

## The Differential Effects of Exercise, Brace and Combined Rehabilitation Treatment in Patients with Adolescent Idiopathic Scoliosis\*

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### Abstract

**Objective:** To compare the effects of different conservative managements on patients with adolescent idiopathic scoliosis (AIS).

**Method:** One hundred and four AIS patients were recruited for this study. The patients were divided into 3 groups: exercise (E group), brace (B group) and combined rehabilitation treatment (brace treatment combined with exercise, CR group). Radiological parameter were used to assess AIS patients before and after treatment. The Chinese version of scoliosis research society-22(SRS-22) patient questionnaires were filled out by patients after treatment. The SRS-22 scores were compared among management groups.

**Result:** The maximal Cobb angles were smaller in E group than in B group or CR group both before and after treatment. The maximal Cobb angles were significantly smaller after treatment than before treatment in B group and CR group. Function/activity was better in E group than in B group or CR group. Self-image/appearance and satisfaction with management were better in E group and CR group than in B group. There was no significant difference among treatment groups in pain and mental health.

**Conclusion:** Both brace and combined rehabilitation treatment can reduce the spinal curve of AIS patients. Both exercise and combined rehabilitation treatment have positive influence on self-image/appearance and satisfaction with management. We support preference of combined rehabilitation treatment above brace treatment.

**Key word** adolescent idiopathic scoliosis; exercise; brace; rehabilitation; health-related quality of life

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### Introduction

Adolescent idiopathic scoliosis (AIS) is a three-dimensional deformity of the spine. It is generally progressive. Progressive scoliosis can produce pain and limited function. Exercise and brace treatment are frequently used for the treatment of AIS<sup>[1]</sup>. The debate about the best option remains undecided. Whether the potential differences exist in the effects of different conservative managements on AIS patients is currently unknown.

The scoliosis research society(SRS) outcome instrument is a simple, disease-specific, patient-based health-related quality of life (HRQOL) questionnaire. It has been

widely used to assess the outcomes of observation, brace and surgery in AIS patients<sup>[2-6]</sup>. The SRS was designed by Haher et al.<sup>[2]</sup> Subsequently, Asher et al<sup>[7]</sup> modified this instrument to improve the internal consistency by rewording questions and revising the domain structure. The SRS-22 patient questionnaire that covers the domains of function/activity, pain, self-image/appearance, mental health and satisfaction with management were proposed<sup>[7]</sup>. This instrument has proved to be reliable<sup>[8]</sup>, reproducible<sup>[8]</sup>, valid<sup>[7-9]</sup>. In China, the SRS-22 has been translated into Chinese, which resulted in an instrument apparently equivalent to the original version and suitable for clinical re-

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search<sup>[10]</sup>.

The radiological parameters and SRS-22 outcomes were studied in AIS patients who had completed exercise, brace treatment or combined rehabilitation treatment. The objective of this study was to compare the effects of different conservative managements on AIS patients. Identifying the effect of exercise, brace treatment and combined rehabilitation treatment on AIS patients would be assistant in treatment recommendations.

## Material and method

### Subject

Subjects were recruited from outpatient clinic of rehabilitation and pediatric orthopaedic of Xin Hua Hospital Affiliated to Shanghai Jiao Tong University School of Medicine between January 2009 and December 2011.

Inclusion criteria: 10 to 16 years old; Cobb angles > 10°. Exclusion criteria: Trauma (n=1); History of surgery (n=5); Younger than 10 years old (n=32); Older than 16 years old (n=25); Scoliosis secondary to congenital or specific causes (n=9).

The Medical Ethical Review Board of Xin Hua Hospital Affiliated to Shanghai Jiao Tong University School of Medicine approved this study. All subjects and their parents gave their informed consent and agreed to participate in this study, without incentives.

According to the degree of spinal curves and maturity, the subjects were assigned into 3 groups: exercise (E group, n=21), brace treatment (B group, n=33) and combined rehabilitation treatment (CR group, n=50). Patients in E group performed exercise three times a week. Exercise consisted of stretching and strengthening activities. Patients in B group were treated with a modified Cheneau brace for at least 21 hours per day. Patients in CR group were treated with both exercise and a modified Cheneau brace. All subjects finished the treatment program for 6 months.

