SURGERY FOR IDIOPATHIC SCOLIOSIS WITH A COBB ANGLE OF LESS THAN 40 DEGREES: RESULTS, QUESTIONS AND PROBLEMS

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Objective. To perform multicomponent assessment of the results of surgical treatment of patients with idiopathic scoliosis of less than 40° according to Cobb and their compliance with patients' expectations.
Material and Methods. A total of 105 patients (97 women and 8 men) with an average age of 18.8 years, including 51 (48.6%) patients aged 18 years and older, were operated on for idiopathic scoliosis with a primary curve that did not exceed 40° (average 34.9°) at the time of surgery. Surgery was performed using Drummond instrumentation (2 patients), Antares system (4), and CDI (99), including using pedicle screws in 47 cases. The average period of postoperative follow-up was 51.1 months (range 24 to 170 months). Examination methods included clinical and radiological examination, SRS-24 questionnaire, and examination by a clinical psychologist.
Results. In the overall group of 105 patients, the primary curve decreased during the intervention from 34.9° to 11.6° (correction – 66.7%), and at the end of the observation period it was 14.1° (loss of correction – 10.7%). The countercurvature correction was 60.1% with a subsequent loss of correction of 1.1° (7.4% of the achieved correction). Transpedicular fixation resulted in significantly greater correction of the primary curve (24.7° vs. 21.7°) with a smaller loss of correction (0.7° vs. 5.4°). Survey using the SRS-24 questionnaire demonstrated significant positive trends in the overall score (the so-called Grand Total) and in the domains of general and professional activity. Negative trends were noted for the assessment domains of postoperative appearance and satisfaction with treatment results.
Conclusion. Idiopathic scoliosis with a primary curve less than 40° is often treated surgically due to patient's demand. A significant proportion of patients are not fully satisfied with the outcome. Indications for surgery for such deformities should be formulated strictly on an individual basis, and patients require special preparation, primarily psychological.
Keywords: idiopathic scoliosis; Cobb angle less than 40°; surgical treatment.
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The first report of successful surgical correction of progressive idiopathic scoliosis was associated with the introduction of the Harrington rod in the early 1960s [1]. Since then, the use of metal implants has been the only effective technique to correct such deformities. Thereafter, the magnitude of the primary curve of 40° according to Cobb [2] was assumed the borderline for indications for surgery [3]. This approach has persisted up to the present day, although some surgeons consider deformities reaching 45° to be an indication for surgery [4]. Nevertheless, this strategy does not necessarily imply that surgeries are never performed for deformity values below this threshold: references to such specific cases are not only found in articles on idiopathic scoliosis surgery with large cohorts [5], but are also repeatedly demonstrated in presentations at conferences of various levels, both national and international.

It is known that patients may strongly refuse scoliosis bracing, most commonly adolescent girls and women who are very self-conscious about their appearance. The introduction of dynamic scoliosis correction techniques, such as Vertebral Body Tethering (VBT) and Anterior Scoliosis Correction (ASC), has slightly reduced the limits for corrective surgery, but the indications for these procedures are limited to cases where at least 50% of mobility has been preserved. Yet, national clinical guidelines and protocols for orthopedic units where these procedures are performed specify 40° as the lower limit for surgical correction of spinal deformities, whereas no strong justification for choosing this particular value has been found. A review of current databases containing information on almost all academic articles on the surgical treatment of idiopathic scoliosis has led to disheartening results: we did not find a single article on surgical treatment of patients with deformities less than 40°.

A retrospective analysis of the experience of the Department of Pediatric and Adolescent Vertebrology at the Novosibirsk Research Institute of Traumatology and Orthopaedics n.a. Ya.L. Tsivyan since September 1996 (the first use of Cotrel–Dubousset instrumentation in Russia) revealed more than 200 patients who underwent surgery for idiopathic scoliosis of less than 40°. The main indication for surgical treatment in these patients, apart from the progression of the disease, was their urgent desire, expressed in the most convincing manner, which we were unable to ignore. The impression was that a considerable part of the patients was adult women who were quite successful

in other areas of their lives, such as family, career, etc. This illogical fact motivated us to examine the collected data.

The objective is to perform a multicomponent assessment of the surgical treatment results of patients with idiopathic scoliosis of less than 40° according to Cobb and their compliance with patients' expectations.

