BMI, stable chronic illnesses, and lower risk comorbidities (Walid et al. 2010; Chin et al. 2016).

Pain management must also be considered for migration to the outpatient setting. This is especially true for cervical laminoplasty as studies have attributed axial neck pain as a major postoperative complication (Sasai et al. 2000; Kato et al. 2008; Takeuchi et al. 2005). Our practice's multimodal analgesia (MMA) protocol has been instrumental in facilitating this necessary pain control in a standardized, predictable way. This protocol's use of a broader range of medications at lower individual doses allows for lower rates of opioid induced side effects (Buvanendran et al. 2003; Singh et al. 2017). Decreased incidence of these side effects can reduce barriers to timely discharge such as persistent nausea and vomiting (Swegle and Logemann 2006; Garcia et al. 2013) and facilitate earlier out of bed ambulation and engagement with physical therapy (Berger et al. 2009). Another important part of our MMA protocol's success is that it begins well before the actual procedure. Preoperative analgesic administration can work proactively to buffer the trauma of surgery and the ensuing inflammatory cascade (K.-T. Kim et al. 2006; Buvanendran et al. 2005). Our MMA protocol is one more of the many ways in which we have standardized our surgical procedures to facilitate the efficiency and predictability that is required for success in the outpatient setting.

EXPERIENCE TO DATE

Our practice has been performing cervical laminoplasty for the treatment of cervical myelopathy, among other conditions, for well over a decade. Over that time, our pre- and postoperative protocols, as well as the procedure itself have evolved substantially. Of particular note, our operative times and lengths of stay have trended toward shorter operative times and more timely discharges (**Figures 1 & 2**). No patients have required readmission due to uncontrolled pain or other complications following surgery. We have already successfully discharged several patients on the day of surgery following cervical laminoplasty, and a majority of recent laminoplasty patients being discharged the following day.

Along with advancement of technique and technology, much of these improvements may be attributed to our standardized, careful selection of appropriate patients for cervical laminoplasty. To date, laminoplasty patients discharged by our practice on the day of surgery have been non-obese, non-smokers with private insurance, no history of diabetes, hypertension, or cardiovascular disease and ages ranging from 48 to 67 years. While such stringent criteria are likely not necessary as a prerequisite for outpatient surgery, this demographic information does highlight the importance of patient characteristics in achieving a timely discharge. The endpoint for continuation of these practices is to transition a majority of cervical laminoplasty procedures on an outpatient basis with same day discharge.

FUTURE DIRECTION

Having already transitioned a number of major spine procedures to outpatient and ambulatory settings, our practice is optimistic that this is achievable for cervical laminoplasty. As we continue to refine our surgical protocols and patient selection criteria, we believe not only that cervical laminoplasty is feasible in the outpatient setting, but that it will become the rule, rather than the exception. Transitioning surgery to the outpatient setting can represent a significant reduction in both financial costs and disruption of