All subjects completed clinical and radiographic examinations during routine visits to the outpatient clinic. Age, gender, history, diagnosis, and treatment data were collected. The Cobb's angle was measured from standing posterior-anterior radiographs before and after treatment.

All participants received the Chinese version of SRS-22 patient questionnaire after completing treatment,

and were requested to fill out the questionnaire by themselves.

The SRS-22 contains 22 questions that cover the domains of function/activity, pain, self-image/appearance, mental health and satisfaction with management<sup>[7]</sup>. The scores for each answer range from 1 (worst) to 5 (best) points, and the scores for each domain range from 5 to 25 points, except for the satisfaction with management domain which range from 2 to 10 points<sup>[8]</sup>. Each domain is often expressed as the average of all item responses. Therefore, a higher score indicates a better outcome. The Chinese version of SRS-22 has proved to be reliable<sup>[10-12]</sup>.

### Statistical Analysis

Mean Cobb's angles were calculated using the maximal thoracic, thoracolumbar or lumbar curve. Mean domain scores were calculated for all groups. Analysis of variance was used to identify statistically significant differences among the groups' demographics, the Cobb's angles, and the domain scores of SRS-22.

All analyses were conducted using SPSS v.17.0. Level of significance was defined as alpha <0.05.

## Results

Table 1 presents the characteristics of all study subjects. In E group, 6 patients had a single thoracic curve, 5 had a single thoracolumbar curve, 4 had a single lumbar curve, and 6 had a double thoracic lumbar curve. In B group, 4 patients had a single thoracic curve, 9 had a single thoracolumbar curve, 3 had a single lumbar curve, and 17 had a double thoracic lumbar curve. In the CR group, 3 patients had a single thoracic curve, 15 had a single thoracolumbar curve, 4 had a single lumbar curve, and 28 had a double thoracic lumbar curve. There was no significant difference among 3 groups in age and total treating duration.

**Table 1 Characteristics of the Study Subjects ( $\bar{x} \pm s$ )**

	Total (n=104)	E group (n=21)	B group (n=33)	CR group (n=50)
Age(years)	13.0±1.6	13.0±1.5	13.4±1.5	12.7±1.7
Males	13(13%)	3(14%)	6(18%)	4(8%)
Females	91(87%)	18(86%)	27(82%)	46(92%)
Thoracic curve	13(12%)	6(28%)	4(12%)	3(6%)
Thoracolumbar curve	29(28%)	5(24%)	9(27%)	15(30%)
Lumbar curve	11(11%)	4(19%)	3(9%)	4(8%)
Double thoracic lumbar curve	51(49%)	6(29%)	17(52%)	28(56%)

Table 2 presents the maximal Cobb's angles before and after treatment for each management group. The maximal Cobb's angle before treatment was  $17^{\circ}(\pm 7.2^{\circ})$  in E group,  $30^{\circ}(\pm 9.6^{\circ})$  in B group, and  $29^{\circ}(\pm 11.1^{\circ})$  in CR group. After treatment, the maximal Cobb's angle was  $16^{\circ}(\pm 8.5^{\circ})$  in E group,  $26^{\circ}(\pm 12.1^{\circ})$  in B group, and  $25^{\circ}(\pm 10.5^{\circ})$  in CR group. The maximal Cobb's angles were smaller in E group than B and CR groups both before and after treatment. There was no significant difference between B and CR groups in maximal Cobb's angle both before and after treatment. The maximal Cobb's angles were significantly smaller after treatment than before treatment in B group and CR group. There was no significant difference between the maximal Cobb's angle before and after treatment in E group.

Table 3 presents the SRS-22 scores for each management group. In three domains differences were found between the management groups. The patients of E group

had significantly better mean function scores than B group and CR group. E group and CR group had significantly better mean self-image/appearance scores than B group. E group and CR group were significantly more satisfied with management than B group. There was no significant difference between the treatment groups in pain and mental health. There was no significant difference between males and females in SRS-22 scores.

