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# Idiopathic scoliosis: long-term results of treatment of patients with the method of transpedicular fixation. Retrospective longitudinal study

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## ABSTRACT

**BACKGROUND:** The study of the treatment results of patients with idiopathic scoliosis should include both objective assessment methods, such as radiography and multispiral computed tomography, and subjective methods related to the response of the patient or his/her parents to treatment. A set of indicators will only allow an objective assessment of the long-term treatment outcomes.

**AIM:** To examine long-term treatment results of posterior transpedicular fixation in patients with idiopathic scoliosis of varying severity.

**MATERIALS AND METHODS:** Long-term treatment results by posterior transpedicular fixation were studied in 300 patients with idiopathic scoliosis of varying severity. To assess the effectiveness of treatment, clinical and radiological diagnostic methods and SRS30 and SRS22 questionnaires were used.

**RESULTS:** Treatment results in 1 year were studied in all patients and in 2 years in 225 patients (75%). In 150 patients (50%), the long-term treatment results was studied in 5, and in 15 of them (10%) in 10–12 years. The achieved correction value was maintained with a slight loss depending on the magnitude of the initial deformity and correction achieved after the operation. The SRS22 questionnaire 2 years after treatment of grade II deformity (according to Chaklin) showed that the indicators of postoperative function and remained practically unchanged, and the scores on self-esteem, appearance, and attitude were higher ( $p < 0.05$ ). In grade IV deformity, the scores on the appearance and attitude of others were high without significant differences.

**CONCLUSION:** Dorsal correction of the spine using transpedicular implants in patients with idiopathic scoliosis allows obtaining good treatment outcomes, which was confirmed by the preservation of correction during dynamic X-ray examination and assessment using the SRS22 questionnaire.

**Keywords:** idiopathic scoliosis; posterior transpedicular fixation; long-term results.

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# Идиопатический сколиоз: отдалённые результаты лечения больных методом транспедикулярной фиксации. Ретроспективное продольное исследование

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## АННОТАЦИЯ

**Обоснование.** Анализ результатов лечения больных идиопатическим сколиозом должен включать как объективные методы оценки, такие как рентгенография и мультиспиральная компьютерная томография, так и субъективные, относящиеся к реакции пациента или его родителей на лечение. Только анализ комплекса показателей позволит объективно оценить отдалённый результат лечения.

**Цель.** Изучить отдалённые результаты лечения методом задней транспедикулярной фиксации больных идиопатическим сколиозом различной степени тяжести.

**Материалы и методы.** Исследованы результаты лечения методом задней транспедикулярной фиксации 300 больных идиопатическим сколиозом различной степени тяжести. Для оценки эффективности лечения применяли клинические и лучевые методы диагностики, а также опросники SRS30 и SRS22.

**Результаты.** Отдалённые результаты наблюдения через 1 год после операции изучены у всех (100%) больных, через 2 года — у 225 (75%) пациентов, ещё у 150 (50%) больных отдалённый результат лечения исследован через 5 лет, у 15 из них (10%) — спустя 10–12 лет. Анализ результатов лечения показал, что достигнутая величина коррекции сохранялась с небольшой её потерей в зависимости от величины исходной деформации и достигнутой коррекции после операции. Анализ анкеты-опросника SRS22 через 2 года после лечения при III степени тяжести деформации (по Чаклину) показал, что показатели функции и боли после операции практически не изменились, самооценка, внешний вид и отношение окружающих имели более высокие баллы ( $p < 0,05$ ). При IV степени тяжести деформации внешний вид, отношение окружающих были оценены выше без достоверных отличий.

**Заключение.** Метод дорсальной коррекции позвоночника с тотальным использованием транспедикулярных имплантов у больных идиопатическим сколиозом позволяет получить хорошие результаты лечения, подтверждённые изучением сохранения коррекции при динамическом рентгеновском исследовании и оценкой состояния больных по опроснику SRS22.

