Clinical Case Report

Medicine®

OPEN

# Surgical treatment for old subaxial cervical dislocation with bilateral locked facets in a 3-year-old girl

## A case report

Cheng Li, BS, Lei Li, MD*, Jingzhu Duan, MS, Lijun Zhang, MD, Zhenjiang Liu, MD

**Abstract**

**Rationale:** This study aimed to describe the case of a 3-year-old girl with old bilateral facet dislocation on cervical vertebrae 6 and 7, who had spinal cord transection, received surgical treatment, and achieved a relative satisfactory therapeutic effect.

**Patient concerns:** A 3-year-old girl was urgently transferred to the hospital after a car accident.

**Diagnoses:** she was diagnosed with splenic rupture, intracranial hemorrhage, cervical dislocation, spinal transection, and Monteggia fracture of the left upper limb.

**Interventions:** The girl underwent emergency splenectomy and was transferred to the intensive care unit of the hospital 15 days later. One-stage anterior–posterior approach surgery (anterior discectomy, posterior laminectomy, and pedicle screw fixation) was performed when the patient stabilized after 45-day symptomatic treatment. The operation was uneventful.

**Outcomes:** The reduction of lower cervical dislocation was satisfactory, with sufficient spinal cord decompression. The internal fixation position was good, and the spinal sequence was well restored. The girl was discharged 2 weeks later after the operation and followed up for 2 years. The major nerve function of both upper limbs was recovered, with no obvious retardation of the growth of immature spine.

**Lessons:** A satisfactory therapeutic effect was achieved for a pediatric old subaxial cervical dislocation with bilateral locked facets using anterior discectomy, posterior laminectomy, and pedicle screw fixation. The posterior pedicle screw fixation provided a good three-dimensional stability of the spine, with reduced risk and complications caused by anterior internal fixation. The growth of immature spine was not obviously affected during the 2-year follow-up.

**Abbreviations:** CT = computed tomography, DR = digital radiography, MRI = magnetic resonance imaging.

**Keywords:** bilateral facet dislocation, pediatric cervical spine, pediatric trauma, spinal cord transection, surgical operation

## 1. Introduction

The pediatric cervical injury is extremely rare, and the incidence is only 1% of total pediatric injuries.[1,2] Patients with spinal injuries are usually classified according to the age.[3,4] The upper cervical injuries commonly occur in children <8 years. Children possess the typical features of the spine in adults at the age of 8 to 10 years. The lower cervical injuries often occur in children with a relatively older age and mature spine, usually caused by high-energy damage and found in the cervical vertebrae C5–C7.[5,6] The blunt damage is the common cause, and 50% of pediatric cervical spine injury is caused by the motor vehicle accidents, or while walking (11%–16%), or riding bicycles (5%).[5,7–11] In addition, children of a younger age are more likely to have nerve damage, subluxation, or complete dislocation than fractures.[3,4,12,13] The treatment is extremely challenging due to the lack of unified guidelines for diagnosis and treatment of pediatric cervical injury. No report is available to date regarding the treatment of old subaxial cervical dislocation with bilateral locked facets in young children.

## 2. Case

A 3-year-old girl was injured to coma by a high-speed car when crossing the highway with her grandmother. She was transferred to the nearest hospital immediately and diagnosed with splenic rupture, intracranial hemorrhage, bilateral rib fractures, subaxial cervical dislocation (Fig. 1A and B), and Monteggia fracture of the left upper limb. Emergency splenectomy was conducted before returning to the intensive care unit, and a tracheotomy was conducted later. The patient was in a coma and transferred to the pediatric intensive care unit of Shengjing Hospital of China

Editor: N/A.

Ethics approval and consent to participate: The study was approved by the Ethics Committees of Shengjing Hospital of China Medical University, and all participants provided written informed consent.

Consent for publication: Not applicable.

Availability of data and material: The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

Funding: This case report was supported by Shenyang Science and Technology Bureau (CN) and the award number was 1801109.

Competing Interests: The authors declare that they have no conflicts of interest.

Department of Orthopaedic Surgery, Shengjing Hospital of China Medical University, Shenyang City, Liaoning Province, P.R. China.

* Correspondence: Lei Li, Department of Orthopaedic Surgery, Shengjing Hospital of China Medical University, Shenyang City, Liaoning Province, P.R. China (e-mail: 18940258679@163.com).



