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Impact of adolescent idiopathic scoliosis on in-school adolescents and intervention

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Abstract. Adolescent idiopathic scoliosis (AIS) is one of the most common types of scoliosis, which affects patients' balance function and spinal mobility, leads to spinal deformity,and also has some degree of negative effect on pulmonary function, which, to varying degrees, seriously affects adolescents' physical and mental health and quality of life, increases patients' family's financial burden, and may also result in the depletion of social resources. Therefore, early identification and intervention of AIS is an urgent issue. There is still some controversy about whether to screen for AIS, and each region should make decisions based on their own situation. The popularisation of the disease should be put on the agenda as soon as possible. This paper summarises the impact of AIS on adolescents' learning and social interaction. In addition, specific interventions after the emergence of AIS, such as conservative treatment, surgical treatment, and traditional Chinese medicine, are generally described, and their advantages and disadvantages are analysed. This paper is intended to provide more theoretical basis for an further understanding of scoliosis.

Keywords: Scoliosis, adolescents, school.

1. Introduction

Idiopathic scoliosis is a three-dimensional structural deformity of the spine accompanied by vertebral rotation of unknown cause and is diagnosed by a Cobb angle greater than or equal to 10° with axial rotation of the vertebrae [1]. AIS is one of the most common types of scoliosis and is prevalent in adolescents who are in a rapid growth spurt [2]. The number of women with severe scoliosis is significantly greater than men (Cobb angle ＞30°, female: male=7:1) [2,3]. Individually, deformities caused by AIS can seriously affect the patient's physical and mental health, which in turn affects the quality of life [3]. As far as society is concerned, AIS reduces the labour force that patients can provide to society and consumes certain social resources, so the disease has some impact on the development of society. The disease has attracted the attention of society and people in related fields. The etiology of AIS is unclear, and a variety of factors may contribute to the development of scoliosis, such as genetic factors, abnormal skeletal growth, estrogen receptor, calmodulin, and melatonin [2,3].

AIS could be screened by ways like the forward bend test, scoliometer measurement, and Moiré topography. Currently, the most common imaging test for AIS in clinical practice is X-ray. EOS also has a good image quality and its additional cancer risk is less than that of x-ray, but its use is discouraged in some countries due to its higher cost. Regarding the treatment of this disease, it is mainly divided into

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conservative treatment and surgical treatment. Conservative treatments include Physiotherapeutic scoliosis-specific exercises(PSSE),brace, etc; Cobb angle >45°or rapid deterioration of scoliosis deformity in patients can be treated surgically [3, 4]. One survey showed that the detection rate of AIS was nearly 10% among 4,531 students in grades 4 to 9 in 16 primary and secondary schools in four districts of Shanghai, China, in 2021 [5]. AIS has serious adverse effects on adolescents, especially on their school life. However, there are little studies on the effects of scoliosis on patients' school life, so this paper intends to summarise the effects of scoliosis on school adolescents in order to provide more theoretical basis for the further understanding of scoliosis.

2. Physiological functions

Scoliosis causes a loss of balance and affects the mobility of the spine [6]. Balance and range of motion are both closely related to sport performance. Sports exams have become one of the criteria for academic advancement in many countries. Poor sport performance can affect students' academic development in physical education exams.This means that scoliosis can have an impact on the academic development of people with AIS.

Decreased balance function in people with AIS increases their risk of sport injuries,such as falls and ankle sprains [6, 7]. Medical staff's education of diagnosed AIS patients can make AIS patients consciously avoid those high-risk sports or engage in sports within their ability, which can reduce the occurrence of sports injuries. However, patients who don't know they have scoliosis lack a full understanding of their balance and movement abilities, meaning that lower balance function and postural stability puts them at greater risk for exercise.

Problems caused by scoliosis, such as spinal deformity, thoracic deformity and weakness of the respiratory muscles, will affect the patient's lung function. A meta-analysis, which included 27 studies (n=3162), showed that the greater the thoracic Cobb angle or apical vertebral rotation angle, the worse the lung function in patients with AIS [8]. Decreasing lung function adversely affects physical activity in adolescents.

3. Learning

3.1. Concentration

concentration ability is especially important for young people in school. However, the structural changes in the spine and postural changes caused by AIS can often cause low back pain and impair concentration ability. Epidemiological surveys have shown that Many patients with AIS (up to 34.7%-42.0%) suffer from lower back pain [9]. In addition to the direct negative impact on the AIS patient's ability to concentrate, the pain caused by AIS can indirectly affect the patient's ability to concentrate by affecting the quality of sleep. Yavuz Yakut et al. observed that most AIS patients with higher Cobb angles did not experience low quality sleep and drowsiness, and most of those AIS patients with sleep problems were accompanied by more severe pain [10]. A study observed 91 patients with IS between the ages of 10-19 years and showed that the decline in sleep quality plagues most of them [10]. Poor sleep quality includes sleep deprivation, sleep deprivation, etc. Lack of sleep has been linked to significant decreases in attention and cognitive processing speed as well as longer reaction times, according to a research [11]. This means that AIS reduces concentration and affects the quality of learning in some patients, thus affecting their learning progress and academic development.

