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Editorial

Anterior scoliosis surgery the state of art procedure

1. Introduction

The indications for surgical treatment for scoliosis are, severe curve, cosmesis, failure of brace treatment, associated thoracic lordosis and pain. The results of surgery provide several benefits to the patient. Once spinal fusion is mature, there is no significant threat of further progression of curve.^{1,2} In posterior instrumentation the corrective forces are applied from the posterior complex which is far away from the original site of deforming force which is at the vertebral bodies. The mechanical advantage of applying the corrective forces at site of deforming force (i.e., the anterior complex) is lost if posterior instrumentation and fusion alone is chosen.³

2. Evolution of anterior spinal instrumentation

Dwyer, et al, reported using anterior instrumentation. Anterior fusion with special instrumentation was first introduced by Dwyer et al in 1969.⁴ The introduction of anterior scoliosis surgery by Dwyer et al⁴ provided a powerful innovative method of deformity correction in the spine. It merely produced compressive force between vertebral bodies, but pseudarthrosis rate was high.⁴ In thoracic scoliosis, posterior instrumentation has been the main component of surgical management. They believed that scoliotic deformities could be approached in two ways, either by stretching the concave side of the curved column or by shortening the long convex side. Titanium screws were inserted into the VB on the convex side. With the aid of plates over these screws, a titanium cable is threaded through the screw heads, and device. By continuing this process down each level of the spine, a bent column would become straighter. Their patients wore a jacket to restrict movement for up to 3 months postoperatively.⁴

The development of Zielke instrumentation resulted in greater correction of deformities than previous techniques. Zielke instrumentation has been associated with high rate of implant failure and pseudarthrosis. This method improved on the Dwyer technique by requiring that the VB screws be placed more posterior to enhance the derotation effect and reduce the incidence of iatrogenic kyphosis. Because anterior techniques do not require for instrumentation and fusion of

long segments as posterior techniques, the incidence of fall-back deformity is reduced but implant failure was high.⁵

In an attempt to overcome these shortcomings, next-generation anterior instrumentation, which involves a dual-rod technique, was introduced. The Kaneda system involves the placement of two screws in each VB that are attached to two rods; this system allows for better derotation and creates a biomechanically stronger construct. Anterior approaches are useful for thoracolumbar curves down to L-5 but cannot be used alone if there is a significant thoracic kyphosis.^{6,7} Kaneda anterior instrumentation was developed with excellent results.^{6,7} The advantages of anterior correction in scoliosis involves better deformity correction, correction of deformity at the site of deformity and maximum motion segment preservation by short segment fusion. The other anterior instrumentation system used in scoliosis include, USS, Texas Scottish Rite system and ISOLA system.³

In the 1990s further developments in the fields of surgical endoscopy led to the application of thoracoscopy to spinal surgery. Video-assisted thoracoscopy has been used to perform anterior release as well as anterior fusion and stabilization in cases of spinal deformity. Morbidity seems to be reduced with this approach. Further studies are necessary to validate the effectiveness of this newer technology.⁸

Idiopathic scoliosis is the most common type of spinal deformity confronting orthopedic surgeons. Its onset can be rather insidious, its progression relentless, and its end results deadly. Proper recognition and treatment of idiopathic scoliosis help to optimize patient outcomes. Once the disease is recognized, effective ways exist to treat it.⁹

Kaneda et al,^{6,7} using KASS (Kaneda Anterior Spinal Stabilization System) anterior instrumentation and fusion reported a post operative Cobb angle of 19° after surgery, with a correction rate of 75%. In anterior only surgery, Kaneda et al reported a thoracic kyphosis change from 33° to 36° and lumbar lordosis change from 48° to 47° which are not statistically significant.⁷ Average 6° loss of correction in the frontal and 8° correction in the sagittal plane has been reported in single rod anterior system. Kaneda et al⁷ reported 1.2° coronal and 1° sagittal plane loss of correction with dual anterior rod system in the lower thoracic and lumbar region.^{6,7} Posterior instrumentation alone needs fusion of more segments with ensuing back pain due to degeneration with an average fusion rate of 10 segments. This is higher when compared to

posterior approach only study results.¹⁰ Few reports of significant implant failure rate of 31% and pseudarthrosis rate of 23% in anterior only correction. To best of the knowledge none of the studies till date has mentioned the incidence of screw pull out in anterior scoliosis surgery.^{11,12} In a study by Brodner et al the patient group with thoracolumbar scoliosis anterior correction for the average 40° curve, the segments fused were 5.6 segments on an average. average number of segments fused was only 5 which is lower than the other studies where anterior only surgery was done.¹³

Anterior correction of scoliosis in adolescent idiopathic scoliosis group in the thoraco lumbar and lumbar spine has already been reported with good results^{14–16} with less implant problems, more rapid healing and lower pseudoarthrosis rate than posterior instrumentation and fusion, even with vertebral screws. With Kaneda Anterior Spinal Stabilization System (KASS), to correct the deformity with a rod rotation maneuver.^{6,7} The fusion segments were in the area of Cobbs angle. Number of segments fused was less than that of Posterior fusion. Even though thoracic curves are severe, reports of thoraco-lumbar and lumbar curves treated by anterior instrumentation is prevalent in literature.^{6,14–16}

