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Acute Spinal Subarachnoid Hemorrhage: Case Report Cured by Continuous Cerebrospinal Fluid Drainage by Lumbar Puncture

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Abstract: Background: Spinal subarachnoid hemorrhage (SSH) is a rare condition that can lead to severe neurological deficits. Clinicians should consider SSH when neurological deficits such as low back pain, pain hyperalgesia, paraplegia, and urinary and fecal incontinence are present. There is much debate as to whether SSH should be treated surgically or conservatively. There are few reports in the literature about this disease. In this paper, we report a case of SSH in terms of etiology, clinical manifestations, diagnosis and treatment. Methods: A case of SSH in our hospital was retrospectively analyzed in terms of etiology, pathogenesis, clinical manifestations, diagnosis and treatment. Results: The possible etiology of SSH in this case was due to rapid changes in intra-thoracic and intra-abdominal pressure due to prolonged bending, which caused tearing of the blood vessels in the subarachnoid space. The patient has returned to normal life with continuous lumbar puncture for cerebrospinal fluid drainage. Conclusion: We report a case of SSH with typical symptoms of back pain, sensory, motor and autonomic dysfunction. MRI is used as the method of choice to diagnose SSH, which is typically characterized by the lumbar sedimentation sign. Lumbar puncture for continuous drainage of cerebrospinal fluid is simple and less invasive, and may be considered by neurosurgeons as the treatment of choice for SSH, with further surgical treatment considered if results are poor.

Keywords: Spinal Subarachnoid Hemorrhage (SSH), Continuous Cerebrospinal Fluid Drainage, Lumbar Puncture, Conservative Treatment, MRI, Paraplegia

1. Introduction

Spinal subarachnoid hemorrhage (SSH) is rare in clinical practice, and when it occurs, it requires rapid recognition, diagnosis, and treatment, otherwise it can cause severe neurological impairment. [1] The etiology of spinal subarachnoid hemorrhage includes traumatic, medical origin, coagulation dysfunction, application of anticoagulant drugs, vascular malformation and tumor. [2, 3] Its clinical symptoms are characterized by compression of the spinal cord and nerve roots: including motor, sensory, and autonomic dysfunction and back pain. [4] Generally, the diagnosis is made mainly by means of MRI, myelography and CT, and with the development of medical imaging technology, magnetic resonance imaging (MRI) has been used as the method of choice to diagnose spinal subarachnoid hemorrhage. [5]

For spinal subarachnoid hemorrhage, there is still a lack of studies comparing surgical and conservative treatment modalities, and its treatment strategy remains highly controversial. In patients with previously reported SSH, most authors believe that surgical decompression must be performed as soon as possible for significant spinal cord hematoma compression, [6, 7] which can preserve and restore the patient's neurological function and improve the patient's postoperative quality of life. However, some cases have also been reported to be fully recovered with conservative treatment. [2]

This paper reports a case of extensive SSH with no obvious history of trauma, whose main clinical manifestations were lumbar pain and gradual paraplegia and urinary incontinence. After conservative treatment of continuous cerebrospinal fluid (CSF) drainage by lumbar puncture, the patient's symptoms gradually improved, and the MRI was repeated one month later, and the spinal subarachnoid hemorrhage was found to have subsided. This can provide some reference for the treatment of extensive SSH.

2. Case Report

A 38-year-old female patient with a history of long-term bending work had a sudden onset of lumbar pain 3 days ago, which gradually radiated to both lower extremities, accompanied by numbness and weakness of both lower extremities, so her family sent her to the local hospital. The physical examination found that the patient had hyperalgesia below the T12 segment, bilateral lower extremity muscle strength of grade 3-4/5, decreased muscle tone, and Positive Babinski sign bilaterally. therefore, the initial neurological diagnosis was American Spinal Injury Association (ASIA) impairment scale (AIS) grade D. [8] The patient was transferred to our hospital 48 hours after the onset of the disease, at which point the patient's weakness in both lower extremities further worsened, and urinary incontinence required catheterization for bladder management. Physical examination revealed muscle strength 0/5 in both lower extremities, The American Spinal Injury Association impairment scale was raised from D to B.