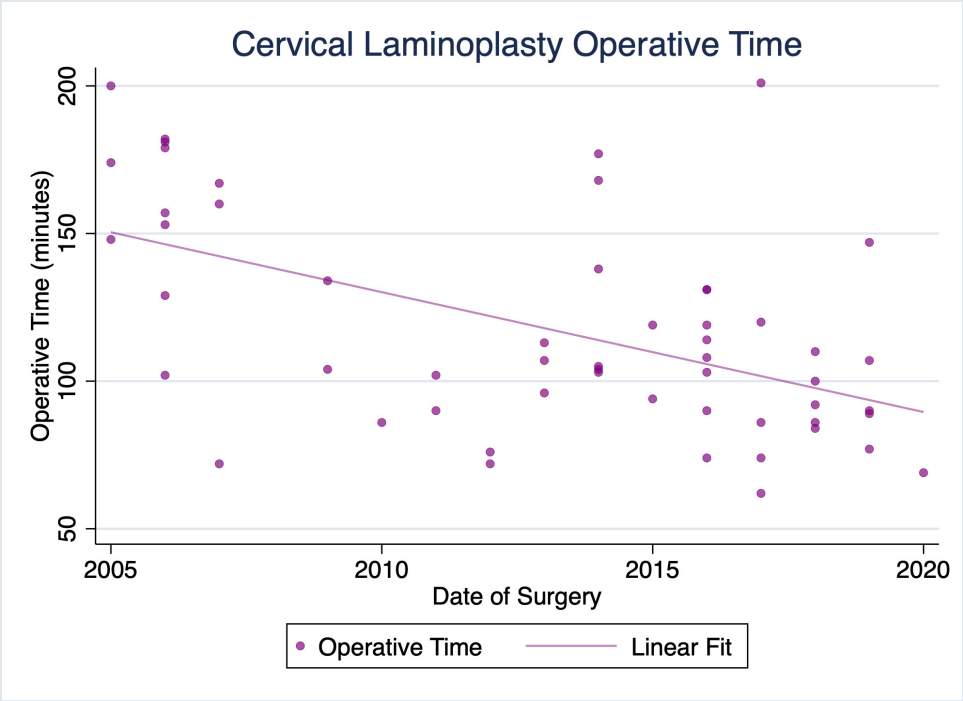

Figure 1: Cervical laminoplasty operative time

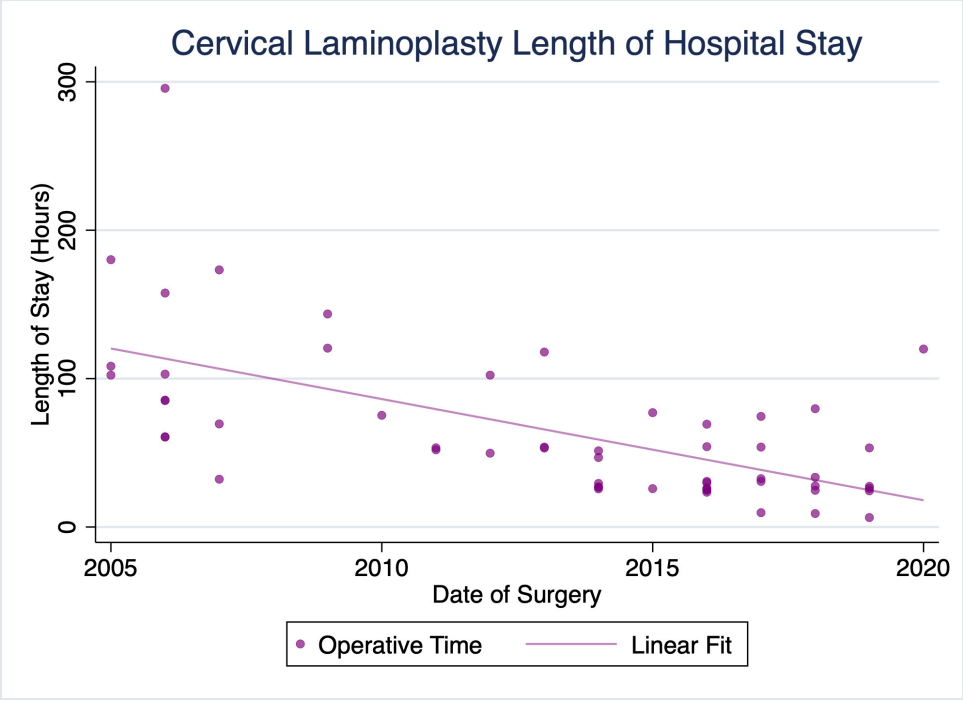

Figure 2: Cervical laminoplasty length of stay

the patient's life. For surgeons with the appropriate technical skills, organizational backing, and properly selected patients, outpatient cervical laminoplasty represents both a realistic and worthwhile goal.

