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POSTERIOR SEGMENTAL INSTRUMENTATION AND FUSION WITH HIGH DENSITY ALL POLYAXIAL PEDICLE SCREW CONSTRUCT IN THE TREATMENT OF ADOLESCENT IDIOPATHIC SCOLIOSIS – SINGLE CENTER STUDY

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SUMMARY

Idiopathic scoliosis is the most common type of spinal deformity in children and adolescents. This type of spinal deformity accounts for about 65% of cases. In contrast, about 15% are congenital and about 10% are secondary to neuromuscular disease. The rest are rare cases of spinal deformities as part of some syndromes. This retrospective study of 14 adolescent idiopathic scoliosis patients was performed to analyze the effectiveness of high density thoracic and lumbar all-polyaxial pedicle screws and rods construct in patients undergoing surgical correction of adolescent idiopathic scoliosis (AIS).

The studied group of patients included 12 female and 2 male patients, average age 16.8 years (12-25 at the age of surgery). The used implants were polyaxial pedicle screws and titanium-alloy rods. A combination of scoliosis correction maneuvers (rod translation, rod derotation, segmental direct vertebral derotation, compression-distraction and in-situ bending) were used depending on the individual case. Standard preoperative and postoperative scoliosis x-ray films with PA and lateral views were used for assessment of radiographic parameters. The follow-up period was in average 22.5 months (6-48 months).

We analyzed preoperative and postoperative Cobb angle, coronal balance, thoracic trunk shift, apical vertebral translation, clavicle angle, shoulder height, thoracic kyphosis, lumbar lordosis and overall sagittal balance. The initial results showed that the obtained correction of the scoliotic curve was significant. This was reflected through improvement of the analyzed radiographic parameters.

Key Words: *high density construction, idiopathic scoliosis, polyaxial pedicle screw*

Introduction

Idiopathic scoliosis is the most common type of spinal deformity in children and adolescents. This type of spinal deformity accounts for about 65% of cases. In contrast, about 15% are congenital and about 10% are secondary to neuromuscular disease. The rest are rare cases of spinal deformities as part of some syndromes.

Idiopathic scoliosis is a complex three-dimensional spinal deformity, with curvature on the side of a part of the spine, in the shape of the letter "S" or "C", greater than 10 degrees (measured radiographically according to Cobb's method), with simultaneous rotation of the vertebrae around the vertical axis. This type of spinal deformity lacks congenital anomalies in the formation and segmentation of the vertebrae.

The present rotation of the vertebrae makes the difference between the so-called structural curves and compensatory curves of the other parts of the spine.

Although the exact cause of this deformity cannot be confirmed (idiopathic scoliosis), in recent years, in the framework of basic research on the possible causes of this deformity, a genetic basis was being evaluated. About 30% of patients have a family history of spinal deformity.

Multiple gene loci have been proven to recur in patients with idiopathic scoliosis. Therefore, genetic tests are already underway to help in the early diagnosis and prognosis of the course of spinal deformity (Scoliscore test).

It occurs the most often in the period of 10-14 years of age, in the pre-pubertal and early pubertal period, therefore marked as adolescent idiopathic scoliosis. During this period, due to the active hormonal status of developing children, rapid progression of the deformity occurs. In girls, this is associated to the first menarche and there is usually a gradual progression of the deformity to the period of stunting. In boys, progression is usually faster and occurs over a shorter period of time, usually before growth stops.

Juvenile idiopathic scoliosis occurs between the ages of 4 and 10 years and accounts for about 10-15% of cases of idiopathic scoliosis. Early onset is usually associated to greater curve magnitude in adolescence.

Infantile idiopathic scoliosis occurs before 4 years of age. Over 90% of them are spontaneously corrected. For the remaining 10%, regular monitoring of the condition and assessment of possible neuraxial anomalies is required.

The clinical examination shows:

- Asymmetry of the shoulder or pelvic girdle, depending on the type of curvature;
- Positive Adams test – if vertebral rotation is present;
- Ligament laxity – in case of collagenopathy;
- Superficial sensory deficit is being exacerbated in case of neurological disorders associated to neuraxial anomalies (Figure 1).

