

Complex Atlantoaxial Dislocation with Basilar Invagination and an Anomalous Dominant Right Vertebral Artery: C1 Lateral Mass Screw Placement Above the Vertebral Artery

Saddam Singh¹, Sotin P², Nikhil Bhatt³, Aditya Shrivastava⁴

¹Resident (MCh Neurosurgery), Department of Neurosurgery, G.R. Medical College & J.A. Group of Hospitals, Gwalior, Madhya Pradesh, India

Corresponding Author Email: [sotinpukhrambam\[at\]gmail.com](mailto:sotinpukhrambam[at]gmail.com)

ORCID ID: <https://orcid.org/0000-0002-0144-4581>

²Resident (MCh Neurosurgery), Department of Neurosurgery, G.R. Medical College & J.A. Group of Hospitals, Gwalior, Madhya Pradesh, India

ORCID ID: <https://orcid.org/0009-0006-9351-0430>;

³Resident (MCh Neurosurgery), Department of Neurosurgery, G.R. Medical College & J.A. Group of Hospitals, Gwalior, Madhya Pradesh, India

ORCID ID: <https://orcid.org/0009-0008-6051-8502>;

⁴Professor, Department of Neurosurgery, G.R. Medical College & J.A. Group of Hospitals, Gwalior, Madhya Pradesh, India

Abstract: *Complex atlantoaxial dislocation (AAD) with basilar invagination (BI) is a craniovertebral junction anomaly that can cause progressive myelopathy, and anomalous vertebral artery (VA) anatomy makes C1–C2 instrumentation hazardous. We report an 18-year-old male with quadriparesis for 2 years, with loss of fine touch and joint position sense, and no history of trauma. Imaging showed complex AAD with BI, atlanto-occipital assimilation, a rotated C1–C2 joint, C2–C3 block vertebra, chronic cervical cord injury at C1 and a dominant, abnormally coursing right VA. Posterior fixation was done with a C2 pedicle screw and a right C1 screw placed above the vertebral artery. There was no blood loss, the post-operative course was uneventful and the post-operative X-ray was satisfactory. Careful pre-operative assessment of VA anatomy allows safe, individualised C1 screw placement.*

Keywords: Atlantoaxial dislocation; Basilar invagination; Vertebral artery anomaly; C1 lateral mass screw; Craniovertebral junction

1. Introduction

Atlantoaxial dislocation with basilar invagination is one of the most challenging craniovertebral junction pathologies. It is often congenital and is associated with atlanto-occipital assimilation, rotational deformity of the C1–C2 joint and variant vertebral artery anatomy.¹ Posterior C1–C2 screw-rod fixation, popularised by Goel and by Harms and Melcher, is the mainstay of treatment, but the vertebral artery is at risk during C1 and C2 screw placement, particularly when its course is abnormal.^{1,2,3} This report presents a patient with complex AAD with BI and a dominant, anomalous right vertebral artery, in whom the C1 screw trajectory was modified to lie above the artery.

Written informed consent was obtained from the patient for the publication of his details and images.

2. Case Presentation

An 18-year-old male presented with weakness of all four limbs for 2 years, which left him unable to carry out his daily activities. There was no history of trauma or of neck pain, and quadriparesis was the only complaint. A congenital atlantoaxial dislocation was suspected.

On examination he was conscious and oriented. Blood pressure was 102/84 mmHg, pulse 76/min and SpO₂ 98% on room air. The pupils were bilaterally normal in size and reactive. Power was 4/5 in all four limbs. Deep tendon reflexes (biceps, triceps, supinator, knee and ankle) were brisk (+3) bilaterally, and sustained clonus was present. Sensory examination showed loss of fine touch and joint position sense. Straight leg raising and FABER tests were negative. Bowel and bladder function was not involved.

MRI of the craniovertebral junction showed complex CVJ anomaly with complete atlanto-occipital assimilation and basilar invagination, with superior migration and retroflexion of the dens, increased atlanto-dental interval and significant foramen magnum crowding. There was ventral compression of the cervicomedullary junction with focal T2 hyperintense myelomalacic/myelopathic signal change in the upper cervical cord at C1, indicating chronic compressive cord injury. Other findings were mild inferior cerebellar tonsillar descent (~5.8 mm) and a congenital C2–C3 block vertebra. CT of the CVJ with 3D reconstruction confirmed complex AAD with BI, a rotated C1–C2 joint, and a dominant right vertebral artery with abnormal anatomy (Figure 1). On CT angiography, the right vertebral artery was dominant and lay

1.39 cm from the C1 lateral mass, while the left vertebral artery lay 1.26 cm from it.