3.2. Sitting tolerance

In primary and secondary schools, completing a lesson requires maintaining a sitting posture for a certain length of time. Although the literature refers to a reduced sitting tolerance in patients with scoliosis , there are also experimental results showing that despite the reduced postural stability in patients with AIS, this stability is sufficient for most of the daily activities of the patients [12]. A lot of patients with AIS face chronic low back pain , which is associated with postural tolerance, suggesting that the pain associated with AIS may also lead to reduced postural tolerance [9]. However, a study has shown that

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most chronic back pain patients can tolerate prolonged sitting (⩾60 minutes) and standing (⩾30 minutes), and this sitting duration is typically sufficient to support patients in completing classroom learning [13].

4. Socialization

4.1. Psychology

The spinal deformity associated with AIS can affect the confidence of many patients in their appearance and can cause personality changes in patients. Many patients with AIS suffer from chronic pain and poor sleep quality, and sleep deprivation and chronic pain can also have a negative impact on mental health [10]. Too little sleep is associated with depression, which means that those with scoliosis who have poorer sleep quality may be at greater risk of depression.Some studies have shown that most AIS patients are introverted and prefer to be alone [14]. These psychological barriers and personality traits are not conducive to patients' communication with their classmates and teachers, and it is not easy for teachers to understand their inner world and help them when they need help.

It is not only AIS itself that can cause psychological problems for patients. For some patients who require conservative or surgical treatments, the interventions they receive may also lead to emotional disturbances, e.g., brace wearing in conservative treatment of AIS can be very stressful for adolescents, and patients with AIS who undergo surgery suffer from anxiety problems, both preoperatively and postoperatively [15]. These psychological problem can affect adolescents social interaction in some degree.

4.2. Sports

Sports are one of the most popular forms of socialising and entertainment. Individuals with AIS have poorer sport performance compared to the healthy population, which affects the status of youth with AIS on the playing field and can take the fun out of playing sports, reducing the chances of winning and the sense of achievement that comes with winning.This may lead to adolescents refusing to participate in sports. Refusal to play sports may lead to a reduction in the patient's choices of ways to interact socially.

5. Emphasis on screening

Today, the question of whether to screen for scoliosis remains controversial internationally. Proponents of screening argue for the advantages and efficacy of early intervention. Opponents argue that screening leads to unnecessary testing, unnecessary treatment, and psychological side effects of treatment.

As far as we can see, AIS has a certain impact on learning, sports and socialising among school youths, so the relevant departments should pay attention to the screening of AIS. Relevant departments should weigh the prevalence of AIS and the benefits of screening in their countries, and then decide whether to add relevant screening to the physical examination of primary and secondary school students. Relevant departments should carry out screening at the age where the disease is highly prevalent. Especially for girls, some surveys show that the proportion of female patients with severe AIS is much larger than that of males, and the relevant departments should pay relatively more attention to females in the age group of high incidence of AIS [2, 3].

Of course, if school-based screening cannot be carried out in a timely manner in clinics due to efficiency and benefit problems, the relevant departments should also promote and disseminate knowledge about AIS and issue instructional videos on easy screening methods, such as the forward bend test and measuring the angle of trunk rotation(people can use the scoliometer measurement software downloaded from their mobile phones).They should also advocate parents to screen their children themselves at home and, if they find anything suspicious, to bring them to hospitals or relevant departments for more tests to determine whether they need to undergo further x-rays or other tests that expose them to radiation.

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6. Intervention

6.1. Conservative treatment

Early conservative treatment of scoliosis is important. Conservative treatment of AIS stabilises or reduces the spinal deformity, with the aim of avoiding or delaying surgical intervention. Conservative treatments commonly used in clinical practice today mainly include bracing and Physiotherapeutic Scoliosis Specific Exercises (PSSE).