Study design: retrospective, non-interventional, uncontrolled, single-center.

Material and Methods

At the Pediatric and Adolescent Vertebrology Clinic at the Novosibirsk Research Institute of Traumatology and Orthopaedics n.a. Ya.L. Tsivyan, 3,995 patients with idiopathic scoliosis were operated on between 1996 and 2025. In 228 (5.7%) of these cases, the magnitude of the primary curve was less than 40°. The inclusion criteria for this study, in addition to the severity of the deformity, were the availability of a complete set of pre- and postoperative radiographs, including functional ones (see below), and a controlled postoperative follow-up period exceeding two years.

A total of 105 patients (97 women and 8 men) met the specified criteria; their mean age was 18.8 (11–43) years, including 51 (48.6%) patients older than 18 years. The mean postoperative follow-up period was 51.1 months (24–170).

All deformities were localized in the thoracic spine; only four cases were classified as rigid (less than 25% correction in the position of lateral tilt), while the rest were classified as mobile. A countercurvature in the lumbar spine was observed in 38 patients and in the thoracolumbar spine in one patient. In 85 cases, the deformity was classified as compensated or subcompensated (the distance between the plumb line and the median sacral line was less than 2 cm), and in 20 cases as decompensated. During the procedures, Drummond spinal instrumentation (2 cases), Antares system (4), and CDI and its derivatives (99) were used. In 47 cases, pedicle screws were used as fasteners.

Comorbidities in the preoperative period were identified in 48 (45.7%) patients: the most common of the 59 diseases identified were gastrointestinal diseases (33 cases), degenerative disc disease (5), and urinary tract disorders (5). Before admission to the clinic, nine patients underwent surgeries, the most severe of which were L5 spondylolisthesis surgery, hip replacement, aortic coarctation repair, and pyloromyotomy.

Examination technics

In accordance with the research objectives, the following data kept in the clinic's database were selected for analysis:

- results of clinical and radiological examinations of all patients at all stages of treatment, including standard radiological spondylograms of the thoracic and lumbar spine in two planes in a standing position and functional radiographs of the same spine departments in the anteroposterior view, supine, in the active lateral tilt;
- patient survey data in the immediate and long-term postoperative periods using the SRS-24 questionnaire, assessing health-related quality of life (HRQoL) [6];
- psychotherapist's conclusions.

Statistical methods

The Mann–Whitney U test was used to compare groups because of the non-normality of distributions for most of the studied indicators according to the Shapiro–Wilk test. The comparison of indicators before and after the surgery was done using the Wilcoxon signed-rank test. Descriptive characteristics of continuous indicators are presented as median [first quartile; third quartile] (MED [Q1; Q3]), mean ± standard deviation (M ± SD), and maximum and minimum values (MIN–MAX); the number of patients and frequency in each category for categorical indicators. The Fisher's exact test was applied for categorical indicators. All comparison tests were bilateral. Statistical hypotheses were tested at a significance value of $p = 0.05$, i.e., differences were considered statistically significant at $p \leqslant 0.05$. Statistical processing of the results was performed in the IDE Rstudio (version 2024.09.1) using the R language (version 4.3.3).

Results

The course of the primary and secondary curves, thoracic kyphosis, and lumbar lordosis. Table 1 provides data on the course of the primary and secondary curves, thoracic kyphosis, and lumbar lordosis for the entire study group as a whole, while Table 2 provides data for two subgroups that underwent surgery using Cotrel–Dubousset instrumentation (CDI) with different types of support elements (hooks and pedicle screws).

The primary curve during the surgery in the overall group decreased from 34.9° to 11.6° (66.7% correction), and at the end of the follow-up period it was 14.1° (10.7% loss of correction). Conversely, countercurve has been corrected by 60.1%, with a correction loss of 1.1° (7.4%). Transpedicular fixation resulted in a significantly greater correction of the primary curve (24.7° vs. 21.7°) and a decreased loss of correction (0.7° vs. 5.4°).

There were 10 patients with complications (0.095 complications/patient): five cases were related to the implant, three cases had mild and completely resolved neurological symptoms, one case was associated with infection of the surgical site, and one case was associated with the development of upper thoracic countercurvature. No additional surgeries were required in any case.