**Ключевые слова:** идиопатический сколиоз; задняя транспедикулярная фиксация; отдалённые результаты лечения.

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## BACKGROUND

In the surgical treatment of patients with idiopathic scoliosis (IS), vertebrology surgeons address a set of tasks, namely, the elimination of spinal deformity, while maintaining the maximum number of free motor segments, the prevention of progression of the deformity, good clinical results, and patient satisfaction with the treatment. [1–5] These tasks were formulated more than a century ago; however, new diagnostic technologies and the improvement and development of instruments and surgical techniques have enabled surgeons to address these required outcomes at a higher methodological level. [6–10] An analysis of data from the literature showed that posterior transpedicular fixation in the treatment of patients with IS was especially significant in addressing this problem and improved treatment results. [5, 11–14] Surgical intervention is one of the stages of the therapeutic process, which includes diagnostics, preparatory actions, direct therapeutic measures, and evaluation of results. The success of the surgery is determined not only by the doctor, who is extremely important, but also by patients and their parents as well, in the case of younger patients. [15] Long-term results of treatment are of the greatest interest since they reflect most fully the clinical effect achieved. The function, appearance, psychological feelings of the patient, and the characteristics of pain are taken into account. The patient's response to surgery is analyzed using various scales and questionnaires. [13, 16–19] Recently, the SRS22, SRS24, and SRS30 questionnaires have been used widely, and are most suitable for assessing the results of treatment of patients with spinal pathology. [13, 16, 20–22] Currently, the SRS22 questionnaire is used more often, but we also used the SRS30 questionnaire which enables clinicians to compare the scores before and after surgery. [21, 23] Nevertheless, it is also important to study objective data on the state of the spine to assess the loss of correction. [24–27]

The study aimed to analyze the long-term results of treatment with posterior transpedicular fixation in patients with IS of varying severity.

## MATERIALS AND METHODS

### Study design

The work was conducted as part of a retrospective longitudinal study, and the evidence level was IV.

### Eligibility criteria

#### *Inclusion criteria:*

- IS in patients aged 11 to 50 years.

#### *Exclusion criteria:*

- Scoliosis of another etiology in patients older than 50 years.

### Target values assessing methods

According to clinical and radiological diagnostic methods, in 225 out of 300 (75%) patients with IS of varying severity, long-term results of treatment were studied after 2 years; in 100 patients (33.3%) these were studied according to the SRS30 and SRS22 questionnaires. In 150 (50%) patients, long-term results were recorded in the period from 5–6 to 10–12 years. The X-ray method was used to examine 300 patients before and after surgery; all patients underwent multi-slice computed tomography (MSCT) and magnetic resonance imaging (MRI) before surgery. After the surgery, MSCT and MRI were performed according to indications.

### Ethical considerations

The Declaration of Helsinki of the World Medical Association “Ethical Principles for Medical Research Involving Human Subjects,” as amended in 2000, was used as a fundamental document for observing ethical principles. Before hospitalization, patients signed documents containing sections on consent to surgery and the publication of the anonymized study results. When completing the questionnaires, patients also indicated their consent to their use as data without the identification of personal details. The study was not approved by the Local Ethics Committee.

