Eur Spine J
DOI 10.1007/s00586-017-5039-1

CASE REPORT

‘Split and splayed C3’—traumatic lateral C2–3 dislocation without neurological deficits: unique case and its management

Apinderpreeet Singh[1] · Pravin Salunke[1] · Rajeev P. Kamble[2]

Received: 8 November 2016 / Revised: 20 January 2017 / Accepted: 9 March 2017

Abstract
Background Traumatic C2–3 dislocation has been often described in the antero-posterior plane but is extremely rare in the lateral plane. Such dislocations have been described in thoraco-lumbar and C1–2. The need to study the imaging in multiple planes has been highlighted to plan proper realignment.
Methods A young male presented with neck pain alone following a train accident. The imaging showed a fracture of C3 splaying it. The C2–3 showed lateral dislocation in the lateral plane with locked C2–3 facets on one side and C3–4 facets on the other. Through the posterior approach, the dislocation was corrected by manipulating (distraction and rotation) the lateral mass screws and rods. Curvilinear rods helped to maintain realignment after reduction. Residual lateral rotation was corrected by subsequent anterior approach.
Results Compression, distraction and lateral force possibly resulted in such fracture dislocation. Using the technique, the fracture fragments could be realigned perfectly and the reduction was maintained.
Conclusion The saddle shape of the sub-axial cervical spine prevents such lateral dislocations. It is imperative to study the radiology in multiple planes to assess the ‘multiplanar dislocation’. Correction is possible with proper planning and manipulation of facets and bodies using the available instrumentation. Though not obtained in this case, a preoperative MRI and a CT angiogram are important in surgery planning.

Keywords C2–3 dislocation · Traumatic lateral dislocation · Multiplanar realignment

Introduction

The traumatic C2–3 dislocations, including complete subluxation, have been described in the antero-posterior plane [1]. These have been classified further based on the stability and fracture morphology. The classification proposed by Effendi et al., and further modified by Levine and Edward, is the most popular one and provides guidelines for management [2, 3]. Theoretically, the dislocation can occur in any plane. Though rare, lateral dislocation in the cervical spine has been described in the past [4]. However, C2–3 dislocation in the lateral plane is extremely rare. The realignment requires the dislocation to be studied in each plane. The vertebral arteries, spinal cord and nerve roots make it challenging to reduce the dislocation. This requires a combination of force with gentle manoeuvring. The fixation in the realigned position is tricky as well.

We present a case of a young male who presented with severe C2–3 lateral dislocation with facet locking with some rotation and tilt following a railway accident. The patient complained of neck pain alone. He had no sensorimotor deficits. The method to realign and stabilize the spine has been described. Although not performed in our case, certain preoperative investigations that can alter the course of management have been highlighted.

✉ Pravin Salunke
drpravin_salunke@yahoo.co.uk

Apinderpreeet Singh
apinderpreetsingh@gmail.com

Rajeev P. Kamble
ralaxgrs@gmail.com

[1] Department of Neurosurgery, PGIMER, Sector 12, Chandigarh 160012, India

[2] Department of Radiodiagnosis, PGIMER, Chandigarh, India

Published online: 21 March 2017

Case report

A 32-year-old male came to the ER with de-gloving injury of the right forearm following a railway accident. He had fallen off the moving wagon. The head struck against a pole and twisted his neck. There was no sensorimotor deficit but a complaint of persistent neck pain. The conventional lateral cervical spine X-ray revealed as if the C2 and C3 bodies were overlapping, apparently appearing to be fused. The antero-posterior image revealed some abnormality but was not clear. A CT scan of the cervical spine was obtained with reconstruction in multiple planes. In the coronal plane, there was severe C2 over C3 lateral listhesis. The C2 body was lying on the left lateral aspect of the C3 body with locked C2–C3 facets on the left side and C3–4 on the right. Apart from that, there were few degrees of lateral tilt. In the axial plane, a fracture line passing through the C3 body pedicle junction with contralateral lamina was evident. The fracture fragments were splayed. A few degrees of axial rotation were noticed as well. The C3 lateral mass on the left side had dislocated laterally and posteriorly over the C4 mass which was evident in parasagittal cut. Whereas on the right side, the C2 lateral mass had locked medial to the splayed C3 lateral mass (Fig. 1). A CT angiogram was planned, but the patient developed hypersensitivity reaction to the contrast and only a plain CT scan could be acquired. An MRI could not be obtained as the machine at our institute was out of order at that time. We proceeded with surgery without MRI assuming that the lateral dislocation would cause a disc rupture laterally, and would not extrude into the canal during posterior realignment.

