REVIEW
By Prof. Dr. Hristo Tsekov, PhD, Head of the Clinic of Neurosurgery, Acibadem City Clinic Tokuda Hospital, EAD - Sofia
Subject: Dissertation on the topic: "Free-hand technique for placement of pedicular screws in the surgical treatment of idiopathic scoliosis in childhood" presented by
Dr. Adelin Ivanov, doctor at the Orthopedic Department of Acibadem City Clinic Tokuda Hospital, EAD - Sofia

Dr. Adelin Georgiev Ivanov was born in 1962 and graduated from the French Language High School in Stara Zagora. He graduated from the Thracian University in Stara Zagora - 1983-1989, with a master's degree. In 1996 he was recognized in Orthopedics and Traumatology. He has been working as an assistant at the Clinic of Orthopedics at the Thracian University, Stara Zagora since 1990, and since 2019 after a competition he has been appointed an assistant at the Medical Faculty of Sofia University "Kliment Ohridski". Since 2006 he has been appointed an intern at the Orthopedic Clinic of Tokuda Hospital, Sofia. In 2005 he already has a recognized master's degree in Health Management. He defended specializations and certificates in health management in 2005 and 2006 in Ascona / Switzerland /. He has specializations in: Surgical treatment of pediatric spinal deformities / SRS program, 2010-2020 /; A. Pare Interuniversity Hospital, Orthopedic Clinic, 1998; 1994-1995.

He speaks English, French and Russian. He is a member of the Bulgarian Orthopedic Society. The presented dissertation is developed on 124 pages, the material is illustrated with 38 tables, 54 figures and 10 graphics. The text is presented intelligently, in correct Bulgarian. Single grammatical errors that do not change the overall pleasant impression when reading the material. The topic is undoubtedly relevant, with a pronounced social effect. The title corresponds to the specific developed topic, but the word "placement" could be replaced with a Bulgarian one, which is not missing in our language.

An abstract written on 64 pages is also presented. Both documents are properly structured. Two scientific full-text publications related to the dissertation are also presented:
1. Ivanov A. Advantages of vertebrodesis with pedicular screws in the surgical treatment of idiopathic scoliosis in childhood. Medical magazine, 2021
2. Ivanov A., Yablanski V., Vlaev E. Surgical treatment of neuromuscular scoliosis in childhood. Medical examination Vol. LII, 4, 53-56, 2016

Orthopedics, as well as some other areas in medicine / cardiology and neurosurgery / have undergone revolutionary changes in the last two - three decades, accompanied by the introduction of new technologies and methods for diagnosis and treatment of a number of problematic diseases with great social impact. These decades are also a period of rapid and significant development of the concepts for surgical treatment of spinal deformities. The main directions in solving the problems related to the last group of diseases are summarized in two groups:
- Development of theories and practical understanding of deformations in the three planes
-Application of secure and stable fixation of the spine through various models of instrumentation, as well as techniques for their application.

The author has focused his creative efforts on the introduction and improvement of free - hand technique for implantation of pedicular screws in the surgical treatment of idiopathic scoliosis in childhood. The progressiveness of this technique is expressed bilaterally - on the one hand the introduction of functional methods and neuromonitoring makes surgery less risky and better comfort for the patient, and on the other hand significantly reduces X-rays for the patient and especially for the doctor.

The free hand technique allows the placement of pedicular screws during the surgical treatment of idiopathic scoliosis to achieve good correction of the deformity in the three planes

of space and stable fixation with early mobilization of the patient at low levels of X-ray exposure, shortened operative time with low levels of infectious complications, low blood loss and a lower rate of neurological complications. In the free hand technique, visible and palpationally accessible anatomical benchmarks are used: the lateral area of the interarticular part, the transverse process, as well as the adjacent upper and lower joint facets, allowing the precise placement of the pedicular screws. Difficulties arise in the placement of screws in the thoracic region, but they can be overcome with the accumulation of more experience in this area. Comparable to other similar techniques, incl. computer - assisted, the technique of free - hand placement is characterized by low beam load, lower cost and easier accessibility.

