

Conservative Treatment of Juvenile and Adolescent Idiopathic Scoliosis

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Abstract

The study relies on data received during treatment of 128 children and teenagers suffering idiopathic scoliosis. The subjects' median age is 10,2±0,39 years old. In the treatment group (90 juvenile subjects), treatment of scoliosis has been carried out according to an optimized conservative integrated algorithm with reliance on bone mineral density indicators and the Cobb's angle. The length of treatment averages 1,5±0,2 years (1 to 3 years).

The control group (30 subjects) has undergone traditional correction on an outpatient basis with the use of standard method: therapeutic exercise, massage, physiotherapy. The length of treatment averages 1.7±0,1 years (1 to 3 years).

Compared to traditional method, optimized conservative integrated treatment of idiopathic scoliosis demonstrates a 29% higher occurrence of positive results. Efficacy of brace treatment of moderate and severe progressive juvenile/adolescent scoliosis has been observed, as it has reduced spinal deformation and eased socio environmental adaptation.

Keywords: *Idiopathic scoliosis, conservative treatment, brace treatment, children.*

Introduction

Idiopathic scoliosis (IS) is a common and serious spinal disorder, which affects children and teenagers (T.N. Sadovaya, 2010; M.V. Mikhailovsky, et al., 2017, Brooks Smyrnis P. et al., 2009),¹ and causes cardiovascular and pulmonary disorders, severe postural abnormalities, early disability and, consequently, affects mental health (V.S. Mironov, 2010; H. Bouloussa. et al., 2019)². Based on statistical data on idiopathic scoliosis, it can be noted that they have not changed much over the last decades: 1% to 12% of juvenile population are affected by scoliosis (Sadovaya T.N., 2010; Brooks Smyrnis P. et al., 2009)³. According to Sadovaya T.N. (2010),⁴ idiopathic scoliosis accounts for 80% to

85% of all spinal deformities. It means that idiopathic scoliosis is one of the most frequently occurring juvenile musculoskeletal conditions. A more detailed statistical analysis reveals other features of idiopathic scoliosis as well: for the most part, it is diagnosed in children aged 10-15 years old, i. e. into adolescence. This is exactly when spinal deformation takes on the most formidable form – adolescent scoliosis (Grivas T.B. et al., 2009) affecting one out of every three or four patients.⁵

Based on the clinical picture and X-ray patterns, idiopathic scoliosis can be defined as typical and atypical. Typical scoliosis is diagnosed when there are curvatures of the vertebral column, mostly right thoracic and left lumbar curves with pronounced physiological

lordosed thoracic kyphosis and increased physiological lumbar lordosis. This type causes an abnormal convex side rotation of vertebrae. One out of every three cases is progressive, and it accounts for the majority of cases of structural heart defects, cardiac, respiratory, digestive and central nervous system disorders (Grivas T.B. et al., 2009).⁶

Fragmentation and disintegration of approaches explains the low efficacy of treatment of this spinal disorder.⁷ The main problem affecting interdisciplinary interaction is limited use of fundamental knowledge within each healthcare field, which impedes development of fairly effective treatment method.⁸ The huge number

of existing symptomatic treatment method target separate stages of the pathological process sporadically and do not provide any ultimate solution.⁹

This study is aimed at optimizing the process of conservative treatment of juvenile and adolescent scoliosis.

Materials and Method

We have investigated 128 juvenile and adolescent subjects with IS. The patients were hospitalized to the Republican Center of Juvenile Orthopedics. Age groups have been formed according to the WHO classification, and the obtained data is shown in Table 1.

Table 1: Distribution of IS patients according to age

Age	Male subjects		Female subjects		Total	
	Abs.	%	Abs.	%	Abs.	%
0 to 3	5	45.5	6	54.5	11	8.6
4 to 6	5	25.0	15	75.0	20	15.6
7 to 9	11	40.7	16	59.3	27	21.1
10 to 13	15	41.7	21	58.3	36	28.1
14 to 17	16	47.1	18	52.9	34	26.6
Total	52	40.6	76	59.4	128	100.0

The majority of cases (28.1%) have been observed in children ages 10-13. The median age is 10.2±0.39 years old. According to some sources, this can be due to rapid skeletal growth during puberty and an increased risk of progressive scoliosis at this particular age. Sex distribution, as follows from the table, is biased towards the female sex (by a factor of 1.5), which corresponds to the data obtained from the sources.

