

VERTEBROGENIC BACK PAIN SYNDROME IN CHILDREN 9–17 YEARS WITH SPINAL DEFORMITIES

© M.S. Vetrile¹, A.A. Kuleshov¹, N.A. Eskin¹, M.B. Tsykunov¹, A.I. Kokorev¹, O.P. Pyzhevskaya²

¹ N.N. Priorov National Medical Research Center of Traumatology and Orthopaedics, Moscow, Russia;

² Department of Rehabilitation and Education Center No. 76 of Labor and Social Protection of Moscow, Moscow, Russia

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Aim. We defined the prevalence of back pain in children and adolescents aged 9–17 years with spinal deformities.

Material and methods. The cross-sectional study included 230 students with different spinal deformities aged 9–17 years. The prevalence of back pain, intensity, location, and situations in which it occurred were assessed via questionnaire.

Results. Among 230 respondents, 186 (80.9%) admitted that they had experienced back pain (mainly in the lumbar spine) at various frequencies within the year preceding the study. Mild pain was prevalent (71% of respondents). Girls experienced back pain significantly more frequently than boys.

Conclusions. Back pain in children and adolescents requires clinical and instrumental examination, including X-ray. Back pain is a frequent phenomenon in children with different spinal deformities. The incidence of pain in children and adolescents with spinal deformities in our study is statistically higher than that of “healthy” individuals of the same age group.

Keywords: back pain in children; scoliosis; spinal deformities.

ВЕРТЕБРОГЕННЫЙ БОЛЕВОЙ СИНДРОМ У ДЕТЕЙ 9–17 ЛЕТ С ДЕФОРМАЦИЯМИ ПОЗВОНОЧНИКА

© М.С. Ветрилэ¹, А.А. Кулешов¹, Н.А. Еськин¹, М.Б. Цыкунов¹, А.И. Кокорев¹, О.П. Пыжевская²

¹ ФГБУ «Национальный медицинский исследовательский центр травматологии и ортопедии им. Н.Н. Приорова» Минздрава России, Москва;

² ГБОУ города Москвы Реабилитационно-образовательный центр № 76 Департамента труда и социальной защиты населения города Москвы, Москва

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Актуальность. Скелетно-мышечные боли представляют собой серьезную проблему современного общества. Эпидемиологические данные свидетельствуют о том, что боль в пояснице является значимой как для взрослых, так и для детей и подростков. Например, распространенность болей в спине у здоровых детей и подростков в Финляндии составляет 20 %, Швеции — 29 %, Швейцарии — 51 %, Канаде — 33 %.

Цель работы — определить распространенность и характер болевого синдрома в спине у детей в возрасте 9–17 лет с деформациями позвоночника.

Материалы и методы. Для оценки распространенности и характера дорсалгий у детей с деформациями позвоночника проведен анализ клинической картины 230 учащихся 3–11 классов ГБОУ РОЦ № 76 Москвы в возрасте от 9 до 17 лет.

Результаты. Среди 230 опрошенных (76 мальчиков и 154 девочки — 30,1 и 69,9 % соответственно), имеющих подтвержденную лучевыми данными неспецифическую патологию позвоночника, боль в спине с различной частотой испытывали 186 (80,9 %). Боль в спине чаще проявлялась в области поясничного отдела позвоночника, при этом доминировала умеренная, тянущая боль, о чем сообщили 71 % всех опрошенных.

Заключение. Боль в спине часто отмечается у детей и подростков с деформациями позвоночника, требует тщательного обследования с изучением клинической картины, анамнеза и лучевой диагностики. У пациентов с деформациями позвоночника частота встречаемости болей в спине статистически выше показателей «здоровых» лиц той же возрастной группы. Заключение о неспецифическом характере болевого синдрома у детей и подростков следует выносить при достоверном исключении других его причин — воспалительных и опухолевых.

Ключевые слова: боль в спине у детей; дорсалгия; ювенильный остеохондроз; сколиоз; нарушение осанки; деформации позвоночника.

