

MR Venography in Cervical Myelopathy before and after Direct Skull Traction

Akira SEKIGUCHI¹, Kyoko ENOMOTO², Hiroshi KATO¹

*¹Department of Orthopaedic Surgery, ²Department of Radiology, Saitama Medical School
38 Morohongo, Moroyama-cho, Iruma-gun, Saitama 350-0495*

MR venography (MRV) was performed to evaluate the anterior cervical venous plexuses in five normal volunteers and eight patients with cervical myelopathy before and after direct skull traction. Visibility of the plexuses from C2 to C7 was evaluated and scored by five observers in those groups.

The venography was performed with FISP sequences (fast imaging with steady state precession) and with the injection of Gd-derivatives. The MRV was obtained after maximum-intensity projection and 3D reconstruction.

In the normal volunteers, the internal vertebral plexus (IVP), intervertebral vein (IV) and anastomotic vein (AV) were all well demonstrated. In the patients, those plexuses were less well demonstrated in comparison with the normal volunteer, particularly in C5 which is the most frequently affected area. That is the patient group had lower scores than the normal group. However, the score at C5 was not lower than those at non-affected sites. After treatment, MRV demonstrated those plexuses better in some cases of cervical myelopathy; although this was not evaluated statistically.

INTRODUCTION

Recent advances in magnetic resonance imaging (MRI) in medicine have expanded its application to the field of venography. Magnetic resonance venography (MRV) of cervical venous plexuses can be performed in 2D and 3D using various methods^{1),2)}. The purpose of

this study was to evaluate MRV images of the anterior cervical venous plexuses in patients with cervical myelopathy before and after treatment with direct skull traction.

SUBJECTS AND METHODS

1. Subjects

Keywords MR venography, cervical venous plexuses, cervical myelopathy, skull traction

Table 1. Patient Characteristics

Patient No.	Age (yrs)	Gender	Diagnosis	Duration (month)	Affected level
1.	41	M	CDH	6	C 5/6
2.	34	M	CDH	35	C 4/5
3.	38	M	CDH	3	C 5/6
4.	39	M	CDH	10	C 4/5
5.	70	M	CSM	13	C 5/6
6.	66	F	CSM	6	C 5/6
7.	43	F	CSM	15	C 5/6
8.	66	M	OPLL	5	C 5/6
Mean	49.5			11.6	

Abbreviations; M: male, F: female, CDH: cervical disc herniation, CSM: cervical spondylotic myelopathy, OPLL: ossification of the posterior longitudinal ligament

The subjects consisted of five normal volunteers (age 19 to 26 years, mean 22.5 years) and eight patients with cervical myelopathy (age 34 to 70 years, mean 49.5 years), consisting of three cervical spondylotic myelopathy, four cervical disc herniations and one ossification of the posterior longitudinal ligament. The mean duration of symptoms before treatment was 11.6 months (3 to 35 months). Other clinical data are shown in Table 1. All eight patients were treated by continuous direct skull traction with a Gardner-Wells traction tongue (RADINONICS, Burlington, Massachusetts) for 4 weeks. The MRV was conducted before and immediately after treatment.

2. MRV

The study was performed with a 1.5 T superconducting unit (Siemens Magnetom H15-SP). FISP sequences (fast imaging with steady state precession), TR/TE/FA (30 to 35 ms/7 ms/15 to 20 degrees) and 1 to 2 coronal

plane acquisitions were used. After the data were obtained, 3D MRV images were reconstructed by the MIP (maximum intensity projection) method. All of the patients were injected with Gd-derivatives (Gd-DTPA, 0.05 mmol/kg i.v.). The study was carried out in a neutral position.

3. Evaluation

The anterior cervical venous plexuses surrounding the pedicles were evaluated from 3D MRV images. The images were observed on the screen by rotating in all directions. Prior to the evaluation, the observers were instructed to adhere to the following scoring method: 2 points-well demonstrated; 1 point-visible, but not clearly demonstrated; 0 point-no veins were demonstrated. The score was evaluated from C2 to C7 for bilateral internal vertebral plexus (IVP), intervertebral vein (IV), and anastomotic vein (AV), separately (Fig. 1). The MRV before treatment was compared with that after treatment. The MRV findings were correlated to the area(s) of the lesion.

The observers were 5 well-trained radiologists. They made their observations separately and mean scores were calculated. If the observers disagreed, the score was determined by consensus.

