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Case Report

Traumatic C2-C3 Coronal Dislocation with Vertebral Artery Injury: Case Report and Literature Review

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Introduction

The coronal subluxation of C2-C3 (lateral leisthesis or non-hangman fracture) is extremely rare and difficult to manage. In this paper, we report a case of a 21-year-old male who came to the ER after a motor vehicle accident (MVA) with C2-C3 lateral leisthesis and, surprisingly, mild neurological symptoms.

Method

This systematic review was conducted following the recommendations of the preferred reporting items for systematic reviews and meta-analyses (PRISMA) checklist. On January 1, 2022, a comprehensive electronic search was conducted through Scopus, PubMed, and Web of Science databases to retrieve original studies.

Results

Seven articles were found reporting on non-hangman traumatic C2/C3 subluxation, with only two cases reporting coronal subluxation or lateral listhesis of C2 over C3. The first case was reported by Rajasekaran et al. Singh reported the second case. Both cases were unilateral facet dislocations with no radiological evidence of intervertebral disc disruption or herniation. We will report the third case in the literature of a non-hangman C2/C3 coronal dislocation. The patient underwent intraoperative manual traction under continuous neurophysiology monitoring. After the satisfactory reduction, fixation was carried out using lateral mass and pars screws from C1 to C3. Postoperatively, the patient recovered well, showed no signs of motor impairment during examination, and was discharged on the fifth day.

Conclusion

The impact of cervical spine injury is tremendous at every level. Management of cervical spine dislocation injury is full of controversies. The C2/C3 traumatic coronal translation with no disc involvement and unilateral facet dislocation may have a better outcome.

Keywords: *Odontoid dislocation, C2/C3 dislocation, C2/C3 subluxation and C2/C3 listhesis.*

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1. Introduction

Cervical spine subluxation is a challenging pathology that requires careful management. It predominantly occurs at the lower segments of the cervical spine, specifically C4-C7 in adults (1). Among these cases, nearly fifty percent involve the highly mobile C5-C6 junction (2). However, subluxations in the upper cervical spine are even rarer and more complex to handle. In fact, individuals who sustain such injuries often do not survive. The anatomical complexity of the upper cervical region contributes to the difficulty in managing these cases. This area serves as the junctional area between the skull base and the spine. Moreover, it houses the major arteries supplying blood to the brain and spinal cord (3). Additionally, the craniocervical junction controls about 50% of the cervical vertebrae's movements. These factors make any pathology in this region challenging to treat. The C2-C3 coronal dislocation, known as lateral leisthesis or non-hangman fractures, is exceedingly rare. However, when they do occur, they can lead to severe complications, such as quadriplegia or stroke, secondary to injuries to the vertebral artery (4). Interestingly, some individuals may not experience any neurological symptoms or only have mild manifestations despite the severity of the injury (5). Here, we report the case of a 21-year-old male who arrived at the emergency room following a motor vehicle accident (MVA). Despite the occurrence of a C2-C3 coronal leisthesis (translation), the patient exhibited mild neurological symptoms. This case highlights the importance of recognizing the potential seriousness of subluxations in the upper cervical spine and the need for prompt evaluation and appropriate management.

2. Case Report

A 21-year-old male came to the nearest hospital after a motor vehicle accident, where he was stabilized, and an initial survey was done. The patient was transported to the Neurotrauma Center 24 hours after the trauma. Examination revealed stable vital signs. The Glasgow Coma Scale (GCS) was 14/15 (E4M6V4), power 5/5 in all muscle groups with normal tone, deep tendon reflex (DTR) 2+, and sensational intact. On imaging, a CT cervical scan, 3D CT reconstruction and CT angiogram revealed C2-C3 dislocation laterally with evidence of left vertebral artery injury, however the right vertebral artery which is the dominant it was intact (Figure **1**,2,3). CT of the brain showed small right cerebellar hypodensity, which represents an old stroke with no evidence of acute infarction (Figure **4**). In the magnetic resonance imaging (MRI), there was no disc disruption or spinal cord injury. The case was discussed with the spine and neurovascular teams regarding whether to put him in cervical traction preoperatively and manage vertebral artery injury before fixing the dislocation. Due to the rarity of the pathology, there was no solid scientific foundation for any approach. Therefore, we decided to fix the fracture dislocation first, then reevaluate the vertebral artery injury postoperatively and treat it accordingly. Surgery was done under general anesthesia, in line with total intravenous anesthesia (TIVA) protocol. A baseline Intraoperative Neurophysiological Monitoring (IONM) was taken, and another baseline was taken after the prone position. After clamping the head with a Mayfield clamp, we achieved a 70% reduction by applying gentle traction while keeping the cervical spine in a neutral position. Further reductions were accomplished intraoperatively after releasing the bilateral facet joints of C2/C3 and reducing it further by applying control traction in extension posture simultaneously with contralateral translation. All steps were done under continuous neurophysiology monitoring. Finally, a satisfactory reduction of the C2-C3 subluxation on both sagittal and coronal plans was achieved. A follow-up brain CT scan showed

