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Aims and effects of physiotherapy in postoperative treatment of scolioses in young people

Zadania i efekty fizjoterapii w pooperacyjnym leczeniu skolioz u młodzieży

Summary
The aim of the paper is a presentation of tasks and effects of physiotherapy in the postoperative treatment of scoliosis in young people. Scoliosis surgery combined with rehabilitation both before and after the procedure is beneficial for the majority of patients. The study included 50 patients with scoliosis diagnosed at a young age. The survey was carried out by means of a self-designed anonymous personal questionnaire. The subjects were divided into two study groups, A and B. Study group A consisted of 40 individuals operated on at the age of 13-19 years., and group B included 10 patients aged 23-43 years, who had been operated on for scoliosis at a young age. Almost all the respondents in both groups availed of the help of a physiotherapist directly after the operation. The most common form of rehabilitation following scoliosis surgery was help with walking, breathing exercises, as well as passive and active exercises. The effects of surgical treatment of scoliosis and physiotherapy were beneficial and brought about improvement in the quality of daily living. Almost all the asked individuals answered that their decision to undergo an operation had been a good one. What was also noted was a growth in the patients' awareness and a big importance of prophylactic body posture correction in the young generation. Own study result analysis also showed that the standards of doctor's treatment are constantly increasing and the role of physiotherapists in postoperative treatment grows gradually. Strict cooperation of all members of the care team is the most beneficial for the patient and gives the best results during hospitalization and ambulatory care.

Key words: physiotherapy, scolioses in young people, physiotherapist, correct body posture

Streszczenie
Tematem pracy jest prezentacja zadań i efektów fizjoterapii po operacyjnym leczeniu skolioz u młodzieży. Leczenie operacyjne skolioz połączone z usprawnianiem zarówno przed jak i po zabiegu przynosi duże korzyści u większości pacjentów. Badaniami objęto 50 osób, u których rozpoznano skoliozę w wieku młodzieńczym. Badania przeprowadzono za pomocą samodzielnie opracowanej anonimowej ankiety personalnej. Badanych podzielono na dwie zasadnicze grupy: A i B. Grupę badaną A stanowiło 40 osób operowanych w wieku 13 – 19 lat, a grupę B stanowiło 10 osób w wieku 25 – 43 lata, które w wieku młodzieńczym były operowane z powodu skoliozy. Niemal wszyscy respondenci obu grup korzystali z pomocy fizjoterapeuty bezpośrednio po zabiegu operacyjnym. Najczęstszą formą działań fizjoterapeutycznych po zabiegu skoliozy była: pomoc przy chodzeniu, ćwiczenia oddechowe oraz ćwiczenia bierne i czynne. Efekty leczenia operacyjnego skolioz i zastosowanej fizjoterapii są korzystne

i wpływają na poprawę jakości codziennego życia. Prawie wszystkie badane osoby odpowiedziały, że podjęta decyzja o leczeniu operacyjnym była słuszna. Odnotowano również wzrost świadomości pacjentów oraz duże znaczenie profilaktycznej korekcji wad postawy ciała młodego pokolenia. Z analizy badań własnych wynika również, że stale podnoszone są standardy stosowanej terapii przez lekarza oraz stopniowo zwiększa się rola fizjoterapeutów w procesie leczenia pooperacyjnego. Ścisła współpraca członków całego zespołu medycznego jest najefektywniejsza i daje największe korzyści dla pacjenta w trakcie leczenia szpitalnego i ambulatoryjnego.

Słowa kluczowe: fizjoterapia, skoliozy u młodych ludzi, fizjoterapeuta, prawidłowa postawa ciała

