Cervical Laminoplasty

Essay submitted for partial fulfillment
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ADL	Activity of Daily Living
CM	Cervical Myelopathy
CT	Computed Tomography
DM	Diabetes Mellitus
DR	Dorsal Rami
DRG	Dorsal Root Ganglion
JOA	Japanese Orthopaedics Association
LB	Lateral Branch
LgCa	Longissimus Capitis
MB	Medial Branch
MMT	Manual Muscle Testing
MRI	Magnetic Resonance Imaging
OPLL	Ossification of Posterior Longitudinal Ligament
ROM	Range Of Motion
SpCa	Splenius Capitis
SpCe	Splenius Cervicis
SSCa	Semispinalis Capitis
SSCe	Semispinalis Cervicis
VR	Ventral Rami

Cervical laminectomy has long been the treatment for multilevel cervical spondylosis. It permits adequate decompression of the cervical spinal cord and is safe and easily performed. Potential adverse outcomes after cervical laminectomy include instability and epidural scar formation. It has been hypothesized that this scar may be responsible for persistent postoperative cervical and head pain after surgery and even neurological deterioration. Fear of instability has resulted in many surgeons performing a simultaneous fusion at the time of laminectomy. This potentially adds morbidity to the procedure, there may be nonunion or construct failure, and it reduces motion in the cervical spine.[1]

Laminoplasty was developed to widen the spinal canal dimensions without permanently removing the dorsal elements of the cervical spine. The retained dorsal elements should aid in the prevention of muscle scarring to the dura (ie. result in less cervical and head pain after surgery) and potentially reduce the incidence of postoperative instability. Cervical motion is theoretically preserved.[1]

Laminoplasty is a unique technique that combines motion sparing with thorough spinal cord decompression. With proper indications and diligent surgical techniques, one can expect predictably good outcomes and patient satisfaction[2]

Indications for laminoplasty include multilevel cervical spondylosis and ossification of posterior longitudinal ligament (OPLL) especially those associated with myelopathy. It may also be used for certain varieties of spinal cord tumors. The procedure is generally contraindicated in kyphotic cervical pathology. It is possible to perform laminoplasty in a straightened spine, but a lordotic posture is preferred.[1]

Laminoplasty can be divided into three basic techniques defined by where the hinge and opening of the lamina are developed. These techniques include the single open door, the French door or midline and the Z-plasty.[3]

In the open-door laminoplasty, one side of the lamina/spinous process/ligamentum flavum complex is hinged open. The other procedures involve creating a midline opening with the left and right hemi-laminae hinging on both sides.[

Cervical laminoplasty was developed in Japan in early 1970s to resolve postoperative problems after conventional laminectomy for instability and deformity which caused a recurrence of myelopathy; there have since been many modifications. The aim of laminoplasty is to expand the spinal canal, to preserve the posterior structure of the cervical spine, and to assure stability and to prevent the formation of postlaminectomy membrane.[5]

Laminectomy of the cervical spine

Posterior approaches for removal of agents compressing the spinal cord were reported between the sixteenth and eighteenth centuries, and laminectomy for intraspinal tumors was first performed in the nineteenth century.[6] In the early twentieth century, cervical spondylosis began to be recognized as a cause of cervical myelopathy. Cervical spondylosis as a cause of cord compression was first understood by Mixter and Barr, 1934[7]. In 1956, Clarke and Robinson[8] advocated the cervical spondylotic myelopathy be defined as a distinct clinical entity. Studies on the pathophysiology of cervical spondylotic myelopathy continued,[9] but it was not until the late 1950s that operative techniques through the posterior approach were described for the treatment of cervical spondylosis, The report by Yuhl et al., 1955[10] on 32 cases of cervical spondylotic myelopathy treated with wide laminectomy and a section of the dentate ligament with the removal of any accessible anterior bony spurs showed this was very unsatisfactory. Clarke and Robinson, 1956[8] described four types for laminectomy; laminectomy alone, laminectomy with opening of the dura for inspection and subsequent closure, laminectomy with a section of dentate ligaments, and laminectomy with the removal of disc material. None of them showed satisfactory results.

