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Management of Unusual Atlantoaxial Dislocation

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Study Design. A case report and review of the literature.
Objective. The aim of this study was to describe the successful treatment of one posterior atlantoaxial dislocation without fracture and to review the relevant literature.
Summary of Background Data. Posterior atlantoaxial dislocation without fracture of the odontoid process is extremely rare. Management of these patients is still unknown.
Methods. A posterior atlantoaxial dislocation without fracture in a 58-year-old man with incomplete quadriplegia was treated surgically with posterior atlantoaxial pedicle screws internal fixation and fusion after closed reduction. The images, treatment, and related literature are reviewed.
Results. The patient had complete recovery of neurologic deficit and bony fusion of the atlantoaxial joint was identified on the follow-up computed tomography taken 3 months after posterior fixation. To our knowledge, no case of posterior atlantoaxial dislocation with neurologic deficit has been previously reported in English medical literature.
Conclusion. We described a rare case of posterior atlantoaxial dislocation with neurologic deficit. Treatment procedure of posterior atlantoaxial dislocation was presented.
Key words: management, neurologic deficit, pedicle screws, posterior atlantoaxial dislocation.
Level of Evidence: 5
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Posterior atlantoaxial dislocation (PAAD) without fracture of the odontoid process is extremely rare; only 12 cases have been reported in the literature,[1–12] to authors' knowledge. Those 12 survived cases had no or mild neurological deficit. In the current report, the authors present a rare instance of PAAD with neurologic deficit caused by traffic accident. This case was treated by closed reduction without anesthesia, and pedicle screws internal fixation *via* posterior approach also differs in this case from the others.

CASE REPORT

A 58-year-old man was admitted with a 3-day history of incomplete quadriplegia, which manifested immediately after a traffic accident. Neurologic examination showed paresthesia below the shoulders and decreased muscle strength of arms and legs (3°). He complained of considerable pain and stiffness in the neck. His neck was skewed to the right. The patient with normal vital signs was immobilized in a soft collar brace and transferred to our university hospital from a local county clinic. Plain radiograph of cervical spine showed a posterior dislocation of the atlas with respect to the axis and soft tissue swelling around the neck (Figure 1).

Magnetic resonance imaging (MRI) demonstrated apparent compression of spinal cord, while no intramedullary cord signal abnormality was found at the level of PAAD. The images showed abnormal signal intensity before cervical (C) 1 to C5 vertebral on T2-weighted image (Figure 2A) and T1-weighted image (Figure 2B).

Axial computed tomography (CT) scan revealed the odontoid peg to lie ventral to the anterior arch of the atlas with intact of anterior arch of the atlas (Figure 3A), while sagittal reconstructions (Figure 3B) and three-dimensional CT reconstructions (Figure 3C) clearly verified PAAD with no fracture of odontoid.

The patient was put on occipital-mandibular leash traction first. The initial 3 kg weight was gradually increased to 6 kg under fluoroscopy (Figure 4A–C). At this stage, the atlas had been positioned over the axis (Figure 4C). Keeping the cervical spine in a slightly flexed position, weight of traction was gradually lowered. The gradual reduction of the dislocation was observed by subsequent radiographs (Figure 4D–F). The procedure was performed without anesthesia. The patient could say his sensory changes during the process. He did not have neurological deterioration. Pain in the neck was relieved timely once the reduction

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Figure 1. Lateral radiograph of the cervical spine demonstrating a posterior dislocation of the atlas with respect to the axis and soft tissue swelling around the neck.

was done. Then halo-vest fixation was applied preparing for the posterior surgery under the local anesthesia. Reduction of the atlantoaxial dislocation was preserved (Figure 5A).

The patient had significant improvement over 11 days. Neurologic examination showed complete recovery of muscle strength and sensation. Two weeks after the halo-vest fixation, the patient complained about neck pain. The instability of atlantoaxial joint was found by the fluoroscopy (Figure 5B). Then surgery was performed *via* a standard posterior midline approach using pedicle screws internal fixation for atlantoaxial arthrodesis. Postoperative imaging revealed that the constructs were satisfactory by sagittal, coronal, and axial CT scans (Figure 6A–F) and rendered CT images (Figure 6G–I). MRI confirmed that there was no compression of spinal cord after the operation.

There was no surgery-related complication. At 3 months after operation, a solid bony union of the atlantoaxial fusion mass was achieved. The patient was still asymptomatic and had no neck pain at the most recent follow-up at 10 months after operation.