### Statistical analysis

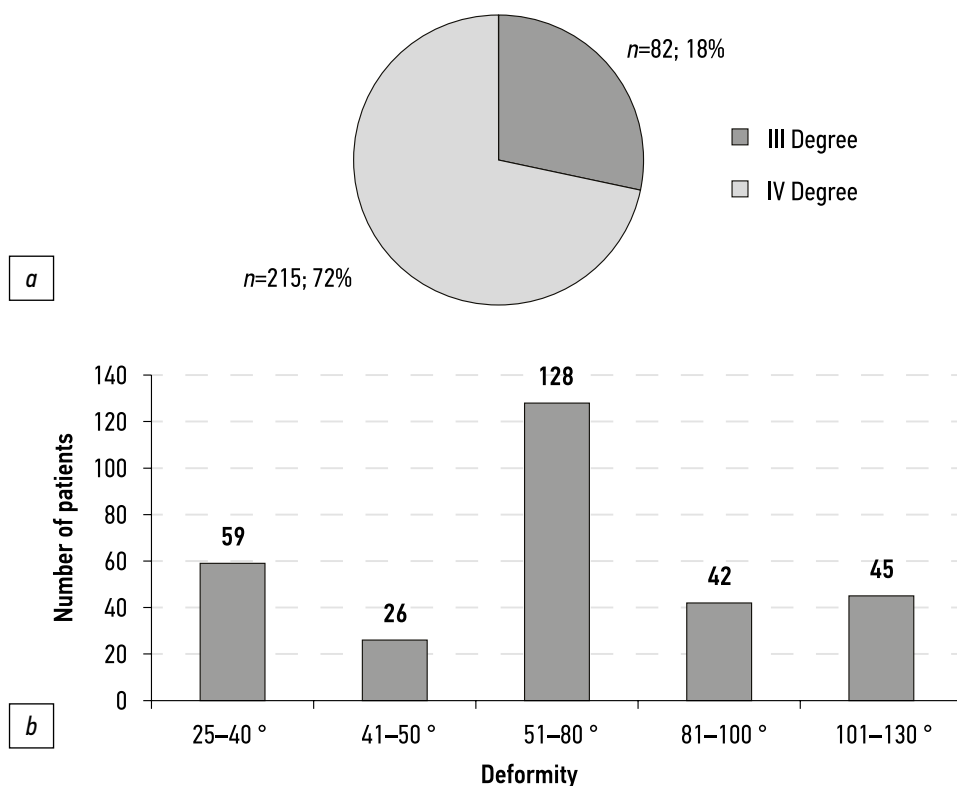
The study results were processed using the AtteStat v software. 13.1 (Russia). The normality of distribution was determined by the Kolmogorov–Smirnov test. The data were presented as  $M \pm \sigma$ , where  $M$  was the sample mean and  $\sigma$  was the sample standard deviation. The level of statistical significance of differences was  $p < 0.05$ .

## RESULTS

All patients were operated on by posterior transpedicular fixation, following the algorithm of complex diagnostics and preparation for surgical treatment, with careful adherence to the treatment methodology, taking into account the structural aspects of the fixed vertebrae, adequate postoperative follow-up, and subsequent rehabilitation. An analysis of the examination of patients with IS before treatment showed that 215 (72%) patients had scoliosis severity IV (according to Chaklin; Fig. 1).

The largest number of patients had a deformity of 51–80° ( $n=128$ , 42.7%); in 45 patients, the deformity was within the range of 101–130°. Long-term results were studied in all patients 1 year after surgery, and in 75% of patients 2 years after surgery; in 150 (50%) patients, the long-term result of treatment was studied after 5 years, and in 15 of them (10%), results were analyzed after 10–12 years.

During control examinations, the clinical situation was assessed, and the angles of deformity were studied using radiographs in comparison with the postoperative images.



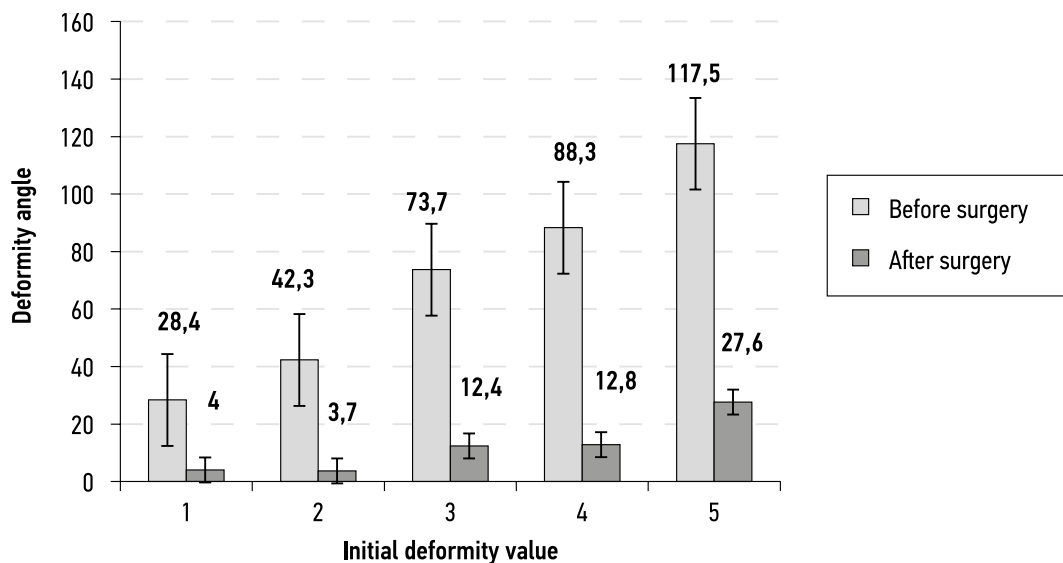
**Fig. 1.** *a* — distribution of patients according to the deformity severity (according to Chaklin), *b* — diagram of the distribution of the spine deformity value in patients with IS (*n*=300).

