Management of a Case with Misdiagnosed Spinal Dural Arterio-Venous Fistula

Chia-Yi Lien[1], Chun-Chung Lui[2], Cheng-Hsien Lu[1], Wen-Neng Chang[1]

Abstract

Purpose: Spinal dural arterio-venous fistula (SDAVF) is an uncommon and easily misdiagnosed vascular malformation. We aimed to report the diagnosis and management of a case with SDAVF.

Case Report: A 62-year-old man suffered from acute paraparesis about 15 months before this study. He underwent a neurosurgical procedure for herniated discs of the cervical spine at that time but there was no relief and the symptoms worsened despite the surgery. Neurologically, he had spastic paraparesis and decreased vibration sensation of the lower limbs. Spinal magnetic resonance imaging (MRI) revealed intra-medullary hyper-intensity lesion at T8 to T10 levels and tubular-like signal void structures in the corresponding posterior sub-arachnoid space. Further trans-arterial angiography through right T6 intercostal artery catheterization revealed engorged veins, thereby confirming the diagnosis of SDAVF. The patient was treated via endovascular embolization (18% Onyx, EV3TM MIT, Bonn, Germany) through spinal angiography and the results showed a marked decrease in engorged veins. After a 4-month follow-up, the patient was symptomatic but stable. Follow-up MRI showed a complete disappearance of the hyper-intensity change of the spinal cord. Spinal MR angiography did not reveal any recurrence of SDAVF.

Conclusion: This case study demonstrated the easily misdiagnosed state of SDAVF. Serial neuroimage studies including spinal MRI, endovascular embolization through spinal angiography and MR angiography can be useful tools for its diagnostic confirmation, management and follow-up study.

Key Words: arterio-venous fistula, dural, mis-diagnosis, Onyx, vascular malformations

Acta Neurol Taiwan 2014;23:29-35

INTRODUCTION

Although spinal dural arterio-venous fistula (SDAVF) is the most common spinal vascular malformations[1-5], accounting for 60-80% of vascular disorders. It is an uncommon and frequently misdiagnosed disorder. Most SDAVFs arise from the lower thoracic or upper lumbar levels[3,4] and around 80% of cases are males, with a peak age of presentation in the 5th or 6th decade of life[1-4]. The clinical presentations are protean and non-specific, including limb weakness, gait disturbance, symmetric or asymmetric sensory impairment (paresthesia or radicular

From the Departments of [1]Neurology and [2]Radiology, Chang Gung Memorial Hospital-Kaohsiung Medical Center and Chang Gung University College of Medicine, Kaohsiung, Taiwan.
Received November 21, 2013. Revised February 7, 2014. Accepted February 21, 2014.

Correspondence to: Wen-Neng Chang, MD. Department of Neurology Kaohsiung Chang Gung Memorial Hospital, 123, Ta Pei Road, Kaohsiung, Taiwan.
E-mail: cwenneng@ms19.hinet.net

pain), and disturbance of micturition and defecation. The slow progression of SDAVF is characterized as "worsening" and "symptoms combination"[1-5].

In clinical practice, neuroimaging studies of the spine, especially vascular system evaluation, are important for SDAVF diagnosis[1-5]. But despite advances in radiologic techniques, the diagnostic time is still delayed and misdiagnosis still frequently occurs[1-5]. Such delays may cause a therapeutic failure and symptom progression. This report demonstrates the clinical features, serial neuro-imaging findings, and therapeutic outcome of a case of SDAVF with delayed diagnosis.

CASE REPORT

On May 7, 2013, a 62-year-old man consulted at the Neurology Department of our hospital for progressive weakness of the lower limbs and gait disturbance for 15 months. Except for the regularly-treated and controlled hypertension, his past history was unremarkable. There was no spinal trauma prior to the development of lower limb weakness, which first occurred on February 1, 2012. He received first aid from a hospital located at mid-Taiwan. Cervical myelopathy due to the compression of herniated discs at C4/5/6 was diagnosed and he underwent a decompression procedure.

