

Marta Motow-Czyż

Effective and innovative methods of scoliosis treatment

Keywords: *scoliosis, methods of scoliosis treatment*

Introduction

Body posture has been long a focus of a variety of research projects conducted by many orthopaedic surgeons, physical therapists and the people employed in physical education. An enormous amount of deviations from the pattern of correct body posture has been observed as a consequence of technological advances and dynamic changes in lifestyles. Contemporary life, which are predominantly based on sedentary lifestyles, reduced physical activity or lack of this activity and longer working or learning time have caused the more frequent incidence of faulty posture. The most serious and the most frequent problems is scoliosis. Z Śliwiński argued that there are 20% of children at the developmental age have scoliosis [Śliwiński, 2008: 1]. Therefore, it can be concluded that scoliosis can be numbered among lifestyle diseases and, if untreated, or treated ineffectively, the scoliosis is likely to progress and other scoliosis-related disorders and diseases might develop.

Scoliosis is a medical condition of the spine which results from the spine's deviation from correct position in three planes of the spinal profile. As a consequence of this deviation, the spine is bent to the left or to the

right in frontal plane. A lordosis occurs in saggital plane in the apex of the curve arc, whereas a rotation of vertebrae is observed in transverse plane. Changes in the three planes cause a series of disorders in motor organ, respiratory or cardiorespiratory systems.

Development and genesis of scoliosis depend on the two factors. The first of them is an etiological factor, whereas the other is a biomechanical one. Etiological factor causes the disturbance of static and dynamic equilibrium of the spine. As a result of this disorder, an arched spinal curve appears in frontal plane in one direction, termed primary curve. In the area of this curve, on the concave side, the flexibility is deteriorated and the intervertebral discs become narrower. As a result of gravity and unsymmetrical load to intervertebral discs on one side and increased force distribution on the other, structural changes are triggered in the vertebrae, which is difficult and sometimes even impossible to be treated. These changes include wedged vertebra, which results from the effect of opposite forces. Further changes result in rotation of the vertebra in transverse plane. It is defined as a rotation of a vertebra around the spinal axis. During rotation, corpus vertebrae are always pointed towards the convexity of the curve and the arch with processes is pointed towards the concavity. The rotation is followed by torsion, also termed the phenomenon of vertebra twist, along the vertical axis of the spine towards the convexity of the curve [Tuzinek, 2004: 38].

A characteristic feature of scoliosis is gibbus costalis, which is a consequence of rotation. It is developed as a result of dislocation of ribs caused by vertebrae twisting towards the rear on the convex side and towards the front on the concave side. A lumbar prominence is formed in the area of lumbar spinal section of the spine. These changes result in modifications in the area of cardiorespiratory system. The rotation, which causes a dislocation of ribs, contributes to the deformation of thorax and dislocation of internal organs, thus disturbing their function. In the case of advanced scoliosis, the lung on the convex site is compressed, whereas the lung on

the concave side overtakes the function of the other and is subjected to partial emphysema [Kasperczyk, 2004: 53].

Primary curve causes disturbances to balance and statics of body trunk. Nevertheless, the system strives for regaining balance and shifting the point of gravity. Consequently, a secondary (compensatory) curve is formed, oriented towards the other side with respect to the primary one. Contrary to the primary curve, the secondary curve is regarded as a positive phenomenon.

Depending on the degree of progression, there is a scoliosis of the first, second, third and fourth degree, with the following values of Cobb angle:

1st degree, up to 30°: clinical symptoms exhibit deviation of the line of spinal processes from the vertical line,

2nd degree, up to 60°: structural changes in vertebrae and intervertebral discs are observed. A gibbus costalis is formed as a result of rotation or lumbar prominence at the scoliosis in L section.

3rd degree, up to 90°: far-reaching structural changes, wedging and torsion of the vertebrae, rib and pelvis deformation.

4th degree, over 90°, development of more serious symptoms [Owczarek, 2009: 340].