RESULTS

In normal volunteers, IVP, IV and AV were clearly demonstrated in all levels bilaterally with scores of 2. Mean scores of the IVP, IV and AV of the patients at each level are listed in Table 2. The scores of the IVP and IV from C2 to C4 were 1.51 to 1.93. At C6, the score of the

Received Sept.14, 1998 ; revised Dec. 8, 1998

Reprint requests to Akira Sekiguchi, Department of Orthopaedic Surgery, Saitama Medical School, 38 Morohongo, Moroyama-cho, Iruma-gun, Saitama 350-0495

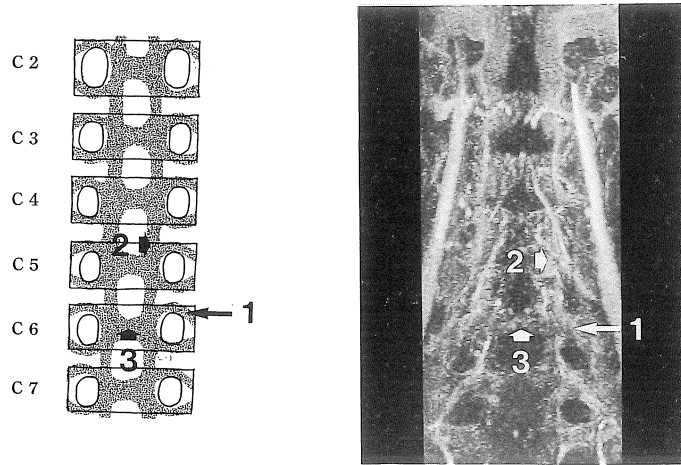


Fig. 1. Normal MRV.
 1 : Internal vertebral plexus (IVP).
 2 : Intervertebral vein (IV).
 3 : Anastomotic vein (AV).

Table 2. Mean Scores of Anterior Cervical Venous Plexuses

	IVP		IV		AV
	Right	Left	Right	Left	
C 2	1.68	1.83	1.53	1.78	1.29
C 3	1.65	1.76	1.93	1.93	1.67
C 4	1.60	1.51	1.65	1.65	1.32
C 5	(1.38)	(1.25)	(1.39)	(1.61)	(1.14)
C 6	1.80	1.80	1.10	1.20	1.50
C 7	0.83	0.66	0.74	0.61	0.61

Abbreviations; IVP: internal vertebral plexus, IV: intervertebral vein, AV: anastomotic vein, (): most affected level by a lesion

IVP was 1.80, while it of the IV was 1.20 on the left and 1.10 on the right. The IV at C7 scored lower, ranging from 0.61 to 0.83. The AV scored lower than the IVP and IV at all levels; i.e., 0.61 (C7) to 1.67 (C3). Since all of the eight patients had a lesion around C5, C5 scores are shown in parentheses in Table 2. However, the C5 score was not significantly

Table 3. Mean Scores of Anterior Cervical Venous Plexuses Pre and Post Treatment

	IVP		IV		AV
	Right	Left	Right	Left	
C 2					
C 3					
C 4	1.65 (1.80)	1.80 (2.00)	1.80 (2.00)	1.70 (2.00)	1.50 (1.40)
C 5	1.38 (1.25)	1.25 (1.18)	1.39 (1.58)	1.61 (1.40)	1.14 (1.33)
C 6	0.67 (0.97)	0.83 (0.70)	0.92 (0.93)	0.99 (0.80)	0.87 (1.02)
C 7					

Abbreviations; IVP: internal vertebral plexus, IV: intervertebral vein, AV: anastomotic vein, (): after treatment

lower than those for the other cervical levels. Six of the eight patients had a lesion at C5-6, and 2 had a lesion at C4-5. Table 3 shows the mean scores of the anterior cervical venous plexuses before and after treatment. No significant difference was noted in the score, al-

Table 4. Mean Scores of the Affected Level Pre and Post Treatment

No.		Pre treatment			Post treatment		
		IVP(R/L)	IV(R/L)	AV	IVP(R/L)	IV(R/L)	AV
1.	C 5	0.8/1.2	1.4/1.4	1	0.8/1	1.6/1.4	1.2
	C 6	0.5/0.8	0.4/0.8	0.8	0.4/0.6	1/0.8	1.2
2.	C 4	2/1.8	1.5/1.8	1	2/2	1.6/2	0.8
	C 5	1.6/1.8	2/2	1	1.2/1.8	1.4/1.8	0.8
3.	C 5	0.8/2	1.2/1.6	1	1/1.2	1.4/1.2	0.8
	C 6	0.2/1	0/0.6	0	0.6/0.8	0.6/0.6	1.2
4.	C 4	1.6/1.6	1.8/1.8	2	2/2	2/2	2
	C 5	1.8/1.8	2/2	1.6	2/2	2/2	1.6
5.	C 5	1.2/1.2	1.2/1.8	0.5	2/0.6	1.2/1.2	1
	C 6	1.2/1.2	0.8/1.8	0.7	1/0.6	1/0.8	0.8
6.	C 5	2/2	1.6/1	1.6	2/1.8	1/1.2	1
	C 6	1.6/1.2	1/0.2	1.2	1.2/1.2	1/0.6	0.8
7.	C 5	1.4/1.4	1/1	1.2	1.6/1.2	1.2/0.6	1.4
	C 6	1/1	1/1	1.2	1.6/1.4	1.8/1.2	1.6
8.	C 5	1.5/1.5	0.8/0.6	1.3	1.6/1.6	0.2/0	1.2
	C 6	1/0.75	0.8/0.6	1	0.8/0.2	0.4/0.2	0.5

