



# Disc herniation, occult on preoperative imaging but visualized microsurgically, as the cause of idiopathic thoracic spinal cord herniation

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## Abstract

Idiopathic spinal cord herniation (ISCH) through an anterior dural defect is rare and the cause is uncertain. Recently, through interpreting imaging studies, disc herniation was proposed to be a major cause for ISCH. We describe the case of a 50-year-old woman with progressive myelopathy who was diagnosed with a thoracic spinal cord herniation. Microsurgical exploration revealed an anterior vertical dural defect and a small concomitant disc herniation, occult on the preoperative imaging, which caused the dural defect and led to ISCH. This intraoperative finding corroborates the emerging notion that disc herniation is the underlying cause of ISCH.

**Keywords** Idiopathic spinal cord herniation · Disc protrusion · Dural erosion · Microsurgical exploration · Spontaneous intracranial hypotension

## Abbreviations

CSF Cerebrospinal fluid  
ISCH Idiopathic spinal cord herniation  
MRI Magnetic resonance imaging

## Introduction

Spinal cord herniation through a defect in the dura at the thoracic level is a rare condition. Since the initial description by Wortzman et al. [11] in 1974, the etiology has remained unclear and fewer than 200 cases have been reported in the literature to date [8]. Surgery is generally performed to achieve a better neurological outcome by releasing the spinal cord through the herniation and repairing the dural defect. Several mechanisms, including minor or unrecognized trauma, congenital meningeal malformations, cerebrospinal fluid

(CSF) flow pulsations, and dural erosion by calcified disc remnants, have been hypothesized as causes [3].

Our findings support the proposal that a herniated disc can cause erosion of the dura and lead to spinal cord herniation. We present a case in which only upon microsurgical exploration could the small disc herniation causing the vertical anterior dural defect be directly demonstrated.

## Case report

A 50-year-old female patient had suffered from progressive myelopathy with a Brown-Séquard-like syndrome for 1 year. The neurological examination revealed a spastic gait disturbance, with a minor monoparesis (M4) of the left leg and hip, increased reflexes of the lower left extremity, presence of left Babinski sign, and decreased sensations of pain, temperature, and touch sub-Th 6 on the right side. Bladder function was unimpaired (20 ml residual urine) according to the ultrasound examination.

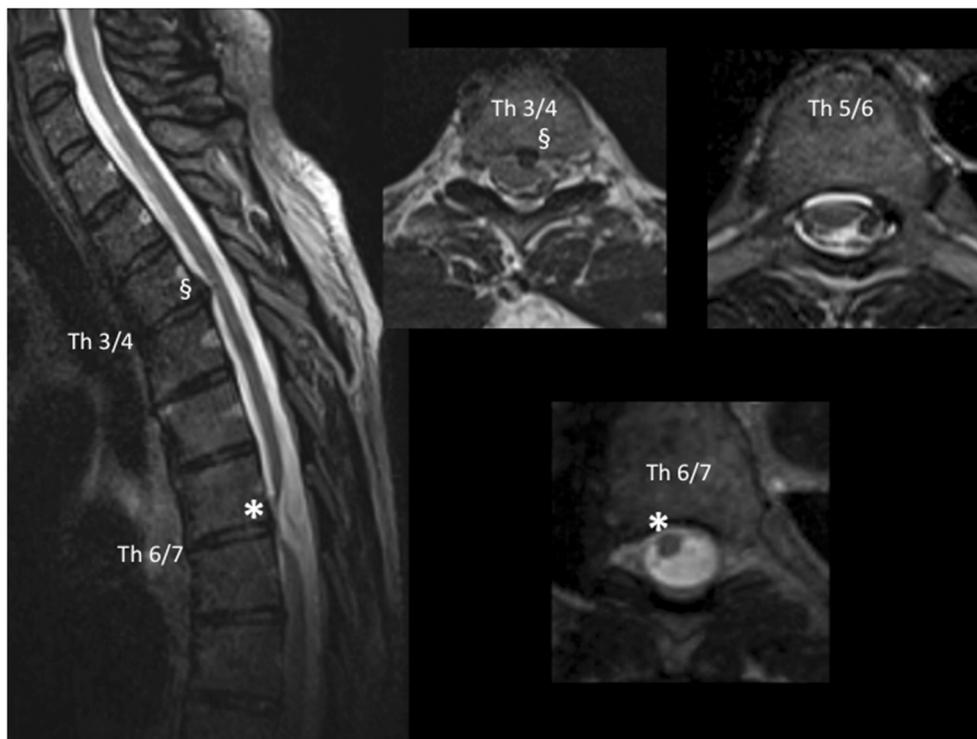
Magnetic resonance imaging (MRI) findings showed a typical herniation of the spinal cord at level Th 6/7 (Fig. 1). At the level above the ISCH (Th 5/6), a circumferential epidural fluid collection surrounded the dural sac. In addition, but asymptomatic, a medio-left-lateral disc herniation at the level of Th

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**Fig. 1** Sagittal and axial T2 MRI with an asymptomatic disc herniation (§) on Th 3/4, spinal cord herniation (\*) on level Th 6/7, and an epidural fluid collection above this level (Th 5/6)