Survey results using the SRS-24 questionnaire. The analysis of most parameters (pain, general appearance, postoperative function, general activity, and professional activity) illustrates positive trends, although the reliability of the changes is confirmed only in relation to the domains of general and professional activity and the total score (the so-called Grand Total; Fig.). Meanwhile, negative trends were observed for domains related to appearance after surgery and satisfaction with treatment outcomes (Table 3).

Discussion

This section traditionally starts with a literature review, yet we were unable to find any articles on the surgical treatment of idiopathic scoliosis with a curve of less

than 40°. We can only mention the study by Friedman et al. [5] that focuses on the treatment of patients with idiopathic scoliosis and a Cobb angle ranging from 40° to 50°. The authors' main conclusion was that surgical treatment is more effective than conservative treatment, which is confirmed by the HRQoL study using the SRS-22 questionnaire. It should be mentioned that positive statistically significant changes were observed in all five domains (pain, self-assessment of appearance, general function, mental health, and satisfaction with the result) and in the total score. In turn, Negrini et al. [7] considered deformities of 40°–50° to be a 'gray area' for which the decision on the choice of treatment option may be challenging. According to data from the SRS-22 questionnaire, Duarte et al. [8] concluded that there were no significant differences in patients with deformities ranging from 30° to 50° who were treated with a brace and AVBGM (anterior vertebral body growth modulation). All of this limited data is not directly related to the issue we are studying.

We were interested in who and why they express a strong desire to undergo such a massive surgery for a minor cosmetic spinal deformity and how patients rate the results.

The study generated controversial results. If we consider the entire study group as a whole, the obtained radiological results seem quite predictable. The initial primary curve (34.9°) demonstrates virtually identical mobility during lateral tilt and during the procedure (up to 11.2° and 11.6°, respectively), with minimal loss of correction over a period of more than two years (2.5°). The same can be said about the secondary curve. At all stages of the examination, lumbar lordosis and thoracic kyphosis remain within physiological parameters. Attempting to compare the surgical outcomes of hook and transpedicular fixation did not reveal any statistically significant differences, with one exception: screw fixation provided significantly greater correction of the primary curve, although the difference in absolute terms was not very high. This result is also quite predictable.

Table 1
Changes of radiological parameters in the general group of operated patients

Number of patients, *n*	105
Male to female ratio	97 : 8
Age, years	18.8 (11–43)
Follow-up period, months	51.1 (24–170)
Primary curve before surgery (standing), degrees	34.9 (25–39)
Primary curve before surgery (lying in lateral tilt position), degrees	11.2 (–14–34) Mobility – 23.7 (67.9%)
Primary curve immediately after surgery, degrees	11.6 (1–25) Mobility – 23.3 (66.7%)
Primary curve at the end of the follow-up period, degrees	14.1 (4–30) Loss of correction – 2.5 (10.7%)
Secondary curve before surgery (standing), degrees	24.8 (2–37)
Secondary curve before surgery (lying in lateral tilt position), degrees	7.2 (–17–21) Mobility – 17.6 (70.9%)
Secondary curve immediately after surgery, degrees	9.9 (1–24) Mobility – 14.9 (60.1%)
Secondary curve at the end of the follow-up period, degrees	11.0 (6–20) Loss of correction – 1.1 (7.4%)
Thoracic kyphosis before surgery, degrees	30.05 (5–58)
Thoracic kyphosis immediately after surgery, degrees	24.1 (9–56)
Thoracic kyphosis at the end of the follow-up period, degrees	25.3 (13–42)
Lumbar lordosis before surgery, degrees	59.1 (31–75)
Lumbar lordosis immediately after surgery, degrees	50.2 (27–73)
Lumbar lordosis at the end of the follow-up period, degrees	51.3 (27–73)

Age aspect. A previously published paper [9] provides a detailed analysis of the surgical outcomes for patients with idiopathic scoliosis of all types of deformities and age groups. The cohort studied was united by the fact that all patients underwent surgery using CDI and its analogues, with hooks used exclusively as fasteners. Among 640 patients, only 58 were of 20 years or older, accounting for 9.1% of the total, and this ratio can probably be considered to be objective, since the selection of patients was completely random. According to this study data, 51 (48.6%) of 105 patients with spinal deformities of less than 40° underwent surgery when they were 18 or older, including 33 (31.4%) who were over 20. An inevitable issue is the following: why are there so many adult female patients among those who have undergone surgery for idiopathic scoliosis with a deformity of less than 40°?

