www.jkns.or.kr http://dx.doi.org/10.3340/jkns.2012.52.6.513
Print ISSN 2005-3711 On-line ISSN 1598-7876
J Korean Neurosurg Soc 52 : 513-516, 2012

Clinical Article

Medial Loop of V2 Segment of Vertebral Artery Causing Compression of Proximal Cervical Root

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Objective : It is rare that the medial loop in the V2 segment of the vertebral artery (VA) causes compression of the proximal cervical root of the spinal cord without leading to bony erosion and an enlarged foramen. We evaluated the clinical significance and incidence of the medial loop in the V2 segment of the VA.

Methods : We reviewed the records from 1000 consecutive patients who had undergone magnetic resonance imaging evaluation of the cervical spine between January 2005 and January 2008. The inclusion criteria were that over a third of the axial aspect of the VA located in the intervertebral foramen was inside the line between the most ventral points of the bilateral lateral mass, and that the ipsilateral proximal root deviated dorsally because of the medial loop of the VA. We excluded cases of bone erosion, a widened foramen at the medial loop of the VA, any bony abnormalities, tumors displacing VA, or vertebral fractures. The medical records were reviewed retrospectively to search for factors of clinical significance.

Results : In six patients (0.6%), the VA formed a medial loop that caused compression of the proximal cervical root. One of these patients had the cervical radiculopathy that developed after minor trauma but the others did not present with cervical radiculopathy related to the medial loop of the VA.

Conclusion : The medial loop of the VA might have a direct effect on cervical radiculopathy. Therefore, this feature should be of critical consideration in preoperative planning and during surgery.

Key Words : Vertebral artery · Medial loop · Spine.

INTRODUCTION

Anterior cervical discectomy and fusion has been performed on patients with cervical degenerative disc disease for the past 50 years[2]. Because a thorough understanding of anatomy related to surgical approach is imperative to prevent catastrophic complications, surgeons should be aware preoperatively of the anatomical variations that can be found for the vertebral artery (VA), internal carotid artery, jugular vein, recurrent laryngeal nerve, and sympathetic nerve[8,9].

Although injury to the VA is rare, it can lead to devastating clinical consequences, such as permanent neurological deficit or death[7,10]. Many variations in the VA have been reported[3,10,13]. The portion of the VA between the transverse process of C-6 and the transverse process of C-2 is called the V2 segment[7,10]. The incidence of an anomalous V2 segment including an abnormal VA entrance, a medial location of the VA, a tortuous VA, was described in 10% of cases[3,15].

Because injury to the VA can be catastrophic, many authors have emphasized the importance of preoperative imaging including computed tomography (CT) angiography or magnetic resonance imaging (MRI)[10,16,17]. To improve surgical safety to the subaxial cervical spine, an awareness of variability in the V2 segment of the VA is critical for a surgeon.

Among the reports on anomalies of the V2 segment, few have described the medial loop of the VA[3]. Moreover, no study has focused on the clinical significance of the medial loop of the VA in the V2 segment and its impact on the cervical proximal root. Therefore, we studied the medial loop of the VA associated with the proximal cervical root in the V2 segment.

MATERIALS AND METHODS

We reviewed the case records from 1000 consecutive patients

• Received : June 29, 2012 • Revised : September 29, 2012 • Accepted : December 18, 2012
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who had undergone MRI evaluation of the cervical spine between January 2005 and January 2008. Patients were included in the study if they had MRI axial images from C2 to C7 and sagittal MRI sections available. However, we excluded cases of bone erosion, a widened foramen at the medial loop of the VA, bony abnormalities, tumors displacing the VA or vertebral fractures. The widened foramen was defined that the axial area of the foramen with the medial loop of the VA was larger than the area of the contralateral foramen without the medial loop of the VA. When the VA causes erosion of the vertebral body or if there is a widened foramen with medial looping of the VA, the possibility of root compression could decrease. Therefore, the presence of erosion and of a widened foramen was added to the exclusion criteria. There were 598 male and 402 female patients enrolled; ranging in age from 10 to 96 years (mean 51.4±13.96).

The medial loop of the V2 segment that caused cervical proximal root compression was defined from the following radiological criteria : over a third of the axial aspect of the VA located in the intervertebral foramen was inside the line between the most ventral points of the bilateral lateral mass, and the ipsilateral proximal root was deviated dorsally by the medial loop of the VA (Fig. 1). Cases in which there was bone erosion or a widened foramen caused by the medial loop of the VA was excluded.

The medical records of all cases satisfying these radiological criteria were reviewed and we evaluated the cervical radiculopathy corresponding to the presence of a medial loop of the VA.

