GROWING RODS AS A TREATMENT MODALITY OF EARLY ONSET IDIOPATHIC SCOLIOSIS

Essay

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LIST OF ACRONYMS USED

EOS	Early-onset scoliosis
TLC	Total lung capacity
FVC	Forced vital capacity
RV	Residual volume
FRC	Functional residual capacity
FEV1	Forced expiratory volume in the first second
PaO_2	Partial pressure of oxygen in the arterial blood
Hb	Hemoglobin
Sao_2	Hemoglobin saturation with oxygen
ml	Milliliter
PA	Posteroanterior
RVAD	Rib Vertebral Angle Difference
CT	Computed tomography
MRI	Magnetic resonance imaging
VEPTR	Vertical Expandable Titanium Rib Device
MCGR	Magnetically controlled growing rod
SRS	Scoliosis Research Society
Fr	French

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INTRODUCTION

Idiopathic scoliosis is defined as a three dimensional deformity of the spine in an otherwise healthy child where no cause has been found, no underlying muscular or neurologic problem. [1]

Idiopathic scoliosis is the most common type of spinal deformity confronting orthopedic surgeons. Proper recognition and treatment of idiopathic scoliosis help to optimize patient outcomes. [2]

Idiopathic scoliosis has been categorized based on the patient's age of onset into: infantile (0 to 3 years), Juvenile (4 to 9 years), and adolescent (10 years to maturity). These three ages of onset were theoretically supposed to coincide with periods of increased growth velocity of the spine, which also coincide with times of maximal scoliosis progression. [3]

The incidence of idiopathic scoliosis has been reported to be 1.5% and infantile scoliosis represents only 4% of this population. However, early-onset scoliosis is an important health issue. These children develop spinal deformities at young ages and if left untreated, are at risk for rapid deformity progression, cosmetic disfigurement and pulmonary insufficiency. [4]

Early-onset scoliosis is defined as scoliosis diagnosed at the age of five years or less. [5]

Early-onset scoliosis (EOS) commonly leads to severe deformities at an early age. Most are double major curves, and some have substantial thoracolumbar kyphosis.[6].

AIM OF THE WORK

To review the literature as regard the clinical outcome, complications and biomechanical advantages and disadvantages of the growing rods in treatment of early onset idiopathic scoliosis.

REVIEW OF LITERATURE

Epidemiology

Infantile idiopathic scoliosis is a structural spinal deformity with apical rotation and wedging that presents in the first 3 years of life. It represents less than 1% of all cases of idiopathic scoliosis Males are more commonly affected than females .Most curves develop within the first year of life and usually are left sided. The prevalence of juvenile scoliosis is estimated to be between 8% and 16% of all patients with idiopathic scoliosis. [(7)]

Biomechanics and Pathogenesis

Scoliosis is a three-dimensional deformity involving the coronal, sagittal, and axial planes . The initiation and progression of the scoliotic curve is commonly thought to result from the effect of Hueter-Volkmann law, which states that epiphyseal growth (ring apophysis of the vertebral body) in the skeletally immature is inhibited when a compressive force acts on it and stimulated when a distraction force is applied.[(8)] An initial abnormality in the axial plane leads to more compressive forces on the ventral aspect of vertebral body or disc and less on the posterior aspect.

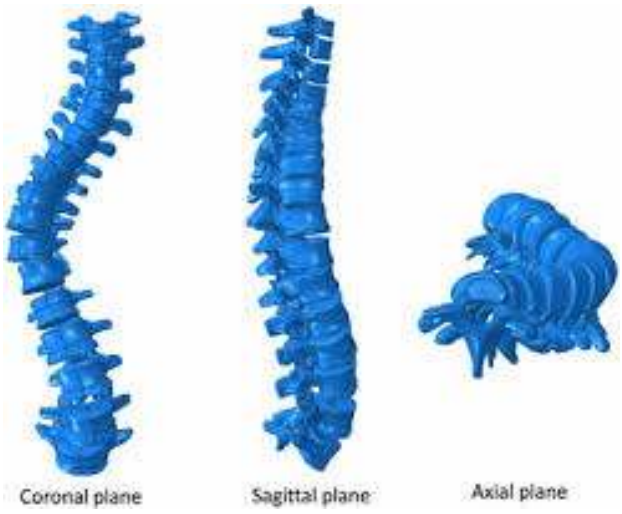

Figure (1): Three dimensional-plane deformity [8]