Introduction

Involving a three-dimensional deformation of spinal curvatures, scoliosis is a common orthopaedic problem of adolescence. All changes within the spine directly affect posture, especially in children and youth at the developmental age. The physical examination discloses a number of symptoms, like: shoulder asymmetry, protrusion of ribs and/or scapulae, enhanced lumbar lordosis, waist asymmetry, increased or decreased thoracic kyphosis, and inequality of lower limbs. The extent of posture defect and the degree of trunk deformation depend on the site and degree of abnormal spine curvature. In early childhood and childhood scolioses more often affect the male population, whereas in older population more scoliosis is observed in girls, with female juvenile scoliosis statistically sevenfold as frequent as male juvenile scoliosis. Scoliosis is commonly divided into functional and structural, where functional scoliosis is usually caused by external factors and can effectively be corrected, and structural scoliosis involves pathological changes in all the locomotor system, which is difficult to cure. Clinical research shows that scoliosis with a small angle is the most common and thus screening tests of children and youth are crucial for prophylaxis and for the introduction of the best possible rehabilitation programme. Clinical studies of scoliosis over many years reveal that the highest risk of scoliosis progression occurs in young people aged 10 – 13 years. Except for rehabilitation procedures and exercises, in patients with curvatures above 25 - 40° Cobb a more aggressive treatment is selected, i.e. a surgery aiming at stabilization of the vertebral column. The general observation is that the earlier posture defects are detected and pathological symptoms appear, the higher the risk of disease progression and the poorer the prognosis. Screening tests, early prophylaxis and radiological examinations play a principal role in scoliosis diagnostics in young people. Precise and non-invasive computerized methods are increasingly applied for the accurate determination of type, location, and size of scoliosis. Any neglect in this respect or inadequate treatment may bring about the development of irreversible changes within the spine itself, as well as permanently disturb functioning of the locomotor system, which in turn significantly limits patients' fitness, aggravates neurological impairment, exacerbates respiratory and cardiovascular insufficiency, causing permanent disability. The main objective of the present paper is to study the aims and effects of physiotherapeutic procedures used in postoperative treatment of scoliosis in young people. Basing on the conducted research, we will also analyse the significance of physiotherapy in the preoperative period of scoliosis treatment, as those procedures complement the entire therapy. Another goal of the present analysis is to evaluate the role of physiotherapist in the management of scoliosis.

Materials and methods

The study was based on a self-designed questionnaire consisting of 51 open and closed questions divided into three parts. The first part of the survey includes instruction on how to fill in the questionnaire and a description of the study objective; the next part comprised questions referring to the respondents' socio-demographic data, like sex, age, education, marital status, information about disease; and in the third part we asked questions directly related to the main subject of the study. The study was conducted in July 2012 among individuals treated in orthopaedic and rehabilitation hospital wards and outpatients' departments of the Lublin region. The main part of the study was carried out on the premises of the Children's Clinical Hospital in Lublin on the rehabilitation and orthopaedic wards and in the children's outpatients' orthopaedic department, as well as in the Independent Public Health Care Complex in Włodawa, Poland. The questionnaire included 50 individuals with scoliosis which had been surgically treated in adolescence. The participation of the under-aged in the study was preceded by obtaining the parents' written consent. All the subjects were informed about the objective of the study, its anonymous character and the aim for which the results will be used. Division of the study population into two groups was performed: group A included 40 patients operated for scoliosis at the age of 13 – 19 years (Tab.1), whereas in group B there were 10 individuals aged 25 – 43 years, who had been operated for scoliosis in adolescence (Tab.2). All the subjects who gave consent for taking part in the study received the study questionnaire in person, by mail, or e-mail. The obtained results were analysed qualitatively and quantitatively, and both study groups were compared in order to find possible differences in the efficacy of scoliosis therapy at present and several years before.

Tab. 1 Group A subjects according to age and sex

		The examined persons		Group A	
		Women	Men		
		number	number	sum of numbers	%
The age examined persons	13 years	1	0	1	2.5
	14 years	4	2	6	15.0
	15 years	5	0	5	12.5
	16 years	4	1	5	12.5
	17 years	6	1	7	17.5
	18 years	6	0	6	15.0
	19 years	10	0	10	25.0
Total:		36	4	40	100.0
Total %:		90.0	10.0	100.0	

Tab. 2 Group B subjects according to age and sex

		The examined persons		Group B	
		Women	Men		
		number	number	sum of numbers	%
The age examined persons	25-27 years	4	1	5	50.0
	31–32 years	1	1	2	20.0
	40–43 years	3	0	3	30.0
Total:		8	2	10	100.0
Total %:		80.0	20.0	100.0	

Results

On the basis of the obtained data and an analysis of the study material, the following results were obtained. The majority of subjects in both study groups A and B were female; in group A there were 90.0% women and 10.0% men, and in group B 80.0% were women and 20.0% were men. A majority of the respondents in both groups live in a town/city: group A – 67.5%, group B – 90.0%; whereas 32.5% of the subjects from group A and 10.0% from group B live in the country. The most common family model that the respondents were brought up in was that with 2-3 children in both groups (40.0% each). The subjects' living conditions in their own opinions were good or average (82.0% respondents in both groups). As regards complaints before the surgery, the respondents in both groups most frequently mentioned back pain (95.0%), dyspnoea (30.0%), headache (17.5%). One respondent (2.0%) from group A also mentioned numbness in the lower limbs (Fig.1).