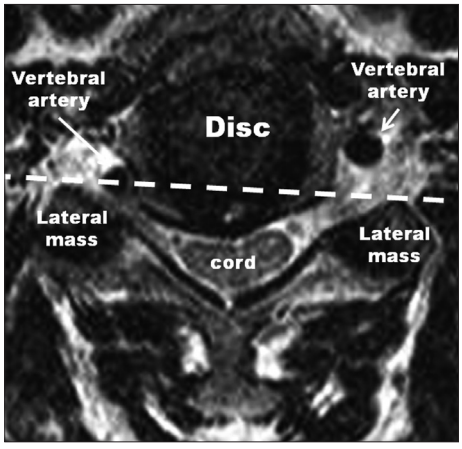

Fig. 1. This picture shows a transaxial section at the level of intervertebral disc. Over a third of the axial aspect of left vertebral artery located in the intervertebral foramen is inside the dotted line between most ventral points of bilateral lateral mass.

RESULTS

In six patients (0.6%), the VA formed a medial loop causing proximal cervical root compression (Table 1). Only one patient (Case 1) had been involved in a minor road traffic accident, after which she began to experience a tingling sensation in the left arm. On neurological examination, there was a sensory disturbance in the left C4 dermatome associated with a positive Spurling sign. An MRI scan was performed revealing a medial VA loop without an enlarged foramen. This had compressed the C4 root because of a tortuous VA on the left side (Fig. 2). The patient had experienced no previous symptoms related to the cervical lesion and complained of a tingling sensation of less than 4 points on a visual analogue scale. Therefore, physiotherapy and therapy with non-steroid anti-inflammatory agents were started. The patient stopped complaining of the tingling sensation in the left arm at the second follow-up visit 2 weeks after therapy initiation. On follow-up 3 months later, there was no symptom related to the cervical spine.

The other five cases with a medial loop of the VA had no related symptoms such as equilateral cervical radiculopathy (Fig. 3). All five cases (83%) had a left-sided medial loop. In Case 5, the VA with a medial loop was the dominant artery and other cases did not have a dominant artery. In three cases (Case 1, 3 and 5), the medial loops were located at the level of C3-4 : in two cases, it was at C4-5 and in one case it was at C5-6.

DISCUSSION

The medical literature mentions several anatomical variations in the VA[3,12,14]. An abnormal course of the VA can cause vessel injury related to serious consequences during cervical surgery. Therefore, authors have emphasized that preoperative MRI or CT scans should be conducted to avoid inadvertent tearing during an anterior or lateral approach to the cervical spine[3,10]. Abnormal levels of entrances of the VA into the C3, C4, C5 and C7 vertebrae and medial loops of the VA, with and without bony erosion were typical abnormalities at the V2 segment[1,3,12,13,15]. The incidence of an abnormal entrance of the VA was reported in 5-7% of cases[13].

Table 1. Demographic data of patients

Case number	Age	Sex	Level	Symptom	Relation to ML of VA
1	27	F	C3-4, Lt	Paresthesia on left arm	Yes
2	51	F	C3-4, Lt	Presthesia on right arm	No
3	55	M	C4-5, Lt	Neck pain	No
4	65	M	C3-4, Lt	Dysesthesia on both hands	No
5	67	F	C4-5, Lt	Presthesia on right arm	No
6	77	M	C4-5, Lt	Sudden right arm weakness	No

ML : medial loop, VA : vertebral artery

The V2 portion of the VA is relatively straight and it is usually located in the extraforaminal area. The medial loops of the VA can course ventromedially to the vertebral body and can develop medially and laterally to some degree, without direct contact with the cervical root[3]. However, when the degree of looping becomes more convoluted, a tortuous vessel could form at the V2 segment with or without enlargement of the transverse foramen, erosion of the vertebral body, or root compression[3,5,6]. There are a few reports on a medial loop of the VA and the incidence ranged between 2.0 and 5.6%[3,10]. In the present study, the incidence (0.6%) was less than in other reports. This was because we excluded cases with bony erosion or an enlarged foramen caused by the VA and included one case with proximal root compression. One report related to anatomical variations of the VA stated that the incidence of a medial loop of the VA protruding into the proximal part of the intervertebral foramen was 0.8%[3]. Reports based on cadaveric and imaging studies only emphasized the importance of preoperative investigations and only two reports described spontaneous cervical radiculopathy[4,11]. However, none of the cases in the present study developed symptoms spontaneously. Case 1 had radiculopathy that developed after minor trauma. In axial MRI images, the medial loop of the VA was located in the proximal portion of the foramen and caused compression of the cervical root. The lesion did not cause spontaneous cervical radiculopathy in the present study. This was probably because the VA could not exert a strong pulsatory effect on the proximal root and there might be a remaining space for the root based three-dimensional constructions. In two other reports with cervical radiculopathy associated with the medial loop of the VA, the symptoms were treated with either conservative or surgical approaches[4,11]. In the present study, the cervical radiculopathy was resolved after conservative treatment.