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Cervical Laminoplasty

URL: https://www.youtube.com/embed/5CE5dNQw02c

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REFERENCES

Adamson, Tim, Saniya S. Godil, Melissa Mehrlich, Stephen Mendenhall, Anthony L. Asher, and Matthew J. McGirt. 2016. "Anterior Cervical Discectomy and Fusion in the Outpatient Ambulatory Surgery Setting Compared with the Inpatient Hospital Setting: Analysis of 1000 Consecutive Cases." *Journal of Neurosurgery: Spine* 24 (6): 878–84. https://doi.org/10.3171/2015.8.spine14284.

Attard, Andre, Gwenllian Fflur Tawy, Michiel Simons, Philip Riches, Philip Rowe, and Leela C Biant. 2019. "Health Costs and Efficiencies of Patient-Specific and Single-Use Instrumentation in Total Knee Arthroplasty: A Randomised Controlled Trial." *BMJ Open Quality* 8 (2): e000493. https://doi.org/10.1136/bmjoq-2018-000493.

Ban, Dexiang, Yang Liu, Taiwei Cao, and Shiqing Feng. 2016. "Safety of Outpatient Anterior Cervical Discectomy and Fusion: A Systematic Review and Meta-Analysis." *European Journal of Medical Research* 21 (1): 34. https://doi.org/10.1186/s40001-016-0229-6.

Berger, Richard A., Sheila A. Sanders, Elizabeth S. Thill, Scott M. Sporer, and Craig Della Valle. 2009. "Newer Anesthesia and Rehabilitation Protocols Enable Outpatient Hip Replacement in Selected Patients." *Clinical Orthopaedics and Related Research®* 467 (6): 1424–30. https://doi.org/10.1007/s11999-009-0741-x.

Beutler, William J., Colleen A. Sweeney, and Patrick J. Connolly. 2001. "Recurrent Laryngeal Nerve Injury with Anterior Cervical Spine Surgery Risk with Laterality of Surgical Approach." *Spine* 26 (12): 1337–42. https://doi.org/10.1097/00007632-200106150-00014.

Boehm, H., R. Greiner-Perth, H. El-Saghir, and Y. Allam. 2003. "A New Minimally Invasive Posterior Approach for the Treatment of Cervical Radiculopathy and Myelopathy: Surgical Technique and Preliminary Results." *European Spine Journal* 12 (3): 268–73. https://doi.org/10.1007/s00586-002-0522-7.

Buvanendran, Asokumar, Jeffrey S. Kroin, Kenneth J. Tuman, Timothy R. Lubenow, Dalia Elmofty, and Pauline Luk. 2005. "Cerebrospinal Fluid and Plasma Pharmacokinetics of the Cyclooxygenase 2 Inhibitor Rofecoxib in Humans: Single and Multiple Oral Drug Administration." *Anesthesia & Analgesia* 100 (5): 1320–24. https://doi.org/10.1213/01.ane.0000150597.94682.85.

Buvanendran, Asokumar, Jeffrey S. Kroin, Kenneth J. Tuman, Timothy R. Lubenow, Dalia Elmofty, Mario Moric, and Aaron G. Rosenberg. 2003. "Effects of Perioperative Administration of a Selective Cyclooxygenase 2 Inhibitor on Pain Management and Recovery of Function after Knee Replacement: A Randomized Controlled Trial." *JAMA* 290 (18): 2411–18. https://doi.org/10.1001/jama.290.18.2411.

Capra, Richard, Stefano A. Bini, Dawn E. Bowden, Katherine Etter, Matt Callahan, Richard T. Smith, and Thomas Parker Vail. 2019. "Implementing a Perioperative Efficiency Initiative for Orthopedic Surgery Instrumentation at an Academic Center: A Comparative before-and-after Study." *Medicine* 98 (7): e14338. https://doi.org/10.1097/md.0000000000014338.