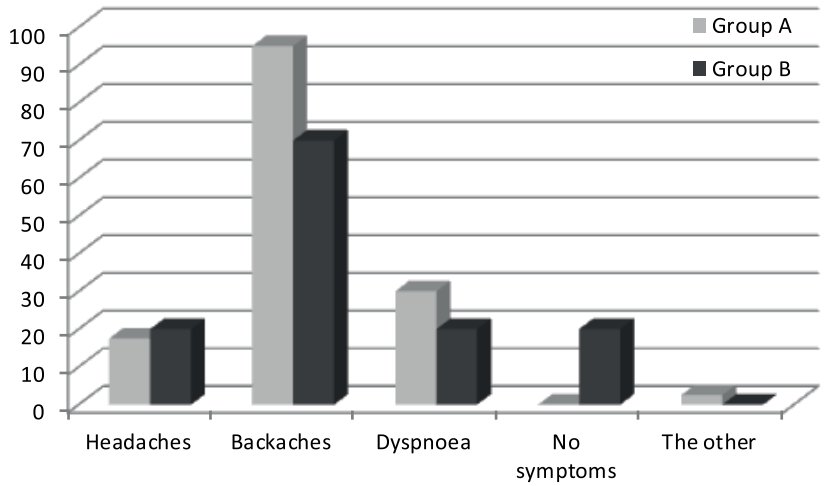

Fig. 1 Common complaints before the surgery

Almost half the subjects from groups A and B (42.5%) described their quality of life before the operation as bad, and 40.0% said it had been satisfactory (Fig.2).

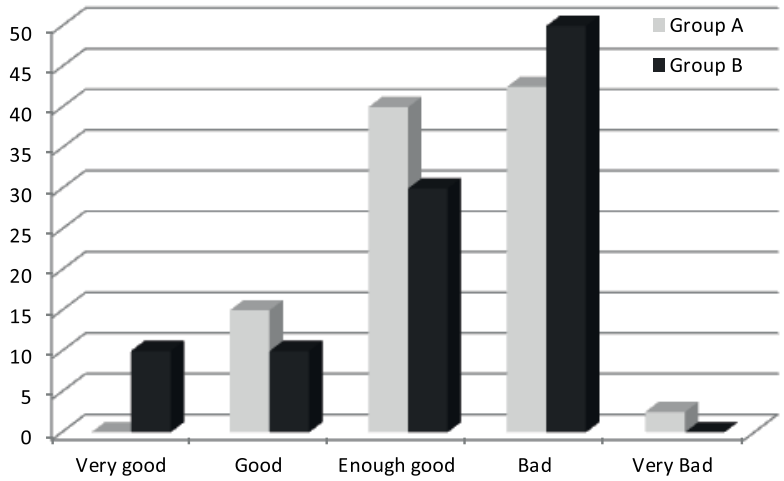

Fig. 2 Evaluation of the quality of life before the operation

In both study groups more than half the respondents admitted to not being able to catch up with their peers in many aspects of life (Fig.3).

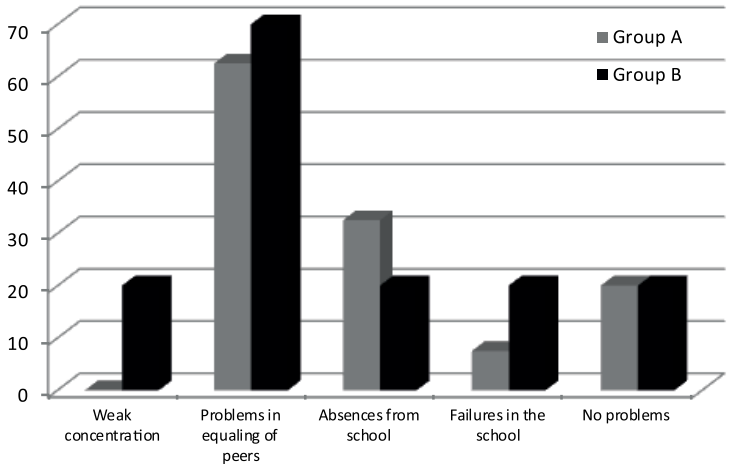

Fig. 3 Youth with scoliosis in school environment

The respondents declared that the disability adversely affected their private lives to a great extent (32.5% of group A and 40.0% of group B subjects) (Fig.4).

