CASE REPORT

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Postoperative iatrogenic spinal cord herniation: three case reports with a literature review

Hiroaki Nakashima[1,2], Yoshimoto Ishikawa[1,2], Fumihiko Kato[3], Tokumi Kanemura[2], Ryuichi Shinjo[4], Kei Ando[1], Kazuyoshi Kobayashi[1], Naoki Ishiguro[1], and Shiro Imagama[1]

[1]*Department of Orthopedic Surgery, Nagoya University Graduate School of Medicine, Nagoya, Japan*
[2]*Department of Spine & Orthopedic Surgery, Konan Kosei Hospital, Konan, Japan*
[3]*Department of Orthopedic Surgery, Chubu Rosai Hospital, Nagoya, Japan*
[4]*Department of Spine & Orthopedic Surgery, Anjo Kosei Hospital, Anjo, Japan*

ABSTRACT

Although a majority of spinal cord herniation reportedly occurs idiopathically, postoperative iatrogenic spinal cord herniation is rare. Therefore, the incidence rate, pathogenic mechanism, and clinical outcomes are not clear. We present three cases of postoperative iatrogenic spinal cord herniation and present a literature review. Our data base included 32253 patients who underwent spinal surgery, and among these patients, 3 showed postoperative spinal cord herniation. Postoperative spinal cord herniation was observed in a 55-year-old man and a 60-year-old man. Both these patients underwent cervical laminoplasty for degenerative cervical myelopathy; however, intraoperative dural tear was reported. They presented with severe quadriplegia and sensory disorders at 8 years and 2 months after initial surgery. The third case of postoperative spinal cord herniation was of a 47-year-old woman who underwent Th11/12 schwannoma resection. Her neurological symptoms did not improve after tumor resection, and MRI at 2 months after surgery revealed spinal cord herniation. All the 3 patients underwent spinal cord reduction surgery; one patient showed sufficient neurological improvement while 2 patients with cervical spinal cord herniation showed limited neurological improvement due to preoperative severe quadriplegia. Although postoperative iatrogenic spinal cord herniation is a relatively rare pathology, careful observation with postoperative MRI is required in cases of patients with new neurological symptoms after dural injury and durotomy.

Keywords: iatrogenic spinal cord herniation, myelopathy, postoperative complication, spinal cord herniation

INTRODUCTION

Postoperative spinal cord herniation was first reported by Cobb et al. in 1974.[1] Spinal cord herniation occurs idiopathically or is due to defective or weakened dura mater resulting from iatrogenic or traumatic lesions.[2-6] Although there have been many reports of idiopathic cases, there are few reports of postoperative iatrogenic spinal cord herniation.[1,2,7-14] Therefore, the incidence

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Corresponding Author: Shiro Imagama, MD, PhD
Department of Orthopedic Surgery, Nagoya University Graduate School of Medicine,
65 Tsurumai-cho, Showa-ku, Nagoya 466-8550, Japan
Tel: +81-52-741-2111, Fax: +81-52-744-2260, E-mail: imagama@med.nagoya-u.ac.jp

rate, pathogenic mechanism, and clinical outcome of postoperative iatrogenic spinal cord herniation are not clear. We describe three cases of postoperative iatrogenic spinal cord herniation that were obtained from the Nagoya Spine Group (NSG) records of 32,253 patients over 12 years and review this serious postoperative complication.

CASE REPORTS

Case 1

A 55-year-old man who had undergone cervical laminoplasty 8 years previously at another hospital presented to our hospital with sudden neurological, motor, and sensory deficits in the extremities. He had gait disturbance due to paralysis (muscle manual testing, 2–4/5) of his lower limbs as well as bladder and rectal disturbance. His medical history included an accidental, small-sized dural tear that had occurred during surgery 8 years previously, which had not been treated. His Japanese Orthopedic Association (JOA) [15] score was 3/17.

Preoperative magnetic resonance imaging (MRI) of the cervical spine showed posterior movement of the spinal cord and dilation of the ventral subarachnoid space on a sagittal image, with a hyperintense area on T2-weighted images at C4/5 (Fig. 1A). In addition, an axial plane image showed dorsal deviations of the spinal cord through the dura mater at C4–5 (Fig. 1A).

