



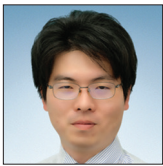
Original Article

Morphological changes in nerve rootlets in patients with cervical radiculopathy assessed using computed tomography myelogram

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ABSTRACT

Background: There are only a few reports that utilize computed tomography myelogram (CTM) to define cervical nerve rootlet compromise in patients with radiculopathy. Here, we assessed the characteristic morphological changes in nerve rootlets in 32 cases with cervical radiculopathy by analyzing CTMs warranting anterior foraminotomy.

Methods: CTMs were analyzed to elucidate morphological changes in nerve rootlets in 31 patients/32 cases with cervical radiculopathy. Notably, three of the four neurosurgeons evaluating these CTM had to agree on the presence of “significant” changes consisting of contrast-enhanced defects near the entrance of the intervertebral foramen on axial sections.

Results: Our findings included; posterior deviation of the ventral rootlet on the sagittal section (63%), ventral rootlet meandering or horizontalization (52%), and dorsal rootlet meandering (39%) on the coronal section. Furthermore, 16% of cervical nerve rootlets may exhibit an abnormal course proximal to the compression site (i.e., the definition of the “rootlet stagnation sign”).

Conclusion: CTM better defines the anatomy, pathology, and radiology impacting the anterior or posterior cervical roots in patients presenting with cervical radiculopathy.

Keywords: Anterior foraminotomy, Cervical nerve root, Cervical radiculopathy, Computed tomography myelogram

INTRODUCTION

Here, we studied how computed tomography myelogram (CTM) better defined the pathology of cervical nerve rootlets for 31 patients/32 cases presenting with cervical radiculopathy about to undergo anterior cervical foraminotomies.^[1,2]

MATERIALS AND METHODS

We assessed 32 cases of cervical radiculopathy in 31 patients, with an average age of 57.4 years (36–81 years), undergoing anterior cervical foraminotomies at the C4/5 (one case: 3%), C5/6

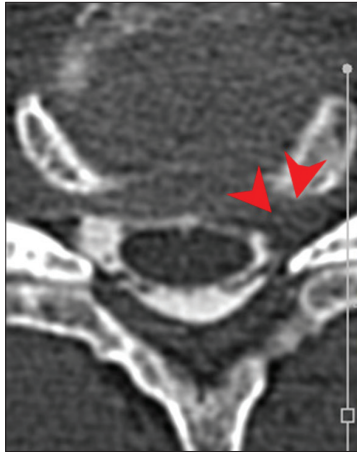


Figure 1: Horizontal section of computed tomography myelogram showing contrast-enhanced defects near the entrance of the intervertebral foramen (arrowheads).

(three cases: 9%), C6/7 (22 cases: 69%), and C7/T1 (six cases: 19%) levels. In addition, clinical outcomes were assessed utilizing the visual analog scale (VAS) [Table 1]. This study was approved by our Institutional Review Board.

Evaluation of CTMs

CTMs were performed and then reviewed by four neurosurgeons who independently evaluated all 31 patients/32 cases who underwent anterior cervical foraminotomy for cervical radiculopathy. Studies were considered “positive” when three of four neurosurgeons agreed on the findings.

RESULTS

Outcomes

Postoperatively, the VAS improved in all patients; median values for the preoperative neck-shoulder and upper limb

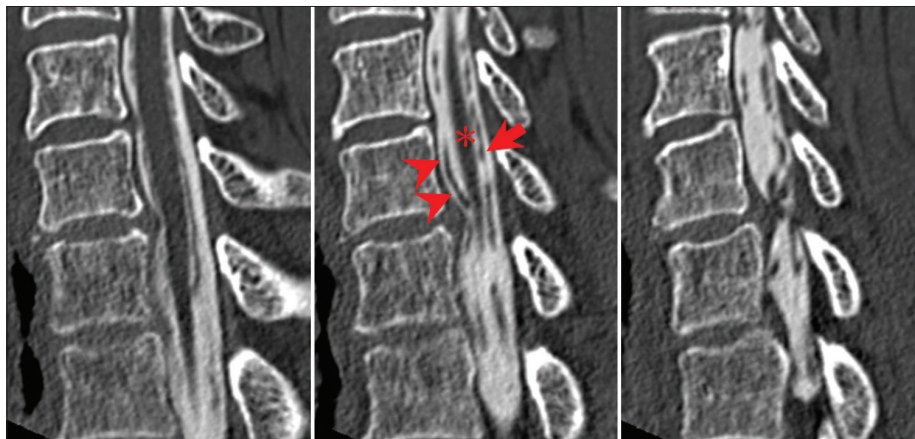


Figure 2: Sagittal section of computed tomography myelogram showing posterior deviation of the ventral rootlet (arrowheads: ventral rootlet, arrow: dorsal rootlet, and asterisk: spinal cord). Ventral rootlet identification was confirmed by examining serial slices of the sagittal section.

