

Study on the Correlation between Primary Dysmenorrhea and Adolescent Idiopathic Scoliosis

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Abstract: *Adolescent idiopathic scoliosis often occurs during adolescence and has become an important public health issue that threatens adolescent health, and is more common in women. Therefore, this study aims to investigate the correlation between menstrual disorders in adolescent women and adolescent idiopathic scoliosis. At present, most scholars have not conducted in-depth exploration and research on the relationship between menstrual disorders and AIS, and the specific mechanism is not yet clear. This article analyzes the recent research progress of adolescent idiopathic scoliosis from the perspectives of biomechanics such as myofascia, muscles, and ligaments. At the same time, it also elaborates on the correlation between menstrual disorders and adolescent idiopathic scoliosis from the perspectives of meridians, anatomy, and neuromuscular aspects, aiming to provide theoretical basis for future research.*

Keywords: Primary dysmenorrhea, Scoliosis, Teenagers, Correlation research.

1. Introduction

Adolescent idiopathic scoliosis (AIS) is the most common type of spinal deformity and one of the most common deformities in the musculoskeletal system of adolescents. It is clinically characterized by a three-dimensional rotational deformity of the spine and torso. AIS is the most common structural scoliosis in clinic, which often occurs in adolescence, and has become an important public health problem threatening the health of adolescents. Clinical studies have found that the progress of scoliosis has a clear relationship with the growth of the spine. The incidence rate of AIS is about 2%~3% in the adolescent population, and it tends to occur in women. As women age, they often develop more severe deformities [1]. The International Society for Scoliosis Research (SRS) defines scoliosis (IS) as the application of the Cobb method to measure the flexion angle of a standing upright X-ray image of the spine. If the coronal Cobb angle is greater than 10 degrees, it is called IS [2]. SRS defines the type of AIS with unclear causes as AIS, which occurs between the ages of 10 and 18 [3].

2. Analysis of Biomechanical Research on AIS

2.1 Myofascial Layer

The myofascial membrane covers muscles, bones, blood vessels, and nerves, and in some aspects, it is consistent with some muscle functions [4]. In an ideal state, the tension balance of the overall structure of the human body is achieved by connecting the muscle fascia into a fascia network [5]. Wang Xiaojie et al. [6] confirmed that a continuous and tense overall fibrous fascial network structure always exists, whether viewed from the depths of muscles or the surface of the skin. Research suggests that compensatory changes in muscle tissue around the imbalanced overall structure of the spine are one of the reasons for further exacerbating IS, indicating the mutual influence between IS and the overall structure of the spine [7]. Therefore, in clinical practice, the spine should be viewed as a whole, and the imbalanced myofascial position should be identified. Specific areas within the fascial network should be treated to maintain body coordination and dynamic balance. The myofascial chain

theory is a holistic thinking pattern that connects soft tissues such as muscles and ligaments through the fascia at specific levels and directions, or indirectly forms a chain like overall structure through mechanical means [8]. There are studies [9-10] that, guided by the theory of myofascial chains, restore the overall balance of the spine from a mechanical perspective by strengthening muscle strength and regulating muscle tension through body training. Liu Jia et al. [11] believe that adjusting the overall structure of the spine can improve scoliosis. Under the guidance of the myofascial chain theory, spinal planing therapy has achieved good results in targeted treatment of AIS. The lumbar spine, which is a relatively independent part of the spine, relies heavily on the surrounding muscle and fascia chains to maintain stability and posture. Therefore, the epigastric chain is the main meridian, which coordinates and coordinates the posture and movements on the sagittal plane of the human body [12]. Based on the analysis of the trigger point theory of myofascia from a modern anatomical perspective, it can be found that it is similar to the traditional Chinese medicine tendon node theory in many aspects [13-14], and has certain therapeutic effects in regulating muscle bone pain and visceral function. Li Wenjing et al. [15] found that the bilateral paravertebral soft tissue of AIS is asymmetric. The application of myofascial release surgery can improve the clinical symptoms of patients, with strong specificity and plasticity. It directly affects the site of tissue morphological changes and can significantly reduce biomechanical stress.