Medicine (2018) 97:18(e0553)

Received: 25 January 2018 / Accepted: 4 April 2018

http://dx.doi.org/10.1097/MD.0000000000010553

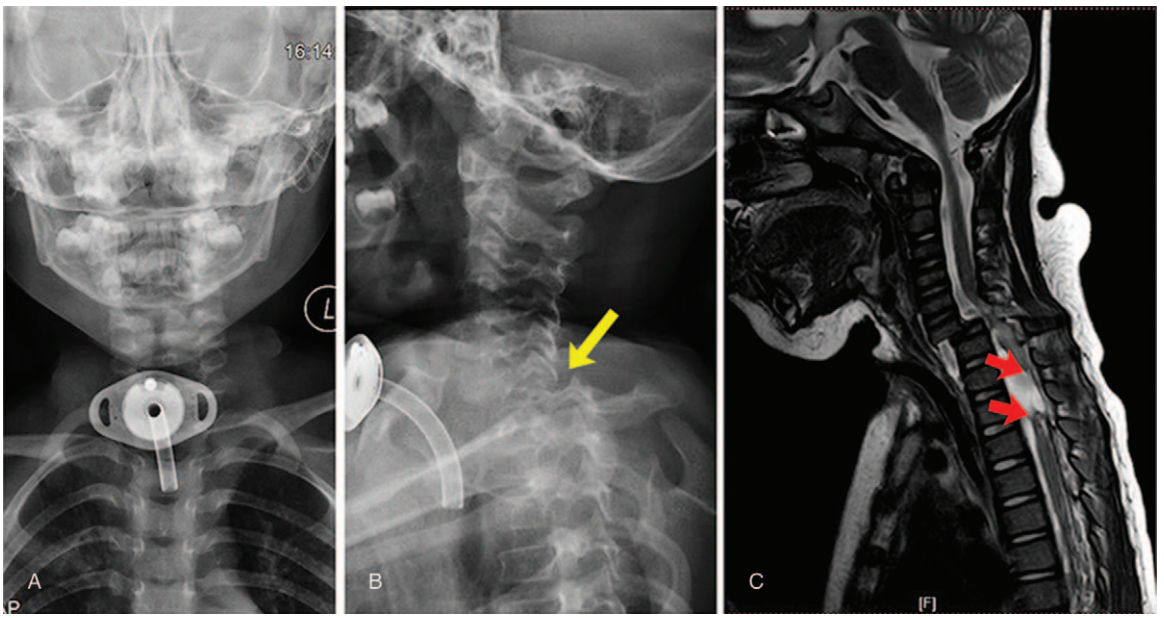


**Figure 1.** Dislocation of C6 and C7 was revealed by DR (A and B) (indicated by yellow arrow), and spinal transection was revealed by MRI (C) (indicated by red arrow). DR = digital radiography, MRI = magnetic resonance imaging.

**Table 1**

**Specialized examination*.**

| Location / Muscle strength | Biceps brachii | Triceps brachii | Hand-gripping force | Lower limb muscle strength |
|---|---|---|---|---|
| Preoperative | L–, R3 | L–, R3 | L2, R2 | L0, R0 |
| 2 years postoperatively | L5, R5 | L4, R5 | L3, R4 | L0, R0 |

* The examination was not done or completed because of the left upper limb Monteggia fracture.

Medical University 15 days after injury with assisted ventilation. The Glasgow score was 6. Forty-five days later, the patient stabilized with a Glasgow score of 13 with symptomatic treatment. The specialized physical examination results are shown in Table 1. Computed tomography (CT) and magnetic resonance imaging (MRI) indicated dislocation of C6 and C7 with bilateral locked facets (Fig. 2) and spinal cord transection (Fig. 1C). After a comprehensive evaluation, the anterior C6/7 discectomy for soft tissue release, posterior C5–T1 pedicle screw fixation, and reduction were performed for the patient.

The patient was placed in a supine position under general anesthesia with the head slightly extended backward about 20° using the pads stacked under the shoulder. The reduction was tried manually but with no improvement. The incision was made about

