

Anterior Technique in Spinal Deformity Correctional Surgery

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ABSTRACT

The aim of this review is to classify spinal deformities, provide knowledge in correctional surgery of spinal deformities and highlight the anterior technique. PubMed and Medline database search was performed for published articles up to October 2017 related to surgical techniques for spinal deformities. Spinal deformity may be the pathology of one vertebra or may develop with pathologies of multiple vertebrae, ribs or the pelvis. The spine must be analyzed in different planes before starting the treatment because it can be accompanied by multiple organ pathologies. Different surgery types can be used and anterior method is one of them, which can give better result in cases with advanced kyphosis. The therapy of serious spinal deformity is challenging and needs a careful analysis of the patient by the orthopedic surgeon, anesthesiologist, pulmonologist, and neurologist especially when neurologic deficits are existing.

Keywords: Anterior Technique , Spinal Deformity.

INTRODUCTION

The vertebral column is an accumulation of articulated, superposed segments, each of that is a functional system. The function of the vertebral column is to support a person in upright placement, mechanically equilibrium to satisfy the stress and anxiety of gravity, allow mobility as well as aid in deliberate activities ^[1].

The head lies over the body of the sacrum, and also the vertebrae in an upright way carries an axial load to hold the human body. Loss of this vertebral equilibrium creates a placement that goes to a biomechanical negative aspect. To stand upright and also look ahead while standing and also strolling, the patient with sagittal plane discrepancy creates back muscle to stress to efficiently or unsuccessfully minimize a patient's sideways tilt ^[2]. The added power expense related to standing and strolling in the patient with a spine defect causes lowered useful capability consisting of lung function and also a poorer lifestyle.

The description and also range of vertebral defect remains to develop. Definitely, the term spine defect consists of problems such as idiopathic adolescent scoliosis, congenital scoliosis, post-traumatic defects and also various other grown-up vertebral defect consisting of post-infective kyphosis. In our community, among one of the most typical extreme defects is the post-infective kyphosis specifically in the much less privileged places ^[3]. In old times, Hippocrates and also his followers dealt with

scoliosis by traction as well as counter-Traction on his bench, and also Ambroise Paré, in

the 16th century, was attributed with explaining the 1st use supporting to deal with scoliosis. The standard approaches to therapy throughout the ages have actually included traction, support and also essentially strenuous redressing plus workout and also massage therapy. In 1911, **Hibbs *et al.*** ^[4], as well as **Albee *et al.*** ^[5], presented their spine fusion for tuberculosis of spinal column, then fusion approach was used for scoliosis management. Nonetheless, there was no constant progression in the management of vertebral defect up until 1945 when **Smith-Petersen** ^[6] presented a spine osteotomy treatment which was customized by the numerous specialists. One negative aspect for surgeons at the time was that interior fixation tool for the osteotomy was not readily available. In 1955, **Harrington** presented the hooks as well as poles system which revolutionized the defect improvement surgical treatment. Halo disturbance device, established by **Nickel and Perry** in 1959 could be used for a seriously flawed as well as stiff spinal column ^[7].

Spine is one the most important structure in the anatomy of the human body that provides balance. The aim of this review is to classify spinal deformities, provide knowledge in correctional surgery of spinal deformities and highlight the anterior technique ^[8].

METHODOLOGY

PubMed and Medline database search was performed for published articles up to October, 2017 related to surgical techniques for spinal deformities. More articles to identified in alternative correctional surgical technique of spinal deformities. The search strategy was limited to clinical studies with human subject published in the English language, the following MeSH terms used in our search strategy: “minimally invasive”, “surgery”, “spine”, “deformity”.

• Data Sources and Search terms

We conducted this review using a comprehensive search of MEDLINE, PubMed, EMBASE, Cochrane Database of Systematic Reviews, and Cochrane Central Register of Controlled Trials up to October, 2017 for published studies in English language and related to surgical techniques for spinal deformities. More articles to identified in alternative correctional surgical technique of spinal deformities. The following MeSH terms used in our search strategy: “minimally invasive”, “surgery”, “spine”, “deformity”.

