

Application Of Exercise Therapy in Scoliosis Rehabilitation

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Abstract. Scoliosis affects people of all ages, especially young adults. Idiopathic scoliosis in adolescents is a common deformity and has a high prevalence. In the early stages, its progress is difficult to detect, but the harm is not underestimated. Therefore, early detection and early intervention or treatment awareness are particularly important for scoliosis. The aim of this paper is to provide a comprehensive review of the classification and diagnosis of scoliosis. Also, the various treatments for different types and degrees of scoliosis are heavily discussed in this paper. A wide range of factors can influence and pace the development of scoliosis, for example, nutrition, genetics, and even sex (females are more prone to have severe scoliosis than males). Currently, due to a limited understanding of the causes and development of spinal deformities, there are no comprehensive, widespread, and recognized effective treatments to prevent or alleviate scoliosis, which means that each case of scoliosis must be managed and cared for with its unique characteristics.

Keywords: Scoliosis; Categorize; Diagnosis; Exercise Therapy.

1. Introduction

Scoliosis, in which the vertebrae bend or rotate at an angle, is a common deformity of the spine. The imaging definition is that X-ray plain film measurement shows that the vertical line of the spine has a curvature deviation greater than 10 degrees compared with normal conditions [1]. The high incidence of scoliosis is because there are no obvious symptoms except abnormal spinal morphology in the early stage of the disease, and it is usually not paid attention to. However, if it is not paid attention to and diagnosed and treated in time at the beginning of the disease, it is easy to lead to the aggravation of scoliosis and may produce complications such as cardiopulmonary injury, and even paraplegia in severe cases [2]. Treatment methods include surgery, wearing orthotics, and exercise therapy. However, studies have shown a high incidence of surgery-related complications in patients with early-onset scoliosis [3]. Exercise therapy is one of the most effective non-surgical treatments for scoliosis, with relatively low risk and fewer complications. However, its suitability and effectiveness remain controversial. Part of the reason for this problem is that the diagnosis of scoliosis by healthcare providers is unclear and the availability of various types of exercise treatment for scoliosis is not comprehensive. In this paper, the classification and effectiveness of core training, specific postural training, and self-stretching exercise therapy for scoliosis were studied, and their advantages and disadvantages were discussed.

2. Classification

Scoliosis can be classified into congenital scoliosis, idiopathic scoliosis, degenerative scoliosis, neuromuscular scoliosis. Congenital scoliosis deformity is more obvious, has rapid progression, is usually found in adolescence, and generally rarely progresses to extremely severe scoliosis. When no other disease is so far identified, it is diagnosed as idiopathic scoliosis. The cause of idiopathic scoliosis is not clear, and genetic factors are more commonly accepted as the general cause [4]. Degenerative scoliosis occurs secondary to disc and vertebral joint degeneration due to local nerve root involvement in the spine, and compensatory scoliosis occurs in the spine to relieve neurological

symptoms. Causes of neuromuscular scoliosis include neurogenic diseases such as cerebral palsy, spinal cord tumors, syringomyelia, spinal cord trauma, poliomyelitis, other viral myelitis, spinal muscular atrophy, and myogenic diseases such as multiple joint contractures, muscular dystrophy, and congenital hypotonia.

Scoliosis can also be divided into structural scoliosis and non-structural (functional) scoliosis. Structural scoliosis is caused by alternation of bony structures, and non-structural scoliosis is a postural scoliosis caused by pain or lumbar disc herniation. Non-structural scoliosis is usually intrigued by a temporal cause (like incorrect sitting posture) or resulted from other irregularity in other parts of the body (like different leg length). Non-structural scoliosis only involves side-to-side curves of the spine. Whereas structural scoliosis involves rotations of the spine [5].

3. Diagnosis

3.1. Physical Examination

Clinically, the Cobb Angle of scoliosis was measured by imaging. The physical examination for scoliosis is characterized by the following features: it is extensive, provocative, it affects treatment, and impact treatment.

