Effect of Environmental Psychological Factors on Compliance with Brace Treatment in Adolescent Idiopathic Scoliosis

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Research Article

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Abstract

Objective

To investigate the Effect of Environmental Psychological Factors on Orthosis Therapy for Adolescent Idiopathic Scoliosis (AIS) in the three-dimensional perspectives included oneself, family and school environment.

Methods

Patients with AIS undergoing bracing therapy from January 2019 to December 2021 were retrospectively studied. Information about the patients included baseline data, Eysenck Personality Questionnaire, family environment scale, and academic achievement was collected. The patient's data of Eysenck Personality Questionnaire and family environment scale was compared with the Chinese norm to determine the representativeness of the included sample. The patients were divided into complianted group and control group according to the compliance condition, single factor analysis was carried out by $\chi^2$ test or independent sample t test. The meaningful variables were further analyzed by multivariate logistic regression.

Results

A total of 50 patients were included. There was no statistical difference observed in patient's statistics compared with Chinese norm ($P < 0.05$). Univariate analysis results showed statistical difference in emotional stability ($t = 3.14, P = 0.00$) of the Eysenck Personality Questionnaire, whereas there was no statistical difference in internal and external direction ($t = 1.07, P = 0.28$), mental quality ($t = 0.17, P = 0.86$); There had statistical difference in intimacy ($t = 3.96, P = 0.00$) in the household environmental scale, whereas contradictions ($t = 1.53, P = 0.13$) and culture ($t = 0.38, P = 0.70$) were not statistically different; Statistical difference was observed in academic performance ($\chi^2 = 7.96, P = 0.00$). In the multivariate logistic regression analysis, Statistical difference was not observed in the emotional stability and academic achievement ($P > 0.05$). Intimacy remained an independent influence factor for compliance ($P = 0.01, \text{Exp (B)} = 3.10, 95\% \text{ confidence interval: 1.27} \text{ 7.56}$).

Conclusion

High-intimacy family environment is an important environmental characteristic of high compliance. Effective communication between parents and patients is required in Orthosis Therapy for AIS.

Background
Adolescent Idiopathic Scoliosis (AIS) is a complex three-dimensional deformity of the spine. In mild to moderate AIS, brace treatment is the main treatment to prevent the progression of lateral curvature and reduce the surgical rate[1, 2]. The success rate of brace therapy depends on the patient's compliance[3].

Bracing for AIS patients is a very difficult and complex treatment[4]. In fact, adolescence as the most critical stage of life with high instability, improving the long-term compliance of AIS patients with scoliosis brace is a real challenge[5]. Anne Morton et al. conducted a study on brace belief questionnaires in 124 AIS patients and showed that compliance with brace treatment was related to patients’ subjective beliefs[6]. Improving long-term compliance with brace could further improve AIS patient outcomes. Long-term compliance is often closely related to the psychological factors of the patient’s environment. Ewa Misterska conducted a questionnaire survey of 63 AIS patients and their parents on mental stress related to braces. The results showed that patients and their families felt the mental stress related to braces during brace treatment, and suggested that mental stress should be carried out during brace treatment Evaluation[7]. As so far, there are few studies on the relationship between AIS bracing treatment and environmental psychological factors of patients.

The purpose of this study is to explore the role of environmental psychological factors in the treatment of AIS braces from the three-dimensional perspectives of self, family and school environment; to screen the aspects related to the compliance of brace treatment among many personality factors and family environment factors, and to target intervene on mental and psychological factors to improve the curative effect of bracing treatment.

**Methods**

This study was approved by the Ethics Committee of Baoding Second Central Hospital. A retrospective investigation was conducted on AIS patients who received brace treatment in Baoding Second Central Hospital from January 2019 to December 2021. This study was approved by the Medical Ethics Committee of Baoding Second Central Hospital (No.202141). All patients gave informed consent and signed an informed consent form.

Inclusion criteria: Age > 10 years old when brace treatment was started, Risser Sign ≤ 2, initial Cobb angle 20°-45°, and no other treatment.

Exclusion criteria: Patients with congenital spinal deformities, neuromuscular scoliosis, or other musculoskeletal disorders.

