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Outlines and Outcomes of Instrumented Posterior Fusion in the Pediatric Cervical Spine: A Review Article

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Abstract

Context: The most common source of cervical spine arthrodesis in the pediatric populace is the instability related to congenital or traumatic damage. Surgery of cervical spine can be challenging given slighter anatomical constructions, fewer hardened bone, and upcoming growth potential and growth.
Evidence Acquisition: Trainings in adult patients recommended that consuming screw constructs results in enhanced consequences with inferior amounts of instrumentation catastrophe. But, the pediatric literature is inadequate for minor retrospective series. Authors reviewed the existing pediatric cervical spine arthrodesis literature. They studied 184 abstracts from January 1976 to December 2014. An entire of 883 patients in 82 articles were involved in the evaluation. Patients were characterized as taking either posterior cervical fusion with wiring or posterior cervical fusion with screws or occipitocervical fusion.
Results: The etiologies faced most frequently were inherited abnormalities (54%) shadowed by trauma (28%), Down syndrome (8%), and infectious, oncological, iatrogenic, or mixed causes (10%). The mean duration of follow-up was 32.5 months.
Conclusions: The consequences of this training are restricted by deviations in construct policy, usage of orthoses, follow-up period and fresher adjuvant produces stimulating fusions. But, a literature review recommend that instrumentation of the cervical spine in children may be harmless and more effective than using screw concepts rather than wiring methods.

Keywords: Pediatric, Arthrodesis, Instrumented Fusion, Cervical Spine, Occipitocervical

1. Context

Cervical spine fusion is usually used in the pediatric populace while a patient has instability associated with congenital or traumatic problems. The reasons of mechanical instability include trauma, osodontoideum, infections, atlantoaxial rotatory subluxation, juvenile rheumatoid arthritis, Down syndrome, mucopoly-saccharidoses, iatrogenic reasons, tumors, and other less communal entities (1-9).

Nevertheless, consuming cervical spine instrumentation by screws in the pediatric populace is a comparatively novel method, and results are not systematically unspoken, given the deficiency of cases in the writings. To better understand the risks and outcomes of instrumented spine surgery in the pediatric, authors reviewed the works and matched the kind of fixations used in the cervical spine.

2. Evidence Acquisition

Authors accomplished PubMed and Ovid searches using the following keywords: pediatric cervical fusion, pediatric cranio-cervical, pediatric occipitocervical, pediatric atlantoaxial, spinal fusion, cervical spine and occipitocervical. Criteria involved objects from journals that described an instrumented cervical fusion in pediatric patients (age < 18 years) and described either fusion rates by radiological assessment at more than 12 weeks follow-up or problems related with the processes. Exclusion criteria were: 1) trainings available in every language other than English, 2) patients older than 18 years at the period of operation, 3) non instrumented cervical process and 4) studies not recording either complications or fusion rates. The 184 abstracts from January 1976 to December 2014 were studied. A total of 883 patients in 82 articles were involved in the evaluation.

Patients were characterized as having either posterior cervical fusion with wiring or posterior cervical fusion with screws or occipitocervical fusion. The etiologies met most frequently were inherited abnormalities (54%) shadowed by trauma (28%), Down syndrome (8%), and infectious, oncological, iatrogenic, or various causes (10%). The mean duration of follow-up was 32.5 months. The qualitative results were presented.

3. Results

3.1. General Features

Cervical spine injury (CSI) is infrequent in children, accounting for about 1% - 2% of pediatric trauma. Motor vehicle accidents are the major device in kids under eight years old; older children most generally withstand sports injuries (9). Child abuse should be done carefully in the young child with an assumed whiplash mechanism of CSI. Spinal damages in children are more probable to be cervical and the occurrence seems to be growing. Spinal cord injury has important significances, with long-lasting neurologic injury in up to 60% and mortality in 40% (9-13).

Cranio-vertebral junction (CVJ) is anatomically a complex of several bone and ligamentous constructions; however functionally, it is a constant interconnecting component that performs as a changeover among the skull and the spine (14, 15). The CVJ permits extension, flexion, and lateral rotation of the head. The geometry of the articular surfaces offers flexibility, and stability is provided via the muscular and ligamentous supplements that extent the skull and the cervical spine (16, 17) the meaning of the CVJ requires many synovial joints, and is composed of the complex mobility of the area; the occipitoatlantoaxial complex is susceptible to trauma and many illnesses.