Figure 1. *Characteristics of the presence of scoliosis in a patient on clinical examination.*

For radiographic assessment of the type of deformity, morphology, magnitude and growth potential, an X-ray of the spine in the PA and lateral projection are performed. The flexibility of the spine is assessed by lateral bending radiographs.

Magnetic resonance imaging is not routinely performed in these patients. It is reserved for patients with present neurological signs or atypical curves.

This retrospective cohort study of 14 patients with adolescent idiopathic scoliosis is performed to analyze the efficacy of a of high-density all polyaxial pedicle screw construct in the surgical correction of adolescent idiopathic scoliosis (AIS).

Patients and Methods

The study analyzed the cases of 14 patients, 12 females, 2 males, with a mean age of 16.8 years (12-25 years in the period of surgery). The median follow-up period was 22.5 months (6 to 48 months). According to the Lenke Classification (1) the patients' curves were as follows (1):

Table 1

Lenke classification	No. of patients	Lenke classification	No. of patients
1A	1	3B	1
1B	3	3C	2
1C	3	5C	1
2C	2	6C	1

Preoperative and postoperative full spine panorama radiographs were analyzed according to the recommendations of the Spinal Deformity Study Group Guidelines, analyzed by the surgeon (2).

The following parameters were analyzed:

- Cobb angle,
- Coronal balance,
- Thoracic trunk shift,

- Apical vertebral translation,
- Clavicle angle,
- Shoulder height,
- Thoracic kyphosis,
- Lumbar lordosis,
- Sagittal balance,

The average preoperative values of the parameters were compared to the average postoperative values using the SPS 13 program.

All patients underwent posterior segmental instrumentation and fusion with a high-density construct (two implants at each instrumented level), entirely constructed of titanium polyaxial pedicle screws and titanium alloy rods. A combination of maneuvers was used to correct the deformity (rod translation, rod derotation, direct segmental derotation, compression-distraction and in-situ banding) depending on the individual case.

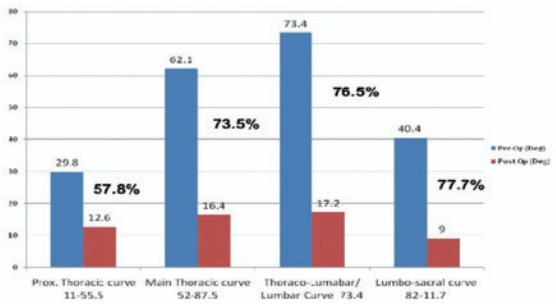
The surgeries were performed at the University Clinic for Orthopedic Surgery, Skopje.

The conduction of this study was approved form the Ethical Committee of the Medical Faculty, University "Ss. Cyril and Methodius", Skopje.

Results

The initial analysis showed Cobb angle correction of 57.8% for proximal thoracic curves, 73.5% correction for major thoracic curves, 76.5% for thoraco-lumbar curves, and 77.7% for limbo-sacral curves (Chart 1).

Chart 1. *Cobb angle correction of parts of the spine.*

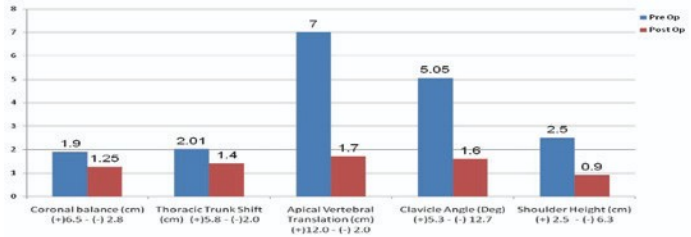


The other parameters are the following:

- The coronal balance preoperatively is 1.9 cm, postoperatively – 1.25 cm (+ 6.5 cm to-2.5 cm).
- Thoracic trunk shift on average preoperatively is 2.01 cm, postoperatively – 1.4 cm (+ 5.8 cm to-2.0 cm).

