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Surgical correction in AIS

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Keywords Double rods · Pedicle screw · High density · Surgical technique · Scoliosis surgery

Learning objectives

- To explain the concept of three-dimensional deformity correction in adolescent idiopathic scoliosis
- To explain the Lenke Classification of AIS
- To explain effects of translation on frontal, sagittal and axial planes
- To explain how direct vertebral rotation works

Introduction

Adolescent idiopathic scoliosis (AIS) is a three-dimensional deformity with coronal, sagittal and axial impairment. These deformities lead to clinical manifestations that include: trunk imbalance, shoulder height difference, rib-hump and thoracic hypokyphosis. The Lenke classification has progressively gained popularity and it is now recognized as the most reliable and complete classification for AIS [1]. The purpose of the surgical treatment is to correct the deformity obtaining a stable balanced spine preserving mobile segments of the lumbar spine when possible with restoration of good clinical alignment on all three planes [2].

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The aim of this paper is to schematically describe the concept of differently shaped rods translation and direct vertebral rotation for the surgical treatment of AIS.

Case description

We present two different cases of AIS as representative of the different techniques used for thoracic, such as Lenke type 1 and 2 curves and lumbar curves such as Lenke type 3 to 6.

Surgical strategy

The skin incision is made from one vertebra superiorly and one vertebra inferiorly to the planned fusion area, to allow the entire spine to be exposed. The facets and their articular process in the fusion area, except at the uppermost and the lowermost levels, are removed in order to facilitate the identification of the entry points, promote arthrodesis and allow an easier deformity correction.

Uniplanar pedicle screws are placed at each level on both sides of the curve using drill assisted technique. High-density system helps to distribute the applied forces during the translation and the direct vertebral rotation on more pedicles with lesser risks of screws pull-out or pedicle breakage. All screws should be placed with the same technique in an harmonic way according to the scoliotic curves [3]. The length of the rod is measured and each rod is bent using a rods bender according to the desired sagittal contour. In case of a main thoracic curve, the rod on the concave side is over-shaped, while the rod on the convex side is under-shaped. The apex of the main thoracic scoliotic curve and the apex of the desired thoracic kyphosis should be determined to achieve the desired rods shape.

Watch surgery online

Due to the different position of the desired thoracic kyphotic apex and the main rotated vertebrae at the scoliotic apex, the over-shaped rod on the concave side remains far distant in two parts including: the apex of the thoracic kyphosis and the zone of maximum rotation of the scoliotic curve; while the under-shaped rod on the convex side remains adjacent to the screw heads in the zone of maximum rotation and far distant from the screw heads on the apex of the thoracic kyphosis at the same level of the other rod on the concave side. At the desired kyphotic apex, both rods must be placed far from the screw heads with low height differences with the aim to restore height. On the contrary, at the apex of the scoliosis curve high height differences with low maximum height must be present in order to restore rotation. In this way while the force is applied to reduce the rod on the screws' head on the concave side, vertebral bodies rotate toward the concave side and vertebral rotation on the axial plane is achieved consequently.

In case of double curves at the level of thoracic and lumbar spine including Lenke 3 to 6 scoliosis curve types, the over-shaped rod is applied on the concave side of the thoracic curve, and on the convex side of the lumbar curve; while the under-shaped rod is applied on the convex side of the thoracic spine and concave side of the lumbar spine. The over-shaped rod on the concave thoracic side remains far distant in two parts including: the apex of the thoracic kyphosis and the zone of maximum rotation of the scoliotic curve, and adjacent to the zone of maximum rotation of the lumbar curve. Instead the under-shaped rod on the convex thoracic side remains adjacent to the screw heads in the zone of maximum rotation and far distant from the screw heads on the apex of the thoracic kyphosis and at the apex of the lumbar lordosis. In these cases, the aim should be to restore rotation at the lumbar level without lowering the lumbar lordosis.

For direct vertebral rotation, the neutral vertebrae are kept stable while the other vertebrae are rotated in a clockwise direction applying a downward and lateral force on the convex side and lateral force on the concave side. This maneuver is a critical part of the correction and neurological monitoring should be performed continuously. When the desired axial correction is achieved, the crickets should be reduced completely in order to complete translation and tighten the rods to maintain the correction.

Postoperative information

For the first 6 weeks after surgery we use a brace to restrict spinal movements and allow initial bone graft fusion. The patient is able to leave the hospital 7 days after the surgery and he is then followed-up at 1, 3 and 6 months and then yearly.

Discussion and conclusion

Aim of this study was to present a corrective strategy using differently shaped rods translation and direct vertebral rotation for the two main different categories of AIS curves.

The rib hump deformity caused by the axial rotational of the vertebrae is an important element of AIS because it is strictly related to the patient's self-image. Several techniques such as translation and DVR have been proposed in order to avoid thoracoplasty procedure and its related complications such as prolonged surgical time, haemothorax and pleural effusion [4]. According to the recent literature, the derotation effect obtained using DVR technique only is between 37 and 63% [5, 6]. Clement et al. [7] first described the translation technique using high-density pedicle screws reporting good clinical and radiological results especially on the sagittal plane, however, they did not use differently shaped rods. We believe that the combination of the translation technique with differently shaped rods and DVR allow good three-dimensional correction of the deformity while reducing the risk of screw pullout at the time of DVR due to the wider distribution of forces on more pedicles and in separate surgical steps [2, 8]. In this paper and in its related video, a step-by-step procedure has been presented in order to explain surgical tricks for AIS deformity correction in different scoliosis curve types.

Compliance with ethical standards

Conflict of interest The authors declare no conflicts of interest.

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