Indirect decompression for a prior severe C1–2 dislocation causing progressive quadriparesis

Case report

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Combined anterior and posterior surgery is frequently chosen for the treatment of prior, severe C1–2 dislocations that occurred during early childhood because of the difficulty in achieving reduction and satisfactory decompression. The authors treated a prior, severe C1–2 dislocation that was causing progressive quadriparesis. The patient was a 14-year-old boy who had suffered a C1–2 fracture-dislocation at 3 years of age and had been treated with a Minerva body jacket cast. The treatment involved posterior C1–2 segmental screw fixation, without direct bone decompression or additional surgery. Satisfactory neural decompression was achieved with the techniques used, and complete bone union was confirmed. The patient showed satisfactory neurological recovery at the 5-year follow-up assessment. (http://thejns.org/doi/abs/10.3171/2014.2.SPINE1352)

KEY WORDS • dislocation • indirect decompression • quadriparesis • cervical
his right side, which slowly progressed to quadriparesis. The quadriparesis was aggravated after a slip injury that occurred 4 weeks before presentation.

Upon examination, the patient’s extremities displayed hyperactive deep tendon reflexes. Ankle clonus was sustained on the right side and unsustained on the left side. The Babinski sign, finger escape sign, and grip and release test were positive on the right side. His motor power in the upper and lower extremities was between Grades 2 and 4. Independent standing and the use of chopsticks were impossible. Dynamic radiographs showed rigid C1–2 dislocation (Fig. 1A and B), without motion. A CT scan showed that C-1 was dislocated ventrally and caudally, and was pseudoarticulated with C-3 on the right side (Fig. 2A and B). Magnetic resonance imaging revealed that the spinal cord was severely compressed between the odontoid stump and the C-1 posterior arch (Fig. 2C). His Japanese Orthopaedic Association scale and Neck Disability Index scores were 10 and 46, respectively.

Operative Course. Preoperative 8-pound traction was applied for 24 hours using Gardner-Wells tongs. Surprisingly, a partial but significant amount of reduction was achieved, even with this small amount of traction (Fig. 1C). Therefore, the surgeon (J.S.Y.) concluded that satisfactory reduction would be possible during surgery. Under general anesthesia, the patient was placed prone with 16-pound traction using Gardner-Wells tongs. With a posterior approach and bilateral transection of the C-2 nerve roots, the C1–2 facet joints were opened, and the hypertrophied intraarticular soft tissues and articular cartilage were removed with a high-speed drill bur, curettes, and micropituitary forceps. During this procedure, various sizes of Penfield retractors and suction tips were used to distract the joint space using craniocaudal leverage. We were able to mobilize the facet joint and thus facilitate the subsequent reduction maneuver. Although the severe anterior tilt of the facet joint surfaces (Fig. 2B) precluded intraarticular preparation for fusion and reduction, resection of the articular process was not performed because it could possibly lead to collapse of the remaining weak cancellous bone during reduction or follow-up. Autologous cancellous chips harvested from the posterior iliac crest were inserted in the facet joint space for intraarticular fusion. Then, before reduction was attempted, C-1 lateral mass screws and C-2 pedicle screws were inserted under fluoroscopic control (Fig. 3 left). Computer image-guided surgery was not used. Temporary rods with sufficient lengths to connect the C-1 and C-2 screw heads, which were far away from each other at this time (Fig. 3 left), were loosely secured with set screws. Reduction was achieved by pulling the C-1 screw heads posteriorly and pushing C-2 screw heads anteriorly using rod holders, and craniocaudal compression between the C-1 and C-2 screw heads with a compressor. While maintaining this maneuver, set screws were tightened on both sides. Then the set screws were loosened on one side. We then further compressed between the C-1 and C-2 screws while pulling the C-1 screw posteriorly and pushing the C-2 screw anteriorly. After this reduction maneuver, the set screws were tightened. This was alternately repeated on each side under intermittent lateral fluoroscopic control (Fig. 3 right). Fluoroscopy revealed progressive reduction as this maneuver was repeated. When the C-1 posterior arch and the C-2 lamina contacted each other and further compression was impossible, the reduction maneuver was stopped and the temporary rods were replaced with final rods with shorter lengths, one at a time. An autologous bone graft harvested from the iliac crest was grafted for extraarticular and posterior fusion. Intraoperative neuromonitoring was not used because it was not available.

Postoperative Course. Sufficient cord decompression was confirmed by postoperative CT myelography (Fig. 4 left). A Miami collar was used for 3 months. The patient’s myelopathy improved gradually, and independent gait was possible 6 weeks after surgery. The patient enjoyed a normal life and could exercise with moderate intensity 5 years after surgery, and the reduction was well maintained (Fig. 4 right). His Japanese Orthopaedic Association scale and Neck Disability Index scores were 16 and 12, respectively.