It has been reported that dual rod system with two screws are more rigid than single rod system for anterior surgery.^{6,7} However all dual rod systems require placement of 2 screws in each segment. This may be impossible in smaller thoracic vertebrae in a child. In 2 screw system, staple is usually a must, which needs ligation of segmental vessel at every level. In single screw system, selected segmental vessels may be saved from ligation. This avoids the danger of ischemic cord necrosis, especially when the vessel to be ligated is the artery of Adamkewicz, which gives the major blood supply to the spinal cord.⁷ Kaneda et al reports a 50% correction of rib hump which is slightly higher than that in other studies.⁷ Kaneda et al also reports a case of secondary decompensation which was successfully managed by brace treatment, just like in other series.⁶

3. Pulmonary function

Studies shows that the reduction in pulmonary function is temporary in anterior scoliosis surgery. Pre operative pulmonary function test in this study showed a FEV1/FVC ratio of an average 88 and immediate post operative value decreased by an average 5 (5.7%). FEV1/FVC ratio on 1 year follow up showed return of the value to preoperative status.¹⁷ To the best of the knowledge none of the studies till date have compared the pre and post op FEV1/FVC ratio. Which is a better predictor of pulmonary function.

4. Special features of thoracic curve

Thoracic spine is connected to the ribs by the costo transverse and rib head articulation of the vertebra. This forms a rigid anatomical structure compared to thoraco lumbar or lumbar spine. The thoracic scoliosis is more rigid than thoracolumbar or lumbar curves for the same reasons.¹⁸ Rib head resection with rod rotation maneuver makes the thoracic spine less

rigid.⁶ Oda et al¹⁹ reported biomechanical role of costovertebral articulation and the rib cages in the stability of thoracic spine and concluded that these were the significant stabilizers in lateral bending and axial rotation. Anterior release and rib head resection makes the curve less rigid.⁶ So a high rate of correction can be obtained with shorter segment fusion, compared to posterior procedure, by rib head resection, derotation after anterior release. Dickson et al²⁰ stressed that the axial plane rotational deformity has got its own importance when attempting sagittal and coronal plane correction. Kaneda et al reported good results without any incidence of implant failure, with no evidence of pseudoarthrosis even with single screw single rod system.^{6,7}

Turi et al reported good results in another study with single rod anterior instrumentation.²¹ It has been reported that⁶ dual rod system with two screws are more rigid than single rod system. However all dual rod systems require placement of 2 screws in each segment. This may be impossible in smaller thoracic vertebrae in a child. There is increased risk of canal penetration in 2 screw systems against in 1 screw system. In 2 screw system, staple is usually a must, which needs ligation of segmental vessel at every level. In single screw system, selected segmental vessels may be saved from ligation.¹⁷ This avoids the danger of ischemic cord necrosis, especially when the vessel to be ligated is the artery of Adam Kewicz, which gives the major blood supply to the spinal cord. In a study by Brodner et al¹³ the patient group with thoracolumbar anterior correction for the average 40° curve, the segments fused were 5.6. This resulted in half the levels to be fused when compared to posterior fusion. Average 6° loss of correction in the frontal and 8° correction in the sagittal plane has been reported in single rod system.²² Kaneda et al reported 1.2° coronal and 1° sagittal plane loss of correction in the thoracic spine.⁶ (But was with dual rod system in the lower thoracic and lumbar region) The correction loss in other studies were-loss of 1° in the coronal and 0.5° in the sagittal plane (in to hypokyphosis) respectively.¹⁷ This is probably due to newer segmental single rod systems used in this study. This may confirm the usefulness of single screw single rod system in the thoracic spine anteriorly. Suggestion of athletic activity after scoliosis surgery is a matter of debate.²³ Bridewell et al studied 82 patients with adolescent idiopathic scoliosis (right thoracic scoliosis) treated by CD instrumentation using posterior derotation maneuver.²⁴ They found 8 patients with gross decompensation on follow up. Majority were type II curves. They stated that in type II curves, too much correction of the primary thoracic curve beyond the flexibility of the lumbar curve may produce decompensation. Schlenzke²⁵ et al compared the radiographic outcome of Harrington rod and CD instrumentation. They stated that rotation was unchanged in Harrington group. But rotation was increased in CD group in comparison to pre-operative assessment.²⁶ This indicates that derotation maneuver transfers the rotation to the un instrumented lumbar curve. In anterior correction of scoliosis also the same principle applies. So it could cause decompensation of the lumbar compensatory curve if it has rotary elements or if the thoracic curve is too rigid in stress films.²⁴ Over correction of thoracic curve should be prevented so that decompensation will not occur. In type III and IV curves, thoracic correction is enough for overall curve correction.

5. Conclusion

Anterior correction with fusion of adolescent idiopathic scoliosis, leads to curve correction which is better when compared to the correction obtained by posterior only surgery. There is no incidence of excess kyphosis, implant failure, gross loss of correction or pseudoarthrosis (which is the major drawbacks of posterior alone instrumentation and fusion) on follow up. Less number of motion segments are fused when compared to posterior alone instrumentation and fusion. The effect of scoliosis surgery on pulmonary function is transient. The outcome of anterior scoliosis surgery in studies is consistent in the literature. Anterior thoracoplasty is a usual adjunct for better cosmetic results may not be needed with the current system of anterior instrumentation.

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