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Standalone Anterior Reconstruction Approach in Traumatic Cervical Spine Instability Lesions

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ABSTRACT

Background: The subaxial cervical spine trauma associated with spinal cord injury carries high rate of morbidity, mortality, with significant socioeconomic impact. There are different modalities for treatment of such cases.

Objective: To evaluate the early outcome of standalone anterior reconstruction cervical spine surgery with cage and plate system in management of displaced subaxial cervical spine injuries with cord compression.

Patients and Methods: The study included 14 patients during the period from January 2020 to January 2024 with displaced subaxial cervical spine injuries associated with cord compression. Preoperative symptoms and postoperative results for those patients who underwent standalone anterior reconstruction of cervical spine by surgery with cage and plate system for treatment of their lesions, were all recorded.

Results: Patients were 9 males and 5 females with mean age 28 years. The most common cervical level affected was C5-C6 accounting for (71.5%) 10 cases, followed by C4-C5 3 cases (21.5%) then C6-C7 (7 case). The average blood loss intraoperatively was 150 ml ± 50. The most common complication was the C5 palsy occurred in 4 cases who improved with medical treatment and follow up. No CSF leak, hardware failure, vascular injury or soft tissue injuries were reported in this series.

Conclusion: Performing immediate intraoperative closed reduction under general anesthesia for subaxial cervical spine dislocations, along with anterior cervical stabilization using a cage and plate system, has been shown to be the preferred treatment option due to its high safety and efficacy rates, with fewer complications.

Keywords: Cervical spine; Dislocations, Treatment.

INTRODUCTION

In 2013 cervical spinal cord injuries contributed for about 43.9% to 61.5% of all spinal cord injuries in the middle-aged population with an active lifestyle prior to their cervical injuries [1].

The subaxial cervical spine is the commonest site especially at the level of C5-7 segment, which contributes for more than 50% of the subaxial fractures due to the high mobility in this region. The subaxial cervical spine trauma associated with spinal cord injury carries high rate of morbidity, mortality, and important functional disability with significant economic and social impact [2].

The assessment of cervical spine stability following trauma can be determined using the 3-column theory. If only one column is disrupted, there is a low risk of cervical cord injury because the remaining two columns can maintain the spine's structural integrity. However, if both columns are affected and disrupted, the cervical spine can move as two independent units, leading to severe cord injury [3].

Unilateral or bilateral facet dislocation causes subaxial cervical displacement, resulting in the displacement of one cervical vertebra in relation to another [4]. In road traffic accidents, the most accepted mechanism for the subaxial cervical dislocation injury is the combination between the flexion and distraction injury [5].

Standalone anterior approach for management of subaxial cervical spine injury is considered less traumatic approach due to its blunt interplane dissection with low infection rate (0.1% to 1.6%) comparable to the posterior cervical approach (16%). Standalone anterior approach gives us direct access to pathological disruption of the disco ligamentous compartments and direct decompression [4].

Hence, this study aimed to evaluate the early outcome of standalone anterior reconstruction cervical spine surgery with cage and plate system in management of displaced subaxial cervical spine injuries with cord compression.

PATIENTS AND METHODS

Fourteen patients with traumatic cervical spine dislocation were introduced to our Emergency Unit in Sohag University Hospital, Department of Neurosurgery between the January 2020 to January 2024.

Inclusion criteria were patients under 60 years old, with an average body weight not exceeding 100 kg, who were vitally stable and had no serious cardiothoracic or abdominal injuries, and no history of previous spine surgery.

Preoperative evaluation:

All patients underwent preoperative evaluation with complete neurological examination, cervical X-ray,

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cervical CT spine, and cervical MRI spine and laboratory investigations.

The Neck Disability Scale and Visual Analogue Pain Scale (VAS) were used in this study for all patient to evaluate the postoperative prognosis.

We used the peak cage for all patients with a size ranged from 6-9 mm and anterior cervical titanium plate.

Postoperative follow up:

All patients were assessed postoperatively: during hospital stay, after 6 months and 12 months, clinically and radiologically.