Figure 2 presents a diagram of changes in the angles of deformity before and after the surgery, depending on the average value of the initial deformity.

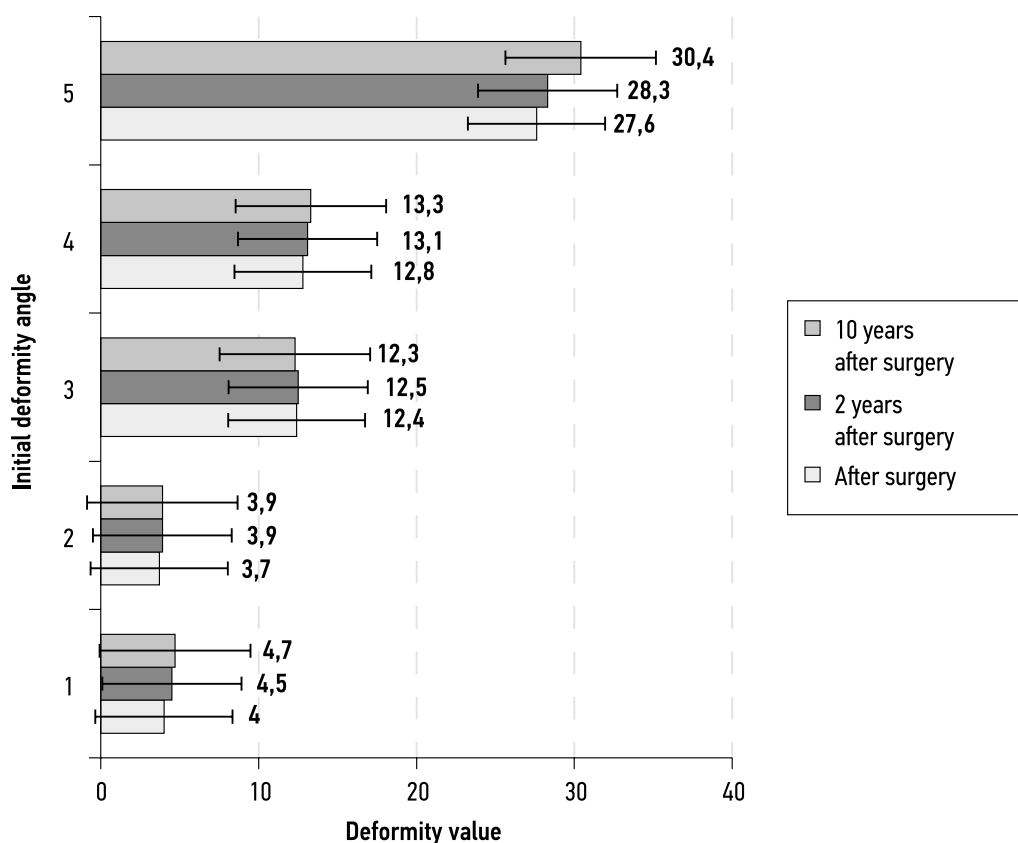
An analysis of the treatment results revealed that the correction value achieved was maintained with a minor loss, depending on the magnitude of the initial deformity, and the correction achieved through surgery. When evaluating the results of long-term treatment, one of the most important indicators was the study of the deformity magnitude in the

various periods after treatment, depending on the initial angle of deformity (Fig. 3).

To demonstrate the long-term result of the treatment of 82° scoliotic spinal deformity, we present the data of patient A., 13 years old, who was admitted to the Department of Traumatology and Orthopedics on February 5, 2020, with a diagnosis of idiopathic progressive right-sided thoracic scoliosis degree IV; Cobb angle 82°; with a posterior right-sided costal humpback. On February 6, 2020, the



**Fig. 2.** Diagram of changes in deformity angles before and after surgery, depending on the average value of the initial deformity (1–28.4°; 2–42.3°; 3–73.7°; 4–88.3°; 5–117.5°).