(1) Screening

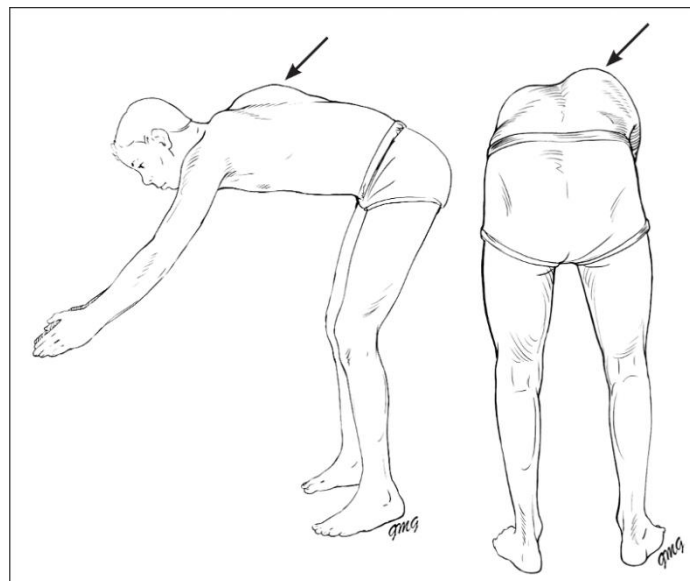


Fig. 1 Adam's forward bend test [6].

The patient stands and bends forward as Figure 1 indicates. The examiner assesses the back from behind and beside for symmetry. Back or rib abnormality, such as a rib hump (as arrows indicate), could signal scoliosis.

(2) Scoliometer

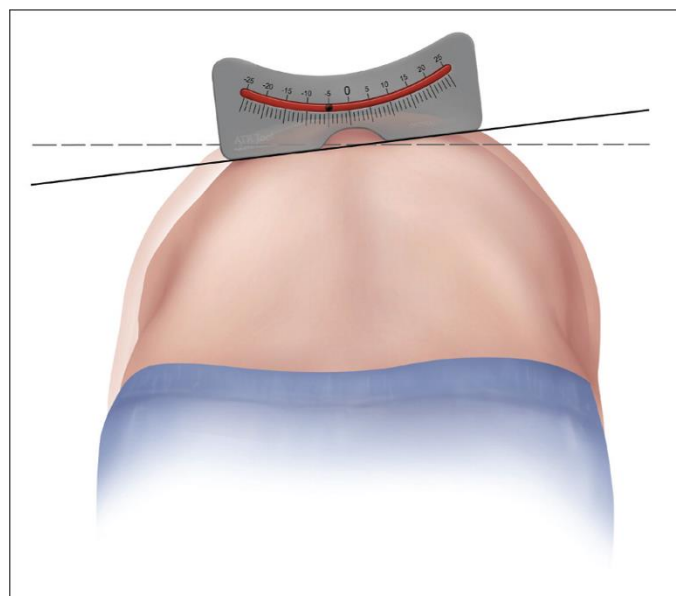


Fig. 2 Scoliometer [7].

Commonly, an angle below 5° measured by a scoliometer (Figure 2) is diagnosed as clinically insignificant and do not require followups. An angle of $5\text{-}9^\circ$ indicates that reexamination after 6 months is recommended. An angle bigger than 9° is a serious case that needs radiologic evaluation for Cobb angle measurement [8].

(3) Alarming cases

Left-sided curvature may be associated with other pathologies, including spinal cord tumors, neuromuscular disorders, or occult syringomyelia [6].