Anterior cervical surgery

An anterior approach to the cervical spine was described by Smith and Robinson,1955,1958[14,15] They stated that the anterior procedure had less morbidity than laminectomy combined with foraminal decompression posteriorly, and allowed safer removal of a degenerated disc without disturbing the spinal cord. In the United States and Europe, technical advances in the anterior cervical spine surgery continued.

Cloward,1958[16] used drill and dowel interposition grafting. As the surgical results of anterior surgery for cervical spondylosis improved,[17,18] the anterior procedure was adopted as the first option, while the posterior by laminectomy was viewed as having a risk of instability, an inability to prevent progression of the condition. A multiple-segment anterior fusion technique, as described by Baily and Badgley,1960[20] has also been used successfully. When the cervical spine is kyphotic, the best surgical option has been believed to be the anterior approach.[21] When combined with halo vests, even four level cervical corpectomy has been possible. A system employing several kinds of locking plate has been used to prevent graft dislodgement. A freeze-dried allograft has been used to achieve anterior fusion. One stage of cervical anterior decompression and posterior stabilization has become another option. However the problems associated with multiple-level anterior fusion still include not only graft dislodgement and pseudoarthrosis, but also accelerated degenerative changes above and below the fusion.[22]

Development of laminoplasty

In contrast to the development of anterior cervical surgery in the United States and Europe, the posterior procedure advanced in Japan with the development of high-speed drill. The main causes of cervical myelopathy in Japanese patients have been multilevel spinal cord compression due to multilevel spondylosis with developmental spinal canal stenosis, or multilevel ossification of the posterior longitudinal ligament (OPLL). These conditions have caused Japanese spinal surgeons to choose a posterior procedure as a treatment option. Kirita and co-workers [23] have used simultaneous decompressive laminectomy since 1968, and their results showed dramatic improvements compared with the previously reported results of laminectomy. The decompressive procedure has become safer with the use of an air-drill rather than a rongeur. However, several authors reported that extensive laminectomy sometimes caused postoperative instability, including swan neck deformity.[24-29] How to preserve structural mechanics of the posterior cervical spine has also been a problem.

Extensive Z-laminoplasty, which was the first type of laminoplasty, was developed by Hattori in 1971.[30] The aim of this procedure was to

prevent postoperative invasion of the laminectomy membrane, which was believed to be one factor causing the late deterioration following surgery. In this method, the spinous processes are excised and the laminae are thinned using an air drill. After making a Z-shaped incision of the laminae, the spinal canal is enlarged, while bony protection of the spinal cord is retained. this technique has been employed mainly in Yamaguchi University, Yamaguchi, Japan, but has not become popular because of its technical complexity. Hirabayashi et al.[31] devised the simpler technique of expansive open-door laminoplasty of the unilateral hinge type in 1977. The mid- and long-term results are reliable from the standpoint of neurological maintenance, preventing postoperative kyphotic deformity, and preventing the progression of OPLL.[32-34] In the 1980s, preliminary reports of certain types of cervical laminoplasty appeared and the results were generally judged to be satisfactory. Itoh and Tsuji,1985[35] added a further refinement to Hirabayashi's method for stabilizing lifted lamina using a bone block, which was called "en bloc laminoplasty". Kurokawa et al.[36] developed double-door laminoplasty (spinous-process-splitting laminectomy) in 1980. In their original procedure, small bone blocks from the posterior iliac crest were grafted to keep the split spinous process separated.[1] Except for Hattori's Z-shaped laminoplasty, laminoplasty of the cervical spine falls into two categories according to the design of osteotomy: the unilateral hinge-type method such as Hirabayashi's, and the bilateral hinge type method such as Kurokawa's. Variations of the unilateral hinge-type method include Itoh's method (en bloc laminoplasty), the Yamagata University method, and the Chiba university method Matsuzaki et al.,1982[37] added unilateral fusion to Hirabayashi's method. Variations of the bilateral hinge-type method of laminoplasty include the techniques of Iwasaki and Yabuki. Iwasaki et al.,1982[38] reported the results of open-door laminoplasty, with removal of spinous processes and thinning down of the lamina in 1982. In 1982, Yabuki began double-door laminoplasty using spinous processes as bone blocks. [5]

Recently in procedures using iliac crest bone blocks such as Kurowaka's method, an artificial spacer has often been used rather than an autograft in order to decrease the operation time and to avoid postoperative pain around the donor graft site. [39-41] Frank and Keenen,1994[42p] and O'Brien et al.,1996[43p] used titanium plates to secure the posterior elements. Wang et al.[29] in 1998 presented a modification of

Hirabayashi's technique using anchor systems to stabilize the posterior elements in the open position without using spacers.

