EVALUATION OF DE-ROTATION IN CORRECTION OF ADOLESCENT IDIOPATHIC SCOLIOSIS

Thesis

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Abstract

Adolescent idiopathic scoliosis treatment has been highly influenced by the understanding of the biomechanics of the deformity. The three dimensions deformity correction with saggital, coronal and rotation correction is becoming the key for best results. The development of deformity correction instrumentation developed over five generations. Two techniques of derotation has been used, the simple rod derotation (SRD) and direct vertebral derotation (DVR). The DVR corrects the intervertebral rotation, which means it enables a three- dimensional correction in scoliosis surgery. The DVR was performed a segmental rotation using 2–3 anchors at the same time to avoid screw pull-out and for more effective derotation and DVR. The direction of the DVR is important and should be opposite to that of the vertebral rotation. In the right thoracic curve, the apical and juxta-apical vertebrae are rotated clockwise in the transverse plane as seen from a caudal position. The uppermost one or two vertebra has to be derotated opposite the direction of the thoracic DVR. On the lowermost one or two screws, however, the direction of DVR depends on the rotation of vertebra in the compensatory lumbar curve.

Key Words:

Pathological Anatomy of scoliosis, Classification of Idiopathic Scoliosis, Measurement of Vertebral Rotation, Vertebral De-rotation Techniques.

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AIS	Adolescent Idiopathic Scoliosis
ASC	All Screws Construct
CD	Cotrel-Dubuosset
DVR	Direct Vertebral Rotation
SRD	Simple Rod Derotation

INTRODUCTION

Idiopathic scoliosis is a multi-factorial, three-dimensional deformity of the spine and the trunk which can appear and sometimes progress during any of the rapid periods of growth in apparently healthy children. The clinical important biomechanical feature of scoliosis can be divided into initiation, progression and management of the curve.

Although the three-dimensional nature of the deformity has been recognized for a long time, lateral deviation in the frontal plane has been considered the main radiological diagnostic sign. It was recently that the importance of other planes deformities like the hypokyphosis in the saggital plane and the spinal/vertebral rotation in the axial plane. The assessment of the Cobb's angle is essential for diagnosis, follow up and evaluation of treatment results [1]. Although some data suggest that vertebral deformity is already present in scoliosis under10°[2], the Scoliosis Research Society (SRS) continues to define idiopathic scoliosis as a lateral deviation of the spine measuring 10° Cobb or more with a certain amount of rotation. Progression is defined as an increase of the Cobb angle over a particular period of time. The importance of frontal plane projection cannot be denied, although concentrating solely on this one-dimensional view of a complex scoliotic 3-D geometry may cause serious errors in diagnosis and subsequent treatment of AIS[3].

The clinically important biomechanical features of scoliosis can be divided into those that are important in the initiation, progression, and treatment of curves. The three dimensional nature of the deformity has been recognized since the original anatomic description of scoliosis.

Despite this, it is only in the last three decades that the importance of the associated deformities in planes other than the coronal has come to light. Other planes deformity like the hypokyphosis in the sagittal plane and the spinal/vertebral rotation in the axial plane. The non-coronal plane components of the deformity appear to have both etiologic and therapeutic significance.

Scoliosis deformity had been recognised at the ancient times. Hippocrates described the deformity and expressed appreciation of magnitude and progression of the deformity.

Treatment of scoliosis ranged from observation, bracing, surgical intervention which include soft tissue release and bracing or traction, in-situ fusion to stop the progression of the curve. And recently the goals of surgery shifted from only stop progression of the curve to correction, balancing and stabilization of the deformity.

Early techniques of correction was only addressing the coronal deformity this included Harrington in 1955, which is concave side distraction instrumentation. Segmental fixation started with Luque in 1970. The beginning of realisation of the importance of correcting the 3D deformity and addressing the coronal, sagittal and rotational deformity came with the CD instrumentation in the 1980s. Yet with the development of CD procedure and the segmental fixation techniques the correction and control of rotational vertebral deformity as well as rib hump prominence was still limited and even worse in some cases. The realisation of the fact that the global correction of the spinal rotation especially in rigid curve will push the vertebrae to the other direction which will essentially worsen the segmental vertebral rotation. With the advancement of pedicle screws as well as the development of the safe techniques of screw insertions in all thoracic and lumbar levels, more control could be achieved over the vertebral rotation and better results with the vertebral derotation as well as less need for thoracoplasty. To gain better control; pedicle screws gain more popularity over time. The fact that it is becoming easier and safer to use made it the default instrumentation in the treatment of AIS. This led to the development of the DVR manoeuvre procedure; which alongside ASC provided better correction and control of both coronal and rotational deformity of AIS. This made the results and expectations of surgical treatment of AIS much higher.

AIM OF THE WORK

In this study, we are aiming to focus on vertebral rotation. The effect of vertebral rotation on the deformity. The difference between the spinal rotation manoeuvre and its effect on the vertebral rotation. Exploring the different methods of measuring vertebral rotation, go through the different techniques of rotational correction. As well we are presenting our experience with the pedicle screws instrumentation and Direct Vertebral Rotation manoeuvre. We will compare our results of both coronal and rotational correction with similar studies and with the results of rod rotation manoeuvre with both the CD instrumentation and with ASC.

CHAPTER I

Pathological Anatomy of scoliosis

The three dimensional normal spine from C1 to S1 can be defined as follows: Seen from the coronal plane, the spine is perfectly aligned with perfect symmetry between the right and left sides. It is the same for the horizontal plane, where the vertebrae do not demonstrate any axial rotation. But on the sagittal plane, the normal spine is built with a succession of curvatures, with cervical lordosis followed by thoracic kyphosis and lumbar lordosis. The junction points between these sagittal segmental curves are smooth and progressive, leading to the harmonious sagittal contour of the human spine with apical zones that are distant from the gravity line and the junctional zones between the curves.

