

# Trends and Challenges in the Usage and Compliance of Bracing in Adolescent Idiopathic Scoliosis: A Review

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## ABSTRACT

**Background:** Adolescent idiopathic scoliosis (AIS) is a three-dimensional lateral curvature of the spine associated with vertebral rotation. It is the most common type of scoliosis and affects 2–3% of the adolescent population. Bracing is the only conservative approach with proven effectiveness. Compliance and primary in-brace correction are the two most important variables associated with good brace outcomes. Poor compliance with wearing a brace is associated with poor quality of life which may relate to psychosocial coping mechanisms.

**Objective:** This literature review aims to review the Compliance and usage of spinal braces in Adolescent Idiopathic Scoliosis.

**Study Design:** Literature Review

**Significance:** This review was done to investigate the use and compliance in Scoliotic patients. These two factors are defined as the main issue that interferes with treatment success and clinical outcomes in Adolescent Idiopathic Scoliosis.

**Method:** An electronic database search was conducted using Google scholar, Science direct, Pub Med, Cochrane Library and reference lists from all retrieved articles.

**Result & Discussion:** The results demonstrated that the type of braces determines structure and appearance and affects compliance. Psychological aspects, age, brace wear pattern (daytime or night time or part time versus fulltime) and the assessment method (using temperature versus pressure sensors) can affect recorded compliance. Recent estimate of compliance was around 65-67% and also the compliance rate for night time was 80%, and daytime was 55%.

**Conclusion:** Compliance can be augmented by considering factors in the design and delivery of the brace. Superior appearance and comfortable within the brace can improve psychological acceptance and improve the compliance. Lower age, involving the patient in treatment procedure, considering the child habits, and improved family awareness of the treatment plan of idiopathic scoliosis can also improve overall compliance of the brace.

**Keywords:** Adolescent Idiopathic Scoliosis, Spinal Braces, Compliance, Usage

## INTRODUCTION

Adolescent idiopathic scoliosis (AIS) is a lateral spine curvature that is associated with vertebral rotation. This is the most common form of scoliosis, affecting 2-3 per cent of teenagers. Girls seem to make more headway than boys. According to the Society for Scoliosis Research, Adolescents with mild curves and

still growing should be tracked until the skeletal maturity. To growing children with curves of 25-45 Cobb angle, brace care is recommended. The indication for bracing was a major scoliotic curve 20° with an observed progression 5° after 4 months and skeletal immaturity evaluated by Risser sign 3 or bone age. While various non-operative approaches have been attempted, including

physical therapy, exercise, massage, manipulation, and electrical stimulation, only bracing is successful in preventing curve progression and the subsequent surgery requirements. Bracing success is assessed by preventing curve progression on standing x-rays and avoiding surgical influence. The effectiveness of brace treatment can be affected by several factors, including age, gender, bone maturity, prescribed brace times, curve pattern and magnitude.<sup>1,2,3</sup>

Indeed, the guidelines released by the Society on Scoliosis Orthopaedic and Rehabilitation Treatment (SOSORT) recommendations suggest adherence as a key element in evaluating the bracing effectiveness. The two most important variables associated with successful brace performance are compliance and primary in-brace correction. Low compliance with brace wearing is associated with reduced quality of life, which may contribute to psychosocial mechanisms for coping.<sup>3,4</sup>

The aim of this study is to highlight trends and challenges in the use and compliance of bracing in adolescent idiopathic scoliosis to recognize which elements bring advantages and disadvantages in compliance rates and brace usage.

## METHOD

A computerized search was conducted in Google Scholar, Science Direct, PubMed and Cochrane Database. The search queries used were – ‘AIS AND spinal Braces’, ‘AIS AND spinal braces and compliance’, ‘Spinal braces AND Compliance Testing’, ‘Spinal Braces AND Quality of life’, ‘Spinal braces AND wearing hours’, ‘AIS AND Orthotic Management AND Effectiveness of Braces’ AIS AND challenges in brace wear’, ‘Trends AND scoliosis orthotic management’.