3.2. Imaging Evaluation

According to the size of the Cobb Angle, it was divided into three levels according to the severity. Grade 1 is mild. Mild scoliosis with a Cobb Angle of less than 20 degrees can usually be achieved without any medical intervention or treatment. Level 2 is moderate scoliosis, and the Cobb Angle is usually measured in the range of 20 to 40 degrees. This stage occurs most often in adolescents, and they can usually choose to exercise or orthopedic braces for correction. The third grade is severe scoliosis, Cobb Angle is greater than 45 degrees, or there is obvious vertebral deformation fusion, may be combined with serious spinal cord and spinal nerve injury, respiratory system and heart dysfunction, seriously affecting the physical and mental health of adolescents, it is recommended to timely surgical intervention [4].

4. Treatment

The fundamental objectives for the treatment of Idiopathic Scoliosis [9]:

(1) Stop or reduce curve progression at puberty.

Bracing is a common non-operative preventive means to slow curve progression to the point of surgery. Bracing for greater than 12 hours per day can control curve progression to less than 5° before adulthood [10].

(2) Exercise therapy to delay or relieve spinal curvature.

(3) Multiple treatments are combined to relieve pain and regulate complications such as respiratory disorders.

Scoliosis occurs when the vertebrae of the lumbar and thoracic spine are twisted to a certain extent, resulting in a three-dimensional change in the shape of the spine, which shows a loss of the normal curvature of the front torso and deformity. The majority of scoliosis cases are idiopathic, as there are many different causes of scoliosis, and they are difficult to determine. Adolescent idiopathic scoliosis (AIS) accounts for a large percentage of the total number of patients with AIS because the adolescent

body is growing extremely rapidly. The ability to intervene early in the course of scoliosis is a very important influence in reducing the incidence [11, 12].

The treatment of scoliosis varies according to the type of scoliosis and the severity of the scoliosis, and mainly includes surgical treatment and conservative treatment [13]. Conservative treatment includes exercise therapy, electrical stimulation, and wearing orthopedic braces. The surgical treatment mainly includes anterior operation, posterior operation and combined anterior and posterior operation. Posterior surgery is the most common after diagnosed above third-grade scoliosis.

At the dawn of scoliosis, however, can be found by physical examination, inspection timely intervention and treatment. Because at this stage, the central nervous system may begin to gradually adapt to this abnormal pattern, seeing this pattern as normal. The compensatory system then deflects the body to maintain balance [4]. After this has occurred, the patient must undergo intervention to slow the progression of this abnormal pattern, including exercise therapy, electrical stimulation, wearing orthopedic braces, traction, and surgery if necessary.

Due to certain risks of surgery, including possible complications and irreversible damage, controlling the process of scoliosis and delaying the disease is the first choice for treating early scoliosis, rather than complex scoliosis surgery [13]. For patients with mild scoliosis, especially adolescents, exercise can promote the overall development of physical functions, including improving the function of the motor system, promoting blood circulation, improving the nervous system and digestive system, and improving cardiorespiratory function. Therefore, exercise therapy is beneficial to the musculoskeletal system, can also play a positive role in the organs, and can also regulate psychological conditions, such as avoiding anxiety, depression and other psychological problems caused by scoliosis. According to the study, for patients with scoliosis, it is an important intervention treatment to insist on exercise rehabilitation and exercise body function [14]. Before treatment, the doctor needs to conduct preliminary assessments for each patient, such as physical examination and imaging diagnosis, to determine the type and severity of the patient's scoliosis. At the same time, the patients' age, exercise ability, nutritional status, psychological status, quality of life and so on were evaluated. And then the patient's treatment plan can be accurately and personally established. Mild patients should pay attention to their own disease process as soon as possible, early detection and early treatment, and exercise treatment according to their own characteristics, including the implementation of personalized exercise treatment programs. Patients with moderate scoliosis need to be combined with the wearing of orthopedic braces based on exercise therapy. Yagci et al [13]. randomly divided 30 adolescent female patients with idiopathic scoliosis into two groups to participate in a personal exercise program of 40 minutes once a week at the clinic, and then exercise at home in the same way for 20 minutes a day and insist on wearing a custom-made thoracolumbosacral spinal brace supports for 23 hours a day for 4 months. The first group was treated with a physician-directed exercise therapy to help stabilize the core, while the other group was treated with a scientific exercise method. After 16 weeks, Cobb Angle, trunk rotation Angle, body symmetry, and beauty of trunk deformity were measured, and it was found that Cobb Angle and trunk rotation Angle, body symmetry and beauty of trunk deformity were improved in the two groups of patients after treatment, and the curvature of some vertebrae was improved. It was proved that the two specific exercise treatments combined with the wearing of orthotics had a certain effect on moderate AIS, and the effect was similar.