According to the cause of formation, the scoliosis can be categorized as functional, structural and idiopathic. The first case concerns the muscular and capsuloligamentous apparatus. Principally, these are smaller curves, with one arch with low progression which is easy to be treated. The second one, structural scoliosis, occurs in the case of changes in osseous structures. These include wedging of discs, rotation or torsion. They are principally multi-arc cases of scoliosis with intensive progression: treatment of these disorders is not easy. In the case of idiopathic scoliosis, which is the most frequent case, the cause remains unknown, whereas the characteristic features are similar to those of structural type [Kowalski, Hurło, 2003: 34].

With regard to the types of scoliosis, there are three types of symptoms characteristic of this disorder. Among them are the symptoms of the first,

second and third order. The symptoms of the first order include changes affecting the spine and sacrum, such as anterior posteriolateral spinal curve, vertebrae rotation, torsion and wedging. The symptoms of the second order concern skeletal elements which are directly connected with the spine. These include gibbus costalis on the convex side, impressio costalis on the concave side, dislocation of thorax towards the convex side, inclination of thorax, torsion of thorax and protruding hips. The symptoms of the third order concern the sections which are distal with respect to the spine. These symptoms include waist triangle, shoulder and arm asymmetry.

Considering the variety of characteristics of scoliosis, it should be noted that, regardless of the progression of the curve and the symptoms which accompany the curve, scoliosis has significant effect on everyday existence of patients and the jobs they perform. The curvature with the angle of 60° does not only reduce respiratory volume of lungs but it also limits heart's stroke volume. F. Sastre argues that in the case of serious scoliosis in children, deformation might also cause paralysis of the lower body and pathological changes in internal organs [Sastre, 2008: 49]. Furthermore, J. Nowotny notes that scoliosis contributes to a limited range of motion of the spine in sagittal and frontal planes [Nowotny, 2000: 52]. Therefore, one disorder is followed by a series of changes which affect functions of human body. In order to prevent them, the treatment must follow as soon as possible.

Study Aim

There is a great variety of methods of scoliosis treatment. It should be noted that treatment of scoliosis begins after a very careful diagnosis of the disorder. Among a plethora of treatment methods are the procedures ranging from pioneer methods of correction through more or less effective procedures to the most innovative methods. The present study aims at presentation of selected effective and innovative methods of scoliosis treatment which are used today by doctors and physical therapists.

Discussion

Treatment of lateral spinal curves is a problem which is extraordinarily complex. It requires application of multilateral procedures. The general aim of each method of treatment is to:

- remove or reduce deformation,
- preservation of the obtained correction through introduction of habitually correct body posture,
- stopping progression of the illness if the correction is impossible.

Each of them differs in their procedures used in order to obtain the correction.

There is a plethora of methods of correction of scoliosis. They include conservative and surgical methods. There are many conservative methods. The main aim of these is to control spinal curvature and prevent from further progression. Nowakowski A. and Łabaziewicz L. stressed that the aim of conservative methods it to ensure that the exercises are performed so that the curvature does not exceed 45 degrees after the completion of the period of growth [Nowakowski, Łabaziewicz, 1997: 407-413]. Furthermore, W. P. Blout argues that the conservative methods of scoliosis treatment are only a supplementation of surgical and orthopaedic interventions [Blout, Bolinski, 1967: 919-925]. Moe J.H also underestimated the important effect of physiotherapeutic treatment of scoliosis [Moe, 1957: 69-184].

One of the methods used in scoliosis treatment is PNF (Proprioceptive Neuromuscular Facilitation). As a proprioceptive method, it affects the improvement of activities in motor centres through stimulation of proprioceptors which exist in muscles, tendons, ligaments and articular capsules. The PNF method is aimed at re-education or reconstruction of a particular motor function, lost as a result of an illness. The movements used in this method match the natural muscle motion and follow the natural movements of a healthy human [Adler, Beckers, Buck, 2008: 20]

The main assumptions of this method include:

1. *Application of a global and complex movement, in which the element of rotation is regarded to be as fundamental, combined with the inclined plane of the movement.*

2. *Technique of proprioceptive stimuli, used through gradually increasing manual resistance, which helps perform a coordinated movement within a particular range.*

