

## Management of Unilateral Facet Dislocation of the Cervical Spine

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**Objective :** Unilateral facet dislocation of the cervical spine occurs by flexion and rotation injuries and cannot be easily reduced by axial traction. We analyzed 14 consecutive patients with unilateral facet dislocation of the cervical spine to increase knowledge about anatomical reduction of locked facet and factors for successful reduction.

**Methods :** Fourteen patients (10 men and 4 women) with unilateral facet dislocation of the cervical spine were retrospectively analyzed. Plain X-ray, computerized tomography scan, and magnetic resonance imaging were performed. All patients underwent manual reduction and surgery with anterior interbody fusion and plate fixation. The manual reduction was performed by neck flexion and rotation to the opposite side of dislocation, followed by rotation and flexion of the head toward the side of dislocation and extension with relaxation of traction. Mean follow-up period was 17 months. The level of spine, amount of subluxation, combined facet fracture, and time from injury to initial reduction were analyzed using the data obtained from medical records.

**Results :** Thirteen (93%) patients were reduced successfully. Immediate reduction was achieved in 7 patients but failed in 7 patients. Seven patients underwent delayed closed reduction under general anesthesia, and successful reduction was achieved in 6 patients. Only one patient with bone chips between articular facets failed to achieve anatomical reduction.

**Conclusion :** In order to reduce the locked facet more easily and safely, we recommend manipulative traction with anterior interbody fusion and plate fixation under general anesthesia after being aware of spinal cord injury with magnetic resonance imaging.

**KEY WORDS :** Dislocation · Locked facet reduction · Fusion.

### Introduction

The best method of obtaining and maintaining the reduction of unilateral facet dislocation remains controversial. Colter et al.<sup>4)</sup> found axial traction with increasing weights to be an effective means of obtaining reduction. However, Shapiro et al. have reported that closed reduction by weight traction is ineffective<sup>14)</sup>. Previous reports have attempted closed reduction by axial traction with Gardner-well tongs, but the mechanism of unilateral facet dislocation also involves rotation injury (Fig. 1). Therefore, axial traction is often unsuccessful in closed reduction of locked facet. We have attempted to manipulative traction which resolves initial injury mechanism of unilateral facet dislocation. Thirteen (93%) patients underwent successful reduction and had good outcomes by anterior interbody fusion

and plate fixation. Therefore, we propose the method for the management of unilateral facet dislocation.

### Materials and Methods

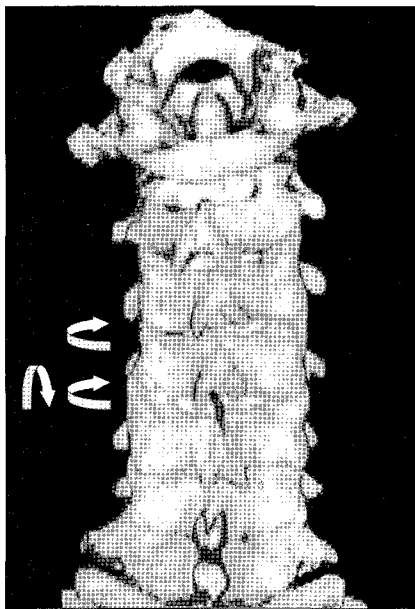
#### Patients population

Fourteen patients with unilateral facet dislocation of the cervical spine were treated between January 1, 1998 and May 31, 2006 using the same method and were retrospectively analyzed. Mean follow-up period was 17 months. There were 10 men and 4 women whose age ranged from 23 to 69 years, with an average age of 44 years (Table 1). There were 11 cases of traffic accidents, 2 cases of fall-down, and one case of slip-down. The levels of dislocation were C4-C5 (7 cases, 50%), C5-C6 (3 cases, 21%), and C6-C7 (4 cases, 29%). All patients

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• Received : December 7, 2006 • Accepted : April 6, 2007

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**Fig. 1.** Mechanism of unilateral facet dislocation is flexion and rotation injury.

showed minor neurologic deficits with Frankel's classification D or E. Three patients (21%) presented with radiculopathy, 3 (21%) with neck pain, 3 (21%) with a neurological symptom of hand grasp grade IV, and 5 (35%) with no specific symptoms. Fracture combined with unilateral facet dislocation was seen in 7 (50%) of 14 cases. Six with

facet fracture, and 1 with facet and pedicle fractures. Diagnoses were made in all cases on the basis of lateral cervical spine radiographs which demonstrated anterior subluxation of the vertebral body with narrowing of the foramen. All patients showed anterior subluxation within 3-5 mm (average 3.5 mm). Anteroposterior radiographs showed subtle deviation of the spinous process toward the side of dislocation.