Scoliosis affects the body in many ways, not only in terms of the degree of curvature of the spine, but also in terms of the uneven distribution of pressure on the soles of the feet and the uneven distribution of the load on the body. Therefore, by reducing the angle, the load on one side of the body can be reduced and the uneven distribution of weight on the body can be minimized. In addition, scoliosis can lead to muscle strain, which can eventually lead to painful overuse injuries. Thus, proper Pilates training can effectively improve the physical condition and contribute to health maintenance. Its main principle is to stimulate and improve muscle function in the body and to rebalance the muscles in the upper body and throughout the body, ultimately having the effect of stabilizing the spine. A Pilates program can include a warm-up phase as well as focused training. Focused exercises

promote spinal alignment and increase core strength and balance. These exercises promote effective stretching and conditioning of the muscles, allowing the posterior muscular chain to become more flexible. During this time, patients can increase resistance through the use of gravity and springs [16, 17].

According to research, Pilates exercises reduce the Cobb's angle which allows the patient's spine to be straighter. The smaller angle means that the load on one side of the body can be reduced, maximizing the problem of uneven loading [16, 17].

In addition to this, Pilates exercises can lead to an improvement in the patient's symptoms and QOL. The rebalancing of the muscles, the strengthening of the core and the postural symmetry promoted by the improved posture of the spine all contribute to the relief of scoliosis-related pain felt by the patient [17].

The advantage of Pilates is that it is a dynamic exercise. During Pilates exercises, patients can gain a better understanding of their muscles and body through body rhythms to music, ultimately allowing the body to become more harmonized and relaxed. Pilates is accessible to patients in a relaxed way, and with the ever-changing movements and music, the exercises become more fun. However, it is also an activity that requires guidance, and patients need specific postures, intensities, and timings to make the whole exercise safer and more effective [3].

Schroth breathing is another way to improve Cobb's Corner and is even more effective than Pilates training. Schroth breathing improves cardiorespiratory fitness and scoliosis in patients. It is a special three-dimensional treatment that strengthens the diaphragm and respiratory muscles while pulling on the spine. It requires the patient to twist the deformed and twisted chest in the opposite direction while breathing, thereby restoring the sunken chest area and flattening the already protruding portion [17]. The procedure is performed in a standing position.

This is accomplished by rotating the scapulae on the convex side backward and inward, while the hip bones on the concave side move toward the rib cage, as well as by guided suctioning of air to the depressed side of the patient in a standing position. In this method, both sensory and respiratory movements of the patient's body are mobilized, while the patient corrects the incorrect posture under external stimuli and proprioception. The Schrott Exercise is more of a correct breathing method, sagittal body correction way to let the patient form a subconscious mind to maintain the correct posture in life. Once the patient is able to have the awareness of the correct posture at all times, the muscles on both sides of the spine gradually move toward rebalancing [18].

Studies have shown that Schrott's breathing method has a relatively large impact on the rehabilitation of patients with mild scoliosis (Cobb angle less than 30°), whereas the effect on patients with Cobb angles of 30° to 50° and 50° or more is not as pronounced. Research has more likely concluded that the effect of Schrott's breathing on these patients with moderate scoliosis is to stop the scoliosis from getting worse, while the effect on decreasing the Cobb angle is moderate [19].