It is more effective to investigate the foraminal area in oblique images than that in sagittal images. Therefore, a future study will use this approach. It will also be necessary to reveal any concordant radiculopathy using nerve conduction studies. Based on this and the other aforementioned cases, the medial loop of the VA might be a cause of cervical radiculopathy. In future studies, we should use three-dimensional CT scans of the foramen of the cervical spine for evaluating the VA.

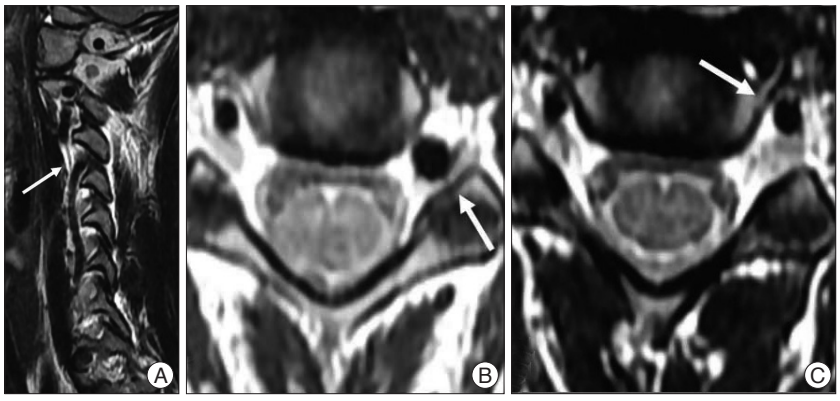

Fig. 2. Medial loop of vertebral artery on MRI scans. T2-weight sagittal MRI section shows a disappearance of vertebral artery at the level of the C3-4 foramen (white arrow) (A). T2-weight axial MRI scans show a abnormal position of the vertebral artery leading to compressing of the left C4 root at the level of the C3-4 foramen (white arrow) (B) and normal position of vertebral artery at the level of the C4-5 foramen (white arrow) (C).

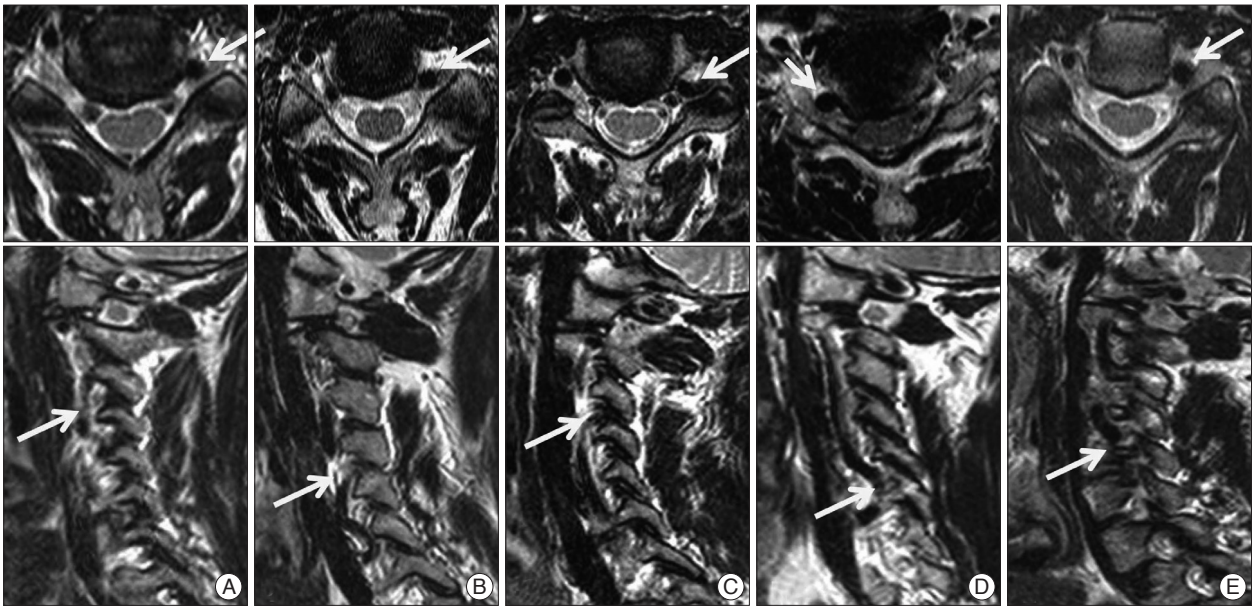

Fig. 3. The vertebral arteries form medial loops into intervertebral foramens and compress the proximal cervical roots (arrow). Upper and lower rows indicate the axial and sagittal section of T2 weight image in MRI scans. Fig. 3A to E corresponds with cases 2 to 6.

CONCLUSION

It is rare that the medial loop of the VA in the V2 segment causes compression of the proximal cervical root without leading to bony erosion and an enlarged foramen. Thus, the presence of a medial loop of the VA might lead to cervical radiculopathy and requires critical consideration during surgery.

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