IDIOPATHIC SCOLIOSIS: A 20-YEAR RETROSPECTIVE ANALYSIS OF THE SURGICAL ACTIVITY IN A HIGHLY SPECIALIZED CLINIC

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Objective. To analyze the number of patients with idiopathic scoliosis operated on using segmental instrumentation in a highly specialized clinic during the period of 20 years and the severity of their deformities.
Material and Methods. The study included patients over 10 years of age with idiopathic scoliosis operated on using segmental instrumentation (CDI, Horizon, M8, Legacy, Expedium, NITEK) in the Children and Adolescents Spine Surgery Clinic of Novosibirsk RITO n.a. Y.L. Tsivyan in 1996–2015. For each year within this period, the number of surgically treated patients, the average Cobb angle of the primary curve, and the number of patients with primary curve less than 90°, from 91° to 120°, and greater than 120° were specified.
Results. Analysis of the dynamics of annual surgical activity related to idiopathic scoliosis showed that number of cases has been growing for a number of years and then stabilized. The severity of spinal deformities in operated patients increased over the years, and for several years the most severe deformities (Cobb angle greater than 90°) exceeded 30 %. Later on, the average severity of deformities significantly decreased, which suggests that active surgical work allowed to operate on a significant portion of patients with advanced spinal deformities.
Conclusion. The presented data may be useful in the formation of a national registry of patients with scoliosis.
Key Words: idiopathic scoliosis, surgical activity, Cobb angle of spinal deformity.

Please cite this paper as: *Mikhaylovskiy MV, Sadovoy MA, Novikov VV, Vasyura AS, Suzdalov VA. Idiopathic scoliosis: a 20-year retrospective analysis of the surgical activity in a highly specialized clinic. Hir. Pozvonoc. 2017;14(1):8–13. In Russian.*
DOI: http://dx.doi.org/10.14531/ss2017.1.8-13.

The history of surgical treatment of patients with progressive forms of scoliosis in Russia has certain distinctions compared to Western countries. Without intention of analyzing this process in detail, it is necessary to mention V.D. Chaklin [4], who proved and tried to turn into reality a bright idea on the necessity of corrective and stabilizing exposure on ventral regions of the deformed spine (the 30-ies of XX century). In 1940–1960 years, rare interventions were limited to dorsal fusion and later to using the Allan's distractor and its modification proposed by A.V. Kazmin [1].

The Harrington's distractor, the gold standard for orthopedics, according to Kostuik [6], has been known worldwide since the early 60-ies of XX century. In Russia, this instrument appeared considerably later. Thus, in the Children and Adolescents Spine Surgery Department of Novosibirsk RITO this distractor came into use in 1975, and using modern terminology, it was a typical import-substitution option. Using the Harrington's distractor, Ya.L. Tsivyan [3] developed and put the idea of V.D. Chaklin into practice with addition of distraction to anterior fusion in various variants and thus succeeded in retaining the achieved correction and preventing the progression of the torsional component of deformity (the two-stage method of Ya.L. Tsivyan).

The Cotrel–Dubousset instrumentation was introduced into practice in 1983 [5], but in Russia it appeared significantly later: the first operation was performed in our clinic on September 19, 1996.

The number of patients operated using segmental instrumentation in the Children and Adolescents Spine Surgery Department of Novosibirsk RITO increased each year and an issue of the high cost was solved through different ways (personal finances, charity funds, and government quotas). There was an impression that an increase in the number of operated patients was paralleled by an increase in the severity of pathologies (first of all, the Cobb angle of the primary curve). Twenty years (1996–2015) is quite a sufficient period to analyze surgical activity in a highly specialized clinic that treats patients exclusively with spine deformities of different etiology. There is reason to suppose that these clinics are not numerous. We believe it is optimal to analyze treatment outcomes in patients with idiopathic scoliosis, who make up 80 % of the operated patients in our clinic. We have failed to find similar studies in the available literature.