3. *A comprehensive utilization of a muscular synergism in order to maximally excite the weaker muscle groups [Białek, 2001: 220-221].*

The PNF method is the most frequently used procedure for scoliosis treatments. It utilizes the patterns of movement with a specific pattern in three planes. Analysis of the parameters of curvature allows for application of suitable movement patterns for upper/lower extremities, scapulae, shoulders and pelvis, which allows for obtaining the necessary correction in three planes. Furthermore, the resistance is applied to specific places in order to obtain the best effect possible. Through application of a suitable position and correction in this position, the method prepares a child for performing everyday activities with optimally corrected spine and pelvis. Unlike previous methods of treatment, this method is based on research projects which have demonstrated that spinal curvature is also connected with disturbances in the central nervous system [Benson, 1998: 1619-1698]. At developmental age, these disorders cause deviations in central nervous system that lead to the asymmetry of motor activity and, consequently, incorrect position of the spine. The progressing deformation of the spine leads to an increased asymmetry of bodily functions. This elevated asymmetry is 'understood' by the nervous system as a norm, which causes that children cease to sense the correct body position. Therefore, PNF method allows therapists, through suitable movement patterns, to correct the faulty posture and, consequently, affect the nervous system, stimulate changes in habitual movements and improve sensing the position of the body. In his study *Możliwości zastosowania PNF w leczeniu skolioz (Opportunities of application of PNF method for treatment of scoliosis)* [Białek, 2001: 220-221], M. Białek notes that scoliosis of the first degree

without structural changes can be corrected after 2-3 months of therapy, whereas in the case of structural changes, the curvature angle is insignificantly improved and the body posture is considerably better. In conclusion, this method seems to be effective and has been increasingly popular in treatment of scoliosis today.

Based on a detailed and long-term research, professor Santos Sastre developed other methods of scoliosis treatment. With regard to children with scoliosis lower than 25 degrees, this researcher developed a set of exercises which are performed by a child assisted by their parents. In order to achieve this, parents are instructed how to perform exercises properly. For the first three months they work alone with children at home. Then the first progress check is carried out. The next check takes place half a year after commencement of the therapy using the recommended exercise set. These checks are aimed at verification whether the recommended procedure is correct. In the case of scoliosis lower than 25 degrees, this method is used until the period of ossification is ended.

Another procedure is used in the case of scoliosis over 25 degrees. To treat this type of scoliosis, the professor S. Sastre developed a FED system (Dynamic and Tridimensional Therapy of Scoliosis), which is based on three-dimensional stabilization of the spine, accompanied by its elongation. The method is one of the conservative procedures for treatment of not only scoliosis but also other types of pathological spinal curvatures. It uses specialized equipment named FED, which reduced the angle of rotation during the operation which takes 30 minutes. There are three therapeutic phases in FED:

- phase of elongation,
- phase of fixation,
- phase of derotation (regression of curvature) [Sastre, 2008: 172].

The precondition for proper treatment using this method is consecutive occurrence of these phases.

During the phase of elongation, a scoliotic patient, with body trunk immobilized by means of an orthopaedic corset, is placed in a FED equip-

ment, where they are subjected to elongation force. Consequently, according to S. Sastre, the following occurs:

- dividing of corpus vertebrae between each other, which balances the differences between the convex and concave sides of the curvature,
- reduction in pressure to half-vertebrae located in concavities,
- reduction in pressure to articular processes on the concave side,
- reduction in asymmetry of intercostal spaces between the convex and concave sides [Sastre, 2008: 173]. Additionally, as a result of elongation, the ligaments and tendons are extended on the concave side. The tissues in the area of curvature are better nourished and vascularized. In this phase, after the application of the force, a functional reduction of the curvature is obtained, which corrects the pathological shape.

During the next phase, the patient is hung in the middle of the FED equipment. The mechanical arm is placed on the apexes of greater curvature. Another stage of this phase is location of the most distal segments of the main curvature on the concave side and fixation of the pelvic crest at the front and the rear. Then, the curvature apex is pressed by means of the arm in order to induce fixation of the adjustment. Consequently, a reduction in the curvature in the apex occurs. Positioning of the mechanical arm at a particular angle on the concave side of the curvature allows for derotation of the spine. This procedure helps subject the pathological curvatures in the spine to tension. This results in an enhanced therapeutic effect of the elongation phase and prepares the body for another phase. During the next phase, the mechanical arm, which performs a rocker bend and derotation of the curvature according to its own axis, causes deformation of the spine.