Introduction

Musculoskeletal pain represents a serious problem in modern society [1]. Back pain, which is one of the most frequent causes for this type of pain, leads to a decrease in the working capability and social adaptation of the adult population. It occurs with approximately the same frequency in different ethnic populations and leads to a significant decrease in the quality of life and working capability [2–4]. According to the World Health Organization experts, the prevalence of spine disorders complicated by pain syndrome (dorsalgia) has reached epidemic proportions.

Epidemiological evidence suggests that lower back pain is significant in adults as well as in children and adolescents [5–10]. According to studies conducted in different countries, there are significant deviations in the prevalence of back pain in healthy children and adolescents, namely, 20% in Finland [11], 29% in Sweden [12], 51% in Switzerland [13], and 33% in Canada [14]. Such dispersion is likely related to not only the ethnic and age heterogeneity of the samples studied but also the lack of uniform terminology and unified diagnostic criteria. Thus, in the same regional group, this figure approaches 11% at the age of 11 years, and it reaches 50% at the age of 15 years [11].

It has been established that tall children with asymmetrical trunks, as well as reduced mobility in the joints of the lower limbs, experience back pain more frequently [15, 16]. The potential risk factors affecting back pain include smoking [17, 18], nutritional disorders [18], physical activity [18–21], psychosocial factors [21], muscle elasticity, and joint mobility [22, 23]. The external factors that most often induce the development of back pain in students include carrying heavy school backpacks (especially in the case of improper carrying, for example, with a load on one shoulder) [24], failure to comply with the requirements for selection of school furniture [25], excessive television viewing

and working at the computer [26], and heavy physical exertion in everyday life [27]. The etiopathogenesis of back pain in children and adolescents can be caused by the inflammatory, tumorous, post-traumatic, and stress-overload processes that occur as a result of practicing sports that are related to extreme physical exertion, sudden movements, falls, and injuries [28].

Despite many studies on the epidemiology of dorsalgia in pediatric patients, the etiology of its development and the causal relationship with various spinal deformities remain not fully understood.

This work aimed to determine the prevalence and the nature of back pain in pediatric patients who ranged in age from 9 to 17 years and had spinal deformities.

Materials and methods

To assess the prevalence and the nature of dorsalgia in pediatric patients with spinal deformities, an analysis of the clinical presentation of 230 pupils in grades 3–11 at the Rehabilitation and Education Center No. 76 of Moscow, aged 9–17 years, was performed. This age group was selected because the pupils were able to answer clearly and reliably the questions posed in the questionnaire. For the younger age category, the questionnaire does not meet the basic requirements, such as simplicity, comprehension, and demonstrativeness, which necessitate the use of an alternative questionnaire survey.

The study was conducted after obtaining the institutional approval of the head and the parent committee. The survey involved 76 boys and 154 girls.

The criteria for inclusion in the study were orthopedic spinal pathology findings confirmed clinically and radiologically; the exclusion criteria were conditions that impeded testing, such as concomitant diseases of the central nervous system, including cerebral palsy, as well as a history of spinal surgery.

Idiopathic scoliosis was most common in pediatric patients ($n = 122$, 53%), 78% of the patients had deformity graded as degrees I–II, 15% had degree III deformity, and 7% had degree IV deformity. Kyphotic deformity of the thoracic spine was noted in 37 (16%) pediatric patients with osteochondropathy; various posture disorders were diagnosed in 43 (19%) patients; Ehlers–Danlos syndrome was noted in 7 (3%) patients; and congenital deformities with spinal anomalies were registered in 21 (9%) patients.

Considering ontogenesis and special aspects of school education, two age school groups are formed:

- The younger age group included 126 patients, aged 9–12 years (54.8%).
- The older age group included 104 patients, aged 13–17 years (45.2%).

A questionnaire was used as a research tool, which the pupils filled out at school in the presence of one of the authors. The questionnaire included questions with a choice of one or several possible answers. Multivariate answers allowed additional comments to questions like “Other?” and “How?”

The main part of the questionnaire concerned the following questions:

- Have the respondents felt back pain over the last year (12 months)? Those who answered the question negatively did not complete the rest of the questionnaire.
- Where is the localization of pain? To indicate this, the questionnaire includes schematic representations of the cervical, thoracic, and lumbar spine.
- How frequent is the pain? How often have children noted back pains over the previous 12 months — a single manifestation or recurrent nature (indicated in figures: 1–2 times, 2–5 times, 5 times or more?)
- What are the time of day and the time of year when back pain is most often manifested?
- What methods do you use to combat back pain, such as painkillers, seeking medical help?
- What situations cause the occurrence of pain syndrome, from the pupil’s perspective?