3.2. Trauma

While it alone accounts for 1% - 4% of general spinal trauma, pediatric spinal trauma is one of the most common explanations children necessitate cervical fusion surgery (16, 18-20). Pediatric spinal trauma is classically restricted to the cervical section (60% - 80%), with upper cervical trauma more common in younger children (2, 7, 21, 22). But, internal spinal fixation in children can be challenging given their slighter anatomical constructions, abridged bone purchase, attentions for forthcoming possible growth, congenital abnormalities, and cartilaginous constituents of bone at younger ages (23-25).

3.3. Clinical Characteristics and Diagnosis

Clinical symptoms of cervical spine involvement can be different ranging from a simple pain to paresthesia and weakness of all four limbs or just upper limbs. Sometimes, depending on the type of conflict, as atypical symptoms mimic other parts of the spine, or other diseases such as infections could be visible (26). Plain radiographs, computed tomography (CT) scan with thin slices and magnetic resonance imaging (MRI) are the most useful tools to diagnose cervical injury or other injuries in the surrounding areas (27).

3.4. Surgical Treatment

3.4.1. Indications

Posterior cervical fusion (PCF) is most commonly done for patients with cervical fractures or instability; nevertheless it is similarly achieved for a diversity of additional spinal situations, such as tumors, infections, and deformity (2, 5, 28, 29).

PCF may also be done in combination with anterior cervical operation, particularly while several levels are complicated.

The aim of a posterior spinal fusion is to permit two or more vertebrae to cultivate collected or fuse into one dense bone. If the procedure is being done since you are distressed from mechanical neck pain, the fusion can break the additional motion among the vertebrae produced by segmental instability. This can decrease patients' discomfort (30-33).

This is predominantly significant when spinal cord is not damaged. Steadying the spine surgically can defend spinal cord from damage throughout the curative course. Even in cases with severe injuries to the spinal cord leading to paralysis, a spinal fusion might be suggested; thus the patients can grow out of bed and into a wheelchair faster. This permits early rehabilitation as the spine is stabilized by the internal fixation (2, 4, 10, 34-40).

A posterior cervical fusion may be similarly recommended to straighten the spine, or control a malformation of the cervical spine such as a cervical kyphosis. The cervical spine usually has a "C" formed bend by opening to the back. A kyphotic curve is precisely the reverse the opening of the "C" arguments forward. This deformity happens once the cervical spine is unstable and initiates to forward bending (40-42).

3.4.2. Surgical Overview and Outcome

The first stated occipitocervical fusion was completed by Dzenitis in 1966 and Foerster in 1927, who used a fibular support graft (42, 43). Wiring methods involved arrangement of rods to the sub occipital bone; Brook (Figure 1), Gallie (Figure 2) and Sonntag fusions; and variants of graft fixation to the spinous processes, facets, and sub laminar fixation. Nevertheless, the use of wires was regularly complemented by external braces such as halo-vest, and had a comparatively high complication rate. Internal fixation of the cervical spine subsequently advanced the use of wiring to the use of laminar hooks and clamps and numerous systems of screw fixation to every level of the cervical spine. Trans articular C1-2 screws as designated by Jeanneret and Magerl, offer an actual rigid construct with the combination of 4 cortical faces, nonetheless the insertion method is technically challenging because of the risk of vertebral artery damage, particularly in cases in which atlantoaxial subluxation leftovers irreducible before surgery (44, 45). While successful transarticular screw fixation of the atlantoaxial area is widely described in adults, here is only a minority of reports in the pediatrics. Investigation of clinical practice in the biggest series of pediatric patients recommended a 4% rate of vertebral artery injury throughout screw employment. None of these damages caused in any durable morbidity or mortality (46, 47).

Wright defined a novel technique aimed at rigid screw fixation of the axis, containing the insert of polyaxial screws into the laminate of C-2 in a bilateral intersection style, and established the possibility of this technique for the universal adult populace (48, 49).