The practice of Schrott's breathing requires attention not only to the external condition of the patient, but also to the psychological problems of the patient. If the patient actively participates in the exercises, the result will be a reduction in the degree of scoliosis and the level of pain. Such a sense of achievement will enhance the patient's self-confidence and improve his/her psychological condition, which will ultimately motivate him/her to cooperate more with the treatment. This creates a virtuous circle of mental health and physical well-being [18].

However, it is difficult to mobilize the patient's initiative with single Schrott therapy because it is a kind of static movement. Therefore, appropriate external stimulation and motivation is essential. Schrott's breathing method combined with membrane chain thrusting can effectively reduce the Cobb angle. Membrane Chain Thrusting is effective in minimizing various myofascial tensions in the patient's backside. The combination of Schrott's Breathing can realign the peripheral muscles and fascia of the spine, ultimately reducing the degree of scoliosis [20].

And after combining 3D Schroth with Pilates, the effects on scoliosis become more effective. The combination of static and dynamic control of spinal stabilization. Compared to current Pilates

breathing, Schrott's breathing method is more effective in returning diaphragmatic and ventilator function, ultimately resulting in restoration of the concave area [21].

5. Conclusion

Scoliosis is a common physical deformity, usually characterized by rotation and curvature of the vertebrae and thoracic spine. The most common case of scoliosis is sudden scoliosis. The cause of this condition is difficult to determine and is most prevalent during the adolescent growth period. Scoliosis can be categorized as congenital scoliosis, degenerative scoliosis, or structural scoliosis. In the early stages of the disease, the patient's physical appearance is not altered to any great extent, making it a relatively unrecognized condition. However, if it is not prevented and treated with outside intervention it can compress organs such as the heart and lungs, and can even lead to serious consequences such as paraplegia.

Scoliosis can be diagnosed through a series of measurements. Clinical imaging is used to measure the Cobb angle to determine the type and degree of scoliosis, primarily by observing and measuring the symmetry of the ribs and back. Scoliosis is graded as mild, moderate or severe. Mild scoliosis does not require special intervention and can be recovered naturally. Moderate scoliosis requires bracing and treatment to prevent the scoliosis from worsening. Severe scoliosis can already affect the patient's nerves and internal organs, leaving the patient's systems and organs damaged to some degree and requiring surgery to help.

Exercise therapy is considered to be an effective treatment with low risk and good therapeutic results. Exercise is already very beneficial for adolescent patients, promoting the development of bodily functions and bringing about positive effects such as improving physical fitness and regulating mental conditions. It is beneficial to the physical and mental health of adolescents through the implementation of personalized treatment methods customized by doctors.

Pilates is one of the most effective exercises in exercise therapy, helping to stretch and tone muscles, strengthen the core, balance the muscles and ultimately stabilize the spine. Pilates, as a dynamic exercise, allows the patient to feel happy during the treatment, which can greatly motivate the patient and regulate the patient's mental condition. Schroth breathing is also an effective treatment to improve the Cobb angle. Schroth breathing is a three-dimensional exercise that allows patients to improve their scoliosis through both external intervention and proprioception. The patient will form new muscle memories in the process, which will result in the reduction of the Cobb angle.

Exercise therapy, as an effective treatment, should focus on both the physical and psychological well-being of the patient. Adolescents still need to pay more attention to scoliosis, and the condition should be prevented from continuing to worsen in the early stages of the disease. For adolescents, apart from the physical damage, the psychological damage needs to be taken more seriously. A large proportion of adolescents suffer from scoliosis, resulting in low self-esteem and closed-mindedness. According to studies, scoliosis is a major burden on the healthcare system, which in turn affects the national economy to a certain extent. Therefore, the popularization of scoliosis and its treatment needs to be further promoted to help the patients out of their psychological and physical difficulties.

Authors Contribution

All the authors contributed equally, and their names were listed in alphabetical order.

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