

## CASE REPORT

# Brown-Sequard syndrome associated with Horner syndrome following cervical disc herniation

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**INTRODUCTION:** Brown-Sequard syndrome (BSS) has been reported in patients with various spinal pathologies, including spinal traumatic injuries, spinal cord neoplasms, epidural hematomas and spinal cord ischemia. Pure BSS caused by cervical disc herniation is very rare.

**CASE PRESENTATION:** We report a rare case of cervical disc herniation presenting as BSS associated with Horner syndrome (HS), which has not been reported up to now. A prompt diagnosis by magnetic resonance imaging (MRI), followed by spinal cord decompression was performed. A postoperative rapid improvement of the neurological deficits was observed.

**DISCUSSION:** We review the literature and discuss the functional anatomy of spinal cord of BSS combined with HS. And it is important that clinicians be aware that a MRI of spinal cord is needed for those patients with a thoracic sensory level, and that a thoracic sensory level might not only depend on the level of spinal cord injury but also on the stage of evolution of the lesion.

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## INTRODUCTION

Brown-Sequard syndrome (BSS) features ipsilateral upper motor neuron paralysis (hemiplegia) resulting from corticospinal tract interruption and ipsilateral loss of proprioception due to posterior columns' impairment, combined with contralateral pain and temperature sensation deficits as a result of spinothalamic tract dysfunction. However, pure BSS is an uncommon occurrence with relatively few studies, and most patients present with an incomplete form of this condition,<sup>1</sup> with or without some additional features, which were called Brown-Sequard-plus syndrome.<sup>2</sup>

In 1849, BSS was first reported as a clinical constellation after a traumatic transverse of the spinal cord from a knife.<sup>3</sup> BSS is most commonly seen in the setting of spinal traumatic injuries or spinal cord neoplasms, epidural hematomas.<sup>1–3</sup> However, cervical disc herniation is a rare cause of BSS;<sup>1–3</sup> so far only 58 cases have been reported in the English-language literature.<sup>4</sup> Here we report a case of a herniated cervical disc resulting in BSS combined with Horner syndrome (HS). To our knowledge, it is the first report of discogenic BSS combined with HS. In addition, the literature pertinent to the case has been reviewed, looking for clinical features and differences.

## CASE PRESENTATION

A 51-year-old woman presented with a 5-day history of progressive right hemiparesis and was admitted to difficulty with walking, as well as numbness in the lower trunk and limbs on the left side, associated with mild neck pain for 2 years. There was no history of trauma, arthritis. On admission, neurological examination revealed motor weakness and spasticity of the right side of the body (Manual Muscle Test 3/5) and diminished

sensation to pain and temperature on the left side below the T6 dermatome, which were consistent with BSS. The patellar-tendon reflexes were bilaterally hyperactive. Positive Babinski signs were present bilaterally. She had reduced neck mobility, combined with a right HS, including slight lid drop, and the right pupil smaller than the left, was also noticed (Figure 1). There was no loss of deep sensation on both sides. Moreover, there were no radicular symptoms and no bladder or bowel dysfunction.

Magnetic resonance imaging of the cervical spine revealed a large central and right-sided extradural C5–6 disc herniation, almost obliterating the right side of the spinal cord, and a small central and extradural C3–4 disc herniation was observed. The underlying cord showed high signal intensity on T2-weighted images (Figure 2).

The patient underwent anterior cervical corpectomy (C5) and reconstruction using titanium mesh cages, associated with cervical immobilization using rigid cervical collar for 8 weeks postoperatively. The patient recovered from surgery with no complications. The neck pain disappeared almost completely within 6 weeks after the surgery. After 2 months from the operation, miosis and ptosis were dramatically recovered (Figure 1). At the 8 month follow-up, the patient had significant improvement with 5/5 strength in right upper extremity and 4/5 in right lower extremity. The numbness had completely resolved, whereas there was some residual lower-limb hypalgesia in left side.

## DISCUSSION

Cervical disc herniation is a common neurosurgical problem that is encountered in routine neurosurgical practice. Cervical disc herniation is a rare cause of BSS. In 1928, Stookey first reported a herniated cervical disc as a etiology of BSS.<sup>5</sup> We found 58 cases

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**Figure 1.** Right-sided ptosis and miosis secondary to Horner's syndrome preoperatively (upper). Miosis and ptosis of the right side were dramatically recovered at 2 months after surgery (lower).



**Figure 2.** Sagittal and axial T2-weighted magnetic resonance imaging of the cervical spine, showing a large central and right-sided extradural C5–C6 disc herniation compressing the right side of the spinal cord and a small central and extradural C3–4 disc herniation.

reported in the literature,<sup>4</sup> with our cases increasing the number to 59. The frequency of this syndrome has been reported to be 2.6% and 0.21% by Jomin *et al* and Kim *et al*, respectively.<sup>6</sup> A review of the literature associated with BSS caused by herniated cervical disc indicates that C5–C6 is the most vulnerable in discogenic BSS,<sup>3,4,6</sup> and that most cases with no or insignificant radicular symptoms resulting from the neural compression seen in most patients of which was primarily paracentral herniation on the spinal cord itself and not the nerve root.<sup>7</sup> In addition, most cases of discogenic BSS were related to extradural herniation, which

seemed to be associated with complete neurological recovery more often compared with these intradural herniation, either an anterior approach or a posterior surgery.<sup>3,4,6,7</sup>

Presenting syndromes of spinal cord injury are based on the functional anatomy, and a basic knowledge of spinal cord anatomy is essential for interpretation of clinical signs and symptoms and understanding of pathologic processes involving the spinal cord.<sup>8,9</sup>