Newly, groups of authors have informed practice by this method of crossing and non-crossing screws in minor series of children (15, 18, 50).

Spine revealed to offer exceptional stability and great rates of fusion in adults. Slight is available around the use of subaxial cervical spine using lateral mass screws in the pediatric age collection. Furthermore, no cadaveric records exist with deference to the use of these kinds of builds in the pediatric cervical spine.

Pedicle screw fixation methods are extensively used to restore the thoracic and lumbar spine because of their biomechanical advantage. Abumi et al. reported experimental consequences of pedicle screw fixation aimed at reconstruction of traumatic and non-traumatic injuries of the middle and lower cervical spine (23) But, using the technique in the upper cervical spine is disapproved owing to the possibly high risk to neurovascular constructions, except on the C-2 level (23, 24).

Previously, pediatric spine surgeons were restricted through a deficiency of suitably sized instrumentation; therefore, either modified adult-sized implements or castoff wiring systems to alleviate the spine (51, 52). Current expansions in instrumentation and systems for the cranio-cervical junction and subaxial cervical spine comprise occipital screws, C-1 lateral mass screws (Figure 3), C1-2 transarticular screws, axial and subaxial translaminar screws, C-2 pedicle/pars screws, and subaxial cervical pedicle screws (51, 53, 54).

3.4.3. Complications by Occipitocervival Fusion

Only seven papers with 116 patients from the occipital condyle (OC) screw collection had adequate records to assess the related complication.

Complications included infection, hematoma, vascular injury, screw pullout, nonunion, transient vocal cord paresis, dysphagia, intraoperative CSF leak, transverse sinus injury and temporary dysphagia.

There was a no important dissimilarity in the number of patients who had screw construct complications and those who had wire made complications (55-61).

Figure 1. Lateral Radiograph Showing Wiring (Brooks Technique) of the Atlantoaxial Segments

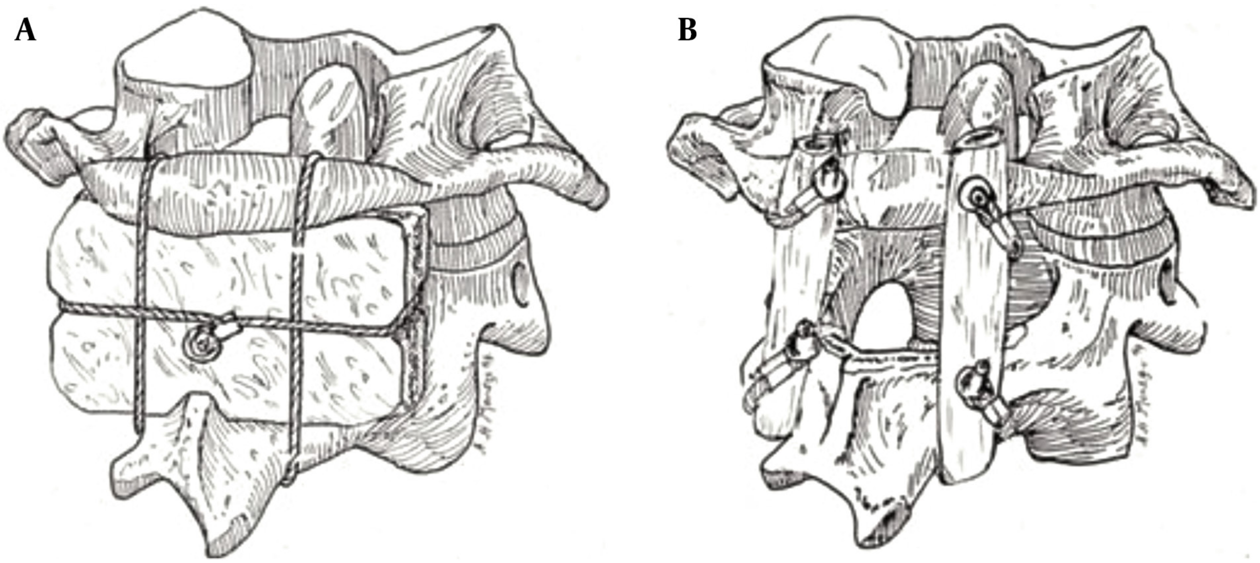

Figure 2. Artist's Illustrations of A, Modified Gallie Fusion and B, Interlaminar rib Graft Fusion

3.4.4. Complications by Cervical Spine Fixation

Documents from 61 cases described in 11 trainings were used to examine complications related to cervical fusion without the occipitocervical junction (Figure 4).