Spine correction in the next phase, i.e. derotation and regression of curvature, is obtained by combining the pulling and derotary movement while extending. S. Sastre emphasizes that this type of movement is achievable only in this method, by means of a device designed by the researcher. Re-

gression of curvature is obtained through *application of a mechanical arm at the angle between a support point and the line of force generated by the engine, reducing this angle depending on the rotation angle* [Sastre, 2008: 179]. As a result of this procedure, the mechanical arm performs a series of therapeutic reactions because the pressure it generates affects the withdrawn ribs which form the posterior convexity of the hump. C.E. Aubin and H. Libelle suggest this therapeutic effect based on the three-dimensional method of correcting deformation [Aubin, 1997: 629-635], [Labelle, 1996: 629-635].

This method proved successful in reduction of the rotation angle, through application of the force of 70kg to the curvature arc. The effects include:

- decompression of the epiphyseal plate on the concavity side,
- growth of the epiphyseal plate,
- changes in the forces acting on neurocentral plates, causing inhibition of rotation.

Z. Sliwiński notes that application of this method for scoliosis treatment helps affect not only musculofascial structures but, first and foremost, it results in even pressure on the cartilage. Even pressure contributes to regaining the proper mechanism of vertebrae growth [Śliwiński, 2008: 1-3]. Therefore, it can be concluded that this method, although not easy, favourably affects the scoliotic posture, corrects it and is particularly effective in idiopathic scoliosis treatments.

Another method of scoliosis treatment was developed as a result of long-term investigations and experience of the doctor Rudolf Ociepka. This type of scoliosis is characterized by lordic scoliosis with fast progression and considerable rotation of the spine. They develop as three-dimensional disturbances in the area of the primary curve. It occurs in the sagittal plane as a result of antecurvation, flat back and deepened lordosis. Lateral plane exhibits lateral deviation, whereas rotation (which deteriorates the posture) occurs in transverse plane. Many researchers, including K. Zelke in 1981, argue that the rotation of the curvature is the most important char-

acteristic of curvature progression [Zelke,1981]. When treating scoliosis, the efforts should be taken in order to prevent rotation or, when it occurs, a force should be applied in order to reduce it. Therefore, the method proposed by R. Ociepka affects the three planes of curvature concurrently, including the rotation where the disturbances occurred. It is also termed SAKIS (*System Aktywnej Korekcji Idiopatycznych Bocznych Skrzywień Kręgosłupa – system of active correction of idiopathic lateral spinal curvature*). This method uses specialized equipment, such as:

- corrective scoliotic belt for selective strengthening of intravertebral involuntary muscles of the convex side of the curvature,
- scoliosis corrector for triplanar correction of curvature in the area of curvature arc.

Furthermore, R. Ociepka proposed the antigravity-kiphositic exercises, whose main aim is prevention and correction of scoliosis in frontal and sagittal plane, reducing load to articular processes and correction of flat back and thoracic lordosis [Ociepka, 2008: 26]. He noted that typical exercises aimed at strengthening dorsal muscles affect primarily sagittal plane [Ociepka, 2008: 22]. Progressive idiopathic scoliosis, i.e. the disorder which is formed throughout the developmental period of child's life, requires triplanar effect. Therefore, although typical corrective exercises for strengthening dorsal muscles reinforce muscle corset, improve body posture and improve cardiorespiratory capacity, they do not correct the curvature [Zelke, 1981].