Immediately after computerized tomography was performed, all patients underwent manipulative traction with an intravenous administration of muscle relaxant (Methocarbamol 2.0 g). Magnetic resonance imaging was performed in patients whose

initial reduction was not successful. In the cases of failed reduction, manual reduction was performed under general anesthesia (Vecuronium bromide 0.12-0.15 mg/kg). All patients underwent anterior interbody fusion and plate fixation after manipulative traction.

**Manipulative traction**

We did not attempt simple axial traction but manipulative traction which was introduced by Frank H. Netter<sup>6)</sup>. The unilateral locked facet could be reduced by neck flexion and rotation to the opposite side of dislocation, followed by rotation and flexion of the head toward the side of dislocation and extension with relaxation of the traction (Fig. 2). The surgeon performed manipulative traction, while the assistants pull both hands of the patient parallel to the ground.

**Results**

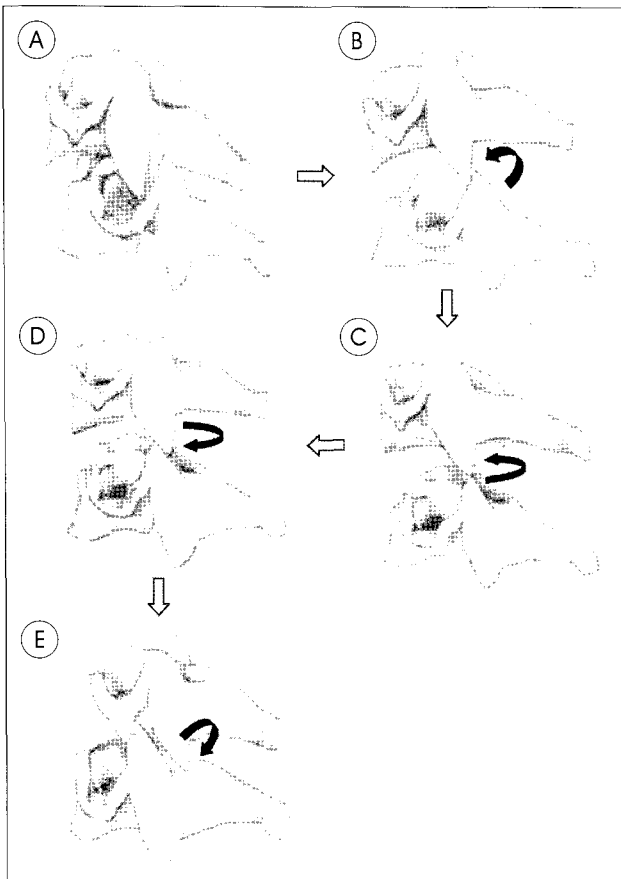
Fourteen patients initially underwent manipulative traction of closed reduction. In 7 (50%) patients, the unilateral facet dislocation was successfully reduced after injecting a muscle relaxant, and in 6 (43%) patients, it was successfully reduced under general anesthesia. One patient failed to achieve anatomical reduction (Table 1).

Seven patients who had successful reduction by manipulative traction without general anesthesia were treated within 8 hours after injury. Six patients who were treated after a delay of more than 8 hours had failed initial manipulative traction, but successful manipulative traction was achieved under general anesthesia. One patient with bone fragments between articular facets failed to achieve anatomical reduction. All patients