**Questionnaire Assessment Before Brace Wearing**

The content of the questionnaire evaluation included the Eysenck personality questionnaire, the family environment scale, and the school environment. The data entry was performed using the EPIDATA data entry program uniformly prepared by the project team. A special person is responsible for entering the
original data in the form of double entry. Since the completion of the questionnaire requires an education level above elementary school, some patients who have not graduated from primary school are assisted by their parents to fill it out.

The Eysenck Personality Questionnaire (EPQ)[8] is used to evaluate the personality tendency of adolescent patients, including four subscales: E(extroversion or introversion), N(emotional stability), P(psychoticism), and L(maskability). Among them, E, N, and P test the three personality dimensions respectively, and L is the validity scale to measure lying and concealment.

The third edition of the Family Environment Scale compiled by MOSS[9] is used to evaluate the family environment. The scale has 90 items in total, each with a score of 0.1. It is summarized into 10 dimensions and evaluates 10 different family environment characteristics: Intimacy; emotional expression; ambivalence; independence; success; culture; entertainment; morality and religion; organization; control. Among them, intimacy, ambivalence, culture and organization have high reliability and validity in the Chinese population. Since the research mainly focuses on factors related to adolescent psychology, this study only includes three dimensions of intimacy, ambivalence, and culturality for investigation.

Assessment of the school environment: The Visual Analogue Scale (VAS) was used to assess the relationship between teachers and students and classmates in the school. A score of 1 to 5 is considered poor, and a score greater than 5 is considered good.

**Standardized Brace Manufacturing Process**

According to the principle of Chêneau-Brace production, the initial degree of correction is adjusted according to the stiffness of spine, and the later adjustment is made according to the comfort of the patient after wearing it (Figure. 1). All braces are made by the same orthopedist, and the production material is poly Vinyl planks. The traditional plaster molding process is used to make the brace. Brace production requirements: the front opening of the orthosis is about 6 cm; the side edge of the orthosis must not press the greater trochanter; the lowest point of the lower edge of the back of the orthosis is kept at a distance of 2 to 3cm from the stool surface; the lowest point of the front lower edge of the orthosis is 2cm above the pubic symphysis; The edge of the groin at the lower front of the orthosis is 3 to 5 cm below the anterior superior iliac spine. After the brace is made, the patient will try it on initially, and evaluate the following conditions: the patient's feeling of the back, chest and waist pressure pads; whether the position of the open area meets the requirements and comfort; the contact between the edge of the window and the body must not Squeeze the skin and soft tissue; whether the pressure and edge cutting of the upper edge of the back of the brace meet the requirements; the attachment of the brace to the body to improve the concealment performance of the brace after wearing. Re-modifications were made when necessary to improve patient comfort and reduce the impact of the brace on the patient's daily life.
Compliance Evaluation

Follow-up was conducted at 1, 3, 6, and 12 months after wearing the brace, and the patients were instructed to wear the brace for 22 hours a day.

The patient records the amount of time the brace is worn each day on a diary sheet. The compliance log form includes: 1. How long the brace was worn at night? 2. How long was the brace worn at school? 3. How long the brace was worn at other times? Calculate the time sum of these three parts. Studies have shown that in order to control the progression of scoliosis, braces need to be worn for more than 20 hours[10]. According to the brace wearing time of patients, patients who wear braces for 20 hours or more per day will enter the compliance group, and patients who wear braces for less than 20 hours per day will enter the control group.

The reliability of the adherence log was assessed during each visit, including examination of brace wear, patient skill in putting on and removing the brace, and skin discoloration caused by the brace in areas of pressure on the patient.

Statistical Methods

SPSS 25.0 was used for statistical analysis of retrospective survey design. The t-test was used to compare the environmental psychological parameters of the patient sample with the Chinese norm to determine the representativeness of the patient sample. The relationship between each independent variable and compliance was preliminarily evaluated by Pearson \( \chi^2 \) test or independent sample t test, and the selected variables with P < 0.05 were subjected to multivariate Logistic regression analysis to determine the relevant factors of compliance.

Results

A total of 50 patients were included in the study. There were 24 cases (48%) in the compliance group and 26 cases (52%) in the control group.