The second question is why young girls and women, often having families, jobs, and social and financial security, insist on immediate correction of spinal deformity that has minimal cosmetic defects and is practically invisible in clothing (i.e., in everyday life)? In our experience, these questions cannot be answered conclusively during an outpatient appointment.

We assumed that the situation could be explained by the data from the health-related quality of life (HRQoL) survey. Why do two domains (appearance and satisfaction with treatment outcomes) show negative trends? Could it be that their connection is driven by the high expectations of patients, the vast majority of whom are women, and in almost 49% of cases, adults? What 'clearly visible' outcomes can be expected with initially very moderate spinal deformity?

The SRS-24 questionnaire is particularly useful in terms of the response to the final question: "Would you have the same treatment again under the same

Table 2

Changes of radiological indicators when using different types of CDI endocorrectors in patient groups

Indicators	CDI group (hooks)	TPF group	*p*
Number of patients, *n*	51	48	–
Male to female ratio	47 : 4	44 : 4	–
Age, years	19.2 (19–42)	18.3 (12–43)	–
Follow-up period, months	56.9 (24–170)	42.3 (24–84)	–
Primary curve before surgery (standing), degrees	34.1 (25–39)	35.6 (27–39)	–
Primary curve before surgery (lying in lateral tilt position), degrees	10.1 (–5–28) Mobility – 24.0 (70.4%)	12.3 (14–34) Mobility – 24.7 (65.5%)	0.696
Primary curve immediately after surgery, degrees	12.4 (4–35) Mobility – 21.7 (63.6%)	10.9 (2–19) Mobility – 24 (71.6%)	0.045*
Primary curve at the end of the follow-up period, degrees	17.8 (5–30) Loss of correction – 5.4 (24.9%)	11.6 (4–19) Loss of correction – 0.7 (2.8%)	0.149
Secondary curve before surgery (standing), degrees	24.9 (12–27)	24.6 (2–39)	–
Secondary curve before surgery (lying in lateral tilt position), degrees	6.2 (–17–21) Mobility – 18.7 (75.1%)	8.4 (–3–23) Mobility – 16.2 (65.8%)	0.689
Secondary curve immediately after surgery, degrees	10.2 (1–22) Mobility – 14.7 (59.0%)	9.4 (3–18) Mobility – 15.2 (61.8%)	0.847
Secondary curve at the end of the follow-up period, degrees	12.8 (9–21) Loss of correction – 2.6 (17.7%)	9.2 (6–13) Loss of correction – 0.0 (0.0%)	–
Thoracic kyphosis before surgery, degrees	30.4 (5–58)	29.9 (5–48)	0.941
Thoracic kyphosis immediately after surgery, degrees	23.7 (9–56)	24.5 (5–44)	0.408
Thoracic kyphosis at the end of the follow-up period, degrees	25.3 (13–42)	30.2 (20–53)	0.348
Lumbar lordosis before surgery, degrees	58.3 (31–75)	59.5 (37–44)	0.408
Lumbar lordosis immediately after surgery, degrees	49.4 (27–66)	50.8 (24–71)	0.481
Lumbar lordosis at the end of the follow-up period, degrees	51.3 (28–77)	61.7 (38–83)	0.205

* Statistically significant differences; TPF – transpedicular fixation; CDI – Cotrel–Dubousset instrumentation.