The purpose of this study was to analyze the number of patients with idiopathic scoliosis who were operated on using segmental instrumentation at a highly specialized clinic during the period of 20 years and the severity of their deformities.

Material and Methods

The study included all patients with idiopathic scoliosis above 10 years of age, who were operated using segmental instrumentation (CDI, Horizon, M8, Legacy, Expedium, NITEK) at the Children and Adolescents Spine Surgery Department of Novosibirsk RITO n.a. Ya.L. Tsivyan during 1996–2015. For each year within the indicated period, the number of operated patients, the average Cobb angle of the primary curve, the number of patients with a magnitude of the primary curve less than 90°, from 91° to 120°, and greater than 120° were specified.

The structured data were put into electronic tables and then analyzed for completeness and errors. Before the analysis, descriptive statistics: graphical analysis of data distribution, estimation of data distribution laws, estimation of descriptive statistical characteristics, and exploratory analysis to identify outlying values in a test data set, was estimated.

The empirical data distribution was tested for fitting to normal distribution using the Shapiro–Wilk test. The estimation showed that all compared parameters deviated from normal distribution; therefore, non-parametric methods not requiring normal distribution were used for the comparative analysis. Descriptive characteristics are presented as the median (the first quartile; the third quartile) for numerical variables, percentage (the lower limit is 95 % CI; the upper limit is 95 % CI) and categorical variables with estimating the limits of confidence intervals using the Wilson formula.

Qualitative characteristics of dependent groups were compared using -square and the Fisher's exact test. Numerical and categorical variables for more than two points of measurements were compared using the nonparametric Kruskal–Wallis test for multiple comparisons; multiple pairwise comparisons were performed using the Dunnett's test (all groups were compared with all groups) with Benjamini corrections. Simple linear regression models were constructed and studied for tendency estimation.

Statistical hypotheses were verified at a critical significance level of $p = 0.05$, i.e., the differences were considered statistically significant at $p < 0.05$. The power of a test was estimated for cases when there was the need to prove lack of statistical difference between variables. An 80 % power or greater was used to detect statistical power.

The estimations were performed using the RStudio software (version 0.99.879).

Results

The total number of patients with idiopathic scoliosis who underwent surgical treatment during 1996–2015 was 2375 (Fig. 1). An almost linear increase in the number of patients during 1996–2007 is noted. In 2008–2015, the number of patients did not increase. Moreover, according to Fig. 2, the number of patients in 2008 and 2013 differed statistically significantly from other values (for the years 2008–2015).

The dynamics of average magnitudes of the primary curve over the years is presented in Fig. 3. Thus, all distributions of the primary curve were not normal and had an asymmetry with two peaks. The average magnitude of the primary curve reduced by 2015.

Fig. 4 shows the number of patients with deformities of different severity in 1996–2015. The number of patients with severe (91–120°) and extra-severe (over 120°) deformities [2] increased statistically significantly from 1996 to 2008 followed by a statistically significant gradual reduction by 2015.

The percentage of three groups of patients according to the severity of deformity (Fig. 5) shows that the number of severe and extra-severe deformities remained high in 1999–2004 followed by a progressive reduction. In some years (2004, 2005), deformities greater than 90° and 120° in total amounted to 30 % or more of the total number of operated patients.

