New double-door laminoplasty procedure for the axis to preserve all muscular attachments to the spinous process

Technical note

TATERU SHIRAISHI, M.D., PH.D., AND YOSHIYUKI YATO, M.D., PH.D.

Department of Orthopaedic Surgery, Saiseikai-Utsunomiya Hospital, Tochigi, Japan

To prevent the occurrence of postoperative cervical malalignment, which is often a complication of conventional axial laminectomy or laminoplasty, the authors developed a new double-door laminoplasty procedure in which the C-2 spinal canal is expanded while all the muscular attachments to each split half of the spinous process remain undisturbed. In conjunction with laminoplasties at other levels, this procedure was performed in five patients with ossification of the posterior longitudinal ligament and cervical myelopathy. Neurological improvement was demonstrated in each patient, and there was no radiological evidence of cervical malalignment. The technique for this procedure is described and its usefulness in preventing postoperative spinal malalignment is discussed.

KEY WORDS • minimally invasive surgery • double-door laminoplasty • axis • cervical spine • spinal deformity

In conventional laminectomy or laminoplasty, the extensor musculature is invariably removed from the C-2 spinous process when the axis lies within the levels intended for decompression. We developed a new procedure of double-door laminoplasty for the axis, which leaves undisturbed all five muscular attachments to each split half of the spinous process. The purpose of this paper is to describe the surgical technique for this procedure and to discuss its usefulness in preventing postoperative cervical malalignment.

CLINICAL MATERIAL AND METHODS

Patient Population

Five patients with ossification of the posterior longitudinal ligament and cervical myelopathy were candidates for the following surgical procedure.

Surgical Technique

After making a midline skin incision that commences at the base of the skull, the funicular portion of the nuchal ligament is divided in line with the skin incision. The interval between the right and left interspinous muscles at C2–3 is spread using a fine nerve retractor to expose the ligamentum flavum and the upper central portion of the C-3 lamina. The loose connective tissue between the right and left rectus capitis posterior major muscles is then bluntly divided to expose the posterior atlantoaxial membrane at C1–2. Following the exposure of the epidural space by resection of the atlantoaxial membrane, the ligamentum flavum between C-2 and C-3, and, if necessary the upper central portion of the C-3 lamina, a surgical thread wire is passed along a guide beneath the C-2 lamina from the C2–3 interlaminar space (Fig. 1 upper). The C-2 posterior arch is then split in the midline by using oscillating the wire. To expose the junction between the lamina and facet joint of the axis, where a lateral gutter is to be made, the interval between the obliquus capitis inferior muscle and the semispinalis cervicis muscle is spread using the nerve retractors. Using a high-speed drill with a 3-mm diamond-tipped burr lateral gutters are made on the C-2 lamina (Fig. 1 lower), after which the split halves of the C-2 posterior arch are opened out like French windows while the muscular attachments to each half of the split spinous process remain undisturbed (Fig. 2, video clip). A hydroxyapatite spacer is inserted between the split halves of the spinous process to secure the expansion (Fig. 3).

Video Clip. Intraoperative video clip showing the surgical stage after splitting the C-2 posterior arch in the midline by oscillating a surgical thread wire, where the junction between the right lamina and facet joint of the axis is exposed by carefully using a fine nerve retractor to spread the interval between the obliquus capitis inferior muscle and the semispinalis cervicis muscle. A right lateral gutter is made on the axis by using a high-speed drill, while the obliquus capitis inferior muscle is retracted upward and the semispinalis cervicis muscle downward. Note that the patient’s head is on the right-hand side.
RESULTS

Five patients with ossification of the posterior longitudinal ligament and cervical myelopathy underwent this procedure in combination with expansive cervical laminoplasties at other levels.

Neurological improvement was demonstrated postoperatively in all the patients. The cervical curvature index according to the Ishihara method indicated no decrease postoperatively and, thus, an absence of cervical malalignment in all patients.

DISCUSSION

The axis plays a principal role in extending and stabilizing the head and neck. To serve this function, it has a large spinous process, which acts as a lever arm to which there are more extensor muscles attached than to the other cervical vertebrae.

At C-2, there are five muscles: 1) the rectus capitis posterior major muscle inserts into the inferior nuchal line and the occipital bone immediately below it; 2) the obliquus capitis inferior muscle inserts into the transverse process of the atlas; 3) the semispinalis cervicis muscle connects to the axis from the transverse processes of the upper thoracic vertebrae; 4) the multifidus muscle connects to the axis from the transverse process of the lower cervical vertebrae; and 5) the interspinalis muscle connects to the axis from the C-3 spinous process. When contracting bilaterally, each of these muscles extends the head and/or neck. Together, they act as a dynamic stabilizer for the cervical spine. Using a three-dimensional biomechanical model, Vasavada, et al., reported that of all the neck

Fig. 1. Upper: Illustration showing that after exposure of the epidural space by removing the atlantoaxial membrane and the ligamentum flavum between C-2 and C-3, a surgical thread wire is passed beneath the C-2 lamina from the C2–3 interlaminar space to split the C-2 posterior arch in the midline. Lower: Illustration showing a high-speed drill making the left lateral gutter on the C-2 lamina while the obliquus capitis inferior muscle is retracted upward and the semispinalis cervicis muscle downward.

Fig. 2. Intraoperative photograph demonstrating how the split halves of the C-2 posterior arch are opened out like French windows without disturbing the attachments of the rectus capitis posterior major muscle (M), the obliquus capitis inferior muscle (m), and the semispinalis cervicis muscle (S), which overlies the multifidus and interspinalis muscles. Note that the dura is exposed between the split halves of the C-2 spinous process (2). 1 = the C-1 posterior arch; 3 = the C-3 spinous process.

Fig. 3. Postoperative computerized tomography scan obtained at C-2, demonstrating that the axial double-door laminoplasty has been performed and that all muscular attachments to the spinous process remain undisturbed; a hydroxyapatite spacer is held in place to secure the expansion of the spinal canal.
muscles, the semispinalis generates the greatest strength for isometric neck extension. It is well recognized that the development of kyphosis and/or postoperative instability generally leads to a small degree of neural recovery and more residual neck pain. Several authors4,5,7,8 have emphasized the importance of reattaching the removed muscles to the C-2 spinous process as a means of preventing postoperative cervical malalignment.

This new procedure enables the C-2 spinal canal to be expanded without disturbing the muscular attachments to each split half of the spinous process. In this procedure, by opening out the posterior arch of C-2, the attachments of the semispinalis cervicis muscles to the axis are shifted laterally in the horizontal plane. The distance between their origins and insertions, however, is hardly shortened by this horizontal shift because the muscles have almost vertical orientations. Therefore, the muscular strength necessary for extending and stabilizing the head and neck is not appreciably weakened by this operation.

CONCLUSIONS

This new double-door laminoplasty procedure for the axis preserves the bilateral attachments of all five muscles to the C-2 spinous process. Therefore, it can reasonably be considered to be a useful alternative to conventional axial laminectomy or laminoplasty.

References


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Address reprint requests to: Tateru Shiraishi, M.D., Ph.D., Department of Orthopaedic Surgery, Saiseikai-Utsunomiya Hospital, 911-1, Takebayashi-Cho, Utsunomiya, Tochigi, 321-0974, Japan. email: tateru_shiraishi@saimiya.com.