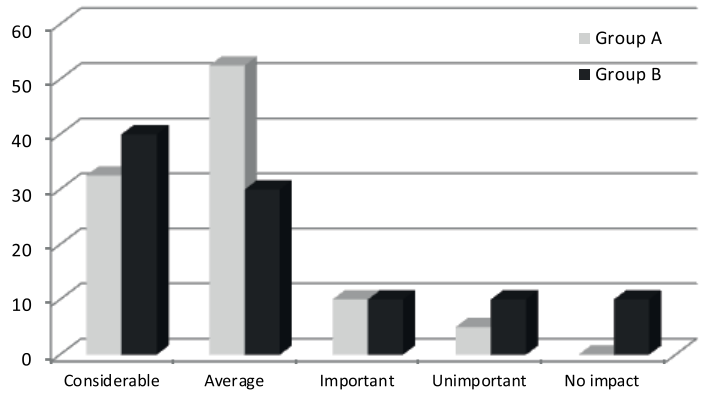

Fig. 4 Negative effect of disease on the patients' private lives

Respondents in both study groups pointed out to parents as the ones who educated them about correct body posture (group A – 95.0%; group B – 80.0%). Parents' disinterestedness in this aspect of their health was declared by 5.0% of the subjects in group A and 20.0% of group B. A great majority of patients from both groups declared having adequate knowledge about scoliosis (95.0% of group A and 90.0% of group B). Only 5.0% of respondents from group A and 10.0% from group B admitted to not being knowledgeable enough in that respect. In group A 82.5% of patients underwent a form of physiotherapeutic treatment before the surgery, and only half the respondents in group B. In group A 17.5% of the surveyed did not undergo physiotherapy before surgical treatment of scoliosis. The kinds of physiotherapy that the patients used before scoliosis surgeries included kinesitherapy (55.0% in group A) and water exercises (50.0% in group A), and massage was the least popular kind of therapy (10.0% of respondents). Among the group A subjects 15.0% mentioned traction as the method of physiotherapy used before the operation. In group B all the mentioned methods of physiotherapeutic treatment were used equally frequently (20 – 30%) by the subjects, except traction (Fig.5).

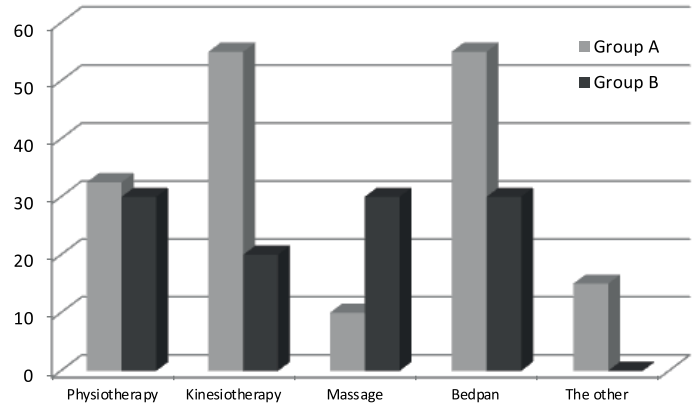

Fig. 5 Use of physiotherapeutic treatment before surgery

The most frequently occurring diagnosis in the study population was idiopathic scoliosis: 75.0% of group A and 50.0% of group B (Fig.6).

