C2 lamina reconstruction using locking miniplate for the intradural tumor of the craniocervical junction (two case reports)

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Abstract

Objective To describe a technique for C2 lamina reconstruction using locking miniplates for the extirpation of spinal tumors in the craniocervical junction.

Summary of background data Many spinal surgery cases in which lamina reconstructions have been performed using non-locking miniplates have been reported. However, there is only one report of the use of locking miniplates for lamina reconstruction in spinal tumor cases.

Methods We performed C2 lamina reconstructions using locking miniplates in a patient with a spinal tumor and another with a cystic lesion. The clinical and radiologic features of both cases are reported, and the surgical technique is described.

Results A 62-year-old female and a 30-year-old male were diagnosed with meningioma and a neurenteric cyst, respectively, in the craniocervical junction. Extirpation of these lesions was performed in combination with C2 lamina reconstruction and reattachment of the paraspinal muscle to the C2 spinous process. A follow-up examination at 1 year postoperatively demonstrated no significant change in the sagittal alignment of the cervical spine and a good postoperative course in both cases. Bony fusion was detected in both cases, and no implant failure occurred in either case.

Conclusions This procedure results in rigid fixation of the reimplanted C2 lamina and helps to restore the paraspinal

muscles. For these reasons, it appears to be a useful surgical procedure for spinal tumors requiring C2 laminectomy and does not cause postoperative kyphosis of the cervical spine.

Keywords Lamina reconstruction · Locking miniplate · C2 · Spinal tumor

Introduction

The postoperative occurrence of cervical kyphosis after C2 laminectomy for extirpation of a spinal tumor in the upper cervical spine is well documented [1–7]. The lack of a C2 spinous process to anchor the paraspinal muscles, such as the semispinalis cervicis, rectus capitis posterior major, and obliquus capitis inferior muscles, after C2 laminectomy causes failure of the extensor mechanism of the cervical spine and can lead to postoperative changes in cervical alignment. For this reason, C2 lamina reconstruction is recommended to be performed as completely as possible in cases of spinal tumor extirpation from the craniocervical junction requiring C2 laminectomy. Although various procedures for lamina reconstruction of the cervical spine involving suture techniques or miniplates have been reported and demonstrated to be useful [8–12], to the best of our knowledge, there are no reports about lamina reconstruction procedures involving locking miniplates. We present two spinal tumor cases treated with C2 lamina reconstruction using locking miniplates and restoration of the C2 paraspinal muscle.

Surgical technique

This procedure is indicated for spinal tumors located in the spinal canal in which sufficient working space can be

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secured to excise the tumor using laminectomy alone without facetectomy. Under general anesthesia, the patient was placed in a prone position on the operating table and fixed in place using a 3-pin Mayfield head holder. A standard posterior midline approach for subperiosteal dissection of the paraspinal muscles was used to expose the spinal lamina of the craniocervical junction. The extent of the laminectomy was decided after referring to the preoperative Magnetic resonance imaging (MRI) and computed tomography (CT) myelography. After laminectomy had been performed at sites other than C2, a surgical threadwire saw was passed under the C2 lamina and used to cut along the lateral borders of the spinal canal and as wide as possible toward the lamina ends. The C2 lamina was then removed en-block from the operative field and stored in a saline-soaked gauze. During these steps, it is important to perform thorough irrigation to avoid thermal bone lesions and to handle the threadwire saw gently to avoid damage to the dura mater and nerve roots. After the completion of the intraspinal surgery, a C2 lamina block was prepared for reimplantation and placed in the desired position. Locking miniplates were then adjusted and bent to achieve optimal realignment of the C2 lamina cut ends. In the two cases described in this report, straight locking miniplates with four holes were used on the C2 bilateral lamina together with 2.0-mm screws of 6 or 8 mm in length. After making two holes in the C2 spinous process in the transverse direction, the C2 paraspinal muscles were sutured to the C2 spinous process using non-absorbable threads. Finally, the operative field was thoroughly irrigated, and a drainage tube was inserted into it. The muscle fascia was then sutured to the superficial part of the ligament. The rest of the wound closure procedure was performed in a regular manner. A soft collar was used for 4 weeks after the operation. No other external orthosis was used.

Case 1

A 69-year-old female with a 2-year history of neck pain was referred to our department due to an intradural tumor in the craniocervical junction. She had no neurological deficits. MRI showed an intradural extramedullary tumor located anterior to the spinal cord at the C1 level. The tumor displayed T1 isointensity and T2 isointensity to high intensity in relation to the spinal cord. It was clearly enhanced by Gd-DTPA and showed the “tumor tail sign” at the tumor edge. Therefore, the patient underwent tumor extirpation using the procedure described above. The tumor was found to be a meningioma by postoperative pathological examinations. At the 1-year follow-up, the patient had no symptoms. MRI showed no evidence of tumor recurrence, and the paraspinal muscle was in an almost

normal position and was the same size as it had been preoperatively. Plain roentgenography of the cervical spine showed satisfactory positioning of the lamina construct with normal alignment and no evidence of implant failure. CT of the reconstructed C2 lamina showed evidence of osseous fusion (Fig. 1).