Distribution according to the severity of deformities has been made according to the V.D. Chaklin's classification (1965). The study has involved children with spinal deformities with 31.3% (40/128) of them diagnosed with scoliosis Grade 1, 23.4% (30/128) - Grade 2, 17.2% (22/128) - Grade 3, and 28.1% (36/128) – Grade 4. Most juveniles have thoracic (35.2%, 45/128), thoracolumbar (27.3%, 35/128), combined (23.4%, 30/128), and lumbar (14.1%; 18/128) scoliosis.

In the control group, 66 children ages 5-17 have been examined. Based on the examination results, no spinal deformities have been observed in these children.

Median age in the control group is 13.8±2.1 years old (p<0.05).

During the physical examination, doctors have checked patients for uneven shoulder height, shoulder-blade asymmetry, spinous process rotation, torsion in the form of a rib hump and muscular embankment in the lumbar area. It is important to check spinal mobility and stability through the pulling of the head. Pelvic tilts and lumbar lordosis are diagnosed in a standing position; abdominal muscles are checked in a lying face-up position; back muscles are examined in a lying face-down position.

Scoliosis patients are examined in a standing position from back and front, in a side-lying position from back, in a standing position from a sagittal perspective, and in a bent-forward position from back and front (Fig. 1).

X-ray imaging has been conducted at the Department of Radiology of the JMDS-Service Clinic on a Silhouette radiographic system (General Electric), (128 images).

Of 128 children, 120 have been examined. A group of 8 children have failed to follow recommendation and regime and therefore have not completed the conservative treatment. The 120 juvenile subjects have been divided into two groups: the treatment group and the comparison group.

The *treatment group* has included 90 children: 33 (36.7%) boys and 57 (63.3%) girls. Treatment of the group's subjects has been administered with the use of the conservative integrated idiopathic scoliosis treatment method developed by us. The treatment has lasted 1 to 9 years (1.5 years on average), the follow-up period has lasted 1 to 13 years, averaging 2.2 years.



Fig. 1. Examination of patient A., 14 years old

The *control group* has included 30 children – 4 (13.3%) boys and 26 (86.7%) girls. The control group subjects have been treated on an outpatient basis according to standard method: therapeutic exercise, massage, physiotherapy. The treatment has lasted 1 to 6 years, on average – 2.1 years. The follow-up period has lasted 1 to 9 years, on average – 3.4 years.

Both control and treatment group subjects diagnosed with scoliosis, along with clinical symptoms, had radiological signs indicating structural changes in vertebrae. Both groups have shown a 100% occurrence of spinal torsion. Wedge-shaped deformities of vertebrae and intervertebral cartilages have been observed in 43.3% and 63.3 control group subjects respectively and in 38.9% and 73.3% treatment group subjects respectively.

Therapeutic exercise is applied as essential therapy to patients with scoliosis Grade 1 and Grade 2 and as adjunct therapy to patients with scoliosis Grade 3 and Grade 4. Exercises are chosen individually depending on the severity of case, presence or absence of underlying diseases and contraindications. Exercises are intended for stimulation and strengthening of back muscles, which help straighten out the spine and other bones. No workouts, racing, jumping and spine-twisting

exercises are allowed. Gym ball exercises and use of specific training devices have proved useful. The length of training courses varied between 2 and 6 months (3.5 ± 0.01 months on average).¹⁰

Massaging scoliosis-affected areas helps muscles regain tone, improves blood circulation and metabolism. Therapy lasts 10 days, and it is repeated every two months over a 12-month period. Physiotherapy is prescribed for patients with a Cobb angle of 10 degrees or more. This kind of therapy improves blood flow and nerve conduction, eliminates pain and normalizes tissue metabolism. Treatment group patients have used Almagand Duna devices, as well as a Vitaфон vibration massage device to stimulate core back muscles. Therapy lasts 10 days and it is repeated every two months over a 12-month period.