The literary review is extensive, covering 144 current titles, of which only three are by Bulgarian groups, which emphasizes the relevance of the topic and the gap in Bulgarian literature. The literature review outlines the problems with this type of surgical treatment and the resulting purpose and objectives of the dissertation. It consistently examines the problems associated with the pathogenesis of pediatric scoliosis, classifications of scoliotic deformities, clinical assessment of the patient's condition, scales for reporting the progression of the deformity, surgical techniques based on biomechanical analysis of screw synthesis, determining the levels of tools areas of the spine, the application of 3D printing. Especially valuable is the literature analysis of the individual anatomical areas with their features related to the free hand placement of pedicular screws. Possible complications are analyzed in detail and sequentially, their classification is applied: biomechanical, clinical problems related to incorrectly positioned screws, neurological complications, injuries of the dura mater, complications related to the positioning of the patient on the operating table, visceral complications / related to gastrointestinal systems, lungs, pleura, esophagus /, blood loss and surgical equipment. Of particular interest are the complications associated with the implants and surgical techniques used.

The main conclusions logically follow from the analysis of the literature review:

1. Surgical treatment of idiopathic scoliosis in childhood is associated with many challenges due to changes in the spine in the three planes and the need to find an approach that provides stable synthesis with the possibility of correction at low levels of radiation and neurological complications.
2. Need for a good assessment of the spinal deformity and the general clinical status of the patient based on clinical and imaging studies.
3. Evidence of biomechanical advantages of pedicular synthesis in surgical treatment, allowing corrections over 70% of the initial deformation and lasting effect of the achieved position.
4. Recommendations for careful planning of the volume and implementation of the operative intervention - levels of vertebrodesis, selection of implants, stages of synthesis and reposition.
5. Advantages of the free-hand technique: easy access, low blood loss, few complications, low level of X-rays, shortened operating time.
6. The implementation of free hand technique requires good knowledge of the anatomical benchmarks and features of the vertebrae in the operating area, as well as developed technical skills of the operators. The risks in its implementation require strict compliance with the individual stages and methods of verification.
7. The reported accuracy in the positioning of the pedicular screws is between 86% and 97%, very low levels of neurological and visceral complications are found.
8. A clear consensus that the use of intraoperative neuromonitoring and the correct interpretation of its data is an important element in surgical treatment.

From this analysis the goal of the present dissertation logically stands out:

To develop protocols for planning, implementation and verification of "Free hand" instrumentation in order to reduce the risk of complications in its application for surgical treatment of idiopathic scoliosis in children.

To achieve this goal, the specific six tasks are set:
1. To study the features of spinal deformity in idiopathic scoliosis and to develop a preoperative plan for correction and fixation.
2. Strictly follow the stages of the intraoperative protocol in the technique used.
3. To follow the achieved results of correction of idiopathic scoliosis with the applied operative technique.
4. To compare the levels of malposition of the screws and the indicators of the size of the deformation / preoperative angle, rotation, type of scoliosis.
5. To compare the number of malpositions at different levels of instrumentation.
6. To monitor the results and the relative weight of the individual stages of verification of the screw malposition.

The material is impressive not only for our country, it is analyzed absolutely correctly, with exceptional professional statistical analysis, which does not call into question the reported results and conclusions. The study is retrospective and includes 68 patients with surgical treatment for idiopathic scoliosis in children for the period 2013-2019. There are 68 females and 12 males. All surgeries were performed at Acibadem City Clinic Tokuda Hospital. Surgical interventions were performed by orthopedic and anesthesiological teams, the latter also performing neuromonitoring. The mean age of the patients was 14.2 + -0.5 years.

All patients were examined preoperatively with all necessary modern methods: CT, MRI, CT / MRI, Ryography of the spine. In the surgical treatment, free hand operative technique for posterior stabilization with pedicular screws was used, combined in some cases with pedicular and laminar hooks, sublaminar bands in strict compliance with the stages of the operative protocol. The following is a detailed description of the operative technique and systematic intraoperative control.

