Incarcerated herniation of the cervical spinal cord after laminectomy for an ossification of the yellow ligament

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Received: 3 June 2009 / Revised: 15 September 2009 / Accepted: 12 October 2009 / Published online: 25 November 2009
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Abstract A 74-year-old man showed a spastic gait and myelopathy in both the hands. Computed tomography revealed an OPLL on C3 and C4, bony spurs on the dorsal side of C4–C6, and an OYL on C3 and C4. We scheduled a two-stage decompression for both the OPLL and OYL. First, we performed laminectomy on the C3–C6 segments and resected the OYL. We did not observe any dural tear or CSF leakage in the dura. The patient's neurological symptoms improved. After the laminectomy, his myelopathy recurred. Postoperative MRI showed a spinal cord herniation. We had the C3/4 anterior cervical disectomy and fusion as we planned. In addition, we performed a surgery to repair the damaged dura mater at the site of spinal cord herniation at the same second surgery. The integrity of the arachnoid membrane was preserved. The patient's myelopathy gradually improved. There have been no reports on postoperative neurological deterioration caused by spinal cord herniation associated with a dural defect at the laminectomy site, without dural tear in the surgery after the resection of a posteriorly located cervical OYL. The possibility of a dural defect in OYL cases should be considered when planning a laminectomy for the resection of the OYL.

Keywords Spinal cord heriniation · OPLL · OYL

Introduction

Simultaneous surgical resection of an ossified posterior longitudinal ligament (OPLL) and an ossified yellow ligament (OYL) of the cervical spine may cause unexpected complications [1]. Various complications of such surgeries, including cerebrospinal fluid (CSF) leakage, C-5 nerve palsy, and spinal cord injury, have been reported [2]. Postoperative neurological deterioration is considered as one of the most serious and unexpected complication associated with the surgical resection of an OPLL and OYL. This complication might occur because the ossified mass tends to adhere to the underlying dura mater or completely replaces it [2–7].

Thus far, there have been no reports on fatal postoperative neurological deterioration possibly caused by massive spinal cord herniation associated with a dural defect at the laminectomy site after the resection of a posteriorly located cervical OYL. In this report, we describe the case of a patient who developed postoperative neurological deterioration and spinal cord herniation after laminectomy for the treatment of an OPLL and OYL of the cervical spinal cord.

Materials and methods

A 74-year-old man who gradually developed gait disturbance and neuropathic bladder was referred to our hospital. Neurological examinations revealed that he had a spastic gait, myelopathy in both the hands, and exaggerated deep tendon reflexes in his legs. Babinski's sign was present on the left side. The score for the severity of cervical spondylosis evaluated using the Japan Orthopaedic Association (JOA) scoring system was 10. Routine laboratory examinations yielded normal results. The patient was nondiabetic.

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Results

A cervical roentgenogram of the cervical spine cord showed an almost normal lordotic alignment. Computed tomography (CT) revealed an OPLL on C3 and C4, bony spurs on the dorsal side of C4–C6 (Fig. 1a), and an OYL on C3 and C4 (Fig. 1b). Magnetic resonance imaging (MRI) showed that the OPLL protruded posteriorly and markedly compressed the spinal cord. The spinal cord was severely compressed both dorsally and ventrally at the level of C3/C4 (Fig. 1c). T2-weighted images (T2WI) revealed high-intensity intramedullary signals at the level of C2/C3 and C5/C6 (Fig. 1d).

We scheduled a two-stage decompression for both the OPLL and OYL. First, we performed laminectomy on the C3–C6 segments and resected the OYL. We feared that

the resection of OYL might damage the dura matter, but noted no dural tear or CSF leakage after the surgery. The patient's neurological symptoms improved after the surgery. However, a month after the laminectomy, he experienced pain at the back of the neck and myelopathy recurred. Postoperative MRI showed a spherical protrusion of the spinal cord from the laminectomy site, dorsal to the cervical spinal canal (Fig. 2a). On the basis of these findings, spinal cord herniation was diagnosed.