Baseline Characteristics

50 patients were included, with an average age of 14.2 ± 2.4; 18 males (36%) and 32 females (64%); 31 cases (62%) lived in cities, 19 cases (38%) were from rural areas; 30 cases were only children (60%); 21 cases (42%) had a good school environment.

Comparison Of Environmental Psychological Parameters Of Patients With Chinese Norms
There was no statistical difference between the patient's environmental psychological parameters and the Chinese norm (P > 0.05), as shown in Table 1. It can be considered that the patient sample and the Chinese norm come from the same population, and the sample is well represented.

Table 1 Comparison of environmental psychological parameters and Chinese norms

<table>
<thead>
<tr>
<th>Subject</th>
<th>Include patients</th>
<th>Chinese norms</th>
<th>T</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eysenck Personality Questionnaire</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extroversion or introversion</td>
<td>13.22 ± 2.83</td>
<td>13.49</td>
<td>0.67</td>
<td>0.50</td>
</tr>
<tr>
<td>Emotional stability</td>
<td>6.16 ± 2.72</td>
<td>6.08</td>
<td>0.20</td>
<td>0.83</td>
</tr>
<tr>
<td>Psychoticism</td>
<td>3.68 ± 1.11</td>
<td>3.50</td>
<td>1.14</td>
<td>0.25</td>
</tr>
<tr>
<td>Family Environment Scale</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intimacy</td>
<td>7.46 ± 0.97</td>
<td>7.70</td>
<td>1.74</td>
<td>0.08</td>
</tr>
<tr>
<td>Ambivalence</td>
<td>2.04 ± 0.92</td>
<td>2.20</td>
<td>1.22</td>
<td>0.22</td>
</tr>
<tr>
<td>Culture</td>
<td>5.24 ± 1.11</td>
<td>5.60</td>
<td>1.97</td>
<td>0.05</td>
</tr>
</tbody>
</table>

Comparison Between Compliance Group And Control Group

There were 24 cases in the compliance group and 26 cases in the control group. No statistics difference was seen in Gender ($\chi^2 = 0.93, P = 0.33$), social environment ($\chi^2 = 0.42, P = 0.51$), only child or not ($\chi^2 = 2.25, P = 0.13$), extroversion in the Eysenck personality questionnaire ($t = 1.07, P = 0.28$), mental quality ($t = 0.17, P = 0.86$) and contradictions in the family environment scale ($t = 1.53, P = 0.13$), cultural ($t = 0.38, P = 0.70$). There were statistical difference in Emotional stability in the Eysenck personality questionnaire ($t = 3.14, P = 0.00$), intimacy in the family environment scale ($t = 3.96, P = 0.00$) and school environment ($\chi^2 = 7.96, P = 0.00$) (Table 2).

Table 2 Comparison between compliance group N=24 and control group N=26
Multivariate Logistic Regression Analysis Of Compliance

The emotional stability score in the Eysenck personality questionnaire and the school environment were not statistically significant (P > 0.05), and the intimacy in the family environment scale was still an independent factor affecting compliance (P < 0.05) (Table 3).

Table 3 Multivariate Logistic regression analysis of compliance
<table>
<thead>
<tr>
<th></th>
<th>B</th>
<th>S.E.</th>
<th>Wald</th>
<th>OR</th>
<th>95%CI</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intimacy</td>
<td>1.13</td>
<td>0.45</td>
<td>6.19</td>
<td>3.10</td>
<td>1.27</td>
<td>7.56</td>
</tr>
<tr>
<td>School environment</td>
<td>1.44</td>
<td>0.74</td>
<td>3.81</td>
<td>4.24</td>
<td>0.99</td>
<td>18.13</td>
</tr>
<tr>
<td>Emotional stability</td>
<td>0.22</td>
<td>0.15</td>
<td>2.17</td>
<td>1.24</td>
<td>0.93</td>
<td>1.67</td>
</tr>
</tbody>
</table>

### Discussion

In this study, the Eysenck Personality Questionnaire, Family Environment Scale, and school environment were used to evaluate the influencing factors of brace wearing compliance in adolescent idiopathic scoliosis patients from three aspects: patient personality characteristics, family environment, and school environment. The results showed that intimacy in the family environment scale was an independent factor affecting compliance. At the same time, the parameters of the Eysenck Personality Questionnaire and Family Environment Scale of the 50 patients included in the sample were compared with the Chinese norm to conduct an independent sample T test to verify the representativeness of the sample, and the results showed no statistical difference (P > 0.05).