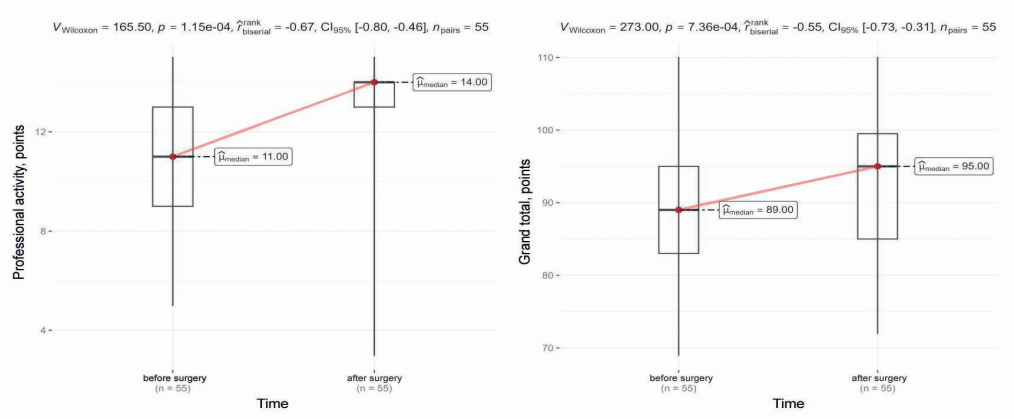

Fig.

Boxplots showing the changes of the professional activity domain in the postoperative period **(a)** and the overall Grand Total score **(b)** in patients with idiopathic scoliosis and a curve magnitude of less than 40°

Table 3

Results of the patient survey using the SRS-24 questionnaire ($n = 55$), points

Indicator (domain)	Before surgery MED [Q1; Q3] M ± SD (MIN–MAX)	After surgery MED [Q1; Q3] M ± SD (MIN–MAX)	Difference assessment PSEUDO MED [95% CI] SMD [95% CI]	Wilcoxon test (*p* value)
Pain (questions 1, 2, 3, 6, 8, 11, 18)	29 [26.0; 30.0] 27.84 ± 3.76 (17–34)	29 [26.0; 30.5] 28.31 ± 3.35 (21–35)	0.5 [0.5; 0.5] 0.13 [0.24; 0.51]	0.289
General appearance (5, 14, 25)	12 [11.0; 13.0] 12.11 ± 1.61 (9–15)	12 [11.0; 14.0] 12.47 ± 1.63 (10–15)	0.5 [0.5; 0.5] 0.22 [0.15; 0.60]	0.085
Appearance after surgery (19, 20, 21)	12 [11.0; 14.0] 12.44 ± 1.77 (9–15)	12 [11.0; 14.0] 12.29 ± 2.11 (7–15)	0 [0.0; 0.0] –0.07 [–0.45; 0.30]	0.709
Function after surgery (16, 17)	2 [2.0; 4.0] 3.56 ± 2.23 (2–10)	4 [2.0; 6.0] 4.15 ± 2.46 (2–10)	0 [0.0; 0.0] 0.25 [–0.13; 0.62]	0.134
General activity (7, 12, 13)	10 [8.0; 10.5] 9.60 ± 2.00 (5–15)	10 [10.0; 12.0] 10.55 ± 1.98 (6–15)	1 [–0.5; 1.0] 0.48 [–0.10; 0.85]	0.015*
Professional activity (4, 9, 10)	11 [9.0; 13.0] 10.95 ± 2.98 (5–15)	14 [13.0; 14.0] 12.73 ± 2.69 (3–15)	2 [2.0; 2.0] 0.63 [0.24; 1.01]	<0.001*
Satisfaction with treatment results (22, 23, 24)	14 [11.5; 14.0] 12.76 ± 2.05 (7–15)	13 [11.0; 14.0] 12.51 ± 1.97 (8–15)	0 [0.0; 0.0] –0.13 [–0.50; 0.25]	0.290
Grand Total	89 [83.0; 95.0] 88.91 ± 8.86 (69–110)	95 [85.0; 99.5] 92.85 ± 9.06 (72–110)	0 [0.0; 0.0] 0.25 [–0.13; 0.62]	<0.001*

* Statistically significant differences

condition?" Nine (16.7%) of 55 patients in our cohort who completed the questionnaire answered this question in the negative. Since question 24 is one of the criteria determining satisfaction with treatment outcomes, it is easy to assume that a negative assessment of this parameter is directly associated with the rejection of the hypothetical possibility of undergoing treatment again. It is highly likely that the negative assessment of satisfaction with the outcomes is associated with a negative assessment of appearance after surgery. E.V. Gubina et al. [10] present data indicating a direct link between satisfaction with appearance after surgical correction of idiopathic scoliosis and consent to surgical treatment under the same conditions; immediately after corrective surgery, 75% of patients gave a positive answer to question 24, before rib hump resection surgery – 80%, and after resection – 100% of patients. Rib hump resection is a treatment that cannot be considered curative since its only purpose is to eliminate a cosmetic defect, namely asymmetry between the right and left hemithorax. What prompted this assessment?