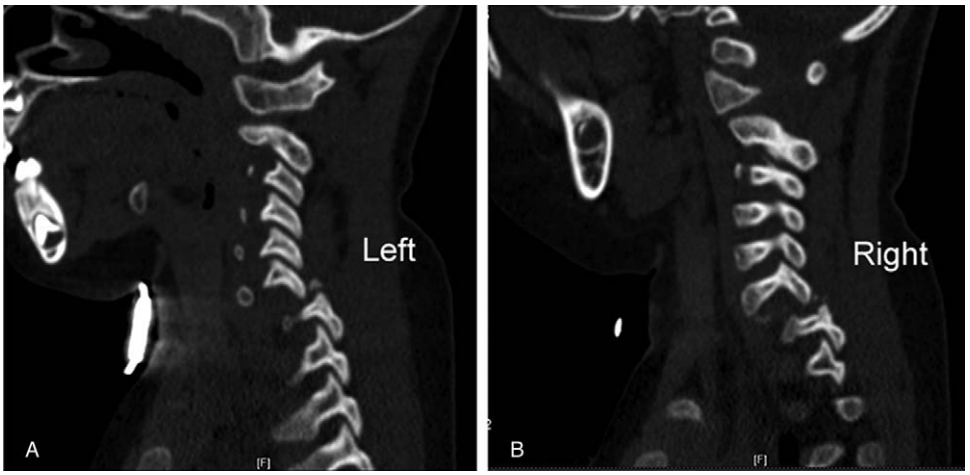


**Figure 2.** Bilateral locked facets and dislocation revealed by 3D CT. CT = computed tomography.

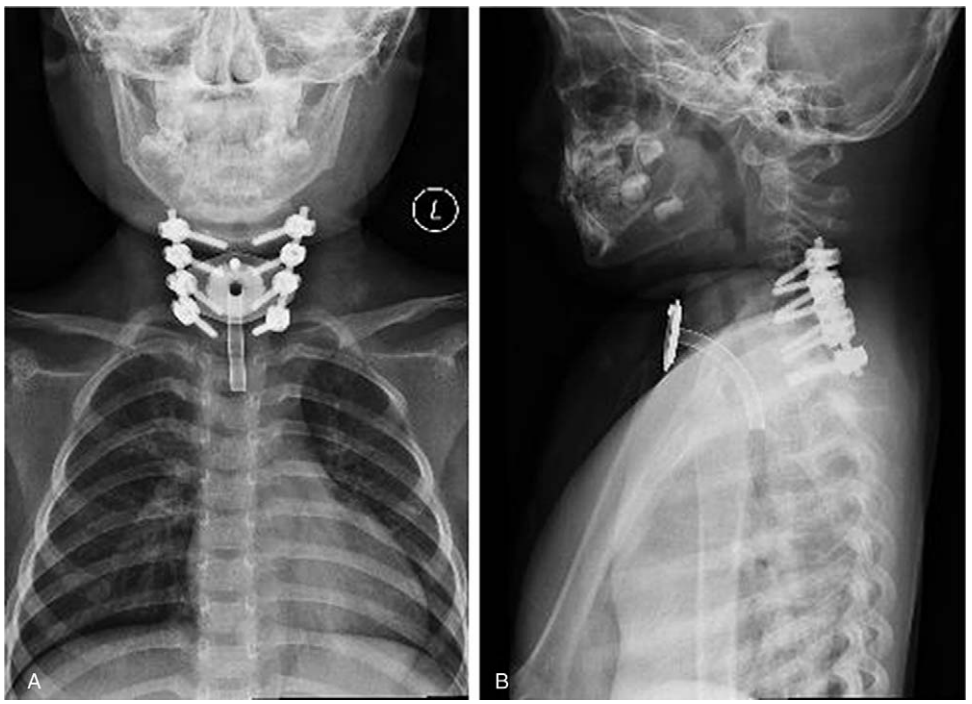


**Figure 3.** Cervical spine sequence restored to normal as revealed by postoperative DR. DR = digital radiography.

4 cm along the inner edge of sternocleidomastoid muscle to avoid the influence of tracheal intubation on the surgical operation. It was found that the vertebrae C6 and C7 were completely dislocated for nearly 0.5 cm, with vertebral fascial hyperplasia and scar/fibrous tissue formation, which were resected; the damaged intervertebral disk of C6 and C7 was removed too. However, the anterior reduction was limited by the posterior locked facets and fibrous connection. The anterior incision was closed, and the patient was replaced in the prone position. The posterior median cervical incision was made. Bilateral articular dislocation with scar/fibrous tissue hyperplasia was observed, which was removed. Eight pedicle screws with a diameter of 3.5 mm were implanted into C5–T1. Meanwhile, the partial superior articular processes of C7 were resected. The fibrous connections around the fracture were released, the joint dislocation was reduced, and the bilateral screws were connected with a connecting rod to stabilize the cervical spine. The lamina of C6 and C7 were completely resected, and the posterior dura mater was intact without cerebrospinal fluid leakage, suggesting thorough decompression of the spinal cord. The operation time was 195 minutes, and the intraoperative bleeding amount was around 50 mL.

