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RESULTS OF THE USE OF A MODIFIED CORRECTIVE MANEUVER OF ARC ROTATION IN THE SURGICAL TREATMENT OF SEVERE SCOLIOSIS

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The aim of the study was to study the effectiveness of the method of correction of severe scoliosis with the help of a modified cantilever maneuver without osteotomies or discectomies.

Materials and methods. The correction of progressive severe scoliosis was evaluated radiologically and clinically.The technique was performed in 24 patients with an average degree of deformation of 82.780±19.890 (minimum 570, maximum 1200) according to Cobb. Of these, 2 are male and 22 are female. The age of the patients was 12-32 years. The long-term results of the 2.5-year period are presented. In all patients, the etiological factor is idiopathic scoliosis.

All patients underwent pre-and postoperative X-rays in standard positions. The Cobb angle of the frontal arc of the deformation was measured and the mobility of the deformation was calculated, which was the difference in the magnitude of the main arcs in the functional images. Surgical placement was performed by posterior access in all patients. The transpedicular screws were applied without the use of an O-arc, using the "hands-free" technique. Neuromonitoring and the wake-up test were not used.

Results. The degree of the main bend is 82.780±19.890 (min. 570, max. 1200). Bending graphs and the average value 21,580±14,460 (26.10%±13.69%; minimum 2.00, maximum 40.10) are determined to measure the mobility of the curvature arc. On the other hand, the average postoperative correction of the main bends 50,080±13,230 (60.49%±14.14%; minimum 33.50, maximum 82.30).

Conclusions. The technique of arc rotation developed by us in order to correct severe rigid scoliosis makes it possible to significantly achieve correction and avoid postoperative complications associated with osteotomies and discectomies performed with the "classic" version of surgical treatment.

Keywords: scoliosis, treatment, modified maneuver.

Introduction. Today, despite the extensive development of technology and medicine, the treatment of severe scoliosis remains a challenge before surgery.

Surgical correction of this type of scoliosis is considered a risky procedure. Hirurgic correction of scoliosis at an angle of 50°-55° can be carried out by corrective maneuvers of derotation, compression- distraction or by variable replacement of the rod.[2]

Surgeons often use special long-head screws of spondylolisthesis in all vertebrae, this helps with the adaptation of the rod in acute-angle deformities. In many cases, in order to treat persistent deformities above 550, posterior osteotomy such as PSO, VCR and Ponte is required. However, these procedures entail high neurological insufficiency and risks of bleeding, according to some authors, complications can reach 80% not only during surgery, but also 6 months after surgery.[1]

There are many sources in the literature describing the difficulties of vertebral osteotomy and the risks of complications. Despite the risks of neurological complications, in 2017 Prataly et al. gave a report on the high clinical effect of vertebral resections, but at the same time they noted a high (60%) complication rate.[6] Trobisch et al. Pedicular osteotomy (PSO) was performed on 22 patients without neuromonitoring and an average blood loss of 2302 ml was reported. Neurological disorders were noted in two patients.[10]

Two-step correction is used in cases of curvature of more than 70 ° according to Cobb, while anterior discectomies are performed, followed by gallovytyazhenie for 2-3 weeks and posterior fusion.[4,6]

The Cantilever maneuver was first described by Chang in 2003, but the author himself noted the time of the first operation in 1998.[3]

The aim of the study is to study the effectiveness of the method of correction of severe scoliosis with the help of a modified cantilever maneuver without osteotomies or discectomies.

Materials and methods. Correction of progressive severe scoliosis was evaluated radiologically and clinically.

The technique was performed in 24 patients with an average degree of deformation of 82.780±19.890 (minimum 570, maximum 1200) according to Cobb. Of these, 2 are male and 22 are female. The age of the patients was 12-32 years. The long-term results of the 2.5-year period are presented. Idiopathic scoliosis is an etiological factor in all patients. The study was approved by the Ethical Council of the AMU (Minutes of the Expert Council No. 15 dated 16.10.2020 Chairman -Candidate of Medical Sciences, Associate Professor R.O. Baylarov - Vice-Rector for Scientific Work of the AMU)

All patients underwent pre- and postoperative X-rays in standard positions. The Cobb angle of the frontal arc of deformation was measured and the mobility of deformation was calculated, which was the difference in the magnitude of the main arcs in functional images. 3D CT and NMRI examinations of the spine were performed. Densitometry was per-

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formed to determine bone density, including echocardiography of the heart.

Surgical placement was performed by posterior access in all patients. Transpedicular screws were applied without the use of an O-arc, using the "hands-free" technique. Neuromonitoring and the wake-up test were not used.