DISCUSSION

Movement of atlantoaxial joint is limited by C1-C2 articulation, ipsilateral transverse ligament, contralateral alar ligament, and capsular ligaments.[13,14] PAAD is always

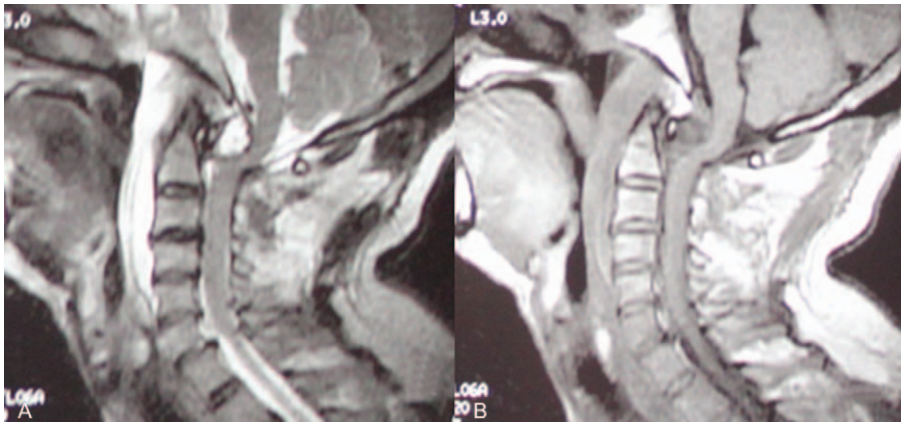

Figure 2. Sagittal magnetic resonance imaging (MRI) revealed apparent compression of spinal cord and abnormal signal intensity before C1 to C5 vertebral (T2-weighted MRI in **A** and T1-weighted MRI in **B**).

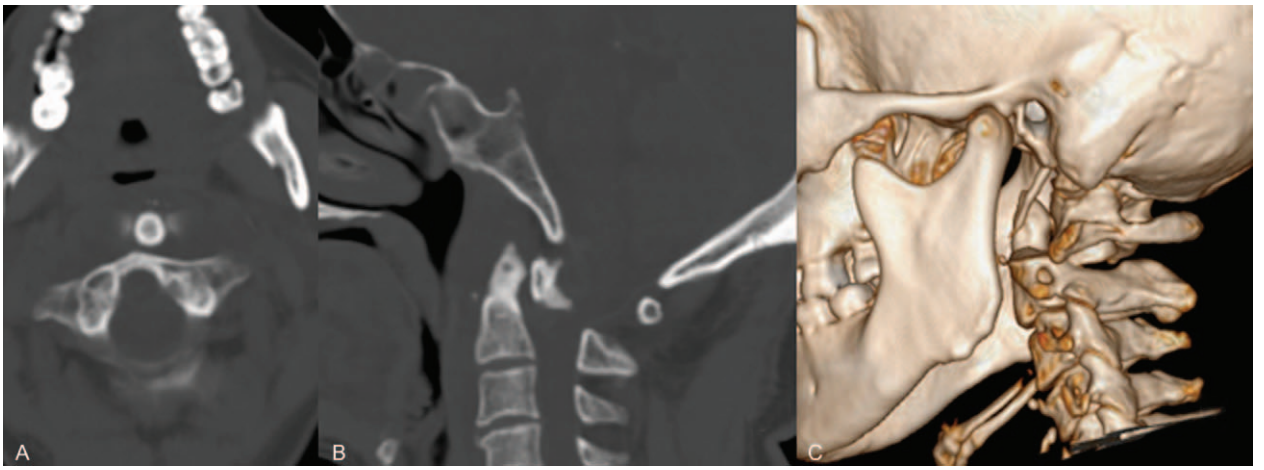

Figure 3. CT scans reveal posterior atlantoaxial dislocation with narrowing of the spinal canal. Axial CT scan (**A**); sagittal CT scan (**B**); three-dimensional CT scans (**C**).