**Fig. 3.** Diagram of changes in the magnitude of deformity at 2 and 10 years after surgery, depending on the initial angle of deformity (1–28.4 °; 2–42.3 °; 3–73.7 °; 4–88.3 °; 5–117.5 °).

patient underwent surgical intervention, namely, posterior transpedicular stabilization of the spine. After surgery, the residual deformity was 25°. After 5 days (02/11/2020), the patient had no postoperative complications and was discharged for outpatient treatment. At the control examination at 16 months, the long-term result of treatment was studied using clinical and radiological methods. There was no loss of correction, the patient had no complaints, and he is now a college student (Fig. 4).

The results of treatment, in addition to studying the X-ray and MSCT data, were also evaluated by using questionnaires. The clinical result of the data of the SRS30 questionnaire at the deformity degree III (according to Chaklin) is presented in Fig. 5a. The graph indicates that 2 years after surgery, the scores assessing appearance, the attitude of others, and self-esteem were higher. The clinical result of the data of the SRS30 questionnaire at the deformity degree IV (according to Chaklin) is presented in Fig. 5b.

The diagram of clinical results before and after treatment in patients with degree IV deformity was somewhat different from the previous one. The differences relate to the assessment of appearance, which can be explained by lower ratings before treatment in degree IV. The results of the SRS22 questionnaire showed that patients rated self-perception and mental health more highly. Pain and functional limitations, as with the SRS30 questionnaire, scored lower after surgery.

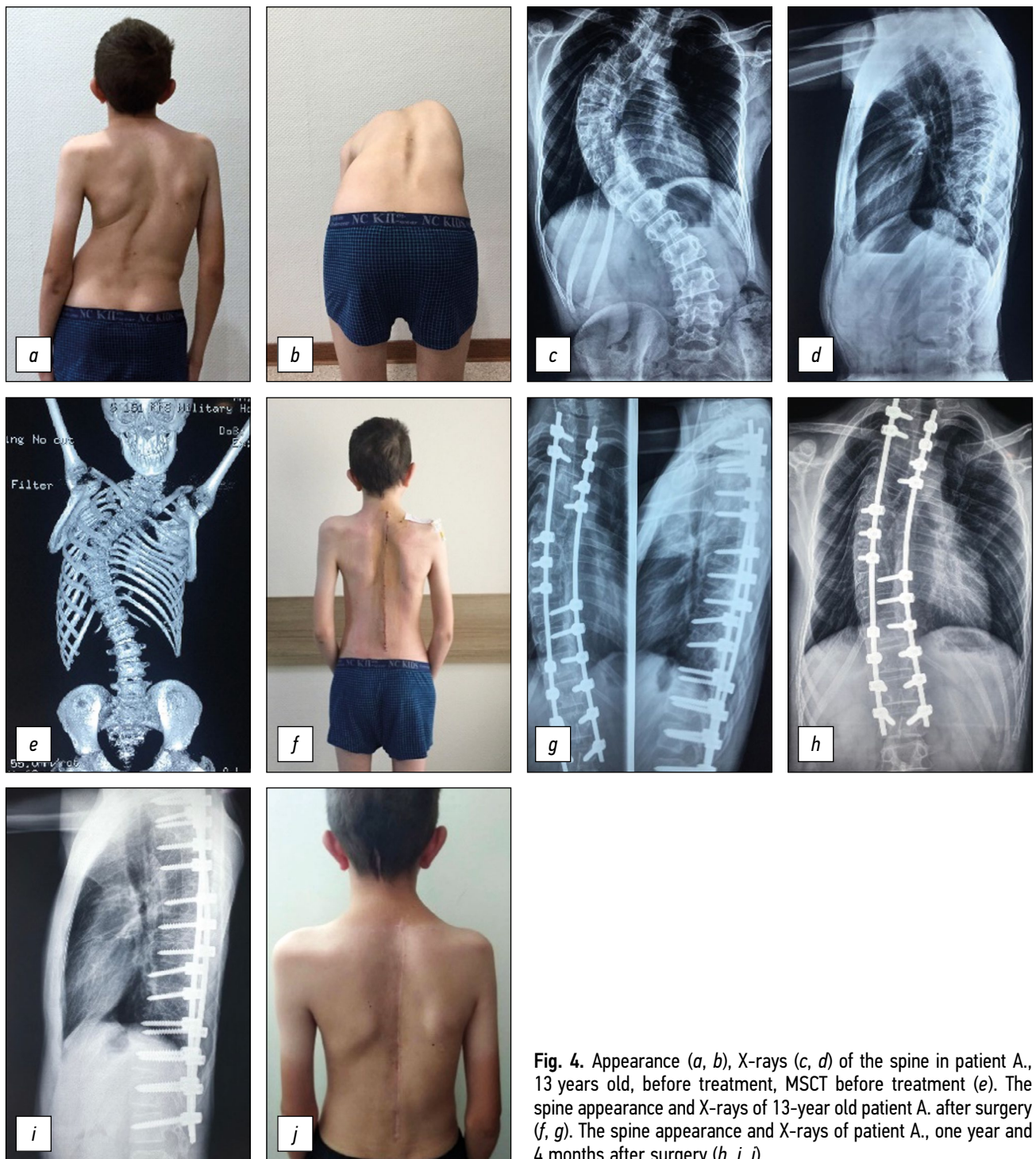
We present the data of patient S., born in 1985, as a long-term result of treatment (9 years and 5 months). Her diagnosis was right-sided progressive thoracic scoliosis, with a deformity angle of 92° according to Cobb; with a posterior right-sided costal humpback. On 04/05/2013, the patient was operated on. Posterior transpedicular fixation was performed, with the length of fixation of Th<sub>II</sub>–L<sub>IV</sub>. In 2019, the patient gave birth to a child; her daughter is now 3 years old and she is planning a second pregnancy (Fig. 6).