Chin, Kingsley R., André V. Coombs, and Jason A. Seale. 2015. "Feasibility and Patient-Reported Outcomes after Outpatient Single-Level Instrumented Posterior Lumbar Interbody Fusion in a Surgery Center: Preliminary Results in 16 Patients." *Spine* 40 (1): E36–42. https://doi.org/10.1097/brs.0000000000000604.

Chin, Kingsley R., Fabio J. R. Pencle, André V. Coombs, Morgan D. Brown, Kasey J. Conklin, Andew M. O'Neill, Michael J. McGarry, Jason A. Seale, and Elijah A. Hothem. 2016. "Lateral Lumbar Interbody Fusion in Ambulatory Surgery Centers: Patient Selection and Outcome Measures Compared With an Inhospital Cohort." *Spine* 41 (8): 686–92. https://doi.org/10.1097/brs.0000000000001285.

Chin, Kingsley R., Fabio J.R. Pencle, André V. Coombs, Corrine F. Packer, Elijah A. Hothem, and Jason A. Seale. 2017. "Eligibility of Outpatient Spine Surgery Candidates in a Single Private Practice." *Clinical Spine Surgery* 30 (10): E1352–58. https://doi.org/10.1097/bsd.0000000000000374.

Chin, Kingsley R., Fabio J.R. Pencle, Jason A. Seale, and Franz K. Pencle. 2017. "Clinical Outcomes of Outpatient Cervical Total Disc Replacement Compared With Outpatient Anterior Cervical Discectomy and Fusion." *Spine* 42 (10): E567–74. https://doi.org/10.1097/brs.0000000000001936.

Fang, Zhao, Rong Tian, Tian-wei Sun, Sandip K. Yadav, Wei Hu, and Shui-qing Xie. 2016. "Expansion Open-Door Laminoplasty With Foraminotomy Versus Anterior Cervical Discectomy and Fusion for Coexisting Multilevel Cervical Myelopathy and Unilateral Radiculopathy." *Clinical Spine Surgery* 29 (1): E21–27. https://doi.org/10.1097/bsd.0000000000000074.

Fleisher, Lee A., Kirsten E. Fleischmann, Andrew D. Auerbach, Susan A. Barnason, Joshua A. Beckman, Biykem Bozkurt, Victor G. Davila-Roman, et al. 2014. "2014 ACC/AHA Guideline on Perioperative Cardiovascular Evaluation and Management of Patients Undergoing Noncardiac Surgery: A Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines." *Journal of the American College of Cardiology* 64 (22): e77–137. https://doi.org/10.1016/j.jacc.2014.07.944.

Fu, Kai-Ming G., Justin S. Smith, David W. Polly, Christopher P. Ames, Sigurd H. Berven, Joseph H. Perra, Richard E. McCarthy, D. Raymond Knapp, and Christopher I. Shaffrey. 2011. "Correlation of Higher Preoperative American Society of Anesthesiology Grade and Increased Morbidity and Mortality Rates in Patients Undergoing Spine Surgery: Clinical Article." *Journal of Neurosurgery: Spine* 14 (4): 470–74. https://doi.org/10.3171/2010.12.spine10486.

Fu, Michael C., Jordan A. Gruskay, Andre M. Samuel, Evan D. Sheha, Peter B. Derman, Sravisht Iyer, Jonathan N. Grauer, and Todd J. Albert. 2017. "Outpatient Anterior Cervical Discectomy and Fusion Is Associated With Fewer Short-Term Complications in One- and Two-Level Cases: A Propensity-Adjusted Analysis." *Spine* 42 (14): 1044–49. https://doi.org/10.1097/brs.0000000000001988.

Garcia, Ryan Michael, Ezequiel H. Cassinelli, Patrick J. Messerschmitt, Christopher G. Furey, and Henry H. Bohlman. 2013. "A Multimodal Approach for Postoperative Pain Management after Lumbar Decompression Surgery: A Prospective, Randomized Study." *Journal of Spinal Disorders and Techniques* 26 (6): 291–97. https://doi.org/10.1097/bsd.0b013e318246b0a6.