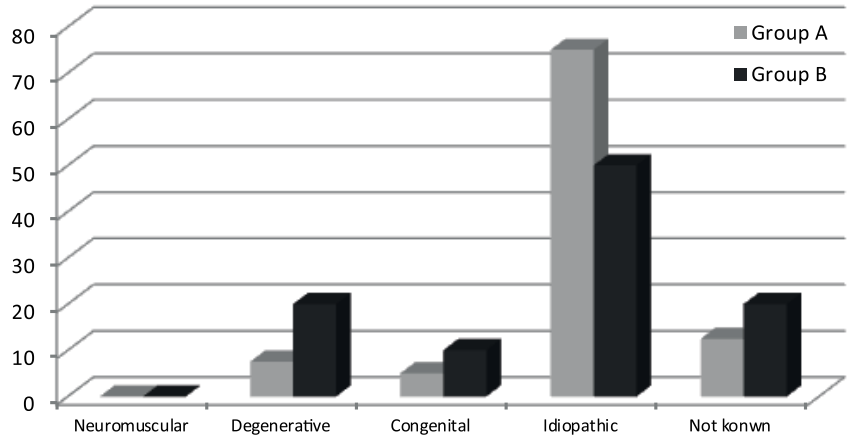

Fig. 6 Scoliosis types according to the subjects

An analysis of medical records disclosed that more than half of group A population (57.5%) suffered from single scoliosis, whereas double scoliosis occurred in 32.5%. In group B half the patients had double scoliosis, and 20.0% suffered from single scoliosis. The medical records showed that 42.5% of people in group A had undergone the scoliosis surgery several months to one year before the study. Those operated on 2 years before the study accounted for 30.0% of group A population, 3 years prior to the study – 15.0% and 4 years before – 12.5%. In group B all the respondents underwent operative treatment of scoliosis 4 or more years before the present study. Study results analysis showed that the majority of the subjects in both study groups A (50.0%) and B (40.0%) maintained that their scoliosis angle (an abnormal curvature of thoracic spine) was equal or exceeded 60˚ according to Cobb, whereas those with scoliosis angle of 50 - 59˚ constituted 37.5% of group A and 10.0% of group B respondents. A great majority of both groups were people whose operations were through posterior approach: 65.0% of group A and 90.0% of group B, and in 22.5% group A subjects were operated on through the anterior approach. Moreover, one person in group A underwent surgical treatment of their scoliosis which involved both anterior and posterior approach, and 15.0% in that group and 10.0% of group B could not give information about the kind of procedure they had undergone. The operative procedures resulted in corrections of scoliosis angles, and it was noted that in both study groups the majority of the subjects benefited from a correction of thoracic spine of 10 - 19˚ Cobb (22.5% in group A and 30.0% in group B) and 20 - 29˚ Cobb (27.5% of A respondents and 30.0% of B). Additionally, it was found that more than half the study population in both groups had undergone just one operative procedure to correct their scoliosis, whereas two-stage surgeries were performed in 17.5% of group A subjects and 10.0% of group B. Scoliosis surgeries consisting of three or more stages accounted for 20.0% of procedures in both study groups. After the surgeries wearing

a back brace was used as a form of treatment in both groups with almost half the respondents of group A using a back brace and 60.0% of group B respondents. The study revealed that the level of self-care that the respondents enjoyed after the operative procedures was described as "slightly limited" by 47.5% of group A subjects and 80.0% of those in group B, with complete self-care declared by every third patient of group A and every fifth of group B. All the group A respondents and almost all of group B underwent physiotherapy directly after operative procedure. The most common forms of physiotherapeutic interventions directly after the surgery included help with walking, according to group A respondents, and help with breathing exercises, according to group B respondents. The next form of physiotherapy that the A subjects mentioned were breathing exercises, as well as active exercises, whereas in group B it was help with walking and active exercises. Passive exercises were the least frequent form of postoperative rehabilitation in both groups. All the respondents stressed that they had felt safe while exercising when the physiotherapist was present (Fig.7).

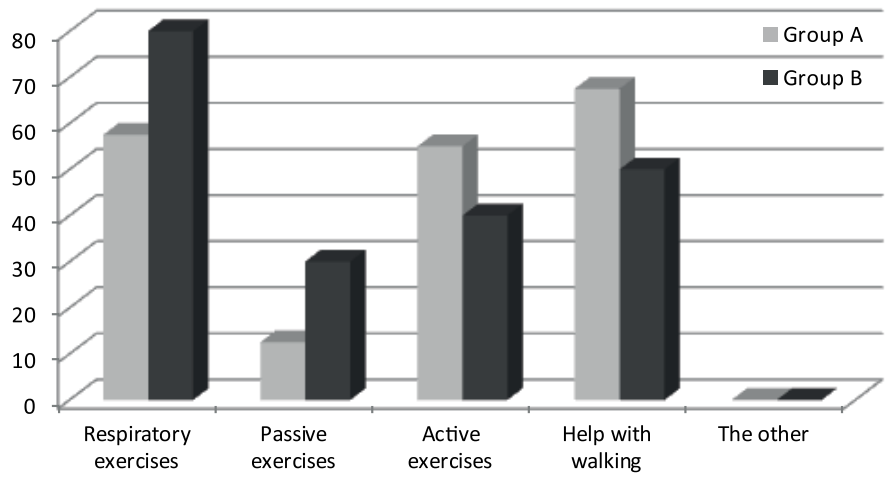

Fig. 7 Types of exercises used for postoperative rehabilitation of scoliosis patients