Brace therapy has been carried out with the use of a Cheneau type functional correcting brace. Measurements have been made individually on each patient. The use of an orthopedic brace is prescribed to patients with steadily progressing scoliosis and a Cobb's angle of 25-40 degrees (Grade 3 and Grade 4). Braces have been made on the basis of individual measurements for 18 subjects in such a way as to minimize discomfort. A brace should be worn several hours a day and removed only during

gymnastics and hydrotherapeutic procedures (Fig. 2) It should be used for a period of 12 months.



Рис. 2. Patient M., 13 years old. Scoliosis Grade 3. Brace therapy, view from the rear and front (a Cheneautype brace)

Late fate has been evaluated based on the results of clinical, X-ray and instrumental method of diagnosis, as well as based on patients' posture and appearance. We have included in the late fate the results of treatment achieved after 12 month of therapy.

The obtained data has been subject to statistical analysis on a Pentium-4 computer with the use of Excel package featuring statistical functions. Differences between median values have been deemed relevant with P-value $P < 0.05$.

Results

Throughout the treatment, all patients have shown a quick improvement as early as by the fifth session, having less pain in the back, neck and legs. A clinical examination revealed a decrease in waist asymmetry in both groups (Table 1). In the comparison group, the asymmetry has decreased by 0.44 ± 0.08 cm (the decrease ratio (DR)=41.0%, $p < 0.005$), in the treatment group – by 0.33 ± 0.07 cm (DR=56.3%, $p < 0.005$). In the comparison group, the discrepancy between shoulder-blade and shoulder angles decreased by 1.0 ± 0.5 cm (DR=30.1%, $p < 0.005$), in the treatment group – by 1.4 ± 0.6 cm (DR=54.3%, $p < 0.005$).

Thus, the treatment group has shown a less severe spinous process rotation in the lumbar area, and the deterioration has been fairly rarer according to 3 out of 5 parameters. In the Grade 1 group, the clinical effect has been achieved both in the comparison and treatment group. In the treatment group, waist asymmetry has decreased by $58.4 \pm 1.4\%$, shoulder asymmetry – by $57.3 \pm 1.2\%$, while in the comparison group it has decreased by $23.5 \pm 1.3\%$ and 24.4% respectively ($p < 0.005$).

Table 1: Dynamics of clinical signs of scoliosis in the groups

Common signs	Treatment group (n=90)		P	Comparison group (n=30)		P
	Pre-treatment	Post-treatment		Pre-treatment	Post-treatment	
Deviation of the body	76 (84.4%)	56 (62.2%)	<0.05	25 (83.3%)	22 (75.9%)	>0.05
Thoracicspinous process rotation	82 (91.1%)	61 (72.2%)	<0.05	27 (90.0%)	25 (83.3%)	>0.05
Lumbar spinous process rotation	88 (97.8%)	75 (83.3%)	>0.05	29 (96.7%)	27 (90.0%)	>0.05
Shoulder-blade asymmetry	76 (84.8%)	38 (42.2%)	<0.05	28 (93.3%)	23 (76.7%)	>0.05
Breastbone-to-superior-iliac-spine asymmetry	90 (100%)	46 (51.1%)	<0.01	29 (96.7%)	21 (70.0%)	>0.01

*P*isthriterion of significance of the difference between pre-treatment and post-treatment indicators within a group.

The Grade 2 group has shown a somewhat lower effect than the Grade 1 group. In the comparison group, waist asymmetry has diminished by $34.3 \pm 1.2\%$, in the treatment group – by $42.4 \pm 1.4\%$ ($p < 0.005$). Shoulder-blade and shoulder asymmetry has decreased by $52.5 \pm 1.3\%$ in the treatment group and by $45.4 \pm 1.1\%$ in the comparison group. Clinical symptoms in juvenile and adolescent subjects with scoliosis Grade 3 have changed as follows: in the treatment group, waist asymmetry has

decreased by $25.3 \pm 1.2\%$, in the comparison group - by $20.1 \pm 1.2\%$.