The special exercises using anti-scoliotic belt proposed by R. Ociepka refer to the principle of unilateral strengthening of the muscles on the convex side of the curvature arch which says that standing on one foot causes tension of the muscles on the opposite side of the spine [Żuk, 1972]. This principle also refers to unilateral load of the upper extremity in thoracic section. The load in the left hand results in tension on the right side of the spine. This principle was used in the exercises with scoliotic belt. R. Ociepka wrote that *....in order to obtain a sustained effect of correction, one should selectively strengthen the involuntary muscles on the convex side*

of the curvature [Ociepka, 2008: 44]. Because there are no opportunities of selective strengthening of involuntary muscles, an individual technique was employed. Lifting of the upper extremity on the concave side of the curvature against the resistance of the spring results in tension of the muscles of the concave side whereas a contraction of involuntary intervertebral muscles is stimulated. Moreover, in order to strengthen involuntary muscles during the phase of maximal correction, a tension should be maintained for several seconds. These exercises are more effective in the position of lying on the back and deepening of the curve in lumbar section.

In the case of scoliosis corrector proposed by R. Ociepka, the patient takes a position in the apparatus while kneeling and stabilized by means of hip and arm locks. The thoracic brace is placed over the costal hump, whereas lumbar brace is attached over the lumbar prominence. In order to obtain the triplanar correction of thoracic section, the patient lifts the concave side of the back as high as possible, whereas the brace on the convex side locks the costal hump. Thus, the induced kyphosis in the concave side of the curvature in saggital plane and derotation in transverse plane stimulates correction of the spine in frontal plane. This allows for triplanar correction in thoracic section. Additionally, the kiphotic movement affects the contracted muscles on the concave side redressingly. Furthermore, the brace placed over the lumbar prominence is aimed at preventing from an increase in lumbar prominence [Ociepka, 1993: 151]. Nowadays, when progressive idiopathic scoliosis is a frequent occurrence, this method provides opportunities for triplanar correction. Despite difficulties the contemporary orthopaedics and traumatology encounters in terms of aetiology and fast progression of scoliosis, this method seems to be effective and innovative.

Ryszard Harężlak developed a method of scoliosis treatment which, similarly to SAKIS, takes into consideration a triplanar corrective effect. This method also restores:

- proper bend of the spine and the arc,

- reduces load to articular processes through strengthening of the convex side,
- has a kiphotic effect, thus derotating the spine.

A special-purpose triplanar corrector, a corrector for the lumbar section and a system of free exercises to be performed at home were developed in order to stimulate the correction. According to R. Hareźlak, a great advantage of this method lies in selection of initial positions. Properly chosen positions act selectively on the muscles of the concave side, stretch them, derotate the spine and strengthen the muscles on the convex side of the arch [Hareźlak, 2002: 15].

The exercises performed on the scoliosis corrector require marking spinous processes in the front bend position in order to fix each lateral arch of the curvature. The patients are positioned in the scoliosis corrector in the position of two-legged kneeling, whereas thorax rests on the supports. The patient performs asymmetric rubber tension until arch correction or hypercorrection is obtained. Correction of scoliosis should be monitored carefully and the effects of correction should be checked by means of palpation. If a patient has a costal hump, the rubbers should be fixed below on the convex side and redression pads should be used on the concave side. This will cause the spine to derotate. It is recommended to perform the exercise using the device in sets of 10 to 20 repetitions (time of sustained tension of expander rubbers: ca. 5-10 seconds).

The effect of triplanar corrector is supplemented by lumbar corrector. This contributes to kiphotic arrangement through using a low grip of a ladder rung (individual selection). Low grip is necessary if idiopathic scoliosis is characterized by flattened thoracic kyphosis or deepening of lumbar lordosis. In this case, redression pads are also applied, located on the concave side of the curvature, thus obtaining derotation. The results of the study presented by R. Hareźlak demonstrated that the method, due to a triplanar nature of the effect on the curvature, is numbered among the extraordinarily good methods of treatment. Analysis of the results of the therapy carried out with this method among 1,050 children during the

school year 2000/2001 confirmed that the improvement was achieved in 89.3% of them. Therefore, the data point to an improved effectiveness of this method [Haręźlak, 2002: 16].

