Case Report

Computer navigation assisted fixation in neglected C2-C3 dislocation in an adult

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Abstract

A 49-year-old male presented with neck pain and deformity following an industrial accident sustained two months back. His neurology was normal except for a minimal weakness in left biceps (grade 4/5). Radiographs, magnetic resonance imaging and computed tomographic scan revealed fracture dislocation of C2-C3 with significant lateral translation of C2 over C3 without disc herniation. In view of unsuccessful closed reduction and absent disc herniation at the level of dislocation, a posterior only reduction, stabilisation and fusion with Iso-C 3D computer navigation-assisted cervical pedicle screw fixation with transverse rod-screw construct was performed. At 6 months followup the patient was completely relieved of his symptoms and was able to return to his previous occupation. The rare case is reported for the management by Iso-C 3D computer navigation assisted cervical pedicle screw fixation and reduction with transverse rod-screw construct at each involved level.

Key words: Neglected C2-C3 dislocation, lateral translation, cervical pedicle screws, Iso-C 3D navigation

Introduction

Upper cervical fractures and dislocations account for 24% of cervical spine injuries,[1] with the atlantoaxial region being the commonly involved site.[2] Subluxation and dislocation of the cervical spine in adults commonly occur at the highly mobile lower segments (C4-C7).[3,4] This is in contrast to the occurrence in children, where it involves the upper cervical spine due to anatomical differences in the developing spine.[5] Dislocation at the level of C2-C3 is an uncommon injury in adults and usually results in mortality or complete quadriplegia.[6] Only two cases of C2-C3 dislocation[7,8] in the sagittal plane have been reported in adults. Dislocation at the level of C2-C3, with lateral translation has not been cited in the literature so far.

We present a rare case of neglected dislocation of C2-C3, with significant lateral translation in an adult with minimal neurological deficit that was managed surgically. The operative technique is also described here.

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Case Report

A 49-year-old man presented with neck pain and deformity following an industrial accident sustained two months back, with injury to the right side of his face by a concrete slab. He was evaluated and treated conservatively with a soft cervical collar in the local hospital. As his neck pain and deformity was persistent, he presented to us for further management. There was no weakness of lower limbs or gait disturbance following the injury. His bowel and bladder habits were normal. Clinical examination revealed a left-sided torticollis with paracervical muscle spasm and severe restriction of neck movements. Neurological examination revealed normal power in all limbs except left biceps (grade 4/5). There was no sensory disturbance and his deep tendon reflexes were exaggerated with a positive Babinski sign.

Plain radiographs of the cervical spine showed left lateral translation of C2 vertebral body over C3 in the anteroposterior view [Figure 1a] and minimal anterior translation of C2 over C3 in the lateral view. The CT scan revealed fracture of the left transverse process and anterior part of the C3 vertebral body with completely dislocated facet joint on right side and perched C2 facet on the left side. There was a near complete lateral translation of C2 vertebral body over C3 in the coronal plane [Figures 1b-d]. Magnetic resonance imaging (MRI) of the cervical spine revealed spondylotic changes, with disc osteophyte complex

