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PRACA POGLĄDOWA
REVIEW

# Influence of orthopedic braces on change in Cobb angle in patients with AIS, according to SRS and SOSORT criteria

## Wpływ ortez ortopedycznych na zmianę kąta Cobba u pacjentów z AIS, według kryteriów SRS i SOSORT

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## ABSTRACT

Adolescent idiopathic scoliosis (AIS) poses a comprehensive diagnostic and therapeutic challenge. It develops mainly in children aged 10 to 16. The etiology of AIS is associated with various genetic, postural and neuromuscular factors.
We pay special attention to the role of orthopedic braces and their impact on changes in the Cobb angle. The research review covers various types of orthoses, both rigid and flexible, determining their effect on the Cobb angle. Despite promising results, there are challenges related to medical adherence and the long-term use of orthoses may affect the psychological aspects of patients and their families.
The twelve studies presented compared patient populations ranging from 2 to 170 people. The following types of braces were analyzed: TLSO, Providence brace, Rigo-Cheneau, Lyon, SpineCor, SPoRT, PASB, rigid brace, Milwaukee, Sforzesco, Sibilla and Risser cast. The results of seven studies indicate therapeutic success, defined as slight progression or stabilization of the Cobb angle in > 82% of patients. Three studies report results in the range of 59–65% success, and two studies report success in less than half of the patients.
In analyzing the research data, we find a beneficial effect of orthoses on stabilization of the Cobb angle in AIS. We suggest that further research in line with SRS and SOSORT guidelines is needed to determine which type of orthoses provides the best results. Focusing on prevention may be the key to better control of scoliosis.

KEYWORDS

scoliosis, SRS, SOSORT, brace, adolescent idiopathic scoliosis

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## STRESZCZENIE

Młodzieńcza skolioza idiopatyczna (*adolescent idiopathic scoliosis* – AIS) stanowi kompleksowe wyzwanie diagnostyczne i terapeutyczne. Rozwija się głównie u dzieci w wieku od 10 do 16 lat. Etiologia AIS wiąże się z różnymi czynnikami genetycznymi, posturalnymi i neuromięśniowymi.

Szczególną uwagę zwracamy na rolę stabilizatorów ortopedycznych oraz ich wpływ na zmiany kąta Cobba. Przegląd badań obejmuje różne rodzaje ortez, zarówno sztywne, jak i elastyczne, określając ich wpływ na kąt Cobba. Pomimo obiecujących wyników istnieją wyzwania związane z przestrzeganiem zaleceń lekarskich, a długotrwałe stosowanie ortez może wpływać na zdrowie psychiczne pacjentów i ich opiekunów.

W dwunastu prezentowanych badaniach porównywano populacje pacjentów liczące od 2 do 170 osób. Analizowano następujące typy stabilizatorów: TLSO, orteza Providence, Rigo-Cheneau, Lyon, SpineCor, SPoRT, PASB, orteza sztywna, Milwaukee, Sforzesco, Sibilla i gorset Rissera. Wyniki siedmiu badań wskazują na sukces terapeutyczny, definiowany jako lekki progres lub stabilizacja kąta Cobba u > 82% pacjentów. Trzy badania raportują wyniki w zakresie 59–65% sukcesu, a dwa badania odnotowują sukces u mniej niż połowy pacjentów.

Analizując dane badawcze, stwierdzamy korzystny wpływ ortez na stabilizację kąta Cobba w AIS. Wskazujemy na konieczność dalszych badań zgodnych z wytycznymi SRS i SOSORT w celu określenia, jaki rodzaj ortez przynosi najlepsze wyniki. Skoncentrowanie się na profilaktyce może być kluczem do lepszej kontroli skoliozy.