Surgical Technique:

Under general anesthesia with supine position, we used the ring tong skull traction system to reduce the displaced level. This maneuver was done under C-arm image monitoring with starting weight 10 kg that could be increased to 15 kg. We stopped the traction if the intervertebral disc space was over distracted. After reduction, longitudinal skin incision was done along the affected level at the anterior border of sternomastoid muscle. Platysma was opened using the bipolar diathermy with blunt dissection to reach the anterior border of the vertebral body leaving the carotid sheath laterally and the esophagus and trachea medially.

Intraoperative image was used to ensure the reduction and the level and in case of failed reduction we could apply more force and distraction to achieve open reduction at this step. As the usual of the anterior cervical approach with the use of Cloward retractor and Kasper distractor with removal of the disrupted disc material under the microscope and ensure complete decompression of the cervical cord, we used the suitable size of the peek cage with artificial synthetic bone granules. The cage was put under the C-arm image to ensure its fit to place and size. Suitable sized anterior cervical titanium plate was used to fix the above and below level. In one case we bypassed one level due to destructed vertebrae.

Intraoperative C-arm was used with anteroposterior and lateral views to ensure optimal position of hardware. Removal the traction force and closure of the wound were done with leaving suction drain for 2 days.

Cervical collar was used during the anesthesia recovery and the patient was transmitted to the ICU for 24 hours for observation of vital signs and adequate respiratory function.

Ethical Consideration:

This study was ethically approved by the Institutional Review Board [IRB] of the Faculty of Medicine, Sohag University (Soh-Med-24-03-01). All participants provided written informed consent. This study was conducted in accordance with the ethical standards outlined in the Declaration of Helsinki by the World Medical Association for research involving human subjects.

Statistical methods

Statistical analysis was performed using Microsoft Excel 2016 (Microsoft Corporation, USA) and SPSS version 24 (IBM Corporation, USA). Qualitative data were expressed as numbers and percentages and were compared by Fisher's exact test. Quantitative data were presented as mean ± standard deviation (SD). Significance was set at a p-value of less than 0.05.

RESULTS

Fourteen patients with traumatic cervical spine dislocation injury, were operated on with standalone anterior cervical reconstruction surgery, with a predominance of male ratio 9 males and 5 females. Our patient's age ranged from 18-44 years with a mean ± SD age of 28.36 ± 5.96 years.

In our study, the most common cervical level was C5-C6 accounting for 10 cases followed by C4-C5 (three cases) then C6-C7 (one case).

On the other hand, the neck disability scale was used, and the preoperative evaluation was compared to the postoperative results, and it showed significant improvement in the scale with P value less than 0.001 **(Table 1)**.

Table 1: Comparison of Neck Disability Index Scores Pre- and Postoperative

Neck Disability Index	Preoperative (n)	Postoperative (n)
0-4 points (no disability)	0	2
5-14 points (mild disability)	0	7
15-24 points (moderate disability)	1	5
25-34 points (severe disability)	9	0
35-50 points (complete disability)	4	0

We used also the visual analogue pain scale (VAS) and it was improved a significant improvement incomparable to the preoperative evaluation with P value less than 0.001 **(Table 2)**.

Table 2: Comparison of Visual analogue Pain scale Pre- and Postoperative:

VAS scale (visual analogue pain)	Preoperative (n)	Postoperative (n)
0 (no pain)	0	2
1-3 (mild)	0	7
2-5 (moderate)	1	5
6 (severe)	9	0
7-9 (very severe)	4	0
10 (worst pain)	0	0

The average ± SD operative time was 100 ± 20 minutes and the blood loss intraoperatively was 150 ± 50 ml.

Complications:

Postoperative complications were reported, we found the most common complication was the C5 palsy accounted for 4 cases, which showed marked improvement with the medical treatment, neck pain presented in 3 cases, which lasted for long time and was improved by physiotherapy and medical treatment, and superficial wound infection was reported in one case and was improved by frequent dressing and antibiotics. No cases were reported with CSF leak, hardware failure, vascular injury or soft tissue injuries **(Table 3)**.