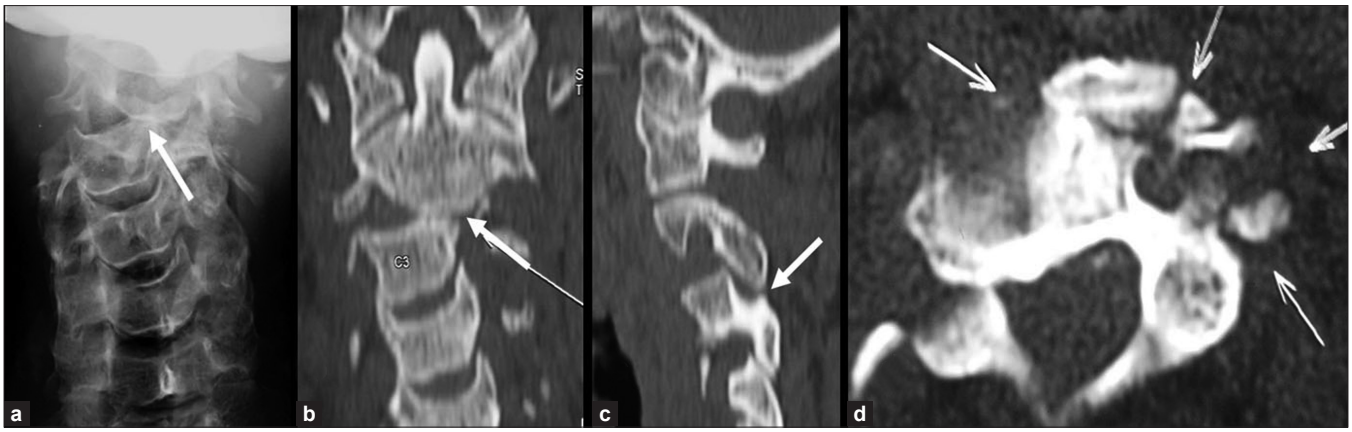

Figure 1: (a) Anteroposterior radiograph of the cervical spine showing significant lateral translation of C2 vertebral body over C3 (white arrow), (b) Coronal section of the CT scan showing near complete lateral translation of C2 over C3 body (white arrow), (c) Sagittal section of the CT scan showing dislocated C2-C3 facet joint on the right side, and (d) Axial section of CT scan showing fracture of the left transverse process (thick white arrows) and anterior part of C3 vertebral body (thin white arrow)

extending from C3-C4 to C5-C6 levels and minimal indentation of the spinal cord without disc herniation at the level of dislocation.

Closed reduction of the dislocation was attempted with skull traction using Gardner Well tongs for a period of one week. As reduction was not achieved, open reduction and stabilisation was planned. Since there was no disc herniation at dislocated level, a posterior approach with cervical pedicle screw fixation using Iso-C 3D computer-assisted navigation was selected for reduction and stabilisation.

Operative procedure

The procedure was done under spinal cord monitoring. The patient was placed prone on a radiolucent operating tabletop. A standard midline posterior exposure from C1 to C4 was performed. The C2 vertebra was found to be rotated over C3, with the inferior articular facet of C2 dislocated anterior to the superior articular facet of C3 on the right side. On the left side, the inferior articular facet of C2 was found to be perched over the superior articular facet of C3 obstructing reduction [Figure 2a]. The superior articular facet of C3 on the right side and inferior articular facet of C2 on the left side were osteotomised to aid reduction. The minimal invasive reflective array was attached to the base of C4 spinous process and the cervical spine was screened using the Iso-C 3D C-arm. The fluoroscopic images were obtained from Siremobil Iso-C3D (Seimens, Germany) image intensifier and data transferred to the computer navigation platform – Vector Vision (Spine version 2.0 Brain Lab, Germany) to provide real-time intraoperative multi-planar images of the spine. The pedicle entry points and screw trajectories for C2 and C3 were determined accurately with the help of pointed tool navigator. A 2.5-mm drill was used for drilling the bone. Frequent intermittent checking with the tool aided in avoiding pedicle breach. The length and size of the screw was estimated using the tool and "planning a screw" option of the software. Screws of size 25 × 3.5 mm were inserted into the pedicles of C2 and C3 bilaterally [Figure 2b]. Straight rods were then connected transversely to the C2 and C3 pedicle screws on both sides. This transverse rod-screw construct at each level provided a strong anchor point with three column fixation for manipulation and reduction of the dislocation [Figures 2c and d]. The depression of C2 over the fractured C3 vertebral body on the left side was elevated by applying distraction between the left-sided C2 and C3 pedicle screws [Figure 2e]. After elevation of C2, the two rods were held with rod holders and the dislocation was reduced by manipulation to achieve correction of the lateral translation and rotation. Complete reduction of the dislocation was not attempted to avoid the risk of neurovascular injury, as the patient had only mild neurological deficit preoperatively and the injury was two months old. The transverse rods were then removed and rods of appropriate size were fixed vertically to the C2 and C3 pedicle screws bilaterally [Figure 2f]. The accuracy of screw placement and adequacy of reduction achieved were again verified using the Iso-C 3D C-arm [Figure 3]. The laminae of C2 and C3 were decorticated and cancellous autografts obtained from the posterior iliac crest were placed in the fusion bed to achieve fusion. The duration of surgery was 115 minutes and blood loss was 180 ml.

The patient was mobilised postoperatively with a Philadelphia collar for a period of three weeks. He was then started on isometric muscle strengthening exercises. At the six-month follow-up, he had normal motor power of all limbs and CT scan revealed good fusion of C2-C3. He returned to his previous occupation without neck pain or neurological symptoms.