though the IVP, IV and AV were better visualized after treatment in the following illustrative cases (Table 4).

Illustrative Patients

Patient No. 5. A 70-year-old male with cervical spondylotic myelopathy showed muscle weakness and sensory disturbance below the C5 level. A myelogram showed cord compression between the C4 and C5 vertebral levels (Fig. 2a). Before treatment, the IVP, IV and AV were poorly demonstrated, with mean scores of 1.2/1.2 (right/left), 1.2/1.8, and 0.5, respectively (Fig. 2b). After 4 weeks of direct skull traction, these scores increased to 2/0.6, 1.2/1.2, and 1, respectively (Fig. 2c).

Patient No. 7. A 43-year-old female with cervical spondylotic myelopathy showed muscle weakness and sensory disturbance below

the C6 level. A myelogram showed cord compression from C4 through C6 (Fig. 3a). The IVP, IV and AV were poorly demonstrated, with scores of 1/1 (right/left), 1/1, and 1.2 respectively before treatment (Fig. 3b), while they were 1.6/1.4, 1.8/1.2, and 1.6 respectively after 4 weeks of direct skull traction (Fig. 3c).

DISCUSSION

The MRV has been reported to be a useful and easy method for examining the venous system, in contrast to conventional venography. Ikawa et al. examined the cervical venous system by using Gd-enhanced MRV and they concluded that the MRV was effective for detecting abnormalities of the venous system³⁾. Spritzer et al. reported that the MRV was

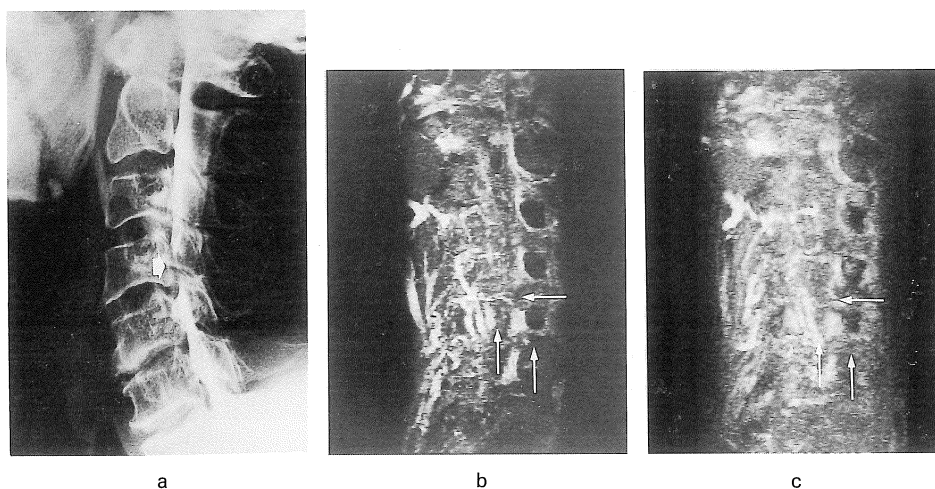


Fig. 2. Patient No. 5, 70-year-old male.

- a) A myelogram shows severe cord compression at the C4 and C5 level (white arrow).
- b) The MRV before treatment shows a poor demonstration of all of the venous plexuses, particularly on the left (white arrows).
- c) After treatment, the demonstration of venous plexuses was slightly improved.