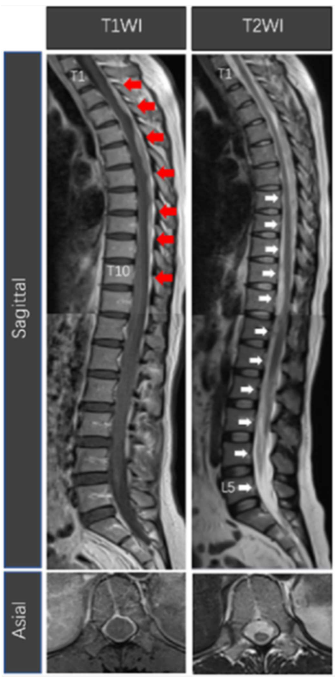

Figure 1. Magnetic resonance imaging (MRI) of the cervicothoracic spine 20 hours after onset. t1-t10 level shows arachnoid inflammation with isosignal T1WI and slightly low signal T2WI (red arrow); T8-L5 level shows subarachnoid hemorrhage with slightly high signal T1WI and slightly low signal T2WI (white arrow). t11 level MRI image shows displacement of the spinal cord due to the lesion.

Routine blood and coagulation results were in the normal range. MRI of the cervical, thoracic and lumbar regions was performed 10 h after the onset of the disease and revealed inflammatory changes in the arachnoid canal at the level of C7-T11 with iso-signal T1WI and slightly low signal T2WI; subarachnoid hemorrhage in the canal at the level of thoracic 8-waist 5 with slightly high signal T1WI and slightly low signal T2WI. The axial image showed that the spinal cord was displaced posteriorly due to subarachnoid hemorrhage Figure 1. A full spinal angiogram was performed 2 h after transfer to our hospital, and no significant spinal arteriovenous malformation or dural arteriovenous fistula was observed.

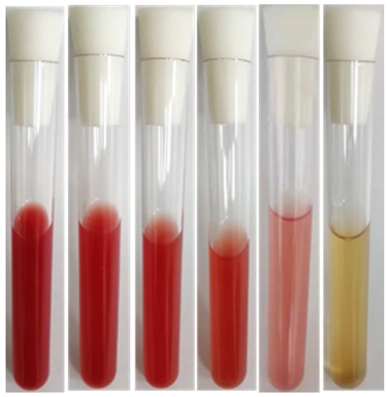

Figure 2. Shows the color of the lumbar pool drainage from day 1 to day 6, respectively, with the cerebrospinal fluid gradually changing from red to yellow.

Considering the extensive bleeding and the high surgical difficulty, we opted for conservative treatment. 6 hours after admission, the patient was given a continuous drainage of CSF by lumbar puncture placement with a CSF pressure of 80 mmH2O, and after 6 hours of drainage, a 60 ml sample of CSF with homogeneous blood color was collected (Figure 2). At this point, the patient's symptoms of lumbar pain and numbness in both lower extremities completely disappeared, the muscle strength of both lower extremities was grade 2/5, and the AIS grade was raised from B to C. The conservative treatment plan was more firmly established. Notably, the patient's cerebrospinal fluid gradually changed from red to yellow after 6 days of drainage (table1), which indicated that there was no further bleeding in the subarachnoid space. A repeat MRI also showed that the blood in the subarachnoid space was decreasing. In addition to the apparent resolution of the subarachnoid hemorrhage, the patient's neurological function was gradually recovering. After 2 weeks of treatment, the patient's neurological improvement had to AIS grade D, and by week 4, the patient had fully recovered with AIS grade E. Bladder management was changed to intermittent self-catheterization after day 3 of admission. Urinary function was completely normalized after day 8 of admission. After the 4th week of hospitalization, the patient was successfully discharged from the hospital. No further symptoms of neurological dysfunction such as lumbar pain, sensation and movement occurred after discharge. Three months after discharge, a repeat MRI showed complete absorption of the hemorrhage in the subarachnoid space, and the patient resumed a normal life course.