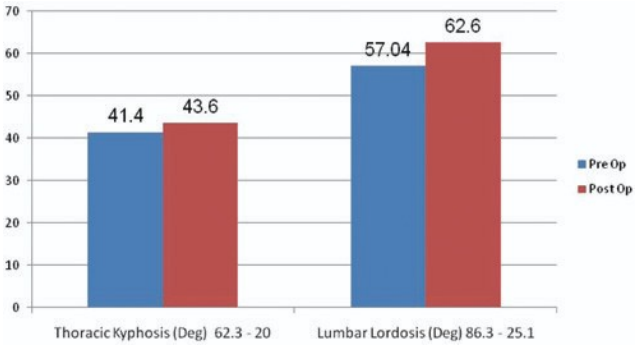
- Apical vertebra translation preoperatively on average is 7 cm, postoperatively – 1.7 cm (+ 12 cm to-2.0 cm).
- The clavicle angle preoperatively average is 5.05 degrees, postoperatively 1.6 degrees (+ 5.3 deg to-12.7 deg).
- Shoulder height preoperatively on average is 2.5 cm, postoperatively 0.9 cm (+ 2.5 cm to-6.3 cm) (Chart 2).

Chart 2. *Coronal balance correction, thoracic trunk shift, apical vertebral translation, clavicle angle, and shoulder height.*



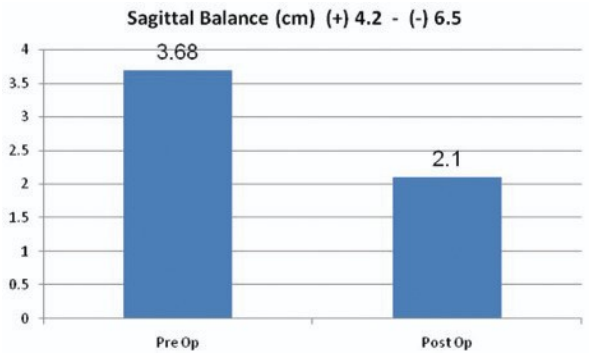
Thoracic kyphosis was corrected from an average of 41.4 degrees preoperatively, to 43.6 degrees postoperatively (20-62.3 degrees). The lumbar lordosis was on average 57.04 degrees preoperatively, to 62.6 degrees postoperatively (25.1 – 86.3 degrees). (Chart 3)

Chart 3. *Correction of thoracic kyphosis and lumbar lordosis.*



The average value of the sagittal balance preoperatively was 3.68 cm, postoperatively 2.1 cm (+ 4.2 cm to – 6.5 cm) (Chart 4).

Chart 4. *Correction of sagittal balance.*



Discussion

Unlike in the past, today we should not focus only on the correction of the coronary deformity. The surgical strategy should be also aimed at effective correction of the sagittal and coronary alignment and balance of the spine because the closer we bring them to the normal parameters, the greater the patients' satisfaction of the surgical intervention is. Ilharebrod in his study from 2018 indicates that the current literature regarding the correction of spinal deformities does not support the preservation of mobile segments (selective fusion) and that no association has been found between distal fusion level and low back pain as a consequence of the fusion (3). The same study showed that sagittal positioning of the spine is more important than the distal instrumental level to avoid disc degeneration at adjacent non-instrumental levels.

Numerous studies on the quality of life of patients with spinal deformities have shown that scoliosis causes mental dysfunction and psychosocial problems of the patient and family that are not commensurate with the severity of the deformity (4,5). Gandehari et al. in their extensive study of 135 patients who were surgically treated, followed for two years postoperatively and evaluated with the SRS-30 questionnaire, showed that aesthetic experience and appearance is the most important factor determining patient's satisfaction and quality of life related to the health condition (6). Therefore, special attention must be paid to maximize the gibbus correction and shoulder asymmetry.

The initial analysis of the parameters in our series, as well as the "behavior" of the curves of the parts of the spine, showed consistency with the change of the parameters, and their correction in the published large series of patients treated with the same method. In a study by Lehman et al., who analyzed 114 cases of operated patients with adolescent idiopathic scoliosis, they obtained an average correction of 68% for major thoracic curve, 50% for proximal thoracic curve, and 66% for thoraco-lumbar / lumbar curve (7). In our study the correction rate is higher, but it remains to be seen whether this higher correction rate will be consistent with a larger number of patients treated.

The design of pedicle screws, whether they are polyaxial, monoaxial or uniplanar, as well as their use for the correction of spinal deformities, is a topic of constant debate. Kuklo et al. in their study comparing correction performed with monoaxial versus polyaxial pedicle screws in 35 operated patients with the most common Lenke Type 1 scoliosis, showed that the constructs with both monoaxial and polyaxial pedicle screws showed excellent coronal correction, but the monoaxial screws achieved better derotation and restoration of the thoracic symmetry (8).