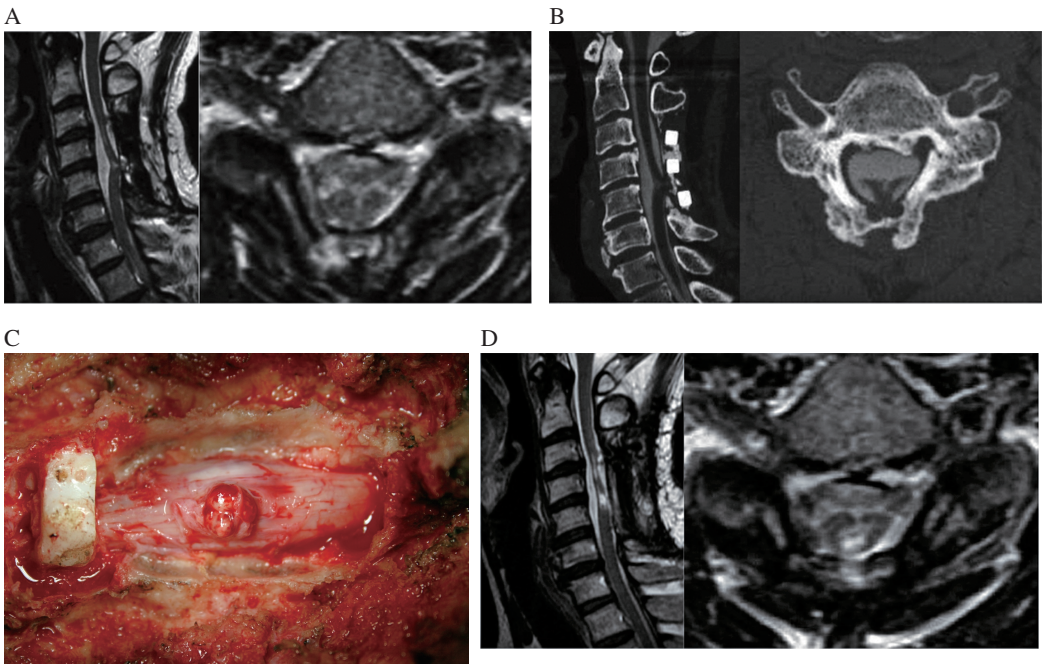

Fig. 1 Case 1

T2-weighted magnetic resonance imaging (MRI) scans (A) showing posterior movement of the spinal cord and dilation of the ventral subarachnoid space in the sagittal plane, with a hyperintense area on the T2-weighted image (C4/5). Computed tomography (CT)-myelogram (B) showed bony defects around the spinal cord herniation. Intraoperative findings (C) showed that the spinal cord was displaced dorsally and was herniated through the dorsal dura mater under the lamina at C4/5. MRI (D) 1 year after surgery showed a high-signal-intensity area in the dorsal part of the spinal cord, but there was no spinal cord herniation.

Computed tomography (CT)-myelography showed the same image findings as those observed on MRI, with bony defects around the spinal cord herniation (Fig. 1B). We made a diagnosis of postoperative iatrogenic spinal cord herniation 8 years after dural tear during cervical spine surgery, and reduction of herniation surgery was performed. The intraoperative findings after removal of the lamina and the lamina spacer showed that the spinal cord was displaced dorsally and was herniated through the dorsal dura mater; it was observed under the lamina at C4–5 (Fig. 1C). We established a diagnosis of spinal cord herniation and repositioned the herniated spinal cord into the interdural space after making an additional 2-mm incision caudally and cranially.

Four months after the operation, the patient could walk stably by using a stick. His 1-year postoperative JOA score was 5/17, and MRI showed a high-signal-intensity area in the dorsal part of the spinal cord, but there was no spinal cord herniation (Fig. 1D).

