Absorbable anterior cervical plate for corpectomy and fusion in a 2-year-old child with neurofibromatosis

Technical note

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Surgical repair of postlaminectomy cervical kyphotic deformities presents one of the most challenging procedures in spine surgery. Correction of this deformity usually requires anterior fusion with plating and a strut graft or interbody cage and posterior fusion with screws and rods. The situation is more complicated in the young child because fusion may affect future growth of the cervical spine. There is also a paucity of adequate instrumentation for the small bony structures. Some authors have reported utilization of absorbable cervical plates for fusion in pediatric patients with favorable results.

The authors present a modified surgical technique that was used for circumferential fusion in a 2-year-old girl with cervical kyphosis and recurrent neurofibroma. Anterior fusion was performed using an autologous rib graft and an absorbable cervical plate. This was followed by posterior fusion using rib bone and cables. Previous reports on the use of absorbable cervical plates are reviewed and the advantages of the current technique are discussed.

(absorbable plate • cervical fusion • neurofibromatosis • pediatric spine)

Abbreviations used in this paper: ACDF = anterior cervical disc-ectomy and fusion; NF1 = neurofibromatosis Type 1.
Absorbable cervical plate fixation

Case Report

This 2-year-old child with NF1 was transferred to our center 5 months following incomplete removal of a C-3 neurofibroma in a procedure that included wide C-3, C-4, and C-5 laminectomies without supplementary fusion. Postoperatively, she developed progressive left hemiparesis with worsening cervical kyphosis. An MRI study showed residual tumor causing significant compression and anterior displacement of the spinal cord with severe kyphotic deformity (Fig. 1). Plain radiographs showed severe kyphosis and instability of the cervical spine (Fig. 2).

An attempt to reduce the deformity using a traction device did not produce any significant sagittal correction.

Therefore, we decided to perform an additional procedure to remove the residual tumor and correct the kyphosis. Initially a C-3 corpectomy was done followed by reconstruction of the anterior spinal column using an autologous rib bone graft from C-2 to C-4 under distraction. Then, the C2–4 vertebral bodies were stabilized using an absorbable craniofacial plate and screw system (LactoSorb, Biomet Microfixation). The patient was then turned to the prone position and the intradural residual tumor was removed through a posterior approach, after which a C2–5 fusion was performed using an autologous rib graft and cables. The cables were chosen to secure the ribs to the C-2 and C-5 laminae without fixation of motion segments. The procedure was well tolerated by the patient.

Postoperatively, a halo vest was applied. At 5 months’ follow-up, improvement of the left hemiparesis was noted. Computed tomography and MRI studies (Figs. 3 and 4), showed complete relief of the cord compression, successful anterior and posterior fusion and stable sagittal alignment, thus the halo vest was removed. As of this writing, 30 months after the second surgery, the child is clinically stable with only mild residual hemiparesis on neurological examination and no evidence of radiological progression.

The LactoSorb plating system was first introduced in 1996 and is made of 82% poly-L-lactic acid and 18% polyglycolic acid. It degrades in the human body via hydrolysis into L-lactic and glycolic acids, which are then metabolized by the body. The system includes plates and mesh panels of different shapes and sizes, with predrilled holes, and screws that may be threaded or push screws, torque limited or direct drive, with variable length and diameter (Fig. 5 upper). In the present case we used a 0.5-mm-thick plate as shown (Fig. 5 lower), which was secured with threaded, direct-drive screws of 2-mm diameter and 7-mm length.

According to the manufacturer, absorption of the plate and screws is quite predictable: significant reduction of the plate mass starts at about 3 months, reaching 50% at about 5–6 months and complete absorption by 12 months. At implantation the strength of the absorbable plate is the same as that of titanium plating; it decreases to about 70% after 8 weeks and is lost by 4–5 months.
Discussion

The indications for surgical cervical spinal stabilization in children differ from those in adults. The chances for bone healing and successful arthrodesis are significantly higher in the growing pediatric spine. However, smaller bony structures and a larger proportion of cartilage make the procedure more challenging. In younger children, under 6 years old, these issues are further complicated by the possible adverse effect of fusion on future growth of the spine and the lack of suitable hardware. Although fixation implants are available for the pediatric thoracic and lumbar segments, such implants have not been established for the cervical spine. In the studies by Dogan et al. and Hedequist et al., which showed feasibility and safety of rigid cervical spinal fixation in children, the patients’ age was 8–16 years and 6 years or older, respectively.

Because of these factors, less invasive approaches for management of cervical spinal instability in children are usually preferred. Often, this management is limited to application of an external orthosis, such as a halo vest.