After the neuro-surgery, his neurologic condition was stable for a while. However, the symptoms eventually progressed and despite medical treatment and a rehabilitation program, spastic weakness, jerking movement of the lower limbs, electric shock sensation of the lower limbs, constipation, and urination problems developed gradually and became more obvious. Because of the progression of his clinical symptoms, he visited another hospital in southern Taiwan on May 7, 2013. Intra-medullary thoracic cord lesion was detected (Fig. 1A). He was then transferred to our hospital for further management.

On physical examination, the patient was conscious, coherent, and alert. The cranial nerves were unremarkable and the muscle powers of the upper limbs were normal, while that of the lower limbs was 4 (MRC grade)/4 (MRC grade). The deep tendon reflexes of upper limbs were normal but there was hyper-reflexia of the bilateral knees. Ankle jerks were also detected as well as bilateral extensor plantar responses. Light touch and thermal sensation were normal while the vibration sensation of the lower limbs decreased. Positive Romberg test was noted.

General blood tests, including complete blood count and renal, liver, and thyroid functions, were all within normal ranges (Table 1). Brain magnetic resonance imaging (MRI) study did not reveal abnormalities but

Table 1. Laboratory data of serology, immunology and cerebrospinal fluid studies

Items (Unit)	Data	Normal range
Biochemistry		
Glucose (mg/dL)	96	70-100
Albumin (g/dL)	3.8	3.5-5.2
Tumor markers		
Carbohydrate antigen 19-9 (U/mL)	11.0	<37
Carcinoma antigen 15-3 (U/mL)	8.0	<30
Carcino-embryonic antigen (ng/mL)	2.57	<5
Alpha fetoprotein (ng/mL)	5.38	<15
Squamous cell carcinoma antigen	0.60	<2.5
Prostatic specific antigen (ng/mL)	0.81	<4
Hepatitis virual detection		
Hepatitis B virus surface antigen	Negative, 0.5	Non-reactive, <0.94
Anti-hepatitis B virus surface antibody	Reactive, >1000	Nonreactive, <100
Anti-hepatitis C virus antibody	Non-reactive, 0.00	Nonreactive, <0.99
Immunological deices		
Rapid plasma regain	Non-reactive	Non-reactive
Rheumatoid factor (IU/mL)	<10.70	<10.70

Table 1. Laboratory data of serology, immunology and cerebrospinal fluid studies (Continue)

Anti-nuclear antibody	Negative	Negative
Anti-ENA screening	0.1	<0.7
Anti-cardiolipin IgG (U/ml)	2.5	<10
Anti-thrombin III (%)	103.1	75-125
Lupus anticoagulant (Sec)	32.6	31-44
Lupus anticoagulant screening test	Negative	Negative
Immunoglobulin G (mg/dL)	1240.0	700-1600
Cerebrospinal fluid data		
Appearance	Clear	-
Color	Colorless	-
White blood cell count (/μL)	1	<5
Lymphocyte	1	-
Red blood cell count	0	0
Total protein (mg/dL)	40.6	15-45
Glucose (mg/dL)	54	40-70
Lactate (mg/dL)	18.2	<25.2
Micro-albumin (mg/dL)	20.3	<30
India ink	Negative	Negative
Gram stain	No bacteria found	-
Acid-fast stain	Negative	Negative
Tuberculosis polymerase chain reaction	Negative	Negative
Rapid plasma regain	Negative	Negative
Cryptococcal antigen test	Negative	Negative
Herpes zoster virus DNA	Negative	Negative
Immunoglobulin G (mg/dL)	2.69	<3.5
Albumin (%)	61.40	56-76
α1-globulin (%)	7.02	2-7
α2-globulin (%)	10.53	4-12
β-globulin (%)	12.28	8-18
γ-globulin (%)	5.26	3-12
Pre-ablumin (%)	3.51	2-7
Immuno-fixation electrophoresis	No paraprotein	-

follow-up spinal MRI study on May 13, 2013 revealed hyper-intensity in the spinal cord at the mid-thoracic levels (Figs. 1B and 1C). Tubular-like signal void structures in the posterior sub-arachnoid space were also noted, suggesting the presence of a vascular lesion. Due to suspicion of SDAVF, the patient underwent a trans-arterial spinal angiography study, confirming the diagnosis (Fig. 1D).