On the first page, the respondents filled out the information regarding grade, gender, age, height, weight, and testing date.

To assess the intensity of pain sensation, we used a survey method of special questionnaires, namely, the pain tolerance scales (visual analog scale (VAS),

Wong–Baker Faces Pain Scale, pain degree scale using verbal description), and four-component visual analog pain scale. For comparison of anthropometric indices, the body mass index (BMI) was used, which was calculated using the standard formula: $BMI = \text{body weight (kg)}/\text{height}^2 \text{ (m}^2\text{)}$.

Statistical and mathematical data processing was performed using variation statistics and analysis of variance. All of the data obtained were processed using the statistical software package Microsoft Office Excel, Word 2016. To verify the intergroup differences, Pearson’s distribution-free test of fit (chi-square) was used. A $p < 0.05$ was considered to be statistically significant.

Results

The statistical analysis included 230 questionnaires. The distribution of respondents who provided positive answers (186 children, 80.9%) to the question about the presence of back pain over the last 12 months is shown in Figure 1.

Idiopathic scoliosis was registered in 100 (53.8%) of 186 pediatric patients, 30 (16.1%) patients had kyphotic deformity with osteochondropathy of the thoracic spine, postural disorders were noted in 32 (17.2%) pupils, Ehlers–Danlos syndrome was diagnosed in 6 (3.2%) patients, and deformities with skeletal abnormalities were noted in 18 (9.7%) pupils. In most cases ($n = 134$ pupils, 72%), spinal deformity was combined with foot deformities (planovalgus deformity, combined platypodia, etc.).

The respondents experiencing back pain comprised 130 (69.9%) girls and 56 (30.1%) boys. The most numerous group of respondents was represented by children who experienced pain rarely, once or twice a year ($n = 80$ respondents, 43%). A total of 48 (25.8%) pupils experienced back pain several times a year, and 58 (31.2%) respondents had frequent or persistent back pain. No statistical correlation was revealed between the age and the incidence of back pain ($p < 0.05$), as the number of people experiencing back pain very rarely (1–2 times a year), several times a year (3–5 times), and very often or constantly has not changed with age.

As a result of the analysis of answers using the VAS and the four-component pain scale, several regularities were revealed:

- Quantitative data: 62 pupils (14 boys and 48 girls; average age, 12.3 years) experienced back pain

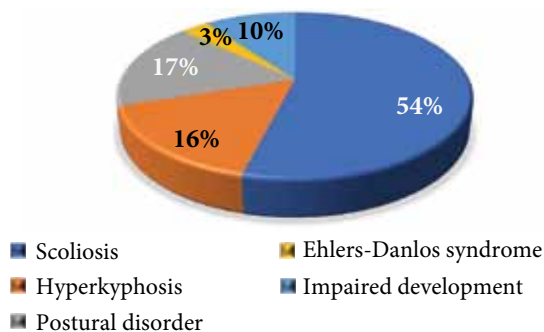


Fig. 1. Distribution of pediatric patients with back pain

during one day or more, and 80% of children in this group had a scoliotic deformity with an angle of 10–25°. There was no statistically significant correlation of the duration and intensity of pain with the subjects' age.

- In a qualitative assessment of pain intensity using VAS and the four-component pain scale, the threshold values of pain at the time of the survey, as well as the average level of pain over the last 4 weeks in patients with prolonged pain, exceeded twice the average values compared with children experiencing short-term episodes of pain (Figure 2), which indicates a direct correlation of the pain intensity and its frequency.

When analyzing the intensity of pain, it was found that moderate nagging pain was predominant, as 71% ($n = 132$) of all respondents reported this.

According to the analysis of pain tolerability, it was found that most children believe that pain of this nature can be ignored and that it does not distract them from their normal activity.

At the same time, 32 (17.2%) pupils replied that pain prevents them from concentrating. These respondents reported severe pain (the average level using VAS was 4.8 points and 7.1 points in the worst periods of the disease), which hinders them from engaging in their daily activities or even requires bed rest.