The postoperative cervical digital radiography (DR) (Fig. 3) and CT indicated that the sequence of cervical vertebrae was recovered well (Fig. 4B) and the screw was accurately implanted

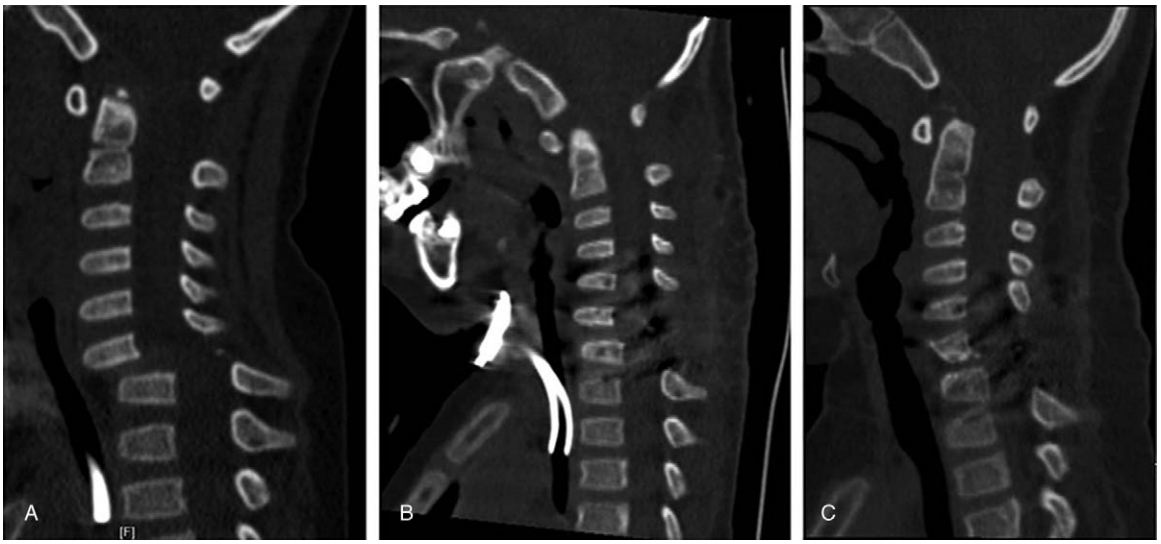


**Figure 4.** Cervical spine sequence and curvature change in screws before the operation (A), after the operation (B), and 2 years after the operation (C).

