CASE REPORT

Theofilos G. Machinis
Kostas N. Fountas
E. Z. Kapsalaki
I. Kapsalakis
A. A. Grigorian

A rare case of complete C2–C3 dislocation with mild neurological symptoms

T. G. Machinis · K. N. Fountas (✉)
E. Z. Kapsalaki · I. Kapsalakis
A. A. Grigorian
Neurosurgery, Medical Center of Central
Georgia, Macon GA, USA
E-mail: knfountasmd@excite.com
Tel.: +1-478-7437092
Fax: +1-478-7430523

T. G. Machinis · K. N. Fountas
E. Z. Kapsalaki · I. Kapsalakis
A. A. Grigorian
School of Medicine, Mercer University,
Macon GA, USA

Abstract The authors report a rare case of complete C2–C3 dislocation with unexpectedly mild neurological symptoms in a 57 year old man involved in a motor vehicle accident, who had previously undergone posterior laminectomy from C3 through C7. A retrospective chart analysis and a thorough radiographic review were performed. X-rays and CT of the cervical spine demonstrated a complete dislocation at the C2–C3 level. Computed tomographic angiography revealed disruption of both vertebral arteries; however, blood flow was evident in the basilar artery. After radiologically guided placement in cervical traction with tongs that reduced the subluxation by approximately 50% the patient had spontaneous eye opening and was able to follow commands. A two-stage 360° stabilization and fusion was performed and the patient was finally discharged 24 days after admission with his neurological status essentially unchanged. In conclusion, our patient presented with surprisingly mild neurological symptoms. The previously performed laminectomy could have both predisposed to injury as well as protected his spinal cord from potentially fatal trauma.

Keywords Anteroposterior stabilization · Dislocation · Fusion · Post-laminectomy · Upper cervical

Introduction

Subluxation of the cervical spine in adults usually occurs at its lower segments (C4–C7) [12, 14]; 50% of anterior subluxation of the neck has been reported to involve the highly mobile C5–C6 junction [11, 14]. In the pediatric population (up to 9 years old), the upper cervical spine is more susceptible to injury due to the anatomical differences in the developing spine [3]. Subluxation at the C2–C3 level is a particularly uncommon injury. We report a case of complete dislocation at the C2–C3 level in a patient involved in a motor vehicle accident who presented with surprisingly mild neurological symptoms.

Case report

A 57 year old African American man under the influence of alcohol and benzodiazepines was involved in a severe motor vehicle accident including one fatality. The patient was wearing a seat belt. He was transferred to our clinic via ambulance from a community hospital, fully immobilized with a hard cervical collar on, while the spinal cord injury solumedrol protocol had been initiated. On arrival to our Emergency Department, the patient had a Glascow Coma Scale (GCS) score of 11 and was thrashing all extremities. He responded to pain. He was intubated and thorough radiologic evaluation was undertaken.

Fig. 1 Plain lateral X-rays of the cervical spine demonstrating a complete C2–C3 dislocation upon the patient's admission

Fig. 2 Computed tomographic angiography obtained at patient's admission demonstrating bilateral complete disruption of vertebral arteries

The CT of the brain revealed a slender tentorial subdural hematoma not requiring surgical evacuation. X-rays and CT of the cervical spine revealed a complete dislocation at the C2–C3 level with acute angulation between the two cervical vertebral segments (Fig. 1). Additionally, the imaging studies demonstrated multilevel degenerative spondylosis, anterior bridging osteophytes from C3 through C7 consistent with Forestier's disease and extensive previously performed posterior laminectomy from C3 to C7. Laminectomy was performed, according to the patient, because of underlying degenerative disease. Computed tomographic angiography (CTA) revealed disruption of the vertebral arteries bilaterally at the level of C2–C3 (Fig. 2). However, flow was identified in the basilar artery indicating a patent posterior circle of Willis providing back flow to the basilar artery and the posterior circulation. No MRI could be obtained due to the presence of a previously implanted cardiac pacemaker.

The patient was placed in cervical traction with tongs under radiologic guidance for verifying alignment. The weight applied was gradually increased up to twelve pounds; at that point, fluoroscopic imaging demonstrated a significant improvement in the angulation of the two separate segments and a reduction of the degree of subluxation. However, a subluxation of approximately 50% of the cervical spine vertebral body length was still present (Fig. 3). Upon reversal of sedation, the patient had spontaneous eye opening and was able to follow commands. His upper and lower extremities' muscle strength was 3/5. The treatment plan for this patient consisted of a two stage 360° stabilization and fusion.