For the management of SDAVF, endovascular embolization through spinal angiography was performed. Briefly, a micro-catheter and a Marathon catheter (COVIDIEN, Bonn, Germany) were used for selective catheterization. After selective catheterization of the distal branch of the right T6 intercostal artery, trans-arterial embolization was performed using a VortX pushable coil (3 x 2.5 mm) (Boston Scientific, Natick, Massachusetts, United States). Selective catheterization of the upper branch of the right T6 intercostal artery was done and embolization was completed using a liquid embolizing agent (18% Onyx, EV3TM MIT, Bonn, Germany) until optimal stasis of blood flow was achieved. Follow-up angiography of the right T6 intercostal artery showed a marked decrease in engorged venous structures (Fig. 1E).

The therapeutic course was smooth and the patient

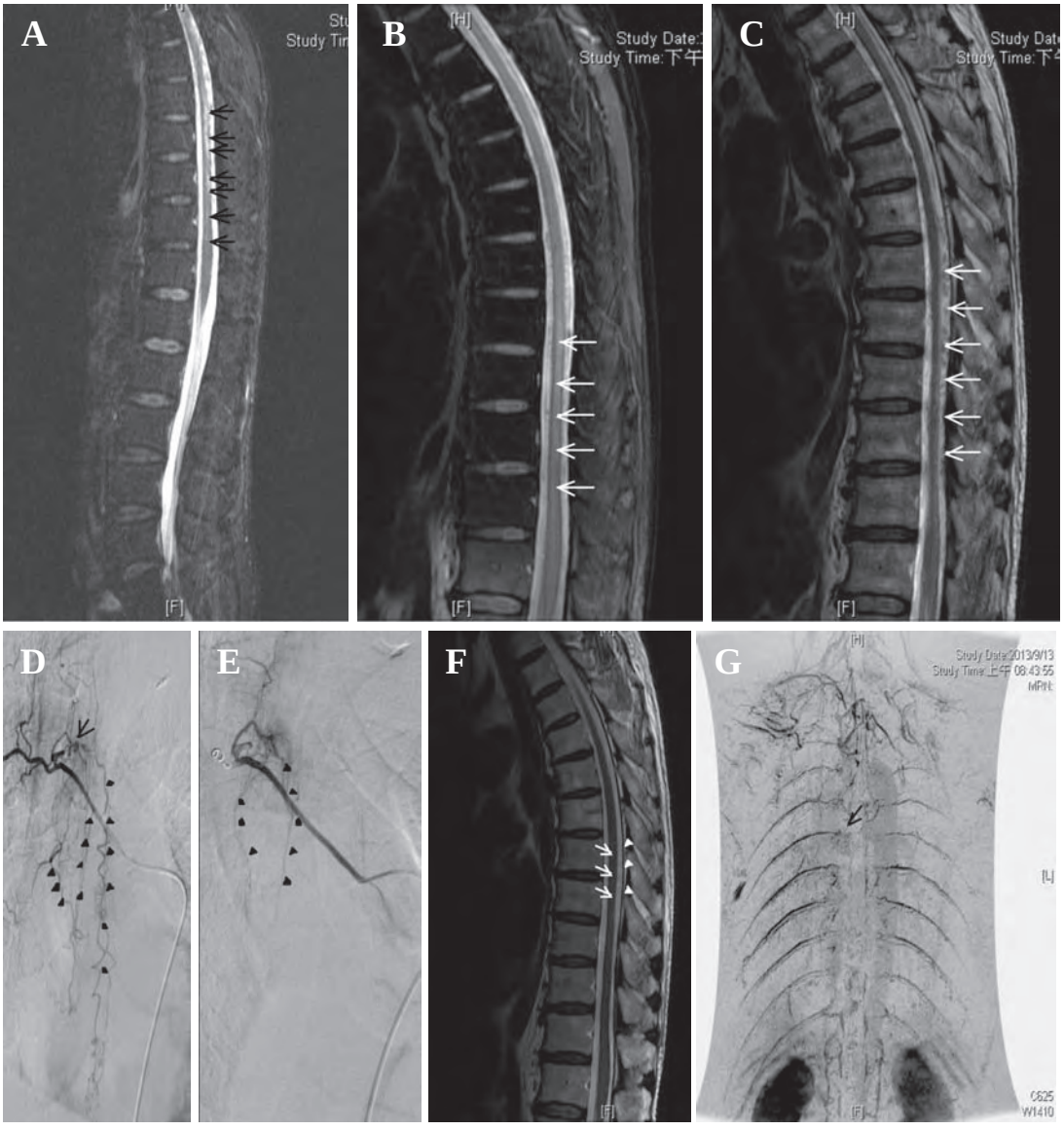

Figure 1. (A) Fat-suppression sagittal T2-weighted spinal MRI (2013/05/07) shows intra-medullary hyper-intensity lesion at T8-T10 levels (arrow). (B) Fat-suppression sagittal T2-weighted spinal MRI (2013/05/13) shows intra-medullary hyper-intense lesion at T8-T10 levels (arrow). (C) T2-weighted spinal MRI (2013/05/13) shows tubular-like signal voiding structures in the posterior sub-arachnoid space at the mid-thoracic level (arrow). (D) Spinal angiography (2013/05/15) shows dural arterio-venous fistula (arrow) and engorged venous structures (arrowhead) through the right T6 intercostal artery catheterization. (E) Spinal trans-arterial embolization (2013/05/21) shows a marked decrease in engorged veins (arrowheads) after embolization. (F) Spinal T2-weighted spinal MRI and MR angiography (2013/09/13) shows disappearance of both hyper-intense lesions from T8-T10 level (arrow) and the tubular-like signal void structures (arrowhead). (G) Spinal T2-weighted spinal MRI and MR angiography (2013/09/13) shows disappearance of the previous engorged veins (arrow).

was discharged on June 1, 2013. On follow-up 4 months after discharge, his neurologic deficits remained. Follow-up spinal MRI and MR angiography on September 13, 2013 revealed a marked improvement (Figs. 1F and 1G).

DISCUSSION