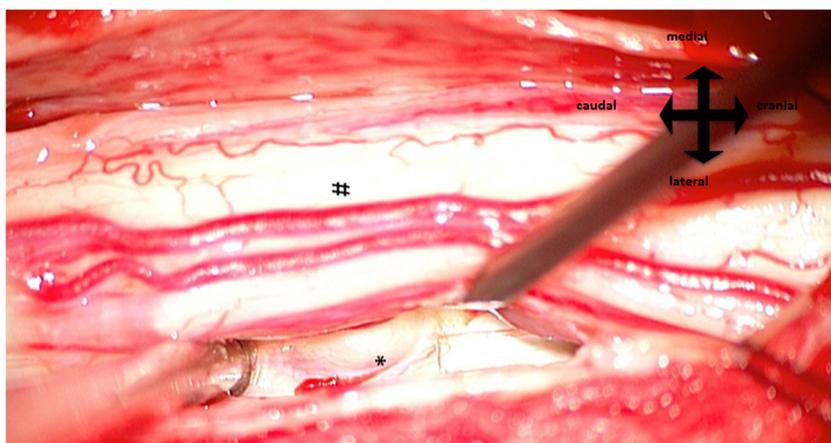


3/4 was present in contact with, but with no compression of the myelon. No evidence of ISCH was present at this site.

The patient's medical history was negative for trauma, central nervous system inflammation, or spinal manipulation.

The patient was referred for surgery with intraoperative monitoring of the motor and sensory evoked potentials. When approaching the intradural space through a laminectomy at Th 6 and 7, a vertical anterior dural perforation of approximately 14 mm in length, with ventral spinal cord herniation and in direct contact with a small soft disc herniation at level Th 6/7, was found (Fig. 2). The dura surrounding the defect was cut within a 2-mm margin to release the trapped myelon. A dural graft matrix (Duragen®, Integra Life Sciences Cooperation) was carefully placed anterior to the spinal cord and fixed with fibrin glue (Tisseel®, Baxter).

**Fig. 2** Intraoperative image of the anterior dural perforation with disc protrusion\* and lateralized spinal cord#. The spinal cord herniation was approached through a posterior, transdural access



Postoperatively, the patient exhibited no new neurological deficits. Subjectively, she recovered sensation, the paresis was alleviated, motor strength returned to normal (M5), and her ambulatory ability was restored.

## Discussion

The pathomechanism of ISCH is still unknown although almost 200 cases have been described in the literature to date [8]. Numerous causes have been proposed, including history of trauma, duplication of the ventral dura, congenital conditions such as meningocele or arachnoid cyst, inflammatory processes, and dural erosion due to CSF flow pulsations or calcified disc herniation [1, 3].

In their review of the literature, Sasani et al. [9] found that ISCH is most common at a mean age of 53 years (range 22–78 years) and occurs predominantly in females. The most frequently involved disc level was T4/5 (19%). The leading clinical symptom was Brown-Séquard syndrome (73%). A neuroradiological review by Brus-Ramer and Dillon [3] evaluated 70 cases of ISCH described in the literature with published images. Fifty-three of these MRIs were clear enough for analysis. Interestingly, more than two thirds (67.1%) of all spinal cord herniation was located at the level of the disc space. Epidural fluid leaks were evident in 28.9%, herniated nucleus pulposus in 30.2%, and posteriorly directed osteophytes in 29.8% at the site of spinal cord herniation. The authors' analysis indicated that spinal cord herniation is caused by a disc herniation or osteophyte progressively eroding the anterior thoracic dura in a vertical fashion. Continuous CSF extravasation through the defect may cause a suction effect that pulls the spinal cord extrathetically. Consequently, the dural erosion defect is tamponaded by the spinal cord, leading to herniation of the myelon (ISCH). The imaging features described by Brus-Ramer and Dillon [3] were partly consistent with our imaging findings: the ISCH was located at the level of the Th 6/7 disc space and an epidural fluid collection was also present at the level of Th 5/6 (Fig. 1). In our patient, the preoperative imaging did not suggest a disc herniation or osteophyte as a cause of thoracic spinal cord herniation. This might be because the spinal cord was displaced anteriorly to the immediate proximity of the vertebral body and obscured the underlying dura-ripping pathology. However, the intraoperative findings clearly showed a disc herniation as the origin of the anterior dural erosion defect. These findings support the pathogenesis of dura-penetrating disc herniation as a cause of thoracic spinal cord herniation. Our microsurgical finding is in line with the conclusions of Brus-Ramer and Dillon [3] based on their analysis of spinal imaging together with the descriptions of three intraoperatively visualized disc herniations as a reason for ISCH [4, 5, 7]. In a series of patients with spontaneous intracranial hypotension, we

found that tiny calcified micro-spurs extruding from the disc space were the main cause for spontaneous CSF fistulas [2]. During microsurgical sealing, we consistently found a vertical slit ( $\varnothing$  6 mm) along the fibers of the anterior aspect of the dura. Therefore, we assume a primarily mechanical etiology of the dural defect, which promotes the herniation of the spinal cord.

