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New horizons for adolescent idiopathic scoliosis treatment through PosturalSpine® D'Amanti Method

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Abstract

The aim of the study is to compare improvement outcomes in patients (aged between 8 and 18 years old) with idiopathic scoliosis treated with a traditional technique with those treated with an innovative method. The study included 17 participants allocated into two groups: experimental (n=8) and control (n=9) groups. The first group was treated with a new method with PosturalSpine® D'Amanti method, twice a week for 30 min per session while the second group was treated with kinesitherapy and traditional tools three times week for 45 min per session. The two groups are similar in the anthropometric characteristics, in baseline Risser index and in the Cobb angles average and no statistically significant differences were found between the two groups. After one year of motor intervention, both treatment groups showed improvements in the progression of scoliotic curves and the PosturalSpine® group showed a significantly higher improvement than the control group. Our results therefore suggest that this new specific method with PosturalSpine® D'Amanti method could play a significant role in improving adolescent idiopathic scoliosis compared to traditional exercises.

Key Words: kinesis; health; scoliosis; adolescent idiopathic scoliosis.

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Scoliosis encompasses a range of pathologies marked by alterations in the shape and positioning of the spinal column, thorax, and trunk and it is a condition characterized by a complex, three-dimensional deformity of the spine, which includes lateral curvature and vertebral rotation. This deformity affects the frontal, coronal, and sagittal planes.[1]
Adolescent Idiopathic Scoliosis (AIS)[2] stands as the most prevalent type of structural spinal deformity, with a documented prevalence in the literature ranging from 0.47% to 5.20%. It is defined by a radiological lateral Cobb angle equal to or exceeding 10 degrees.[3] The Cobb's angle is the angle formed by the extension lines of the upper-end plate of the most inclined vertebral body within the curved segment and the lower end plate of the most inclined vertebral body below. This measurement is taken from posteroanterior X-rays of the spine, conducted in an up-right position, encompassing both the pelvis and temporomandibular joint.[4] The female-to-male ratio ranges from 5:1 to 3:1 and it increases substantially with aging.[5]
The etiology of AIS is multifactorial involving genetic factors and environmental influences that negatively affecting some features of the quality of life.[6] Individuals with AIS commonly exhibit chest deformities, protuberances, and asymmetries.[7,8] Despite these conditions, patients may be asymptomatic, particularly when the curvature is mild.[9]
Various non-invasive, radiation-free techniques have been suggested for assessing scoliosis without harmful effects, such as Moiré topography, infrared thermography, 3D scanning. These methods are generally restricted to laboratory settings and however, X-rays remain the gold standard for diagnosing and monitoring scoliosis.[10] The Italian Society of Scoliosis advises obtaining a two-view X-ray during the initial scoliosis evaluation and another X-ray at least a year later.[11]
Skeletal maturity is assessed using the Risser index, determined by the ossification degree of the iliac crest's secondary ossification core. The Risser index serves as a dependable indicator of the spine's corresponding age.[12]
In girls, the age of menarche is often used as a rough

guide: puberal spurt generally ends by the time of the menarche, and the spinal column ends its growth approximately two years later.[13]

Scoliosis worsens in the pronounced stages of development and becomes impossible to modify when the proliferation of the growth cartilages stops, therefore it is necessary to intervene promptly.

Specific approaches differ between children/adolescents and adults due to differences in bone plasticity and skeletal maturity[14] but the goal of treatment for all types of scoliosis is the same: to slow down and/or stop the progression of the curve. Treatment involves different approaches: the observational approach, the orthopedic-kinesiological approach and the surgical approach, both requiring specific involvement.[15] The observational approach consists of periodic checks of the scoliotic curve and abstention from any type of treatment. This approach can be considered for all curves less than 10°, regardless of the degree of skeletal maturity. The orthopedic-kinesiological approach is based on the use of orthopedic braces or casts in association with motor intervention and is adopted for curves between 10° and 45° and skeletal immaturity (Risser scale <3). This approach aims to control or stop its progression until skeletal maturity is reached. Surgical treatment is adopted for all curves greater than 45° and with a skeletal maturity grade <3, while it is considered for curves of slightly greater magnitude if a Risser value ≥3 is found.[16]

Scoliosis management also includes kinesitherapy, a set of Physiotherapy Exercises Specific to Scoliosis (PSSE) including active and passive mobilization, breathing exercises and postural re-education, that can be used as an integral part of a therapeutic approach, alone or in combination with bracing or surgery, depending on the individual needs and indications of the patient. According to literature progression it is defined by an enhancement of 5 to 10 degrees in Cobb's angle.[17] Among adolescents with a scoliotic curvature exceeding 20° combined with immature bone status, the likelihood of progression may be 70% or higher.[18,19]

The PosturalSpine D'Amanti method belongs to the field of kinesiotherapy management of scoliosis and it is an innovative method of postural re-education that consists of combinations of 3D corrective movements, global and segmental muscle rebalancing exercises, selective breathing exercises, self-stretching exercises, anti-gravity exercises, proprioceptive exercises, body awareness exercises on both static and dynamic planes with oscillations on the concave areas of the deformity performed on a special bench. The PosturalSpine® bench was born in 2017, together with an exercise protocol (D'Amanti method), its penultimate prototype was the subject of study at the scientific laboratory of the Master in Posturology and Biomechanics of the University of Palermo and is a mechanical device with predefined oscillations.