Case 2

A 60-year-old man underwent cervical laminoplasty (C2–7) for myelopathy with gait disturbance due to ossification of the posterior longitudinal ligament. His medical history included infantile right-sided hemiparalysis due to poliomyelitis, and French-Door laminoplasty was

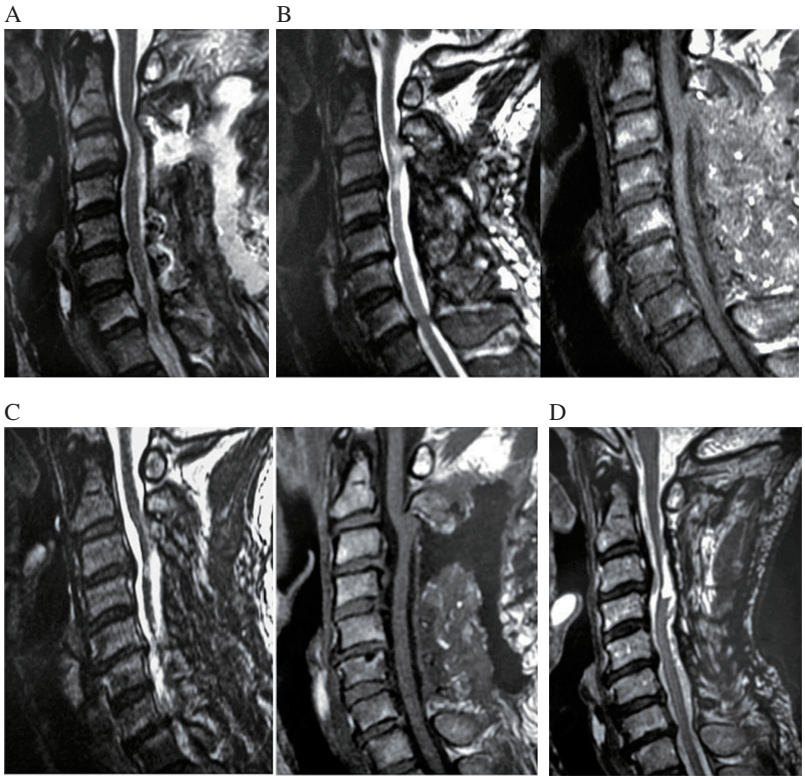

Fig. 2 Case 2
Magnetic resonance imaging (MRI) scans obtained immediately after primary surgery showed no presence of spinal cord herniation (A). However, MRI scans obtained 2 months after surgery (B) showed posterior movement of the spinal cord and presence of a high-signal-intensity area at C3 in the spinal cord on a T2-weighted image. MRI scans obtained 6 months after surgery (C) showed the prognosis of spinal herniation compared with previous images. MRI at 1 year after surgery showed a high-signal-intensity area in the dorsal part of the spinal cord (D).

performed.[15] A dural tear occurred when right side gutters were created as hinges at the border of the laminae and facets during surgery. The surgeons sprayed fibrin glue without direct suturing of the dural tear. After surgery, his preoperative right upper limb pain and numbness decreased (Fig. 2A). Cerebrospinal fluid leakage was identified on MRI. Two months after surgery, the patient complained of worsening lower leg numbness with gait disturbance. MRI performed at that time showed decompression of the spinal cord due to the laminoplasty and the presence of high signal intensity at the C3 level in the spinal cord on a T2 image (Fig. 2B). At that stage, iatrogenic spinal cord herniation was not be suspected, and therefore therapeutic intervention was not conducted. Six months after surgery, the patient complained of severe gait disturbance and upper arm motor weakness, as well as bladder dysfunction. MRI showed the presence of high signal intensity at the C3 level of the spinal cord and spinal cord herniation at C2–3 (Fig. 2C). Based on these findings, the patient was diagnosed with postoperative iatrogenic spinal cord herniation with a JOA score of 3/17, and he underwent additional surgery for the spinal cord herniation.

C2 and 3 laminectomy and duraplasty were performed. His 1-year postoperative JOA score was 3.5, and MRI 1 year after surgery showed a high-signal-intensity area in the dorsal part of the spinal cord, but there was no spinal cord herniation (Fig. 2D). He still had numbness of the limbs and motion dysfunction and showed Romberg sign positivity due to posterior funiculus damage.

