

ORIGINAL ARTICLE

TREATMENT OF SEVERE SPINAL DEFORMATIONS IN CHILDREN WITH IDIOPATHIC SCOLIOSIS USING HALO-GRAVITY TRACTION

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ABSTRACT

The aim: To chose the best way treatment and achievement of 3-dimensional spinal correction in order to maximize its parameters to the physiological norms is a choice of the optimal surgical severe scoliotic spinal deformity correction technology.

Materials and methods: Performed surgical treatments to 60 children of two patient's groups, that were under surgical treatment for severe scoliotic spinal deformations with preliminary used halo-gravity traction and one-step correction; to establish an effective and safe protocol of the treatment for children with severe scoliotic spinal deformations (>100°). The results comparative analysis of 60 patients with severe scoliotic spinal deformations, with a two-step surgery treatments (first step – halo-gravity traction and second step – correcting spinal instrumentation) and patients with one-step correction.

Patients were divided into 2 groups with 30 children in each of them. The first group treated with preoperatively HGT (halo-gravity traction) and after that a spinal instrumentation together with osteotomies (3-4 levels by Ponte; VCR (vertebral column resection) osteotomy 1 level) were performed. The second group – performed one-step spinal instrumentation with osteotomies (3-4 levels by Ponte; VCR osteotomy 1 level).

Results: One-step implanted construction in children with severe scoliotic spinal deformations, compare to HGT treatment that were carried out in stages – is increasing the danger of neurological deficiency by 17%, HGT allows to make more corrections and to adjust spinal cord for the next correction treatment. .

Conclusions: Halo-gravity traction as a first stage of severe scoliotic spinal deformations treatment allows to increase the mobility of the vertebral column and to adjust spinal cord step by step for the next correction treatment.

KEY WORDS: vertebral column resection, Ponte osteotomies, severe scoliotic spinal deformations

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INTRODUCTION

Severe pediatric scoliotic deformations (>100°) make up 0,12–1,7% of all scoliotic spinal deformations [1,2].

The one-step correction for severe scoliotic spinal deformations in modern surgery practice includes the usage of osteotomies Ponte and Vertebral Column Resection (VCR), which are improving the ability to correct deformations, but also increasing risks of neurological complications, intra-operational blood loss volume.[3,4].

An alternative approach is a preliminary correction of deformation prior to the surgical treatment by applying the Halo-gravity traction. That allows to decrease complications from surgical treatment, to reduce risks of neurological complications and provides a better final spinal correction of the deformation. [5,6,2]

Protocols for the surgical treatment of severe spinal deformations are not developed completely and require further study.

THE AIM

To chose the best way treatment and achievement of 3-dimensional spinal correction in order to maximize its parameters to the physiological norms is a choice of the optimal surgical severe scoliotic spinal deformity correction technology.

MATERIALS AND METHODS

Orthopedic Traumatology Department of National Children's Specialized Hospital "Ohmatdyt" performed surgical treatments of 60 children with severe scoliotic spinal deformations (>100°) during the period of 2013-2018. Patients were divided into 2 groups with 30 children in each (25 male and 35 female).

Patients with idiopathic scoliosis only were included in the research.

All surgical interventions were carried out by the same surgeon using neuro-monitoring.

The following factors were taken into consideration during the research: age, sex, type of spinal deformation, complexity of the surgical interventions, remote surgical treatments results (1-3 years).

The first group treated with preoperatively HGT (halo-gravity traction) and after that a spinal instrumentation together with osteotomies (3-4 levels by Ponte; VCR

Table 1. Dynamics of the main radiological indicators in the first patient's group (n-30)

№	Indicators	Before	After	1 year	3 years
1	Chest curvature	108,67±5,01	47,25±3,21	46,02±2,13	44,73±2,21
2	Lumbar distortion	69,95±4,43	28,67±3,45	27,59±2,93	28,04±2,34
3	Chest kyphosis	64,28±3,21	49,72±4,35	47,21±3,92	48,24±3,75
4	Lumbar lordosis	49,15±2,05	38,24±2,76	36,11±3,21	37,31±3,05
5	Sacral slope	72,37±2,24	54,23±2,66	53,63±2,23	52,92±3,11
6	Pelvic Incidence	41,22±1,82	34,92±2,36	31,68±3,14	32,88±3,02
7	Pelvic tilt	9,52±1,52	9,72±1,26	9,11±1,54	9,52±1,84

(vertebral column resection) osteotomy 1 level) were performed. The second group – performed one-step spinal instrumentation with osteotomies (3-4 levels by Ponte; VCR osteotomy 1 level).