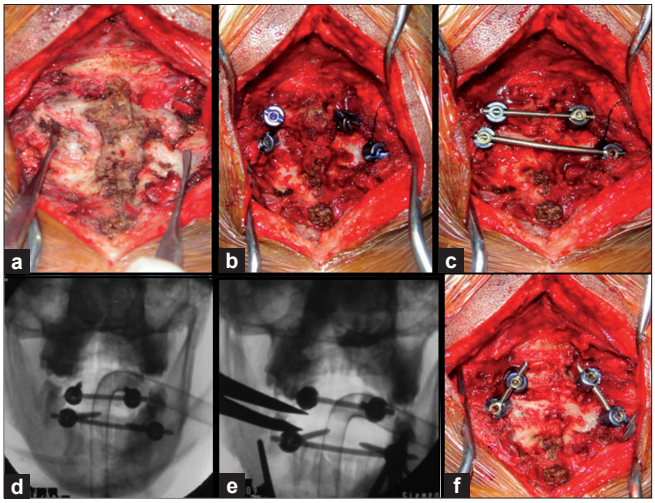

Figure 2: Intraoperative photographs and images (a) demonstrating the dislocated facet on the right side and perched facet on the left side. (b) C2-C3 pedicle screws *in-situ* showing the extent of rotation and depression of C2 over C3 on the left side. (c) Rods connected transversely to the pedicle screws at both levels to hold the vertebrae and manipulate during reduction. (d) Fluoroscopic image showing the transverse-rod screw construct with (e) elevation of the depressed C2 vertebral body by distracting C2 and C3 pedicle screws on the left side. (f) Final image shows the vertical rods fixed to pedicle screws

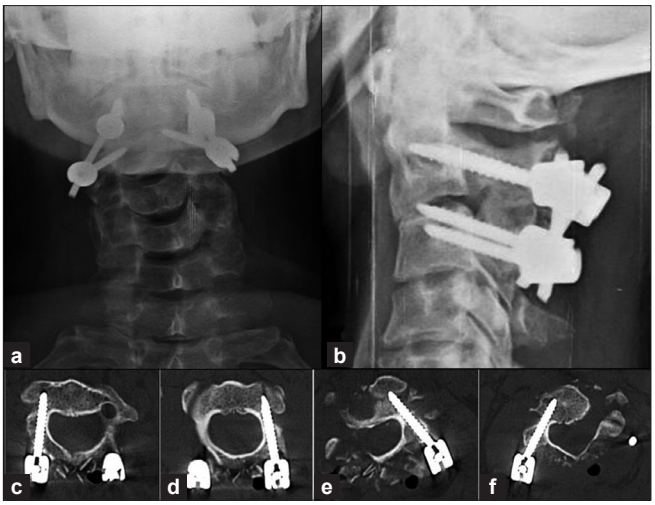

Figure 3: (a) Postoperative anteroposterior and (b) lateral radiographs of the cervical spine. (c and d) Postoperative axial sections of CT scan showing the accurate screw placement in the pedicles of C2 and (e and f) C3 vertebrae with the aid of Iso-C navigation

Discussion

Injuries of the upper cervical spine commonly involve the atlantoaxial region.[2] Subluxations and dislocations of the cervical spine in adults usually involve the lower segments (C4-C7), as they are highly mobile in contrast to the upper segments.[3,4] However, dislocation in children is common in upper cervical spine due to anatomical differences of the developing spine.[5] About 5-20% of cervical spine injuries are usually missed or diagnosed late.[9-11] Misinterpretation and inadequate radiographs are the common reasons for missed diagnosis.[12] Although few reports of C2-C3 dislocation are described in the pediatric age group,[6,13,14] only two cases are reported in adults so far[7,8] [Table 1]. Delayed or missed diagnosis of C2-C3 dislocation in adults can lead to serious consequences including complete tetraplegia and even death.[6]

Management of cervical dislocations is challenging when it is delayed by more than three weeks. Liu *et al.*[15] and Jain *et al.*[16] reported satisfactory results by a two-staged procedure for neglected subaxial dislocations. Posterior release of the fibrocartilaginous tissue around the facet joints, partial facetectomy with interspinous wiring was performed in the first stage followed by anterior release of the uncovertebral joints and interbody fusion in the second stage under single anaesthesia. Bartels *et al.*[17] advocated a three-staged (posterior-anterior-posterior) approach in the delayed management of traumatic bilateral cervical facet dislocation. However, there are no reports of the management of neglected dislocation in coronal plane with only a minimal neurological deficit. Hence, we preferred a posterior-only surgery to avoid the morbidity of two or three staged surgeries and risk of worsening of the neurological deficit associated with change of position.

