Anterior Instrumentation and Fusion in Pediatric Spinal Deformities

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‘From inability to leave well alone;

From too much zeal for what is new and contempt for what is old;

From putting knowledge before wisdom, science before art, cleverness before common sense;

From treating patients as humans not cases;

And From making the cure of a disease more grievous than its endurance,

Good Lord, Deliver Us’

Sir Robert Hutchison

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Abstract

Management of spinal deformity caused by a hemivertebra is controversial. Early diagnosis and early aggressive surgical treatment are mandatory in progressive cases. Several techniques have been reported for the surgical treatment of young children with congenital spinal deformities. There have been concerns regarding epidural bleeding, neurological complications, pedicle screw placement, implant failure and prominence of posterior constructs in young age group for posterior instrumented patients. A single stage partial corpectomy of the hemivertebra with anterior instrumentation and simultaneous posterior non-instrumented fusion can offer a new alternative which can avoid these concerns. Anterior instrumentation is safe and effective technique capable of transmitting a high amount of convex compression, and allowing short segment fusion which is of great importance in the growing spine, meanwhile allows control of segmental kyphosis.

Key Words: Hemivertebra, congenital scoliosis, anterior instrumentation.

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List of Abbreviations

3-D CT: Three dimensional computed tomography
C.C.: Cubic centimeter
CD: Cotrel Dubousset
CSA: Cobb scoliotic angle
CSVL: Central sacral vertical line
CT: Computed tomography
Ed.: Edition
Eds.: Editors
F: Female
FS: Fully segmented
FU: Follow up
HV: Hemivertebra
ICR: Instant center of rotation
Kyph: Kyphosis
L: Lumbar
Lat.: Lateral
Lt.: Left
M: Male
MPa.: Mega Pascal
ML: Milliliter
MRI: Magnetic resonance imaging
N: number
PA: Posteroanterior
PEEK: Polyethylethylketone
Post: Postoperative
Pre: Preoperative
Rt.: Right
S: Sacral
SKA: Segmental kyphosis angle
SS: Semi-segmented
STD: Standard deviation
SVA: Sagittal vertical axis
T: Thoracic
TL: Thoracolumbar
TLSO: Thoracolumbosacral orthotic
TSRH: Texas Scottish Rite Hospital system
VATER: The initials in VATER Syndrome refer to five different areas in which a child may have abnormalities: **V**ertebrae, **A**nus, **T**rachea, **E**sophagus, and **R**enal (kidneys).
VPTR: Vertical expandable prosthetic titanium rib

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Aim of Study

Introduction

The anterior approach to scoliosis was first reported by *Dwyer* in 1969 and although techniques for instrumentation have expanded, the benefits of this strategy continue to be observed. Anterior spinal instrumentation is not recommended in idiopathic scoliosis in young children since it involves long segment fusion and hence impairs normal spinal growth and lung development which is vital in that age group. Anterior instrumentation for correction of congenital spinal deformities due to failure of formation is a novel technique. Posterior instrumentation has been well described in literature. Because of the age at which partial corpectomy is performed in congenital scoliosis patients, instrumentation is difficult.

The natural history of congenital scoliosis is usually progressive and surgery is required in most of cases. Hemivertebrae are the most frequent causes of congenital scoliosis. The management of spinal deformity caused by a hemivertebra is controversial. However, there is a consensus in the literature that early diagnosis and early and aggressive surgical treatment are mandatory in progressive cases for a successful treatment and to prevent the progression of the deformity and the development of secondary compensatory deformities.

Several techniques have been reported for the surgical treatment of young children with congenital spinal deformities. Previously described surgical procedures include in-situ posterior or anterior-posterior fusion with or without instrumentation, combined anterior and posterior convex hemiepiphysiodesis, hemivertebra excision with fusion, and more recently posterior hemivertebra resection with transpedicular instrumentation. There have been concerns regarding epidural bleeding, neurological complications, pedicle screw placement, implant failure and prominence of posterior constructs in young age group. A single partial corpectomy of the hemivertebra with

anterior instrumentation and simultaneous posterior non-instrumented fusion can offer a new alternative which can avoid these concerns.

Anterior instrumentation is safe and effective technique capable of transmitting a high amount of convex compression, and allowing short segment fusion which is of great importance in the growing spine, meanwhile allows control of kyphosis which is commonly coincident with congenital scoliosis in that type of patients. Partial corpectomy and anterior instrumentation of congenital spinal deformities due to failure of formation offers the following advantages; excision, correction and instrumentation are at the site of pathology, anterior concave strut graft can be put under vision, more radical discectomy and end plate preparation, preservation of the concave side growth plates, and direct compression of the graft by anterior instrumentation

However; there have been concerns about; the hold of screws in small cartilaginous vertebral bodies, the amount of correction while leaving the posterior convex intact, compression of nerve roots on the convex side, ability to correct sagittal plane deformity meanwhile exerts compression on the graft site, the problems of adding on and junctional kyphosis. A short fusion increases the risk of newly developing deformity and the need for reoperation; however this should be accepted in order to minimize the compromise of spinal growth.

Aim of the current study is to evaluate the safety and efficacy of a single stage partial corpectomy with anterior instrumentation and simultaneous posterior non-instrumented fusion in the management of progressive congenital spinal deformities due to failure of formation in young age.

Congenital Scoliosis

Review of literature

Chapter I

Congenital scoliosis

Definition

Congenital scoliosis is a progressive three-dimensional deformity of the spine due to congenital anomalies of the vertebrae that result in an imbalance of the longitudinal growth of the spine. These anomalies are numerous and varied. Thus to understand their natural history and their treatment, it is important to understand the embryologic development of the vertebrae. [1]

Embryologic Development of the Vertebrae

Mesoderm on either side of the notochord condenses to form somites, which will form vertebrae. During the fourth week of development, cells from the sclerotome region of the somite on each side of the body migrate ventrally and surround the notochord and the neural tube **[Figure 1].** Each vertebra is formed by sclerotome cells from two somite levels. The cranial and caudal parts of adjacent sclerotomes, which are not ossified yet, fuse with each other [2] **[Figure 2].**

The ventral part of each vertebra forms the body around the notochord, and the dorsal part forms costal processes laterally and the vertebrae arch dorsally. Ossification begins during the sixth week from three primary ossification centers: one in the body or centrum (formed by the early fusion of two centers), and on one each half of the vertebral arch. This is called *the fusion stage.* [3]