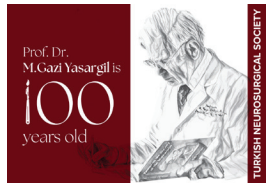
Turk Neurosurg 35(3):403-411, 2025
DOI: 10.5137/1019-5149.JTN.46843-24.4

Original Investigation

Spine and Peripheral Nerves

Received: 20.06.2024
Accepted: 21.09.2024
Published Online: 30.04.2025



Management of Subaxial Cervical Spine Injury with Unilateral Locked Facet: An Institutional Experience

Gyani J S BIRUA, A R PRABHURAJ, Gaurav TYAGI, Manish BENIWAL, Dwarakanath SRINIVAS

NIMHANS, Department of Neurosurgery, Bangalore, India

Corresponding author: Dwarakanath SRINIVAS ✉ dwarakaneuro@yahoo.com

ABSTRACT

AIM: To describe a series of 31 surgically managed cases in a single center.

MATERIAL and METHODS: We retrospectively collected data from 31 surgically managed cases that occurred between October 2014 and July 2019. We used the PubMed database to conduct a systematic literature search.

RESULTS: Out of 31 patients, 24 (77.4%) were male and seven (22.6%) were female, with a male-to-female ratio of 3.42:1. The mean age of injury was 45.81 years (range: 25–67 years). In 20 (64.51%) cases, the mode of injury was a fall, followed by a road traffic accident (RTA) in nine (29.03%) cases. The average duration from trauma to admission in the hospital was 8.13 days (range: 0–63 days), and the average duration of hospital stay was 13.03 days (range: 2–36 days). The most commonly involved vertebral level was C5–C6, affecting 16 (51.6%) cases. In 22 (70.96%) cases, closed reduction was achieved, while in nine (29.03%) cases, the reduction was achieved by open reduction. Of the 31 cases, 22 (70.96%) were managed by the anterior approach only, whereas seven were managed by the combined approach.

CONCLUSION: Subaxial cervical spine subluxation with a unilateral locked facet is an unstable injury; it should be managed surgically. For single-level subluxation with a unilateral locked facet, fixation and fusion from the anterior approach alone are sufficient if the closed reduction is achieved. In case of failed closed reduction, fixation and fusion using the anterior approach alone are sufficient after completing an open reduction from the posterior approach.

KEYWORDS: Cervical vertebrae injuries, Cervical vertebrae, Locked facet, Subaxial cervical vertebrae

INTRODUCTION

A unilateral cervical locked facet of the subaxial cervical spine is a relatively uncommon, often undiagnosed injury (21). In this injury, the inferior articular process of a subaxial cervical vertebra on one side is moved over and anterior to the superior articular process of the vertebra below. The mechanism of flexion rotation of the cervical spine is responsible for this injury (9,28). Approximately 12–15% of cervical spine injuries are unilateral facet joint dislocations (6). The term "locked" is used when the dislocated facet cannot return to its normal position without reduction effort (27). Rorabeck et al. reported that unilateral facet dislocation is an unstable injury (24). Failure rates with conservative therapy have ranged from 0% to 50% (6,19,24). At the same time, higher fusion rates and better outcomes have been documented with internal fixation (6,24).

MATERIAL and METHODS

The aim of the present study is to present a series of 31 surgically managed unilaterally locked facet subluxations of the subaxial cervical spine at a single center.

Gyani J S BIRUA : 0000-0003-0544-3954
A R PRABHURAJ : 0000-0002-5986-1521
Gaurav TYAGI : 0000-0002-3189-2641
Manish BENIWAL : 0000-0001-6037-3368
Dwarakanath SRINIVAS : 0000-0001-7330-0627

A total of 631 patients with traumatic cervical spine injury and subluxation were surgically managed between October 2014 and July 2019 in the National Institute of Mental Health and Neurosciences (NIMHANS), India. Data from all patients were retrospectively collected. Patients with associated severe head injuries and unstable patients at admission were excluded from the study due to unreliable neurological examinations. Furthermore, patients with incomplete records or follow-up data were also excluded. Patients of all ages and genders with subaxial cervical spine injuries with unilateral locked facets were included in this study. A total of 31 patients met our inclusion criteria. Patient records were reviewed and charted for age, sex, mode of injury, level of subluxation, type of reduction, subaxial injury classification and severity scale (SLICS), surgical approach, and the American Spine Injury Association (ASIA) score at admission and final follow-up. In all cases, computed tomography (CT) and magnetic resonance imaging (MRI) of the spine and CT angiography were performed preoperatively. Radiological data were collected from an electronic database of the institution, and the pattern of injury, type of fixation, presence of ventral compression of the spinal cord, and spinal cord changes were examined. We found the previous literature from the PubMed database using the keywords "unilateral," "locked facets," "subaxial cervical spine," "cervical spine subluxation," and combinations of these words.

We attempted the closed reduction of the dislocated facet joint using axial traction with Gardner-Wells tongs. During the closed reduction attempt, the patients' vital parameters and motor and sensory examinations were monitored regularly. If closed reduction was achieved, the patients primarily underwent fixation and fusion using the anterior approach. The standard Smith–Robinson approach was used for anterior cervical discectomy and fusion (ACDF) with an iliac crest graft and fixation with plates and screws.

In cases where closed reduction failed, patients were managed with combined approaches. In all these cases, a direct open reduction from the posterior approach was achieved by complete or partial drilling of the unilateral superior articular facet of the inferior vertebrae. Subsequently, the lateral mass or transpedicular screw fixations were performed using the posterior approach, followed by the ACDF using the anterior approach. Open reduction can be achieved using the anterior or posterior approach; however, in our institution, the posterior approach is preferred.