Localization of back pain. Questions about the localization of back pain were multivariate. Back pain most often manifested itself in the lumbar region; more than 70 (37.6%) respondents reported this location, and approximately 30% of them had idiopathic scoliosis. The pain was localized less commonly in the thoracic spine ($n = 26$ respondents, 14%); and 52 (28%) pediatric patients reported pain in the cervical region. A total of 38 (20.4%) patients experienced pain simultaneously in several regions of the back, and the lumbar region was involved in all cases. Thirty (16.1%) pediatric patients noted that with back pain, they also felt pain in their legs, but it was not possible to register true radicular irradiation in this study.

Situations causing pain and methods to treat back pain. Pediatric patients consider physical exertion ($n = 50$, 26.9%), a heavy backpack ($n = 48$, 25.8%), an uncomfortable body position ($n = 32$, 17.2%), and stress ($n = 30$, 16.1%) as primary causes of back pain. Other reasons were noted by 54 (29%) respondents.

During a severe back pain attack, 68 pediatric patients sought medical help, and approximately 50% of them received medications (nonsteroidal

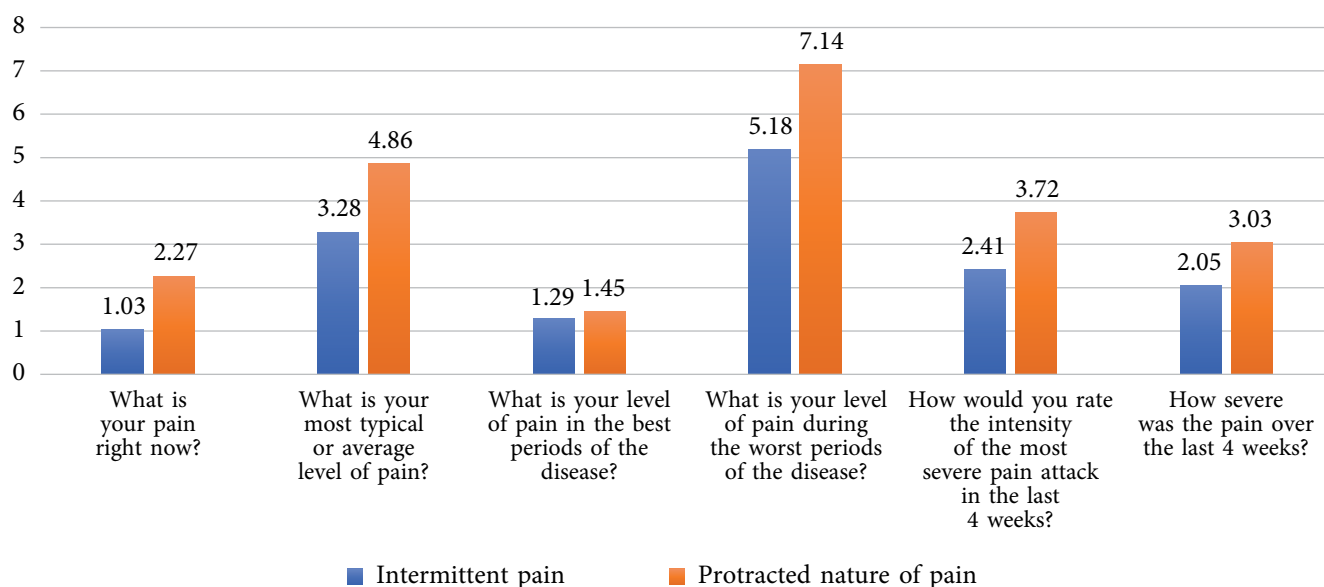


Fig. 2. Qualitative pain assessment using VAS and the four-component pain scale

anti-inflammatory drugs). It should be noted that School No. 76 is a rehabilitation institution, where children on a weekly basis practice therapeutic swimming, exercise therapy, and regularly receive massage and physiotherapy.

Correlation between back pain, age, and gender.

A statistically significant correlation between age and the occurrence of back pain ($p < 0.05$) was found, with the prevalence of patients in the older age group. The other analyzed variable indicated a relationship between the appearance of back pain and gender; girls experienced back pain more often than boys did.