Shortly after his arrival to our hospital, the patient started to experience respiratory difficulties, leading the authors to the decision to delay surgery until the respiratory condition of the patient was stabilized. Two days after his admission, anterior cervical discectomy and fusion (ACDF) with the standard Smith-Robinson technique and bone allograft was performed at the C2–C3 level. A 24 mm Synthes (Paoli, PA, USA) statue plate was utilized after appropriate bending in order to contour the curvature of the cervical spine. Intraoperatively, disruption of the anterior longitudinal ligament at the C2–C3 level as well as fracture of the anterior osteophytic bony bridges, were evident. The vertebral endplates of the vertebral bodies at that level were severely degenerated. At the conclusion of the case, adequate reduction, satisfactory alignment and stabilization of the

Fig. 3 Plain lateral X-rays of the cervical spine on the same patient obtained after applying external traction via tongs, demonstrating sub-optimal realignment of his cervical spine

Fig. 4 Post-operative lateral X-rays on the same patient after completion of anterior and posterior fusion

anterior cervical spine were accomplished. A halo vest was applied post-operatively for additional stabilization, necessary for the aggressive physical therapy that the patient's respiratory condition demanded. Post-operative X-rays demonstrated reduction of the dislocation of C2 with respect to C3 and anatomic alignment of the structures of the cervical spine.

The patient's neurological condition remained unchanged during the following days. Respiratory distress was however noted, and a few days later, the patient was diagnosed with pneumonia. Appropriate treatment with antibiotics was initiated and it was decided to delay the second, posterior surgical approach until the patient's respiratory condition was stabilized and his pneumonia resolved. Eighteen days after the initial operation, a second, posterior approach was employed. Under general endotracheal anesthesia, through a midline skin incision, a posterior cervical fusion and instrumentation (Synthes, Paoli, PA, USA) with pedicle screws at C2 level (20 mm long and 4 mm in diameter) and lateral mass screws (12 mm in length and 3.5 mm in diameter) at C3 level was undertaken. After optimal position of the screws was fluoroscopically verified, a 40 mm rod was used, which was attached and secured on a C2 and a C3

screw. Allograft bone chips were then appropriately placed (Fig. 4). The patient was placed back in the halo post-operatively due to his age and some concerns regarding osteoporosis. The halo vest was kept for four weeks after the second operation. He was finally discharged from the hospital to a rehabilitation clinic 24 days after admission. His neurologic status was essentially unchanged, with a muscle strength 3/5 in the upper and lower extremities.

The patient was followed at a different institution. At the last follow-up visit, 12 months postoperatively, his neurological status showed improvement with muscle strength of 4/5 in the upper and lower extremities.(Fig. 5a, b)