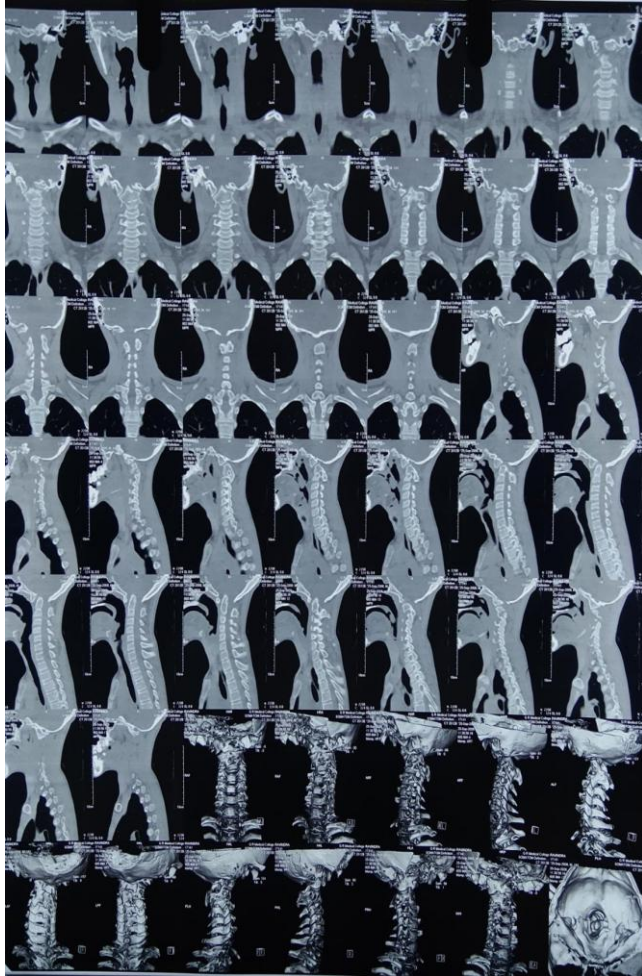


Figure 1: Pre-operative CT (coronal and sagittal MPR, 3D VRT) showing complex atlantoaxial dislocation with basilar invagination

Under general anaesthesia the patient was positioned prone with the head placed on a horseshoe headrest, and a midline posterior exposure was made from theinion to the C3 spinous process. Intra-operatively, the C1–C2 joint was rotated and the right vertebral artery was dominant with abnormal anatomy. The right C1 screw (20 mm) was therefore inserted through the posterior arch, in a trajectory above the vertebral artery. The C2 screw (20 mm) was inserted through the pedicle, and the screws were connected with a rod. The polyaxial screw heads are shown in Figures 2 and 3. There was no blood loss in the operating theatre.