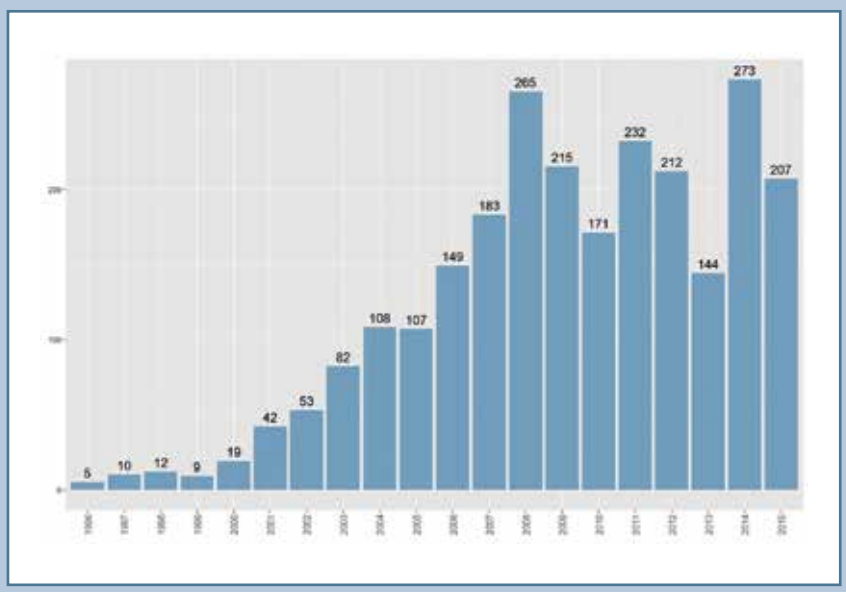

Fig. 1
Dynamics of the number of patients with idiopathic scoliosis operated per year during 1996–2015

General tendencies for three groups of patients are shown in Fig. 6. The quantity of deformities of less than 90° decreased from 1996 to 2002 followed by a gradual increase since 2003. An exactly opposite dynamics was observed for two other groups. Deformities from 91° to 119° increased until 2002, and then their number declined. Deformities greater than 120° had similar changes, but the peak was in 2006–2007.

Discussion

We have not found any studies analyzing the results of a highly specialized clinic over the period of 20 years in the literature. We have only our own experience, which is very specific, because the beginning of this 20-year period coincides with the first application of segmental instrumentation in Russia for correction of spinal deformities and with a radical restructuring of the Children and Adolescents Spine Surgery Clinic.

We believe that implementation of a completely new method of treatment can be initiated when the two rules are met: there are a relatively small number of relatively simple cases. In our situation, both conditions were met.

The number of operated patients increased slowly (the very few or tens of operations per year) but steadily and reached more than two hundred operations a year. We account for this dynamics by several factors: expansion of the indications, raising patient awareness, mobile team consultations. The increase continued up to 2008 followed by a period of stability with relatively high numbers of first operated patients. It is also necessary to mention the financial component of these processes. The third generation segmental instrumentation has always been quite expensive and the cost tended to a further increase. Since 1999 we had worked with leading charity funds of Russia, but since 2010 their involvement in treatment financing decreased due to the assignment of state quotas for high-tech surgical treatment; moreover, the number of quotas provided to Novosibirsk Research Institute of Traumatology and Orthopaedics increased from 10 to 310 per year over five years.

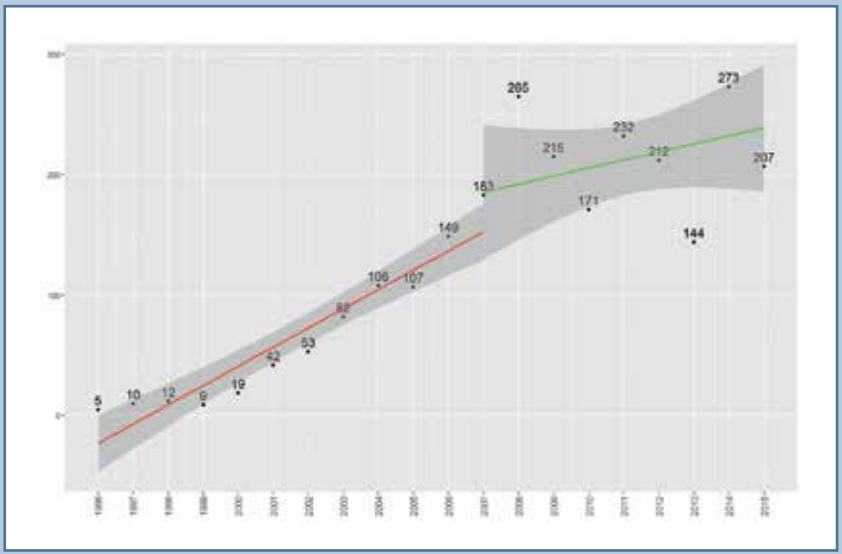

Fig. 2
The quantitative trends in the total number of patients with idiopathic scoliosis in 1996–2015