## RESULT

Total 18 articles were taken and reviewed. Of which two were studied for Charleston brace study, two were for Spinecor brace study, two for Wilmington brace study, two for Rigo Cheneau brace study, two for Providence Brace study, two for Boston brace study, and two for Milwaukee brace study, two for TriaC Brace and two for Lyonnaise brace respectively. The descriptions of the papers reviewed are listed in the table provided 1.

Table 1: Details of the reviewed articles

Author	Title	Spinal Brace	Use	Compliance
Rahimi S, Kiaghadi A, Fallahian N. (2019)	Effective factors on brace compliance in idiopathic scoliosis: a literature review.	Providence Brace	Using an acrylic frame to apply direct corrective forces to the patient, effective correction of scoliotic curves could be achieved. The brace can be used to handle both single and double curves. The frame works by the application of guided, forward, lateral, and rotational forces on the trunk to move the spine toward the midline or beyond the midline. <sup>5</sup>	At night time, braces caused lower comfortable sleep, because of the rigidity of structure and stiff surrounding all over the trunk, so the patients prefer to take off the brace during sleep. <sup>6</sup>
Yrjönen T, Ylikoski M, Schlenzka D et al.	Effectiveness of the Providence nighttime bracing in adolescent idiopathic scoliosis: A comparative study of 36 female patient.			
Maruyama T, Takeshita K, Kitagawa T. (2014)	Disability and Rehabilitation: Assistive Technology Milwaukee brace today.	Milwaukee brace	It is used for both double and thoracic curves. It consists of a plastic pelvic section with an anterior and two posterior uprights superiorly connected by a neck ring with an anterior throat mold and later occipital pads or a low-profile neck ring contoured with plastic; corrective pads are also used. The Milwaukee brace is prescribed for full time wear. <sup>7</sup>	Compliance as tolerating the brace has been reported to be both secondary to skin contact pressure and mandibular pressure. As malocclusion and dental abnormalities developed, the chin rest was abandoned in favour of a throat mold. One of the greatest "complications" is the inability to encourage patients and families to comply with the prescribed use of the brace 20-23 hours per day. <sup>8</sup>
Mo F, Cunningham ME	Pediatric scoliosis			