The patient feels well and has no complaints. Sometimes she notes insignificant fatigue after exercise. Because she is planning a second pregnancy, she came for a follow-up examination. On radiographs 9 years and 5 months after the surgery, the position of the implants is stable, and there is no loss of correction compared to radiographs previously performed 5 years after the surgery.

## DISCUSSION

Many years of experience in monitoring patients operated on for IS using posterior transpedicular fixation indicates that the correction value achieved is maintained with any minor loss relating to the magnitude of the initial deformity. A minor residual deformity, inevitable in some cases due to a large initial deformity, does not affect the results adversely and is well-tolerated by patients without causing functional limitations. Our data are consistent

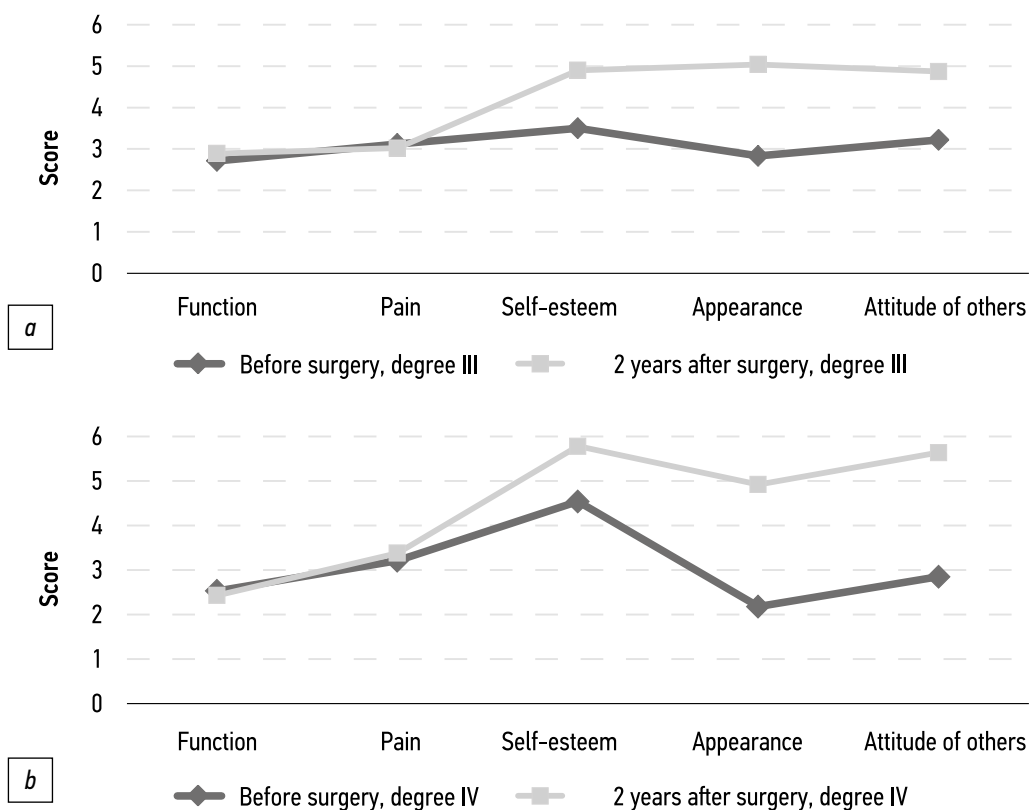




**Fig. 4.** Appearance (*a, b*), X-rays (*c, d*) of the spine in patient A., 13 years old, before treatment, MSCT before treatment (*e*). The spine appearance and X-rays of 13-year old patient A. after surgery (*f, g*). The spine appearance and X-rays of patient A., one year and 4 months after surgery (*h, i, j*).