Figure 1. CT pre OP saggital view with C2/3 non hangman dislocation.

Figure 2. CT angio pre OP showed coronal translation of C2 over C3 with injury to vertebral artery.

no acute insult, and the patient started antiplatelet therapy with aspirin. On the first day post-operation, the patient was hemodynamically stable with GCS 14/15 (E4M6V4), pupils 2mm reactive bilaterally with left raccoon eye, power 5/5 with normal tone, DTR 2+, and sensations intact. On day two, he was extubated and discharged on day five postoperatively (Figure **5**,6). A follow-up CT-Angio after 2 months showed intact vertebral artery with satisfactory alignment (Figure **7**)

3. Methodology

This systematic revie w was conducted in accordance with the recommendations of preferred reporting items for systematic reviews and

Figure 3. 3DCT revealed coronal dislocation of C2 over C3 with unilateral dislocation with left vertebral artery non dominant showing irregular outline and interrupted course with non-opacification of the cervical segment from C4 level up to the level of odontoid process.

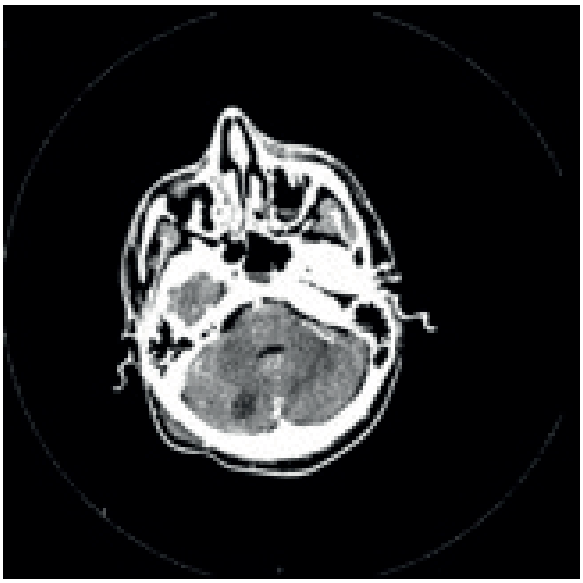

Figure 4. CT scan of brain axial cut revealed no acute insult.

meta-analyses (PRISMA) checklist. On January 1, 2022, a comprehensive electronic search was conducted through Scopus, PubMed, and Web of Science databases to retrieve original studies. The search strategy was as follows: ("C2-C3" OR "C2/C3" OR "odontoid") AND ("subluxation" OR "dislocation" OR "listhesis") NOT ("Atlantoaxial" OR "Atlanto-axial"). Studies with traumatic C2/3 dislocation were included. Hangman fracture, C1/2 dislocation, C2 pars or pedicle fracture, pediatric, non-English, non-surgical treatment, and insufficient data were the reasons for exclusion. A manual search was also conducted which covered all references of the selected articles (Figure **7**).

Figure 5. Lateral X-ray showed satisfactory reduction of C2/C3

Figure 6. Anterior posterior X-ary revealed satisfactory alignment of C2/C3.