• Data Extraction

Two reviewers independently reviewed studies, abstracted data, and resolved disagreements by consensus. Studies were evaluated for quality. A review protocol was followed throughout.

The study was done according to the ethical board of Jazan university.

DISCUSSION

• Classification

It is feasible to examine spine deformities [9] as congenital vertebral defects and also idiopathic vertebral defects. Congenital vertebral deformities are categorized in accordance with the etiology. Due to the absence of any kind of well-known etiology for adolescent spine defects, different categories have actually been made in accordance with medical and radiological indicators. Degenerative spine defects seen in the advanced age teams should likewise be stated besides these 2 teams.

Congenital vertebral deformities: Congenital spine defects usually existing at really young ages. These are viewed as an outcome of the development problems of the vertebrae, division flaws, or development and also division problems both.

1. **Formation deformities:** These are defects that establish in connection with insufficiencies of the embryological components needed for the advancement of a regular vertebra. They have a vast range varying in between easy occult spina bifida to numerous hemivertebrae. Dimension, localization as well as sort of the flaw can be totally occult, or the problem can be a really intricate defect with really severe defects as well as neurologic problems.
2. **Segmentation deformities:** The most constant kind is the unsegmented bar, which is a segmentation deformity that includes one vertebra unilaterally or that encompasses greater than one segment as well as includes various locations. The unsegmented bars, which are most often seen in the thoracic area, create medical symptoms based upon the development capacity of this area.

Idiopathic spinal deformities: deformities in this group are those mostly seen in the adolescent period [10]. Many subtypes can be mentioned within this group. The most frequently seen types are listed below.

1. Infantile scoliosis
2. Juvenile scoliosis
3. Adolescent scoliosis
4. Adult scoliosis

Defects in this team are those mainly seen in the adolescent time frame [10]. Numerous subtypes can be stated within this team. One of the most often seen types are mentioned below.

Back defects in the pediatric age could establish in a relationship with congenital abnormalities, neuromuscular problems, neurofibromatosis, connective tissue conditions or skeletal dysplasia. Idiopathic scoliosis is one of the most typical type, as well as it is detected after getting rid of the generalized disorders, and also congenital or inflammatory reasons. Idiopathic scoliosis is a pathology that could have a family trait and also reveals bimodal dissemination.

Adolescent scoliosis and also adult scoliosis [11] vary from each other as concerns the medical indications, radiologic outcomes, therapeutical strategies as well as diagnosis. Consequently, numerous categories of AIS have actually been created.

Table 1: Classification of Spinal Deformities Based on Etiology ^[12].

Idiopathic	Congenital	Neuromuscular
Early onset	Abnormal segmentation	Neuropathic diseases
Late onset	Vertebra abnormality	Upper motor neuron disease
Adult	Formation abnormality	Spinocerebellar degeneration
Developmental Syndromes	Hemivertebra	Cerebral palsy
Skeletal system dysostosis (such as Neurofibromatosis)	Unilateral bar	Lower motor neuron disease
Skeletal system dysplasia (like osteogenesis imperfecta)	Rib fusion	Poliomyelitis
Tumoral:	Spinal dysraphism	Myopathic
Osteoblastoma	Tight spinal cord syndrome	Congenital hypotonia
Osteoid osteoma	Chiari malformation	Duchenne’s muscular dystrophia
Intraspinal-intramedullary tumors	Syringomyelia	
Extramedullary tumors	Tethered spinal cord syndrome	

King Classification

This is a category system created to identify the thoracic fusion degrees in AIS. King has actually promoted that lumbar, as well as sacral pathologies, could be fixed extra conveniently if the fusion section in the thoracic area is chosen properly, and also focused on establishing the quickest and one of the most exact thoracic blend segment. This category does not consist of the thoracolumbar, lumbar dual significant and also triple significant scoliosis. Assessment of the coronal system as well as overlooking the sagittal plane at the same time as well as minimal variety of functioning viewers are the problems that have actually been slammed ^[13].