Case 2

A 30-year-old male with a history of neck pain and left shoulder pain for the past few years was referred to our department due to an intradural cystic lesion in the craniocervical junction. He had no neurological deficits. MRI and CT myelography showed an intradural extramedullary cystic lesion located anterior to the spinal cord at the C2 to C3 level. Therefore, the patient underwent extirpation of the cystic lesion using the above-mentioned procedure. The cystic lesion was found to be a neurenteric cyst by postoperative pathological examinations. At the 1-year follow-up, the patient had no symptoms. MRI showed no evidence of recurrence, and the paraspinal muscle was in an almost normal position and was approximately the same size as before the operation. Plain roentgenography of the cervical spine showed satisfactory positioning of the construct with almost normal alignment and no evidence of implant failure. CT of the reconstructed C2 lamina showed evidence of osseous fusion (Fig. 2). The patient has since resumed his job.

Discussion

During functional reconstruction of the spine, it is important to reconstruct the posterior element of the cervical spine as anatomically accurately as possible after intraspinal surgery. In cases involving the extirpation of spinal tumors in the craniocervical junction using a posterior approach, it is usually necessary to remove the C2 lamina and detach the paraspinal muscle from the C2 lamina. Many reports have described the postoperative occurrence of kyphosis after C2 laminectomy [1–7]. The paraspinal muscles attached to the C2 spinous process are dynamic stabilizers of the cervical spine, and they are considered to be associated with postoperative kyphosis [13]. Katsumi et al. [7] reported that C2 laminectomy and the destruction of facet joints are risk factors for cervical kyphosis after spinal tumor extirpation. Inoue et al. [14] also reported that postoperative kyphosis in the upper cervical spine occurred much more frequently in patients who had undergone spinal tumor extirpation combined with C2 laminectomy. For these reasons, reconstruction of the C2 lamina and paraspinal muscle is considered to be important for the prevention of postoperative kyphosis of the cervical spine.

Fig. 1 MRI, an intraoperative photograph, a plain radiograph, and a CT scan from case 1, which involved the extirpation of a meningioma. **a** Preoperative gadolinium enhanced magnetic resonance images (MRI) showing an intradural extramedullary tumor that was clearly enhanced at the C1 level. **b** Intraoperative photograph showing the

operative field with the reimplanted C2 lamina. **c** Plain radiograph and **d** a CT scan demonstrating normal alignment of the cervical spine, and appropriate anatomical repositioning and good bony healing of the C2 lamina arch 1 year after surgery

Fig. 2 An MRI, a plain radiograph, and a CT scan from case 2, which involved extirpation of a neuroenteric cyst. **a** Preoperative T2-weighted MRI demonstrating an intradural extramedullary cystic lesion. **b** Plain radiograph, **c** a 3D CT scan, and **d** a CT scan

demonstrating normal alignment of the cervical spine, and appropriate anatomical repositioning and good bony healing of the C2 lamina arch 1 year after surgery

The restored lamina prevents the formation of scar tissue and the laminectomy membrane, which could cause canal stenosis around the dura mater. Even if tumor recurrence or regrowth occurs postoperatively, taking a posterior approach remains as safe and easy as during the first operation because the dura mater is covered by the restored lamina [15–17]. Furthermore, other authors feel that osteoplastic laminectomy prevents the musculoskeletal pain observed after laminectomy [18].

Using the threadwire saw for lamina osteotomy makes the preparation of the laminectomy block easier [19]. Reducing the width of the lamina excision line is the key to rigid and stable lamina reconstruction. In particular,

widening the lamina incision line toward the end of the lamina can be useful for preventing the reimplanted lamina from moving into the spinal canal, and moreover, this technique permits increased bony contact at the lamina excision line during the subsequent union.

There have been several reports about lamina reconstruction using suturing techniques or non-locking metal miniplates [8–12]. Lamina suturing is one of the most popular techniques, but we think that the stability of the reimplanted lamina is suboptimal and that movement of the osteotomy line is not completely prevented. The advantage of non-locking metal plates is that they achieve immediate stable fixation of the reimplanted lamina in all three

directions. However, if loosening of the plates and screws occurs, it is relatively easy for the screws to fall out and for stable fixation failure to occur. On the other hand, as the locking metal plate displays angular stability between the plate and screw, it is thought that the pullout strength between the screws and bone is much higher than that of non-locking plates [20, 21]. For these reasons, we used locking miniplates for C2 lamina reconstructions in expectation of achieving rigid fixation against due to the tensile strength of the C2 paraspinal muscle. The disadvantages of this method are the cost and the interference of the metal plates with postoperative neuroimaging studies. As the locking miniplates we used in this series were made of titanium, they caused few MRI artifacts, and a sufficient evaluation of tumor recurrence was possible by MRI. Purvines et al. recommended that CT is suitable for postoperative studies for evaluating bony fusion because it is not significantly affected by metal plates [8].

In summary, we experienced two spinal tumor cases that were treated with C2 lamina reconstruction using locking miniplates and restoration of the C2 paraspinal muscle. No changes were seen in cervical alignment in either case, and bony fusion and a good postoperative course were obtained in both cases. Although several lamina reconstruction procedures using miniplates have been reported, to the best of our knowledge, all of them have involved reconstruction of the lamina using non-locking miniplates, and we believe that this is the first report regarding reconstruction of the C2 lamina using locking miniplates.

Conflict of interest None of the authors has any potential conflict of interest.

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