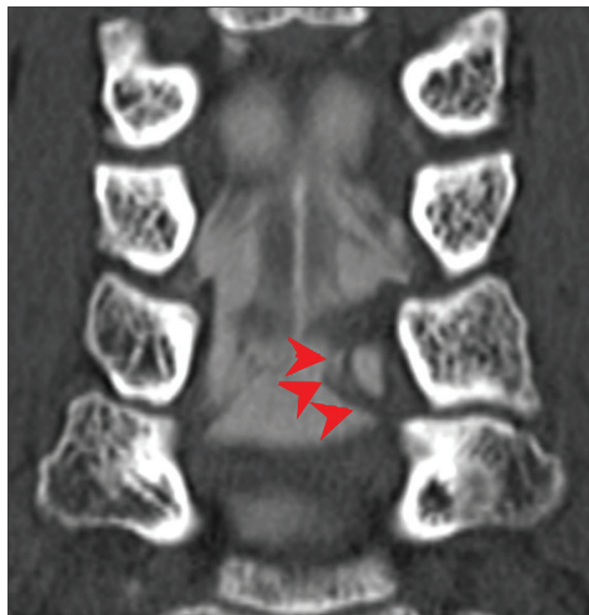
Table 1: Inclusion criteria.			
	Number of cases	Number of patients	Exclusion criteria for the next step
Anterior cervical foraminotomies※	45	44	Patients who could not undergo preoperative CTM
CTM prior to the operation	43	42	Patients who underwent ACDF at another level simultaneously Patients who underwent anterior cervical foraminotomies at multiple levels simultaneously
Clinical outcome evaluation using VAS※※	37	36	Patients with a VAS improvement of less than 50% in the region (in two regions) with a higher preoperative VAS score Patients with equal preoperative VAS scores in the two regions were excluded, if the improvement in both VAS scores was <50% Patients in whom either of the VAS scores worsened after operation compared with the preoperative VAS score
CTM analysis	32	31	

※One of these patients underwent anterior cervical foraminotomy twice because of recurrence at another level. ※※Both VAS of the neck-shoulder and upper limb regions evaluated using pre- and post-operative questionnaires (days after surgery=median [range]: 7 [5–32] days). CTM: Computed tomography myelography, ACDF: Anterior cervical discectomy and fusion, VAS: Visual analog scale

Table 2: Evaluation of the computed tomography myelogram.

Findings	Image	Positivity rate (%)
Contrast-enhanced defects near the intervertebral foramen decompression site	Axial	100
Posterior deviation of the ventral rootlet	Sagittal	63
Ventral rootlet meandering or horizontalization	Coronal	52※
Dorsal rootlet meandering	Coronal	39※
Rootlet stagnation sign	Axial	16

※One patients excluded

**Figure 3:** Coronal section of computed tomography myelogram showing meandering or horizontalization of the ventral rootlet (arrowheads).

VAS were 7 (1–10) cm and 7 (0–10) cm, respectively. Median values of the postoperative neck-shoulder and upper limb VAS were 1 (0–8) cm and 0.5 (0–3) cm, respectively.

Evaluation of CTM

Contrast-enhanced defects near the entrance of the intervertebral foramen were seen in all 32 cases on axial CTMs, while posterior deviation of the ventral rootlets was seen in 63% of patients on serial sagittal studies [Figures 1 and 2, Table 2]. In addition, meandering or horizontalization was documented on coronal images in 52% of cases and meandering for the dorsal rootlets on coronal images in 39% of the cases [Figures 3 and 4]. Further, “stagnation” of the nerve rootlet or the “rootlet stagnation sign,” indicative of proximal compression of

**Figure 4:** Coronal section of computed tomography myelogram showing meandering of the dorsal rootlet (arrowheads).

the root was observed on horizontal contrast-enhanced studies 16% of the time, but with an extensive range from 9% to 59% [Figure 5].