The complications counted in temporary paresthesias, unintentional delay of fusion, donor-site graft pain, kyphotic malformation, infection, pseudarthrosis, and rod relocation (19, 20, 22, 62-67).

3.4.5. Pediatric Occipitocervical Instrumentation

Also, the assessment is strained from retrospective sequences and a topic to the characteristic restrictions of such trainings. Numerous series originate in the literature report data for a heterogeneous collection of patients; therefore, authors could only distribute the patients into very wide groups and had to except some studies (68, 69). Unreliable reports of detailed variables that unquestionably influence outcomes similarly limit substantial understanding of the current review. Furthermore, some writers might have printed the similar clinical outcomes in different series, which could perhaps lead to data duplication. Authors were incapable of recognizing which cases may have been repeated; therefore, some consequences may be tilted based on these trainings.

Figure 3. Lateral Radiograph of C-1 Lateral Mass Screws With C-2 Translaminar Screws

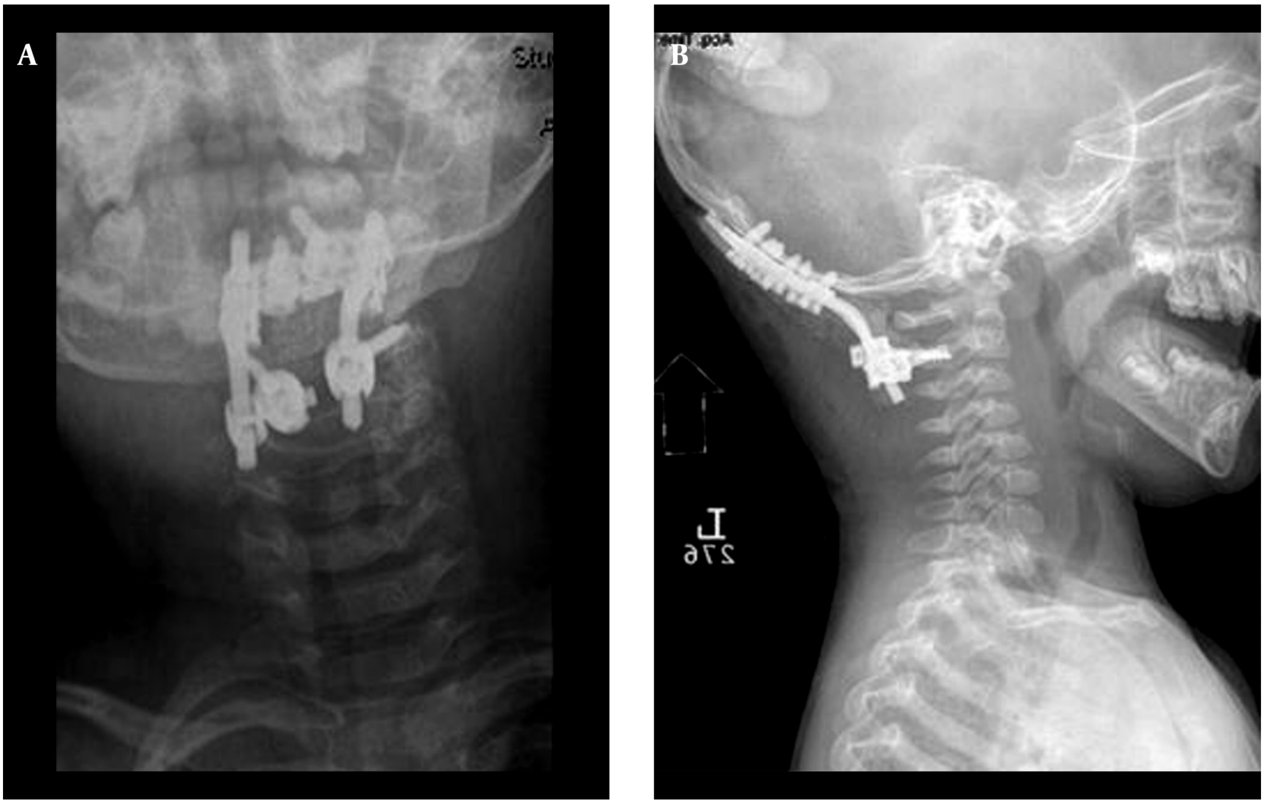

Figure 4. A, Anteroposterior and B, Lateral Radiographs Showing an Occipitocervical Fusion in a Two-Year-Old Girl Involved in a Motor Vehicle Accident With Occipitoatlantal Instability

4. Conclusions

Instrumenting the cervical spine in the pediatric populace leaves the existing trials to surgeons (37). Children have slighter anatomical organizations, amplified segmental motion, bigger ligamentous laxity and fewer solidified bones; furthermore, the necessity of fusion guarantees growth and development. Still, numerous pediatric patients demanding a cervical fusion have congenital syndromes and regularly have coexisting osseous, neurological, or vascular anatomical anomalies. Since a successful fusion needs restriction of favorite segments by a bone graft below compression, immobilization via rigid internal screw concepts seems beneficial (9). Screw instrumentation constructs have greater biomechanical stabilization matched by wiring methods, nonetheless slight records exist in the literature about their application and consequences in pediatric patients. Obtainable documents were joint in the literature to explore outcomes of cervical instrumentation in the pediatric population (70-72).

While osseous fusion is dangerous, the instrumentation choice needs biomechanical stabilization by diminishing operating morbidity. With an overview of the literature, 26% skilled a complication and 5% hurt from numerous complications. In the occipitocervical groups, 14% of the patients with screws and 50% of the patients with wiring had complications.