This 62-year-old man had acute paraparesis followed by a progressive course of myelopathy that included pyramidal signs, sensory symptoms, and autonomic dysfunction. All the clinical presentations correlated with the neuroimaging findings (Figs. 1A-1C), which showed spinal cord abnormalities at the T8-T10 levels. However, the spinal cord lesion with a hyper-intensity signal change was not specific for SDAVF and could be seen in lesions of other pathologies[1,2,6,7]. The suspicion of SDAVF was raised by the presence of tubular-like signal void structures (Fig. 1C), which indicated serpinginous and enlarged spinal vessels. Although this neuro-imaging finding is more specific for SDAVF, trans-arterial spinal angiography remains the gold standard in diagnostic confirmation[1,2,4,6-8] as this procedure may also locate the exact site of the fistula, identify the feeding artery and other possible collateral feeders, and evaluate the venous drainage. Thus, the diagnosis of SDAVF (engorged venous structure with right T6 intercostal artery as the feeding artery in Figure 1D) of present case was confirmed.

Although spinal MRI is important for the study of spinal vascular malformations, its diagnostic value in SDAVF detection is still limited by many factors[5,7,9-13]. Clinically, the median time between the onset of clinical symptoms to the diagnostic confirmation of SDAVF ranges from 12 to 44 months and most cases have an initial diagnosis of more commonly seen disorders like degenerative disc disease, myelitis, syringomyelia, or spinal cord tumor[1,4,5]. Early in the clinical stage, the present case was misdiagnosed as cervical disc herniation with cord compression and the patient underwent a corresponding neurosurgical procedure as treatment. The cause of the misdiagnosis and the 15-month delay in SDAVF confirmation can be attributed to: 1) the present case does not have any known preceding events[14,15] such as trauma before the development of clinical symptoms and 2) the tubular-like signal voiding structures are not obvious in the first spinal MR imaging. The "acute onset" of clinical symptoms in this case somewhat mimics that of anterior spinal artery syndrome. The same pattern of symptom onset is also noted in 5-18% of reported SDAVF cases[6]. Thus, one of the important strategies for early SDAVF diagnosis is a high index of suspicion of SDAVF when approaching a case presenting with myelopathy[5].