with the results of other authors on the successful use of posterior transpedicular stabilization of the spine in IS when assessed by radiography and MSCT to determine the preservation of correction achieved and the extent of its loss in the long-term. [1, 2, 4, 5, 9, 25, 26, 28, 29] According to our data, there was no loss of correction in patients with deformity of less than  $90^\circ$  ( $p > 0.05$ ), and it was minimal with an initial deformity greater than  $110^\circ$  ( $p < 0.05$ ). However, the assessment of treatment outcomes is not only based on objective methods of clinical and

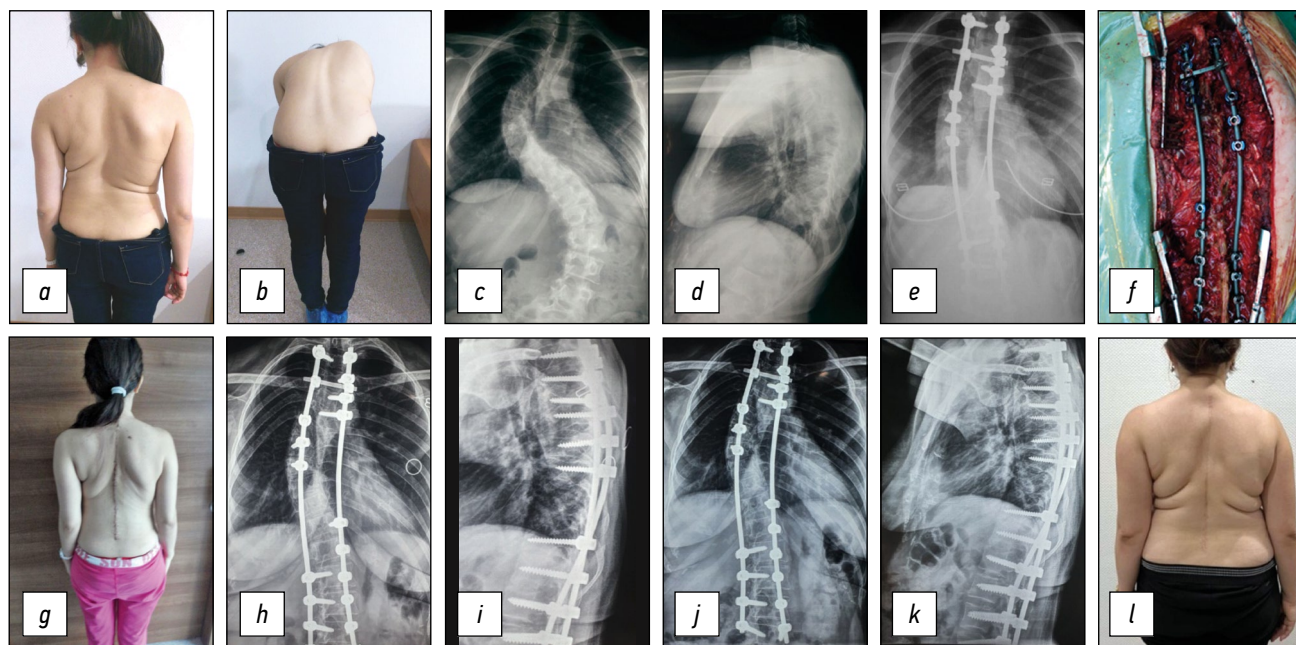
radiological diagnostics. The reaction of patients, or their parents in the case of younger patients, to the treatment efficacy is also important. [30] In this case, various scales and questionnaires are of the greatest importance and are currently widely used by patients for self-assessment of their condition before and after surgery. For this purpose, we used the SRS30 and SRS22 questionnaires; the latter is recommended by AO Spine for studying the state of the spine in patients with deformity. Analysis of the SRS22 questionnaire 2 years after treatment with degree III of