**Table 1.** Summary of cases with unilateral facet dislocation (n=14)

Case no.	Age /Sex	Mode of injury	Level	Initial symptom	Frankel's classification	Sub-luxation (mm)	Fracture	Time to initial reduction(h)	Time to delayed reduction(h)	Follow-up period (months)	†OP	Last symptom
1	39/M	*MVA	C6-C7	hand grasp †G IV	D	4	facet	2	-	7	§AIF	none
2	41/M	MVA	C4-C5	neck pain	E	3	facet	41	48	8	AIF	none
3	35/M	fall down	C4-C5	neck pain	E	4	none	9	31	10	AIF	none
4	25/F	MVA	C4-C5	none	E	3	facet	4	-	10	AIF	none
5	63/F	MVA	C6-C7	radiculopathy	E	5	facet	5	10 (failed)	11	AIF Halo vest	neck pain
6	58/M	slip down	C6-C7	hand grasp G IV	D	3	facet	60	84	14	AIF	none
7	46/M	MVA	C4-C5	none	E	5	facet	33	35	17	AIF	none
8	51/M	MVA	C5-C6	none	E	3	none	5	-	20	AIF	none
9	44/M	MVA	C6-C7	none	E	3	none	6	-	21	AIF	none
10	69/F	fall down	C4-C5	neck pain	E	3	none	8	36	21	AIF	none
11	36/M	MVA	C5-C6	hand grasp G IV	D	4	none	6	-	23	AIF	none
12	23/M	MVA	C5-C6	radiculopathy	E	3	facet, pedicle	4	-	24	AIF	none
13	51/M	MVA	C4-C5	radiculopathy	E	3	none	8	-	29	AIF	none
14	41/F	MVA	C4-C5	none	E	3	none	8	26	31	AIF	none

\*MVA : motor vehicle accident, †OP : operation, ‡G : grade, §AIF : anterior interbody fusion



**Fig. 2.** A : Unilateral locked facet of the cervical spine. B : Initial manipulative axial traction with neck flexion. C : Maximal neck flexion with rotation to the opposite side of dislocation in order to resolve the locked facet. D : Rotation and flexion of the head toward the side of dislocation. E : Extension with relaxation of traction resolving the locked facet. Black arrow is the direction of reduction.

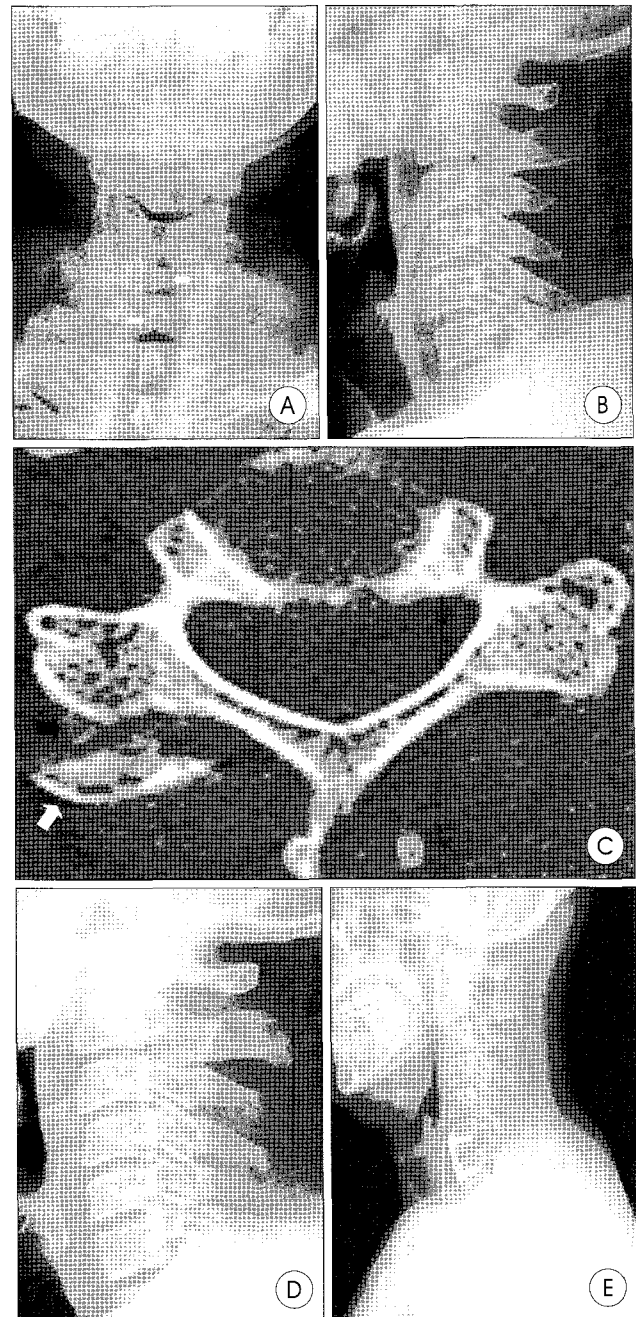
underwent anterior interbody fusion and plate fixation. One patient who failed in reduction underwent halo vest after operation.