Lenke Classification

Lenke et al. established the Lenke category along with SRS ^[14]. In the developing stage of this category system, incorporation of all the scoliotic sections in the coronal, as well as sagittal planes, was focused on. It consists of 6 significant teams as well as 2 extra teams based upon adjustments in the thoracic and also lumbar regions. Treatment all the scoliotic sectors in AIS, enabling assessment on 2 planes, recommending the fusion sector and also suggesting the sections that fusion must be prevented.

Schwab Classification

This is the category system established by Schwab and also coworkers with a medical research they accomplished on 947 grownups with spine

defects ^[15]. This category radiologically reviews the frontal Cobb angle, the apex of the defect, lumbar lordosis and intervertebral subluxation. This category system has actually been developed based upon 3 standards.

SRS classification

The significance of all these scoliosis categories consists of the standardization of the interaction in between medical care specialists and making the analysis and also therapy methods much easier. While the Lenke category is presently one of the most regularly applied AIS category, SRS category takes top place in grown-up scoliosis instances with the richness of the information, the Schwab category is favored due to the medical relevancy, and also the Aebi category is favored due to the simplicity in usage ^[16].

- **Physical examination**

Because vertebral defect is a predicted problem in patients with congenital spine pathologies, medical diagnosis is normally feasible with medical follow-up. In the idiopathic spine defects nevertheless, the medical diagnosis is typically postponed. Background, as well as checkup in a patient offering with back defect, will certainly be extremely valuable in distinguishing the second reasons for the spine defect. Family history, menstrual cycle condition, visibility of discomfort, neurological modifications and also any kind of intestinal tract or

bladder disorders should be doubted. Neurologic searching for as well as the extent of the discomfort will certainly provide a concept concerning the seriousness of the defect. The Tanner phases and also neurological evaluation have to be performed totally in the physical exam of the situations with scoliosis^[17].

The physical exam begins in the standing setting and also from the behind. Back equilibrium is examined with 2 techniques:

1. A plummet line-passing tangent to theinion or the vertebra prominent is taken to identify range in between the line as well as the congenital slit. If this range in between this line as well as the congenital cleft goes beyond 2 centimeters, idiopathic scoliosis or a neural problem need to be considered.

2. The distance between the line drawn from the thoracic area with the maximum width and the congenital cleft will be measured. The measured value shows the decompensation of the body.

The symmetry between the shoulder heights and symmetry of the body are evaluated with inspection. The spinous processes will be palpated from cervical to sacral areas and the grade of scoliosis and rotation will be evaluated. In addition, it will be determined whether or not that there are any missing spinous processes.

- **The essential preventative measures with surgical management are:**

1. Cautious preoperative patient's examination.
2. Gentle and cautious cord exposure.
3. Best care and special need to be paid in insertion of hooks, cables, and also screws and the invasion of screws ought to be low when possible
4. In case of anterior surgical treatment, the vessel ligation need to be done just on one side and constantly on convexity.
5. Extreme distraction must never ever be done due to the fact that inadvertent stretch and kinking may quickly harm cord circulation.
6. Cord observation and/or wake-up examination must be done throughout surgical treatment
7. Hypotension must be prevented throughout surgical treatment to preserve the typical blood circulation to the cord.

- **Surgical treatment**

The basis of the medical therapy of scoliosis includes decrease and also fusion. Fusion application in scoliosis surgical treatment has actually been

understood for a while. **Hibbs** released his collection of 59 patients with scoliosis that he managed with fusion applying autogenic bones with a posterior method in 1924^[18].

A number of alterations of back fusion were defined by **Hibbs**^[18] Various alternatives consisting of bovine bone graft, autogenic bone graft and also rib grafts have actually been pursued spine fusion^[19]. Various rates of contentment were gotten in various collection in later durations. While just posterior treatments were specified in the very early durations, the anterior treatment was reported very first time by William von Lackum and also associates along with these advancements^[20].