In cases that require surgical management, most cervical fixations in the pediatric population are performed via the posterior approach. In a review of occipitocervical arthrodesis in the pediatric age group, Schultz et al. concluded that posterior on-lay grafting with or without wiring remains the preferred procedure.

The preference for the posterior approach stems from concern about causing damage to the superior and inferior endplates, which may cause subsequent cervical instability, and anterior plates hindering normal growth of the spine. The use of standard titanium plates in children younger than 6 years is especially problematic due to the small size and delicate structure of the vertebral bodies as well as the lack of suitable hardware.

Different solutions have been attempted to surmount the adverse effect of rigid anterior cervical plating in children. Shacked et al. reported on 6 children aged 3–14 with traumatic spinal injury, who were treated by means of anterior cervical fusion without instrumentation. Bony fusion was achieved in all cases, but all of the patients developed slight kyphosis. Sohn et al. used a miniplate after corpectomy in a child with eosinophilic granuloma. Patel et al. performed circumferential fusion for C6–7 fracture in a 2-year-old girl using craniofacial miniplates for both anterior and posterior (lateral mass) fixation. In their case, fusion was satisfactory at 6 months’ follow-up, but no data regarding the effect of long-term fixation on the growing spine were provided. In a case described by Ozer et al., the authors used a metallic anterior cervical plate in a 7-year-old child and removed the plate after fusion was achieved at the surgically treated level, thus avoiding the potential risk of irregular growth.

The use of cervical absorbable plates for anterior fixation is a relatively novel procedure, even in adults. Vaccaro et al. reported the use of bioabsorbable plates for an-
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terior cervical discectomy and fusion in 9 patients. There were no complications and the fusion rate was comparable to that with titanium plates. Franco et al.3 reported on a series of 16 patients treated by means of single-level ACDF with absorbable plates. No complications were recorded, alignment was preserved, and good fusion rates were noted. Nabhan et al.9 performed a prospective study recorded, alignment was preserved, and good fusion rates for the treatment of cervical radiculopathy by single-level ACDF. Titanium plates were used in 18 patients and absorbable plates in 19 patients. No differences were found between the 2 groups in clinical or radiological outcome, cervical stability and fusion rates, or complications.

Dickerman and colleagues1 described a case of an 18-month-old child with disruption at the odontoid and C-3 vertebra that was managed with circumferential fusion. The child underwent anterior corpectomy of C-3 and the base of C-2 and C2–4 fusion with rib bone graft and MacroPore as an anterior plating system. Posterior occiput–C3 fixation was performed using a single titanium rod placed in a midline trough and secured to the occiput with wires; autologous rib grafts were placed along both sides of the rod and secured with sublaminar wires. Four months postsurgery, good bony fusion was observed, allowing removal of the halo orthosis, but no details of long-term follow-up were given.

Our case illustrates a unique method of circumferential fixation. For anterior fusion an autologous bone graft and an absorbable plate were used, while posteriorly ribs were secured with cables that did not cross motion segments. The construct resulted in bony fusion across only the motion segments necessary to provide stable fixation. No intra- or postoperative complications were encountered. Theoretically, after plate absorption, this technique should not result in any irregular growth of the spine. Indeed, 30 months after the operation, stable fusion and proportional growth of the cervical spine including the anterior and posterior grafts, were demonstrated on CT.

It is possible that the same result could have been accomplished without the absorbable plate because a halo orthosis was applied postoperatively—or that the plating, together with the posterior fixation, would suffice without the need for the halo device. We believe that the absorbable plate helped to provide the immediate stability required for successful fusion. Because of the severe deformity and gross instability in this case, we elected to add the halo device.

In their report on late-onset spinal deformities in children treated with laminectomy and radiation for malignant tumors, de Jonge et al.2 noted that after cervical or cervicothoracic laminectomy (with or without facetectomy) deformities appeared within 5 months. In the present case, the patient was admitted to our service 5 months after the first surgery, but it is probable that the deformity had appeared even earlier.

Prevention of postlaminectomy cervical deformities in children deserves special attention. Some authors recommended posterolateral fusion without instrumentation.12 When the posterior bony elements are not involved by the tumor, a laminoplasty should be preferred. Postoperative use of an external orthosis does not completely prevent the development of postlaminectomy deformity, but it is useful, especially when used together with laminoplasty or laminectomy and onlay fusion.

Conclusions

Surgical management of cervical spinal deformity in young children is challenging due to small bony structures, lack of suitable hardware, and the possible adverse effect on future growth of the immature spine. This case demonstrates that circumferential cervical fusion, using autologous rib grafts, absorbable plate, and sublaminar wires, may be an efficient method of fusion that theoretically should not interfere with normal proportional bone growth.

Disclosure

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

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