Although the superior articular facet of the inferior vertebrae and posterior ligamentous complex were intact in most cases, fusion and fixation were performed using only the ACDF approach. Only partial reduction was achieved in one patient after closed reduction with the Gardner-Wells tongs, as the patient was uncooperative. The posterior ligamentous complex was intact, and there was no spinal cord compression from the ventral aspect. Therefore, complete reduction was achieved by open reduction from the posterior approach by partially drilling (1/3rd) the unilateral superior articular facet of the inferior vertebrae. The reduction was followed by fixation using the posterior approach with only lateral mass screws and rods.

One neglected case (presentation > 3 weeks) was managed using a posterior–anterior–posterior approach in a staged manner. In the first stage, transpedicular/lateral mass screw placement and open reduction of locked facets were performed by drilling the unilateral superior articular facet of the inferior vertebrae using the posterior approach. However, no reduction in subluxation could be achieved. Therefore, the open reduction was completed in the second stage using the anterior approach with ACDF followed by rods from the posterior approach. A closed reduction was attempted in one patient, but the patient was uncooperative. There were associated C1 arch fractures; the patient underwent direct open reduction and fixation of both C1–C2 (lateral mass) and dislocated subaxial vertebral segments from the posterior approach (posterior approach only). The management algorithm is illustrated in Figure 1.

In all cases, the somatosensory evoked potential (SSEP) and motor evoked potential (MEP) were monitored intraoperatively. The transpedicular screw is the preferred mode of fixation for the C7 spine. This preference was also considered when the pedicle diameter of the subaxial spine was > 5 mm. Lateral mass screws were placed in the rest of the subaxial spine.

Regarding the level of vertebral body needed to fuse posteriorly, we chose the same level of vertebrae for fixation as the pathology level in the case of pure facet dislocation without any other fractures of subluxated vertebral bodies (for example, in the case of C5–C6 dislocation, the fusion would be of the C5–C6 vertebrae). In the case of fracture of the lamina/pedicle or lateral mass of the subluxated vertebral bodies, we went one vertebral level above or below for posterior fixation (for example, if the C5 facets/lamina/lateral mass was fractured in the case of C5–C6 dislocation, we chose C4 for fixation).

Postoperatively, all patients wore Philadelphia collars for six weeks. We followed up on the patients for an average of 37.14 months (26–59 months) with cervical spine radiography and neurological examinations. Since it is a retrospective study and all data and images have been anonymized, institutional ethics were not sought in accordance with the Indian Council of Medical Research (ICMR) National Ethical Guidelines.

RESULTS

The most common symptom was neck pain, which was invariably present in all cases. Furthermore, 18 (58.06%) patients had weakness in the four limbs, followed by urinary retention in eight (25.80%) patients. A history of brief loss of consciousness was observed in three cases. Of the 31 patients, 24 (77.4%) were male and seven (22.6%) were female, with a male-to-female ratio of 3.42:1. The mean age at the time of the injury was 45.81 years (range: 25-67 years). However, nine (29.03%) patients were between 31 and 40 years old when they were affected. In 20 (64.51%) cases, the mode of injury was fall, followed by road traffic accidents (RTA) in nine (29.03%) cases. The average duration from trauma to admission to the hospital was 8.13 days (range: 0-63 days), and the average duration of hospital stay was 13.03 days (range: 2-36 days). The most commonly involved vertebral level was C5–C6,