The aim of the study is to compare the improvement results in patients with idiopathic scoliosis treated with traditional kinesitherapy with those treated with the innovative PosturalSpine® D'Amanti method.

We hypothesize that this new approach can induce significant improvements in this pathology in shorter treatment times and with a more playful approach than traditional exercises. This perspective aligns with recent findings highlighting the need for improved adherence to conservative scoliosis treatments, as suggested by Maccarone *et al.* in their retrospective analysis of treatment strategies during the pandemic era.[20] Similarly, Paramento *et al.* underscore the importance of neurophysiological, balance, and motion evidence in understanding AIS, advocating for a holistic approach in managing this condition.[21]

Materials and Methods

Participants

The participants were recruited from the Kinesis study, located in Ragusa, Italy. Out of more than 40 patients with idiopathic scoliosis aged between 8 and 18 years, the present study ultimately included 17 subjects. This reduction was due to the exclusion of male participants and the absence of follow-up radiographs for some patients after the treatment period. The final sample consisted exclusively of female participants (mean age: 14±3 years; weight: 45.7±10.1 kg; height: 152.1±9.9 cm). The 17 subjects were randomly divided into an experimental group and a control group. The experimental group, called PosturalSpine group, included 8 subjects (13.1±2.6 years, Risser index 1.7±1.1, 44.7±10.2 kg, H 150.1±9.3 cm) who performed a postural work protocol with the use of the Postural Spine bench and the control group included 9 subjects (14.8±3.2 years, Risser index 2.2±1.7, 46.5±10.6 kg, H 153.8±10.6 cm) who performed a postural work protocol. Scoliosis cases were diagnosed through orthopedic and physiatric evaluations supported by Cobb angle measurements from radiographs. Male gender was not considered due to the small number of participants. Inclusion criteria were: scoliosis cases with detailed radiographic measurements and with up to two scoliotic curves (thoracic and lumbar) at most 40 degrees Cobb and a Risser index of less than 5. Exclusion criteria were: scoliosis cases identified only by postural examination, subjects with three scoliotic curves, 5 Risser indices scoliotic curves greater than 40 degrees Cobb. The procedures were conducted in accordance with the ethical principles set out in the Declaration of Helsinki and were performed with the ethical approval of the university. The study design was approved by the Departmental Research Committee (approval number: UKE-IRBPSY-12.11.23). Before the start of the study, each participant received a full explanation of the study procedures and signed a written consent form to provide their data. For participants under 18 years of age, a consent form was signed by the parents.

Procedures

The control group performed traditional postural gymnastics, based on exercises from the main re-educational methods: self-elongation, translation, derotation, breathing, stretching, proprioception and toning. The equipment used included wall bars, Bobath balls, Fit benches, six benches, Hyper benches, inclined benches, flat benches, Pivetta benches, Medusa, dynaso, Bobath

swing, Daedalus, self-orthopedic, straps, wedges, cubes, mats, proprioceptive rollers, proprioceptive balls, balance mats, chest shaper, elastic bands with various tensions, pulley systems and weights ranging from 1 to 5 kg. The PosturalSpine group, throughout the treatment, strictly followed the same principles as the control group, including body awareness, breathing, self-stretching, muscle chain stretching, proprioception and translation, but with the use of the PosturalSpine® bench. The PosturalSpine® equipment was the only tool used, taking advantage of its multisensory, biomechanical and proprioceptive features, including anti-gravity cushion, simultaneous backrest, backrest and shoulder rest, adjustable straps and angles (Figure 1). Posturalspine® was created to accelerate postural recovery and is defined as: "Portable Multi-sensory Postural Gym". The carefully calibrated corner games, the central slot, the anti-gravity cushion and the double mirrored structure induce the correction of scoliosis.[22]

Subjects with scoliotic curves greater than 20 degrees Cobb, in the PosturalSpine group and control group, wear the Chêneau brace during treatment and in daily life activities.