The degree of subluxation of cervical spine need not necessarily correlate with clinical symptoms and neurological signs.[7] Fountas *et al.* evaluated the size of the cervical spinal cord using post myelogram computed tomographic measurements. He reported that the diameter of the cervical spinal cord is 15-20% smaller than what has been reported by autopsy studies and a small diameter spinal cord is less susceptible to injury by compression.[18] This is probably the reason of minimal neurological deficit seen in our case.

The surgical approach for acute dislocation of cervical spine is highly controversial.[19] The presence or absence of traumatic intervertebral disc herniation, neurological status and experience of the surgeon are some of the factors that need to be considered while planning the surgical approach.[20] An anterior procedure is advocated when there is a traumatic disc herniation at the level of dislocation to decompress the neural elements. Additional posterior stabilisation is necessary if the dislocation is bilateral or if the anterior reduction fails. Posterior reduction and instrumented fusion is recommended for patients with irreducible unilateral or bilateral dislocation without associated disc herniation.[21] Machinis *et al.* performed a 360-degree stabilisation in two stages for their patient with C2-C3 dislocation.[7] Sharma *et al.* reported delayed pharyngeal perforation and spontaneous graft extrusion

Table 1: Literature review of C2-C3 dislocation in adults

Author (Year)	Age (Years)/ Sex	Etiology	Diagnosis	Plane of dislocation	Neurological deficit	Treatment	Complication
Sharma *et al.*[8] (2001)	32/F	RTA	Bilateral transpedicular C2 fracture with C2-C3 dislocation	Sagittal	Triplegia (Bilateral lower limb and left upper limb weakness)	ACDF, K wire fixation of graft and anterior cervical plating	Plate removal for dysphagia, Delayed pharyngeal perforation and complete extrusion of graft along with the K wire
Machinis *et al.*[7] (2006)	57/M	RTA	C2-C3 dislocation	Sagittal	Motor-Grade 3/5 in all limbs	1st stage: ACDF and plate fixation 2nd stage: Posterior cervical stabilisation and fusion	Nil
Present Case	49/M	Blunt injury (2 months back)	Neglected C2-C3 dislocation	Coronal	Normal motor power in all limbs except left biceps (4/5)	Posterior only stabilisation and fusion with navigation-assisted cervical pedicle screw fixation	Nil

RTA – Road traffic accident

with the fixation device in a case of traumatic C2-C3 dislocation stabilised by an anterior approach.[8]

Reduction of cervical spine dislocation through a posterior approach in the presence of an associated disc herniation can lead to neurological deterioration.[22-24] Abumi *et al.*[25] reported the successful use of posterior surgery alone using cervical pedicle screws in the management of acute cervical spine injuries associated with a traumatic disc herniation. The initial distractive force applied by the pedicle screws allows restoration of the disc height and reduction of both disc herniation and injured cervical segment without additional need for anterior decompressive procedures.[25] However, this might be possible only in fresh injuries and its role in neglected cases is doubtful. As the dislocation in our case was in the coronal plane without a herniated disc or anterior compression, we preferred a posterior only surgery with cervical pedicle screws to avoid the need for combined anterior and posterior procedures.

Cervical pedicle screw fixation offers superior 3D biomechanical stability and pullout strength. Kotani *et al.* demonstrated the advantage of cervical pedicle screw fixation over combined anterior and posterior fixation even in severe discoligamentous injury model.[26] However, special care and skill is needed to insert pedicle screws in cervical spine when it is associated with significant coronal displacement and fracture. Iso-C 3D computer-assisted navigation was useful in this situation for accurate placement of cervical pedicle screws without risking the neurovascular structures. Although computer navigation-assisted surgery improves the accuracy of pedicle screw placement in these cases with altered anatomy, it has its limitations. It has limited use in patients with severe deformities, as here it is difficult to centralise the spine in both anteroposterior and lateral views and the software programme can crash at any time. Hence, it is used only as a complimentary tool and not as a substitute for the surgeon's anatomic knowledge.[27]

As the C2-C3 dislocation in our patient was irreducible on closed reduction without a disc herniation, a posterior approach was selected for reduction and stabilisation.

This rare case highlights the importance of posterior only surgery with navigation-assisted cervical pedicle screw fixation as a treatment option in patients with neglected C2-C3 dislocation with significant lateral translation without a disc herniation.

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