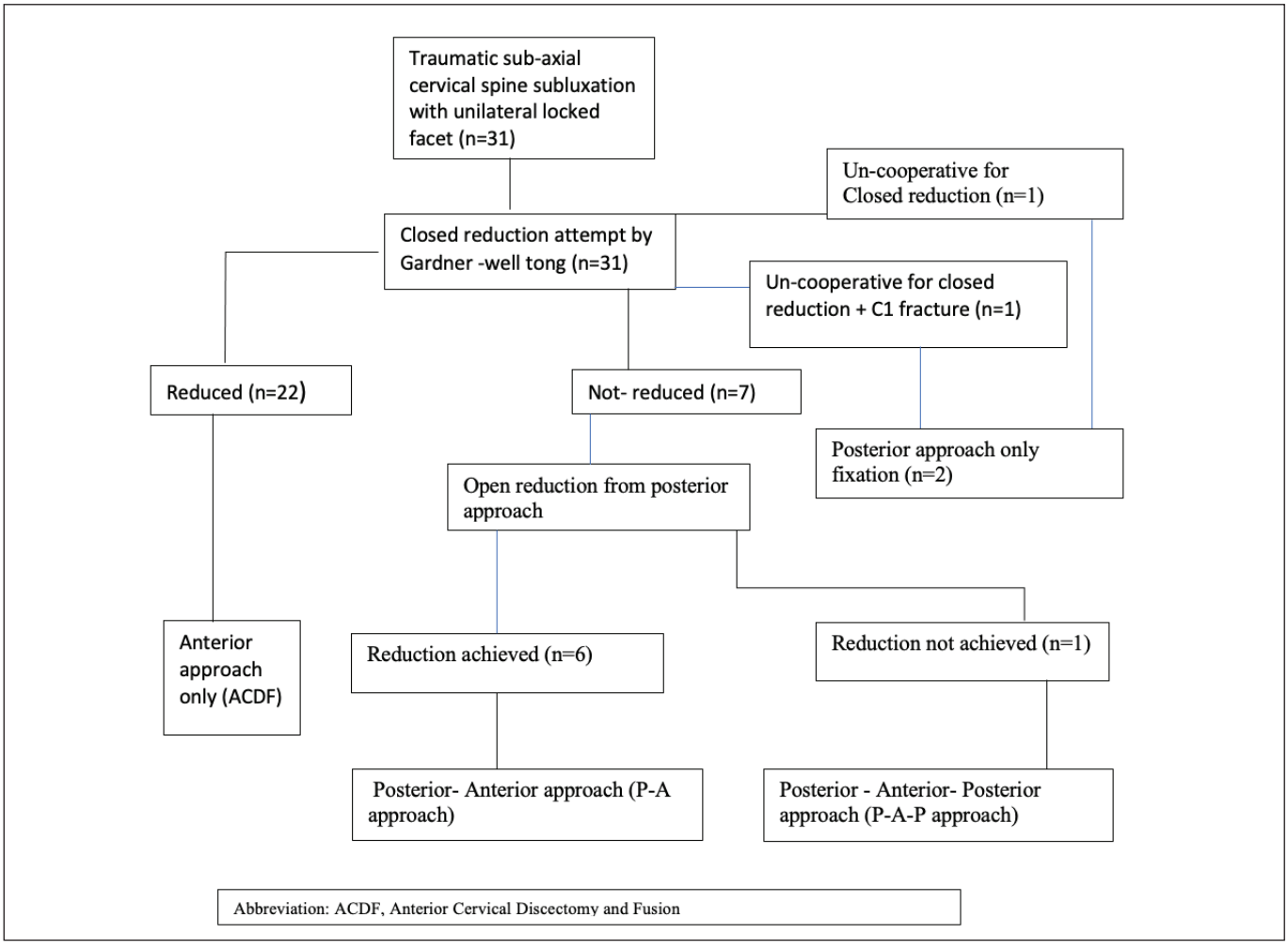


Figure 1: Management algorithm for subaxial cervical spine subluxation injury with unilateral lock facet.

affecting 16 (51.6%) patients. In 22 (70.96%) cases, closed reduction was achieved, while in nine (29.03%) cases, open reduction achieved the reduction. The left facet was locked in 16 (51.6%) cases, and the right facet was locked in 15 (48.4%) cases. The average SLICS score was 7.8, with a maximum score of 10. Of the 31 cases, 22 (70.96%) cases were managed using the anterior approach only and seven cases using the combined approach. A foramen transversarium fracture was seen in five cases, but no vertebral artery injury was observed on CT angiography. The demographic characteristics of the patients are summarized in Table I.

None of the patients had complete spinal cord injury (ASIA A) in the present study. A maximum two-grade improvement in the ASIA score was observed in only one case. One patient died 3 months after surgery from a chest infection.

Case Illustration 1

The patient was a 29-year-old female with a history of RTA, followed by pain and restriction of neck movement. She had urinary retention, for which she was catheterized at another hospital before being referred to our emergency department. The patient was conscious, alert, and oriented. The sensory and motor examination results were normal, except for paresthesia of the C6 dermatome of the left upper limb. The cervical spine was suggestive of C5–C6 grade 2 subluxation with fracture of the left C6 lamina and transverse process of C5 and C6. Left-sided C5–C6 facets were locked, while the right-sided facets were normal (Figure 2A, 2B). An MRI of cervical spine T2W images showed changes in the cord signal at the level of subluxation (Figure 2C).

She was placed on Gardner-Wells tongs traction, and the weight was gradually increased to 6 kg, after which the C5–C6 locked facets were reduced (Figure 2D). The patient underwent ACDF with an iliac crest graft and fixation with a plate and screw (Figure 2E, 2F). There was no deterioration in the sensory or motor status of the patient during the closed reduction. The patient was discharged on the fourth postoperative day.

Case Illustration 2

A 37-year-old female with a history of slipping and falling downstairs 2 months (63 days) prior, followed by paraparesis and urinary retention, was brought to our emergency services by a non-government organization. The patient was

Table I: Patient Demographics

Gender	**n (%)**
Male	24 (77.4)
Female	7 (22.4)
Age (years)	**n (%)**
21-30	3 (9.67)
31-40	9 (29.03)
41-50	8 (25.80)
51-60	7 (22.58)
61-70	4 (12.90)
Injury level	**n (%)**
C3-C4	2 (6.5)
C4-C5	8 (25.8)
C5-C6	16 (51.6)
C6-C7	5 (16.1)
Mechanism of Injury	**n (%)**
Fall	20 (64.51)
RTA ¶	9 (29.03)
Hit by Animal	1 (3.22)
Fall of heavy object	1 (3.22)
Duration of stay in Hospital	**Days**
Average days	13.03 days
Range	(2 – 36) days
Duration from trauma to intervention	**Days**
Average	8.13 days
Range	(0-63) days
Reduction	**n (%)**
Open	9 (29.03)
closed	22 (70.96)
Surgical approach	**n (%)**
Anterior only (ACDF)*	22 (70.96)
Posterior only(posterior reduction and fixation)	2 (6.45)
Combined approach (P-A)**	6 (19.35)
Combined approach (P-A-P)***	1 (3.22)

** ACDF~ Anterior cervical discectomy and fixation, **P-A~ Reduction & instrumentation by posterior approach followed by anterior approach (ACDF). ***P-A-P ~ Reduction & lateral mass screws by posterior approach then Anterior approach (ACDF) followed by fixation with rods by posterior approach. ¶ **RTA:** Road Traffic Accident.*

conscious, alert, and oriented. Tone increased bilaterally in her lower limbs. The power of the bilateral shoulder and elbow was 3/5, the bilateral wrist was 1/5, and the bilateral handgrip was 0%. Moreover, the power of the bilateral lower limbs was 3/5, with a graded sensory loss below the T1 vertebral level. A Foley catheter was used in situ.