F. Zaina, J. C. De Mauroy TG (2014)	Bracing for scoliosis in 2014: state of the art		The TriaC is another tension based dynamic scoliosis orthosis. Its name derives from the C's three: comfort, control and cosmesis. The orthosis is prefabricated, and fits the patient directly <sup>9</sup>	The orthosis was not accepted widely. This can be due to manufacturing and fitting challenges caused by a lack of familiarity with the component materials. <sup>10</sup>
Nijenbanning G. et al.	Clinical effect of continuous corrective force delivery in the non-operative treatment of idiopathic scoliosis: a prospective cohort study of the triac-brace.	<b>TriaC Brace</b>		
Claude J, Mauroy D, Fender P et al. (2014)	Lyon Brace		The treatment is based on two main principles: an initial plaster cast is intended to stretch the deep ligaments before the Lyon brace is applied and the adjustable brace is applied afterwards. <sup>11</sup>	The indication for this brace is scoliosis patients with 11-15 ages. This brace is not meant to prevent tubular deformation of the thorax in younger patients. <sup>12</sup>
Mauroy D, Mauroy JC, De, Lecante C, Barral F.	"Brace Technology" Thematic Series-The Lyon approach to the conservative treatment of scoliosis.	<b>Lyonnais Brace</b>		
Lee CS, Hwang CJ, Kim DJ et al. (2012)	Effectiveness of the Charleston night-time bending brace in the treatment of adolescent idiopathic scoliosis.		It is a custom-molded spinal orthosis which holds the patient in a position of overcorrection. In a bending position opposite the curvature, the patient is casted supine while the corrective force is applied at the curve apse. This brace is a night time brace only. <sup>13</sup>	Night-time bracing and flexible spinal orthosis have been introduced in order to improve compliance whether it showed a good compliance than other braces but providing little discomfort during sleeping as complained about high temperatures <sup>14</sup>
Brox JI, Lange JE, Gunderson RB et al.	Good brace compliance reduced curve progression and surgical rates in patients with idiopathic scoliosis.	<b>Charleston brace</b>		
Hasler CC, Wietlisbach S, Bu P. (2010)	Objective compliance of adolescent girls with idiopathic scoliosis in a dynamic SpineCor brace		It uses a specific Corrective motion depending on the curve type. The brace must maintain and intensify the corrective movement over time to be successful and to achieve a neuromuscular use. For a minimum of 18 months, the brace must be worn 20 hours a day to create a neuromuscular integration of the Corrective force through active biofeedback. <sup>1</sup>	In particular, toilet facilities tended to be an issue with the flexible brace such as Spinecor brace. <sup>15</sup>
Schiller JR, Thakur NA, Ebersson CP.	Brace management in adolescent idiopathic scoliosis	<b>Spinecor brace</b>		
Schiller JR, Thakur NA, Ebersson CP et al. (2010)	Brace management in adolescent idiopathic scoliosis.		It's kind of a TLSO brace. It is conceived as a body jacket that opens at the front and is easily removable. Corrective molds are manufactured into body jacket plastic. It is typically prescribed for full-time wear. Wilmington brace was more effective than electrical stimulation in curve progression. <sup>16</sup>	In an attempt to improve wear compliance the Wilmington brace was developed by altering the brace's cosmetic appeal. Compared with other braces, the patient records no such poor compliance. <sup>1,17</sup>
Fayssoux RS, Cho RH, Herman MJ et al.	A History of Bracing for Idiopathic Scoliosis in North America.	<b>Wilmington brace</b>		
Grivas TB, Kaspiris A. (2010)	European braces widely used for conservative scoliosis treatment.		It is a rigid brace that provides three-dimensional correction and opens up anteriorly.	Poor compliance with wear schedules in braced patients is a significant recurring theme. Bracing success is similar to any prescribed orthopaedic therapy, it depends on patient compliance. <sup>1,19</sup>
Rigo MD, Villagrasa M, Gallo D. et al.	A specific scoliosis classification correlating with brace treatment.	<b>Rigo Cheneau brace</b>	In this analysis, the explanation for the good in-brace correction is probably the good RSC brace three-dimensional designs. <sup>18</sup>	
Lange JE, Steen H, Brox JI et al. (2009)	Long-term results after Boston brace treatment in adolescent idiopathic scoliosis		The Boston Brace System provides a repeatable set of procedures that must be followed to achieve the end goal. A functioning system has many parts, and in order to be productive, those components need to be in harmony. Modules are designed with lumbar flexion. The Boston brace is a full-time brace. <sup>20</sup>	The jacket exerts an external pressure which tends to correct the spinal deformity. Such pressure would be expected to restrict respiratory movements, leading to changes in lung volumes and pulmonary mechanics, which also affect elastic pulmonary behaviour and rib cage-spine coupling Changes in lung volumes and compliance are highly predictable immediately after application of a Boston brace. <sup>21</sup>
Ran B, Fan Y, Yuan F, Guo K et al.	Pulmonary function changes and its influencing factors after preoperative brace treatment in patients with adolescent idiopathic scoliosis.	<b>Boston brace</b>		

## DISCUSSION

Results show that compliance can be influenced by the type of brace, designed to measure method, age, daytime or night time or part-time or full-time wear and psychological aspects. Brace type may play a major role in regulation. Studies have suggested the wearing time in the different brace groups is different. Characteristics such as form, colour, style, stiffness and body coverage influence patients' interest in wearing brace. Rigid braces are responsible for problems such as stiffness, high temperature and pressure on bony prominence, difficulty in dressing and doffing, restriction on clothing selection and restriction of movement, while soft braces do not cause problems as much as deeper rigid braces, although their effect on brace treatment performance is still controversial. Another source of inadequate treatment with the use of braces may be increased weight. A study by O'Neill et al found a significant difference between overweight patients and those that were not overweight. Age plays the significant role in compliance rate. Four studies confirmed the rate of compliance in various ages but compliance in younger patients had far better. Accepting new conditions is more adoptable in lower age; moreover, emotional adjustment may be harder for older teenagers.<sup>16,22</sup>