Preoperative skull traction was applied 24 h prior to the surgery beginning with 4 kg and gradually increased to 6 kg. The effect of traction was monitored using serial X-rays. There was no C2–3 distraction following traction. He complained of increased neck pain with traction of 6 kg and further increment of weight was stopped. A 360° fixation was planned in view of the significant instability.

Surgery

Initially he was operated through a posterior midline incision. Facets and lamina and C2–3 and 4 lateral masses were exposed on either side. Screws were inserted in C2 pedicle and lateral masses of C3 and C4. Initially, rods were loosely fastened onto the tulips of C3, C4 screws on the left side and C2, C3 screws on the right side. These were then distracted to unlock the facets following which the rods were tightly fastened to maintain distraction. Stout rod holders were used as levers to hold the rods in the centre and rotated clockwise to reduce the lateral dislocation of facets. More torque was applied on the right side. Antero-posterior alignment was achieved by turning the rod holder superiorly. The facets were held in the reduced position using gentle external pressure provided by the assistant. The rods were now replaced by curved rods (convexity inside) to fit C2–3–4 tulips. Bone chips were

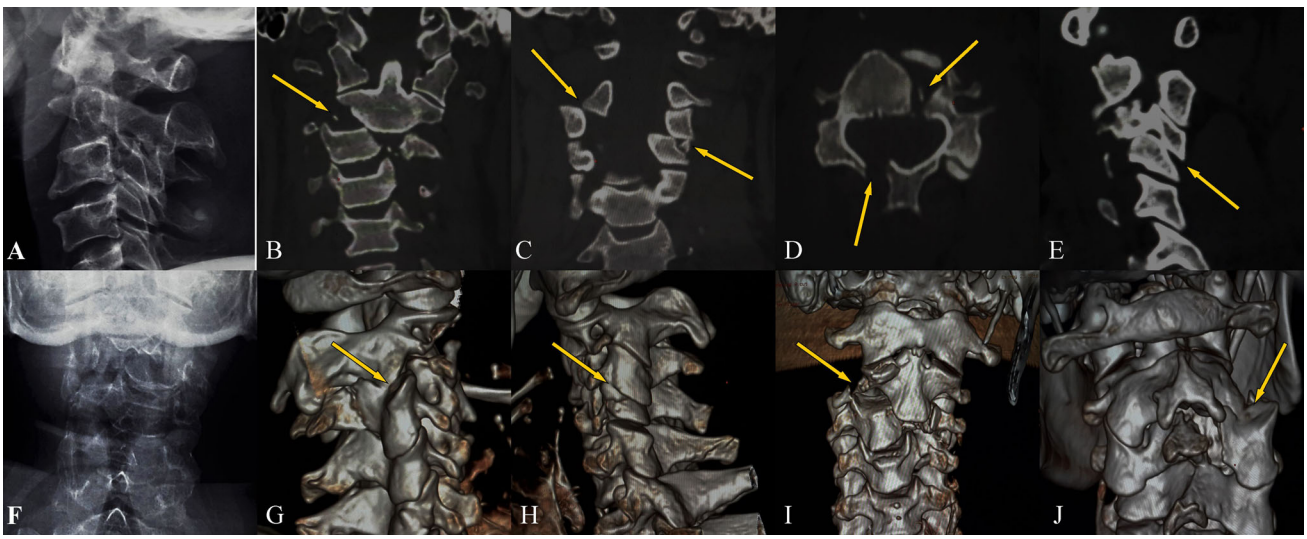

Fig. 1 **a** Preoperative radiology lateral view X-ray showing overlapping C2–3 body confusing it to be fused congenitally, **b** Coronal view CT showing lateral displacement of C2 over C3 body with mild lateral tilt (*arrows in yellow*), **c** coronal CT showing laterally locked C2–3 facets on *right side* and C3–4 on *left side* (*arrows in yellow*), **d** axial image showing fracture of C3 lamina on *right side* and body pedicle junction on *left side* (*arrows in yellow*), **e** parasagittal CT showing antero-posterior locked C2–3 facets (*arrows in yellow*), **f** X-ray C spine AP view showing possible lateral dislocation (*arrows in yellow*), **g**, **h** 3D reconstructed CT images as viewed from right and left lateral aspects, respectively, showing facet dislocation (*yellow arrows*). **i**, **j** Anterior and posterior views showing severe C2–3 lateral dislocation and naked right C3 facet (*yellow arrows*)

inserted in the denuded facet joints after drilling the surfaces. Gentle compression was used over C2–3 as well as C3–4 to keep the facets aligned, which was confirmed by matching the posterior and lateral surfaces (Fig. 2).

