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Clinical Study

‘‘Spring-back’’ closure associated with open-door cervical laminoplasty

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Abstract

BACKGROUND CONTEXT: Spring-back complication after open-door laminoplasty as described by Hirabayashi is a well-known risk, but its definition, incidence, and associated neurologic outcome remain unclear.

OBJECTIVE: To investigate the incidence and the neurologic consequence of spring-back closure after open-door laminoplasty.

STUDY DESIGN: A retrospective radiographic and clinical review.

OUTCOME MEASURES: Lateral cervical spine X-rays were evaluated. Anteroposterior diameters (APD) of the vertebral canal of C3–C7 were measured. Spring-back was defined as loss of APD on follow-up in comparison to immediate postoperative canal expansion. The loss of the end-on lamina silhouette with consequent reappearance of the lateral profile of the spinous processes was also assessed to verify the presence of spring-back. Spring-back closure was classified based on whether the collapse was total or partial, and whether all the operated levels or only a subset had collapsed (ie, complete vs. partial closure, segmental closure vs. total-construct closure). Neurologic status was documented using the Japanese Orthopaedic Association (JOA) score.

METHODS: Thirty consecutive patients who underwent open-door laminoplasty from 1995 to 2005 at a single institution with a minimum follow-up of 2 years were assessed. They were all operated on using the classic Hirabayashi technique. Radiographic outcomes were assessed independently by two individuals.

RESULTS: Sixteen men and 14 women with an average follow-up of 5 years (range, 2–12 years) were included. Of these patients, 24 had cervical spondylotic myelopathy and six had ossification of the posterior longitudinal ligament. Spring-back closure was found in three patients (10%) and 7 of 117 laminae (6%) within 6 months of the operation, which was further confirmed by computed tomography and magnetic resonance imaging. All spring-back closures were partial segmental closures. Gender and age were not significant factors related to spring back ($p>.05$). The mean JOA score on follow-up was 12.5, with a recovery rate of 40%. All patients with spring back and available JOA data exhibited postoperative neurologic deterioration. Of the three patients with spring back, two patients underwent revision surgery, whereas one declined.

CONCLUSIONS: Spring-back closure occurred in 10% of our patients at or before 6 months after surgery. The incidence of spring-back by level (ie, 117 laminae) was 6%, mainly occurring at the lower cervical spine. All spring-back closures were partial segmental closures, most commonly

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involving C5 and C6. Postoperative neurologic deficit was associated with spring-back closure; therefore, surgeons should adopt preemptive surgical measures to prevent the occurrence of such a complication.

Keywords: Laminoplasty; Spring-back; Closure; Complication; Outcome

Introduction

Cervical laminoplasty is an established procedure for treatment of cervical myelopathy [1–5]. Throughout the years, various laminoplasty techniques have been described. However, open-door laminoplasty, first described by Hirabayashi [6] in the 1970s, is commonly performed. The procedure allows widening of the spinal canal without permanently removing the dorsal cervical elements, thereby addressing the disadvantages of laminectomy (ie, spinal cord vulnerability, cervical kyphosis, etc). Although successful outcomes have been associated with this procedure, various postoperative complications may occur, such as axial neck pain, neck stiffness, nerve root palsy, loss of lordosis, and ''spring-back'' closure of the elevated lamina [3,7–11].

Collapse or spring-back of the open door, whereby the lamina closes back on the spinal cord, has been a salient concern. Such a complication would negate the benefit of the procedure, leading to immediate restenosis of the canal. Since the initial description of open-door laminoplasty, reports of spring-back closure emerged as the procedure was more widely adopted. Although there have been numerous reports on the long-term results of open-door laminoplasty [9,10,12–18], little is known of the actual definition, the detailed incidence, and the attendant neurologic outcomes associated with spring-back closure. As such, the following study proposes a definition of spring-back closure as well as addresses the incidence and clinical outcomes associated with spring-back complication based on a review of patients who underwent open-door laminoplasty at a single institution.

Materials and methods

Between January 1995 and December 2005, 30 consecutive patients who underwent open-door laminoplasty at the Duchess of Kent Children's Hospital, Hong Kong, were reviewed retrospectively. The diagnosis of cervical myelopathy was made based on clinical signs and symptoms, with corresponding levels of stenosis confirmed by magnetic resonance imaging of the cervical spine.

Surgical technique

The operative levels were dependent on the neurologic status and the radiological findings. The open-door laminoplasty technique described by Hirabayashi and Satomi [11] was used. Because the C3–C5 spinous processes were typically very short, they did not necessitate shortening or cutting, thereby preserving the supraspinous and interspinous ligaments. Normally, the tips of the C6 and/or C7 spinous processes were shortened because they were too long in comparison to the other spinous processes, and if not shortened, the posterior elements may be pushed back after wound closure. Both the hinge- and open-side gutters were created with a high-speed burr. The open-side gutter was completed with a Kerrison rongeur and the laminae elevated by gently pushing the spinous processes toward the hinge side. Stay sutures were inserted between the base of the spinous process and the facet joint capsule at each level. The neck was immobilized with a rigid collar for 3 weeks.

Radiographic assessment

Pre and postoperative lateral cervical spine X-rays were obtained for all patients. Standardization was achieved by ensuring 150-cm film-to-tube distance and centering on the C4 body. Radiographs were digitized and entered into a Digital Imaging and Communications in Medicine picture archiving and communication system. Visualization and measurements were taken using a Radworks 5.1 (Applicare Medical Imaging BV, Zeist, The Netherlands) system. Postoperative X-rays were taken on the day after the operation, and subsequently during outpatient follow-up. Follow-up was usually scheduled at 2 to 4 weeks after hospital discharge and at 3- to 6-month intervals thereafter in the first 2 years.

The anteroposterior diameter (APD) of the vertebral canal for each level was measured independently by two orthopedic spine surgeons. Preoperative APD was measured using Wolf's method (Fig. 1A) [19]. Postoperative APD was measured from the middle of the posterior border of the vertebral body to the anterior cortex of the elevated lamina (Fig. 1B), which is fully compatible with the preoperative APD measurement.

Spring-back complication was defined as loss of initial elevation of the lamina as determined on the postoperative follow-up radiographs. A classification scheme was proposed and illustrated in Table 1. In the lateral cervical X-ray, a closed lamina would also appear as substitution of the oval or teardrop silhouette of the elevated lamina by the shape of the remaining spinous process profile. Significant APD decrease was corroborated by the loss of the oval or teardrop silhouette on the lateral X-ray. Thus, for any patient with spring-back, there could be partial or complete closure (for any one level), whereas the involvement maybe segmental (only a subset of levels operated is/are affected) or total construct (all levels involved). Although there may be other combinations of spring-back, some levels are less likely