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Operative Technique

Hybrid lateral mass screw sublaminar wire construct: A salvage technique for posterior cervical fixation in pediatric spine surgery

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ABSTRACT

We present a novel salvage technique for pediatric subaxial cervical spine fusion in which lateral mass screw fixation was not possible due to anatomic constraints. The case presentation details a 4-year-old patient with C5–C6 flexion/distraction injury with bilateral jumped facets. Posterior cervical fixation was attempted; however, lateral mass fracture occurred during placement of screws. Using a wire-screw construct, an attempt was made to provide stable fixation. The patient was followed post-operatively for assessment of outcomes. After the patient had progressive kyphosis following initial closed reduction and external orthosis, internal reduction with fusion/fixation was performed. Lateral mass fracture occurred during placement of lateral mass screws. After placement of a sub-laminar wire-lateral mass screw construct, intra-operative evaluation determined stability. Post-operatively, the procedure resulted in stable fixation with evidence of bony fusion on follow-up. Pediatric subaxial cervical spine instrumentation provides rigid fixation however is technically difficult due to anatomic and instrumentation related constraints. In the presented patient, the wire-screw construct resulted in stable fixation and bony fusion on follow-up. A modified sublaminar wire-lateral mass screw construct is an example of a salvage technique that provides immediate stability in the event of instrumentation related lateral mass fracture.

1. Introduction

Cervical injuries in preschool aged children (<5 years old) usually result from falls, motor vehicle accidents, and non-accidental trauma [1,2]. Spine trauma in pediatric populations is relatively uncommon, accounting for about 1–2% of pediatric trauma cases, with 60–80% involving the cervical spine [1]. In children less than 10 years of age, most cervical injuries involve the upper cervical spine. In this group the immature spine has increased mobility and a relatively larger head-to-body size ratio. Cervical spine injury patterns in children older than 10 years of age more closely resemble patterns seen in the adult population due to the relatively more mature spinal anatomy. This group is mostly injured in the lower cervical spine, with typical compression fractures, lateral mass fractures, spinous process fractures, and facet dislocation.

Surgical treatment of pediatric cervical spine injuries may be required in cases of spinal cord compression, persistent malalignment or severe instability [2–4]. Pediatric cervical spine stabilization through operative fixation represents a formidable challenge especially in the preschool age patient population. The challenges lie not only in the small, fragile bony elements but the limited availability of appropriately sized instrumentation [5]. Reported surgical treatment of pediatric cervical spine injuries and instability has commonly involved fusion with instrumentation, usually posterior wiring [6]. However, most authors suggest that rigid instrumentation be performed only in children over 8 years of age and sublaminar wiring in patients over 3 years of age. Recent reports suggest that use of rigid instrumentation is possible and preferable in very young children and that anatomic size of the patient is the most important factor in determining the type of instrumentation that can be used [3].

Pediatric cervical spine stabilization through operative fixation represents a formidable challenge especially in the preschool age patient population. The challenges lie not only in the small, fragile bony elements but the lack of appropriately sized instrumentation available for these procedures, causing many surgeons to adopt alternative fixation techniques [5,7]. In this case we report on the successful use of an improvised wire-screw subaxial cervical spine fixation technique after an instrumentation related fracture during cervical lateral mass screw placement.

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2. Case report

The patient, a 4-year-old boy, was an unrestrained passenger involved in a high speed motor vehicle accident during a suicide attempt by the driver in which there were two associated fatalities. After emergency responders provided rigid fixation and transport, the patient was treated and medically stabilized at an outside hospital. He was found to have suffered multiple neurologic and spine injuries including C1–C2 subluxation resulting in a C2 level spinal cord injury, bilateral C5–C6 perched facets and a severe anoxic brain injury. The patient was transferred to our facility for definitive management of his cervical spine instability. Given the severe degree of neurological deficit the patient was initially treated conservatively with external bracing. Follow-up imaging 3 months after initial injury revealed interval focal kyphosis at C5–C6 with bilateral facet disruption, left C5 facet fracture and 2 mm anterolisthesis of C5 on C6 (Fig. 1). On examination the patient had diffusely increased tone throughout the upper and lower extremities, weak motor function, and bilateral clonus. Cognitively he was awake but could not track or attend to visual stimuli. The patient had a tracheostomy and gastric tube in place since the initial hospitalization. As collar stabilization had been maintained during his initial rehabilitation stay, fluoroscopy with passive flexion/extension by the attending surgeon was performed to determine whether the patient had persistent instability or if an adequate fibrous union had developed. In neutral and flexion, the patient had perched facets at C5–C6, which reduced with extension. The disk space at C5–C6 demonstrated a simultaneous widening, and therefore intra-operative reduction and fixation was deemed necessary.