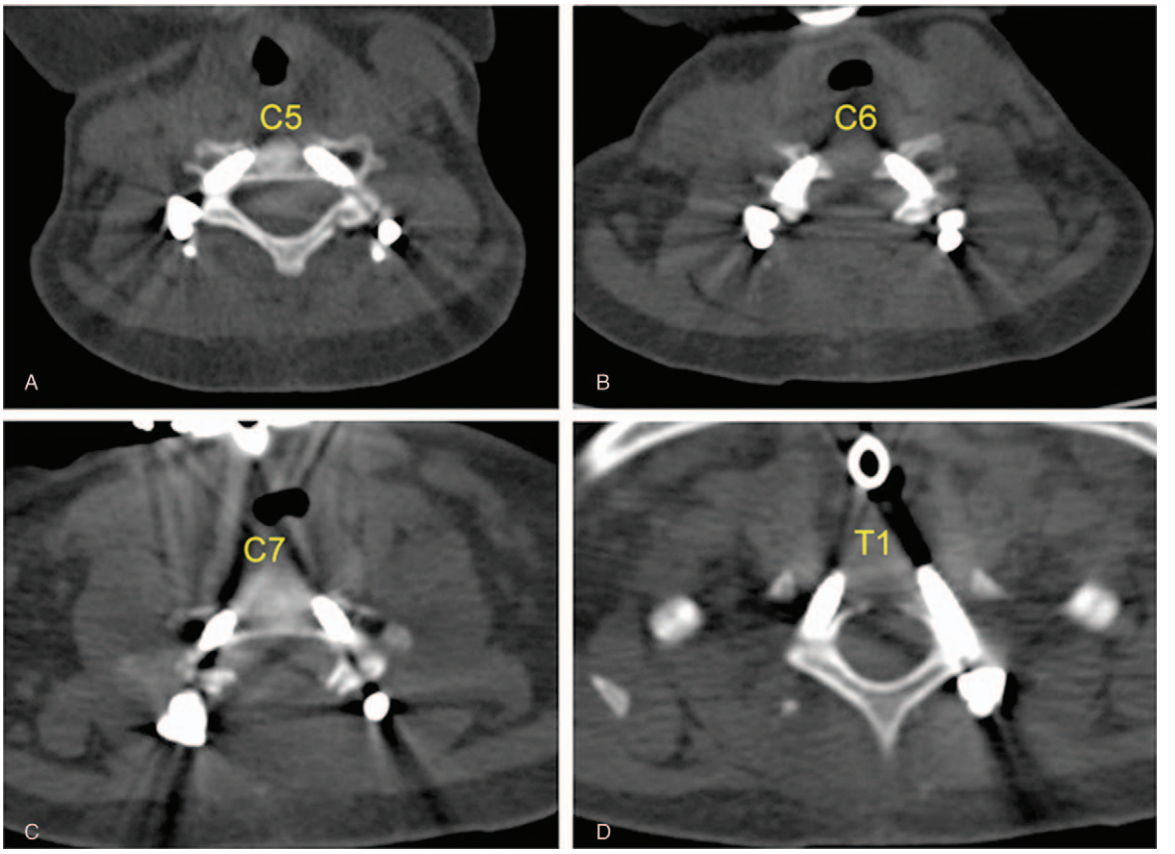


**Figure 5.** Positions of 8 pedicle screws were accurate.

into the vertebral pedicle (Fig. 5). The girl was discharged 2 weeks after the operation. The function of the bilateral upper limb was obviously recovered at the 2-year follow-up (Fig. 6 and Table 1). However, both lower limbs and urinary/defecation function were not recovered, and no other complication was found. DR and CT revealed that the morphology of the spine was good, the positions of screws were intact, and no retardation of the growth of spine occurred (Fig. 7).

## 3. Discussion

The lower cervical injury (C3–C7) is rarely found in toddlers and young children. The lower cervical injury in young children is only 22% to 31% of total cases of pediatric lower cervical injury. The younger the age, the more likely are the complications with craniocerebral trauma.[5] The mortality ranged between 4% and 27%, mainly caused by the severe trauma to the head and brain.[7,14,15] Fracture and dislocation of the articular process were the second most common types of injuries in children with lower cervical fractures (compression fractures were the most common). Unilateral dislocations tended to damage the nerve roots, while bilateral dislocations affected the spinal cord. Fractures and dislocations of the bilateral facet joints were often considered as unstable; therefore, the reduction and fixation were usually required.[16] Children have been found to adapt to spinal cord injury better than adults. Anderson et al[17] followed


**Figure 6.** Bilateral upper limb nerve function was obviously recovered 2 years after the operation; the patient was able to have dinner and write by herself.

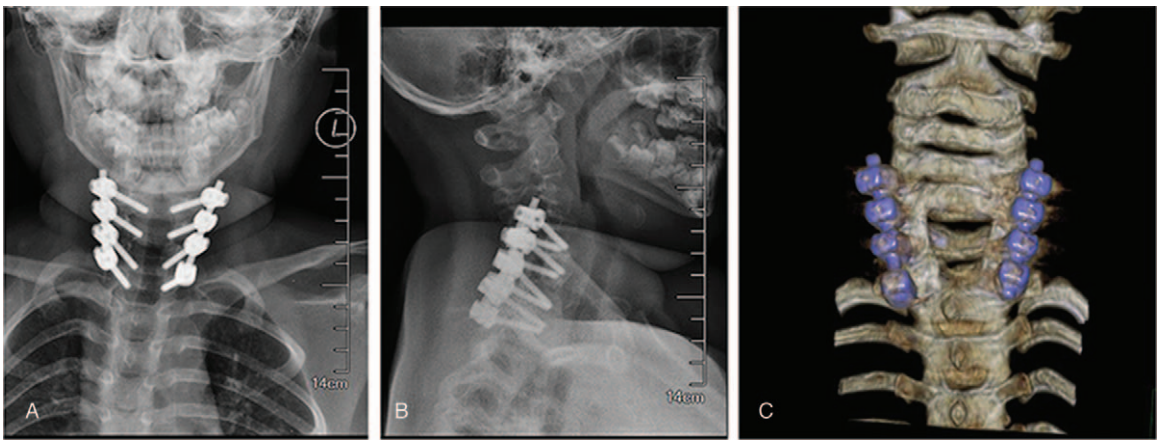


**Figure 7.** No obvious retardation of the vertebral body and spinal canal development occurred 2 years after the operation.

up 161 children who had a spinal injury during childhood and found that 64% children could live independently and 50% of them were satisfied with the life quality. The operation could help patients, who had a spinal fracture with spinal cord injury, to use a wheelchair 5.2 weeks in advance.