Statistical processing was performed on Office Microsoft WINDOWS10 and IBM SPSS 23, GRAPH Pad Prism 9.0.0. The conclusions are too many - 17 in number, but each of them complements the picture of scientific - practical contributions of this dissertation. Pearson's correlation coefficient for 2,3 and more interval and proportional variables, Spearman's rank correlation, linear regression analysis, one-way analysis of variance, non-parametric methods for nominal and ordinal data, logistic regression, etc., as the results are presented in a detailed and concise tabular and graphical form.

The generalized conclusions, results and recommendations are a logical solution of the set tasks and the achieved goal of the scientific development:
1. It is necessary to conduct clinical and imaging preoperative examination of the patient and subsequent planning of surgical intervention - assessment of coronal, sagittal and axial deformation, size and mobility of curves, Lenke classification, determination of levels and type of instrumentation.
2. For the implementation of the FH technique it is necessary to have a good knowledge of the anatomical benchmarks and structural features of the vertebrae in the thoracic and lumbar departments. It is mandatory to use IONM, including SSEP, TKMEP, EMG, EEG. Electrophysiological monitoring is an effective method with a specificity of 93.3% and a sensitivity of 90%
3. Surgical treatment is associated with a relatively high level of blood loss of 969.7 ml, requiring the use of cellsaver, preparation of organic products, compliance with BMI of the patient and the possible conduct of osteotomies.
4. A preoperative angle correction angle of 64% has been achieved. The intraoperative possibility for additional correction is necessary to comply with the data from the BSM and the search for a result of a balanced spine. The achieved synthesis density of 79% has sufficient biomechanical possibilities for correction and stability.

5. Idiopathic scoliosis with a large preoperative Cobb angle is associated with an increased risk of malposition and complications.
6. Higher levels of rotation of apical zones is associated with risks in helical positioning and higher levels of malposition at levels Th7, Th8 and Th9.
7. A larger number of screw malpositions was found in the proximal thoracic department - Th3-Th4.
8. Juvenile type scoliosis and scoliosis classified Lenke 3 and Lenke 4 have structural and anatomical features and elevated levels of helical malposition.
9. The reported number of malpositions in the thoracic zone is 8.43%. and in the lumbar region 9.3%. The total number of malpositions is 8.7%, which are comparable with the data from the literature review. The number of lateral malpositions is higher - thoracic 66.7%, lumbar. the medial ones are thoracic 30.9%, lumbar 25.8% of the total number of malpositions. The more frequent lateral malpositions are related to the desire to avoid penetration into the spinal canal and the denser medial pedicular wall.
10. The omission of 1 or 2 positions of screws on 4 levels in the apical zone does not disturb the stability of the synthesis and does not affect the correction of the scoliotic deformity.
11. The verification of the screw positioning is performed according to an established protocol. The reported problems with screw stimulation test are in 23.5% of cases, and with intraoperative X-ray control in 13% of cases, which shows their relative weight in the assessment of screw positioning. The final number of malposition of screws was reported on postoperative radiographs and traffic police.
12. No permanent neurological or visceral damage was reported. 8.9% of complications were reported - 2 cases of cerebrospinal fluid and 4 cases of infectious complications. The reported 14% of transient postoperative problems require attention in the positioning of the patient and analgesia in the postoperative period.
13. A multidisciplinary approach is needed with the active participation of a surgeon, anesthesiologist, neurophysiologist, cardiologist, pulmonologist.

In conclusion, I believe that the dissertation is completed, the tasks and objectives are met. Scientific - practical contributions are specific and valuable, the material is collected with the direct participation of the author, who is a prominent specialist in his field. I also believe that the dissertation meets all the requirements of the Law on the Development of Academic Staff in the Republic of Bulgaria and the Regulations of Acibadem City Clinic and I invite the scientific jury to award the degree of Doctor of Medicine to Dr. Adelin Ivanov, for which I vote "Yes".

12.05.2021 Prepared the review: Prof. Dr. Hristo Tsekov, PhD