The research of neurological status was conducted, X-rays (Radiography in standard planes, traction test, tilt test, CT, MRI of the spine). The assessment of the probability of congenital spine and spinal cord diseases was

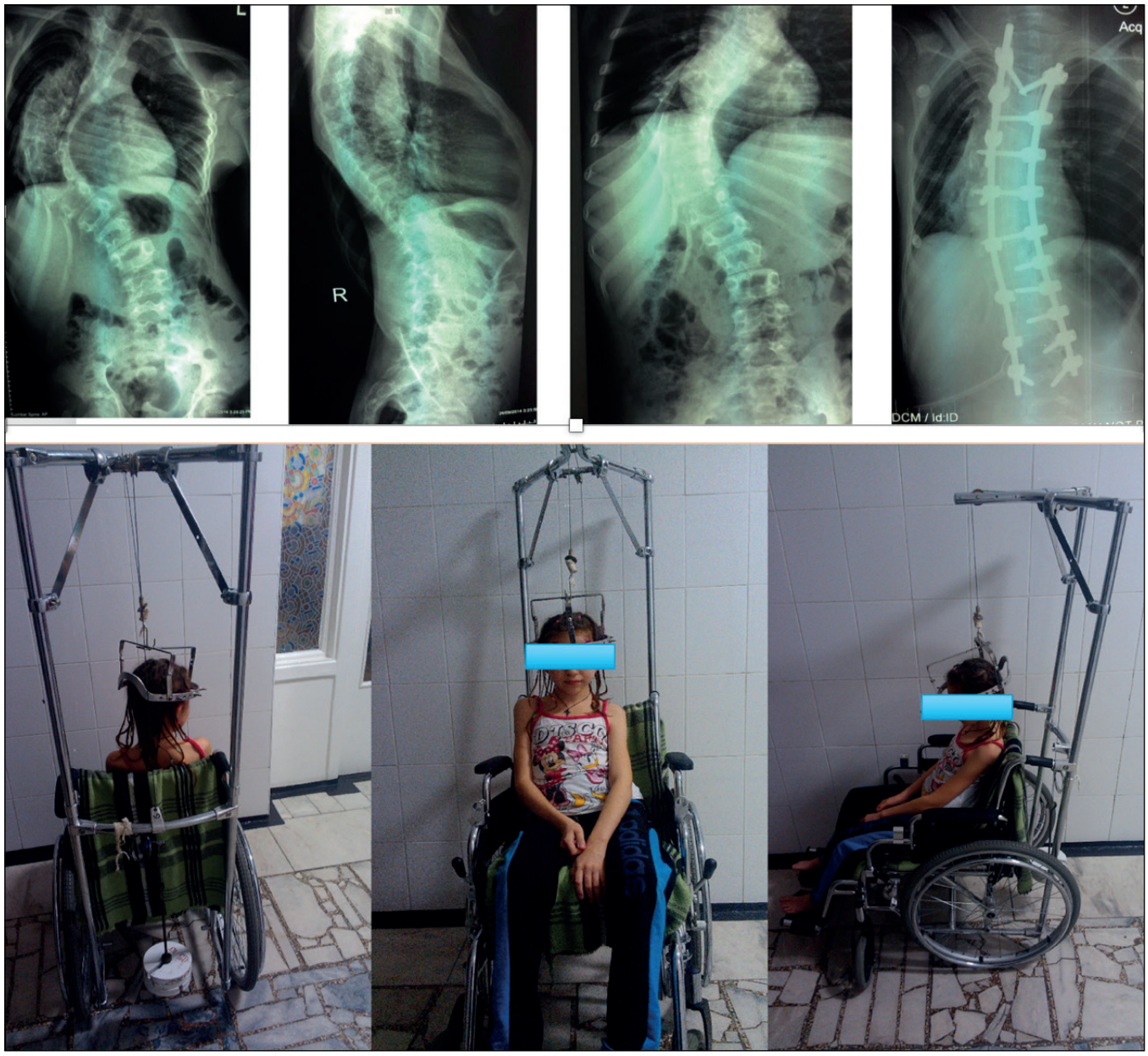

Fig 1. General view and photographic pictures of radiographs of patient K. (12 years old) from the first group with idiopathic lumbosacral scoliosis (major arch 104 degrees before surgery and 43 degrees after posterior instrumentation and osteotomy by Ponte on 4 levels using preliminary halo-gravity traction.