Conclusions

Nowadays, scoliosis and, more specifically, idiopathic scoliosis, is a major problem of growing children and young people. They frequently cause a series of unfavourable changes which disfigure and deform the body, disturbing cardiorespiratory and motor deficiencies. Therefore, it is of utmost importance to find the methods of treatment which would be effective. Due to a triplanar character of idiopathic scoliosis, traditional methods do not produce the expected results. In order for these types of scoliosis to be effective, it must be primarily based on triplanar effect. Regardless of which method is used, their main aim is to prevent progression of pathological curvature and permanent correction of the curvature.

Development of science and computerization allows scientists to diagnose and focus on the problems which result from the pathological curvature. This causes that the methods of conservative treatment are becoming more sophisticated, thus contributing to effective correction of deformations and faster return of a patient to active life. Although there are a number of methods of treatment of scoliosis discussed in the related literature and dynamic progress in this field can be observed today, it is important to note that therapy of scoliosis belongs to one of the most difficult and prolonged processes of treatment. Its efficiency depends on the time when the therapy is started and on the continuity of corrective measures.

- [1] Adler, S.S., Beckers, D., Buck, M. 2008. *PNF in Practice*. Springer Verlag. Berlin.
- [2] Aubin, C. E., Dansreau, J., De Guise, J.A., Labelle, H. 1997. *Rib cage – spine coupling patterns involved in brace treatment of adolescent idiopathic scoliosis*, Spine, 1997.

- [3] Benson, D. R. 1987. *Idiopathic scoliosis. The last ten years and state of the art. Orthopedics*, 10.
- [4] Białek, M. 2001. *Możliwości zastosowania metody PNF w leczeniu skolioz. Fizjoterapia Polska*. Warsaw, vol 1, No. 2.
- [5] Blount, W.P., Bolinski, J. *Physical therapy In the monopoperative treatment of scoliosis*. Phys. Ther., 46.
- [6] Harężlak, R. 2002. *Nowa Koncepcja korekcji skolioz idiopatycznych*. Wychowanie Fizyczne i Zdrowotne, No. 2.
- [7] Kasperczyk, T. 2004. *Wady postawy ciała- diagnostyka i leczenie*. Kasper. Kraków.
- [8] Kowalski, J., Hurło, L. 2003. *Zaburzenia postawy ciała w wieku rozwojowym*. Uniwersytet Warmińsko-Mazurski, Olsztyn.
- [9] Moe, J.H. *Management of idiopathic scoliosis*. Clin. Orthop., 20.
- [10] Nowakowski, A., Łabaziewicz, L. 1997. *Leczenie operacyjne skolioz idiopatycznych instrumentarium wielosegmentowym i jego wpływ na pooperacyjną dekompensację tułowia*. Chirurgia Narządu Ruchu i Ortopedia Polska, LXII.
- [11] Nowotny, J. 2000. *Zarys rehabilitacji w dysfunkcjach narządu ruchu*. Katowice.
- [12] Ociepka, R., Łęczyński, J. 1993. *Zastosowanie autokorekt ora skolioz do rozluźniania kręgosłupa przed stabilizacyjnym zabiegiem operacyjnym [w:] Dysfunkcje kręgosłupa diagnostyka i terapia*, AWF Katowice.
- [13] Ociepka, R., Wagner, T. G.. 2008. *Leczenie Skolioz – system aktywnej korekcji idiopatycznych skrzywień bocznych kręgosłupa*. Łódź.
- [14] Owczarek, S. 1998. *Atlas ćwiczeń korekcyjnych*, WSiP, Warsaw.
- [15] Sastre Fernandez, S. 2008. *Metoda leczenia skolioz, kifoz i lordoz*. Markmed Rehabilitacja Ostrowiec.
- [16] Śliwiński, Z. 2008. *Wstęp do wydania polskiego*, w: *Metoda leczenia skolioz, kifoz i lordoz*. S. Sastre Fernandez. Markmed Rehabilitacja Ostrowiec.
- [17] Tuzinek, S. 2004. *Postawa ciała. Fizjologia, patologia i korekcja*. Politechnika Radomska. Radom.
- [18] Zelke, Kalus. 1981. *Lehrbuch der Orthopädie und Traumatologie*. Enke Verlag- Stuttgart.