The questions, therefore, multiply. A non-standard issue should be solved in a non-standard way.

Opinion of a psychotherapist. The discussed group of patients does not have a critical need for surgery, and their health condition does not cause concern; nevertheless, people insist on correcting deformities that can often only be visible on radiological images. Psychological reasons may be hidden behind such a decision.

• *Low self-esteem.* An individual's self-esteem is formed from birth and depends on a variety of factors and situations through which the child has developed certain beliefs, including whether he or she is good or bad, how well he or she meets the expectations of parents, teachers, friends, partners, and society, whether he or she is attractive or not, and why. Commonly, scoliosis is manifested during periods of rapid growth, when an individual is experiencing a crisis of self-formation, identity, and relationships with peers. It is crucial for girls to accept their femininity and attractiveness. Given the prevalence of adolescent body dysmorphic disorder (rejection of changes in their growing bodies) during this period, manifestations of spinal deformity can cause emotional harm to

their developing personalities. A feeling of inferiority and inadequacy arises, along with fear of increased deformity and the appearance of a rib hump. The level of anxiety about the future increases. The reaction of those around the child is very much a factor: if loved ones are frightened by the diagnosis, the child's anxiety will intensify. An imagined picture of oneself as ugly, followed by a negative belief about one's appearance based on this picture, often becomes a traumatic experience. There comes a desire to get rid of it at any cost, sometimes even years later.

• *A high level of personal anxiety* discourages one from seeing the situation in reality and diminishes confidence in oneself and a happy future. During this and other stages, the help of a psychologist or psychotherapist is crucial. The goal is to reduce emotional responses and objectively assess the current situation. If there is a calm, rational approach from adults, psychologists, and doctors, it is possible to get support, accept the situation, and formulate a rational plan for solving the challenges as they arise.

• *Depressive disorders* at any age contribute to a blighted vision of the present and future, as well as negative self-esteem.

• *Personality disorders*, such as emotionally unstable, avoidant, dependent, paranoid, histrionic (hysterical), and mixed types.

When analyzing the results of the SRS-24 questionnaire, especially the dissatisfaction with the surgical outcomes, it can be assumed that patients expected a different result from the surgery, but their expectations did not match reality. Possible options:

1) the expectation that the appearance will not just be different but perfect; since the initial deformity is not particularly noticeable, the difference cannot be grate;

2) underestimation or inconsistency between the severity of the postoperative period and the duration of the rehabilitation period with the outcome achieved;

3) elimination of scoliosis involves getting rid of all unresolved life challenges, which is essentially shifting responsibility for one's life onto circumstances ("waiting for a miracle");

4) the desire to get rid of inferiority, to become like everyone else; this internal picture of one's body image can only be modified through collaboration with a psychologist or psychotherapist;

5) retention of negative beliefs about oneself, one's self-worth, and identity;

6) insufficient awareness of the need to adhere to an orthopedic regimen and of possible complications; an unwilling refusal of favorite hobbies, such as equestrian sports or downhill skiing.

Any assessment is subjective and largely depends on the perspective through which the outcome is being assessed. For patients with spinal deformities up to 40°, many complaints are those of psychological dissatisfaction with quality of life, which cannot be corrected through surgery. For this reason, prior to referring a patient for surgical treatment, it may be recommended to undergo a course of psychotherapy, which will enable them to distinguish between internal and external issues and guide them in making a decision that they will be satisfied with.

Conclusion

Idiopathic scoliosis with a primary curve of less than 40° is often surgically treated because of the strong desire of patients, almost half of whom are over 18 years old. Moreover, some patients are not fully satisfied with the outcome, even when the correction is sufficient from the surgeon's perspective. Considering this, the indications for surgery in such patients should be very thoughtfully and strictly individualized, and patients need special, primarily psychological, preparation.

Limitations of validity. The main limitation of the study is its retrospective design, which is designed to examine only data that was available at the time of treatment and accessible in the archives of the institution or researcher. This also clarifies the fact that not all patients in the cohort under study have a complete set of assessed data.