4. Results

The total number of patients involved was eight, including our case, of whom six were males and two were females, reported collectively in 7 case reports (Table I). The average age was 37, with 59 and 21 being the oldest and youngest, respectively. All cases resulted from trauma, five of them due to motor vehicle accidents. Unilateral facet dislocation was present in four cases, while two had a bilateral dislocation, one was a widening of the joint, and one was not mentioned. The orientation of dislocation

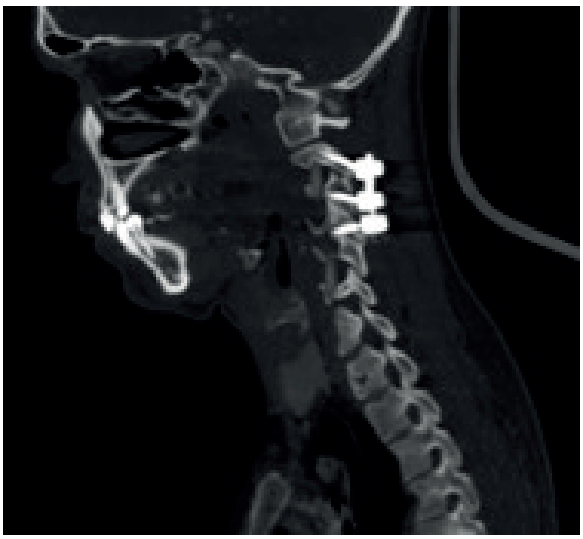

Figure 7. A CT angio3 months follow-up showed satisfactory reduction of C2/C3.

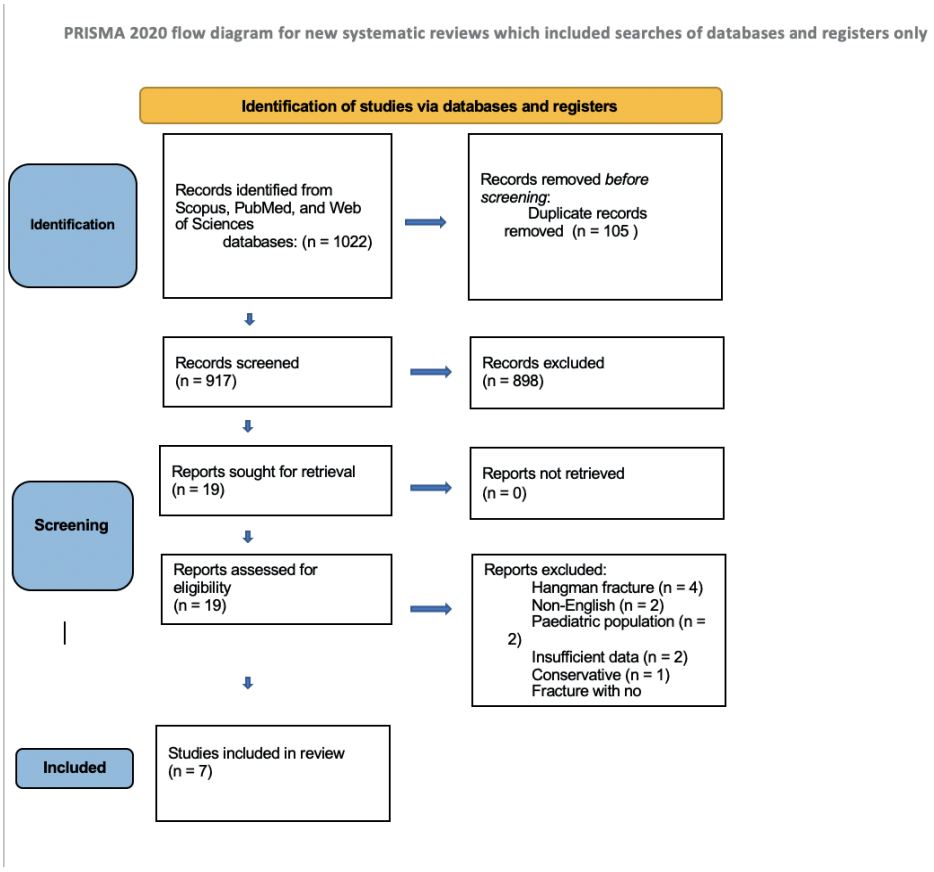

Figure 8. Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) Chart.

was sagittal dislocation in five cases and coronal in three cases. As for the status of the disc, it was intact in three cases, while two cases had the disc violation, and three cases did not mention it. All coronally dislocated cases were unilateral facet dislocations and had intact vertebral discs. Four cases reported vertebral injury, no vascular injury in two cases, while two cases did not mention it. All cases

Table I. Literature review summary for all articles reported Non Hangman C2/C3 dislocation.