Discussion

Injury of the cervical spine is a potentially fatal and debilitating incident due to the risk of damage of the cervical spinal cord. Although the degree of subluxation
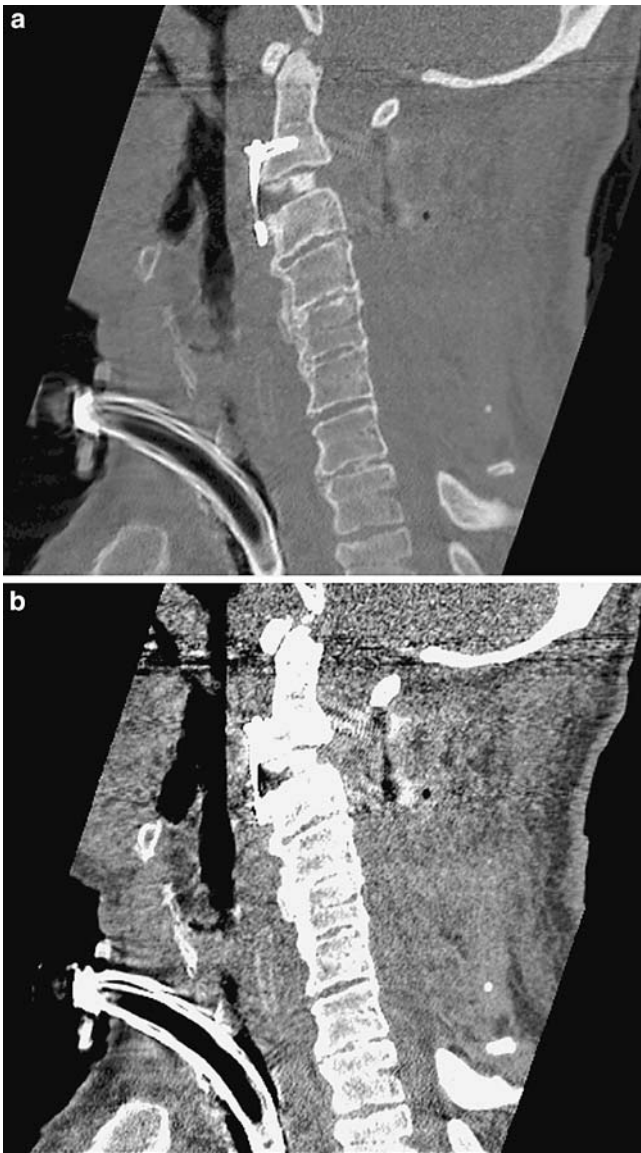
Fig. 5 a Post-operative CT (3D reformatted midsagittal image) of the cervical spine demonstrating adequate anatomical alignment at the C2–C3 level. **b** Post-operative CT (3D reformatted midsagittal image) of the cervical spine demonstrating adequate anatomical alignment at the C2–C3 level

does not necessarily correlate with clinical symptoms and neurological signs, one would agree that the patient described above presented with unusually mild symptomatology in regards to the complete dislocation of the cervical vertebrae of the C2–C3 level, evident in his radiological examination.

In reviewing the possible parameters related to this patient's favorable outcome, attention should be drawn to the posterior cervical laminectomy previously performed on our patient due to underlying degenerative disease. It is quite likely that the lack of dorsal spinal

elements of the C3 level, provided for adequate space for the posterior dislocation of the spinal cord to occur without sustaining the anticipated injury due to compression. This must have been of great importance both during the injury itself, as well as, after the dislocation had been established.

Interestingly, Fountas et al. [5] noted in their study using postmyelogram computed tomographic measurements, that the cervical spinal cord might be smaller than considered. Specifically, they found that the diameter of the cervical spinal cord was 15–20% smaller than has been reported by autopsy studies. A smaller cervical spinal cord would also be less susceptible to injury due to compression. Although this is an interesting point that should perhaps be taken into consideration when referring to compression of the cervical spinal cord, its role in our case of a complete dislocation of the cervical spine could not have been, by itself, determinant without the history of previous laminectomy.

On the other hand, the removal of the posterior arc of the vertebral bone may have predisposed for the development of such a complete dislocation. Hansen-Schwartz et al. [7] observed that 26% of patients developed static subluxation at the cervical spine 7.7 ± 0.6 years after cervical laminectomy. Cusick et al [2], in a cadaveric study examining the biomechanical responses of the cervical spine to laminectomy, concluded that multilevel cervical laminectomy induces increases in total column flexibility, allowing additional motion in the flexion-extension plane. This observation may well describe the mechanism of injury in our case in which extension of C2–C3 induced a posterior dislocation and was not limited to a severe sprain. Likewise, Hong-Wan et al. [8] noted in their biomechanical study a significant increase in intersegmental motions following cervical laminectomy. Furthermore, Fields et al. [4] observed in their randomized study comparing the effects of laminectomy and laminoplasty in the rabbit, that laminectomized animals had poorer clinical outcome at 3 months postoperatively, associated with statistically significant angular deformity. Similarly, Baisden et al. [1], using a goat model, concluded that laminoplasty is superior to laminectomy in maintaining sagittal cervical alignment and preventing spinal deformities. The removal of bony and ligamentous structures of the posterior cervical spine might alter the biomechanics of the vertebral column and predispose to instability. The involvement of the C2–C3 level in our patient which coincides with the transition from non-laminectomized to laminectomized segments raises further suspicion regarding the putative role of laminectomy in the mechanism of injury in our case. Finally, the presence of osteophytes in the anterior cervical column in our patient (Forestier's disease) could predispose to injury; more severe neurologic deficits

have been described in patients with diffuse idiopathic skeletal hyperostosis even following minor trauma [15].