We had the C3/4 anterior cervical disectomy and fusion as we planned. In addition, we performed a surgery to repair the damaged dura mater at the site of spinal cord herniation at same second surgery. During the second operation, we made an incision in the dura and placed the spinal cord back into the intradural space. No CSF leakage from the dural opening was noted, and the integrity of the

Fig. 1 **a** Computed tomography (CT) images in the sagittal plane revealed an ossified posterior longitudinal ligament (OPLL) on C3 to C4 and bony spurs on the dorsal side of C4–C6. **b** CT at the level of C3–C4 revealed an OPLL on the right side and an ossified yellow ligament (OYL) on the left side. **c** T2-weighted magnetic resonance imaging (MRI) revealed an OPLL that protruded posteriorly and markedly compressed the spinal cord. **d** T2-weighted MRI revealed high-intensity intramedullary signals at the levels of C2/C3 and C5/C6

Fig. 2 **a** Postoperative MRI showed a spherical protrusion of the spinal cord from the laminectomy site, dorsal to the cervical spinal canal. **b** During the surgery, incarcerated herniation of cervical spinal cord was noted, but there was no CSF leakage from the dural opening. The integrity of the arachnoid membrane was preserved

Fig. 3 After the second surgery, magnetic resonance imaging (MRI) revealed an improvement in the spinal cord herniation and canal stenosis. Slight high-intensity intramedullary signals were still observed on T2-weighted images

arachnoid membrane was preserved (Fig. 2b). After the second surgery, the patient's myelopathy gradually improved. Subsequent MRI revealed an improvement in the spinal cord herniation and canal stenosis. T2WI showed only slight high-intensity intramedullary signals (Fig. 3).

Discussion

Previous studies have reported various complications associated with the surgical resection of an OYL. The most common complication of OYL resection is a dural tear that causes CSF leakage [2, 6, 8]. This is because the OYL tends to adhere to the underlying dura, or in some adverse situations, the dura is completely replaced by the ossified mass [3, 4, 6, 9]. This can increase the risk of damage to the spinal cord or nerve root [6, 7]. Although only a few studies have reported spinal cord damage in OYL resection cases, surgical insult is generally considered the main cause of this damage. However, spinal cord damage induced by cord herniation has rarely been reported.

Spinal cord herniation is a rare but reversible cause of spinal cord dysfunction. In a retrospective study, Kumar et al. [10] reported 13 cases of spinal cord herniation confirmed during surgery. Of these cases, six showed herniation of the cord into a pseudomeningocele; the pseudomeningocele was iatrogenic in five and traumatic in one. In the remaining seven cases, spontaneous herniation with incarceration was noted.

In the five iatrogenic cases, a part of the spinal cord (1–2 cm in diameter) had herniated dorsally through the dura into a cervical pseudomeningocele, and remained adherent to the dura at the neck of the hernia. Lysis of the adhesions resulted in the intradural repositioning of the spinal cord, leading to neurological recovery.

Normally, the spinal cord is not situated centrally in the dural sleeve: the cervical spine is located more dorsally and the thoracic spine, more ventrally. The cord also shows mobility: during flexion, it moves in the craniocaudal direction and during extension, it moves in the anteroposterior direction, as has been revealed by cine MR imaging studies. Pulse-synchronous sagittal displacement of the spinal cord has been observed on transesophageal ultrasonographic images of the spinal canal captured via the acoustic window of an intervertebral disc [11]. The spinal cord shows maximum mobility in the areas with the most severe pathology [12].

Kumar et al. postulated that the following conditions cause herniation of the spinal cord through the dura: (1) a dural defect leading to the formation of an extradural arachnoid cyst (congenital) or pseudomeningocele (iatrogenic) and (2) the defect located on the concave surface of the spinal curvature (dorsally in the cervical spine and

ventrally or ventrolaterally in the thoracic spine) [10]. Herniation of the spinal cord is a rare event because it requires the simultaneous presence of both these phenomena. This means that after laminectomy, a dural defect may appear on the dorsal surface of the cervical spine and on the concave side of the spinal curvature.

The spinal cord presses against the dural defect and over time, develops adhesions at the origin of the dural defect. In the absence of a communication block between the spinal subarachnoid space and the extradural cyst, the CSF easily enters and leaves the cyst with each cardiac pulsation. When this opening is completely or partially blocked by the spinal cord, the CSF pulsations push the spinal cord further into the preexisting cyst, causing herniation of the spinal cord. The dynamic anteroposterior movement of the spinal cord and the flow of CSF in and out of the dural defect with each cardiac pulsation and respiratory movement have been observed intraoperatively [13].

In our case, we did not observe any dural tear or CSF leakage in the dura after the laminectomy for resection of the OYL, but we speculate that there could have been a latent dural tear that exacerbated the preexisting pseudomeningocele. In conclusion, spinal cord herniation may develop as a complication of laminectomy performed for the resection of an OYL, and surgeons should be alert of this possibility.

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

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