It is fundamentally impossible to use modern specialized questionnaires for a 30-year retrospective. For this reason, the psychologist's opinion is derived from the data of the general SRS-24 questionnaire and is given in the "Discussion" section rather than the "Results" section.

The heterogeneity of surgical treatment technologies, including CDI techniques (hook and screw structures) that totally accounts for more than 93% of surgeries.

A detailed analysis of many factors inevitably influencing the subjective assessment of treatment outcomes is impossible because of relatively small number of patients. Their assessment within different age groups (the study included adolescents, young women, and mature women aged 11 to 43), professional groups, and social groups necessitates a significantly larger set of data and the use of specialized assessment tools.

We believe that a prospective psychological study of patients suffering from spinal deformities is imperative for evaluating the treatment efficacy of any specialists, including orthopedists, surgeons, orthotists, and rehabilitation specialists. Yet, considering the initially limited clinical group (idiopathic scoliosis less than 40°), this analysis is unlikely to be realized within a single surgical unit.

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The study was approved by the local ethics committee of the institution.
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References

1. **Harrington PR.** Treatment of scoliosis. Correction and internal fixation by spine instrumentation. *J Bone Joint Surg Am.* 1962;44-A:591–610. DOI: 10.2106/00004623-196244040-00001
2. **Cobb J.** Outline for the study of scoliosis. *American Academy of Orthopedic Surgeons Instructional Course Lect.* 1948;5:261–275.
3. **Tsutsui S, Pavelek J, Bastrom T, Lenke L, Lowe T, Betz R, Clements D, Newton PO.** Dissecting the effects of spinal fusion and deformity magnitude on quality of life in patients with adolescent idiopathic scoliosis. *Spine.* 2009;34:E653–E658. DOI: 10.1097/BRS.0b013e3181b2008f
4. **Dimitrijevic V, Raskovic B, Popovic M, Viduka D, Nikoli S, Drid P, Obradovi B.** Treatment of idiopathic scoliosis with conservative methods based on exercises: a systematic review and meta-analysis. *Front Sports Act Living.* 2024;6:1492241. DOI: 10.3389/fspor.2024.1492241
5. **Friedman A, Koneru M, Gentile P, Clements D.** Investigating the long-term outcomes and efficacy of surgical intervention in patients with adolescent idiopathic scoliosis and Cobb angles ranging between 40 and 50 degrees. *Spine Deform.* 2025;13:489–495. DOI: 10.1007/s43390-024-00984-y
6. **Haher TR, Gorup JM, Shin TM, Homel P, Merola AA, Grogan DP, Pugh L, Lowe TG, Murray M.** Results of the Scoliosis Research Society instrument for evaluation of surgical outcome in adolescent idiopathic scoliosis. A multicenter study of 244 patients. *Spine.* 1999;24:1435–1440. DOI: 10.1097/00007632-199907150-00008
7. **Negrini S, Donzelli S, Aulisa A, Czaprowski D, Schreiber S, de Mauroy JC, Diers H, Grivas TB, Knott P, Kotwicki T, Lebel A, Marti C, Maruyama T, O'Brien J, Price N, Parent E, Rigo M, Romano M, Stikeleather L, Wynne J, Zaina F.** 2016 SOSORT guidelines: orthopaedic and rehabilitation treatment of idiopathic scoliosis during growth. *Scoliosis Spinal Disord.* 2018;13:3. DOI: 10.1186/s13013-017-0145-8
8. **Duarte V, Aubin C, Cobetto N, Roy-Beaudry M, Bellefleur C, Turgeon I, Labelle H, Guy A, Barchi S, Parent S.** 3D radiological outcomes and quality of life of patients with moderate idiopathic scoliosis treated with anterior vertebral growth modulation versus bracing: two-year follow-up. *Spine.* 2022;47:1063–1070. DOI: 10.1097/BRS.0000000000004335
9. *Surgery for Idiopathic Scoliosis: Immediate and Long-Term Results*, ed. by M.V. Mikhaylovskiy. Novosibirsk, 2007. ISBN: 978-5-91475-005-0
10. **Gubina EV.** Clinical application of the Russian-language version of the Scoliosis Research Society outcomes instrument-24 (SRS-24) questionnaire. *Russian Journal of Spine Surgery (Khirurgiya Pozvonochnika).* 2004;(2):34–36. EDN: HSOYBP

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