In all patients, initial symptoms improved, and bony fusions were maintained, but 1 patient continued to complain of neck pain who underwent halo vest. The patient showed good bony fusion ultimately after halo vest removal, but plate malposition was detected during the follow-up period. Thus plate was removed and maintained bony fusion without additional operation.

### Illustrative cases

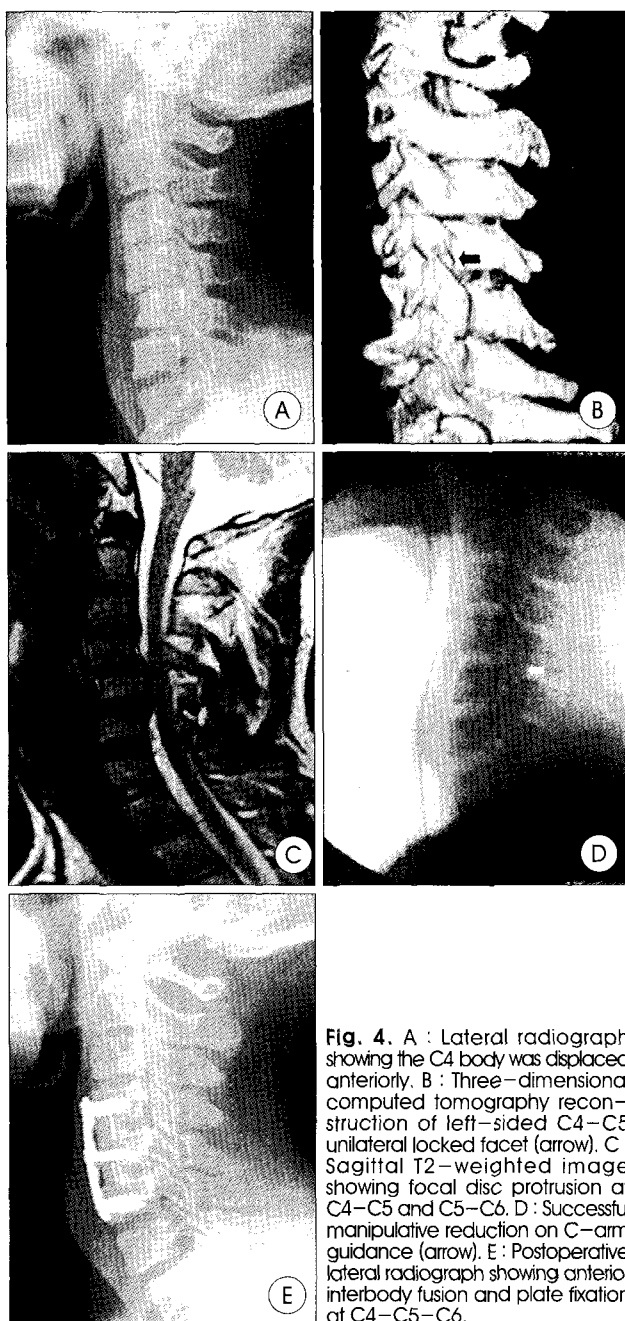
#### Illustrative case 1

A 39-year-old man presented with decreased hand grasp power after a traffic accident, 1 hour after injury. Anteroposterior radiograph showed deviation of the cervical spinous process toward the side of dislocation, and lateral radiograph showed anterior 4-mm displacement of the vertebral body at C6-C7 (Fig. 3A, B). Computerized tomography was performed 2 hours after injury, and showed right-sided unilateral facet