Table 1. *Changes in cerebrospinal fluid in spinal subarachnoid hemorrhage.*

Time of Cerebrospinal fluid drainage	1d	2d	3d	4d	5d	6d	Reference values
drainage (ml)	60	50	50	40	30	30	_
Appearance	Deep red	red	red	red	reddish	Yellow	_
Red blood cells (10^6/L)	33000	310000	270000	86000	29000	11000	0
White blood cell (10^6/L)	4797	3800	3500	370	383	125	0-8
Protein (mg/ml)	1731	4194	3390	3601	1449	1903	100-450
Glucose (mmol/l)	4.81	2.33	2.49	2.26	1.4	1.34	3.89-6.11

3. Discussion

This case reports the complete recovery of neurological function in a patient with extensive SSH after conservative treatment including continuous CSF drainage by lumbar puncture. During the conservative treatment period, we closely reviewed the patient's thoracic and lumbar MRI scans to observe the gradual regression of the hematoma with CSF drainage and the neurological improvement from AIS grade B to grade E.

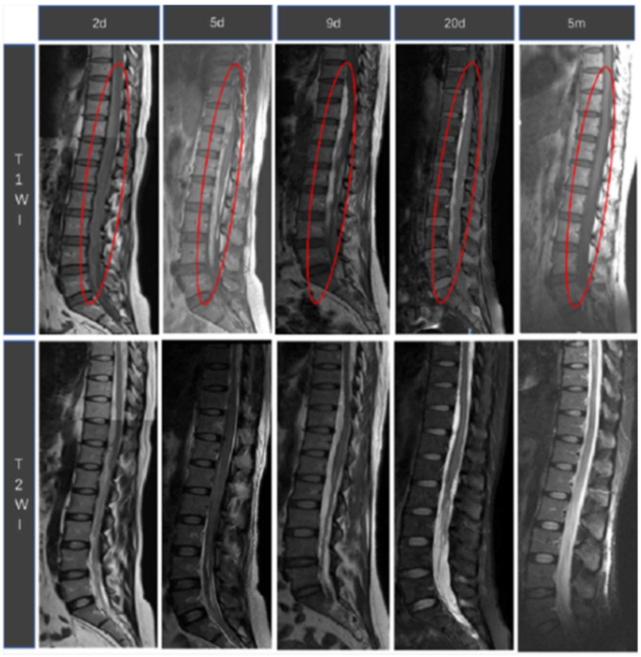

Figure 3. *The chronological MRI images show the process of lesion resolution. After 20 days post-onset, the spinal cord compression was completely and largely resolved.*

Table 2. *Neurological function after the occurrence of spinal subarachnoid hemorrhage.*

Time after the onset of paraplegia	ASIA Grade
1h	B
13h	C
7d	D
4w	E
3m	E
6m	E

This case is unique in that it successfully documented the regression process of spinal subarachnoid hemorrhage with continuous cerebrospinal fluid drainage by lumbar puncture, and also described the relationship between the gradual improvement of the patient's neurological function and the changes in MRI of the thoracic and lumbar regions with continuous CSF drainage from the large lumbar pool (figure 3, table 2), which provides an important reference value for the conservative treatment of SSH.

As a rare neurosurgical emergency, the etiology of spontaneous SSH includes coagulation dysfunction, anticoagulation therapy, and vascular malformation. Currently, the mechanism of hemorrhage remains unclear, and some authors suggest that rapid changes in intrathoracic and intra-abdominal pressure can cause tearing of blood vessels within the subarachnoid space. Mechanical obstructions in the spinal canal, such as cervical spondylosis, disc herniation, arachnoiditis, or thickening of the ligamentum flavum can lead to subarachnoid hemorrhage, which can be further aggravated by acute, rapid subarachnoid hemorrhage. [9] The patient in this case had a history of prolonged bending work, which may have led to increased intra-abdominal and intrathoracic pressures and may be a potential cause of spinal subarachnoid hemorrhage. [10] In addition, the patient presented with arachnoiditis in C7-T11, which was also a factor contributing to the subarachnoid hemorrhage.