SŁOWA KLUCZOWE

skolioza, SRS, SOSORT, stabilizator, młodzieńcza skolioza idiopatyczna


## INTRODUCTION

Adolescent idiopathic scoliosis (AIS) is a diagnostic and therapeutic challenge, characterized by deformation of the spine, manifested by its lateral bending in three dimensions. By definition, the exact etiology of idiopathic scoliosis is unknown. Perhaps spinal curvature disorders result from various genetic, postural and neuromuscular factors. To diagnose AIS, it is necessary to determine whether the lateral bending of the spine in the frontal plane exceeds 10 degrees of the Cobb angle and causes vertebral rotation [1]. The Cobb angle is determined by the sum of the inclination angles of the lower and upper ends of the vertebrae and serves as a quantitative method for measuring scoliotic deformity [2,3].

The disease develops during growth and puberty, usually between the ages of 10 and 16, in 2 to 4% of children [2]. There are many theories about the etiology of AIS, including melatonin deficiency, higher levels of calmodulin in blood platelets, lower bone density, and an impaired correlation between the ligament, joint and muscle systems of the spine. In the context of the development of AIS, the role of rib stabilization and the location of organs in the chest, especially the eccentric position of the aorta in relation to the spine, are also emphasized [4]. The incidence of AIS depends on latitude, but only in girls [5]. Age at menarche and estrogen concentration may also influence the incidence of this disease [6,7].

In the case of scoliosis with a Cobb angle of 20–40° in patients with an immature skeletal system at grade 0–1 according to Risser, treatment with an orthosis is recommended to prevent the progression of scoliosis during the period of spine growth [8,9]. There is also evidence of the effectiveness of stiffening in reducing the progression of curves, especially those with surgical risk, which emphasizes the importance of appropriate treatment and rehabilitation of patients with AIS [9].

Although adherence to the prescribed treatment regimen for AIS is challenging, conservative treatment with an orthosis clearly gives better results than the natural course of the disease [10]. There are many types of orthoses: TLSO, Providence, Rigo-Cheneau, Lyon, SpineCor, SPoRT, PASB, rigid brace, Milwaukee, Sforzesco, Sibilla and Risser [6,10,11,12,13,14,15,16,17,18,19,20,21,22]. All of them are intended to correct or prevent the progression of pathological curvatures in AIS. They operate on the principle of external forces applied to the trunk, which generate pressure on anatomical structures and cause changes in the curvature of the spine in accordance with the Hueter-Volkmann principle [23]. It is highly probable that the orthosis also works by changing neuromotor stimulation by constantly providing somatosensory stimuli that are intended to help the patient become aware of incorrect body posture [24].

## RESULTS

The test results are presented in Table I. The influence of orthopedic braces on the progression of the Cobb angle was examined and conclusions were formulated.