**Fig. 3.** A : Plain anteroposterior radiograph showing the deviation of the cervical spinous process toward the side of the dislocation (upper arrow) and the midline spinous process (lower arrow). B : Lateral radiograph showing anterior 4-mm displacement at C6-C7. C : Computed tomography scan showing right-sided unilateral facet dislocation at C6-C7 (white arrow) with combined articular facet fracture (black arrow). D : Lateral radiograph showing successful closed reduction. E : Postoperative lateral radiograph showing anterior interbody fusion and plate fixation state with successful reduction.

dislocation at C6-C7 with combined articular facet fractures (Fig. 3C). Immediately, manipulative traction was attempted with intravenous administration of muscle relaxant. After manipulative traction, the patients was followed up for any change in neurologic symptoms. The locked facet was reduced



**Fig. 4.** A : Lateral radiograph showing the C4 body was displaced anteriorly. B : Three-dimensional computed tomography reconstruction of left-sided C4-C5 unilateral locked facet (arrow). C : Sagittal T2-weighted image showing focal disc protrusion at C4-C5 and C5-C6. D : Successful manipulative reduction on C-arm guidance (arrow). E : Postoperative lateral radiograph showing anterior interbody fusion and plate fixation at C4-C5-C6.

successfully, and thereafter the patient was maintained with Holter traction (Fig. 3D). Twenty-four hours later, the patients underwent anterior interbody fusion and plate fixation (Fig. 3E). During the follow-up period of 7 months, he showed successful anatomical alignment and normal hand grasp power.

#### Illustrative case 2

A 41-year-old man was involved in a motor vehicle accident. He complained of neck pain, but there were no significant neurologic deficits. Examination immediately after injury revealed unilateral facet dislocation at C4-C5 level. Cervical

radiography and computerized tomography showed anteriorly displaced C4 body (Fig. 4A, B). Forty-one hours after injury, manipulative traction was attempted with intravenous administration of muscle relaxant, but failed in closed reduction. Magnetic resonance imaging was performed and it showed disc protrusions at C4-C5 and C5-C6 (Fig. 4C). We attempted manipulative traction again under general anesthesia with C-arm guidance and achieved successful reduction (Fig. 4D). The patient underwent anterior interbody fusion and plate fixation at C4-C5 and C5-C6 (Fig. 4E). Eight months later, he showed a good bony fusion and had no symptoms.

## Discussion

Unilateral facet dislocation is a common injury of the cervical spine with incidence of 12-16%<sup>1)</sup>. The mechanism of unilateral facet dislocation is different from that of bilateral facet dislocation. Unilateral facet dislocation of the cervical spine cannot be easily reduced by axial traction in comparison with bilateral facet dislocation whose mechanism is pure flexion injury, because it occurs by flexion and rotation injuries (Fig. 1). Rorabeck et al.<sup>13)</sup> have reported that closed reduction rate of unilateral facet dislocation is less than 25%, and that of bilateral facet dislocations 55-75%. Another study showed that closed reduction rate of bilateral facet dislocation by axial traction was 88.2%, and that of unilateral facet dislocation was 77.8%<sup>14)</sup>.

Treatment of unilateral facet dislocation is divided into 2 stages. The first stage is reduction of the dislocation, and the second one is stabilization by fusion and fixation. Until now, many spine surgeons have attempted closed reduction by axial traction using Gardner well tongs. Gardner tong traction is performed to obtain reduction with progressively increasing weights from 5-15 lb to a maximum of 45-50 lb. Nevertheless, Rorabeck et al.<sup>13)</sup> reported that failed reduction with 45 lb weight traction was observed in 20 of 26 cases. Jeon et al.<sup>8)</sup> reported that failed reduction with Gardner tong traction from 10 lb to 50 lb was obtained in all of the 10 cases. It is conceivable that forced traction may cause severe damage to injured spinal cord with subsequent neurologic deficits.

In this study, closed reduction rate was 93%, although previous studies have reported difficulty in closed reduction in unilateral facet dislocation. We attempted manual reduction<sup>6)</sup> by reverse manipulation of the injury mechanism with neck flexion and rotation to the opposite side of dislocation, followed by rotation and flexion of the head toward the side of dislocation and extension with relaxation of traction (Fig. 2). Therefore, closed reduction was successful in 7 cases with intravenous administration of muscle relaxant, and 6 cases under general anesthesia. However, it failed in 1 case with bone fragments between articular facets. In this case, patient underwent halo vest after

operation, but plate malposition was detected during the follow-up period, so plate removal was performed. Ultimately we achieved a bony fusion without additional operation, but patient complained of neck pain for several months. We believe that neck pain was due to failure of anatomical reduction, thus posterior approach would have been better than anterior approach in case of failure of manual reduction.