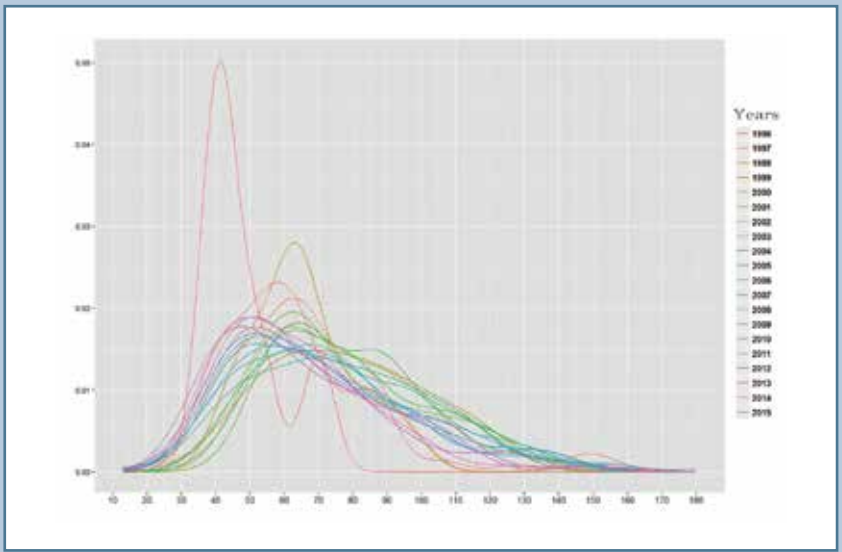

Fig. 3
Distribution density of primary curve magnitudes in all patients with idiopathic scoliosis in 1996–2015

The number of patients with severe scolioses (the average Cobb angle greater than 90°) showed a different dynamics: first, there was a gradual increase (up to 2008) and then a gradual decline. We suggest that the initial increase is associated with the same causes as the number of operated patients. In terms of the second stage of the process (the reduction in the number of severe cases), it is possible to say that the surgical activity

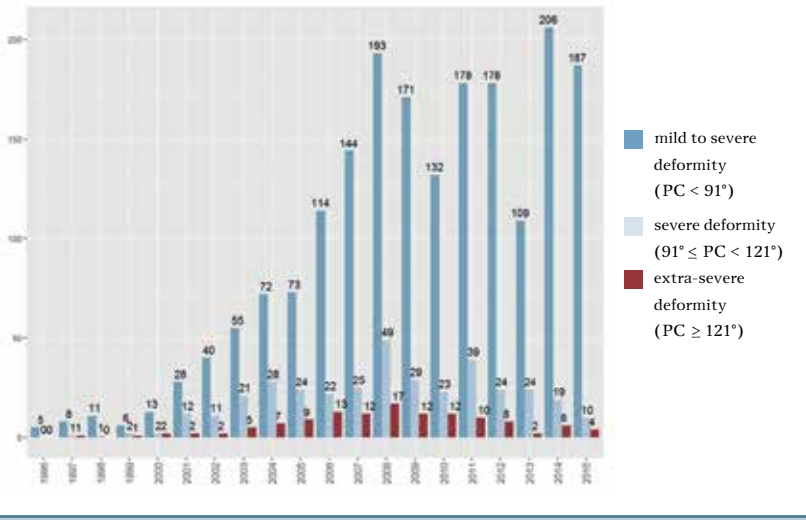

Fig. 4
Absolute values of the number of patients with different magnitudes of the primary curve (PC) in 1996–2015