In the present study, the girl was injured and the dislocation of cervical vertebrae was hardly reduced after 60 days because of the fibrous connection formed around the dislocated joint. The manual reduction was not an option anymore, and the anterior or posterior surgical approach alone was not able to achieve the reduction as well. Therefore, the operation with anterior and posterior approaches in combination was mandatory. However, the internal fixation mode selection was another dilemma. The growth of spine was not appropriate to use an anterior cervical titanium plate and screws. Moreover, the girl had the tracheal incision casing. The anterior approach might increase the risk of infection and other complications. Thus, the anterior approach was not the most optimal option.

Posterior laminar screw fixation, lateral mass fixation, and pedicle screw fixation are among the common methods of operative fixation of the subaxial cervical spine. Although laminar screw fixation is now rarely used, both lateral mass fixation and pedicle screw fixation are technically challenging and present the risk of significant complications if performed incorrectly. Pedicle screw systems are the gold standard posterior stabilization systems because of their 3-column fixation and superior biomechanics. Though infrequently used, the cervical pedicle screws have advantages such as reducing the extent of fixation and fusion, superior biomechanics, enhanced fusion rate, and obviating the need for external immobilization.[18]

The pediatric anatomical morphology of the cervical spine for children <10 years old was shown by Kwak et al[19] through CT scanning to evaluate the anatomical feasibility of inserting 3.5-mm screws into the cervical spine in the pediatric population and establish useful guidelines for their placement. They believed

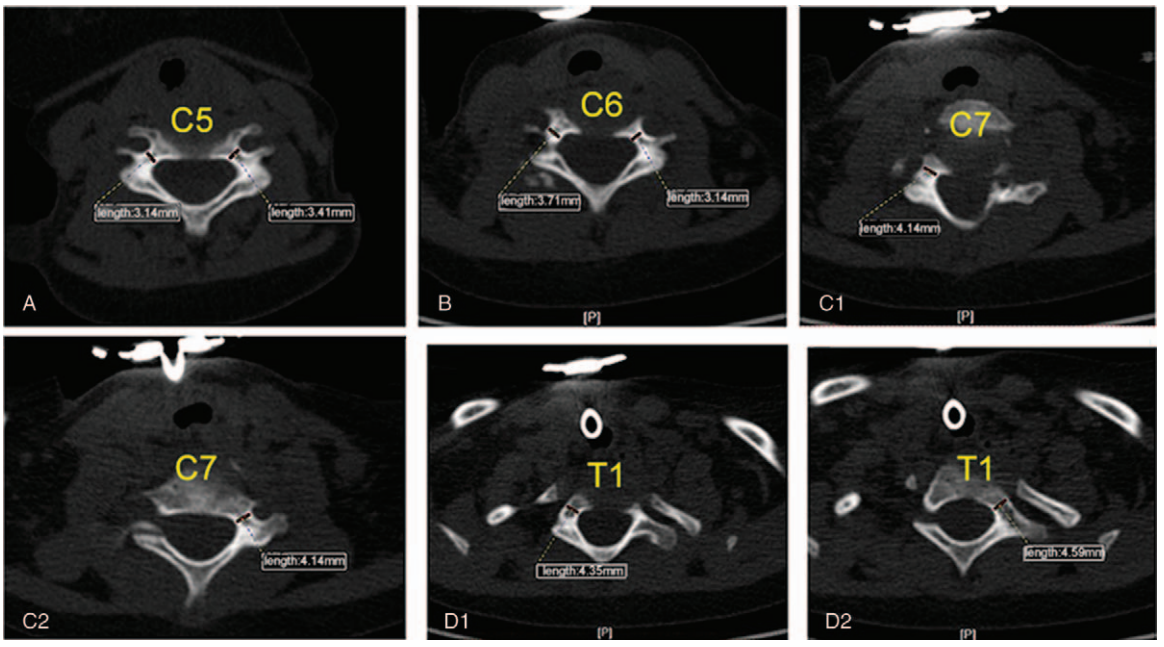


**Figure 8.** Measurement of bilateral pedicle diameter of C5–T1 before the operation.

**Table 2**

**Diameter of the C5–T1 pedicles (mm).**

| Spinal sequence<br>Diameter of cervical pedicle, mm | C5 | C6 | C7 | T1 |
|---|---|---|---|---|
| Left | 3.41 | 3.14 | 4.14 | 4.59 |
| Right | 3.14 | 3.71 | 4.14 | 4.35 |