**Table I.** Summary of research results [Title/Orthesis/Results/Conclusions]

| Test | Brace type research group | Cobb angle | Conclusions |
|---|---|---|---|
| 1 | 2 | 3 | 4 |
| Janicki et al. [11]<br>**SRS** | **TLSO**<br>**n = 48** | progression ≤ 5°<br>15% of patients<br>progression ≥ 6°<br>85% of patients<br>progression > 45°<br>63% of patients | Providence orthosis occurred to be more effective than TLSO orthosis in stopping progression of scoliosis and in curvature progression > 45° |
| | **Providence**<br>**n = 35** | progression ≤ 5°<br>31% of patients<br>progression ≥ 6°<br>69% of patients<br>progression > 45°<br>43% of patients | |
| Coillard et al. [14]<br>**SRS** | **SpineCor**<br>**n = 170** | progression < 5° or stabilization ≥ -5° and ≤ 5°<br>59.4% of patients<br>progression > 45°<br>1.2% of patients | More than half of the people achieved therapeutic success. Very small percentage of patients with disease progression with Cobb angle > 45° may be due to 22.9% of patients (about half of patients who were not successful) being operated on during treatment. |
| Negrini et al. [17]<br>**SRS/SOSORT** | **Risser cast and then Lyon**<br>**n = 2** | progression < 5°<br>96% of patients<br>improvement (reduction of Cobb angle ≥ 6°)<br>59% of patients | Treatment brought very good results, better than those in previous studies. |
| | **Lyon SPoRT**<br>**n = 40** | progression ≥ 6°<br>4% of patients<br>progression > 45°<br>0% of patients | |
| Aulisa et al. [8]<br>**SRS/SOSORT** | **Progressive Action Short Brace (PASB)**<br>**n = 40** | progression ≤ -5°<br>94% of patients<br>progression ≥ -5° and ≤ 5°<br>6% of patients<br>progression > 5°<br>0% of patients<br>progression > 45°<br>0% of patients | PASB is effective method of conservative treatment because curve progression ≤ -5° was achieved in vast majority of patients, while curve progression > 5° did not occur in any patients. PASB can achieve stable correction of thoracolumbar curves; it is also able to derotate vertebrae in the curve. |
| Aulisa et al. [22]<br>**SRS/SOSORT** | **Progressive Action Short Brace (PASB)**<br>**n = 40** | curve correction<br>82.5% of patients<br>curve stabilization<br>17.5% of patients<br>curve progression<br>0% of patients | PASB allows full curve correction in most cases. No patient experienced curvature progression. |
| Gammon et al. [12]<br>**SRS** | **TLSO**<br>**n = 35** | curve progression ≤ 5°<br>60% of patients<br>never made it to 45°<br>80% of patients | Both orthoses are similarly effective in treating AIS. There were no significant differences in maintaining curve progression. |
| | **SpineCor**<br>**n = 32** | curve progression ≤ 5°<br>53% of patients<br>never made it to 45°<br>72% of patients | |
| Guo et al. [21]<br>**SRS** | **SpineCor**<br>**n = 20** | progression > 5°<br>35% of patients<br>progression > 45°<br>5.0% of patients<br>stabilization<br>65% of patients | Rate of curve progression was significantly higher in SpineCor compared to rigid brace. If curve progression of > 5° occurred during SpineCor treatment, a rigid orthosis can better control further curve progression in most patients. Both braces have a similar effect on Cobb angle progression > 45° |
| | **rigid brace**<br>**n = 18** | curvature progression > 5°<br>5.6% of patients<br>progression > 45°<br>5.6% of patients<br>stabilization<br>94.4% of patients | |

**cd. tab. I**

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| Zaborowska-Sapeta et al. [16]<br>**SRS** | **Cheneau**<br>**n = 79** | progression<br>25.3% of patients<br>stabilization<br>22.8% of patients<br>progression < 50°<br>39.2% of patients<br>progression > 50°<br>12.7% of patients | During treatment, Cobb angle improved or stabilized in 48.1% of subjects. This is evidence that, compared to the natural course, the frequency of the need for surgery is significantly reduced. |
| Aulisa et al. [10]<br>**SRS/SOSORT** | **PASB**<br>**Lyon**<br>**Milwaukee**<br>**n = 113** | progression ≤ 5°<br>77.8% of patients<br>stabilization > -5° and < 5°<br>15.9% of patients<br>progression ≥ 5°<br>6.2% of patients<br>need surgery > 45°<br>3.5% of patients | Conservative treatment was used with high effectiveness in correction and stabilization of Cobb angle. Small number of subjects had progression ≥ 5°. Greatest improvement in reduction of Cobb angle was observed in group of patients with lumbar spine curvature; lowest in group of patients with curvature in thoracolumbar section. Treatment of curves below 30° (frequency of operations: 1.6%) gives better results than curves above 30° (frequency of operations: 5.5%), but compared to natural course of the disease, treatment always gives better results. |
| Negrini et al. [19]<br>**SRS/SOSORT** | **Sforzesco**<br>**Lyon**<br>**Sibilla**<br>**SpineCor**<br>**n = 73** | reduction by 6°<br>52.3% of patients<br>progression ≤ 6°<br>the rest<br>progression ≥ 6°<br>9.6% of patients<br>progression > 45°<br>1.5% of patients | Used orthoses are highly effective in reducing Cobb angle. |
| Aulisa et al. [20]<br>**SRS/SOSORT** | **Lyon**<br>**n = 69** | progression ≤ 5°<br>85.5% of patients<br>curve stabilization > -5° and < 5°<br>13% of patients<br>progression ≥ 5°<br>1.5% of patients | Lyon brace is very effective in improving spinal curvature. |
| Wynne and Houle [13]<br>**SRS/SOSORT** | **Boston**<br>**Brace 3D**<br>**n = 178** | AIS single arc<br>improvement (reduction of Cobb angle ≥ 6°) or stabilization ± 5°<br>84% of patients | AIS double arc<br>improvement (reduction of Cobb angle ≥ 6°) or stabilization ± 5°<br>64% of patients | Boston Brace 3D effectively stabilizes progression of the disease and, in some cases, also improves curvature progression. |