Anthropometric data. Analysis of the BMI data showed that pediatric patients with back pain had normal height and weight in 58 cases, body weight deficiency in 88 cases, and obesity in six cases (38%, 58%, and 4%, respectively), which practically does not differ from those in patients who do not have back pain, as the ratio of people with average height and weight, patients with body weight deficiency, and those who are overweight is 36:63:1.

Discussion

Utkina cites data obtained by examining 497 children aged 10–17 years. According to her, the prevalence of pain affects the gender of the child at the age of 10–12 years, and the frequency of pain among boys and girls is comparable (6.6% and 5.7%, respectively); however, by the age of 16–18 years, girls experience more pain than boys (11.7% and 21.5%, respectively) [29]. Our research confirms these findings.

Shostak et al. examined 137 pupils in secondary schools in Moscow within the framework of the Moscow program “Monitoring of Health of Schoolchildren” in 2004–2005. A screening survey of adolescents aged 14–17 years ($n = 75$ girls, 62 boys) was performed using a questionnaire to identify the pain syndrome registered over the last 12 months. The incidence of pain syndrome in adolescents aged 14–17 years was 27.7%, and in its structure, pain in the upper back (52.6%) prevailed. Risk factors included genetic predisposition (family cases of disease amounted to 65.8%), work with a computer (73.3%), and excessive sports load (31.6%). Musculo-ligamentous disorders were detected in 84.2% of adolescents [30].

Anisimova and Rachin, during an examination of 292 schoolchildren from Smolensk (41.1% of

boys and 58.9% of girls), aged 6–17 years, using psychometric methods, revealed back pain in 29.1% of cases, myofascial pain syndrome in 11% of patients examined, postural defects in 8% of patients, and scoliosis in 7% of patients. In 2% of schoolchildren, back pain could not be attributed to any of the variants [31].

Ivashchenko conducted a study of 274 schoolchildren ($n = 148$ girls, 54%; 126 boys, 46%), aged 10–17 years, permanently residing in the city of Zaporozhye, to evaluate the presence of pain syndrome. Complaints of pain syndrome were presented by 31.4% (86 patients) of children, 39.5% of whom were boys, and 60.5% were girls. The pain syndrome peaked in girls at the age of 13 years, while an increase in the frequency of pain in the lower back was noted in boys, aged 15–16 years [32].

According to Murphy et al. [25], 22% of English schoolchildren, aged 11–14 years had complaints of lower back pain. Olsen et al. [33] published evidence that lower back pain was noted by 30.4% of American pupils.

Watson et al. provided data on the presence of lower back pain in 24% of cases of complaints among schoolchildren aged 11–14 years in northern England during the month of monitoring [34].

Harreby et al., having conducted a study of 1389 Danish children aged 13–16 years reported that 58.9% of children experienced lower back pain during their lifetime, and 50.8% of children experienced pain during the year of monitoring [35].

According to Balagué et al., complaints of back pain throughout the year were registered in 26% of schoolchildren aged 12–17 years in Switzerland [36]. Salminen et al. noted the presence of lower back pain with limited physical activity during the year in 17.6% of 14-year-old Finnish children [37]. A little later, Taimela et al. recorded the frequency of pain during the year in 18% of cases according to similar criteria, also in Finland [38]. Kedra and Czaprowski, in their study of the prevalence of low back pain among Polish children and adolescents aged 10–19 years, revealed that 76.2% of 1089 respondents complained of lower back pain during the previous year [39]. In the group with the presence of complaints, there were more girls (52.2%). Drozda et al. studied a group of 1,475 pupils aged 13–20 years in the city of Poznan and found that 67% of all respondents experienced back pain and that 49% had recurrent back

pain [40]. Romicka et al. interviewed 3386 children and adolescents aged 6–17 years from Warsaw and 10% of them reported having back pain [41].