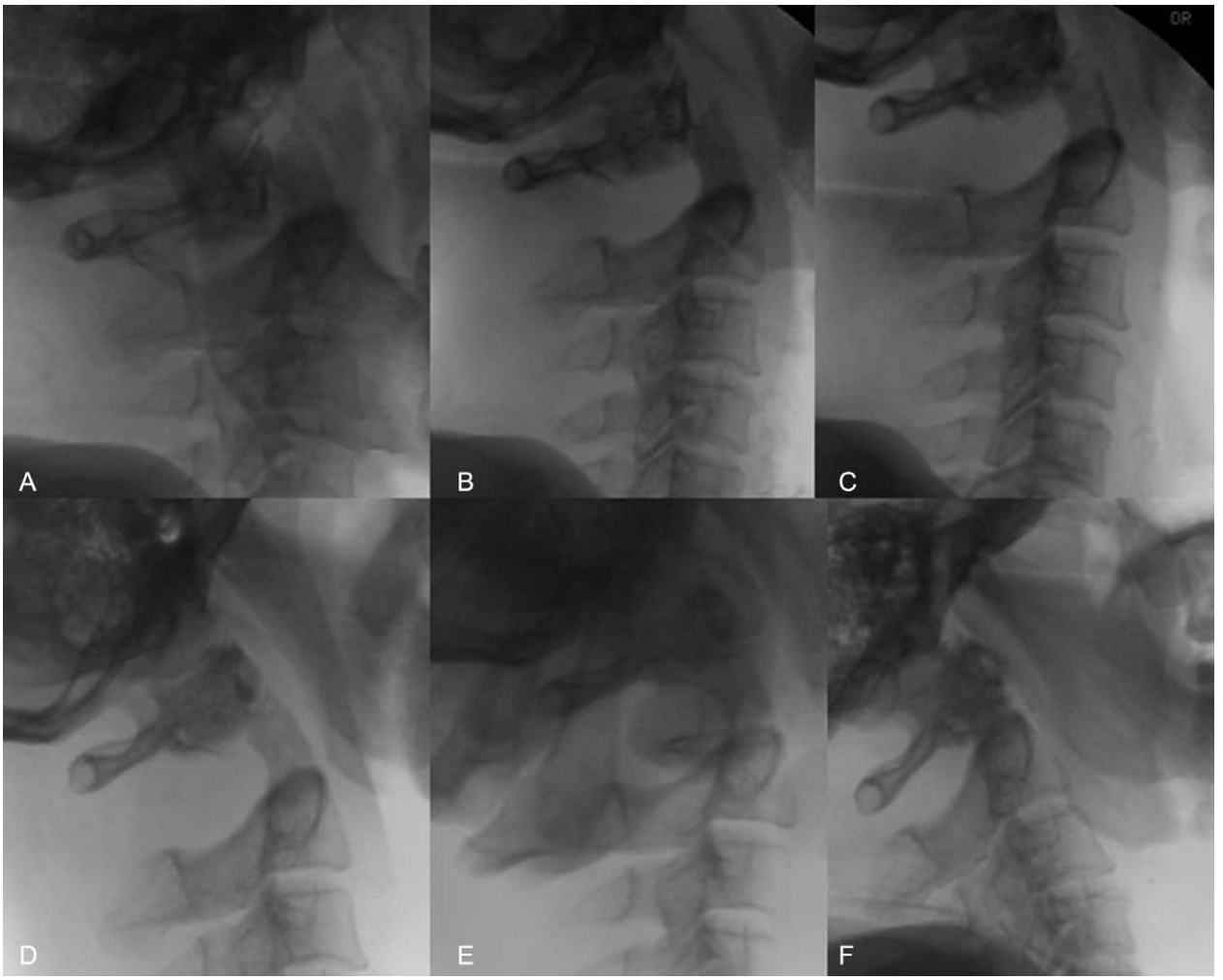

Figure 4. Intraoperative imaging from fluoroscopy revealed process of reduction of the atlantoaxial dislocation. Initial weight increased from 3 to 6 kg (**A–C**). Reduction of the dislocation by gradually lowered weight of traction (**D–F**).

caused by odontoid fracture or atlantoaxial ligaments ruptures.[10,15] PAAD without fracture is a rare injury. Several authors have been proposed that such injury would tend to cause severe distraction of the spinal cord and immediate death.[7–9,16] Only 12 patients of PAAD who had been survived were reported.[1–12] We present here the thirteenth case of PAAD combined with neurologic deficit.