**Fig. 5.** The clinical result of the data of the SRS30 questionnaire in points at degree III of deformity (a); the clinical result of the data of the SRS30 questionnaire in points at degree IV of deformity (b).

deformity (according to Chaklin) showed that the self-esteem of patients increased by 1.5 points, self-assessment of appearance increased by 2 points ( $p < 0.05$ ), and the perception of the attitude of others increased by almost

2 points ( $p < 0.05$ ) compared with preoperative survey data. With degree IV of deformity (according to Chaklin), self-esteem was 0.5 points lower than with degree III, appearance was 1 point higher, and the attitude of others



**Fig. 6.** Appearance of patient S., born in 1985 (a, b). Spine X-rays in frontal and lateral views before treatment (c, d). The spine X-ray of the spine in frontal view after surgery (e). Photo from the operating room and the patient after the surgery (f, g). The spine X-rays in frontal and lateral views five (5) years after surgery (h, i). The spine X-rays in frontal and lateral views 9 years and 5 months after surgery (j, k). The patient photo 9 years and 5 months after surgery (l).



was 0.6 points higher. Interim follow-up of patients treated with posterior transpedicular fixation, according to Hwang et al., revealed that SRS total and domain scores demonstrated a significant improvement after 2 years, but decreased slightly after 5 years ( $p=0.06$ ). The SRS self-esteem scores improved significantly after surgery with minimal changes after 5 years. Change in total SRS scores from 2 to 5 years was associated with differences in pain and mental health SRS scores ( $p < 0.05$ ). [25] Our results are consistent with Schlösser et al. that the SRS-22r questionnaire enables the detection of differences between groups with varying severity of curvature; patients with severe scoliosis had significantly lower pain and self-esteem scores than patients with relatively mild scoliosis. [22] The works of Russian and international authors concerning the SRS22 questionnaire showed its sufficient validity and focus on problems associated with idiopathic scoliosis, which also enabled its use in evaluating the efficacy of treatment of patients with IS. [22, 31–34]

### Study limitations

for treatment, we used only one technique; this decision was due to the need for a more detailed study of patients before and after surgery to develop surgical and rehabilitation measures, taking into account the changes identified in the musculoskeletal system.

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## CONCLUSION

The method of dorsal correction of the spine with the total use of transpedicular implants in patients with IS provides good treatment results. This is subject to the algorithm of complex diagnostics, preparation for surgical treatment, careful adherence to the treatment methodology, and takes into account the structural characteristics of the fixed vertebrae and adequate postoperative monitoring and subsequent rehabilitation. The results were confirmed by the study of the preservation of the correction on dynamic X-ray examination and assessment of the patient's condition according to the SRS22 questionnaire.

## ADDITIONAL INFO

**Author contribution.** Thereby, all authors made a substantial contribution to the conception of the work, acquisition, analysis, interpretation of data for the work, drafting and revising the work, final approval of the version to be published and agree to be accountable for all aspects of the work.

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**Consent for publication.** Written consent was obtained from the patients' for publication of relevant medical information and all of accompanying images within the manuscript.

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