The subjects were also asked about the knowledge they possessed concerning physical activity after an operative treatment of scoliosis, and it was found that three quarters of group A patients and all the group B respondents exhibited a good level of education in this respect. It was observed that two thirds of the subjects in group A and almost a half of group B underwent physiotherapy after the operative procedure, with a physiotherapist present during rehabilitation exercises. The respondents were also asked about most common complaints and it was noted that 35.0% of those in group A and 10.0% of group B did not declare any. The complaint that occurred the earliest after the surgery was back pain in 30.0% of group A subjects and 80.0% of those from group B. Headaches appeared in 5.0% of group A and 10.0% of group B. Asked about the main source of information, the majority of respondents pointed to a doctor (87.5% - group A , 90.0% - group B); however, it is worth noting that the subjects confirm an increasing role of physiotherapist in this respect, with 47.0% of the

questionnaires in group A containing such reference. It was also noted that almost all the patients in both groups (92.5% and 90.0% respectively in groups A and B) strictly adhered to recommended limitation of physical activity after surgery. The most common form of physical activity declared by the respondents was walking (70.0% in group A and 60.0% of group B); water exercise was the next popular form of activity (A – 40.0%, B – 60.0%); the respondents also mentioned dancing (A – 30.0% and B – 20.0%), cycling (5.0%), and skiing (2.5%). A great majority of the respondents in both groups (A – 72.5% and B – 80.0%) advocated support on the part of their parents/ family as the most desirable. In group A a lot of respondents (37.5%) expected support on the part of peers, whereas in group B there was only one (10.0%) such person. About 30.0% of the subjects in both groups expected support on the part of their siblings. The subjects' evaluation of the physiotherapist's level of care was positive in both groups. The characteristics that were used the most frequently in the descriptions of the physiotherapist were: supportive (A – 65.0%, B – 30.0%), well-wishing (A – 35.0%, B – 30.0%), understanding (A – 25.0%, B – 80.0%), and nice (A – 22.5%, B – 60.0%). No less than 80.0% of the subjects in both study groups expressed their satisfaction with the cosmetic effect that had been achieved as a result of scoliosis surgery, with the remaining 20.0% of the subjects not satisfied with such effect. The majority of both groups stated that postoperative scarring was visible (60.0% of group A and 70.0% of group B), with only 3 individuals in group A (7.5%) maintaining that the scarring was too big. Almost all the studied individuals from both A and B groups declared that the scoliosis surgery was a good decision in their lives.

Discussion

Ongoing research on large populations of children and youth carried out around the world and in Poland revealed incidence of scoliosis in 4-14% of schoolchildren aged 10-14 years, which means that, on average, every tenth child is diagnosed with scoliosis. In the majority of the cases the scoliosis measures less than 20˚ Cobb, yet those values confirm the social significance of the problem. Researchers found that among 10-11-year-old schoolchildren scoliosis occurs as frequently among girls as among boys; however, at the age of 14 years, the proportion of girls to boys among those with progressive scoliosis equals 10:1, which means that scoliosis itself is not connected with the person's sex but its progression is, to a certain extent, correlated with the level of sex hormones (Feizi, Mohseni, 2009; Milanowska, Dega, 2003). An etiology of just a small number of scoliosis types has been discovered, constituting just 10-20% of all pathological curvatures of the spinal column. Idiopathic scoliosis is the most common, accounting for 80-90% of all diagnoses (Feizi, Mohseni, 2009; Stępień 2010; Kwolek 2003; Majcher, Fatyga 2000; Milanowska, Dega, 2003; Nowotny 2006; Piątkowski 1990; Wilczyński 2000). The division of scoliosis depending on age only refers to idiopathic scoliosis. W. James introduced the classification of scoliosis into three principal groups: infantile scoliosis, juvenile scoliosis, and adolescent scoliosis. The results of the present study concerning incidence of scoliosis indicate a statistical advantage of women over men in this respect at the proportion of 88% to 12% of the subjects (Feizi, Mohseni, 2009; Karski 2003; Kutzner–Kozińska, 2004; Kwolek 2003; Majcher, Fatyga 2000; Milanowska, Dega, 2003; Piątkowski 1990). The common classification of scoliosis, i.e. abnormal sideways curvature of thoracic spine segment, is that developed by Cobb, basing on the scoliosis angle; thus,