Case 3

A 47-year-old woman underwent durotomy for resection of a spinal cord tumor (schwannoma) at Th11/12. The dura mater was closed by 6–0 polypropylene sutures. After the drain was removed on postoperative day 2, she experienced new left leg numbness on postoperative day 3. Her JOA score, excluding the upper limbs, was 10.5/11. On postoperative day 11, MRI showed no tumor, but cerebrospinal fluid leakage was identified on a T2-weighted image and a slight posterior shift of the spinal cord (Fig. 3A). However, we could not find spinal cord herniation initially, and she was discharged on postoperative day 14. Two months after surgery, the patient did not show any neurological improvement, and MRI showed a further posterior shift of the spinal cord (Fig. 3B). We made a diagnosis of postoperative spinal cord herniation. We

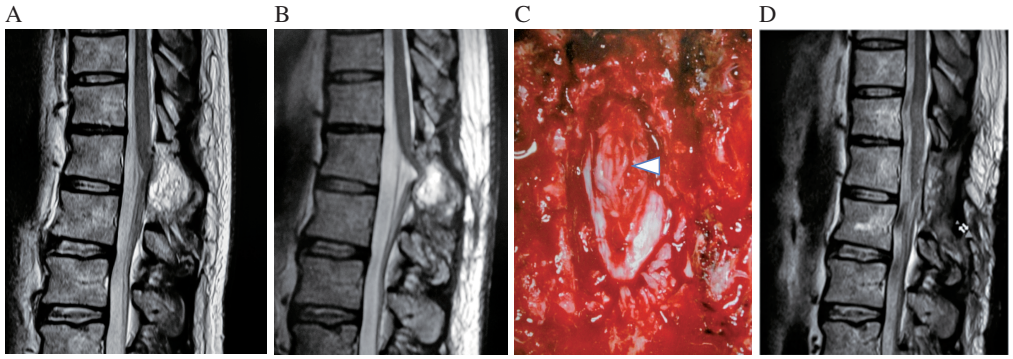

Fig. 3 Case 3
Magnetic resonance imaging (MRI) scans obtained immediately after primary surgery showed no tumor, but they showed high-signal-intensity and low-signal-intensity areas behind the spinal canal in the operative area (A). MRI obtained 2 months after primary surgery (B) showed posterior shift of the spinal cord. Intraoperative findings showed that the spinal cord was displaced dorsally through the dorsal dura mater (white arrow) (C). Postoperative MRI showed reduction of spinal cord herniation (D).

performed reduction surgery for the spinal cord herniation, and intraoperative findings showed that the deviated spinal cord was displaced dorsally and had herniated through the dorsal dura mater (Fig. 3C).

A confirmed diagnosis of spinal cord herniation was made. We repositioned the herniated spinal cord into the interdural space while resuturing the dura mater without using a patch or graft. Postoperative MRI showed resolution of the spinal cord herniation (Fig. 3D). One year after the second operation, her JOA score was 10.5/11, and she could walk normally. However, she continued to experience left leg numbness.

DISCUSSION

The number of reported cases of postoperative spinal cord herniation is limited; only nine cases of postoperative spinal cord herniation in the cervical spine and one case of postoperative spinal cord herniation at the thoracolumbar junction have been reported (Table1).[1,2,7-13,16] Therefore, many aspects of postoperative spinal cord herniation are still unknown. Our cases were retrieved from the NSG database in which 32,253 patients who underwent spinal surgery were registered. According to our results, the incidence rates of spinal cord herniation after cervical spine surgery

Table 1 Data of 10 cases of postoperative spinal cord herniation in the past literature