As safety measures during such screws, the channel of the vertebral arch leg was carefully mechanically checked, in case of suspected damage to the wall of the screw channel, they refused to use the screw at this level or used screws of smaller diameters.

Hirrurgic technique. Posterior chirrugic access to the spine was performed under neuroleptoanalgesia. The patient is brought into the pronation position, lying on parallel cylindrical supports. Starting from the cervical region, the surgical area and the lower extremities are treated with an antiseptic solution and covered with a sterile insulator. The skin incision was made according to the projection of the spinous processes of the C7-S1 vertebrae. (fig.1).

Subperiosteal dissection of the paravertebral muscles is carried out from the spinous to the transverse processes. Three semi-axial transpedicular screws are implanted starting from the cranial neutral vertebra in the concave part of the deformity. On the concave and convex parts of the deformation, the spondylolisthesis screws are placed at all possible levels. The rod is bent by repeating the bending of the arc of curvature and is mounted in three cranial screws located on the cranial part of the concave area. The assistant corrects the deformation by applying force in opposite directions; one hand of the assistant is located in the convex part of the rib, the other hand is in the iliac crest of the patient.

The surgeon inserts the rod into the caudal screws, carefully watching the cranial screws to avoid their spontaneous exit. The rod is rotated around its axis by special holders, the proposed arc rotation maneuver is performed and the rod is fixed in the slots of the caudal screws as a result. A light derotation maneuver is performed. The limit of the implementation of the derotation maneuver is the feeling of increasing resistance to the surgeon's hands. Next, we place the rod on a convex area in the same shape and connect it with screws. We carefully carry out the derotation as far as possible. If a large derotation is carried out, a spontaneous exit of the screws may occur. The rod of the concave part is removed, its bending in the frontal plane decreases, it is mounted back into the screws and

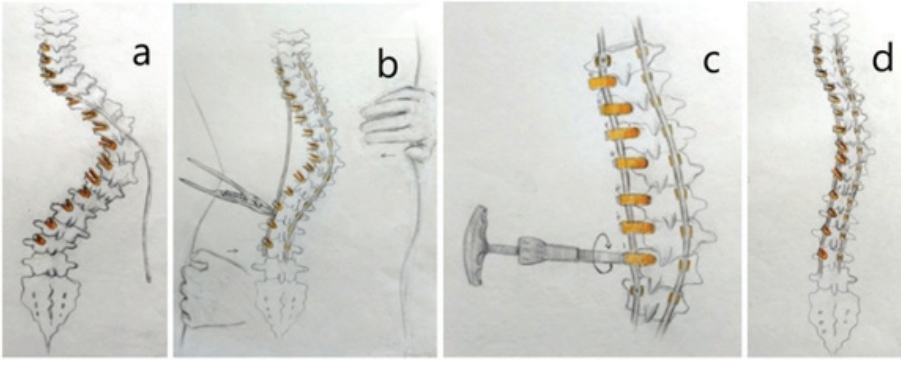

Fig. 1. Arc rotation is a cantilever technique (a) Mount the screws from the cranial neutral vertebra to the caudal neutral vertebra using long-headed spondylolisthesis screws on the concave side, connect the rod with three screws of the cranial neutral vertebrae, the rod will have the position as shown in the figure, (b) a passive correction was performed by the assistant and the rod was inserted into the caudal screws by the operator, (c) the screws are superimposed in the convex side of the curvature arc and the rod is also placed in a similar position. Further, the rod is removed from the concave part and re-placed in its place after straightening with the rod flexor (d) as a result of straightening and derotation of the rod in the convex region, the rod has reached the spondylolisthesis screw in the concave region.

derotirovaetsya. At the same time, there is a decrease in resistance to the derotation maneuver and it is done with ease. The same is done on the convex side of the arc of curvature, while not forgetting about the risk of dislocation of the screws. The assistant can still correct by applying pressure with his hands in order to avoid dislocation during derotation. One or two transverse connectors are placed between the rods and the fusion of the auto-fluid is carried out. The wound is stitched in layers, the wound is bandaged. The results of the treatment were evaluated by SPSS statistical analysis. The probability index is 0.05.

Results. The degree of the main bend is 82.780±19.890 (min.570, max. 1200). Bending graphs and average value 21,580±14,460 (26.10%±13.69%; minimum 2.00, maximum 40.10) are determined to measure the mobility of the curvature arc. This means that all patients were with rigid deformities (t:2.01; p>0.05). On the other hand, the average postoperative correction of the main bends 50,080±13,230 (60.49%±14.14%; minimum 33.50, maximum 82.30) with static confidence (t:14.85 ; p<0.01). (Table).

