Redundant anomalous vertebral artery in a case of congenital irreducible atlantoaxial dislocation: Emphasizing on the differences from the first intersegmental artery and operative steps to prevent injury while performing C1-2 joint manipulation

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ABSTRACT

Anomalous vertebral artery (VA), commonly the persistent first intersegmental artery (FIA) is often seen with congenital atlantoaxial dislocations (AAD). An unusual redundant/ectatic loop of VA passing below the C1 (upside down VA) has been described below and appears to be different from FIA. The operative technique to protect it while C1-2 joint manipulation has been described. A 35 year old male presented with progressive spastic quadriplegia after trivial trauma. Radiology showed irreducible atlantoaxial dislocation with occipitalised C1 and C2-3 fusion. The left VA was anomalous passing beneath the C1 arch with a redundant loop lying posterior to the C1-2 joint. This was unlike the persistent first intersegmental artery (FIA) and was safeguarded while dissecting the C1-2 facet. The artery was dissected and safeguarded while performing C1-2 joint manipulation. A redundant/ectatic loop lying posterior to C1-2 joint is an unusual variant of anomalous VA. Evaluation of preoperative radiology helps in diagnosing such anomalous VA. Dissection of the entire redundant loop of the anomalous artery is important in opening the C1-2 joint required for reduction and placement of spacer/ bone grafts to achieve good bony fusion. Also mobilizing the loop allows safe insertion of lateral mass screw. Care needs to be taken while fastening screws to prevent compression of the loop.

KEY WORDS: Vertebral artery anomaly; Redundant loop; Persistent first intersegmental artery; Operative steps; Injury prevention

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Introduction

Anomalous vertebral artery (VA) or its branches are not uncommon with congenital craniovertebral junction (CVJ) disorders.¹⁻⁴ Unfortunately little has been discussed about safeguarding such vessels during dissection of the C1-2 joint posteriorly, required for reduction and achieving a good bony fusion.³ We describe an unusual redundant loop of

VA, in a patient with congenital Irreducible atlantoaxial dislocation (IrAAD). This anomalous vessel was safeguarded intraoperatively while achieving C1-2 posterior reduction and fusion.

Case description

A 35 year old male presented with progressive spastic quadriplegia of 3 months duration following trivial trauma. He wasn't able to work but was able to perform activities of daily living. Radiology showed occipitalised C1 with C2-3 fusion with Irreducible AAD causing compression at the cervicomedullary junction. The C1 inferior facet angles measured 145° (Figure 1A-C).⁵ The CT angiogram showed left anomalous VA (Figure 1 lower row). The left VA after exiting from the C2 transverse foramen took a lateral course towards the C1 transverse foramen. However, instead of traversing through the C1 foramina it turned medially and inferiorly, forming a superior

loop coursing beneath the C1 arch and crossing the C1-2 joint. It formed another short inferior loop here taking a 'U' turn and coursed superiorly before piercing the dura. (Figure 1 lower row). He experienced incomplete reduction on traction.

The C1-2 joints were approached posteriorly. (video clip 1). Bilateral C2 nerve root ganglia were cut. The left anomalous VA loop was seen anterior to the C2 ganglia. The ectatic VA was dissected carefully to expose the entire loop. No spicule could be appreciated. The loop was retracted superiorly while the posterior wedge of C2 and anterior wedge of C1 facet were drilled to make the inferior facet angle flat. Spacers and bone grafts were placed in the C1-2 joint spaces. The VA loop was gently retracted inferiorly to insert the C1 lateral mass screws. The screws were tightened taking care to leave enough space between the screw head and the facet surface for the VA. Good reduction was achieved.

The postoperative course was uneventful and he recovered completely. He is independent and has resumed work at 3 month follow up. Informed Consent was obtained from patient before carrying out the study.

Discussion

In its normal course the VA courses postero-laterally after exiting from the C2 transverse foramen to enter the transverse foramen of atlas, forming a short proximal loop. It then courses obliquely on the dorsum of the posterior arch of atlas forming the distal loop before penetrating the posterior atlanto-axial

Fig. 1: Upper row: A & B) Mid sagittal CT and MRI image showing AAD & BI with cervico-medullary junction compression C) Parasagittal CT section through left C1-2 joint showing (arrow) oblique C1 facet. Lower row: 3D CT angio-left anomalous VA with proximal superior loop (arrow) reaching just short of transverse foramen and then turning horizontally beneath the C1 arch posterior to its inferior facet. This is followed by an inferior distal loop (arrow). The course of right VA is normal. The left and right oblique views showing the Right and left VA with its relationship to the C1-2 facets.