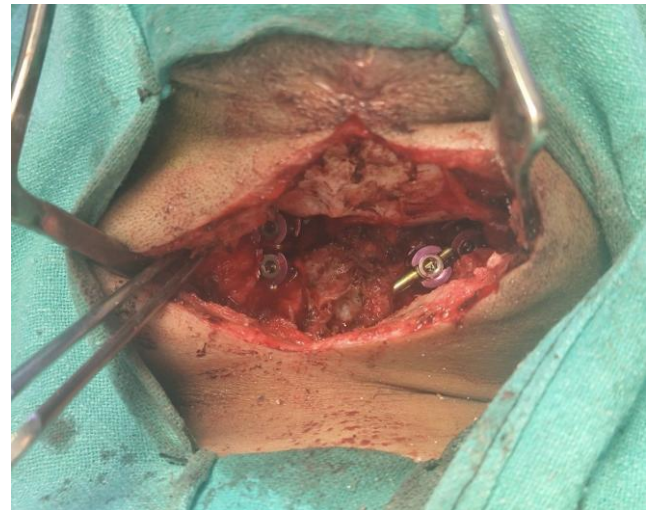


Figure 2: Intra-operative view of the C1 and C2 screws in the surgical field

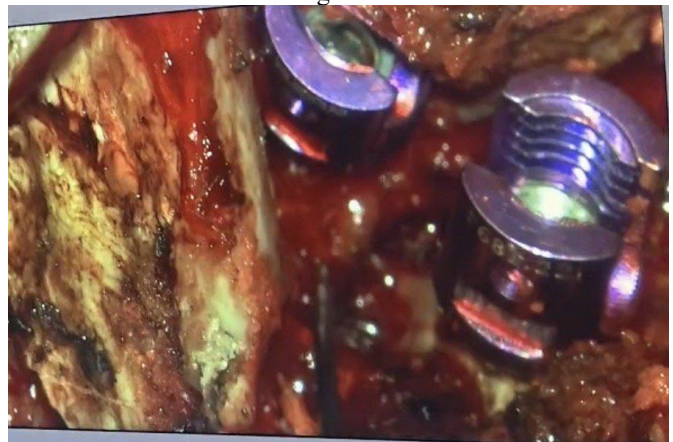


Figure 3: Magnified intra-operative view of the screw heads

The post-operative course was uneventful and the patient remained stable. The post-operative X-ray showed satisfactory screw position and alignment (Figure 4). The patient was discharged walking with support, in a soft cervical collar, and was advised regular follow-up.

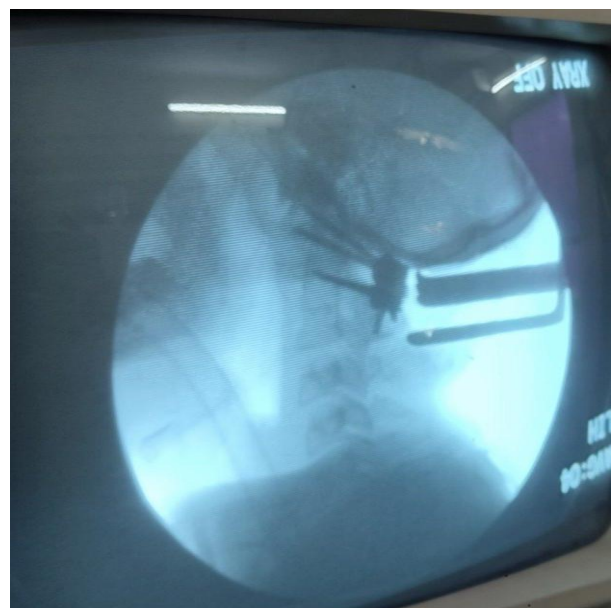


Figure 4: Post-operative X-ray after C1–C2 screw fixation

3. Discussion

In complex AAD with BI, the C1–C2 joints may be rotated, deformed or fixed, and the course of the vertebral artery can be altered by assimilation of the atlas, a high-riding VA or a ponticulus posticus. Pre-operative CT angiography is therefore essential for planning.^{1,2} The standard C1 lateral mass screw is placed through the posterior arch into the lateral mass, close to the vertebral artery groove. When the VA is dominant and runs abnormally, the usual entry point may carry an unacceptable risk, and an individualised trajectory away from the artery is required.

In our patient, the combination of a rotated C1–C2 joint, atlanto-occipital assimilation and a dominant right VA led us to place the right C1 screw above the vertebral artery. Injury to a dominant VA can cause haemorrhage, stroke or death, and its sacrifice is poorly tolerated, which makes preservation critical. Direct C1–C2 joint fixation also restores craniovertebral alignment and treats BI without transoral decompression.^{1,3} The MRI showed chronic cord injury at C1, which is consistent with the long-standing myelopathic signs in this patient. The patient showed good neurological recovery during the follow-up period.

4. Conclusion

In complex atlantoaxial dislocation with basilar invagination and an anomalous dominant vertebral artery, patient-specific planning and a modified C1 screw trajectory above the vertebral artery allowed safe posterior fixation. Surgeons should review the vertebral artery anatomy on CT before any C1–C2 instrumentation.

Acknowledgment

None.

Author's Contributions

[e.g. SS: clinical management, literature survey, first draft; SP: ...; N: ...; AS: concept, supervision, manuscript revision. Confirm each author's role.]

Work attributed to: Department of Neurosurgery, G.R. Medical College & J.A. Group of Hospitals, Gwalior, Madhya Pradesh, India.

Source of Support: Nil

Conflicts of Interest: None declared

References

- [1] Goel A. Treatment of basilar invagination by atlantoaxial joint distraction and direct lateral mass fixation. *J Neurosurg Spine*. 2004;1(3):281–286.
- [2] Goel A, Laheri V. Plate and screw fixation for atlanto-axial subluxation. *Acta Neurochir (Wien)*. 1994;129(1–2):47–53.
- [3] Harms J, Melcher RP. Posterior C1–C2 fusion with polyaxial screw and rod fixation. *Spine*. 2001;26(22):2467–2471.