Subsequently the patient was turned supine and operated through a transverse incision at the hyoid. There was residual mild C2–3 lateral dislocation still persisting. A discectomy was performed and an osteotome was insinuated flat in the disc space. The osteotome was then rotated anticlockwise to correct the remaining dislocation (Fig. 2). An iliac graft was placed in the disc space and C2–3 was fixed with a plate and screws, while the assistant applied external force on the right lateral aspect of C3 to prevent re-dislocation.

Post-operatively, the patient had no deficits. His neck pain had improved. The post-operative CT showed complete realignment in all planes (Fig. 3). The follow-up scan at 4 months showed that the alignment was maintained, but fusion was yet to occur.

Discussion

In the subaxial spine, maximum movement occurs at C4–5 and C5–6 and the minimum at C2–3 level. Thus, C2–3 should be the most stable joint. The cervical spine injury classification is divided into C1–2 injuries or sub-axial spine injuries. However, the junction of these forms a unique zone of C2 and C3. Traumatic C2–3 dislocation is usually seen in the sagittal plane and is often associated with C2 pars interarticularis fracture [1–3, 5]. This sagittal C2–3 dislocation can be translational or angular. These are classified further depending on the fracture morphology as proposed by Effendi (modified by Edward and Levine) [2, 3]. Type I has minimal C2–3 dislocation. Type II has translation of C2–3 or angular C2–3 dislocation (IIa). Type III has C2–3 dislocation with locked facets. Type IIa and III are generally considered unstable and require surgical intervention [2, 3, 5]. Theoretically, translational or rotational dislocation can occur in the coronal plane as well. However, such lateral dislocation and tilt is extremely rare [4].

Compared to cervical spine, lateral or transverse dislocation has been commonly described at the thoraco-lumbar region [6]. It may be common at this junction due to the increased stress between the relatively stable thoracic spine and the mobile lumbar spine. The thoracic and lumbar vertebral bodies are not saddle-shaped unlike the cervical spine. This anatomical difference reduces the possibility of lateral or transverse dislocation in the cervical spine as compared to the thoraco-lumbar junction. Though rare, lateral dislocation has also been described at the C1–2 joint. This again is associated with dens fracture and the flat C1–2 facets that allow such lateral translation [7].