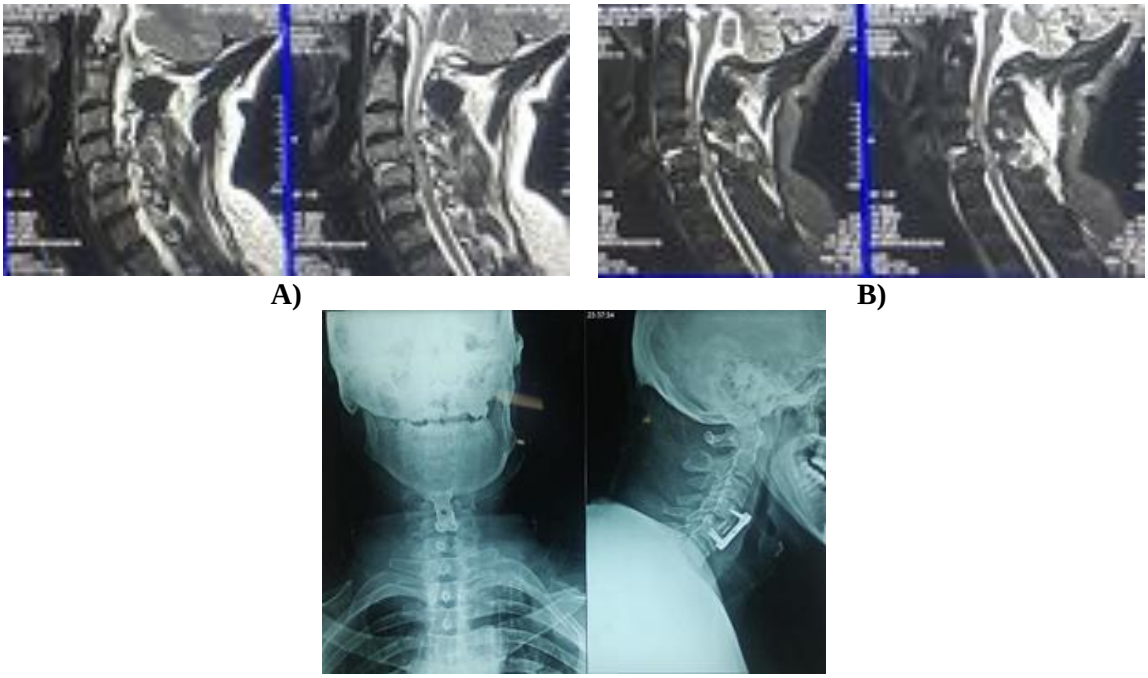
Table 3: postoperative Complications:

Postoperative complications	Patients (n)
C5 nerve palsy	4
Neck pain	3
Superficial wound infection	1

CASE PRESENTATION

CASE 1

A male patient 35 years old presented by quadriparesis and urine retention and C4-5 fracture dislocation **(Figure 1)**.



A) **B)**

C)

Figure 1: (A and B) MRI show displaced C4-5 with disrupted disc material, (C) Postoperative X rays show C4-5 fixation with peek cage and plate.

CASE 2

A male patient 30 years old presented with C5-6 displaced fracture **(Figure 2)**.

A)

B)

C)

Figure 2: (A) MRI shows displaced fracture C5-6, (B and C) Postoperative X rays show C5-6 fixation with peek cage and plate.

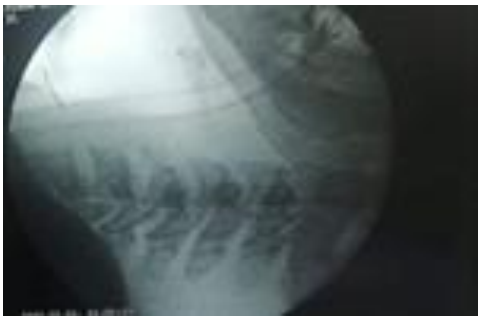
CASE 3

A male patient 25 years old presented by quadriparesis and urine retention **(Figure 3)**.