A high-grade hyperextension with variable amounts of distraction was proposed as the probable mechanism of PAAD by Haralson and Boyd.[1] It was associated with the high-energy injury such as traffic accident or earthquake.[9,10] The patient was struck from behind while the cervical spinal muscles were relaxed. PAAD occurred after the force of collision applied to the trunk. Older patients always have cervical disc degenerative disease. They probably have less tolerant of such an injury. Thus, most patients surviving were younger. Interestingly, almost all the cases were male. Irritability and driving faster in male population may be attributed to traffic accident. Twelve patients were caused by traffic accident.

Excepting our case, other cases did not have any definite signs of neurologic deficit. It can be explained by Steel's Rule of Thirds.[17] He proposed that space available for the cord (SAC) in level of atlas was about one-third of the spinal canal. Furthermore, Tucker and Taylor[18] had demonstrated that if the posterior dislocation reduced canal area less than 36%, it was sufficient to avoid cord compression. Although dislocation occupied over the tolerance of SAC in our case (Figure 2), he combined with incomplete quadriplegia.

PAAD is a rare injury and only isolated cases have been reported. Treatment procedure is unclear. Eight cases were successfully managed with closed reduction (Table 1). We suggest to reduce the dislocation by closed way firstly. It is better to carry out this technique during patient awake without anesthesia. It is crucial for patients with neurologic deficit. Haralson and Boyd[1] reported the first case of close reduction by cervical traction in 1969. It became the first-line approach to treat subsequent similar patients.[2,3] Sud *et al.*[7] reported a case developing quadriparesis during cervical traction, indicating that close reduction is dangerous especially for patients with neurologic deficit. To make a wise choice, a comprehensive evaluation should be proceeded. Closed reduction decreases the operating harm, while it increases the potential possibility of spinal cord compression and endorhachis avulsion. To ensure safety, our procedure

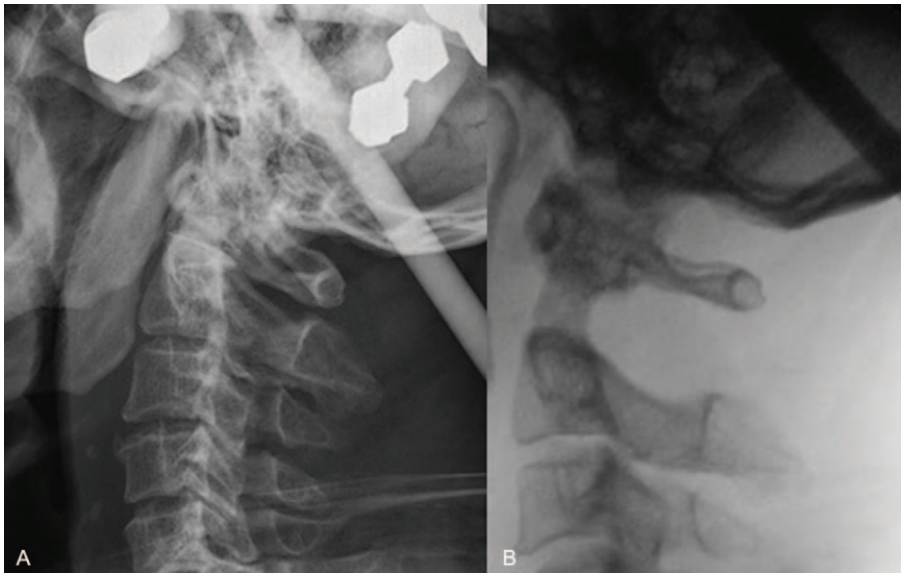

Figure 5. After 3 days of halo-vest fixation, lateral radiography of the spine showing reduction of the atlantoaxial dislocation was obtained as the red arrow pointing to (**A**). Although 2 weeks after the halo-vest fixation, the instability of atlantoaxial joint was found by C-arm radiograph as the red arrow pointing to (**B**).

strictly followed the rules we presented above in a definite slow pace. We should stop the process whenever the patient says any discomfort. As described by Wong *et al*.,[6] we carried out the reduction in three phases (Figure 4). Nine of thirteen cases were supplemented with internal fixation for fear of residual instability or incomplete reduction as in our patient (Table 1). As described by Bransford *et al*.,[19] we chose the pedicle screws internal fixation by posterior approach. This is the first case with PAAD who was underwent such a surgery. There was no surgery-related