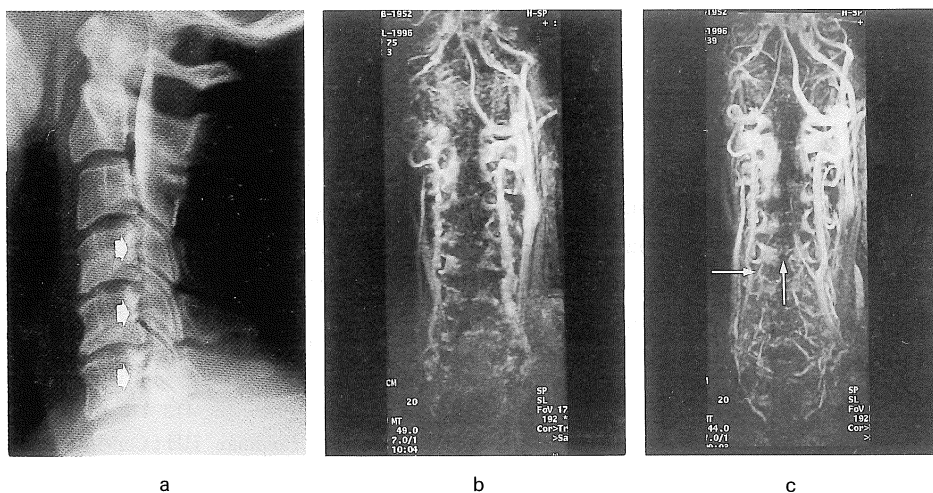


Fig. 3. Patient No. 7, 43-year-old female.

- a) A myelogram shows cord compression between C4 and C6 (arrow).
- b) The MRV before treatment shows a poor demonstration of all of the plexuses.
- c) After treatment, IVP and AV were clearly demonstrated.

non-invasive and more useful method for detecting a deep venous thrombosis in the lower extremities than other methods⁴). However,

there is little information available regarding the effectiveness of the MRV for demonstrating venous plexuses in spinal lesions. Enomoto

clearly demonstrated lumbar venous plexuses by a 3D reconstruction technique by using Gd-DTPA, and the concluded that venous plexuses could be detected in 77.5% of 31 cases by this method¹⁾. We applied the same method as Enomoto's to the examination of the anterior cervical venous plexuses. With Gd-DTPA, the reduced T₁ relaxation effect within veins enhances the anterior venous plexuses. Since the pedicle is a good anatomical landmark, the venous system surrounding the pedicle could be clearly observed from all directions without losing the reference point.

The current study did not find any significant difference in the scores before and after direct skull traction. However, the IVP and IV scores at C5, where the lesion was most often present, were lower than those at a higher level. An earlier report of catheter cervical venography by Miyasaka et al.⁵⁾ indicated that interruption of the internal vertebral plexuses and internal veins with cervical disc disease and dilatation of these veins above the affected sites. The current method was unable to detect slower flow. To overcome these disadvantages, a subtraction method based upon the flow phase may be helpful. In myelopathy patients, anterior cervical venous plexuses were poorly demonstrated before treatment, but this improved along with the clinical symptoms after direct skull traction^{6),7)}.

CONCLUSION

MR venography can provide useful but limited information on the effect of direct skull

traction.

ACKNOWLEDGMENTS

The authors wish to thank Prof. Hirohiko AZUMA, President of Saitama Medical School and former Chief of the Department of Orthopaedic Surgery, and Prof. Atsuko HESHIKI, Chief of the Department of Radiology, Saitama Medical School for their excellent guidance in this study.

REFERENCES

- 1) Enomoto K : 2D MR angiography of lumbar venous plexuses. *Nippon ACTA Radiologica* 1994 ; 54 : 40-45
- 2) Mattel HP, Wentz KU, Edelman RR, Wallner B, Finn JP, Barnes P, Atkinson DJ, Kleefeld J, Hoogewoud HM : Cerebral venography with MR. *Radiology* 1991 ; 178 : 453-458
- 3) Ikawa F, Sumida M, Uozumi T, Kiya K, Kurisu K, Arita K, Satouh H : Demonstration of the venous systems with Gadolinium-enhanced three-dimensional phase contrast MR venography. *Neurosurg Rev* 1995 ; 18 : 101-107
- 4) Spitzer CE, Sostman HD, Wilkes DC, Coleman RE : Deep venous thrombosis : experience with gradient-echo MR imaging in 66 patients. *Radiology* 1990 ; 177 : 235-241
- 5) Miyasaka K, Takei H, Ito T, Tashiro K, Abe H, Tsuru M : Catheter cervical venography. *Neuroradiology* 1978 ; 16 : 413-415
- 6) Kang JD, Bohlman HH : Cervical spondylotic myelopathy. *Curr Opin Orthop* 1996 ; 7 (II) : 13-21
- 7) Shin M : An experimental study of cervical myelopathies due to venous congestion. *J Jpn Orthop Assoc* 1972 ; 46 : 155-166