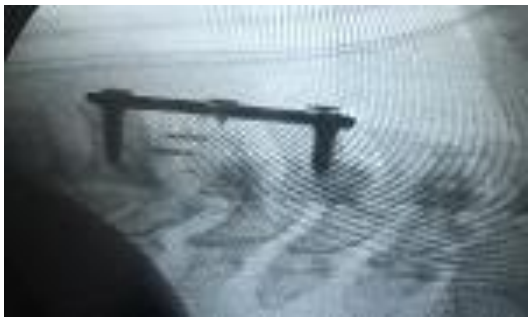
A)

B)

C)



D)



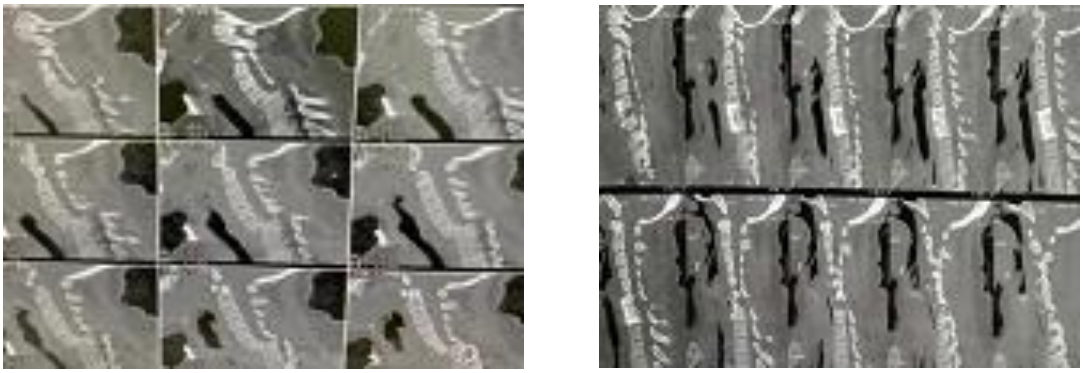
E)

F)

Figure 3: (A and B) MRI and CT (C) show displaced C4-5 with disrupted disc, (D) Intraoperative images under C arm reduction achieved and detection of the level with mark (E) After placement of the cage and the plate, (F) Follow up X ray showing reduction with fixation and good alignment of the cervical spine.

CASE 4

A male patient 55 years old presented with C6-7 fracture dislocation **(Figure 4)**.



A) **B)**

Figure 4: Preoperative MRI (A) and postoperative MRI (B) showing C6-7 dislocation.

DISCUSSION

The Subaxial Injury Classification (SLIC) scale helps guide the management of subaxial cervical spine trauma, focusing on three key factors: morphology, neurological status, and integrity of the disc ligament complex. This scale helps determine treatment options: scores 1-3 may be managed conservatively, while patients with a score of 4 may be treated conservatively or surgically based on surgeon preference and patient comorbidities. Patients with a score of five or higher are typically recommended for surgical realignment with neurological decompression and stabilization [6-10]. The conservative management of subaxial dislocation with halo traction and immobilization using a collar has met many objections nowadays due to the high rates of instability, with progressive disability caused by pain and delayed neurological injuries and stiffness. Failure rate in conservative management reached to 77%. So, the surgical treatment is the golden role in management of cases of subaxial cervical dislocations [11, 12].

Grant *et al.*, Star *et al.* and **Vaccaro *et al.*** recommend immediate closed reduction in awake patients based on plain X-rays film without wasting critical time for doing MRI and they reported no neurological worsening occurred in these cases [13-15]. However, **Eismont *et al.*** recommend MRI before doing the closed reduction to assess the disc material and showed 50-80% incidence of disc herniation in cases of subaxial cervical dislocation with a report of two cases of neurological worsening when they underwent closed reduction without pre-MRI due to migration of the pre-existing disc fragment [16].