The CT of the cervical spine was suggestive of C6–C7 grade 3 subluxation with a left-sided locked facet (Figure 3A). There were changes in the cord on the T2W MRI at the C6–C7 level (Figure 3B). She was placed on Gardner-Wells tongs traction, and the weight increased gradually to 6 kg, after which the gross power of the bilateral upper and lower limbs improved from 3/5 to 4/5. However, there was no reduction in subluxation on the serial X-ray of the cervical spine (Figure 3C). In the first stage, the patient underwent a posterior cervical approach; right-side C5, C6, C7, T1 pedicle screw placement; and left-side C5, C6, T1 pedicle screw placement with left C6–C7 drilling and unlocking of the facet joint under SSEP and MEP (Figure 3D). In the second stage, the patient underwent an anterior cervical approach, C6–C7 discectomy, drilling of C6 to T1 neo-ossified bone, and reduction of C6–C7 subluxation, followed by C6–C7 fusion with the iliac crest graft and fixation with plate and screws (Figure 3E). This process was followed by the posterior cervical approach, distraction, and fusion with the left C5 to T1 rods and right C5 to C7 and C6 to T1 rods (Figures 3E and 3F). The patient was discharged on the 19th postoperative day. At the final follow-up, she walked, but some residual weakness persisted on the left side.

Case Illustration 3

A 58-year-old male presented to our emergency department with a history of a fall from a height of approximately 10 feet, followed by neck pain radiating to the right shoulder. The power was 5/5 in all four limbs, and the sensation was intact. No bladder or bowel involvement was observed. The cervical spine CT showed C1 anterior and posterior arch fractures (Figure 4A). Grade 1 C4–C5 subluxation with a left-sided locked facet was observed (Figure 4B). Spinal cord compression was also observed, but no spinal cord changes were observed on the cervical spine MRI (Figure 4C). The patient was placed on Gardner-Wells tongs but was uncooperative, and there was no reduction in subluxation on serial cervical radiography (Figure 4D). The patient underwent open reduction from the posterior approach and C1–C2 lateral mass fusion and fixation (Figures 4E and 4F), followed by left-side C3–C5 and right-side C3–C4 lateral mass screw placement and fixation with a rod (Figures 4G and 4H). The patient was discharged on the fourth postoperative day. The power of all limbs was 5/5 at the time of discharge and follow-up (Figure 4I).

DISCUSSION

The closed reduction of cervical deformities resulting from facet dislocation by manipulation was first described by Walton in 1893 (31). Crutchfield introduced tongs in 1933 for the traction reduction of cervical deformities (12). Since then, many authors have successfully used similar techniques for the traction-reduction of cervical dislocations (10,25,26,30,33). Manipulation under anesthesia (MUA) is a common technique used when traction reduction fails; however, it is occasionally used to achieve reduction (17,26,29,33). We did not use MUA in any of our patients.

The incidence of neurological deterioration due to closed reduction was low (8,11,30). Studies have reported transient neurological deterioration from 2% to 4% following closed reduction. These neurological deficits usually improve spontaneously after weight reduction or after achieving open reduction (8,17). Closed reduction is not recommended in patients with additional rostral injury. Restoration of anatomical

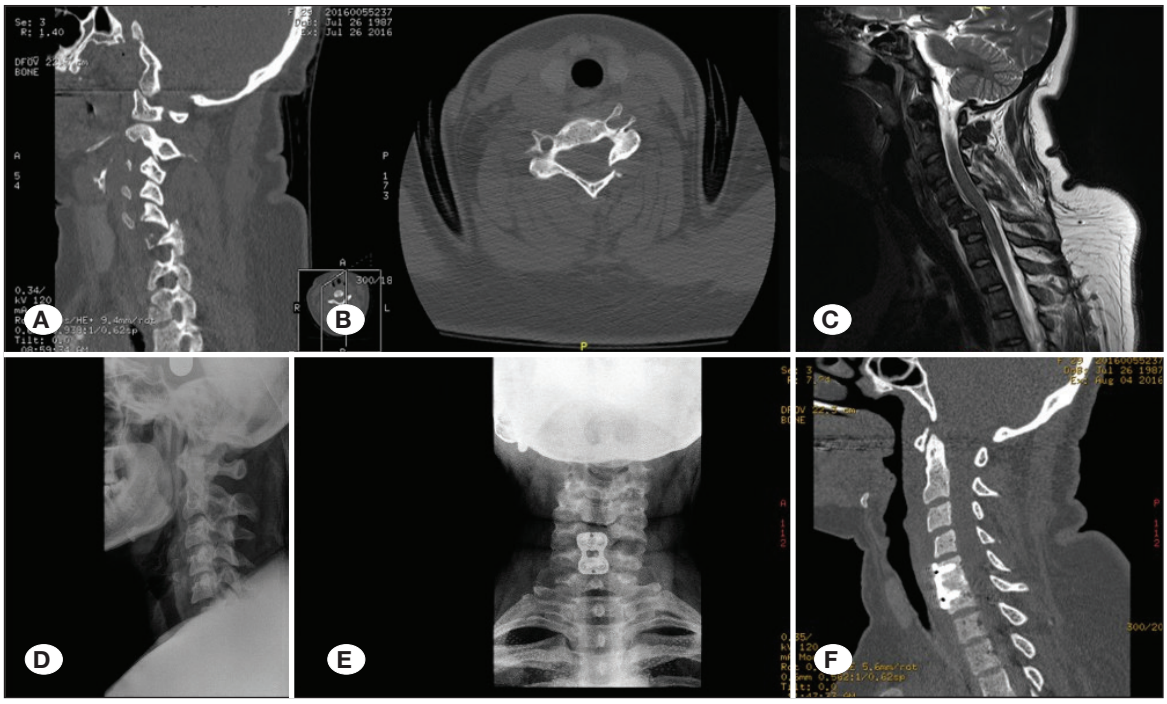


Figure 2: A) CT cervical spine sagittal section shows subluxation of the C5 vertebral body over the C6 vertebral body with a left-sided locked facet. **B)** CT cervical spine axial section shows a fracture of the left-sided lamina of the C6 vertebral body. **C)** MRI cervical spine T2W sagittal image shows minimal change in cord signal at the level of subluxation. **D)** Radiographic cervical spine lateral view shows the prereduction status of the spine. **E, F)** X-ray cervical spine antero-posterior view and CT cervical spine sagittal view at follow-up shows fused C5–C6 vertebral bodies with screws and plate in situ.