Fig. 2: Upper row: Intraoperative images showing A) Left anomalous VA (*) and its ectatic loops lying posterior to the C1-2 joint. B) the ectatic loop is retracted superiorly and protected while drilling the joint. C) the ectatic loop (*) is seen below the rod but free of compression. 1-2 joints. Lower row: D) Midsagittal CT image showing complete reduction of Atlanto-axial dislocation. E) parasagittal CT image passing through left C1 and C2 facets with screws and spacers. Note the flat drilled inferior surface of C1 facet as compared to preop. Also note the adequate space between the posterior surface of inferior C1 facet and the screw head, enough to house the anomalous VA loop without compressing it.

membrane and dura.^{6,7} However, the course may be abnormal in congenital craniovertebral junction anomalies. It is extremely important to know such an anomalous VA to avoid its inadvertent injury especially if direct posterior reduction and fusion by manipulation of C1-2 joint is planned.³

A variety of anatomical aberrations of VA between C2 and C1 have been described.¹⁻⁴ A unilateral ectatic loop of VA with bony segmentation defects has been described in the past.² Though passing beneath the C1 arch, such an ectatic loop of VA is different from the persistent First intersegmental artery (FIA).^{1,3} The proximal and distal loops are not seen in FIA. Of interest, the proximal loop reached just short of the C1 transverse foramen.

Embryologically, the VA is formed by vertical channel interconnecting the cervical intersegmental arteries. These intersegmental arteries disappear whereas the vertical connections persist.⁸ The portion of VA between in C2 and C1 is possibly derived from various channels of which only one remains. This is akin to formation of vertebro-basilar junction from various channels and thereby giving rise to a large number of variations.⁹ If the first intersegmental artery persists alone, it leads to FIA. If the connecting channel persists with the first intersegmental artery it leads to fenestration. The connecting channels may be both cranial and caudal to the first sclerotome. If both the cranial channels and the first intersegmental artery gets blocked due to some reason, the caudal channels would persist giving rise to such ectatic anomalous VA. However, a possibility of traction on the FIA in the embryological stage due to a spicule, giving rise to loops cannot be ruled out.

The anomalous vessel may be injured during manipulation drilling of facet surfaces and placement of spacers and insertion of lateral mass screws. The operative steps to safeguard anomalous VA have been described.³ It is preferable to expose the redundant loop so that it can be easily retracted superiorly to expose the joint space for drilling and placement of spacers. Later it can be displaced down gently for exposure of posterior surface of C1 facet for screw insertion. The screw length should be adequate to get a good purchase, taking care that the screw head doesn't compress the VA. Some surgeons may prefer an OC2 fusion in presence of anomalous VA especially with occipitalised C1, thereby avoiding the artery.

However, it is difficult to reduce the dislocation without opening the facets.

A careful evaluation of preoperative angiogram gives an idea of anomalous VA. Careful dissection of the loop of such an artery beneath the C1 arch provides a good access to C1-2 facets for reduction and fusion without injuring it. The length of the C1 screw needs to be chosen properly so as to gain adequate bony purchase without compromising this anomalous VA.

Authorship Contribution

Devi P Patra: Manuscript drafting, **Pravin Salunke:** Design and concept and collection of data, **Sushanta K Sahoo:** Collection of data, **Mandeep Ghuman:** Collection of data

References

1. Futane S, Salunke P. Klippel-Feil syndrome with atlanto-axial dislocation, anomalous vertebral artery, dextrocardia and situs inversus. *Clin Neurol Neurosurg.* 2013; 15(10): 2304-6.
2. Jian FZ, Santoro A, Wang XW et al. A vertebral artery tortuous course below the posterior arch of the atlas (without passing through the transverse foramen). Anatomical report and clinical significance. *J Neurosurg Sci.* 2003; 47(4): 183-7.
3. Salunke P, Futane S, Sahoo SK et al. Operative nuances to safeguard anomalous vertebral artery without compromising the surgery for congenital atlantoaxial dislocation: untying a tough knot between vessel and bone. *J Neurosurg Spine.* 2014; 20(1): 5-10.
4. Yamazaki M, Okawa A, Furuya T et al. Anomalous vertebral arteries in the extra- and intraosseous regions of the craniovertebral junction visualized by 3-dimensional computed tomographic angiography: analysis of 100 consecutive surgical cases and review of the literature. *Spine (Phila Pa 1976).* 2012; 37(22): E1389-97.
5. Salunke P, Sharma M, Sodhi HB et al. Congenital atlantoaxial dislocation: a dynamic process and role of facets in irreducibility. *Clinical article. J Neurosurg Spine.* 2011; 15: 678-685.
6. Cacciola F, Phalke U, Goel A. Vertebral artery in relationship to C1-C2 vertebrae: an anatomical study. *Neurol India.* 2004; 52(2): 178-84.
7. Sawlani V, Behari S, Salunke P et al. "Stretched loop sign" of the vertebral artery: a predictor of vertebrobasilar insufficiency in atlantoaxial dislocation. *Surg Neurol.* 2006; 66(3): 298-304; discussion 304.
8. J.N. Bavinck, Weaver DD. Subclavian artery supply disruption sequence: hypothesis of a vascular etiology for Poland, Klippel-Feil, and Möbius anomalies. *Am J Med Genet.* 1986; 23: 903-918.
9. Macchi V, Porzionato A, Guidolin D et al. Morphogenesis of the posterior inferior cerebellar artery with three-dimensional reconstruction of the late embryonic vertebrobasilar system. *Surg Radiol Anat.* 2005; 27(1): 56-60.