The presence of lateral dislocation in the sub-axial spine suggests severe capsulo-ligamentous injury. A compression force on the ipsilateral facet will fracture it and will distract and dislocate the contralateral facet [8]. However, that does not explain the lateral dislocation. The injury requires significant distraction and a lateral force. In our case, a preceding compression force probably caused the fracture of C3 with its splaying. Fortunately, the splaying helped in increasing the canal diameter and preventing any damage to the cord. Such lateral

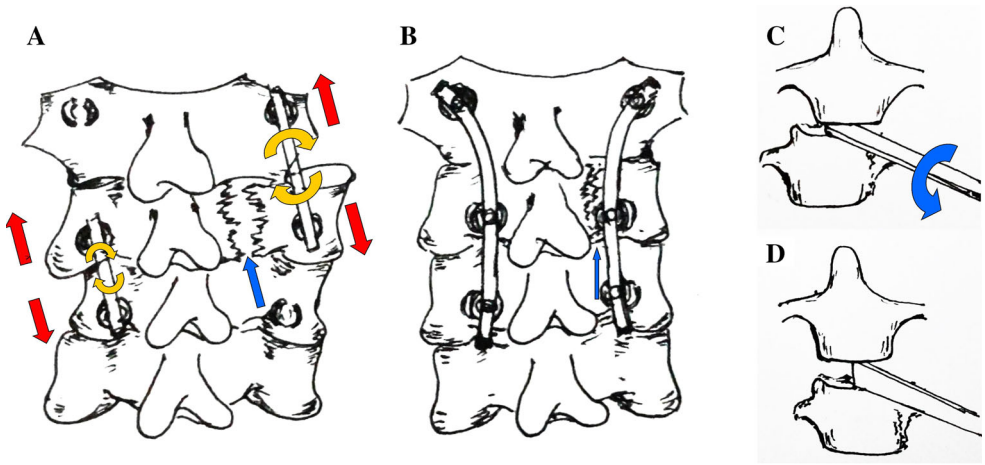

Fig. 2 Diagrammatic representation of operative technique. **a** Posterior view of cervical spine showing position of facets and fracture line (*blue arrow*). The C2 pedicle and C3–4 lateral mass screws have been inserted. Clockwise rotation of rods (*yellow curved arrows*) after distraction (*red arrows*) has been elucidated, **b** showing realignment and replacement of rods by curved rods fastened over all the tulips to maintain its position. **c**, **d** Anteriorly anticlockwise rotation (*blue arrow*) of osteotome inserted between C2 and C3 bodies corrects the residual lateral dislocation