Garringer, Sean M., and Rick C. Sasso. 2010. "Safety of Anterior Cervical Discectomy and Fusion Performed as Outpatient Surgery." *Journal of Spinal Disorders & Techniques* 23 (7): 439–43. https://doi.org/10.1097/bsd.0b013e3181bd0419.

Guigui, Pierre, Michel Benoist, and Alain Deburge. 1998. "Spinal Deformity and Instability after Multilevel Cervical Laminectomy for Spondylotic Myelopathy." *Spine* 23 (4): 440–47. https://doi.org/10.1097/00007632-199802150-00006.

Hirabayashi, Kiyoshi, and Kazuhiko Satomi. 1988. "Operative Procedure and Results of Expansive Open-Door Laminoplasty." *Spine* 13 (7): 870–76. https://doi.org/10.1097/00007632-198807000-00032.

Hirabayashi, Kiyoshi, Kenichi Watanabe, Koichi Wakano, Nobumasa Suzuki, Kazuhiko Satomi, and Yoshiaki Ishii. 1983. "Expansive Open-Door Laminoplasty for Cervical Spinal Stenotic Myelopathy." *Spine* 8 (7): 693–99. https://doi.org/10.1097/00007632-198310000-00003.

Hosono, Noboru, Kazuo Yonenobu, and Keiro Ono. 1996. "Neck and Shoulder Pain After Laminoplasty." *Spine* 21 (17): 1969–73. https://doi.org/10.1097/00007632-199609010-00005.

Hukuda, S., M. Ogata, T. Mochizuki, and K. Shichikawa. 1988. "Laminectomy versus Laminoplasty for Cervical Myelopathy: Brief Report." *The Journal of Bone and Joint Surgery. British Volume* 70-B (2): 325–26. https://doi.org/10.1302/0301-620x.70b2.3346317.

John-Baptiste, A., L.J. Sowerby, C.J. Chin, J. Martin, and B.W. Rotenberg. 2016. "Comparing Surgical Trays with Redundant Instruments with Trays with Reduced Instruments: A Cost Analysis." *CMAJ Open* 4 (3): E404–8. https://doi.org/10.9778/cmajo.20150092.

Kato, Minori, Hiroaki Nakamura, Sadahiko Konishi, Sho Dohzono, Hiromitsu Toyoda, Wakaba Fukushima, Kyoko Kondo, and Hideki Matsuda. 2008. "Effect of Preserving Paraspinal Muscles on Postoperative Axial Pain in the Selective Cervical Laminoplasty." *Spine* 33 (14): E455–59. https://doi.org/10.1097/brs.0b013e318178e607.

Khanna, Ryan, Robert B. Kim, Sandi K. Lam, George R. Cybulski, Zachary A. Smith, and Nader S. Dahdaleh. 2018. "Comparing Short-Term Complications of Inpatient Versus Outpatient Single-Level Anterior Cervical Discectomy and Fusion." *Clinical Spine Surgery* 31 (1): 43–47. https://doi.org/10.1097/bsd.0000000000000499.

Kim, Ki-Tack, Sang-Hun Lee, Kyung-Soo Suk, and Sung-Chul Bae. 2006. "The Quantitative Analysis of Tissue Injury Markers after Mini-Open Lumbar Fusion." *Spine* 31 (6): 712–16. https://doi.org/10.1097/01.brs.0000202533.05906.ea.

Kim, Phyo, Hidetoshi Murata, Ryu Kurokawa, Yoshiyuki Takaishi, Keizo Asakuno, and Toshiki Kawamoto. 2007. "Myoarchitectonic Spinolaminoplasty: Efficacy in Reconstituting the Cervical Musculature and Preserving Biomechanical Function." *Journal of Neurosurgery: Spine* 7 (3): 293–304. https://doi.org/10.3171/spi-07/09/293.