In 2013, Yao et al. [42] conducted a survey of 2083 schoolchildren in China aged 10–18 years old to identify and characterize the pain in the lower back. The questionnaire provided demographic and anthropometric data, as well as the characteristics of the pain syndrome, namely, frequency, duration, VAS, etc. The scientists revealed a high incidence of nonspecific lower back pain among pupils; 29.1% of respondents noted pain in the recent 3 months (24.7% of boys and 33.1% of girls), while an increase in the frequency of pain complaints with age was recorded. Therefore, when comparing the age groups of 10–14 years and 15–18 years, the frequency of dorsalgia was 24.5% and 38.2%, respectively. It was also revealed that lower back pain was more characteristic of young girls and adolescent girls, while they were less likely to go to the doctor about them. However, in both boys and girls, the frequency of lower back pain equally increased with age. Thus, the frequency of pain at the age of 10 years was 20.3%, and at the age of 17 years, it was 42.7%. In the age group of 10–14 years, the frequency of lower back pain, in turn, was 21.5%, and in the age group of 15–18 years, it was 38.2%.

According to a major study conducted by Sato et al. in Japan, among 43,630 pupils in Niigata, the prevalence of pain syndrome in the patients' history was 28.8% (48.5% of male patients and 51.5% of female patients) [43, 44]. In a survey of 1,470 pupils in senior schools in the cities of Barcelona (Spain) and Freiburg (Switzerland), Pelliseetal et al. (2009) revealed isolated pain in the lower back in 42.6% of schoolchildren, which was more common among girls [45]. Masiero et al. (2009) reported that 20.5% of 7542 teenagers examined in Italy had back pain episodes [46].

The majority of the researchers reported an increase in the frequency of complaints of lower back pain with increasing age in children and adolescents. According to some authors, an increase in the frequency of pathological changes in the spine in children and adolescents [46, 47] is due, to a certain extent, to the general deterioration in the health of the pediatric population.

Screening of back pain conducted among schoolchildren with orthopedic pathology indicates a high prevalence of dorsalgia in the pediatric

population (80.87%), and its frequency and intensity increase with age, as confirmed by several studies [48, 49].

Back pain in childhood and adolescence often occurs along with various connective tissue anomalies. Ivanova (2010) examined 40 adolescents who visited a neurologist because of back pain and/or headache complaints and proved the existence of a pathogenetic relationship between chronic pain syndromes and connective tissue dysplasia [50].

Various congenital anomalies of spinal development are considered by most authors not as an immediate cause of back pain but as risk factors that accompany the spinal instability formation contributing to the occurrence of overload and, as a result, chronic pain syndrome in the spine [50]. In childhood, back pain is often associated with scoliosis and postural disorder, since secondary connective tissue disorders develop in their presence and pain syndrome occurs in the back [51].

According to the literature, most commonly, pain in the back is local nociceptive in nature, that is, associated with a lesion of the musculoskeletal system with direct activation of pain receptors. Much less often, back pain occurs as a result of damage to the spinal root or ganglia and is neuropathic in nature, that is, associated with the involvement of the central or peripheral nervous system [22, 23, 52]. The leading causes of vertebral dorsalgia in pediatric patients are Perthes disease and hereditary syndromic pathology of the connective tissue, manifested by functional segmental instability of the spine. According to the literature, congenital anomalies of the spine account for 15%, scoliosis (idiopathic, secondary) is registered in 9%, Scheuermann's disease occurs in 6%, tumors are noted in 2%, and sacroiliitis is revealed in 1%. In the adult population, in the study of the structure of vertebragenous pain syndromes, degenerative and dystrophic changes in the spine are also revealed most often [53–55].

Back pain can be caused by fatigue, weak muscular corset, postural disorders, and reduced motor activity, qualified as myostrainopathy [56].

Conclusion

Back pain often occurs in children and adolescents in cases of spinal deformities and exceeds significantly the average population

level, as 80.9% of such pupils experience it with varying frequency and intensity; and with age, the proportion of pediatric patients experiencing severe pain increases, as well as the frequency of its occurrence. Girls complain of back pain more often than boys do.

Considering the localization in the structure of dorsalgia, pain syndrome prevails in the lower back, then in the cervical and thoracic spine. Less commonly, pain is localized in several parts of the spine. Pain is most often characterized as moderate.