SRS – Scoliosis Research Society; SOSORT – International Society on Scoliosis Orthopaedic and Rehabilitation Treatment

## DISCUSSION

Analysis of the impact of orthopedic braces on changing the Cobb angle in scoliosis sheds light on various aspects of this form of therapy, both beneficial and potentially problematic. The adoption of SOSORT and SRS guidelines seems to bring promising results in the future in terms of generating better results in improving spinal curvature in the frontal plane (Cobb angle), due to specific and measurable criteria for inclusion in studies. Many studies do not have a classification of the variability of the Cobb angle in relation to the section of the spine in which the curvature occurs, which makes it difficult to draw conclusions about the change in the Cobb angle while wearing orthoses regarding a given type of curvature (lumbar, thoracic, lumbo-thoracic, double).

In practice, there is a challenge with medical adherence. Takemitsu et al. [25] proved that patients with AIS adhere to an average of 75% of the prescribed time of wearing the brace and overestimate the number of hours of wearing the brace to their doctor. Long-term use of an orthosis may affect self-esteem and self-worth in young patients. However, problems with social acceptance may lead to social exclusion, making it difficult to use the orthosis regularly, which affects the effectiveness of the therapy [26]. Mitsiaki et al. [27] in their review of the literature indicate that during a twelve-month observation period of the treatment process using an orthopedic brace, teenagers showed an increased level of stress and anxiety. What is more, the

incidence of depression and anxiety in parents was 14.1%, which was much higher than in the control group, suggesting a causal relationship between parents' mental disorders and the general suffering of teenagers. According to Payne et al. [28], scoliosis was an independent risk factor for suicidal thoughts, worries and fears related to body development and interactions with peers after the use of the brace.

A critical look at the use of orthopedic braces also reveals certain aspects related to communication between the patient, his family and the doctor. It seems that the lack of an individual approach, or understanding of the patient's needs may affect the effectiveness of the therapy. It is also important for doctors to engage in open and supportive conversations with patients' parents as this is a key element of effective disease management and support of children in the difficult process of wearing orthopedic braces. It is important for caregivers to understand the potential benefits and risks associated with the treatment. A study from 2017 proved that children's major motivation for treatment is the desire to avoid surgery, and support from the community can potentially improve treatment results [29].

A reliable analysis of available data based on uniform inclusion criteria is the strength of these studies, explaining the impact of brace treatment on the development of the disease. Further research is needed, according to SRS and SOSORT guidelines, to determine which type of orthosis produces the best results. The multifactorial nature of AIS brings hope for the discovery of new treatment methods and the identification of populations at high risk of developing scoliosis [30].

## CONCLUSIONS

The above-mentioned studies clearly indicate that treatment with an orthopedic brace, regardless of the type, has a beneficial effect on the stabilization of the Cobb angle in patients with scoliosis, even leading to its reduction. In some patients, despite therapy, surgery may be necessary, but the number of these cases is much smaller than in the natural course of the disease [16]. Further research is needed, according to SRS and SOSORT guidelines, to determine which type of orthosis produces the best results.

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The authors declare no conflict of interest.

**Author's contribution**

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