A study by Blondel, Lafage et al. showed that polyaxial pedicle screws achieved significantly greater correction of thoracic kyphosis (9). This is an important fact because one of the most important features of idiopathic scoliosis is the applanation of thoracic kyphosis (hypokyphosis), which is important to correct within the sagittal positioning of the spine postoperatively.

Uniplanar pedicle screws have been presented in recent years. Although they have been shown to achieve greater apical vertebral derotation compared to polyaxial in Lenke Type 5 curves, according to a study by Tao Lin et al., no studies are yet available to confirm their efficacy in a larger series of patients with other types of curves and compared to polyaxial implants (10).

There is still debate about whether to focus on low-or high-density structures. High-density structures provide greater power of correction but are associated to longer duration of surgery and greater blood loss.

A very important element in the correction of spinal deformities is its retention. In the study by Hwang, Samdani and co-workers analyzed 800 patients regarding the reduction of the correction postoperatively (11). Decreased correction postoperatively is usually associated to the presence of pseudoarthrosis, loosening of the instrumentation, or an "adding-on" phenomenon. In their study, these factors were excluded as a reason for postoperative reduction of correction. They associated the reduced correction to a positive correlation with a greater magnitude of the thoracic curves, as well as with the use of hybrid constructs (laminar hooks in combination with the pedicle screws or sublaminar wires, which are essentially low-density structures). On the other hand, they have proven that the use of pedicle screws reduces the incidence of loss of correction.

In lower-density construct, the duration of the surgery is shorter and blood loss is lower as shown in the study by Shen et al. The important issue with low-density constructs is that they can be associated to implant loosening, and also to the possibility of "Crankshaft" phenomenon in skeletally immature patients (12,13).

Conclusion

The analysis of our series of operated patients with adolescent idiopathic scoliosis, as well as a review of the literature on this topic, shows that the high-density construction made entirely of polyaxial pedicle screws and rods, is a powerful tool for three-dimensional correction of the adolescent idiopathic scoliosis.

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FIRST MAJOR ELECTIVE ORTHOPEDIC SURGERY IN A PATIENT WITH SEVERE HEMOPHILIA A AND FACTOR VIII INHIBITORS IN MACEDONIA

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ABSTRACT

Orthopedic surgery in patients with hemophilia and inhibitors is not straightforward due to the increased bleeding risk compared to the patients without inhibitors during the surgical procedure. We describe the use of rFVIIa using the Giangrande protocol for the first elective orthopedic surgery in a patient with severe hemophilia A and inhibitors performed in Macedonia, a country with limited resources.

Key Words: *hemophilia, inhibitors, orthopedic surgery, rFVIIa*

Introduction

Plasma-derived factor VIII (FVIII) concentrates and the subsequent development of recombinant FVIII (rFVIII) products have advanced care and contributed to better outcomes in patients with hemophilia A (1-3). An adverse consequence of exposure to FVIII replacement therapy is the risk of developing anti-FVIII neutralizing antibodies (inhibitors) that markedly reduce the effectiveness of the treatment, with consequent bleeding events (3). Inhibitor incidence rates of up to 30% have been reported in patients with severe hemophilia A (3).

Repeated bleeding into joints may lead to synovitis, joint instability and progressive arthropathy in people with hemophilia (4-7). Patients with inhibitors have a greater incidence of joint abnormalities and more rapid progression of arthropathy than those without inhibitors and they experience a greater range of joint motion limitations and joint pain at an earlier age (8). Furthermore, patients with high-titres of inhibitors have substantially worse clinical and radiological joint scores than patients without inhibitors, and a three-fold increased risk of disability due to joint disease progressing more rapidly (8,9).

Corrective orthopedic surgery may be the best option to improve quality of life for some patients with hemophilic arthropathy (4). However, orthopedic surgery in patients with inhibitors is not straightforward due to an increased bleeding risk compared to the patients without inhibitors (4,10). The presence of inhibitors in patients with hemophilia was previously considered as a contraindication to elective surgery (4). However, bypassing agents (i.e., rFVIIa or