Table 2. Dynamics of the main radiological indicators in the second patient's group (n-30)

№	Indicators	Before	After	1 year	3 years
1	Chest curvature	112,24±4,23	62,15±4,41	61,34±3,01	62,01±3,54
2	Lumbar distortion	72,11±3,63	31,15±3,84	30,72±3,26	31,46±3,15
3	Chest kyphosis	66,12±3,77	49,12±3,93	48,32±4,02	48,98±3,88
4	Lumbar lordosis	47,32±3,31	39,55±2,29	40,17±3,11	39,84±2,84
5	Sacral slope	68,21±3,11	52,42±3,05	53,15±3,41	54,21±4,08
6	Pelvic Incidence	45,15±2,07	36,25±3,18	32,43±2,96	31,92±2,97
7	Pelvic tilt	8,24±1,52	9,12±1,54	9,34±1,71	9,46±1,71

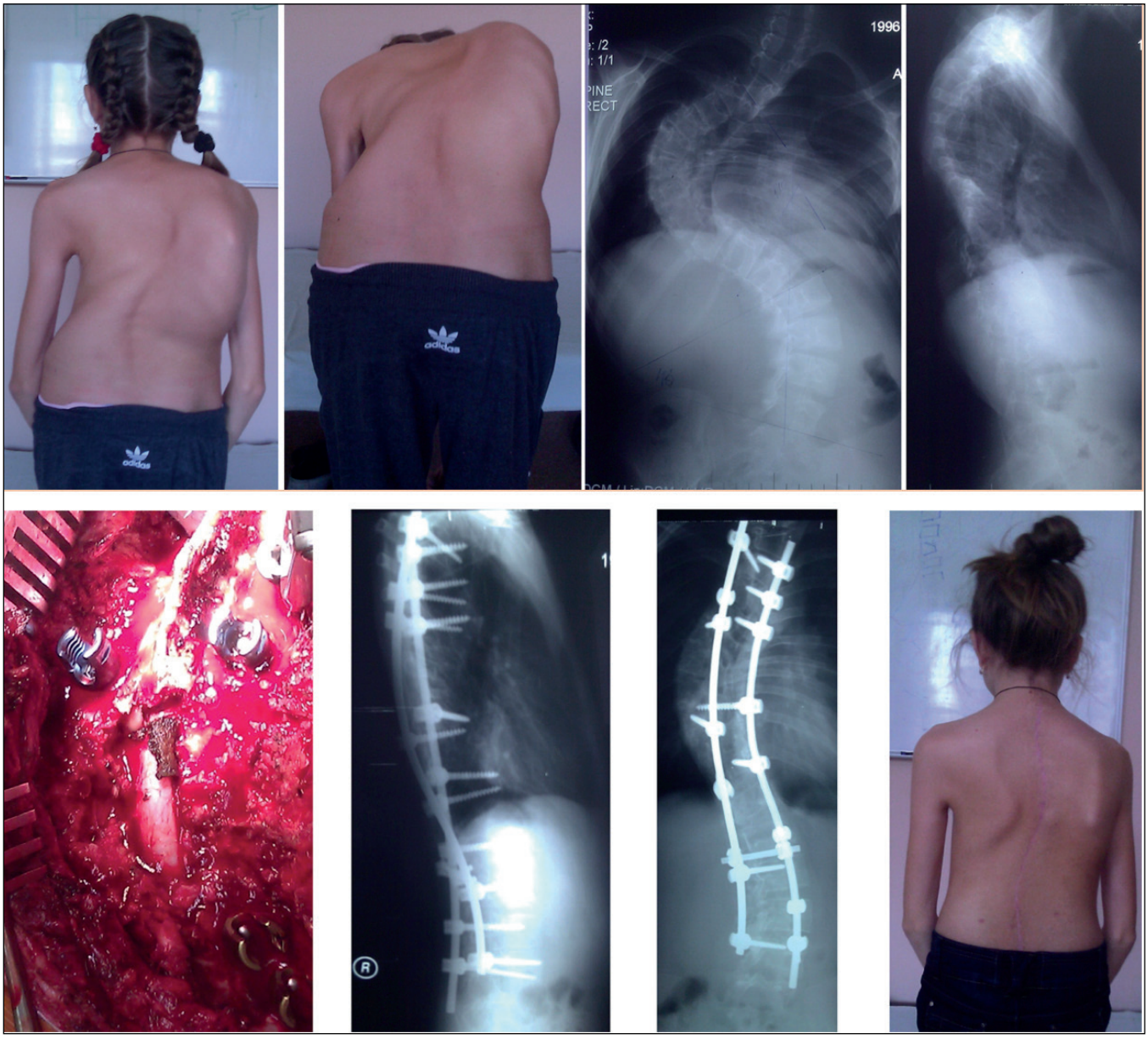

Fig 2. General view and photographic pictures of radiographs of patient O. (14 years old) from second group with idiopathic thoracic lumbar scoliosis (major arch was 112 degrees before surgery and 39 degrees after posterior instrumentation and osteotomy by Ponte on 4 levels plus VCR osteotomy on 1 level, that had been conducted a one-step spinal deformations correction.

based on the CT and MRI data. Frontal and sagittal balance assessed by X-ray data, the angle of scoliotic deformation was determined by Cobb.

On the radiographs of the spine in the lateral plane with the capture of the hip joints and a wire temple centered on the spinous sprout C VII in the position of the patient

standing, determined the magnitude of thoracic kyphosis, lumbar lordosis, obliquity and inclination of the pelvis, inclination of the sacrum. Pathological rotation and torsion of the vertebrae were measured at the apex of the thorasic and lumbar curvatures by using CT. Functional condition of the cardio-respiratory system assessed by using the Spirograph, electroneuromyography of limb muscles (electrophysiological studying methods), electrocardiography, ECHO cardiography.

The amount of trunk decompensation in comparison to sacrum was determined by measuring the distance that moved the pull cord weight.

Halo-gravity traction procedure was performed under full anesthesia in operating room. To minimize the risk of possible instability usually being installed from 6 to 8 screws through halo nimbus. Screws are implanted through a single cortical plate, depending on the size of the patient and the total bone density of the skull. Traction usually started the next day with a minimum weight of 2 to 4 kilograms. Weight was gradually increased from 1 to 2 kg per day.