Author & year	Age (yrs), Sex	Level of herniation	Previous Surgery	Onset period after surgery	Symptoms	PMC	Operative result
Cobb et al. 1973	39, M	C5–6	Laminectomy	3 years	Motor and sensory dysfunction in both upper and lower limbs	+	Improvement
Hosono et al. 1995	45, M	C2–3	Laminectomy	14 years	Gait disturbance and clumsiness of the right fingers	+	Improvement
Abd et al. 2015	56, M	C2/3	Neurofibroma resection	5 years	Neck pain and progressive weakness of the right upper limb	+	Improvement
Belen et al. 2009	22, M	C1–2	FMD with C1 laminectomy for Chiari malformation	7 years	Worsened hand function in both upper extremities and gait disturbance	+	Improvement
Burres et al. 1978	41, M	C2	C3–6 posterior decompression	18 years	Motor and sensory dysfunction in left arm function	+	Improvement
Dunn et al. 1987	33, M	C1–2	C1–2 wire fixation for odontoid fracture	2 weeks	Numbness and weakness in the left hand and leg	+	Improvement
Iencean et al. 2014	51, M	C2/3	Ependymoma resection	5 years	Spastic tetraparesis with impossibility of in standing and walking	–	Improvement
Mizuno et al. 1986	55, M	C6–7	Laminectomy, C4–7	13 years	Gait disturbance	+	Improvement
Moriyama et al. 2013	51, M	C7	Spinal tumor resection	10 years	Gait disturbance and urinary incontinence	+	Improvement
Zakaria et al. 2013	57, M	Th12–L1	Intramedullary cyst resection	8 weeks	Gait disturbance, and numbness of both both lower legs numbness	–	Improvement

and after incision of dura mater were 0.02% (2/4477) and 0.01% (1/782), respectively.

As in previous reports (Table1)[1,2,7-13,16] and our three cases, dura injury or durotomy resulting in weakness of the dura mater was the cause of iatrogenic spinal cord herniation.[2,3] In previous reports of cervical iatrogenic spinal cord herniation, the causes of herniation were hypothesized as weakness of the dura mater, cervical lordosis, and physiological damage to the spinal cord that gradually resulted in extrusion of the cord into a pseudomeningocele through a defect of the dura mater.[2,13,17] Dural structure was not performed at all in cases 1 and 2. While it was performed in case 3, the primary dural suture was not sufficient, which led us to suspect that iatrogenic spinal cord herniation had occurred. To prevent this rare complication, sufficient dural suture (completely sealing the incision) is essential at the primary surgery stage. With the revision surgery, there is a high risk of neurological deficit or other surgical complications because the spinal cord has to be repositioned under severe adhesive conditions. For this reason, careful exposure of herniated spinal cord using a microscope is mandatory.

Previous reports showed neurological improvement after surgery for spinal cord herniation in the majority of cases (Table 1).[1,7-14,16] However, neurological improvement in JOA score for our cases 1 and 2 was limited. These patients needed a cane or walker to walk, and upper limb numbness and motion dysfunction did not improve well. In case 3, the preoperative symptoms were very severe, as the patient could not walk. Thus, severe preoperative symptoms do not resolve well, and early surgery is mandatory. Before spinal cord herniation was detected on MRI, the patients in cases 2 and 3 showed new neurological symptoms. Radiographic examination should be performed as early as possible after new symptoms in patients with dural injury and durotomy.

In cases 2 and 3, MRI after the primary surgery showed gradual projection of the herniation. However, these findings could not lead to a diagnosis of spinal cord herniation. Therefore, there was a delay in the postoperative diagnosis. Although the spinal cord shift was limited immediately after initial surgery, new neurological symptoms and signal intensity changes on MRI were found in both cases. Postoperative spinal cord herniation is very rare, but these radiographic findings should be considered as this diagnosis.

CONCLUSION

We report three cases of postoperative iatrogenic spinal cord herniation. Only a slight spinal cord shift was observed immediately after the initial surgery, and therefore careful postoperative observation with MRI is crucial. The outcomes of postoperative spinal cord herniation with severe preoperative symptoms were poor. Therefore, early second surgery for postoperative spinal cord herniation is mandatory.

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CONFLICT OF INTEREST

Tokumi Kanemura is a consultant of NUVASIVE, Medtronic and Baxter.

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