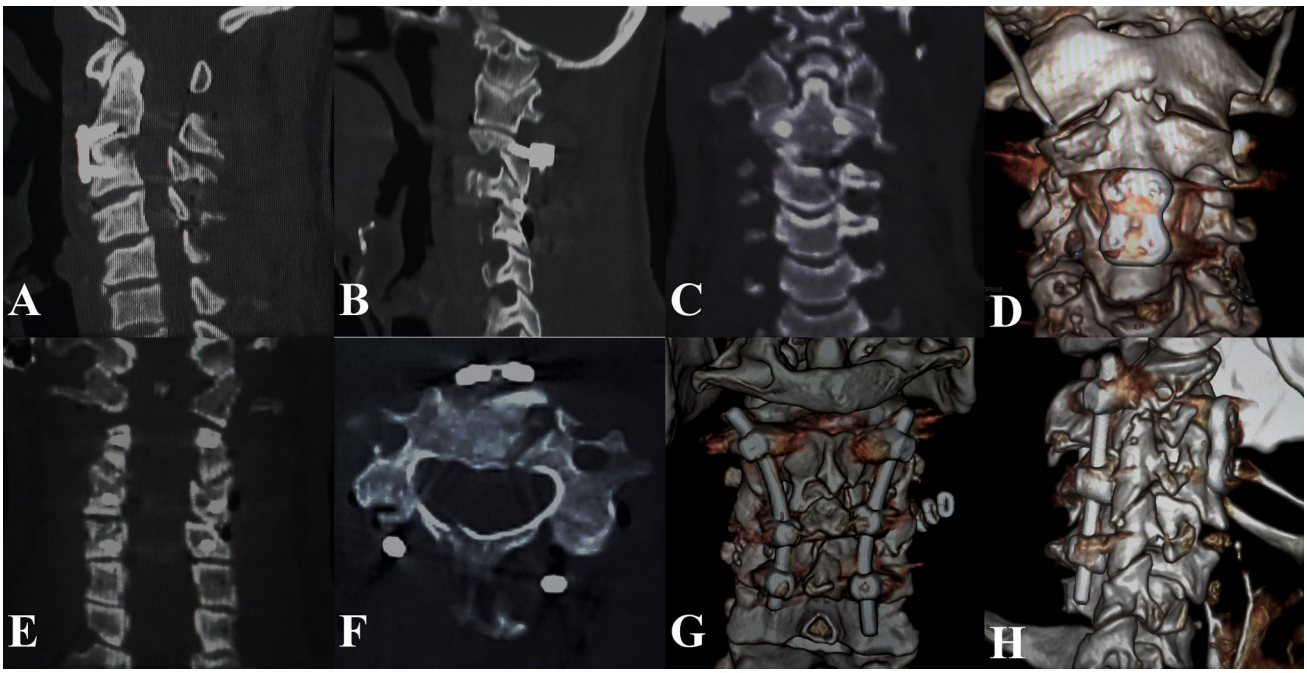

Fig. 3 Post-operative images. **a** Mid-sagittal cut showing C2–3 anterior fusion using plate-screws and graft, **b** parasagittal cut showing the realignment of facets, **c** coronal cut showing realignment of C2–3 body, **d** 3D reconstruction of the same **e** and **f** posterior coronal and axial cut showing realignment of facets and the fractured fragments. **g**, **h** Posterior and lateral views of 3D reconstructed image showing position of the curved rods and perfect realignment

dislocations can be missed on plane X-rays, especially, without any neurological deficits.

While managing such cases, the understanding of the dynamics and dislocation in each plane is important. The challenge was to realign the spine in all planes without compromising the neurovascular structure as traction usually fails in such cases. However, it is very important to maintain traction during surgery because it helps in realigning the spine after manipulation. The severity of the injury was quite compelling for a 360° fixation.

Why posterior first?

Unlocking of facets required drilling and direct manipulation, which would not have been possible anteriorly, as the lateral exposure and manipulation are limited by the vertebral arteries. A combination of brute force and gentle manoeuvring was required to realign the facets. The manipulation and realigning of lateral masses was achieved by using rod holders as levers and rotating the rods in clockwise direction [9]. Moving the rod holder in cranio-caudal plane brings about antero-posterior alignment. This manipulation also corrects the position of the dislocated bodies of the cervical vertebrae to some extent. The tulip of the C2 pedicle screw is more lateral to the lateral mass screws in C3 and C4. Using a curvilinear rod maintains this position. Inclusion of additional levels of lateral masses was not deemed necessary in view of the 360° fusion. Additionally it would have hampered the neck movements further.

Anterior approach

The small residual dislocation can easily be corrected by the technique (counter-clockwise rotation of the insinuated osteotome in the disc space) described above. In lateral splay such a manoeuvre is unlikely to destabilise the posterior construct. The alignment is maintained using a plate and screws.

Pitfalls and importance of preoperative MRI and CT angiogram

A preoperative MRI has been recommended for fracture dislocation of cervical spine that does not realign on closed reduction [10]. Preoperative MRI shows not only the extent of cord injury but also associated disc disruption. The presence of a disrupted disc is a relative indication for 'anterior first approach' [10–12]. The disrupted disc is usually posterior to the vertebral body dislocated anteriorly and protrudes into the canal once the vertebral bodies are realigned by 'posterior first approach' [11]. Therefore, removal of such a disrupted disc has been suggested before any manipulation of vertebral bodies. In the described case, the dislocation was mainly in the lateral plane. Expecting

lateral disruption of the disc, we took a chance in proceeding with surgery without preoperative MRI. It is also important to look for vertebral arteries in such cases. Vertebral artery injury is likely with lateral dislocations with fractures passing through or close to transverse foramina of cervical spine. During intraoperative manipulation, a thrombus from such injured vertebral artery can shower emboli leading to posterior circulation strokes [4, 13]. Besides, there is a possibility of traumatic pseudoaneurysm that can rupture during manipulation. Knowing such details is important. We got away without any complications, but do feel that these investigations would have made us aware of any possible dangers.