Some spine surgeons have asserted that patients with cervical spine subluxation injuries may suffer neurological deterioration following closed reduction in the presence of an associated herniated disc. Nonetheless, in patients with minor neurologic deficits at the initial injury, the incidence of neurological deterioration following closed reduction is low<sup>7)</sup>.

The benefits of early manual reduction have not yet been proven by prospective, randomized studies. However, the goal of closed reduction is to restore anatomical alignment of the spine as quickly as possible after initial resuscitation at the emergency department<sup>7)</sup>. In this study, closed reduction without general anesthesia was more successful when it was performed earlier. However, manipulative reduction was also successful under general anesthesia regardless of delayed reduction time. Therefore, delayed reduction under general anesthesia may be a preferred method, if physicians are fully aware of spinal cord injury with magnetic resonance imaging before manipulative traction.

The methods of fixation after reduction of locked facet are external brace and surgical fixation. However, high fixation failure rate has been reported to be 38-45% and cervical kyphosis to be 64% in the use of external brace<sup>2,3)</sup>.

Anterior and posterior approaches have been used for surgical fixation. Progressive cervical kyphosis and dearticulation of bony grafts may occur after fixation method via anterior approach at the first stage. Nevertheless, these complications have decreased with the advent of plates and screws<sup>9,11)</sup>. Posterior approach involves posterior cervical internal fixation and bony fusion and wiring<sup>14)</sup>. This approach has a high successful rate with a bony fusion rate 96%, but with maintenance of perfect anatomical alignment being possible in 46% which may be necessary in some cases for additional fixation via anterior approach for cervical kyphosis<sup>14)</sup>.

Unilateral facet dislocation has difficulty in closed reduction and requires surgical reduction. Therefore, posterior approach has been performed mainly due to its ease of surgical reduction<sup>14,15)</sup>.

Posterior approach has an advantage that reduction can be performed under direct vision of the dislocation site<sup>14,16)</sup>. However unilateral facet dislocation is often accompanied by traumatic disc herniation, facet fractures, and rupture of the posterior longitudinal ligament<sup>10-12)</sup>. Therefore, surgical reduction via posterior approach without management of these associated injuries can lead to neurological deficits<sup>10,11)</sup>.

On the other hand, anterior approach has an advantage that the causes of neurological deficits can be managed easily, but anterior approach is vulnerable to surgical reduction. In this study, preoperative manual reduction rate was increased with maintenance of anatomical alignment via anterior interbody fusion and plate fixation.

## Conclusion

In summary, preoperative manual reduction rate of unilateral facet dislocation of the cervical spine was increased by reverse manipulation of the injury mechanism with good maintenance of anatomical alignment through anterior interbody fusion and plate fixation. In order to reduce the locked facet more easily and safely, authors recommend manipulative traction under general anesthesia after being aware of spinal cord injury with magnetic resonance imaging.

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## Commentary

Traumatic unilateral facet dislocation contains mechanism of rotational deformity. Simple distraction is not enough to reduce the dislocated vertebrae. The authors introduced the manipulative reduction and anterior fusion for the management of unilateral facet dislocation. I agree with the author's policy for this treatment. But I'd like to point out two things. Before the manipulative reduction procedure, it is needed to check the pre-reduction MRI. Several authors have described devastating neurological sequelae after attempting closed reduction due to retropulsion of disc material into the spinal canal<sup>1,2</sup>. If there is no disc material on MRI, manipulative reduction can be attempted. But if the cord was compressed by disc material, anterior open reduction procedure introduced by Ordonez et al. can be a safe method<sup>3</sup>. The open reduction

can be attempted via posterior approach also and posterior instrumented fusion can be applied with lateral mass screw and rod system. Posterior reduction procedure is an easy and safe alternative procedure if closed reduction is failed and there is no disc material in the spinal canal.

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