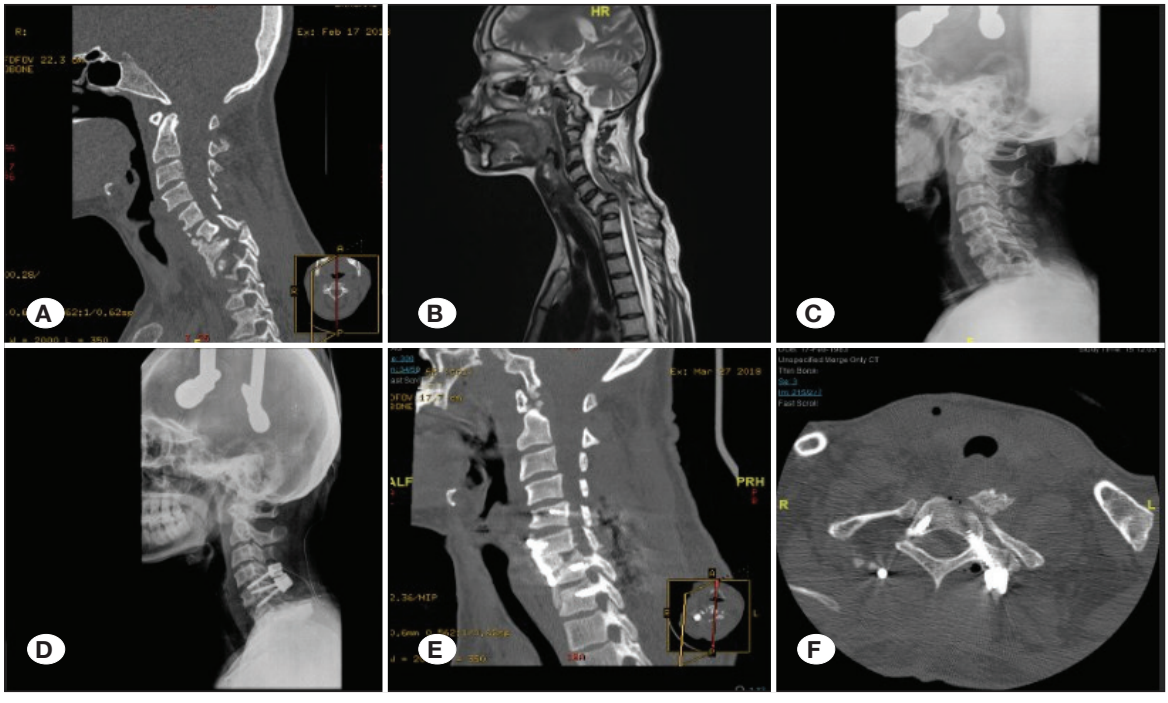


Figure 3: A) CT cervical spine sagittal section shows subluxation of the C6 vertebral body over the C7 vertebral body with a unilateral locked facet. **B)** MRI T2W sagittal image shows the compression and signal intensity changes of the cervical spine at the level of dislocation. **C)** X-ray cervical spine lateral view shows dislocation of C6 over C7 with Gardner-Wells tongs in situ. **D)** X-ray cervical spine lateral view shows transpedicular screws after the first stage of surgery. **E)** X-ray cervical spine lateral view shows the anterior (transpedicular screws and rods) and posterior fixation (ACDF) after the second stage of surgery.