They performed study in 10 patients and demonstrated night time compliance was 80%, and daytime was 55%<sup>6</sup>

### Compliance

Compliance is called the percentage of hours worn relative to the prescribed 23-h regimen. Apparently no treatment can operate unless the patient needs it. Compliance is a key concern in bracing, but nowadays it seems to be viewed as a justification not to apply braces (because patients do not comply) rather than something that needs to be achieved by diligent attention to the patient and family. Compliance should be considered a failure of the treating doctor and staff, not a failure of the treatment. There are definitely therapies in medicine which cost much more

than braces. These are applied whenever necessary, and in such cases the goal of a good physician is to obtain compliance, rather than avoid treatment if compliance is difficult to achieve. It is not the only point to consider when choosing a care, because there are financial, medical, human and social values that are far more important in these decisions, but compliance cannot be seen as an excuse to avoid bracing.<sup>4,23</sup>

### Compliance Testing

Given these concerns, determining compliance with bracing by either using dedicated questionnaire or applying sensors within the brace. Compliance had been very difficult to measure objectively in the past. The most popular methods relied on subjective surveying of patients regarding brace wear and brace wear and tear inspection. New technological advancements have required devices such as force-sensitive resistors, sensor loggers and temperature-moisture gauges to measure compliance.<sup>3,14,24</sup>

### Orthosis effectiveness measure

Landauer et al. suggested that an initial correction of over 40% and good compliance would have a significant impact on the outcome. In order to understand its relationship, in-brace correction was categorized as 40 percent or above and below 40 percent; and bracing hours were also divided into three groups: from the lowest level of compliance to the highest level of compliance. No major difference was observed in brace correction between the three groups of bracing hours, but the in-brace correction appeared to be less than 40% for the least compliant category of patients. This implies that the more compliant a patient becomes, the greater the correction in-brace. In addition, Kinel et al. showed a minimum of 16 hours of wearing the Cheneau brace per day, resulting in less clinical deformity than was the result of non-treatment. The study demonstrated that highly compliant patients (85% compliance) showed no curve progression at the end of the treatment, whereas poorly compliant

patients (62% compliance) showed curve progression of more than 6°<sup>25,26</sup>.

### Compliance Counselling

Providing a report on brace-compliance and therapy at each appointment could increase the stress already felt by the patient during brace care. Studies have shown that adolescents undergoing scoliosis brace treatment may experience greater psychological stress than is normal. If compliance monitoring and therapy will increase wear every day by 3 hours, some children who receive such therapy during their orthotic use may be treated successfully with the brace and avoid spinal surgery.<sup>27,28</sup>

The appearance and developing of braces, age and psychological characteristics will alter the amount of brace wearing hours. The awareness of influential compliance factors and their incorporation into each other can affect the improvement of hours of wear.<sup>6</sup>

Cooperation of the patient in brace design process tends to reduce the level of negative emotions. The idea of co-design can be implemented in the first meeting between the patient and the orthotist and it will offer an opportunity to select the color and design chosen. Psychological dimension is the inseparable element in the compliance protocol, and further research and studies are also needed. If we collect any psychological items listed in this section in one treatment project and design "Psycho-Scolio" (combined psychological aspect and scoliosis brace care) program, adherence may be improved. The Psycho-Scolio plan may include therapy sessions, remembering appropriate encouragement during each visit, educating the family of the patient, peers and classmates to provide a healthy atmosphere and eventually patient cooperation during brace design.

### CONCLUSION

Literatures have suggested that quality of life should be monitored carefully during treatment, highlighting the difficulties experienced by patients when

undergoing conservative treatment. Considering the factors affecting compliance with brace treatment can improve the compliance and overall treatment in idiopathic scoliosis. Spinal braces should be designed with comfortable structure and suitable appearance. Starting brace wear within earlier ages and considering the child habits and preferences along with the treatment plan and prescribed regimen for the orthosis can revolutionize the overall compliance. The ultimate effect of treatment may then be enhanced (in both physical and psychological aspects).

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