DISCUSSION

This study examined the efficacy of CTMs in displaying the morphological changes of the nerve rootlets in patients with cervical radiculopathy. Abnormal contrast-enhanced CTMs documented proximal compression of the cervical nerve roots (i.e., “rootlet stagnation sign”) on axial, sagittal, and coronal CTMs proximal to the compromised neural foramina [Figures 6a and b]. Anterior compression on axial images further showed how both the ventral and dorsal rootlets were also compressed posteriorly just proximal to the neural foramina (i.e., “rootlet stagnation sign”) [Figure 6c]. In summary, these CTMs may help elucidate the indications for/need for anterior cervical foraminotomies in patients with cervical radiculopathy.

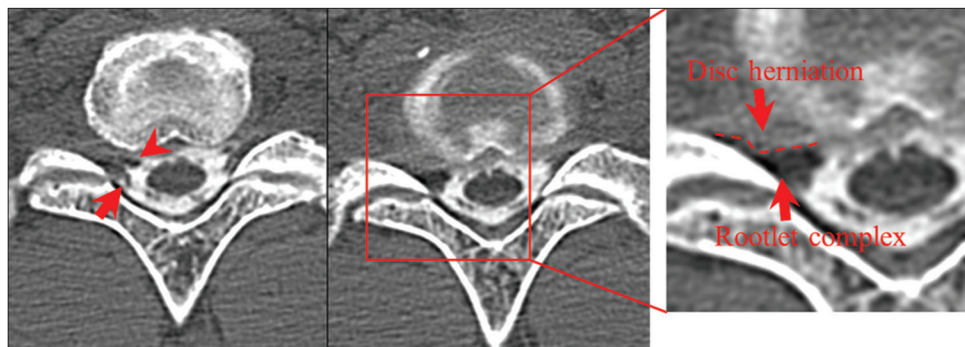


Figure 5: Horizontal section of computed tomography myelogram showing contrast-enhanced defects contributed by rootlet stagnation (arrowhead: ventral rootlet and arrow: dorsal rootlet). In this representative case, the disk contrast and rootlets complex could be clearly differentiated based on the density of CT images.

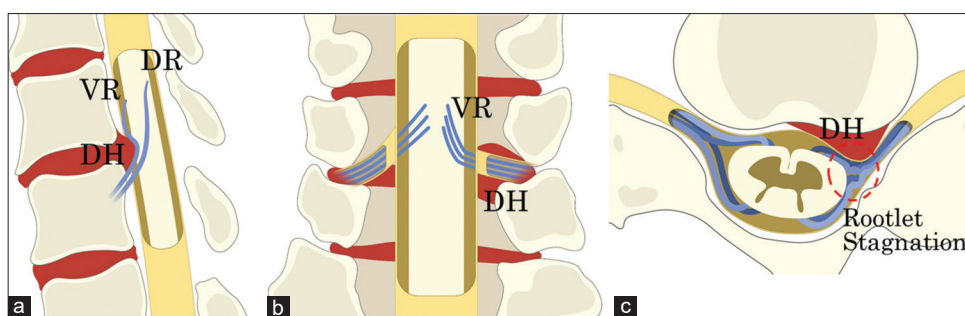


Figure 6: Illustrated images of the morphological changes in cervical nerve rootlets in cervical radiculopathy. (a) The sagittal image shows posterior deviation of the ventral rootlet due to anterior compression. (b) The coronal image shows the ventral rootlet coursing laterally, near the entrance of the intervertebral foramen. (c) The axial image shows the ventral and dorsal rootlets coming close together due to anterior compression at the proximal margin of the compression in the dural canal, and the rootlets appear to be stagnating near the entrance of the intervertebral foramen (“rootlet stagnation sign”). VR: Ventral root, DR: Dorsal root, and DH: Disk herniation.

CONCLUSION

For patients with cervical radiculopathy, preoperative CTMs document multiple abnormalities on the axial, sagittal, and coronal sections that provide further documentation as to whether anterior foraminotomies are warranted.

Declaration of patient consent

Institutional Review Board (IRB) permission obtained for the study.

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Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Sato S, Miyoshi S. A study of MRI findings and CT myelograms of the cervical foraminotomy cases. *Nihon Sekitsuseikizuiyougakkai Zasshi* 2005;16:117.
2. Song KJ, Choi BW, Kim GH, Kim JR. Clinical usefulness of CT-myelogram comparing with the MRI in degenerative cervical spinal disorders: Is CTM still useful for primary diagnostic tool? *J Spinal Disord Tech* 2009;22:353-7.

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