scoliosis of the 1st degree measures 30˚ Cobb; 2nd degree - 30˚-60˚; 3rd degree - 60˚-90˚; 4th degree – above 90˚Cobb. The determination of scoliosis angle is crucial for the choice of treatment and recommendation as to subsequent rehabilitation (Karski 2003; Kwolek 2003; Majcher, Fatyga 2000; Piątkowski 1990; Wilczyński 2000). Our study revealed that almost half the respondents in both study groups declared scoliosis angle of 60˚, according to Cobb; those with the angle of 50˚-59˚Cobb were similarly numerous. According to the number of arches within the developing scoliosis, it is divided into single, double, and multi-curve scoliosis (Kasperczyk 1994; Kwolek 2003; Majcher, Fatyga 2000). The study showed that single scoliosis occurred in more than half of group A respondents, and double scoliosis was diagnosed in every third patient. The study disclosed that half the group B subjects had double scoliosis, whereas single scoliosis was diagnosed in just every fifth subject. Research carried out recently in England, United states and Russia has confirmed the significance of genetic predisposition to idiopathic scoliosis. Its results have indicated a high familial correlation with possible inheritance or multifactorial influence (Milanowska, Dega, 2003). Own study results did not confirm that finding, as the majority of our study population denied cases of scoliosis in the close family. One of the factors that adversely influence the health of the locomotor system is obesity and it is increasingly common among the young generation. In obese individuals hip joints are usually positioned in bending, which negatively influences the formation of spinal curvatures, gradually leading to abnormalities. On the other hand, in children and young people who are excessively thin, where the back is flat, the vertebral column is unequally weighted, which leads to decreased endurance, stiffness of joints, and, consequently, scoliosis (Wiercicka, 2010). In the present study more than 60% of the respondents had normal body weights, whereas every fifth subject was overweight. Management and treatment of scoliosis being lengthy, it requires decisiveness and consequence on the part of patients, but also their parents and the whole medical team. The aim of therapy is to diminish the deformation of the spine, to check the progression of scoliosis, and, lastly, to retain the corrected body posture. Modern methods of non-operative treatment of scoliosis involve regular exercise and the use of adequately chosen orthopaedic aids, i.e. orthopaedic braces. Kinesitherapy has always been the rule of thumb in non-surgical treatment of scoliosis, consisting in a correct selection of general fitness exercises, which help create correct body shape and strengthen muscles which stabilize the spine. Exercises improve the child's general condition, strengthen the muscle corset and decrease the commonly occurring contracture within the muscle-ligament system, which frequently results in stopping scoliosis progression and in correction of body posture. In spite of appropriate kinesitherapy, the deformation sometimes increases and its angle grows; then the range of treatment is extended to include electrotherapy or orthopaedic devices (Kutzner–Kozińska 2004; Kwolek 2003; Majcher, Fatyga 2000; Milanowska, Dega, 2003; Nowotny 2006; Piątkowski 1990). Own study revealed that almost half the group A patients underwent brace treatment, and more than two thirds of group B respondents were treated with orthopaedic braces. More than three quarters of group A patients and half the group B subjects underwent physiotherapy prior to operative procedure, most common forms of therapy being kinesitherapy, water exercises, and massage. Kinesitherapy of young people treated non-surgically is very different from that designed for young individuals prepared for the operation. The main importance is attached to elongation and derotation of the spinal column. Preparing the patients for the