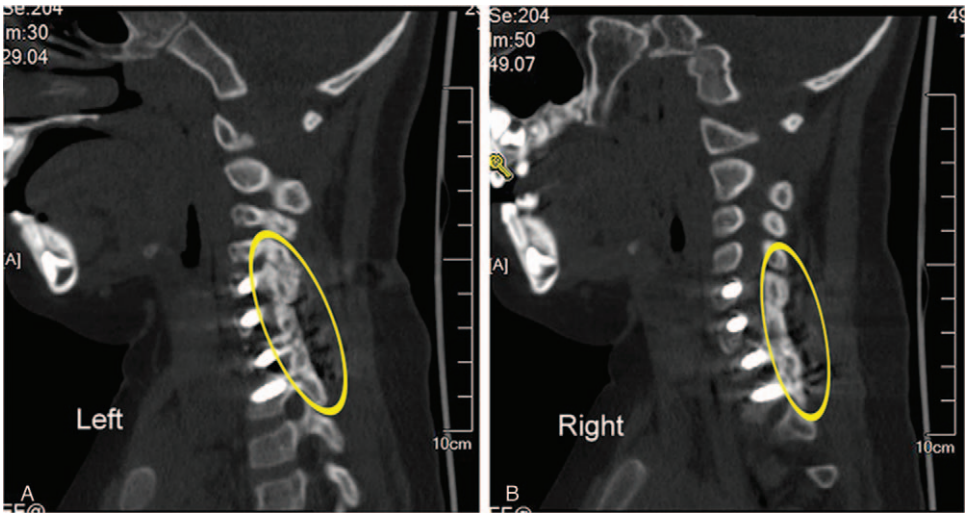


**Figure 9.** Although the anterior or posterior fusion surgeries were not performed, C5–T1 articular fusion was revealed 2 years after the operation (indicated by yellow arrow oval).

that pedicle screw placement was preferable to translaminar screw placement in the subaxial spine, except at C7.

A total of 376 normal pediatric cervical spine pedicles of 30 children (mean age = 6.7 ± 3.9 years) were analyzed by Kanna et al[20] to study the normal cervical pedicle morphometrics, the changes in pedicle morphology with skeletal growth, and the possibility of pedicle screw insertion. In their opinion, a majority of C3 pedicles were thin, rendering screw fixation unsafe. However, at all other levels, the pedicle morphometrics per se were adequate and did not restrict the safe application of 3-mm cervical pedicle screws.

In summary, the cervical pedicle screw implantation in children was feasible, and the pedicle morphometrics should be individually analyzed for the safety of screw insertion.

The accurate measurement was carried out with preoperative CT examination (Fig. 8 and Table 2). Meanwhile, combined with a previous skillful pedicle screw implantation technique, 8 pedicle screws with a diameter of 3.5 mm were accurately implanted into C5–T1 of the girl.

The function of the bilateral upper limb was obviously recovered during the follow-up examination 2 years after the operation (Table 1); however, both function of lower limbs and urinary/defecation function were not recovered. The screws were accurately implanted as planned, and the sequence of cervical vertebrae was recovered well. Although the anterior or posterior fusion surgeries were not performed, C5–T1 articular fusion was revealed by 3D CT reconstruction 2 years after the operation (Fig. 9) and no retardation of the vertebral body and spinal canal development occurred. The effect of the posterior pedicle screw on the lower cervical development needs further long-term follow-up observation.

## 4. Conclusions

Old subaxial cervical dislocations with bilateral locked facets in children are a big challenge for spine surgeons. The analysis and therapeutic strategy should be individualized for each patient to select the most optimal option. The posterior pedicle screw fixation could stabilize 3-column fixation of the spine to enhance the stability. Meanwhile, the risk and complications associated with the anterior approach could be minimized. Therefore, a combined operation with anterior discectomy, posterior laminectomy, and pedicle screw fixation was suggested to be a feasible surgical option for treating pediatric old lower cervical dislocation with bilateral locked facets.

## Author contributions

Cheng Li and Lei Li carried out the studies, participated in collecting data, and drafted the manuscript. Jingzhu Duan and Lijun Zhang performed the statistical analysis and participated in its design. Zhenjiang Liu helped to draft the manuscript. All authors read and approved the final manuscript.