In the 2nd half of the twentieth century, the inner instrumentation system created by Dr. Harrington was applied successfully for long years in the medical therapy of vertebral defects^[21, 22]. Later on, Harrington applied his system he had actually applied on a poliomyelitis patient for the very first time on various other instances with various other defects. Harrington did not perform fusion in his preliminary treatments and experienced some issues connected to crucial failings; in later phases, he included the fusion to instrumentation as well as acquired a lot more effective outcomes^[21, 22]. Regular use pedicle screws in thoracic as well as lumbar vertebrae and also the application of osteotomy techniques like Smith-Peterson have actually led to vital renovations in back defect surgical treatment. Although the standard concepts are the same as of today, the adhering to treatments are applied for congenital as well as idiopathic scoliosis.

- **Surgical approach in congenital spinal deformities**

There are no criteria for the therapy of congenital vertebral defects. Numerous aspects consisting of the kind of the pathology that triggers the defect, bone maturation of the patient and also standing of the neurological injury identify the medical therapy to be utilized. Intra-channel pathologies or neural problems are normally contributed to the defect in congenital scoliosis. Straight stepping in the defect in such instances could raise the neural damages, in addition to triggering neural problems^[23]. Because the vertebral canal is typical in idiopathic defects, the therapy method as well as timing in such patients are established by the defect degree, patient's age and also aesthetic assumptions. Nevertheless, the

excellent therapy in congenital vertebral defects consists of very early medical fusion prior to the development of the defect or modification in cases with extreme defects.

The surgical options include the following: 1- Posterior fusion, 2- Anterior fusion, 3- Combined anteroposterior fusion, 4- Hemivertebra excision, and 5- Spinal osteotomy and fusion.

Anterior fusion

Anterior fusion application is just one of the choices applied in vertebral defect instances. It is applied to grown-up patients as well as pediatric situations where improvement with the posterior method is difficult. Discectomy, as well as corpectomy, can be carried out with anterior or anterolateral strategies on the vertebral bodies that consist of the pathologic sector. The anterior method could give far better modification in cases with advanced kyphosis, while it likewise attends to a risk-free functioning setup for the security of the spine. Although they are not as typical as the posterior fusion strategies in the scoliosis surgical treatment, anterior fusion strategies are additionally applied. In this treatment that is used in the retroperitoneal technique, in thoracotomy, and also the thoracoabdominal technique, interbody fusion is carried out at the discectomy or corpectomy websites, and also is lowered along with the former body screws. The largest benefit of this treatment, which is favored for Lenke Types IA as well as IB, as compared with the posterior fusion strategies is that it attends to the participation of fewer degrees in the combination sector by 1.2 to 1.5 typically^[24, 25]. Nevertheless, it has actually been reported that kyphosis is a lot more typical in the long-term in patients where anterior fusion alone has actually been applied, and also the resistance against axial rotational motions is much less^[24, 25].

The anterior strategy should be prevented in cases with high thoracic scoliosis, lung lacks, or if could not endure big quantities of hemorrhaging^[26].

CONCLUSION

Spinal deformity may be the pathology of one vertebra or may develop with pathologies of multiple vertebrae, ribs or the pelvis. The spine must be analyzed in different planes before starting the treatment because it can be accompanied by multiple organ pathologies. Different surgery types can be used and anterior method is one of them, which can