Good compliance can improve the prognosis of AIS patients and reduce the rate of surgery. The brace treatment for AIS usually needs to be worn for 18–23 hours a day, but the compliance of AIS patients to the brace treatment can only reach 27–47% of the prescribed time, and the psychological pressure of the patient is the main factor affecting compliance[11]. Improving patient adherence is a big challenge and researchers consider multiple reasons for poor patient adherence. Karol et al. conducted a prospective study on the compliance of brace wearing in 222 AIS patients using monitors and found that compliance counseling based on sensor data can increase brace wearing time by 3.2 hours per day and reduce surgery rate by 11%[12]. It is suggested that the psychological adjustment of adolescents is insufficient, and external factors need to be involved in improving the compliance of wearing braces. A suitable family environment can help improve the compliance of adolescents wearing AIS orthopedic braces[13]. In this context, parental involvement in the adolescent's bracing treatment program plays an important role in improving bracing compliance[14]. Family efficacy and flexibility are strongly associated with patient compliance. During brace treatment, adequate brace treatment information needs to be provided to patients and parents to guide parents to quickly detect changes in the patient 'mood and intervene.[15].

Although parental supervision is important for treatment adherence, parental emotional support may more fully reflect family functioning[16, 17]. Parents need to strike a balance between emotional support and promoting adolescent autonomy, and family members' intimate relationships are particularly important in achieving this balance. Alexandra et al. ’s study found families with fewer conflicts, high cohesion, high flexibility, and active communication were positively associated with high adherence [18]. When family members are able to recognize and understand the emotional challenges experienced by adolescent patients and provide emotional support, they can help adolescents through the adaptation
period of brace wear[19]. With increasing self-awareness among adolescent AIS patients, interventions targeting family issues have helped to improve adherence to brace wear.

In this study, it was found that personality traits, family culture and contradictions, and social environment did not independently influence adherence. Self-discipline and perseverance are traits that determine long-term adherence to tasks to achieve long-term goals. This trait is not associated with personality traits, family culture and contradictions, and social environments[20]. It is suggested that Chinese parents should not only improve the condition of life and work for the patients, but also give more emotional care to AIS patients, to help them develop the habit of self-discipline.

This study has certain limitations. First of all, this study is a retrospective analysis, and the inclusion and exclusion criteria of AIS patients may be biased. In addition, this study is a research report of a single medical clinical center, and the influencing factors of brace compliance still need to be further explored in multi-center studies. Similarly, it is necessary to design studies with larger sample sizes to confirm this conclusion. At last, this study did not include objective electronic monitoring measures for compliance assessment. With the development of technology, subsequent studies can use pressure sensors that can be implanted on the inner surface of the brace to objectively detect and improve compliance. Despite the limitations, the study remains of great interest. Emotional care has been found to be more conducive to improving adherence to brace use among adolescents relative to living and working conditions. This finding could guide brace wear in AIS patients, thereby improving patient outcomes.

In conclusion, a high-intimacy family environment is an important environmental feature for high compliance in brace treatment for AIS, and effective communication between parents and patients is required in brace treatment for AIS.

Abbreviations

AIS
Adolescent Idiopathic Scoliosis EPQ:Eysenck Personality Questionnaire
VAS
Visual Analogue Scale

Declarations

Ethics approval and consent to participate

The study was approved by the ethical committee of Second Central Hospital of Baoding. All clinical investigations were conducted according to the principles expressed in the Declaration of Helsinki. Informed consent was obtained from all subjects or their legal guardians.

Consent for publication
Not applicable.

**Availability of data and materials**

The data sets used and/or analysed during the current study are available from the corresponding author on reasonable request.

**Competing interests**

The authors declare that they have no competing interests.

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**Author contributions**

Kepeng Li conceived and designed the study. Ye Han analyzed the data. All authors read and approved the final manuscript.

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Not applicable.

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**References**


Figures
Figure 1

Cosmetic photos and X-ray before and after wearing Chêneau-Brace