**Conceptualization:** Cheng Li, Lei Li, Lijun Zhang, Zhenjiang Liu.
**Data curation:** Cheng Li, Lijun Zhang.
**Formal analysis:** Lei Li, Jingzhu Duan, Zhenjiang Liu.
**Funding acquisition:** Lei Li, Zhenjiang Liu.
**Investigation:** Lei Li.
**Methodology:** Cheng Li, Jingzhu Duan.
**Project administration:** Lei Li, Lijun Zhang.
**Resources:** Zhenjiang Liu.
**Supervision:** Lei Li, Lijun Zhang, Zhenjiang Liu.
**Validation:** Jingzhu Duan, Lijun Zhang, Zhenjiang Liu.

**Writing – original draft:** Cheng Li, Jingzhu Duan.
**Writing – review and editing:** Lei Li, Lijun Zhang, Zhenjiang Liu.

## References


[1] Patel JC, Tepas JJ, Mollitt DL3rd, et al. Pediatric cervical spine injuries: defining the disease. J Pediatr Surg 2001;36:373–6.
[2] Viccellio P, Simon H, Pressman BD, et al. A prospective multicenter study of cervical spine injury in children. Pediatrics 2001;108:E20.
[3] Finch GD, Barnes MJ. Major cervical spine injuries in children and adolescents. J Pediatr Orthop 1998;18:811–4.
[4] Kokoska ER, Keller MS, Rallo MC, et al. Characteristics of pediatric cervical spine injuries. J Pediatr Surg 2001;36:100–5.
[5] Murphy RF, Davidson AR, Kelly DM, et al. Subaxial cervical spine injuries in children and adolescents. J Pediatr Orthop 2015;35:136–9.
[6] Rush JK, Kelly DM, Astur N, et al. Associated injuries in children and adolescents with spinal trauma. J Pediatr Orthop 2013;33:393–7.
[7] Leonard JR, Jaffe DM, Kuppermann N, et al. Cervical spine injury patterns in children. Pediatrics 2014;133:e1179–88.
[8] Hannon M, Mannix R, Dorney K, et al. Pediatric cervical spine injury evaluation after blunt trauma: a clinical decision analysis. Ann Emerg Med 2015;65:239–47.
[9] Knox JB, Schneider JE, Cage JM, et al. Spine trauma in very young children: a retrospective study of 206 patients presenting to a level 1 pediatric trauma center. J Pediatr Orthop 2014;34:698–702.
[10] Rozzelle CJ, Aarabi B, Dhall SS, et al. Management of pediatric cervical spine and spinal cord injuries. Neurosurgery 2013;72(suppl):205–26.
[11] Schottler J, Vogel LC, Sturm P. Spinal cord injuries in young children: a review of children injured at 5 years of age and younger. Dev Med Child Neurol 2012;54:1138–43.
[12] Eleraky MA, Theodore N, Adams M, et al. Pediatric cervical spine injuries: report of 102 cases and review of the literature. J Neurosurg 2000;92(1 suppl):12–7.
[13] Nuckley DJ, Ching RP. Developmental biomechanics of the cervical spine: tension and compression. J Biomech 2006;39:3045–54.
[14] Cirak B, Ziegfeld S, Knight VM, et al. Spinal injuries in children. J Pediatr Surg 2004;39:607–12.
[15] Hamilton MG, Myles ST. Pediatric spinal injury: review of 61 deaths. J Neurosurg 1992;77:705–8.
[16] McCall T, Fassett D, Brockmeyer D. Cervical spine trauma in children: a review. Neurosurg Focus 2006;20:E5.
[17] Anderson CJ, Vogel LC, Willis KM, et al. Stability of transition to adulthood among individuals with pediatric-onset spinal cord injuries. J Spinal Cord Med 2006;29:46–56.
[18] Ludwig SC, Kramer DL, Vaccaro AR, et al. Transpedicle screw fixation of the cervical spine. Clin Orthop Relat Res 1999;77–88.
[19] Kwak Y, Lee HE, Kim WH, et al. The clinical implication of cancer-associated microvasculature and fibroblast in advanced colorectal cancer patients with synchronous or metachronous metastases. PLoS ONE 2014;9:e91811.
[20] Kanna PR, Shetty AP, Rajasekaran S. Anatomical feasibility of pediatric cervical pedicle screw insertion by computed tomographic morphometric evaluation of 376 pediatric cervical pedicles. Spine (Phila Pa 1976) 2011;36:1297–304.