One of the largest published case series described 12 consecutive cases treated within 14 years at a single institution. All 12 patients underwent microsurgery to treat neurological symptoms [6]. In none of these patients could an etiology of ISCH be found intraoperatively. To our knowledge, there are only three cases reported in the literature [4, 5, 7], where a disc herniation was recognized to be the underlying cause for an ISCH and was verified by microsurgical exploration (Table 1). The hypothesis of a local cause for the dural defect is supported by a histological analysis [10]. Shimizu et al. conducted a histopathological examination at two sites in a patient with ISCH: at the edges of the ventral dura (site of spinal cord herniation) and the dorsal dura (site of transdural approach). At the site of the ventral dura defect, they found signs of degeneration with a loose arrangement of collagen fibers and edematous changes as well as macrophage and angiogenesis. By contrast, the specimen from the dorsal durotomy revealed a normal arrangement of collagen fibers without evidence of inflammation. This might be interpreted as a primarily local cause of dura defect with an inflammatory reaction occurring secondarily.

The etiology of ISCH is still uncertain. We describe an intraoperatively verified case in which a vertical anterior dural defect was caused by a small disc herniation that subsequently resulted in spinal cord herniation. This phenomenon can be present without any specific preoperative radiographic findings. Considering this finding in the light of recent data from imaging studies [3], we conclude that disc herniation may be a predominant cause of ISCH. However, larger case series and further reports supporting the proposed etiologies would be required to prove this assumption.

**Table 1** Summary of case reports describing a disc herniation as the underlying cause for an ISCH which was verified by microsurgical exploration

Author (year)	Age (years)	Sex	Level of spinal cord herniation	Level of intraoperative disc protrusion	Surgical approach	Intraoperative pathological findings	Disc herniation described in preoperative imaging?
Hausmann and Moseley (1996) [4]	57	F	Vertebra Th 6	Th 6/7	Costotransversectomy Th 6 and 7	Calcified disc	Yes
Miyaguchi et al. (2001) [5]	54	F	Disc space Th 3/4	Th 3/4	Laminectomy Th 3 and 4	Extruded disc	No
Sagiuchi et al. (2003) [7]	48	M	Vertebra Th 7	Th 7/8	Laminectomy Th 7 and 8	Calcified disc extrusion	Yes
Present case	50	F	Disc space Th 6/7	Th 6/7	Laminectomy Th 6 and 7	Soft disc extrusion	No

F female, M male

**Contribution of authors** Christian T. Ulrich: conception and design, acquisition of data, analysis and interpretation of data, drafting the article, critically revising the article, administrative/technical/material support, and study supervision

Christian Fung: acquisition of data, analysis and interpretation of data, and critically revising the article

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## Compliance with ethical standards

**Conflict of interest** The authors declare that they have no conflict of interest.

**Patient consent** The patient has consented to submission of this case report to the journal.

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## Comments

The experience at our department is that the majority of thoracic ISCH have an anatomical correlation to a locally degenerated disk. The perception is that the etiology of these dura defects, together with medullary adhesions and posterior arachnoid cyst-like membranes which all show a similar appearance on sagittal MRI of a typically ventrally displaced and deformed spinal cord, is primarily caused by local inflammatory processes in the acute phase of a disk degeneration. Only secondarily, an erosion of the dura is caused by spondylophytes and/or calcifications of the disk.

The authors' opinion is that a locally bulging disk has eroded the dura. This bulging is quite discrete as it is not clearly visible on the MRI. It is of course difficult to estimate the degree of pressure on the dura from the enclosed image (Fig. 2).

I do not share the theory of mechanical erosion as main cause of the pathology in this case. An intraoperatively visualized dural opening or defect amounting to 14 mm cranio-caudally is described. A standard mid-thoracic dorsal disk height normally amounts to about 3–4 mm, and a bulging would cause another mm of disk exposed to the dura.

It is known (Takaguchi 2009 and others) that there is next to no vertical shift of the dura in the thoracic region. At the Th11–12 level, there is a sub mm shift compared to the mid-lumbar region with about 3 mm shift. An erosion alone from a small disk bulging or herniation 4–5 mm in height therefore does not explain a 14-mm defect. There etiology may be a congenital disorder or more probable, a local inflammatory reaction from the initial disk-degeneration phase. An erosion of the dura causing a defect by means of friction may play only an accessory role in this case. In either case, a local degeneration should be established as one of the main etiologies for ventral dural defects as the cause of spinal cord herniation and/or CSF leakage and associated signs and symptoms of intracranial hypotension.

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The paper reports an interesting finding and a novel theory regarding the pathogenesis of spinal cord herniation; thoracic disk extrusion or spur, even small as depicted in this case, can cause dural erosion, defect, and subsequent cord herniation. The theory appears to be sound, albeit leaving some uncertainty as to if it is in fact the cause in the majority of cases with spinal cord herniation. The issue is to be solved in future with accumulation of experiences in our community. Despite the limitation, the paper indicates a rationale for surgical strategy of microsurgical dural repair and is very educative.

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