Bracing is a common form of conservative treatment for AIS. There is a difference between soft and rigid braces and the wearing time of braces is classified as all-weather, part-time, and nighttime wear. In general, soft braces are less effective than hard braces, and patients who wear soft braces generally achieve better treatment results compared to patients who are only observed. Although rigid braces are the most effective, they may cause side effects such as pain, psychological disorders and pressure sores. In order to avoid unnecessary side effects, the therapist should choose the appropriate treatment plan for the patient according to the patient's actual needs. When brace therapy is established, patients should receive regular aerobic training to optimise lung function , and receive regular nursing care and checks or more appropriate lengths of wear and rest designed to prevent other side effects such as pressure sores [8]. The pain and odd appearance caused by bracing may make patients less compliant with treatment. Adherence to brace therapy in patients with AIS can be improved by Sensor monitoring and Psychosocial intervention, and it has been shown in a study that adherence to bracing in patients with AIS was significantly improved (3.47 more hours/day) after intervention with sensor monitoring [16]. Therefore, psychological interventions and sensor monitoring can be given to patients while giving them brace therapy to enhance the therapeutic effect by improving patients' compliance.

PSSE is one of the best conservative treatments for AIS. There are many different schools of PSSE in Europe, of which the Schroth, SEAS and BSPTS methods are all good for efficacy, but only Schroth reduces the angle of axial rotation of the spine [17]. PSSE alone can avoid the psychological side effects and physical pain associated with brace wearing. In addition, PSSE is often combined with bracing in clinical practice, and some studies have shown that this method not only improves the reduced balance function brought about by bracing , but also achieves better results than bracing treatment alone [18, 19].

Unnecessary treatments may consume a lot of the patient's time and may also have unwanted psychological and physical side effects. When Continued deterioration of spinal deformity, pain caused by scoliosis, respiratory dysfunction and esthetics problem, which generally are main purposes of treatment for scoliosis, are not appear, patients are usually observed and educated [4]. Staff should also encourage the adolescent to participate in appropriate amounts of physical activity and to have regular follow-up and examinations if necessary.

6.2. Surgical treatment

Surgical treatment is recommended when the cobb angle is >45° or when the patient has a rapidly deteriorating scoliotic deformity [4]. The most common surgical procedure is multilevel surgical instrumentation with vertebral fusion, which is often associated with significant therapeutic benefits, but also carries a high degree of risk and complications. Currently, there are many surgical procedures available, and they should be selected or adjusted individually by the surgeon according to the patient's specific clinical situation.

6.3. Traditional Chinese medical treatment

In addition to modern medical technology tools, traditional Chinese medicine (TCM) rehabilitation therapy has also been shown to have good efficacy in AIS. Common types of AIS in Chinese medicine include Yin deficiency of the liver and kidney, Yang deficiency of the spleen and kidney, Qi and blood insufficiency, wind in the spine, kidney deficiency and blood stasis [1]. Patients should choose to take different Chinese medicines according to the different types of AIS. In China, many TCM rehabilitation doctors use modern physiotherapy combined with herbal tinctures, and these treatments have achieved good efficacy. In a clinical study, 120 patients with AIS were enrolled, and the test group (Chinese herbal

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tincture combined with Schroth therapy, n=60) had better Cobb's angle, VAS scores, SFMA scores, and VC levels than the control group (Schroth therapy only, n=60), and the combination of Chinese herbal medicine was found to be more effective after 3-6 treatments, and the differences were all statistically meaningful ($p<0.05$) [20].

In addition to traditional Chinese medicine, acupuncture, moxibustion, tuina and osteopathy are also clinically effective, and common tuina manipulation techniques include tending tendon manipulation, lever positioning manipulation, recumbent distraction manipulation, and balanced chiropractic manipulation. A study showed that the total effective rate of treatment for patients who received brace correction combined with postural training, acupuncture and moxibustion combined with orthopedic massage (95.00%, 38/40) was significantly higher than that of patients who received only brace correction combined with postural training (80.00%, 32/40) ($P<0.05$), and that the VAS scores and spinal Cobb angles of the former were better than those of the latter after the treatment ($P<0.05$) [21].

7. Conclusion

AIS results in decreased balance and spinal joint mobility, which affects sport performance in adolescents and increases risk for sports (especially in those who are unaware of their scoliosis). Many patients with AIS have problems with sitting tolerance, sleep, and other issues that affect concentration, cognitive processing speed, and reaction time, and therefore the quality of learning and academic progress may be affected. Additionally, most patients with AIS are introverted, the deformed spine has an impact on the appearance and self-confidence of many patients, and bracing and surgical treatment can cause intense anxiety. These psychological disorders and personality traits caused by AIS can have an impact on patients' social life. Countries should develop screening programmes based on age, gender and location of high prevalence of AIS. Relevant departments should increase publicity efforts and disseminate knowledge about AIS and screening methods, especially for school adolescents. Families and society should pay high attention to AIS in order to detect, intervene and prevent the disease at an early stage, and try to decrease the progression of the disease and avoid progression to the surgical stage.

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