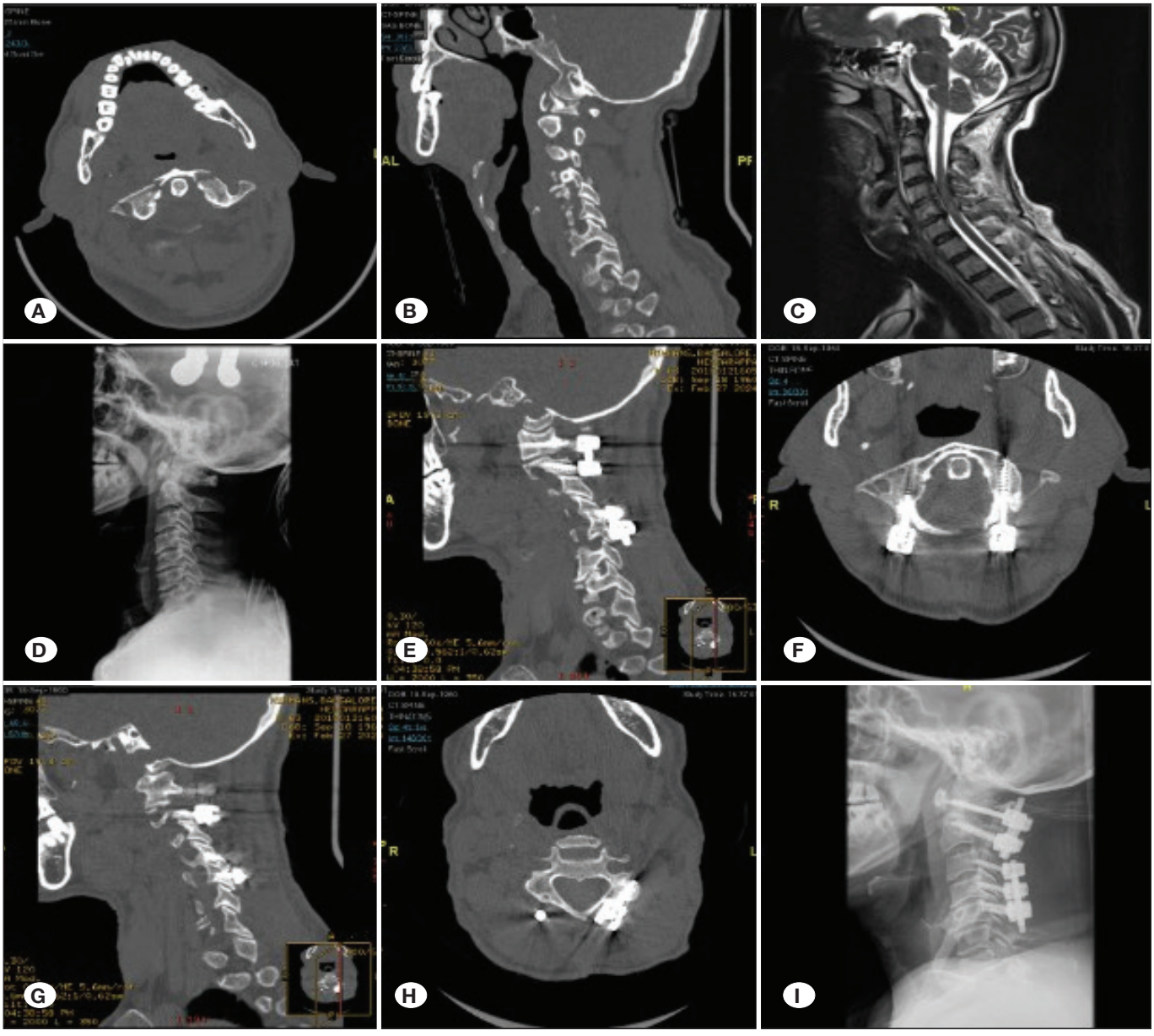


Figure 4: A) CT cervical spine axial section showing a fracture of the C1 arch. **B)** CT cervical spine sagittal section shows the subluxation of the C4 vertebral body over the C5 with a unilateral locked facet. **C)** MRI T2W sagittal section shows spinal cord compression at C4–C5 vertebral bodies level. **D)** X-ray cervical spine lateral view shows Gardner-Wells tongs. **E-H)** Post-operative CT cervical spine sagittal and axial sequences show bilateral C1–C2 lateral mass, right-sided C3–C4, and left-sided C3–C5 lateral mass screws and rod in situ. **I:** X-ray cervical spine lateral view at the 6th-month follow-up.

alignment is recommended for conscious patients with cervical spine fractures or dislocation injuries (16). There are many reasons for neurological deterioration following a closed reduction in patients with unstable cervical spinal injury. These reasons include unrecognized rostral injuries; overdistraction; loss of reduction; inadequate immobilization; and cardiac, respiratory, and hemodynamic instability (16). No permanent neurological deterioration was observed in any of our patients.

In addition to neck pain, clinical evidence of spinal cord compression was reported in 8-48% of cases by Payer et al. (20). The present study found clinical evidence of spinal cord involvement in 58.06% of the cases. Male patients were affected more than female patients; this disparity may be due to the greater involvement of males in outdoor activities and probably the more females remained in households. Most other studies have shown a male preponderance (4,21,22). RTA is the most common mode of injury in studies conducted in the West (4,20). Falls are the most common in Indian studies (22). The present study also found that falls were the most common mode of injury, including from trees, roofs, and stairs, as well as on the ground level. A previous study by Piccirili et al. found a mean age of 44 years (18-67 years), which is comparable

Table II: Neurological Status of Patients on Presentation and at Final Follow Up

Neurological Injury (ASIA score)	Pre-operative, n (%)	At final follow-up, n (%)
ASIA B	1 (3.22)	0
ASIA C	6 (25.80)	2 (3.22)
ASIA D	19 (54.83)	9 (41.93)
ASIA E	5 (16.12)	19 (54.83)
Total number	31	30 ¶

¶ one patient died 3 months post-surgery.

Table III: Improvement in ASIA Score at Final Follow-Up

Improvement in ASIA score	n
ASIA C - ASIA D	3
ASIA D - ASIA E	13
ASIA C - ASIA C	2
ASIA B - ASIA E	1
ASIA D - ASIA D	6
ASIA E - ASIA E	5
Total number	30*

***ASIA:** American spine injury association. *one patient died 3 months post-surgery.*

to the mean age of this study (21). However, the mean ages of 33 years (18-50 years) and 35.7 years (18-53 years) were reported by Prabhat et al. and Craig et al., respectively (22,23). The mean duration of hospitalization was relatively high in the present study, compared to the mean duration of 5 days (4-6 days) reported by Piccirilli et al. (21). The 8.23-day average (0–31 days) in this study may be due to attempts at closed reduction. The most commonly involved vertebral level was C5–C6, similar to other studies (1,20-22). Many studies have shown that the chance of successfully reducing a dislocation that has been present for more than 72 hours by closed means is approximately 20% compared with 64% in a fresh dislocation (3,32). In the present study, a closed reduction of 75% was achieved when the patient was brought in within 72 hours of trauma. Approximately the same percentage of closed reduction was achieved when the patient came even after 72 hours of trauma.

Do Koh et al. reported that posterior fixation might be biomechanically superior to rigid anterior fixation (13). However, the posterior-only approach complicates the procedure when subluxation is associated with disc herniation or ventral compression with bony fragments. Furthermore, it requires immobilization of multiple vertebral levels (34). The posterior approach has inherent risks of injury to neurovascular structures and complications related to muscle dissection, postoperative pain related to muscle contraction, increased blood loss, and longer hospital stays. On the other hand, the anterior approach is technically easier; less traumatic and ventral decompression of the spinal cord and stabilization can be achieved with less risk of catastrophic neurological sequelae and complications (2). Furthermore, with the introduction of titanium-locked plates and threaded cages, anterior fixation and fusion provide satisfactory results without dislodgement of the bone graft, significant late displacement, or kyphotic angulation (35). In the present study, only 22 (70.96%) patients were treated with the anterior approach.