Transverse injury of hemicord disrupts descending corticospinal tract has already crossed in the pyramidal decussations, resulting in upper motor neuron paralysis in the ipsilateral side below the level of the lesion,<sup>1,3–6,8,9</sup> or combined with ipsilateral lower motor neuron weakness at the level of the lesion or above,<sup>8,9</sup> reflecting an injury of anterior horn.<sup>8,9</sup> Second-order neurons of the spinothalamic tract, which mediate sensation of pain and temperature, cross the anterior commissure of the spinal cord one to three segments cephalad to ascend in the contralateral ascending anterolateral pathway; therefore, hemicord lesions lead to contralateral deficit in sensation of pain and temperature from one to three segments below the lesion.<sup>1,3–9</sup> However, the 'sensory level' of spinal cord that was often more than three segments below the level of the lesion of BSS caused by cervical disc herniation had been documented in many reports,<sup>10</sup> including ours that the sensory level is at the level T6 dermatome on the left side secondary to the compressive lesion at C5/6 on the right side. This phenomenon may relate to the lamination of spinothalamic tracts in the transverse section—with sacral fibers most lateral and cervical fibers most medial. Therefore, the sacral fibers from the surface of spinothalamic tracts are most vulnerable to extrinsic compression in the anterolateral direction.<sup>8,9</sup> Moreover, the 'sensory level' of spinal cord is also related to the damage lamination of the spinothalamic tracts or the duration of the compression.<sup>8,9</sup> Early in its evolution, the compressive lesion from cervical compression may cause relatively only mild cord impingement, damaging the outermost layers of the spinothalamic tracts. As the compression worsens, deeper thoracic and cervical fibers within the white matter become affected, along with the sensory level ascending toward the level of lesion gradually.<sup>8,9</sup> Some scholars called this phenomenon as 'progressive' BSS.<sup>4</sup> In one word, the sensory disturbance level not only depends on the level of spinal cord injury (cervical or thoracic) that we called 'Vertical positioning' but also on the stage of evolution of the lesion, which mostly attribute to the damaged lamination of spinothalamic tracts in transverse section that we called 'horizontal positioning'. In addition, previous reports described ischemia by compression and intramedullary stasis and hypoxia due to venous obstruction also may be an underlying mechanism of the above-mentioned phenomenon.<sup>11</sup> Fibers of the posterior column system are responsible for the transmission of sensations of vibration, proprioception,<sup>8,9</sup> which travel the entire length of the ipsilateral spinal cord until reaching the medulla. Therefore, BSS leads to vibration and position sensation loss in the lesion ipsilateral side, however, which is uncommon in discogenic BSS,<sup>8,9</sup> whereas a dorsal spinal cord compression should be excluded.

Pure BSS, which is very rare, and most patients present with incomplete BSS, or incomplete BSS with some additional features, such as BSS plus HS, is more frequent.<sup>1,2</sup>

Typical HS is characterized by the classic triad of ipsilateral eyelid ptosis and miosis, combined with ipsilateral anhidrosis.<sup>12</sup> HS is often classified into central, preganglionic and postganglionic types, based on the interruption localization of the oculosympathetic pathway.<sup>13,14</sup> Central HS is uncommon, which usually is a part of brain disorders, including brain stem ischemia, brain tumors, and it is often associated with other neurological findings.<sup>12,13,14</sup> Postganglionic HS may often relate to the lesions involving the internal carotid artery, skull base or cavernous sinus/ and orbital apex.<sup>12,13,14</sup> The most frequent causes

of preganglionic HS are tumor and trauma, which is the most common variety seen in clinical practice. However, cervical herniated disc caused HS were very rare; we found only 2 cases reported in the literature, including ours.<sup>12,13,14</sup> Spinal cord compression relates to cervical disc herniation at C4–5 or C5–6 levels producing an insult to the sympathetic pathway, which may be a possible cause of HS in our case.<sup>12,13,14</sup>

The procedure for the treatment of cervical disc herniation includes analgesics, cervical soft collar and surgical treatment.<sup>15</sup> However, mounting data indicated that a prompt surgical decompression should be recommended for cases with progressive neurologic deterioration.<sup>15</sup> The treatment decision of anterior or posterior surgical approaches is based on multiple factors, including the anatomical location of the herniated disc, the longitudinal extent of disease, the alignment of the spinal column and the dimensions of the spinal canal.<sup>10,15</sup> In our case, an anterior cervical corpectomy with fusion and instrumentation was performed. At final follow-up, our patient got a good functional recovery, except for the residual hypalgesia, which was consistent with that in previous study by Kohno M *et al*.<sup>16</sup>

## CONCLUSION

Cervical disc herniation as a very rare cause of BSS and HS, especially for those patients with BSS associated with HS, an accurate diagnosis and early surgical decompression of the spinal cord, is the most important for patients to get an improvement in neurological function. And also it is important that clinicians should be aware that a magnetic resonance imaging of spinal cord (cervical and thoracic level) is needed for those patients with a thoracic sensory level, and that a thoracic sensory level might not only depend on the level of spinal cord injury (cervical or thoracic) but also on the stage of evolution of the lesion, which mostly attributes to the damaged lamination of spinothalamic tracts in transverse section, as well as, a thoracic sensory level may be a false localizing sign in cervical spinal cord sometime, especially for those patients with normal findings on magnetic resonance imaging of thoracic spinal cord.

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## COMPETING INTERESTS

The authors declare no conflict of interest.

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