operation involves the use of traction in order to stretch the shortened soft elements of perispinal structures (Milanowska, Dega, 2003; Nowotny 2006). Own study shows that in group A traction as form of physiotherapy was used in every seventh respondent, and in group B traction was not used at all, whereas all the other forms of physiotherapy were equally used among the study population. Research confirms that the most appropriate time for a scoliosis surgery is the age of 13-15 years. Qualification requirements for an operative procedure include idiopathic scoliosis with the angle greater than 45-50 degrees Cobb. Surgical treatment of moderate scoliosis ($50–70^0$) allows for remarkable correction, making scoliosis practically invisible (Kwolek 2003; Milanowska, Dega, 2003). Similar results were obtained in the present study. Own study also shows that the majority of patients in both groups underwent surgical correction of thoracic spine segment deformation of the order of $10–19^0$ and $20–29^0$ (30% each) with the best therapeutic results. In progressive scoliosis a surgical treatment is seen as a continuation of rehabilitation, i.e. the extension of the preceding non-surgical treatment. Operation is the middle stage between the preceding conservative treatment and rehabilitation that follows as the last stage of therapy. The surgery may be performed in two ways: through anterior approach and through posterior approach. Quite frequently those two ways are combined in order to enhance the corrective effect and to free the patients from the necessity of using external stabilizers (Feizi, Mohseni, 2009; Milanowska, Dega, 2003; Nowotny 2006). Own study disclosed that a great majority of both study groups (9 in 10 cases) were operated on through the posterior approach, and only every fifth respondent was treated through anterior approach. After the surgery, whether the child is wearing a brace or not, isometric exercises of dorsal muscles, exercises increasing muscular strength of shoulder girdle, and pelvic girdle, and breathing exercises (Kwolek 2003; Milanowska, Dega, 2003; Nowotny 2006) are used. An analysis of the present study shows that almost all the patients in both groups were aided by a physiotherapist directly after the operation. The most common form of rehabilitation after scoliosis surgery according to the respondents was help with walking and monitoring the correctness of breathing exercises. The task of physiotherapy is also to educate the patient and his family as to physical activity before and after the operation (Stępień, 2010). It is good to note that over the years patients start to appreciate the role of a physiotherapist as the basic source of information. Long experience of Polish and foreign centres dealing with the treatment of scoliosis has revealed that the best results are achieved while basing management on early detection of scoliosis, early introduction of regular rehabilitation, and continuation of treatment with regular check-ups at least until the end of bone growth, i.e. up to 16-18 years of age (Milanowska, Dega, 2003).

Conclusions

1. Scoliosis most frequently affects females and the most common variety is idiopathic scoliosis, with deformation of the spinal column equal or greater than 60˚ according to Cobb, corrected surgically and giving remarkable health and aesthetic benefits to patients' satisfaction.
2. A physiotherapist is an integral member of the rehabilitation team rehabilitating children and young people diagnosed with scoliosis before and after the operation.

3. The parents, teachers, and the young people themselves should become complementary members of the rehabilitation team, possessing a high level of knowledge concerning prophylaxis.
4. The effects of operative procedure and physiotherapy on scoliosis beneficially influence the quality of everyday life of the young population.
5. The young people's strict cooperation and compliance with the recommended limitations after operative correction of scoliosis are closely associated with continuous education as to possible threats and complications after the surgery.
6. Cooperation with the physiotherapist, their effort and level of care were positively evaluated by the patients, which proves a growing level of service and growing patients' awareness.
7. Almost all the questionnaire respondents agreed that scoliosis surgery had been a good decision in their lives, and the effects of therapy significantly improved their quality of life.

Bibliography

1. Feizi H., Mohseni M. (2009) Scoliosis curve: before and after surgical correction. "Pakistan Journal of Biological Sciences", 12(10): 786-791.
2. Karski T. (2003) Skoliozy tzw. idiopatyczne, Wydawnictwo Folium, Lublin.
3. Kasperczyk T. (1994) Wady postawy ciała, Kraków.
4. Kutzner–Kozińska M. (2004) Proces korygowania wad postawy, Wyd. AWF, Warszawa.
5. Kwolek A. (2003) Rehabilitacja medyczna, Wyd. Urban & Partner Wrocław.
6. Majcher P., Fatyga M. (2000) Wady i zniekształcenia kręgosłupa, Wyd. Centrum Medycznego Kształcenia Podyplomowego Lublin.
7. Milanowska K., Dega W. (2003) Rehabilitacja medyczna. PZWL, Warszawa.
8. Nowotny J. (2006) Podstawy kliniczne fizjoterapii w dysfunkcjach narządu ruchu, Wyd. Medipage, Warszawa.
9. Piątkowski S. (1990) Ortopedia, traumatologia i rehabilitacja narządów ruchu, Wyd. PZWL, Warszawa.
10. Stępień A. (2010) Ocena pacjenta ze skoliozą idiopatyczną na poziomie struktur i aktywności dla potrzeb planowania procesu fizjoterapii. Kręgosłup (część 2) „Praktyczna Fizjoterapia & Rehabilitacja", 3: 59-62.
11. Wiercicka M. (2010) Profilaktyka zaburzeń postawy ciała u dzieci. „Praktyczna Fizjoterapia & Rehabilitacja", 4: 57-58.
12. Wilczyński J. (2000) Boczne skrzywienia kręgosłupa (część I), Wyd. Wszechnica Świętokrzyska, Kielce.

Number of signs with spaces: 30 470