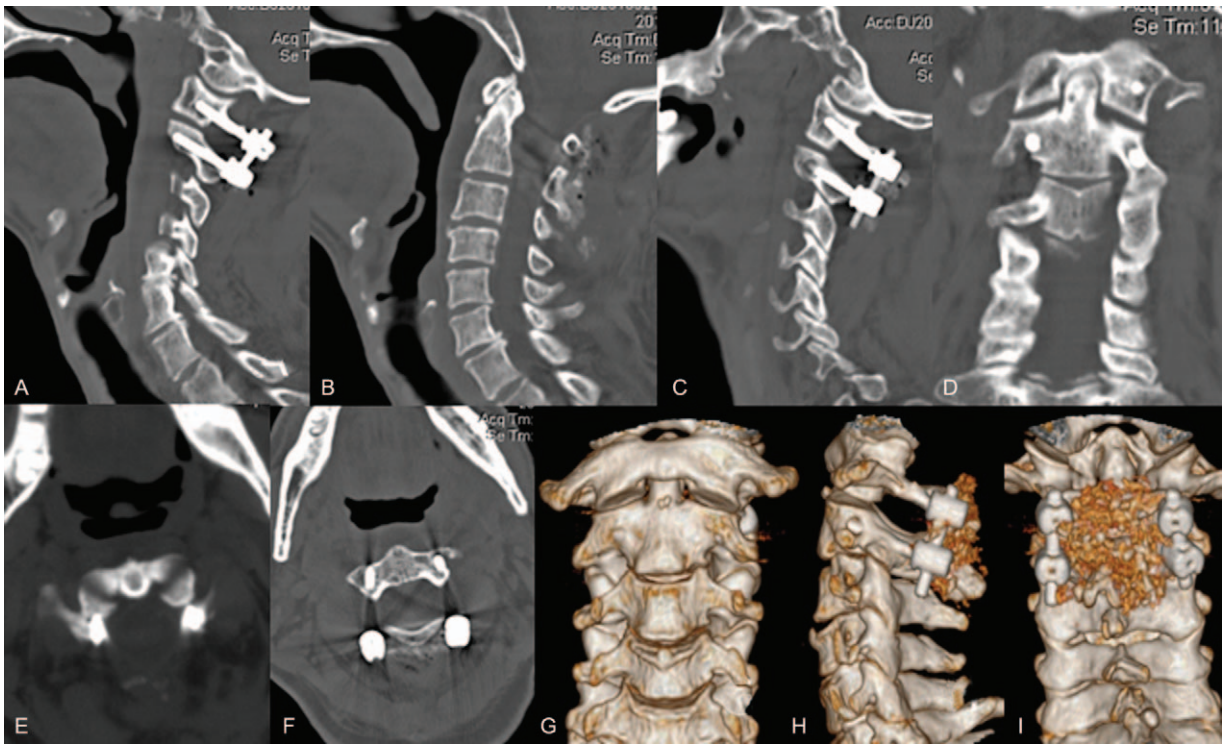

Figure 6. Three-dimensional computed tomography of the cervical spine, made 1 week after surgery, clearly showed the constructs were satisfactory and the location of nails was precise. What is more, it revealed that there were adequate bones for the fusion. Sagittal CT scan (**A–C**); coronal CT scan (**D**); axial CT scan (**E, F**); anterior volume rendered CT image (**G**); lateral volume rendered CT image (**H**); posterior volume rendered CT image (**I**).

TABLE 1. Analysis of Treatment Procedure for the Dislocation

CR (8) Cases				OR (5) Cases			
N	A	P	A&P	N	A	P	A&P
4	0	4	0	0	1	0	4

A&P indicates anterior and posterior approach; A, anterior approach; CR, indicates closed reduction; N, no operation; OR, open reduction; P, posterior approach.

complication. A solid bony union of atlantoaxial joint was achieved.

CONCLUSION

We described a rare case of PAAD with neurologic deficit. It is suggested to reduce the dislocation by closed way firstly. For fear of residual instability or incomplete reduction, pedicle screws internal fixation by posterior approach may be one good choice to realize the sufficient rigid stability.

➢ Key Points

- ❑ This is the first case illustrating a rare case of posterior atlantoaxial dislocation with neurologic deficit.
- ❑ Complete recovery of quadriparesis was followed by reduction. Bony fusion of the atlantoaxial joint was identified after posterior fixation.
- ❑ The level of C1-C2 is the vital center of the body. Treatment procedure of posterior atlantoaxial dislocation is the key point for management of such an injury.

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