The goal was to achieve maximum traction from 33% to 50% of body weight, depending on how well it was being tolerated. Traction was applied for a minimum of 12 hours per day. The thrust was performed at wheelchair or inside a standing device. Neurological surveys were conducted every day. Duration of extension was usually from 2 up to 12 weeks, depending on the mobility of the spine. Patients were doing a breathing exercises every day.

Statistical data processing was performed in SPSS 17.0 program.

The study does not contradict the of Helsinki declaration, and received a positive feedback from the Bogomolets National Medical University ethics Commission

RESULTS

Patients in the first group had been treated with halo- gravity traction to gradually reduce the scoliotic deformations and to prevent neurological disorders. An average duration of spinal traction treatment was ± 1,5 (P>0,01) month. While conducting halo- gravity traction 40-50% of the patient's body weight had been used. After halo-gravity traction stage the spine was stabilized with polysegmental structure. An average length of spinal fusion ± 11,8 vertebrae (P>0,01).

The angle of main deformation in the first group was 108,67±5,01 (P>0,01) in average, in the second group – 112,24±4,23(P>0,01). All the patients had rigid scoliosis deformation: by traction testing the correction of deformation was up to 15-20%. In the first group associated pathology was identified in 7 patients (23,1%): 4 patients (13,2%) –infundibular deformity of the chest; 2 patients (6,6%) had a congenital club foot; 1 patient (3,3%) had cervical deformity of the chest.

In the second group the associated pathology was noted in 10 patients (33,3%): 2 patients (6,6%) – infundibular deformity of the chest; 1 patient (3,3%) had a congenital club foot; 4 patients (13,2%) had cervical deformity of the chest; 3 patients (9,9%) had congenital hip dislocation.

In 92% ± 0 (P>0,01) of patients the treatment was conducted at the stage of full grown spine, that was indicated by median of Risser's Sign, CRITOE test, X-ray studies of Ossification of the ulnar process, Taner scale.