The work protocols were designed based on the Risser index, the Cobb angle and the type of scoliosis and lasted one year for both groups. The control group performed 12 sessions per month lasting 45 minutes each, the PosturlSpine group performed 8 sessions per month lasting 30 minutes including 6 exercises lasting 5 minutes for each exercise. The exercise protocols were adapted every 12 sessions to maintain motivation and monitor training progression.

Measurements

Considering each patient, the Cobb's angles (both Thoracic and Lumbar) were measured by RX technique in the beginning and at the end of the treatment. Considering the sum of the differences between the final Cobb's angle and the initial Cobb's angle for Thoracic and Lumbar one, it was possible to compute the total improvement of the treatment in terms of Cobb's angle.

Statistical analysis

The results are expressed as mean±SD. A two-way ANOVA is used to determinate determine pre-post treatment differences. The significance level was performed of $p<0.05$. Statistical analyses were performed using the statistical software (SPSS for Windows version).

Results

The two groups are similar in anthropometric characteristics, baseline Risser index, and Cobb angles average before treatment, and no statistically significant differences were found between the two groups. After one year of motor intervention, the progression of the scoliotic curves in adolescent subjects suffering from idiopathic scoliosis improved in both work groups. Results for each group are presented in Table 1.

In the PosturalSpine group, a significant improvement in the thoracic curve was observed, with a reduction in the Cobb angle from a mean value of 22°±6.6° to 9.1°±8.7°. This result, statistically significant ($p=0.001$), demonstrates the effectiveness of the proposed motor intervention in reducing the severity of thoracic scoliosis. On the contrary, in the control group, no statistically significant improvement occurred, despite the specific treatment of the condition.

Regarding the lumbar curve, both groups showed improvements, but the extent of the improvement in the PosturalSpine group was significantly greater. In particular, in the PosturalSpine group, an 87% reduction in the Cobb angle occurred ($p=0.02$), while in the control group, a 23% reduction was observed ($p=0.02$). Although both results are statistically significant, the difference in the rate of improvement between the two groups highlights the superior efficacy of the treatment proposed in the PosturalSpine group.

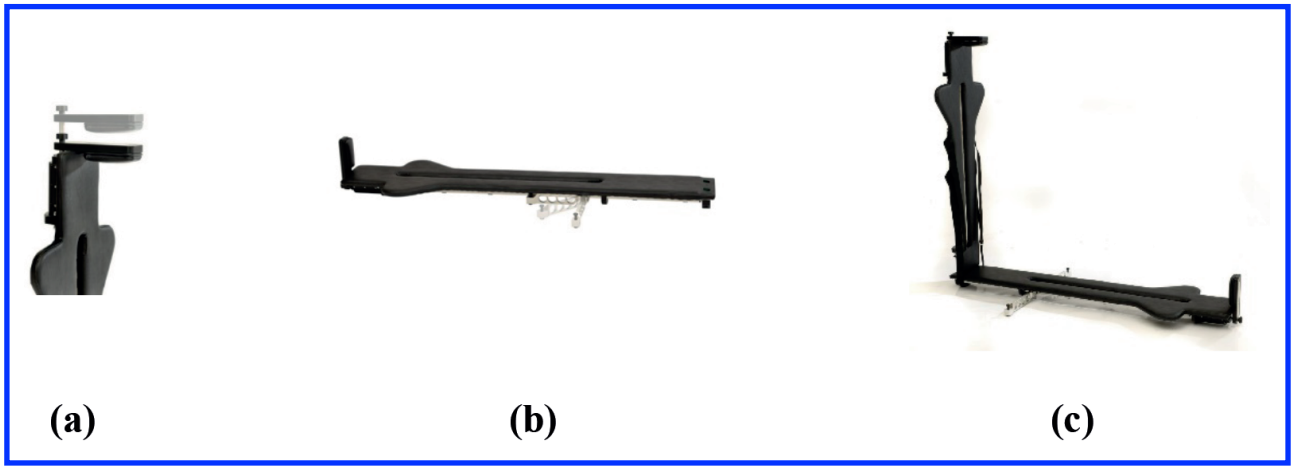

Figure 1. *PosturalSpine® bench. (a) Anti-gravity pillow. (b) PosturalSpine® bench way of using the arms, with the button it is possible to increase or decrease the oscillations. (c) Full PosturalSpine® bench.*

Table 1. *Data are mean±SD Cobb degrees.*

		Pre	Post	Δ Post/pre (%)	p Post/pre
PosturalSpine group	Toracic curve	22±6.6	9.1±8.7	-142	0.001
	Lumbar curve	22.8±9.5	12.2±13.7	-87	0.02
Control group	Toracic curve	19.9±5.5	9.1±7.9	-4	0.3
	Lumbar curve	22.1±4.4	18±5.1	-23	0.02

Discussion

The results of our study, which compared patients with idiopathic scoliosis treated with a traditional technique with those treated with the PosturalSpine® D'Amanti method, supported the initial hypothesis that both methodologies could induce improvements, but the treatment proposed to the PosturalSpine group produced significantly greater improvements than the control group, both in thoracic and lumbar scoliotic curves.