As cervical laminoplasty has become popular in Japan, Japanese spinal surgeons have shown on interest not only in osseous reconstruction, but also in reconstruction of soft tissue, The reattachment of the errector spinae muscles to C2 and preservation of the continuity of the nuchal ligament have been recognized as important in preventing flexion deformity.[5,44,45] Various modifications of laminoplasty to preserve the posterior element as far as possible, also have been reported,[46,47] However, it is not yet clear to what degree stability is improved and motion of the cervical spine is preserved with the preservation and reconstruction of the posterior soft tissues.

Some authors have reported a reduction in the range of motion (ROM) as a disadvantage after laminoplasty,[48,49] and postoperative maintenance of ROM of the neck remains a problem. Early mobilization of the neck has recently been recommended in order to avoid postoperative stiffness,[46,48] On the other hand, some workers are of the opinion that this reduction of ROM may be beneficial in maintaining neurological improvements and may suppress the growth of of OPLL.[33, 30,49]

The reliable long-term results of laminoplasty have recently caused spinal surgeons to discuss an extension of surgical indication for cervical stenotic myelopathy. Are patients with a very mild disability due to cervical stenosis candidates for laminoplasty instead of conservative treatment? Is laminoplasty a better treatment option for elderly people than laminectomy in spite of the longer operative time? These questions must be addressed and decision made in the near future.

Laminoplasty Versus Laminectomy:

The results of cervical laminectomy were poor in the early period, and several authors reported spinal deformity, instability, and the formation of haematoma in the dead space following surgery.[24-25,28,50-53] However, there is still a general opinion that cervical laminectomy is one of the viable options for multilevel spondylosis and OPLL, especially for aged patients when the anterior approach is not favorable, because the high-

speed air drill has made this procedure safer and the technique is now simple.[54,55] There are also several reports about attempts to prevent postlaminectomy instability by posterior fusion with or without instrumentation, instead of laminoplasty.[28,56] Posterior instrumentation surgery includes correction of malalignment of the cervical spine. With regard to postoperative instability after laminectomy, there are reports that cervical laminectomy in which the facets are not disturbed can be well tolerated,[57,58] and the deformity occurs more frequently in children than in adults.[51,59-61] Raynor et al.,1985[57] in biomechanical studies of cervical segments in human cadavers, demonstrated that shear strength is not compromised until more tan 50% of the facets have been removed bilaterally. Some surgeons insist that postoperative instability after laminectomy does not occur unless the facet joints are sacrificed.[50,58,62]

There is no prospective control study to confirm the superiority of laminoplasty over laminectomy, and such claims thus remain controversial. However, the long-term results of laminoplasty are stable from the point of view of neurological recovery and prevention of deformity.[32,48] Moreover, the technique of laminoplasty is safer and simpler than inexperienced spinal surgeons often imagine, and the risk of intraoperative bleeding is minimal because the surgeon need not enter the posterolateral epidural space in which the rich venous plexus exists. Therefore, most spinal surgeons who are familiar with laminoplasty have abandoned the use of laminectomy.[5]

Laminoplasty Versus Anterior Decompression

The controversy over laminoplasty versus subtotal corpectomy for multiple cervical spondylosis remains unresolved.[21,63,64] Laminoplasty is frequently chosen as a surgical option for Japanese patients because their cervical canal is generally narrower than that of American and European individuals, and multi-segmental OPLL is a common cause of cervical myelopathy. In contrast to the situation in Japan, the predominant pathology of cervical myelopathy has been believed to be anterior in Europe and the United States, and anterior decompression and stabilization has been viewed as radical treatment for cervical spondylotic myelopathy because anterior surgery removes the anterior spinal compression and does not allow motion at the pathological segments. laminoplasty is seen as having an indirect decompression effect resulting