Also, the complications in the screw fixation seemed to be less severe than those in the wire technique. No CSF leaks from either of the screw group's obligatory additional interference, but several of the CSF leaks with wires ran to wound infection, wound amendment, or lumbo peritoneal shunt employment. While many of the neurological complications in patients preserved with screws were temporary, several neurological complications in patients treated with wires run to quadriparesis or death. Generally, the complications of the wiring methods were more common and more severe.

A greater part of patients in the wire surgery were positioned in halo immobilization postoperatively; however, the mainstream of patients in both wiring and screw groups had some system of rigid cervical orthosis. Halo-vest placement in young children can transfer substantial morbidity, but complications are characteristically minor such as pin-site infection or pin loosening and can be easily managed (24, 33, 73). Even with a lesser rate of halo immobilization, the patients treated with screw fixation had upper rates of fusion.

The use of new technical methods, particularly CT scan measurements of vertebrae pedicle can facilitate various surgical procedures in the cervical spine in children (74-76).

With respect to spinal fusion, auto graft bone is the golden standard by which all other grafting tools are arbitrated.

Cadaveric allograft is extensively used as a substitute, however current investigation and development have directed to numerous synthetic allograft materials that offer a support for bone growth based on mixtures of calcium, phosphate, collagen and/or hydroxyapatite. The potential profits of using recombinant human bone morphogenetic protein-2 (rhBMP-2) over auto graft or allograft bone are abundant; they may contain reduced operational time, blood loss, donor-site morbidity, transmission of infection because of allograft, and rate of pseudarthrosis (77, 78).

On junction with adjuvant bone marrow aspiration or biological agents that comprise precursor cells to promote osteogenesis, and in some cases osteo induction, provide the required elements for osseous fusion (68, 69, 79-83).

Restricted trainings are obtainable matching the opposing products to discriminate clinical dominance, leaving selection of graft material largely to the pleasure of the surgeon.

As pediatric fusion concepts advanced from in situ fusions to rigid internal fixation, improved fusion rates lacking the need for lengthy, bulky, and, at times, dangerous external immobilization are reached. While the accessible records regarding complications are incomplete, this review of the literature maintains the statement that the complication rates related to rigid internal screw instrumentation are inferior to the ones related to the older wiring constructs.

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