Operations were performed without neuromonitoring, neurological disorders of patients were not observed. One of the patients had postoperative decompensation of the trunk, which was corrected by additional fixation of the L4 vertebra. Complications related to surgical infection, secondary displacement of screws, blood loss and mortality were not observed.

Clinical example: A 19-year-old male patient was admitted to the clinic with severe and rigid right-sided thoracic idiopathic scoliosis (1230 Cobb), with decompensation of the trunk. The main arc was rigid with a mobility of 2°. The patient underwent preoperative studies and was offered surgery to correct the spine with

Indicative static data

	Average Value	Limits
Age	19.04±5.62	12-32
Cobb angle	82.78±19.89	57-120
Arc mobility (degree)	21.58±14.46	2-40.1
T	2.01	
P	>0.05	
Correction (degree)	50.08±13.23	33-82
T	14.85	-
P	<0.01	-
%FLEX,**	26.10±13.69	-
%COR,***	60.49±14.14	-
T	-15.42	-
P	<0.01	-

a transpedicular system with posterior fusion. The operation was performed using a corrective maneuver of arc Rotation. Postoperative radiographic images show that the deformity was corrected by 57.70 % and this is 47 % of the correction. The patient was very pleased with the result (Figure 2).

Clinical example: A 14-year-old patient came to our clinic with rigid right-sided idiopathic thoracic scoliosis (1100 Cobb). The main bend was rigid with mobility 11.40. The patient underwent preoperative studies and was offered a spinal correction operation with a transpedicular system with posterior fusion. The operation was performed using a corrective maneuver of arc Rotation. Postoperative radiographic images show that the deformation was corrected to 74.70 and this is 68° correction. After 9 months, the patient was admitted to the clinic for the purpose of subsequent surgery for additional correction during which we reduced the bending of the rods in the frontal plane by placing 2 more screws on the concave side of the curvature. Additionally, we have achieved 100 corrections and this is 77.2%. The patient is satisfied with the result (Figure 3).

Discussion. Thus, the operative correction of scoliotic deformities using polyaxial transpedicular systems is carried out by a derotation maneuver, 3-mesh technique, direct derotation of the vertebral body, segmental derotation and cantilever maneuvers.[4]

First of all, the classic cantilever maneuver provides for bending the rods using a rod flexor on the convex side, with the screws and the rod already installed. We think that this will not be effective enough in deformations of 900-1200. Obviously, the traditional cantilever maneu-