The treatment group has demonstrated a 6% increase in active spinal flexibility while performing forward bends and a 14.1% increase while performing backward leans. The asymmetry of left-side and right-side tilt depth values in patients with early stage and mild scoliosis has not exceeded 10%. The asymmetry has

been more pronounced in Grade 2 and Grade 3 groups (14.5%±6.2%). This category of patients has shown the best result in the treatment group, where the asymmetry ratio has decreased by 42%, while in the comparison group the ratio has decreased by 23%.

The conservative integrated treatment has boosted muscular endurance, raised tolerance to physical workload, as the subjects have done well in back therapy training and had no back pain after exercising. The investigation has revealed a potential for a longer abdominal muscle workout in the treatment group. At the lower end, the maximal increase – by 59% - has been observed in the treatment group (27.1±22.1 seconds before treatment vs. 86.0±29.3 seconds, $p>0.05$), while in the comparison group – by 20.2% (67.1±35.5 seconds before treatment and 86.0±29.3 seconds after treatment, $p>0.05$). The endurance of back muscles in a lying-straight position has increased in both groups by 27% to 30% (82.0±34.9 seconds before treatment and 103.0±34.3 seconds, $p<0.05$)

Discussion

A comparative analysis of the results of the therapy achieved by the treatment and control groups has shown that positive changes have been more pronounced in the treatment group. These changes have been observed both during a clinical and radiological examination. The biggest achievement is that the obtained data correlate and demonstrate mitigation of structural scoliosis symptoms.¹¹

A review of the results achieved by the comparison

group reveals mild positive clinical dynamics in juvenile and adolescent subjects. The Cobb's angle dynamics observed across the groups, which takes into account the degree and localization of curvatures, is presented in Table 2.

As follows from the table, the juvenile and adolescent subjects of the treatment group show a more pronounced decrease in the Cobb's angle regardless of grade, relative to the comparison group.¹²

The comparative analysis has revealed the most prominent positive results in the treatment group. The changes have been observed both during clinical and following radiological examinations.

A frontal radiograph made in a lying position (Fig. 2c) is used to evaluate frontal imbalance and determine the Kazmin's index of stability, which can be deemed as orthostatic interdependence of deformation parameters. The frontal images (Fig. 2d, e) made in maximal right- and left-side bending positions are functional *bending test* type radiographs.

It is advisable to plan orthopedic tests at this stage, depending on the clinical picture and bone maturity, at a two to six-month interval. During treatment, radiographic imaging is carried out as part of brace therapy; frontal and lateral images are made in a standing position (Fig. 3) The following radiographs reflect the result of the correction therapy, and their data is compared to initial curvature parameters, particularly with those of the bending test images, which are actually the target parameters for the correction therapy.

Table 2: Cobb's angle dynamics during the treatment

	Type of scoliosis	Severity of curvature (degrees)		Correction		P
		Pre-treatment indicators	Post-treatment indicators	Degrees	%	
Comparison group (n=30)	Grade 1 (n=7)	7.6±0.3	6.6±0.2	1.0±0.01	6.0	>0.05
	Grade 2 (n=8)	17.7±2.5	16.1±2.5	1.6±0.1	9.0	>0.05
	Grade 3 (n=9)	50.4±3.6	50±3.8	0.4±0.08	0.79	>0.05
	Grade 4 (n=9)	73.2±4.1	72.3±5.6	0.9±0.06	0.81	>0.05
Treatment group (n=90)	Grade 1 (n=29)	7.2±0.2	4.9±0.09	2.3±0.01	9.2	<0.05
	Grade 2 (n=20)	18.75±1.3	14.5±1.5	4.25±0.3	22.7	<0.05
	Grade 3 (n=11)	18.2±1.1	14.2±1.4	4±0.4	22	<0.05
	Grade 4 (n=30)	44±4.7	40.6±4.3	3.4±0.5*	7.7	>0.05