Although SDAVF is a potentially curable cause of myelopathy, if not treated, 50% of cases will have progression of symptoms to become severely disabled and more than 90% become unable to walk independently three years after the onset of clinical symptoms[16]. Therefore, upon SDAVF diagnosis, appropriate treatment and an inter-disciplinary approach are needed. Significant improvement can be expected even in those with severe disabilities[17,18]. At present, options of SDAVF treatment include endovascular embolization and obliteration of arterialized veins via microsurgery. Both therapeutic procedures aim to prevent the shunting veins from draining into the venous plexus[4,17,19].

Because endovascular treatment is less invasive and has comparable long-term outcome to surgical intervention[4,17,18], the present case underwent endovascular embolization via spinal angiography by using the embolic agent "Onyx". Although the effect of using Onyx for SDAVF treatment needs further large-scale study for confirmation[20]; this procedure had an immediate effect and a marked decrease in engorged veins. This improvement in neuro-imaging findings was further confirmed by a 4-month follow-up spinal MRI and spinal MRA studies that showed a complete disappearance of the hyper-intensity spinal cord lesions and disappearance of tubular-like signal void structures.

In the present case, the neuroimaging improvement has a lack of correlation with the clinical outcome. This dissociation is also noted in the report of Kaufmann et al.[21]. In the meanwhile, the following conditions may also result in the dissociation in SDAVF study: 1, the severity of clinical symptoms was to mild and the need of angiography study was neglected[5,6,9]; 2, the fistula might be found at a distant site from the cord signal abnormality [11,12]. 3, the demonstration of vessels supplying SDAVF might be compromised by artherosclerosis of the segmental vessels or thrombosis of the draining veins[5,9], and 4, the conspicuity of abnormal vessels on MRI may depend on flow velocity and imaging parameters[10].

Nonetheless, endovascular embolization through spinal angiography is still an important and effective procedure for SDAVF treatment. Compared to trans-arterial spinal angiographic study, spinal MRA is superior in its time-saving and non-invasive characteristics. It also has a comparable capacity for investigating SDAVF[5,21-23]. The capability of MRA evaluation in the SDAVF follow-up study is demonstrated in the present case (Fig. 1G). However, a longer period of periodic MR imaging follow-up study for the present case is still needed in order to have an earlier detection of re-canalization of SDAVF after the therapeutic procedure.

In conclusion, the clinical presentation of SDAVF is non-specific, making its diagnosis usually delayed or neglected. The appearance of tubular-like signal void structures in spinal MRI study is more specific for SDAVF, although spinal angiography is still the main diagnostic method for SDAVF confirmation. Of the therapeutic methods, endovascular embolization through spinal angiography is effective for neuro-image improvement and clinical stabilization or recovery. On follow-up, non-invasive spinal MR angiography can be one of the important choices for monitor the therapeutic results.