	Name	Year	Age	pre-Exam	injury disc	Fusion type	Facet dislocate	Plan of dislocation
1	Sharma	2001	32	B	NM	A	NM	Sagittal
2	Machinis	2006	59	C	Y	C (AP)	Bi	Sagittal
3	S Rajasekaran	2011	49	D	**N**	**P**	**UNI**	**Coronal**
4	Hong-jun Zou	2017	50	E	NM	A	Uni	Sagittal
5	Singh	2017	32	E	**N**	**C (PA)**	**UNI**	**Coronal**
6	Alexander	2019	29	C	Y	C	widening distance	Sagittal
7	G. Lakshmi	2020	29	D	NM	P	Bi	Sagittal
8	Our case	2022	21	E	**N**	**P**	**UNI**	**Coronal**

N= no, NM= not mention, A= anterior, P=posterior, C=combined

underwent surgical fixation and fusion. Three cases were operated on with a posterior approach, two cases had an anterior approach, and three cases had a combined approach. All cases showed a favorable outcome with a significant improvement compared to the pre-operative examination. The average follow-up duration was ten months. The ASIA score pre-operatively was as follows: B (12.5%), C (25%), D (25%), E (37.5%). Post-operatively, it was D (37.5%) and E (62.5%).

5. Discussion

Upper cervical spine injuries are considered lethal and have devastating neurological outcomes due to the risk of damaging the spinal cord and vascular supply. However, in some cases, the degree of cervical spine dislocation may not necessarily correlate with clinical presentation and neurological signs (1). Fountas measured the spinal cord anteroposterior and transverse diameter from C2 to T1 using a CT myelogram and found the spinal cord measurement was smaller by 15-20% than what was reported by autopsy data (7). Thus, the smaller the spinal cord, the less susceptible it is to injury. This could explain the mild neurological manifestations in these complicated dislocations (2). Due to the rarity of this pathology, the management is challenging, and the prediction of the outcome is difficult. However, the outcome, as in any spine injury, correlates with pre-operative clinical status and, to some extent, with the type of dislocation, whether it is unilateral or bilateral (6,3). Our observation of the included studies is consistent with the results reported in the literature. The treatment of cervical spine dislocation is highly controversial and debatable. However, the American Association of Neurological Surgeons and the Congress of Neurological Surgeons have not favored any approach over the other. Both approaches are effective as long as they provide adequate decompression of the neuronal structure (4). As there is insufficient evidence to recommend any specific treatment, surgical treatment of C2/3 dislocation remains challenging. However, the management type could vary based on multiple factors, such as the presence of traumatic intervertebral disc herniation, neurological status, and surgeon experience. These factors need to be evaluated when planning the surgical approach. An anterior approach is preferred in cases with disc herniation to decompress the spinal cord or unilateral dislocation. Cases with irreducible unilateral or bilateral fact dislocation with no disc violation posterior approach could be used as a standalone if it is reduced. A combined approach is recommended in cases with bilateral facet dislocation with violated disc or cases where the

reduction cannot be achieved in a single approach (1)(3)(4). To conclude, the surgical approach in such cases is still controversial and dependent on many factors.

Vertebral artery injury in cervical spine trauma is commonly encountered, as multiple prospective studies showed abnormal vertebral arteries in 24–75% of cases following major blunt cervical spine trauma (8). It is essential to determine the status of the vertebral artery by doing a CT- Angio, MRA, or cerebral angiogram pre-operatively if the patient's clinical status permits. Treating vascular injury depends on many factors, such as the level of injury, dominant, non-dominant, occlusive or nonocclusive, and whether the patient has a collateral supply to the brain (10). A detailed discussion of vertebral injury management is not the scope of this article; however, each case must be discussed with the neurovascular teams and tailored to patient needs.

6. Conclusion

The C2/C3 coronal translation, with no disc disruption and unilateral facet dislocation, may be associated with better outcomes. Moreover, in coronal translation posterior, fixation and fusion could provide satisfactory outcomes. However, it is important to acknowledge that managing cervical spine injuries is a complex task, and there may still be areas of uncertainty and ongoing debate. Further research and clinical trials are necessary to explore the optimal management strategies for different types of cervical spine injuries, including those with coronal translation.

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