2.1. Operation

The patient was brought to the operating room and general anesthesia was induced. The patient was carefully positioned prone in a horseshoe head frame. Closed manual reduction was successfully accomplished using fluoroscopy. His posterior cervical spine was exposed from C4 to C7 taking care to avoid entering the facet capsules at C4 and 7. Bilateral 3.5 mm diameter lateral mass screws (Depuy Mountaineer Short, DePuy Synthes, Raynham, MA, USA) screws were placed at bilateral C5 lateral masses and right C6 lateral mass with good bony purchase. During the placement of the left C6 lateral mass screw a superior and lateral breakout occurred. A rescue screw was placed with good bony purchase, however following placement of rods and torquing of the left side construct, the left C6 lateral mass screw pulled out. Due to the very small diameter of the C5 and C6 lateral mass it was felt that a unilateral fixation would not be sufficient to ensure stable fixation and bony fusion. In order to ensure a bilateral stable fixation, a sublaminar cable was then passed under the left C6 lamina and wrapped around the left C5 lateral mass screw, tightened to compress the space between the lamina/facets and secured in position with a locking cap (Fig. 2). Next the right C5–C6 lateral mass screws were connected with a standard rod construct. The remaining lateral elements were decorticated using a high-speed drill and morselized autograft was placed over the decorticated surfaces. The incision was closed in a standard fashion and a rigid cervical collar continued for the post-operative period.

2.2. Postoperative course

The patient tolerated the procedure and was transferred to the pediatric intensive care unit in a stable condition. A post-operative CT scan of the cervical spine demonstrated good reduction of the bilateral C5–C6 perched facets with good placement of all screws, right C5–C6 rod, and the left C5–C6 lateral mass screw/sublaminar wire construct. He was discharged to a rehabilitation facility on post-operative day 3 with an uncomplicated post-operative course. The 3 month post-operative repeat CT scan of the cervical spine showed good alignment and bony fusion across the C5–C6 posterior elements, and cervical spine flexion-extension radiographs showed no abnormal motion across the C5–C6 fusion with stable alignment in both flexion and extension (Fig. 3, 4).

3. Discussion

Current techniques for subaxial spine fixation in the pediatric population include sublaminar wiring, lateral mass screw fixation and various hybrid constructs [8]. Lateral mass screw fixation in the cervical spine has been shown to provide excellent stability and high rates of fusion in adult patients, however, little has been published about the use of subaxial lateral mass screws in the pediatric age group [9].

Despite the challenges that operative procedures involving the immature cervical spine present, there is a growing body of evidence to suggest that cervical instrumentation can be safely preformed in very young children [9]. Initial reports on cervical fixation in preschool aged children focused on non-rigid techniques such as wire–rod constructs. More recently posterior cervical screw–rod constructs have been shown to be safe and effective, which has resulted in the increased application in younger children. Hedequist

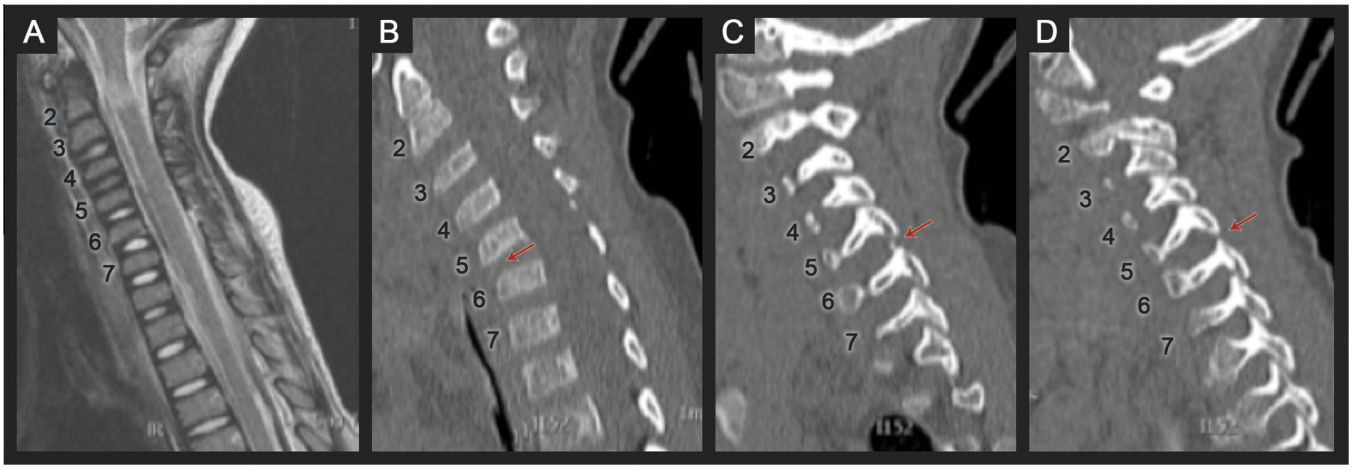

Fig. 1. Follow-up imaging 3 months after initial injury. (A) Sagittal MRI demonstrating myelomalacia at the C1–C2 level. (B–D) Sagittal CT scan demonstrating focal kyphosis at C5–C6 (B) with bilateral facet disruption (C,D), left C5 facet fracture (C) and 2 mm anterolisthesis of C5 on C6.