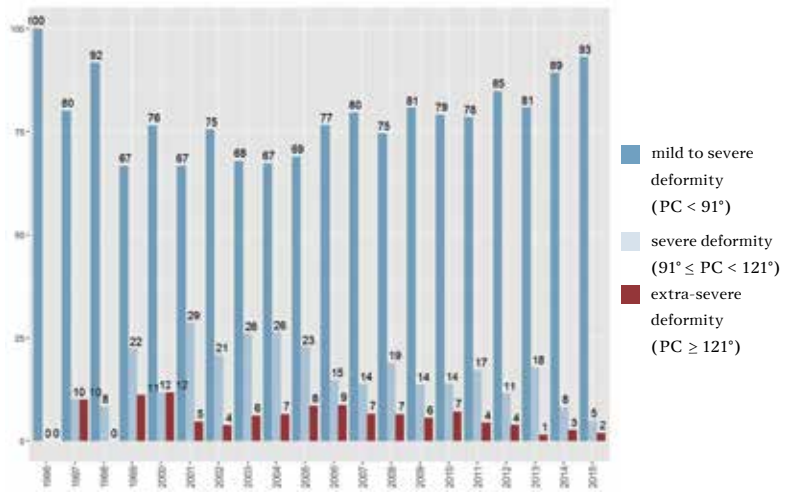

Fig. 5
Annual structure representing the severity of scolioses operated in 1996–2015: PC – primary curve

helped, to a certain extent, to "pick out" this complex category of patients. All these changes are statistically significant.

The main limitation of the analysis is the absence of data on the patient place of residence, though it is known that most of them live in the Siberian Federal district.

Conclusion

According to our research (the paper is in preparation for publication), the frequency of idiopathic scoliosis in Russia is consistent with the parameters for other regions of Europe and Asia. A certain percentage of patients with idiopathic scoliosis and other spine deformities need surgical treatment. In our strong opinion, treatment should be performed in highly specialized clinics with relevant personnel and equipment. The planning of work of these clinics, including on a national scale, should be based on objective information.

This analysis is the first attempt of this kind. We believe that it is very important to form a general idea about the situation with the treatment of patients with spinal deformities. This will allow one to begin the creation of a registry that includes patients with scoliosis, the value of which cannot be overestimated.

The study was not supported with sponsorship. The authors claim no conflict of interest.

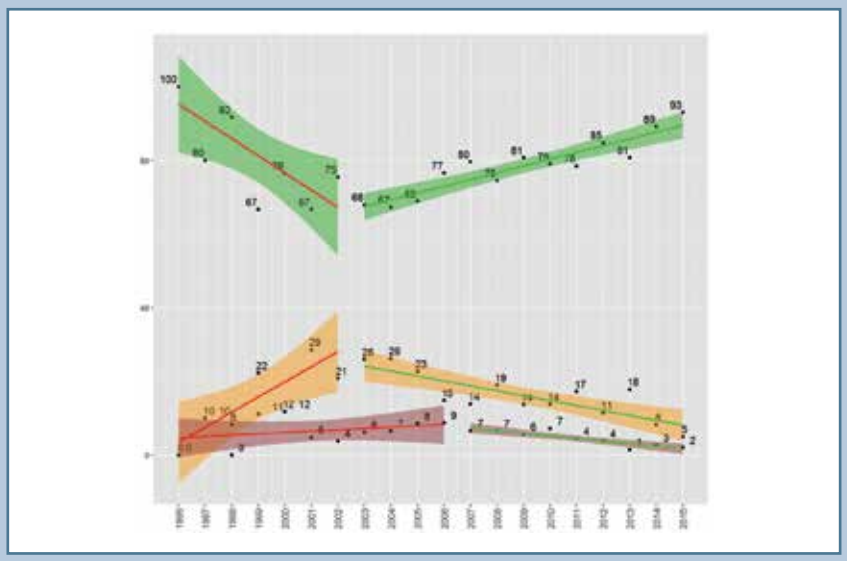

Fig. 6
General tendencies for three groups of patients according to primary curve severity

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Received 03.10.2016
Review completed 31.10.2016
Passed for printing 09.11.2016

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