Analysis of the neurological state of our patient's preoperatively and postoperatively showed improvement in the neurological outcome, which agreed with the trail of STASCIS with recommendation for early decompression within 24 hours to achieve neurological improvement. Traction and closed reduction in awake patients can achieve indirect decompression with reduction and this form of decompression is relevant in the logistic settings with no available immediate surgical intervention. We recommend, in cases of subaxial cervical dislocation injury, reduction under general anesthesia with immediate surgical decompression with removal of the disrupted disc material and stabilization through standalone anterior approach, which carries a safe efficient approach [17-20].

In our series, we achieved closed reduction in most cases (12 cases) using the ring and skull traction under C-arm in the operative theater. There were 2 cases (14.2%) in which open reduction after removal the disrupted disc material with traction achieved. Authors reported in previous studies about 26% failure of closed reduction [17-20]. Recently many series proved that the anterior surgical reduction is effective even in cases with locked cervical facets and hence the anterior cervical procedures provide safe and effective approach for management of subaxial cervical dislocation and alternative for the posterior surgery [21,22]. The safety of the anterior procedures can be proved by our results that we have no recorded cases of soft tissue injuries of neurovascular insults.

A study reported 109 cases of subaxial cervical dislocation underwent anterior approach surgery with no single case of soft tissue or neurovascular injuries. Even with the long period follow up they discovered 35% of his cases with hardware failure with no signs of tracheoesophageal erosion or neurovascular injuries [23].

In 2015, 12 cases reported by **Shen *et al.*** underwent immediate skull traction and reduction in the

operative theater under general anesthesia followed by standalone anterior cervical procedures with stabilization cage and plate system [24]. This is similar to our series when we achieved closed reduction under general anesthesia in most cases. Two cases in our surgery; for the fear of excessive manipulation, we preferred the open reduction. Anterior cervical stabilization using the cage and plate system is a solid efficient fusion.

It is known that with the posterior cervical procedures there is increased risk for infection and neurovascular injuries compared to the anterior approach. In addition, the prone position in the posterior approach carries difficulties in maintaining intraoperative safe vital signs especially in polytrauma patients. With the risk of anterior collapse and progressive kyphosis in posterior procedures and the lack of rigid fixation with the fractured inferior articular process, the anterior approach provides the advantages in these points The anterior approach is considered less traumatic with solid stabilization and cervical lordosis preservation [25,26]. In our study, the mean of the operative time was 100 ± 20 minutes with no obvious blood loss with a mean of 150± 50 ml. **Kwon *et al.*** proved that the anterior cervical approach have the advantage of the shorter time and less blood loss than the posterior approach with a time mean 103 minutes and blood loss less than 100 ml [27]. **Yukawa *et al.*** reported the same results with an operative time 101 minutes and blood loss does not exceed 190 ml [28].

Using the VAS score for the postoperative evaluation of our cases, we found that the VAS score for the neck and arm pain showed significant improvement ($p< 0.001$). These results agreed with **Kwon *et al.*,** who reported significant VAS improvement postoperatively in cases treated with anterior cervical approach using cage and plate ($p< 0.001$) between pre- (7.1 ± 1.9) and postoperative (2.0± 1.7) scores (average improvement 4.6 ±2.1) [29]. On the other hand, the anterior cervical procedures provide to us a familiar safe approach with short segment construct and direct attack to the ruptured disc material and hence direct neurological decompression.

From our series, we found that the result of traction with reduction could be achieved more easily under the general anesthesia with muscle relaxant with elimination of the patient pain during the reduction steps. This is followed by immediate stabilization using the cage and plate system with its long-term spinal stability. From all of this, we consider the anterior approach the first line of treatment in cases of subaxial cervical dislocation. In cases with severe cervical injuries that affect the 3-column standalone anterior approach, it will not be enough for the treatment and combined approaches (360) anterior and posterior could be the choice of treatment.

CONCLUSION

Immediate intraoperative closed reduction under general anesthesia in cases of subaxial cervical spine dislocation injuries followed by anterior cervical stabilization by cage and plate system proved to be the treatment of choice with high rate of safety, efficacy and less complications.

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Conflict of Interest: Nil.

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