In the first group the average age of patients was 13,7 years old ± 0. The median for Risser's Sign was 4,2. (P>0,01). 9,9% of patients at first group had deformations of 1 type by Lenke; 62,7% had 2 type, 16,5% had the 3 type; 3,3% had the 4th type; 6,6% had the 5th type.

In the second group the average age was 12,6 years old ± 0. The median for Risser's Sign was 4,1. (P>0,01). 23,1% of patients at second group had deformations of 1 type by Lenke; 52,8% had 2 type; 13,2% had 3 type; 6,6% had 4th type; 3,3% had 5th type.

In the first group an osteotomy by Ponte on 4 levels was performed in 18 patients (59,4%), and osteotomy by Ponte on 6 levels performed in 10 patients (33%), and osteotomy by Ponte on 4 levels plus VCR (Vertebral Column Resection) osteotomy on 1 level – in 2 patients (6,6%).

For further description of an X-ray indicators of a scoliotic spinal deformations their medians obtained during statistic data processing will be used (Table 1).

At first patient's group an average spinal deformation correction was 57± 12% (Figure 1). Blood loss during surgery was 20 ± 10% (volume of blood in the circulatory system), Cell Saver autogemotransfusion system had been used in all cases. An average duration of surgery was 347 minutes. 2 Patients (6,6%) had Transient neurological deficit, 3 patients (9,9%) had inflammation of the soft tissues around the core.

In the second patient's group a one-step spinal stabilization by polysegmented structure was performed. An average length of spinal fusion ± 12,6 vertebrae (P>0,01).

In the second group osteotomy by Ponte on 4 levels and VCR osteotomy on 1 level was performed in 14 patients (46,2%), osteotomy by Ponte on 5 levels and VCR osteotomy on 1 level – to 11 patients (36,3%), and osteotomy by Ponte performed on 6 levels – in 5 patients (16,5%).

For further description of an X-ray indicators of a scoliotic spinal deformations their medians obtained during statistic data processing will be used (Table 2).

In the second patient's group an average spinal deformation correction was 47± 17% (Figure 2). Blood loss during surgery was 30 ± 15% (volume of blood in the circulatory system), Cell Saver autogemotransfusen system was used in all cases. An average duration of surgery was 432 minutes. 6 Patients (19,8%) had Transient neurological deficit.

DISCUSSION

The one-step correction for severe scoliotic spinal deformations in modern surgery practice includes the usage of osteotomies Ponte and Vertebral Column Resection (VCR), which are improving the ability to correct deformations,

but also increasing risks of neurological complications, intra-operational blood loss volume.[3,4].

An alternative approach is a preliminary correction of deformation prior to the surgical treatment by applying the Halo-gravity traction. That allows to decrease complications from surgical treatment, to reduce risks of neurological complications and provides a better final spinal correction of the deformation. [5,6,2].

Our patients were divided into 2 groups with 30 children in each of them. The first group treated with preoperatively HGT (halo-gravity traction) and after that a spinal instrumentation together with osteotomies (3-4 levels by Ponte; VCR (vertebral column resection) osteotomy 1 level) were performed. The second group – performed one-step spinal instrumentation with osteotomies (3-4 levels by Ponte; VCR osteotomy 1 level).

Between first patient's group was made a poll for subjective analysis on treatment results by SRS-30. Data poll showed more then 800 points, which means that results of the study are good.

Data poll by SRS-30 patients from the second group showed more then 700 points, which means that results of the study are good.

In the course of our work, the scientific goals were achieved in full scope, as evidenced by the results of the study. The lack of a standard approach in the treatment of complex scoliotic deformities of the spine makes this study very promising.

Possible limitations of the current study are patients with a rigid spinal deformities over 100 degrees.

Despite the fact that our patients who used Halo-Gravity Traction were in hospital longer, nevertheless, this is justified by the significantly better clinical and radiological results.

CONCLUSIONS

One-step implanted construction in children with severe scoliotic spinal deformations, compare to HGT treatment that were carried out in stages – is increasing the danger of neurological deficiency by 17%, HGT allows to make more corrections and to adjust spinal cord for the next correction treatment.

In the surgical treatment of severe scoliotic deformations, HGT reduces the risks of neurological complications, decreases the time of surgery and volume of blood losses, also allows to obtain a better correction results.

The choice of surgical intervention scope was based on anatomical and functional criteria.

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Conflict of interest:
The Authors declare no conflict of interest.

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