It is interesting to note that our patient had no signs of posterior fossa infarction despite the fact that both of his vertebral arteries were disrupted at the C2–C3 level. We assume that this is because of the presence of fetal circulation in this patient providing back flow to the basilar artery as this was demonstrated in his CTA, thus maintaining adequate perfusion of the posterior fossa [9].

Treatment of subaxial cervical spinal injury remains controversial. Both the anterior and posterior procedures have serious advantages and disadvantages [6, 10, 13]. In our case, we decided to perform a combined anterior and posterior surgical procedure, since both the anterior and posterior longitudinal ligaments were disrupted and we felt that a circumferential approach would sufficiently restore the lost stability. Furthermore, the presence of disc fragments compromising the spinal canal could not be ruled out, due to the inability to obtain an MRI in our patient. A posterior approach, thus, without anterior stabilization was considered to harbor an increased risk of spinal cord compromise. It needs to be emphasized that further multiinstitutional prospective clinical studies are required in order to establish guidelines for the management of subaxial cervical spine injury.

Conclusion

In conclusion, we have reported a rare case of complete C2–C3 dislocation with unexpectedly mild neurological symptoms in a patient who had previously undergone a C3–C7 laminectomy. The previously performed laminectomy might have both predisposed and protected the patient's spinal cord from severe injury.

References

1. Baisden J, Voo LM, Cusick JF et al (1999) Evaluation of cervical laminectomy and laminoplasty. A longitudinal study in the goat model. Spine 24(13):1283–1289
2. Cusick JF, Pintar FA, Yoganandan N (1995) Biomechanical alterations induced by multilevel cervical laminectomy. Spine 20(22):2392–2399
3. Eleraky MA, Theodore N, Adams M et al. (2000) Pediatric cervical spine injuries: report of 102 cases and review of the literature. J Neurosurg (Spine 1) 92:12–17
4. Fields MF, Hoshijima K, Feng AHP et al (2000) A biomechanical, radiologic, and clinical comparison of outcome after multilevel cervical laminectomy or laminoplasty in the rabbit. Spine 25(22):2925–2931
5. Fountas KN, Kapsalaki EZ, Jackson J et al. (1998) Cervical spinal cord—smaller than considered? Spine 23(14):1513–1516
6. Hadley MN (2002) Treatment of subaxial cervical spinal injuries. Neurosurgery 50(3):S156–S165
7. Hansen-Schwartz J, Kruse-Larsen C, Nielsen CJ (2003) Follow-up after cervical laminectomy, with special reference to instability and deformity. Brit J Neurosurg 17(4):301–305
8. Hong-Wan N, Ee-Chon T, Qing-Hang Z (2004) Biomechanical effects of C2–C7 intersegmental stability due to laminectomy with unilateral and bilateral facetectomy. Spine 29(16):1737–1745
9. Jongen JC, Franke CL, Soeterboek AJ, Versteege CW, Ramos LM, Van Gijn J (2002) Blood supply of the posterior cerebral artery by the carotid system on angiograms. J Neurol 249:455–460
10. Maiman DJ, Barolat G, Larson SJ (1986) Management of bilateral locked facets of the cervical spine. Neurosurgery 18(5):542–547
11. Miller MD, Gehweiler JA, Martinez S et al. (1978) Significant new observations on cervical spine trauma. AJR 130:659–663
12. Ooi SS, Wong SV, Radin Umar RS, et al. (2004) Mechanisms of Cervical Spine Injuries for Non-fatal Motorcycle Road Crash. Med J Malaysia 59(2):146–152
13. Payer M (2005) Clinical Article: Immediate open anterior reduction and antero-posterior fixation/fusion for bilateral cervical locked facets. Acta Neurochir 147:509–514
14. Plunkett PK, Bedmond AD, Billsborough SH (1987) Cervical subluxation: a deceptive soft tissue injury. J R Soc Med 80(1):46–47
15. Sreedharan S, Li YH (2005) Diffuse idiopathic skeletal hyperostosis with cervical spine cord injury—a report of 3 cases and a literature review. Ann Acad Med Singapore 34(3):257–261