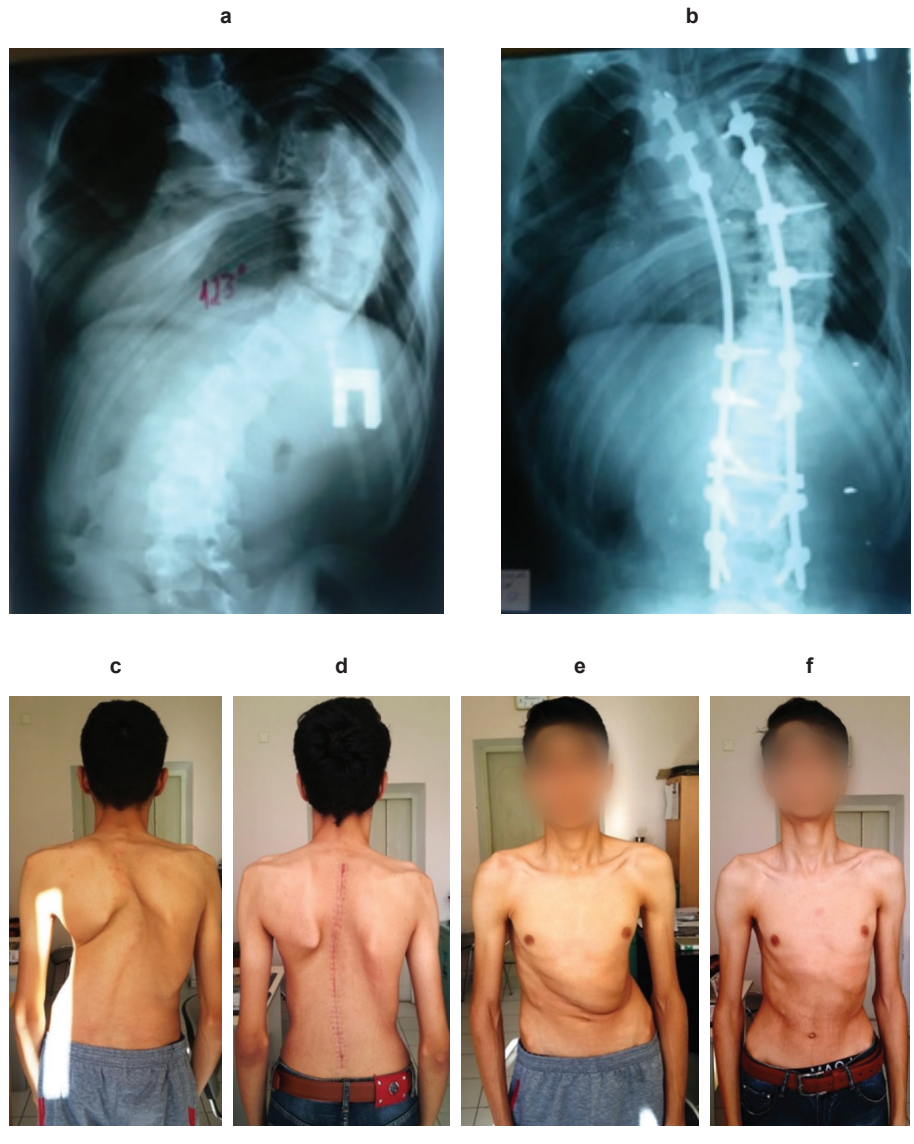

Fig. 2. Radiographs of the spine and photographs of the patient before and after surgery. A) An X-ray of the patient's spine before surgery, B) an X-ray after surgery C) a photo of the back before surgery, D) a photo of the back 6 months after surgery, E) a photo of the torso in front before surgery, F) a photo of the torso in front after surgery

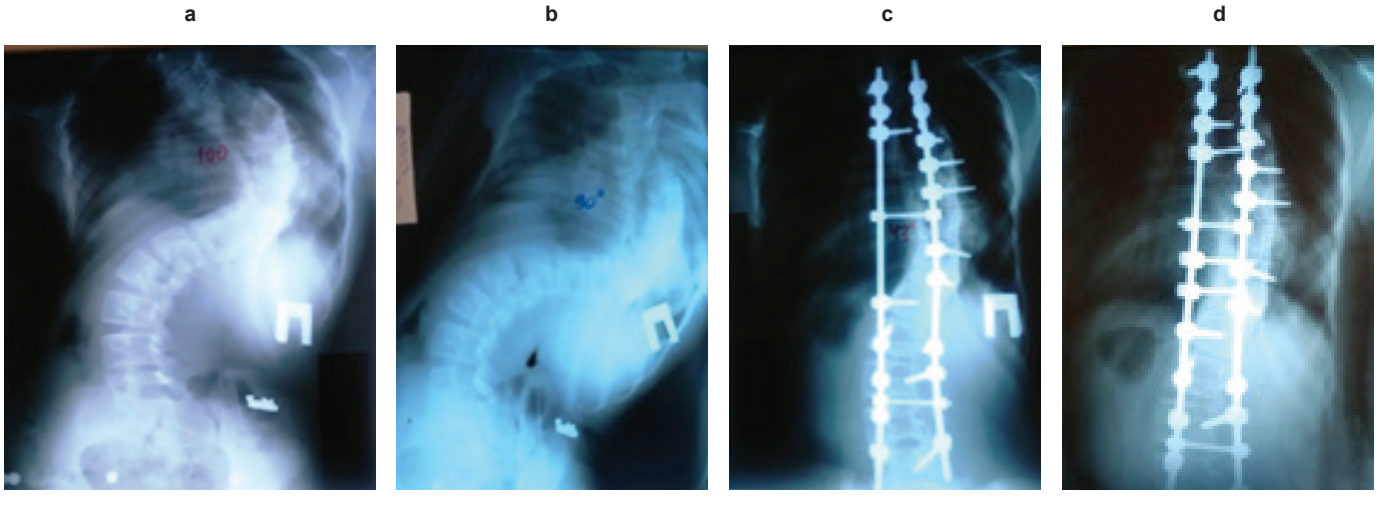

Fig. 3. Radiographs of the patient's spine before and after surgery a) X-ray of the patient before the operation, b) X-ray of the patient before the operation in the functional position, c) X-ray of the patient after the operation d) X-ray of the patient after the second operation of additional correction.

ver in cases of rigid scoliosis will make heavy operations necessary, such as anterior discectomies or pedicular osteotomies.