This discrepant growth of the anterior part versus the posterior part of the spine is accentuated over time, particularly during rapid skeletal growth, leading to eventual differential growth of the left and right sides of the spine, with suppression of growth on the concave side and excessive growth on the convex side eventually leading to scoliosis.[8]

This asymmetric growth not only forms the genesis of the curve but may also have significant surgical implications, as the pedicles on the concave side become asymmetrically smaller, posing a surgical challenge in pedicle screw for spinal fixation [9]

Pathophysiology and effects of idiopathic scoliosis on respiratory function

Spinal development is closely linked to both intra-parenchymal and extra-parenchymal pulmonary growth. Lung compliance, lung volumes, and alveolar growth may all be affected by the development of spinal deformity. As lung compliance diminishes, children with severe scoliosis may have increased work of breathing and an elevated respiratory rate due to an inability to generate adequate tidal volumes during normal respiration. (10)

Long standing hypo-inflation and atelectasis probably leads to irreversible atrophy of the lung and further reduction of lung volume. (11)

The decrease in lung volume is multifactorial and may reflect different pathophysiology depending on the age of the patient at the onset of scoliosis and the chronicity of the problem. It is mainly due to restriction which is related to the severity of scoliosis (Cobb angle), the location of the curve, and the loss of normal thoracic kyphosis. (12)

A part from the degrees of the curve, the level of the curve and the amount of spinal rotation are also important in determining the amount of respiratory compromise. The more

cephaled the curve, the more severely the lung on the convex side is compressed. Spinal rotation shifts the ribs laterally, so that the midpoint of the sternum is lateral to the midpoint of the spine and this, further compresses, or distorts the lungs, by flattening them in the lateral plane. (13)

Airway obstruction may occur but is uncommon. Rotation of the chest can produce displacement/rotation of the intrathoracic and/or mainstem bronchi, or compression of a mainstem bronchus against vertebra and mediastinal structures, produce mechanical airway obstruction, reduce expiratory flows and increase airway resistance. (14)

Cardiac consequences of scoliosis

Decrease in the anteroposterior diameter of the thorax and actual displacement of the heart may impede on its function by not allowing the increase in stroke volume necessary during conditions of increased metabolic demand. (11)

DIAGNOSIS

History

A careful history and physical examination is important to arrive at an appropriate treatment for patients with EOS. Scoliosis and thoracic insufficiency may have a profound impact on patient quality of life, with children with EOS having quality of life similar to children with severe asthma or cardiac disease. [15]

Patient evaluation should begin with a careful birth history focusing on prenatal and peri-natal complications, time spent in an intensive care setting, and hospitalizations for pulmonary issues. One should seek to understand the initial discovery of the curvature and any apparent progression noted by the parents. Since many children with EOS have associated co-morbidities such as neuromuscular, dysplastic, or syndromic conditions, these co-morbidities must be characterized as well. [16].

The most common findings of early-onset scoliosis are: [17]

- Tilted, uneven shoulders, with one shoulder blade protruding more than the other (Figure 2)
- Prominence of the ribs on one side (Figure 3)
- Uneven waistline
- Difference in hip height or position
- Overall appearance of leaning to the side.

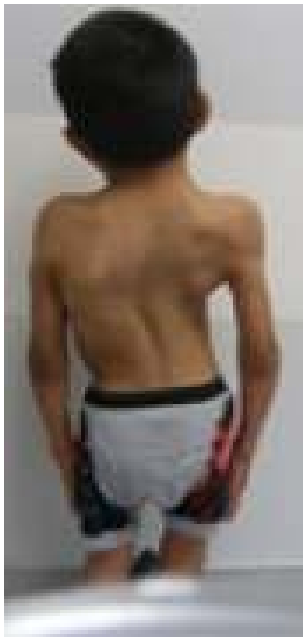

Figure (2): Clinical findings of early onset scoliosis. [18]

Figure (3): Prominence of the ribs to the left side [18]