Discussion

Sufficient cord decompression, satisfactory reduction, and rigid fixation, along with solid bone union are
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the major goals in the treatment of C1–2 dislocations. Acute dislocation of the C-1 and C-2 joints may be reduced without obvious difficulty. However, in cases of severe cord compression and myelopathy due to prior C1–2 dislocations, particularly ones that occurred during early childhood, effective cord decompression using reduction alone, without bone resection, is difficult to achieve. Contracture of soft tissues and severe bone deformities frequently inhibit restoration of proper alignment. Therefore, some authors have reported direct decompression, with removal of the odontoid process via an anterior approach, with or without posterior fixation. However, this approach provides a narrow operative field and may result in complications such as infection, nonunion, vertebral artery rupture, and dural tears. Wang et al. advocated soft-tissue release via a transoral approach, without odontoid removal, combined with posterior fixation and fusion. To avoid the disadvantages of the anterior approach, the posterior approach with a C-1 posterior arch resection was reported, but effective fixation of dislocation and bone union is difficult to achieve, and occipitocervical instability may occur. Li et al. reported favorable results for indirect decompression without C-1 posterior arch resection via a posterior approach in prior C1–2 dislocations. These authors used skeletal traction as the main technique for reduction, and posterior instrumentation was added for maintenance of the reduction. However, they did not mention whether they achieved successful results in extremely severe cases.

The current case showed severe cord compression. In addition, C1–2 dislocation was accompanied by severe deformation of the C1–2 facet joints, and the right inferior articular process of C-1 had pseudoarticulated with C-3, a condition that should not normally exist. Fortunately, partial reduction was achieved with preoperative skeletal traction, thus demonstrating a high probability of further reduction with the application of greater reduction force during surgery. The use of segmental screw fixation allows application of a strong reduction force during rod assembly after screw placement has been completed. In the current case, this method enabled satisfactory indirect decompression of the spinal cord without direct removal of bone structures or additional anterior surgery. In addition, occipitocervical fusion was avoided because the posterior arch of C-1 was not resected. Thus, the patient was effectively treated with indirect decompression and

Fig. 2. Preoperative imaging studies. On 3D CT scans (A and B), the dislocated C-1 inferior articular process showed pseudo-articulation with the C-3 vertebral body on the right side (arrowheads). A T2-weighted sagittal MR image (C) shows severe cord compression (arrowheads) and an anteriorly displaced odontoid process (arrow).

Fig. 3. Intraoperative fluoroscopic images obtained before (left) and after (right) the reduction maneuver performed during rod assembly.
C1–2 segmental screw fixation, without either bone resection or additional anterior surgery.

Goel et al. reported a technique for reduction of irreducible dislocations using intraoperative traction, transection of the C-2 nerve roots, opening of the joints, and segmental fixation of the atlas and axis. They extensively removed the articular surface of the C-1 and C-2 facets using a microdrill, distracted the facets using an intervertebral spreader, and inserted hydroxyapatite blocks or titanium spacers and bone graft in the facets. The final reduction was achieved using a plate and segmental screws. Similar techniques were used for the treatment of basilar invagination and fixed atlantoaxial dislocation in cases with congenital anomalies and in cases of rheumatoid arthritis by the same author group. While their principle of reduction included distraction of the facet joint, we obtained reduction by compression between the C-1 and C-2 screw heads. The posterior aspect of the C-1 inferior and the C-2 superior articular processes worked as a fulcrum during the reduction procedure, leading to distraction of the anterior soft tissues. In addition, whereas Goel et al. first tightened axial screws and then tightened the atlantal screws using plate-and-screw constructs to obtain reduction, we obtained reduction by pulling the C-1 screw heads posteriorly and pushing the C-2 screw heads anteriorly, similar to the technique described by Suh et al. These maneuvers were repeated alternately on each side until acceptable reduction was achieved, which can be attained with polyaxial screw-rod systems but not with plate-and-screw systems.

Three types of screws are commonly used for posterior segmental screw fixation of C-2. The principles of placing a C-2 pars screw are similar in most aspects to posterior transarticular screw placement, except that the length of the pars screw is significantly shorter so as to avoid the vertebral artery foramen. The C-2 pedicle screw has a less cephalad and more medial angulation and is longer than a pars screw. In this case, we chose to use pedicle screws because they have longer purchase in C-2, providing greater stability than pars screws. Translaminar screws may be used if the anatomy precludes placement of pedicle and pars screws. However, assembly of those screws to the rods may not be easy and application and maintenance of a sufficient amount of reduction force may be challenging. For this reason we did not choose translaminar screws in this case. Computer image-guided surgery and intraoperative neuromonitoring may enhance the accuracy of screw placement and decrease the risk of neurovascular injuries, although they were not used in this case.

The findings of the present case suggest that indirect decompression with C1–2 segmental screw fixation is helpful for patients who can accommodate the segmental screw trajectories, who have shown partial reduction with preoperative traction, and who have satisfactory bone quality to prevent bone failure during reduction or screw loosening. However, we are not sure about the results of posterior surgery alone in those patients who cannot accommodate such screws, who do not show even partial reduction with preoperative traction, or who have poor bone quality to endure a significant amount of reduction force or to maintain reduction after surgery without screw loosening. Further research is required to define the proper indications for the technique reported in the present study and to preoperatively predict the necessity of additional anterior release or direct decompression.

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Disclosure

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