Conclusion

Lateral dislocations being uncommon, are often missed on plain X-rays on a cursory look unless suspected. These dislocations require careful evaluation of the CT scan in multiple planes. Realignment should be done with careful planning and fixation has to be circumferential in view of the severe capsulo-ligamentous injury.

Author contributions AS: Collection and collation of data, manuscript drafting. PS: Concept and design, collection and collation of data, manuscript drafting and reviewing, final approval of manuscript. RPK: Collection and collation of data, manuscript drafting.

Compliance with ethical standards

Conflict of interest No financial support, grants, no conflict of interest.

References

1. Machinis TG, Fountas KN, Kapsalaki EZ, Kapsalakis I, Grigorian AA (2006) A rare case of complete C2–C3 dislocation with mild neurological symptoms. Eur Spine J 15(Suppl 5):585–589
2. Schleicher P, Scholz M, Pingel A, Kandziora F (2015) Traumatic spondylolisthesis of the axis vertebra in adults. Global Spine J 5(4):346–358
3. Li XF, Dai LY, Lu H, Chen XD (2006) A systematic review of the management of Hangman's fractures. Eur Spine J 15(3):257–269
4. Parent AD, Harkey HL, Touchstone DA, Smith EE, Smith RR (1992) Lateral cervical spine dislocation and vertebral artery injury. Neurosurgery 31(3):501–509
5. Salunke P, Sahoo SK, Krishnan P, Chaterjee D, Sodhi HB (2016) Are C2 pars-pedicle screws alone for type II Hangman's fracture overrated? Clin Neurol Neurosurg 141:7–12
6. Parker JW, Lane JR, Karaikovic EE, Gaines RW (2000) Successful short-segment instrumentation and fusion for thoracolumbar spine fractures: a consecutive 41/2-year series. Spine (Phila Pa 1976) 25(9):1157–1170
7. Salunke P, Sahoo SK, Doddamani R, Ahuja CK, Mukherjee KK (2014) Direct posterior reduction in a case of posttraumatic irreducible lateral atlantoaxial dislocation. J Neurosurg Spine 20(6):722–725
8. Ngo LM, Aizawa T, Hoshikawa T, Tanaka Y, Sato T, Ishii Y, Kokubun S (2012) Fracture and contralateral dislocation of the twin facet joints of the lower cervical spine. Eur Spine J 21(2):282–288
9. Salunke P, Sahoo S, Khandelwal NK, Ghuman MS (2015) Technique for direct posterior reduction in irreducible atlantoaxial dislocation: multi-planar realignment of C1–2. Clin Neurol Neurosurg 131:47–53
10. Gelb DE, Hadley MN, Aarabi B, Dhall SS, Hurlbert RJ, Rozzelle CJ, Ryken TC, Theodore N, Walters BC (2013) Initial closed reduction of cervical spinal fracture-dislocation injuries. Neurosurgery 72(Suppl 2):73–83
11. Doran SE, Papadopoulos SM, Ducker TB, Lillehei KO (1993) Magnetic resonance imaging documentation of coexistent traumatic locked facets of the cervical spine and disc herniation. J Neurosurg 79(3):341–345
12. Ordonez BJ, Benzel EC, Naderi S, Weller SJ (2000) Cervical facet dislocation: techniques for ventral reduction and stabilization. J Neurosurg 92(1 Suppl):18–23
13. Salunke P, Sahoo SK, Ghuman MS (2014) Vertebral artery thrombosis in a case of traumatic atlanto-axial dislocation with delayed presentation: emphasis on preoperative evaluation and operative steps to prevent a catastrophe. Neurol India 62(3):310–313