Kobayashi, Kazuyoshi, Kei Ando, Fumihiko Kato, Tokumi Kanemura, Koji Sato, Yudo Hachiya, Yuji Matsubara, et al. 2019. "Predictors of Prolonged Length of Stay After Lumbar Interbody Fusion: A Multicenter Study." *Global Spine Journal* 9 (5): 466–72. https://doi.org/10.1177/2192568218800054.

Kotani, Yoshihisa, Kuniyoshi Abumi, Manabu Ito, Hideki Sudo, Masahiko Takahata, Shigeki Ohshima, Yoshihiro Hojo, and Akio Minami. 2009. "Minimum 2-Year Outcome of Cervical Laminoplasty with Deep Extensor Muscle-Preserving Approach: Impact on Cervical Spine Function and Quality of Life." *European Spine Journal* 18 (5): 663–71. https://doi.org/10.1007/s00586-009-0892-1.

Kubo, Shinichiro, Vijay K. Goel, Seok-Jo Yang, and Naoya Tajima. 2002. "The Biomechanical Effects of Multilevel Posterior Foraminotomy and Foraminotomy with Double-Door Laminoplasty." *Journal of Spinal Disorders & Techniques* 15 (6): 477–85. https://doi.org/10.1097/00024720-200212000-00008.

Kurokawa, T. 1982. "Enlargement of Spinal Canal by the Sagittal Splitting of the Spinous Process." *Bessatsu Seikeigeka* 2:234–40. https://ci.nii.ac.jp/naid/10018098404/.

Lied, B., P. A. Rønning, C. M. Halvorsen, K. Ekseth, and E. Helseth. 2013. "Outpatient Anterior Cervical Discectomy and Fusion for Cervical Disk Disease: A Prospective Consecutive Series of 96 Patients." *Acta Neurologica Scandinavica* 127 (1): 31–37. https://doi.org/10.1111/j.1600-0404.2012.01674.x.

Lin, Xiang, Jie Cai, Chuan Qin, Qinghua Yang, and Zengming Xiao. 2019. "Comparison of Clinical Outcomes and Safety between Laminectomy with Instrumented Fusion versus Laminoplasty for the Treatment of Multilevel Cervical Spondylotic Myelopathy." *Medicine* 98 (8): e14651. https://doi.org/10.1097/md.0000000000014651.

Manzano, Glen R., Gizelda Casella, Michael Y. Wang, Steven Vanni, and Allan D. Levi. 2012. "A Prospective, Randomized Trial Comparing Expansile Cervical Laminoplasty and Cervical Laminectomy and Fusion for Multilevel Cervical Myelopathy." *Neurosurgery* 70 (2): 264–77. https://doi.org/10.1227/neu.0b013e3182305669.

McGirt, Matthew J., Saniya S. Godil, Anthony L. Asher, Scott L. Parker, and Clinton J. Devin. 2015. "Quality Analysis of Anterior Cervical Discectomy and Fusion in the Outpatient versus Inpatient Setting: Analysis of 7288 Patients from the NSQIP Database." *Neurosurgical Focus* 39 (6): E9. https://doi.org/10.3171/2015.9.focus15335.

Mikawa, Yoshihiro, Jitsuhiko Shikata, and Takao Yamamuro. 1987. "Spinal Deformity and Instability after Multilevel Cervical Laminectomy." *Spine* 12 (1): 6–11. https://doi.org/10.1097/00007632-198701000-00002.

Minamide, Akihito, Munehito Yoshida, Andrew K. Simpson, Hiroshi Yamada, Hiroshi Hashizume, Yukihiro Nakagawa, Hiroshi Iwasaki, et al. 2017. "Microendoscopic Laminotomy versus Conventional Laminoplasty for Cervical Spondylotic Myelopathy: 5-Year Follow-up Study." *Journal of Neurosurgery: Spine* 27 (4): 403–9. https://doi.org/10.3171/2017.2.spine16939.