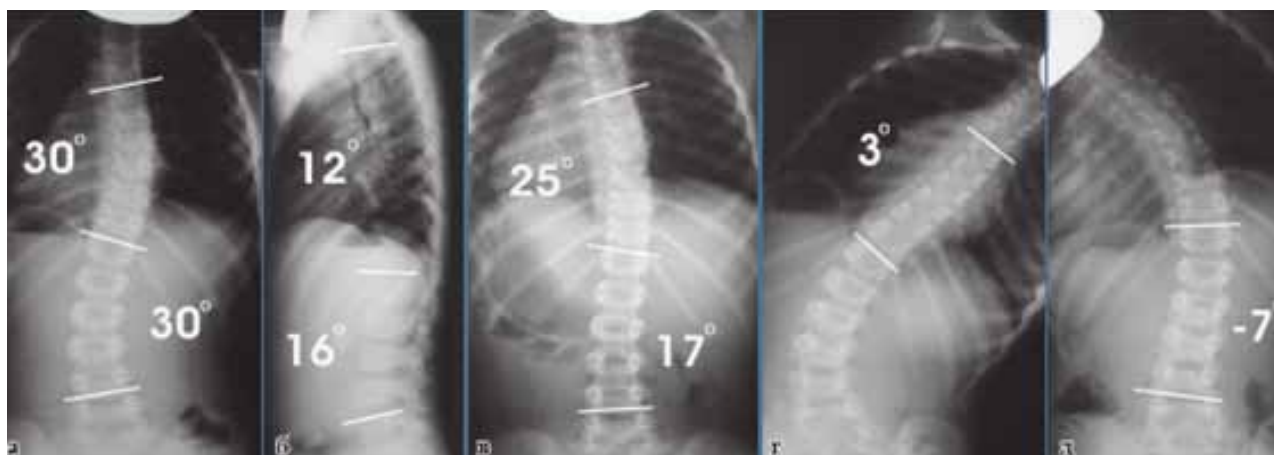


Fig. 2. X-ray images of an idiopathic scoliosis patient requiring brace treatment: frontal image made in a standing position (a); lateral image made in as tan ding position (b); frontal image made in a lying position (c); frontal image made in a maximal right-side bending position (d); frontal image made in a maximal left-side bending position (e).



Fig. 3. Pre-treatment (a) and corrective brace therapy (b) radiographs of the spine: effect achieved following frontal major curve correction Th11-L3 on the left



Fig. 4. A 8-year-old girldiagnosed with moderatescoliosis: a –case record; b –a Cheneau type brace; c) radiograph received during initial medical examination; 6) radiograph received following the brace therapy

In all 18 subjects deformities have improved. In 12 patients, the positive effect has lasted throughout the follow-up period (Fig. 4 a, b, c, d).

In five subject deformities continued to deteriorate throughout six months due to failure to follow brace

treatment requirements. Correction has required two additional braces on average.

Two subjects needed a surgery, one due to refusal to undergo brace treatment; the other had a severe case of scoliosis without a possibility of curve correction.

Conclusion

Therefore, treatment of children suffering idiopathic scoliosis Grade 3 and Grade 4, with a Cheneau brace in combination with individual therapeutic exercises, in most cases helps eliminate scoliosis symptoms. However, in cases when a visibly good effect is achieved, which is purely cosmetic, without actually progressing in the correction of spinal deformities, surgical treatment is still admissible. Refusal to wear a brace is the most common cause of deteriorating deformities. It is necessary to carry out socio-educational work to provide early diagnostic of IS to avoid progressive spinal deformities and reduce the risk of having to undergo surgeries.

1. Juvenile and adolescent idiopathic scoliosis is characterized by a spinal dysfunction, as in 85.2% of scoliosis subjects deflection of spinous processes from the axis has been observed, 78.9% have shoulder-blade asymmetry, and 53.1% of subjects have shoulder asymmetry. The Nash and Moe method has helped reveal torsion in 13.3% of children.
2. Children and teenagers with IS have bone tissue pathologies resulting in a 2.8 times lower Z-score in mineral bone density tests, which signifies low osteosynthesis and structural changes in the spine.
3. Data obtained during mineral bone density tests on children and teenagers with IS can be used as prognostic criteria to evaluate the likelihood of deterioration.
4. The newly developed conservative integrated IP treatment method is more effective than traditional method, as it helps achieve a positive effect in 89.4% of cases compared to traditional method providing 56.9% of such cases.
5. The study has proved the efficacy of brace therapy in juvenile and adolescent IS subjects, as it has stopped the deterioration and helped correct axial spinal deformities.

Ethical Clearance: No ethical approval is needed.

Source of Funding: Self

Conflict of Interest: Nil

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