A posterior approach is necessary when there is a failed closed reduction of the dislocation and is preferred when there is a facet fracture or severe posterior ligamentous injury (14). Piccirilli et al. have recommended that the anterior approach should be followed in case of disc herniation or fractures of the posterior bony elements & ligamentous complex (21). In the present study, seven cases were managed using a combined approach, including one neglected case (18). This neglected case was managed in two stages as ossification at the involved vertebral level had already started. For grades 1 and 2, subluxations with an intact posterior ligamentous complex, one-sided lateral mass screw, and rod fixation were performed. In case of severe posterior ligamentous complex injury, bilateral lateral mass and/or transpedicular screw fixation were performed. Although vertebral artery injury in cervical spine injuries is approximately 0.53-1.03% (7), no such injury was found in the present study. At the final follow-up, 13 patients showed improvement from ASIA D to ASIA E (Tables II and III). In the present study, only one patient improved by two grades in the ASIA score, probably due to the late presentation of the patients to the hospital. Fehlings et al. found that nearly 20% of patients who underwent early operation (within 24 hours) had at least a two-grade improvement in the ASIA score at the 6th-month follow-up (15). In comparison, only 9% of patients showed a two-grade improvement in the delayed surgery group.

The present study is one of the largest studies describing the outcome of a closed reduction in cases of traumatic subaxial cervical spine injury with unilateral locked facets. It also describes the management algorithm and outcomes in such cases. There are a few limitations to this study. First, this study collected data retrospectively, which may have introduced bias. Second, the potential for selection bias could influence the surgeon's preference for a particular surgical approach. This study also pointed out the need for further studies regarding sub-axial spine injury with unilateral locked facets.

CONCLUSION

Subaxial cervical spine injury with unilateral locked facets is relatively common and often undiagnosed. It is an unstable injury that requires surgical management. For single-level subluxation with a unilateral locked facet, fixation and fusion using the anterior approach alone are sufficient if a closed reduction is achieved. In case of failed closed reduction, fixation and fusion using the anterior approach alone are sufficient after achieving an open reduction from the posterior approach.

Declarations

Funding: This paper was non-funded.

Availability of data and materials: The datasets generated and/or analyzed during the current study are available from the corresponding author by reasonable request.

Disclosure: The authors declare no competing interests.

AUTHORSHIP CONTRIBUTION

Study conception and design: GJSB, GT,ARP, S

Data collection: GJS, GT

Analysis and interpretation of results: GJSB, ARP, DS

Draft manuscript preparation: GJSB,GT, MB, ARP, DS

Critical revision of the article: GJSB, MB, ARP, DS

Other (study supervision, fundings, materials, etc...): GT, MB, ARP, DS

All authors (GJSB, ARP, GT, MB, DS) reviewed the results and approved the final version of the manuscript.