**Table 2 The Maximal Cobb's Angle of the Treatment Groups Before and After Treatment** ( $\bar{x} \pm s$ )

Groups	Maximal Cobb's angle before treatment( $^{\circ}$ )	Maximal Cobb's angle after treatment( $^{\circ}$ )
E group	$17.4 \pm 7.2^{23}$	$15.6 \pm 8.5^{23}$
B group	$29.5 \pm 9.6^{12}$	$25.9 \pm 12.1^{12}$
CR group	$29.2 \pm 11.1^{13}$	$25.4 \pm 10.5^{13}$
Total	$26.8 \pm 11.0^1$	$23.2 \pm 10.9^1$

① Significant difference between the maximal Cobb's angle before and after treatment; ② Significant difference between exercise and brace treatment; ③ Significant difference between exercise and combined rehabilitation treatment

**Table 3 SRS-22 Scores of the Treatment Groups** ( $\bar{x} \pm s$ )

Groups	Function/activity	Pain	Self-Image/appearance	Mental Health	Satisfaction with management
E group	$4.3 \pm 0.35^{12}$	$4.8 \pm 0.43$	$3.6 \pm 0.50^1$	$4.2 \pm 0.58$	$4.4 \pm 0.55^1$
B group	$4.1 \pm 0.43^1$	$4.5 \pm 0.53$	$3.2 \pm 0.61^{13}$	$4.0 \pm 0.64$	$3.4 \pm 0.90^{13}$
CR group	$4.0 \pm 0.38^2$	$4.5 \pm 0.39$	$3.6 \pm 0.60^3$	$4.2 \pm 0.59$	$4.3 \pm 0.57^3$

① Significant difference between E and B groups; ② Significant difference between E and CR groups; ③ Significant difference between CR and B groups

## Discussion

This study provided some evidence of the effects of different conservative managements on AIS patients. Both brace and combined rehabilitation treatment reduced the curve of AIS patients. Differences of HRQOL among management groups were found in function/activity, self-image/appearance, and satisfaction with management scores, but were not found in pain and mental health scores.

Patients treated with a modified Cheneau brace had significant reduction of Cobb's angles. The continuous wearing of Cheneau brace can improve the curve of AIS<sup>[13]</sup>. Although brace treatment reduced the curve, those patients had significantly lower mean scores in function/activity, self-image/appearance and satisfaction with management domain than patients treated with exercise and combined rehabilitation. Obvious reasons for this difference were that the brace restricted patients' physical activities

and affected the appearance. This reason might also explain the lower function/activity scores found in CR group (consisted of exercise and a brace). The impairment could alter the HRQOL measures.

In the present study, patients treated with exercise had highest scores in the function/activity, self-image/appearance and satisfaction with management domain. This difference might partly be attributed to the fact that patients in E group had smaller Cobb's angles, while patients in B group and the CR group had larger Cobb's angles. The scores obtained in the various domains of SRS-22 questionnaire might be correlated with the severity of radiographic impairments of the patients. Significant correlations had been observed between SRS-22 scores and Cobb's angle in patients treated non-surgically<sup>[2-3,14-15]</sup>.

Furthermore, patients treated with exercise and combined rehabilitation were much more satisfied with management than patients treated with a brace, despite no im-

provement of the maximal Cobb's angles in E group and the maximal Cobb's angles being quite similar in B group and CR group. This difference cannot be explained by improvement of the maximal Cobb's angle. Rehabilitation could improve patient's function and perceptions. This condition could affect HRQOL. This difference in satisfaction with management might partly be attributed to the fact that patients treated with exercise and combined rehabilitation had better perceptions, while patients treated with a brace had worse perceptions. Patients scored higher points in self-image/appearance domain, which implied that these patients were satisfied.

In line with our results, other studies also found no major impact of gender<sup>[4,16-18]</sup> on HRQOL in AIS patients.

Since the most common conservative management strategies used for AIS were exercise and bracing, we selected the 3 management groups to compare the differences. Our design was limited to a short-term cross-sectional assessment after treatment. The short-term results was important, but not conclusive. Longitudinal data could provide more insight into the impacts of different conservative managements on AIS patients.

In conclusion, there were obvious short-term differences in the effects of exercise, brace treatment and combined rehabilitation treatment on AIS patients. Both brace and combined rehabilitation treatment could reduce the spinal curve of AIS patients. Exercise had positive influences on function/activity, self-image/appearance, and satisfaction with management. Combined rehabilitation had positive influences on self-image/appearance and satisfaction with management. The idea that combined rehabilitation was to be preferred to brace treatment was supported by the differences in this study. These findings should be taken into account in the debate about the preferred option for conservative managements in AIS.

Further research should also focus on the effects of observation, exercise, brace, combined rehabilitation, or surgery and on the long-term follow-up after different conservative managements.

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