REFERENCES

1. Atkinson JL, Miller GM, Krauss WE, Marsh WR, Piepgras DG, Atkinson PP, Brown RD Jr, Lane JI. Clinical and radiographic features of dural arterio-venous fistula, a treatable cause of myelopathy. Mayo Clin Proc 2001;76:1120-1130.
2. Muralidharan R, Saladino A, Lanzino G, Atkinson JL, Rabinstein AA. The clinical and radiological presentation of spinal dural arterio-venous fistula. Spine 2011;36:E1641-E1647.
3. Cenzato M, Debernardi A, Stefini R, D'Aliberti G, Piparo M, Talamonti G, Coppini M, Versari P. Spinal dural arterio-venous fistulas: outcome and prognostic factors. Neurosurg Focus 2012;32:E11.
4. Marcus J, Schwarz J, Singh IP, Sigounas D, Knopman J, Gobin YP, Patsalides A. Spinal Dural Arterio-venous Fistulas: A Review. Curr Atheroscler Rep 2013;15:335.
5. Donghai W, Ning Y, Peng Z, Shuo X, Xueen L, Peng Z, Bin H, Xingang L. The Diagnosis of Spinal Dural Arterio-venous Fistulas. Spine 2013;38:E546-E553.
6. Jellema K, Tijssen CC, Gijn J. Spinal dural arterio-venous fistulas: a congestive myelopathy that initially mimics a peripheral nerve disorder. Brain 2006;129(Pt 12):3150-3164.
7. Morris JM. Image of dural arterio-venous fistula. Radiol Clin North Am 2012;50:823-839.
8. Koch C. Spinal dural arterio-venous fistula. Curr Opinn Neurol 2006;19:69-75.
9. Matsubara T, Akutsu H, Watanabe S, Nakai K, Ayuzawa S, Matsumura A. Histologically proven venous congestive myelopathy without concurrent vascular malformation: Case reports and review of the literature. Surg Neurol Int 2012;3:87.
10. Sakai Y, Matsuyama Y, Imagama S, Ito Z, Wakao N, Ishiguro N. Clinical utility of multi-detector row computed tomography for diagnosing spinal dural arterio-venous fistulas undiagnosed by magnetic resonance imaging. Geriatr Gerontol Int 2010;10:255-263.
11. Kim NH, Cho KT, Seo HS. Myelopathy due to intracranial dural arterio-venous fistula: a potential diagnostic pitfall. J Neurosurg 2011:114:830-833.
12. Perkash I, Punj V, Ota DT, Lane B, Skirboll SL. Intracranial dural arterio-venous fistula causing a myelopathy. Spinal Cord 2002;40:438-442.
13. Gilbertson JR, Miller GM, Goldman MS, Marsh WR. Spinal dural arterio-venous fistulas: MR and myelographic findings. Am J Neuroradiol 1995;16: 2049-2057.
14. Koerts G, Vanthuyne V, Delavallee M, Rooijakkers H, Raftopoulos C. Spinal dural arterio-venous fistula presenting with paraplegia following lumbar puncture. J Neurosurg Spine 2013;19:57-60.
15. Nishio A, Ohata K, Takami T, Nishikawa M, Hara M. Atypical spinal dural arterio-venous fistula with supply from the lateral sacral artery. J Clin Neurosci 2007;14:65-68.
16. Aminoff MJ, Logue V. Clinical features of spinal vascular malformations. Brain 1974;97:197-210.
17. Ruiz-Juretschke F, Perez-Calvo JM, Castro E, García-Leal R, Mateo-Sierra O, Fortea F, Iza B, Garbizu JM, Villoria F. A single-center, long-term study of spinal dural arterio-venous fistulas with multidisciplinary treatment. J Clin Neurosci 2011;18:1662-1666.

18. Saladino A, Atkinson JL, Rabinstein AA, Piepgras DG, Marsh WR, Krauss WE, Kaufmann TJ, Lanzino G. Surgical treatment of spinal dural arterio-venous fistula: a consecutive series in 154 patients. Neurosurgery 2010;67:1350-1357.
19. Wakao N, Imagama S, Ito Z, Ando K, Hirano K, Tauchi R, Muramoto A, Matsui H, Matsumoto T, Matsuyama Y, Ishiguro N. Clinical outcome of treatments for spinal dural arterio-venous fistulas: results of multivariate analysis and review of the literature. Spine 2012;37:482-488.
20. Blackburn SL, Kadkhodayan Y, Ray WZ, Zipfel GJ, Cross DT 3rd, Moran CJ, Derdeyn CP. Onyx is associated with poor venous penetration in the treatment of spinal dural arteriovenous fistulas. J Neurointerv Surg 2013.
21. Kaufmann TJ, Morris JM, Saladino A, Mandrekar JN, Lanzino G. Magnetic resonance imaging findings in treated spinal dural arterio-venous fistulas: lack of correlation with clinical outcomes. J Neurosurg Spine 2011;14:548-554.
22. Mull M, Nijenhuis RJ, Backes WH, Krings T, Wilmink JT, Thron A. Value and limitations of contrast-enhanced MR angiography in spinal arterio-venous malformations and dural arterio-venous fistulas. Am J Neuroradiol 2007;28:1249-1258.
23. Oda S, Utsunomiya D, Hirai T, Kai Y, Ohmori Y, Shigematsu Y, Iryo Y, Uetani H, Azuma M, Yamashita Y. Comparison of dynamic contrast-enhanced 3T MR and 64-row multi-detector CT angiography for the localization of spinal dural arterio-venous fistulae. AJNR Am J Neuroradiol 2014;35:407-412.