REFERENCES

1. Aebi M: Surgical treatment of upper, middle and lower cervical injuries and non-unions by anterior procedures. Eur Spine J 19 Suppl 1:S33-39, 2010. https://doi.org/10.1007/s00586-009-1120-8
2. Alexander EDC, Forsyth HF: Reduction and fusion of fracture dislocation of the cervical spine. J Neurosurg 27:588-591,1967. https://doi.org/10.3171/jns.1967.27.6.0588
3. Allen BL Jr, Ferguson RL, Lehmann TR, O'Brien RP: A mechanistic classification of closed, indirect fractures and dislocations of the lower cervical spine. Spine 7:1-27, 1982. https://doi.org/10.1097/00007632-198200710-00001
4. Anissipour AK, Agel J, Baron M, Magnusson E, Bellabarba C, Bransford RJ: Traumatic cervical unilateral and bilateral facet dislocations treated with anterior cervical discectomy and fusion has a low failure rate. Global Spine J 7:110-1105, 2017. https://doi.org/10.1177/2192568217694002
5. Berry CA, Rao RD: Compressive flexion and vertical compression injuries of the subaxial cervical spine. Seminars in Spine Surg 25:36-44, 2013. https://doi.org/10.1053/j.semss.2012.07.001
6. Beyer CA, Cabanela ME, Berquist TH: Unilateral facet dislocation and fracture -dislocations of the cervical spine. J Bone Joint Surg 73:977-981, 1991. https://doi.org/10.1302/0301-620X.73B6.1955448
7. Biffl WL, Moore EE, Elliott JP, Ray C, Offner PJ, Franciose RJ, Brega KE, Burch JM: The devastating potential of blunt vertebral arterial injuries. Ann Surg 231:672-681, 2000. https://doi.org/10.1097/00000658-200005000-00007
8. Burke DC, Berryman D: The place of closed manipulation in the management of flexion-rotation dislocations of the cervical spine. J Bone Joint Surg Br 53:165-182, 1971. https://doi.org/10.1302/0301-620X.53B2.165
9. Cheshire DJ: The stability of the cervical spine following the conservative treatment of fractures and fracture-dislocations. Spinal Cord 7:193-203, 1969. https://doi.org/10.1038/sc.1969.31
10. Cloward RB: Reduction of traumatic dislocation of the cervical spine with locked facets. Technical note. J Neurosurg 38:527-531, 1973. https://doi.org/10.3171/jns.1973.38.4.0527
11. Cotler HB, Miller LS, DeLucia FA, Cotler JM, Davne SH: Closed reduction of cervical spine dislocations. Clin Orthop Relat Res 214:185-199, 1987. https://doi.org/10.1097/00003086-198701000-00028
12. Crutchfield WG: Skeletal traction in treatment of injuries to the cervical spine. J Am Med Assoc 155:29-32, 1954. https://doi.org/10.1001/jama.1954.03690190035010
13. Do Koh Y, Lim TH, Won You J, Eck J, An HS: A biomechanical comparison of modern anterior and posterior plate fixation of the cervical spine. Spine 26:15-21, 2001. https://doi.org/10.1097/00007632-200101010-00005
14. Eismont FJ, Arena MJ, Green BA: Extrusion of an intervertebral disc associated with traumatic subluxation or dislocation of cervical facets. Case report. J Bone Joint Surg Am 73:1555-1560, 1991. https://doi.org/10.2106/00004623-199173100-00014
15. Fehlings MG, Vaccaro A, Wilson JR, Singh A, Cadotte DW, Harrop JS, Aarabi B, Shaffrey C, Dvorak M, Fisher C, Arnold P, Massicotte EM, Lewis S, Rampersaud R: Early versus delayed decompression for traumatic cervical spinal cord injury:Results of the surgical timing in acute spinal cord injury study (STASCIS). PLoS One 7(2):e32037, 2012. https://doi.org/10.1371/journal.pone.0032037
16. Gelb DE, Hadley MN, Aarabi B, Dhall SS, Hurlbert RJ, Rozzelle CJ, Ryken TC, Theodore N, Walters BC: Initial closed reduction of cervical spinal fracture-dislocation injuries. Neurosurgery 72 Suppl 2:73-83, 2013. https://doi.org/10.1227/NEU.0b013e318276ee02
17. Harrington JF, Likavec MJ, Smith AS: Disc herniation in cervical fracture subluxation. Neurosurgery 29:374-379, 1991. https://doi.org/10.1097/00006123-199109000-00006
18. Hassan MG: Treatment of old dislocations of the lower cervical spine. Int Orthop 26:263-267, 2002. https://doi.org/10.1007/s00264-002-0350-8
19. Lifeso RM, Colucci MA: Anterior fusion for rotationally unstable cervical spine fractures. Spine 25:2028-2034, 2000. https://doi.org/10.1097/00007632-200008150-00005
20. Payer M, Gluf W, Schmidt MH: Management of a traumatic unilateral locked facet of the subaxial cervical spine. Contemporary Neurosurgery 26:1-4, 2004. https://doi.org/10.1097/00029679-200401150-00001
21. Piccirilli M, Liberati C, Santoro G, Santoro A: Cervical posttraumatic unilateral locked facets: Clinical, radiologic, and surgical remarks on a series of 33 patients. Clin Spine Surg 29:261-265, 2016. https://doi.org/10.1097/BSD.0b013e3182870c3f
22. Prabhat V, Boruah T, Lal H, Kumar R, Dagar A, Sahu H: Management of post-traumatic neglected cervical facet dislocation. J Clin Orthop Trauma 8:125-130, 2017. https://doi.org/10.1016/j.jcot.2016.10.002
23. Rabb CH, Lopez J, MD, Beauchamp K, Witt P, Bolles G, Dwyer A: Unilateral cervical facet fractures with subluxation: Injury patterns and treatment. J Spinal Disord Tech 20:416-422, 2007. https://doi.org/10.1097/BSD.0b013e318030d32a

24. Rorabeck CH, Rock MG, Hawkins RJ, Bourne RB: Unilateral facet dislocation of the cervical spine. An analysis of the results of treatment in 26 patients. Spine 12:23-27, 1987. https://doi.org/10.1097/00007632-198701000-00004
25. Rosenfeld JF, Vaccaro AR, Albert TJ, Klein GR, Cotler JM: The benefits of early decompression in cervical spinal cord injury. Am J Orthop (Belle Mead NJ) 27:23-28, 1998
26. Sabiston CP, Wing PC, Schweigel JF, Van Peteghem PK, Yu W: Closed reduction of dislocations of the lower cervical spine. J Trauma 28:832-835, 1988. https://doi.org/10.1097/00005373-198806000-00020
27. Scher AT: Unilateral locked facet in cervical spine injuries. Am J Roentgenol 129:45-48, 1977. https://doi.org/10.2214/ajr.129.1.45
28. Shanmuganathan K, Mirvis SE, Levine AM: Rotational injury of cervical facets: CT analysis implications neurologic of fracture patterns with for management and outcome. Am J Roentgenol 163:1165-1169, 1994. https://doi.org/10.2214/ajr.163.5.7976894
29. Shrosbree RD: Neurological sequelae of reduction of fracture dislocations of the cervical spine. Paraplegia 17:212-221, 1979. https://doi.org/10.1038/sc.1979.44
30. Sonntag VK: Management of bilateral locked facets of the cervical spine. Neurosurgery 8:150-152, 1981. https://doi.org/10.1227/00006123-198102000-00002
31. Walton GL: A new method of reducing dislocation of cervical vertebrae. J Nerv Mental Dis 18:609-611, 1893. https://doi.org/10.1097/00005053-189309000-00003
32. Vaccaro AR, Nachwalter RS: Is magnetic resonance imaging indicated before reduction of a unilateral cervical facet dislocation? Spine 27:117-118, 2002
33. Vital JM, Gille O, Senegas J, Pointillart V: Reduction technique for uni- and biarticular dislocations of the lower cervical spine. Spine 23:949-954, 1998; discussion 955. https://doi.org/10.1097/00007632-199804150-00021
34. Ye ZW, Yang SH, Chen BJ, Xiong LM, Xu JZ, He QY: Treatment of traumatic spondylolisthesis of the lower cervical spine with concomitant bilateral facet dislocations: Risk of respiratory deterioration. Clin Neurol Neurosurg 123:96-101, 2014. https://doi.org/10.1016/j.clineuro.2014.04.010