Mohandas, Anita, Chris Summa, W. Bradley Worthington, Jason Lerner, Kevin T. Foley, Robert J. Bohinski, Gregory B. Lanford, Carol Holden, and Richard N.W. Wohns. 2017. "Best Practices for Outpatient Anterior Cervical Surgery: Results From a Delphi Panel." *Spine* 42 (11): E648–59. https://doi.org/10.1097/brs.0000000000001925.

Purger, David A, A. Pendharkar, A.L. Ho, E.S. Sussman, L. Yang, M. Desai, A. Veeravagu, J.K. Ratliff, and A. Desai. 2019. "Outpatient vs Inpatient Anterior Cervical Discectomy and Fusion: A Population-Level Analysis of Outcomes and Cost." *Neurosurgery* 85 (2): 298.

Purger, David A, Arjun V Pendharkar, Allen L Ho, Eric S Sussman, Lingyao Yang, Manisha Desai, Anand Veeravagu, John K Ratliff, and Atman Desai. 2018. "Outpatient vs Inpatient Anterior Cervical Discectomy and Fusion: A Population-Level Analysis of Outcomes and Cost." *Neurosurgery* 82 (4): 454–64. https://doi.org/10.1093/neuros/nyx215.

Ratliff, John K., and Paul R. Cooper. 2003. "Cervical Laminoplasty: A Critical Review." *Journal of Neurosurgery: Spine* 98 (3 Suppl): 230–38. https://doi.org/10.3171/spi.2003.98.3.0230.

Santiago, Paul, and Richard G. Fessler. 2007. "Minimally Invasive Surgery for the Management of Cervical Spondylosis." *Neurosurgery* 60 (suppl 1): S1-160-S1-165. https://doi.org/10.1227/01.neu.0000215349.40925.88.

Sasai, K., T. Saito, S. Akagi, I. Kato, and R. Ogawa. 2000. "Cervical Curvature After Laminoplasty for Spondylotic Myelopathy-Involvement of Yellow Ligament, Semispinalis Cervicis Muscle, and Nuchal Ligament." *Clinical Spine Surgery* 13 (1): 26. https://journals.lww.com/jspinaldisorders/Fulltext/2000/02000/Cervical_Curvature_After_Laminoplasty_for.5.aspx.

Seichi, Atsushi, Katsushi Takeshita, Isao Ohishi, Hiroshi Kawaguchi, Toru Akune, Yorito Anamizu, Tomoaki Kitagawa, and and Kozo Nakamura. 2001. "Long-Term Results of Double-Door Laminoplasty for Cervical Stenotic Myelopathy." *Spine* 26 (5): 479–87. https://doi.org/10.1097/00007632-200103010-00010.

Sheperd, Courtney S, and William F Young. 2012. "Instrumented Outpatient Anterior Cervical Discectomy and Fusion: Is It Safe?" *International Surgery* 97 (1): 86–89. https://doi.org/10.9738/cc35.1.

Shiraishi, Tateru, Yoshiyuki Yato, Hiroshi Yoshida, Tomoyuki Abe, and Takeshi Ikegami. 2002. "New Double-Door Laminoplasty Procedures to Preserve the Muscular Attachments to the Spinous Processes Including the Axis." *European Journal of Orthopaedic Surgery & Traumatology* 12 (4): 175–80. https://doi.org/10.1007/s00590-002-0050-5.

Singh, Kern, Daniel D. Bohl, Junyoung Ahn, Dustin H. Massel, Benjamin C. Mayo, Ankur S. Narain, Fady Y. Hijji, et al. 2017. "Multimodal Analgesia Versus Intravenous Patient-Controlled Analgesia for Minimally Invasive Transforaminal Lumbar Interbody Fusion Procedures." *SPINE* 42 (15): 1145–50. https://doi.org/10.1097/brs.0000000000001992.