Pure coronal or pure horizontal deformities are almost never seen because of the sagittal curvatures that exist physiologically. Any lateral bending produces an automatic effect of rotation of the vertebra in the same direction as the bending because of the arrangement of the facet joints at the level of the functional unit. This phenomenon is well known and is called the coupling effect.[8,41] Hence, scoliosis is a complex three-dimensional deformity with lordosis, lateral deviation, and axial rotation of the spine.[1,2]

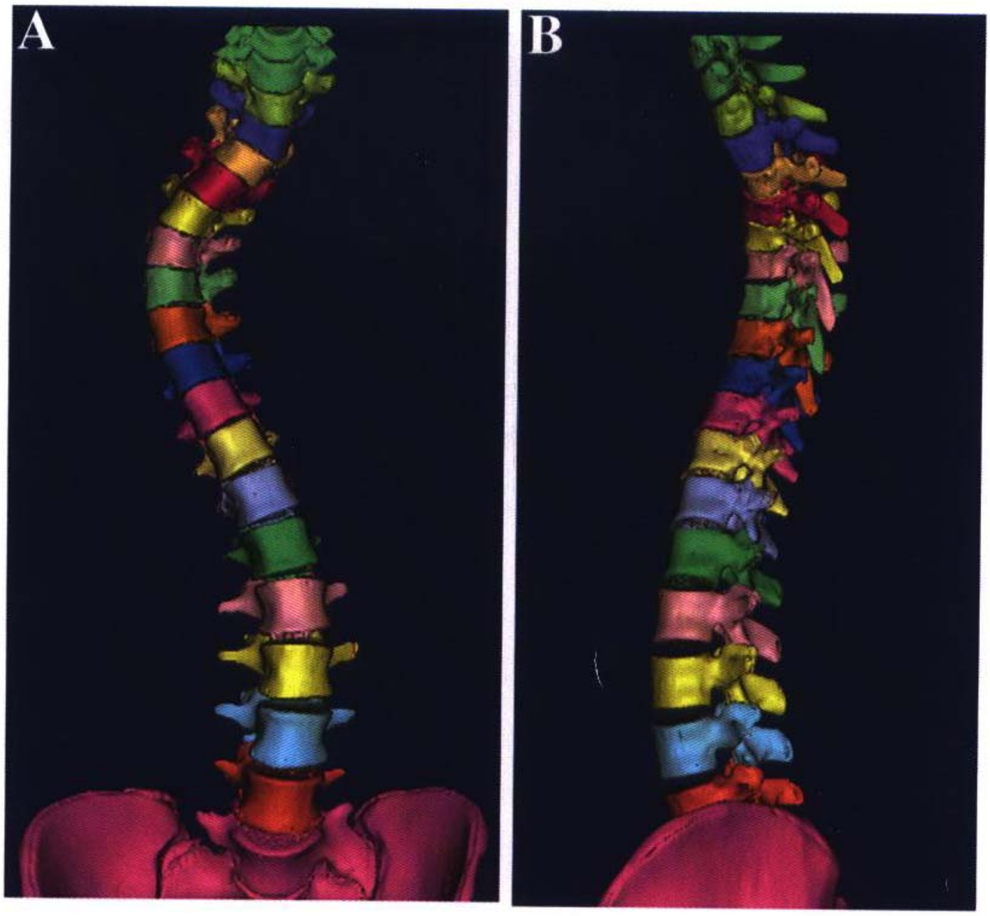

Fig. (1): ***Segmented 3D spine model. A: Frontal view. B: Lateral view. A segmented 3D model of the whole spine***

The earliest pathological changes that occur in adolescent idiopathic scoliosis are in the soft tissues. When scoliosis has been present for a period of time, certain specific deformities of the vertebral column and ribs occur. With progression of the curve, these deformities usually increase. In scoliosis in growing children asymmetric forces due to stress of shortened and tight soft tissues in the concavity of the curve are applied to the epiphyses, resulting in the vertebrae becoming deformed. The severity of these changes varies according to the forces applied to a particular vertebra, which again depends on the position of the vertebra in the curve. With lateral deviation of the spinal column, unilateral compression of the vertebra in the concavity of the curve will occur, and in accordance with Heuter-Volkmann`s law growth will be diminished on this side.[3,4] The compressive force on the vertebrae in the concavity will be maximal at the apex of the curve, and it's apical vertebra that becomes most deformed. The forces on those vertebrae at the ends of the curve, where the deformity is tending to return to normal, will be more balanced on the two sides of the body, and therefore there will be less deformity.

Anatomic Changes of the Vertebrae

In advanced cases of scoliosis the results of two changes, lateral bending and rotation, are quite evident and characteristic. At the apex of the curve the effect of increased pressure caused by lateral deviation results in a decrease in the height of the vertebral body on the concave side of the curve, producing a trapezoid shaped vertebra. The severity of this deformity will depend on the age at which the scoliosis first occurs.

Not only is the vertebral body affected, but these forces and rotation also act on the bony posterior elements. On the concave side of the curve, the pedicle is thin and the lamina is shortened and thickened, and decreased growth leads to narrowing of the vertebral canal on that side. On the convex side the pedicle becomes strong and stout. The transverse process is affected in a similar manner, being shorter and thicker on the convex side. The facets on the concave sides are compressed, deforming the joint and damaging the articular cartilage.[5,11]