We gave the modified maneuver the name "Arc Rotation". The first movement corrects the deformation in the frontal plane, which begins with 3 screws on the cranial arc of deformation and helps to obtain a primary correction by turning the rod in the frontal plane. Further stages of correction consisted of classical corrective maneuvers. The correction of the main arc of curvature was 82.780±19.890 (min.570, maximum 1200). The deformities of the patients were rigid, the correction of bends in the bending graphs (26.10%±13.69%) was not statistically significant (p> 0.05). The average value of the correction of the main bending 60.49%±14.14 with a static value (p<0.01). At this time, interest indicators of postoperative correction was higher than the correction of the curves in the graphs of the curves with a static value (p> 0.01).

It is possible to obtain sufficient radiological and cosmetic correction performing this maneuver on their respective convex and concave sections of the scoliotic arch.

In the traditional methodology, the correction of severe scoliosis requires vertebral osteotomy Ponte, pedicular osteotomy (PSO) or removal of the vertebral body, which leads to increased bleeding, surgery time and risks of neurological complications. According to Saifi, transient neurological complications can reach 13.8%, persistent neurological complications can reach 6.3%, with 50-70% correction during spinal column resection.[8] According to our studies, similar correction indicators were obtained in us, but we did not observe neurological complications in our patients. We attribute this to the loss of the need for vertebral osteotomies during the proposed arc rotation maneuver.

According to Shankoil, in order to reduce the risk of dislocation in a classic cantilever maneuver, several spondylolisthesis screws with oblong heads should be applied.[9]

We tried to show it as a separate maneuver and demonstrate its strength without osteotomy. It is not difficult to place the rod when stretching the spine to obtain a passive correction. But this requires the help of two people - one must pull the patient from the armpits, and the other pull from the legs. We carried out a passive correction using the strength of one assistant who pressed with muscular force (ribs and pelvic area) on the frontal surface.

The traction method is used in cases of severe scoliosis. Halotraction is used in various methods of exposure both in the case of vertebral osteotomy and after anterior thoracotomy. The disadvantage of the technique is the long period of hospitalization.

In 2018, Qiao et al. proposed a 3-stage surgical correction in the treatment of severe scoliosis. [7]

1. Stage-1: Smith-Petersen posterior vertebral osteotomy.

2. Stage-2: in the second phase, stretching over the shoulder area and hips with prolonged heavy loads.

3. Stage-3: posterior correction and fixation in the third stage.

63 patients participated in the study. The average frontal Cobb angle of the main bend was 118.70 before surgery, the postoperative degree of correction averaged 57.3° (55%). According to Qiao, displacement of 17 screws was observed in 12 patients in the first phase of surgery, which were corrected during the last phase of surgery. Pleural injury in 2 patients. Pleural discharge was noted in one of two patients whose pleura was opened and closed thoracic drainage was applied. One of the patients had a short-term postoperative neurological disorder. Total complications were 19.0% after the first operation and 4.8% after the last operation. Two patients suffered from brachial plexus paralysis and one patient had femoral nerve paralysis. After conservative treatment, nerve functions were restored. Two patients had short-term hematuria. One of the patients had gastrointestinal symptoms, and these symptoms were mitigated after lowering the load applied for traction. Two patients had deep vein thrombosis (DVT), one of the patients had a venous filter applied. Complications related to stretching were 11.1%. [7]

We did not observe any spontaneous displacement (pull-out) of the screws with the modified Arc Rotation technique. Pleural complication was not noted with the proposed technique due to the absence of the need for thoracoplasty. Postoperative neurological insufficiency was not noted.

There is a lot of information in the literature about the complexity of vertebral osteotomies and the risks of complications, including the risks of neurological hemorrhagic nature. Modi HN and the authors developed and made a report on the results of posterior polysegiental vertebral osteotomy (PMVO) for the correction of severe idiopathic and neuromuscular scoliosis. The average indicator of the number of osteotomy levels is 4.2±0.8 (norms 3-5). The average Cobb angle before surgery was 99.20±29.60, after surgery this indicator decreased to 44.70±12.30. Correction of frontal deformation was 54.3% according to the authors. The average rate of blood loss and operation time, respectively, 3015 ± 1213 ml and 6.01 ± 1.09 hours. Three of the patients had respiratory complications, two of the patients had hemothorax, and one had lung atelectasis. Two of the patients had complications associated with implants; 1 screw fracture. Long periods of bed rest imposed psychological stress on patients. [5].

Conclusions. The technique of arc rotation developed by us in order to correct severe rigid scoliosis makes it possible to significantly achieve correction and avoid postoperative complications associated with osteotomies and discectomies performed with the "classic" version of surgical treatment.

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