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REFERENCE

1. **Lonstein JE, Winter RB, Bradford DS, Ogilvie JW(1995):** Moe's textbook of scoliosis and other spinal deformities. 3rd ed. Philadelphia: Saunders.
2. **Herring JA(2002):** Tachdjian's pediatric orthopaedics. 4th ed. Philadelphia: Saunders Elsevier.
3. **Marieb EN(1998):** Human anatomy and physiology. San Francisco: Benjamin Cummings.
4. **Hibbs RA(1911):** An operation for Pott's disease of the spine. J Am Med Assoc. ,59:433–6.
5. **Albee FH(1911):** Transplantation of a portion of the tibia into spine for Pott's disease. J Am Med Assoc. ,57:885–6.
6. **Smith-Petersen MN, Larson CB and Aufranc OE (1945):** Osteotomy of the spine for correction of flexion deformity in rheumatoid arthritis. J Bone Joint Surg., 945:27:1–11.
7. **Perry J and Nickel VL(1959):** Total cervical spine fusion for neck paralysis. J Bone Joint Surg Am. ,41:37–60.
8. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3392017/>
9. **Lenke LG, Betz RR, Harms J(2001):** Adolescent idiopathic scoliosis: A new classification to determine extent of spinal arthrodesis. J Bone Joint Surg Am., 83: 1169–1181.
10. **Joseph A, Benjamin A (2007):** Scoliosis: Review of diagnosis and treatment. Paediatr Child Health, 12(9): 771–776.
11. **King H, Moe J, Bradford DS(1983):** The selection of fusion levels in thoracic idiopathic scoliosis. J Bone Joint Surg Am .,65: 1302-1313.
12. **Lowe T, Berven SH, Schwab FJ, Bridwell KH(2006):** The SRS classification for adult spinal deformity: Building on the King/ Moe and Lenke classification systems. Spine, 31:119-125.
13. **Cummings RJ, Loveless EA, Campbell J, Samelson S, Mazur JM(1998):** Interobserver reliability and intraobserver reproducibility of the system of King et al. for the classification of adolescent idiopathic scoliosis. J Bone Joint Surg Am., 80:1107–1111.
14. **Lenke LG, Betz RR, Harms J(2001):** Adolescent idiopathic scoliosis: A new classification to determine extent of spinal arthrodesis. J Bone Joint Surg Am., 83: 1169–1181.
15. **Schwab F, Benschick el-Fegoun A, Gamez L(2005):** A lumbar classification of scoliosis in the adult patient: Preliminary approach. Spine, 30: 1670–1673.

16. **Lowe T, Berven SH, Schwab FJ, Bridwell KH(2006):** The SRS classification for adult spinal deformity: Building on the King/ Moe and Lenke classification systems. *Spine*, 31:119-125.
17. <https://www.ncbi.nlm.nih.gov/pubmed?db=pubmed&cmd=link&linkname..>
18. **Hibbs RA(1924):** A report of 59 cases of scoliosis treated by the fusion operation. *Journal of Bone and Joint Surg.*, 6: 3-7.
19. **Brown LT(1922):** Beef bone in stabilizing operations of the spine. *J Bone and Joint Surg* .,4: 711.
20. **Leatherman KD, Dickson RA(1979):** Two-stage corrective surgery for congenital deformities of the spine. *J Bone Joint Surg Br.*, 61: 324–328.
21. **Harrington PR(1962):** Treatment of scoliosis. Correction and internal fixation by spine instrumentation. *J Bone Joint Surg Am.*, 44: 591–610.
22. **Harrington PR(1973):** The history and development of Harrington instrumentation. *Clin Orthop Relat Res.*, 93: 110–112.
23. **Arlet V, Odent T, Aebi M(2003):** Congenital scoliosis. *Eur Spine J.*, 12: 456-463.
24. **Kuklo TR, Lenke LG, Won DS, Graham EJ, Sweet FA, Betz RR, Bridwell KH, Blanke KM(2001):** Spontaneous proximal thoracic curve correction after isolated fusion of the main thoracic curve in adolescent idiopathic scoliosis. *Spine*, 26: 1966–1975.
25. **Kuklo TR, O'Brien MF, Lenke LG, Polly DW, Sucato DS, Richards BS, Lubicky J, Ibrahim K, Kawakami N, King A(2006):** Comparison of the lowest instrumented, stable, and lower end vertebrae in “single overhang” thoracic adolescent idiopathic scoliosis: Anterior versus posterior spinal fusion. *Spine*, 31: 2232–2236.
26. **Betz RR, Harms J, Clements DH 3rd, Lenke LG, Lowe TG, Shufflebarger HL, Jeszenszky D, Beele B(1999):** Comparison of anterior and posterior instrumentation for correction of adolescent thoracic idiopathic scoliosis. *Spine*, 24:225–239.