Figure 4. *Sagittal T2WI patient showing stratification of acinar material in the sacral canal (white arrow).*

In diagnostic imaging, MRI is the first method to assess spinal cord injury and prognosis, not only to show the site of the hematoma and to assess whether the spinal cord is combined with other lesions, but also to make prognostic judgments based on the damage to the spinal cord. [11, 12] On MRI, SSH has a characteristic feature: cerebrospinal fluid appears to be stratified with blood (The lumbar sedimentation sign), but this stratification is typical of lower lumbar arachnoid hemorrhage. [5, 13] After subarachnoid hemorrhage, low-signal iron deposits are often seen along the dural and soft spinal surfaces in T2/GRE sequences of MRI. [14] Based on these features, it can be differentiated from a spinal epidural hematoma, which usually shows a biconvex shape on MRI due to compression of the dural sac and epidural fat, both of which shrink or even disappear. [15] In this case, the hemorrhage was extensive and from T8-L5, clear the lumbar sedimentation sign could be seen (Figure4), and the cerebrospinal fluid results collected supported that the hemorrhage was located in the spinal subarachnoid space.

The treatment strategy for the patient was also controversial, as the patient was already experiencing hyperalgesia, bilateral lower extremity paraplegia and urinary incontinence at the time of referral to our hospital, and surgical decompression therapy was recommended once sensory, motor and autonomic dysfunction was present, although there are no conclusive data showing that surgery is superior to conservative management methods. [16] However, considering that the outcome of surgery is uncertain and there are cases of complete recovery with conservative management, [1, 3, 4] coupled with the fact that this patient, with extensive hemorrhage (T8-L5), underwent extensive surgical decompression, which is difficult and traumatic and may result in unexpected complications. Moreover, the recovery effect after surgical treatment of spinal subarachnoid hemorrhage was not higher than conservative treatment, and considering that subarachnoid hemorrhage rarely forms blood clots and the bleeding site is located in the lower thoracolumbar segment, it was decided to adopt conservative treatment such as lumbar puncture placement for continuous drainage of cerebrospinal fluid, while surgeons were on standby to perform immediate surgical decompression if symptoms became worse. Fortunately, after treatment, the patient's symptoms gradually subsided.

The potential mechanisms for taking continuous drainage of CSF by lumbar puncture placement for SSH, about which there are few reports, are: 1) Blood can rarely form clots in the CSF because the CSF is constantly circulating and can dilute and diffuse blood, making it difficult for blood to reach the concentration needed for clotting, and after subarachnoid hemorrhage, fibrinolytic activity and degradation products in the CSF increases, and the pulsation of the spinal cord can cause the possibility of blood defibrillation. [17-19] 2) The blood density is greater than the CSF density. Both of these causes can lead to continuous deposition of blood from the spinal subarachnoid space in the lumbosacral spine, and continuous drainage through lumbar puncture placement can then clear the bleeding from the spinal subarachnoid space and release the spinal cord from compression. However, lumbar puncture can lead to medically induced intraspinal hemorrhage, which can further aggravate the condition, although it is very rare, [20-22], but can be identified based on continuous CSF samples, and if the continuously drained CSF samples gradually become clearer from a blood color, traumatic puncture is considered to cause, and if all continuously drained CSF remains blood-colored, it suggests subarachnoid hemorrhage. [23] shows a sample of CSF drainage from the first lumbabr puncture, which continuously drained 60 ml of homogeneous bloody CSF over 24 hours, which is further evidence that the hemorrhage was located in the subarachnoid space. When erythrocytes break down and bilirubin levels increase, at that point, the CSF turns yellow.

4. Conclusion

We report a case of SSH with typical symptoms of back pain, sensory, motor and autonomic dysfunction and MRI with typical features of the lumbar sedimentation sign. Reduction of back pain and improvement of sensory, motor and urethral sphincter function may be predictive factors for successful conservative treatment. The progressive improvement of neurological function after the onset of this patient is closely related to the drainage removal of blood from the spinal subarachnoid space and the release of spinal cord compression. Therefore, neurosurgeons may consider conservative methods such as lumbar puncture for continuous drainage of CSF to treat SSH, especially for hemorrhage in the thoracolumbar segment, even if symptoms such as paraplegia and urinary incontinence occur.

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