Sivaganesan, Ahilan, Brandon Hirsch, Frank M Phillips, and Matthew J McGirt. 2018. "Spine Surgery in the Ambulatory Surgery Center Setting: Value-Based Advancement or Safety Liability?" *Neurosurgery* 83 (2): 159–65. https://doi.org/10.1093/neuros/nyy057.

Song, John K., and Sean D. Christie. 2006. "Minimally Invasive Cervical Stenosis Decompression." *Neurosurgery Clinics of North America* 17 (4): 423–28. https://doi.org/10.1016/j.nec.2006.06.008.

Swegle, J.M., and C. Logemann. 2006. "Management of Common Opioid-Induced Adverse Effects." *Am Fam Physician* 74 (8): 1347–54. https://www.ncbi.nlm.nih.gov/pubmed/17087429.

Takebayashi, Tsuneo, Mitsunori Yoshimoto, Kazunori Ida, Hajime Tsuda, Yoshinori Terashima, and Toshihiko Yamashita. 2013. "Minimum Invasive Posterior Decompression for Cervical Spondylotic Amyotrophy." *Journal of Orthopaedic Science* 18 (2): 205–7. https://doi.org/10.1007/s00776-012-0330-9.

Takeuchi, Kazunari, Toru Yokoyama, Shuichi Aburakawa, Akira Saito, Takuya Numasawa, Tetsuya Iwasaki, Taito Itabashi, et al. 2005. "Axial Symptoms After Cervical Laminoplasty With C3 Laminectomy Compared With Conventional C3-C7 Laminoplasty." *Spine* 30 (22): 2544–49. https://doi.org/10.1097/01.brs.0000186332.66490.ba.

Walid, M. Sami, Joe S. III Robinson, Edward R.M. Robinson, Benjamin B. Brannick, Mohammed Ajjan, and Joe S. Robinson Jr. 2010. "Comparison of Outpatient and Inpatient Spine Surgery Patients with Regards to Obesity, Comorbidities and Readmission for Infection." *Journal of Clinical Neuroscience* 17 (12): 1497–98. https://doi.org/10.1016/j.jocn.2010.03.037.

Wang, Michael Y., Barth A. Green, Ernesto Coscarella, Mustafa K. Baskaya, Allan D.O. Levi, and James D. Guest. 2003. "Minimally Invasive Cervical Expansile Laminoplasty: An Initial Cadaveric Study." *Neurosurgery* 52 (2): 370–73. https://doi.org/10.1227/01.neu.0000043933.32287.ee.

Weinberg, Douglas S., and John M. Rhee. 2020. "Cervical Laminoplasty: Indication, Technique, Complications." *Journal of Spine Surgery* 6 (1): 290–301. https://doi.org/10.21037/jss.2020.01.05.

Yeh, Kuang-Ting, Ing-Ho Chen, Tzai-Chiu Yu, Kuan-Lin Liu, Cheng-Huan Peng, Jen-Hung Wang, Ru-Ping Lee, and Wen-Tien Wu. 2015. "Modified Expansive Open-Door Laminoplasty Technique Improved Postoperative Neck Pain and Cervical Range of Motion." *Journal of the Formosan Medical Association* 114 (12): 1225–32. https://doi.org/10.1016/j.jfma.2014.10.005.

Yen, David, and Abdu Albargi. 2017. "Results and Limitations of Outpatient and Overnight Stay Laminectomies for Lumbar Spinal Stenosis." *Canadian Journal of Surgery* 60 (5): 329–34. https://doi.org/10.1503/cjs.002017.

Yuan, Xiaojun, Chunmei Wei, Wenhua Xu, Xinrong Gan, Shengsheng Cao, and Jiaquan Luo. 2019. "Comparison of Laminectomy and Fusion vs Laminoplasty in the Treatment of Multilevel Cervical Spondylotic Myelopathy: A Meta-Analysis." *Medicine* 98 (13): e14971. https://doi.org/10.1097/md.0000000000014971.