Several studies support the importance of postural exercise-based treatments to improve scoliotic curves, particularly in the lumbar regions. Studies conducted by Monticone *et al.*[23] have shown that targeted exercises, combined with constant clinical surveillance, can significantly reduce the Cobb angle in juvenile idiopathic scoliosis. Other studies have also highlighted the effectiveness of non-invasive treatments in the management of scoliosis. Schreiber *et al.*[24] demonstrated that daily exercises lasting 30-45 minutes, performed at home with weekly supervision, resulted in an improvement in the Cobb angle between 3.5° and 5.9° over 6 months. However, compliance with treatment played a key role, as patients were responsible for independently performing the exercises. It is worth noting that while comparisons with these prior studies are valuable, our study population differed in patient demographics and severity levels of scoliosis, which may have influenced the outcomes. For example, our cohort included patients with a broader range of curve severities and a structured, supervised treatment environment, potentially reducing variability in adherence compared to the largely self-directed protocols in the Schreiber study.

Polak's study[25] emphasized the role of muscle contraction in the pathogenesis and treatment of scoliosis, but it lacked long-term follow-up to evaluate the sustainability of post-treatment correction, an aspect that our study addressed with a one-year evaluation. Patient compliance was also crucial in our study, as the playful and interactive approach of the PosturalSpine D'Amanti method likely improved adherence to treatment, contributing to better results. The 61% reduction in the PosturalSpine group represents a very significant improvement. While this figure exceeds the reductions reported in other studies (where reductions in the Cobb angle typically range from 10% to 40%, depending on the severity and duration of intervention),[26,27] it is crucial to contextualize these results. The clinical implications of this reduction, such as improvements in quality of life, functional capacity, or reduced risk of long-term complications like chronic pain, warrant further investigation to strengthen the impact of these findings.

The overall results show that the motor intervention in the PosturalSpine group had a significantly greater positive effect than in the control group, especially in reducing the lumbar curvature, where the improvement was almost three times higher. The treatment therefore seems particularly effective in reducing the progression of scoliotic curves, especially in the lumbar areas, although it also offers significant benefits in the thoracic region. The importance of lumbar curve correction has also been highlighted by recent research, as the progression of untreated lumbar curves can lead to long-term functional problems, including chronic low back pain and mobility limitations.[24]

Despite the promising results, this study has some limitations. First, the one-year duration may not be sufficient to evaluate the long-term effects of the motor treatment on scoliosis. Longer follow-up studies could provide clearer data on the durability of these improvements. Furthermore, it would be useful to investigate whether the observed improvements can be maintained or enhanced with a prolongation of the intervention.

Future research could focus on larger population samples and include additional parameters, such as quality of life, pain perception, and motor function, to obtain a more comprehensive picture of the treatment's impact. Establishing the broader clinical significance of the 61% improvement observed in the PosturalSpine group would be particularly valuable, as it could confirm the method's potential to improve patients' overall well-being and functional outcomes.

Conclusions

In conclusion, this study compared the improvement results in patients with idiopathic scoliosis treated with a traditional technique to those treated with the Postual-

Spine® D'Amanti method. Exercises performed with Postural Spine D'Amanti method led to an improvement in adolescent idiopathic scoliosis for both thoracic and lumbar curves, unlike the traditional method which stabilizes the thoracic curve without improving it. Thanks to the shorter duration of each session (30 minutes instead of 45) and the lower number of sessions needed per week (twice instead of three), the PosturalSpine® D'Amanti method could increase patient compliance and tolerance to scoliosis treatment. These findings highlight the potential of this innovative approach as a viable, efficient, and effective method for managing idiopathic scoliosis in adolescents, with significant clinical implications for improving both curve severity and patient adherence.

Contributions

Conceptualization, DDC and VF; methodology, VF, MCP, and AZ; formal analysis, FC, MCP and DDC; data curation, FC, MCP and DDC; writing—original draft preparation, FC, MCP and DDC; writing—review and editing, VF and DDC; supervision, EP and GM. All authors have read and agreed to the published version of the manuscript.

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Conflicts of interest

The authors declare no conflicts of interest.

Ethics approval

The study was conducted in accordance with the Declaration of Helsinki and the recommendations of the Ethical Code of the University of Palermo. The Code of Ethics approved by the General Assembly of the Italian Association of Psychology held on 27 March 2015. The study design obtained ethical permission from the University Enna Kore Internal Committee for research (approval number: UKE-IRBPSY-12.11.23).

Informed consent

Informed consent was obtained from all subjects involved in the study.

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