Dorsalgia can be an indication of the development of musculoskeletal disorders. In the presence of back pain in children and adolescents, the clinical presentation, history, and radiation images must be studied carefully. The early diagnostics of back pain and the development of rehabilitation and treatment algorithms will improve the quality of life not only of children and adolescents but also of the adult population. Only by ruling out all of the anatomical causes of pain syndrome in the lower back in children and adolescents can we make a conclusion about its nonspecific nature.

Additional information

Source of finding. The study did not have financial support or sponsorship.

Conflict of interest. The authors declare that they have no potential conflicts of interest to disclose.

Ethical review. The study was approved by the ethical committee of the Priorov National Medical Research Center of Traumatology and Orthopedics, Protocol No. 1, dated September 7, 2018. All of the patients (their representatives) agreed to participate in the study.

Contribution of the authors

M.S. Vetrile and *A.A. Kuleshov* created the concept and design of the study, performed the survey data analysis, material processing, and wrote the article.

A.I. Kokorev and *O.P. Pyzhevskaya* created the concept and design of the study, compiled the questionnaire, implemented the survey, collected and processed the material, performed the literature analysis, and wrote the article.

N.A. Yeskin and *M.B. Tsykunov* performed the literature review and the statistical processing of the material, and edited the manuscript.

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Information about the authors

Marchel S. Vetrile — MD, PhD, Senior Researcher Physician of Vertebrology Department of N.N. Priorov National Medical Research Center of Traumatology and Orthopaedics, Moscow, Russia. <https://orcid.org/0000-0001-6689-5220>. E-mail: cito-spine@mail.ru.

Aleksandr A. Kuleshov — MD, PhD, Leading Researcher, Head of Vertebrology Department of N.N. Priorov National Medical Research Center of Traumatology and Orthopaedics, Moscow, Russia. <https://orcid.org/0000-0002-9526-8274>. E-mail: cito-spine@mail.ru.

Марчел Степанович Ветрилэ — канд. мед. наук, старший научный сотрудник группы вертебологии ФГБУ «НМИЦ ТО им. Н.Н. Приорова» Минздрава России, Москва. <https://orcid.org/0000-0001-6689-5220>. E-mail: cito-spine@mail.ru.

Александр Алексеевич Кулешов — д-р мед. наук, ведущий научный сотрудник, руководитель группы вертебологии ФГБУ «НМИЦ ТО им. Н.Н. Приорова» Минздрава России, Москва. <https://orcid.org/0000-0002-9526-8274>. E-mail: cito-spine@mail.ru.

Nikolai A. Eskin — MD, PhD, Professor, Deputy Director of Science Department of N.N. Priorov National Medical Research Center of Traumatology and Orthopaedics, Moscow, Russia. E-mail: dissovet@cito-priorov.ru.

Mikhail B. Tsykunov — MD, PhD, Doctor of Medicine, Head of the Rehabilitation Department of N.N. Priorov National Medical Research Center of Traumatology and Orthopaedics, Moscow, Russia.

Alexey I. Kokorev — MD, Orthopedic Surgeon, PhD Student of Vertebrology Department of N.N. Priorov National Medical Research Center of Traumatology and Orthopaedics, Moscow, Russia. <https://orcid.org/0000-0002-5829-6372>. E-mail: cito-spine@mail.ru.

Olga P. Pyzhevskaya — MD, Head of the Rehabilitation Department of Rehabilitation and Education Center No. 76 of Labor and Social Protection of Moscow.

Николай Александрович Еськин — профессор, заместитель директора по науке ФГБУ «НМИЦ ТО им. Н.Н. Приорова» Минздрава России, Москва. E-mail: dissovet@cito-priorov.ru.

Михаил Борисович Цыкунов — д-р мед. наук, заведующий отделением реабилитации ФГБУ «НМИЦ ТО им. Н.Н. Приорова» Минздрава России, Москва.

Алексей Иванович Кокорев — врач травматолог-ортопед клинко-диагностического отделения, аспирант группы вертебрологии ФГБУ «НМИЦ ТО им. Н.Н. Приорова» Минздрава России, Москва. <https://orcid.org/0000-0002-5829-6372>. E-mail: cito-spine@mail.ru.

Ольга Петровна Пыжевская — заведующая отделением медицинской реабилитации ГБОУ РОЦ № 76, Москва.