2.2 At the Muscular Level

Muscles are distributed between joints, providing a source of energy, maintaining body stability, and controlling human movement. Whole body movement is completed between muscle contraction and relaxation [16]. Liu Yuzeng et al. [17] believe that muscle mechanical imbalance is one of the options to consider the cause of scoliosis. The mechanical properties of muscles are an important source for the smooth generation and good control of human strength. The normal shape of the spine relies on the muscle strength on both sides of the spine to maintain it. When one side of the muscle is excessively pulled or relaxed, the mechanical balance on both sides of the spine will be disrupted, leading to IS. AIS mainly

involves changes in the structure and pathology of the paraspinal muscles, especially the structures and pathological changes of the psoas major and erector spinae muscles. Abnormal development of paraspinal muscles is an important cause of scoliosis. According to "Lingshu · Cijie Zhenxie", "the lumbar spine is the major joint of the body," indicating that the lumbar spine plays an important role in the overall movement of the spine. The progressive increase in AIS is often caused by damage to muscle groups such as the lumbar major muscle attached to the lumbar spine, leading to spinal instability. The paraspinal muscles such as the psoas major exist as the main force to maintain the mobility and flexibility of the lumbar spine. To regulate the clinical symptoms of AIS, the primary goal of traditional Chinese spinal manipulation is to focus on the pathological changes of the psoas major muscles. Clinical studies [18] have confirmed the cornerstone role of the lumbar spine in structural mechanics and spinal motion mechanics, and the lumbar major muscle is the main muscle force for performing lumbar spine movements (lumbar rotation and lumbar flexion and extension) and maintaining lumbar curvature. There is a strong correlation between AIS and spasmodic contraction of the psoas major muscle, which plays an important role in maintaining spinal stability. Spasm of the psoas major muscle can also lead to changes in pelvic structure and lumbar spine position [19]. In clinical practice, the effect of AIS treatment is often significant when relieving spasms in the lumbar muscles and correcting sacral deviation. A study [15] has shown that the imbalance of bilateral erector spinae muscle strength is one of the important reasons for the progression of IS, suggesting that clinical treatment should pay more attention to the pathological and mechanical changes of the paraspinal muscles. The erector spinae muscle is the main muscle in the lower back, reaching up to the occipital bone and down to the sacrum. Muscle contraction controls the direction of spinal movement, regulates spinal movement status, maintains overall spinal coordination, and enhances the flexibility and stability of upright posture in the human body. Adolescents have a rapid growth and development rate, and their paraspinal muscles have not yet fully developed, making them unable to adapt to the rapid growth of the spine. There is a certain gap in muscle strength matching, resulting in a pathological state of muscle bone imbalance.

2.3 Ligament Level

Ligaments exist as a mechanical structure, and their mechanical effects can be better utilized through the attachment points of ligaments. Spinal ligaments mainly include central ligaments and lateral ligaments [20]. From a biomechanical perspective, lateral ligaments have more advantages in providing better lateral support than ligaments that only adhere to the center. AIS is mainly characterized by body asymmetry, motion imbalance, vertebral and thoracic deformation, etc. The spinal ligaments can maintain spinal stability through biomechanical constraints and neuromuscular feedback [21]. Spinal ligaments play a crucial role in maintaining spinal flexibility and stability in vertebrates. All animals have a central ligament, but the lateral ligament only exists in upright walking animals, indicating that the lateral ligament plays an important role in ensuring posture standards of the spine during both dynamic and static movements. The lateral ligament structure itself is a

response to the increased physiological stress on the spine of animals during upright walking, and it plays a significant role in maintaining spinal stability. It is also a fundamental condition for maintaining spinal erectness. Jia Nan et al. [22] believe that the adaptive changes in the spine of bipedal animals during upright walking are related to the stability of the lateral ligaments. AIS has specific manifestations of lateral curvature and vertebral rotation, and therefore, a hypothesis has been proposed that the biomechanical asymmetry changes in the lateral ligaments of the spine are extremely important factors in the occurrence and progression of AIS.

3. The Correlation between Primary Dysmenorrhea and AIS

AIS patients are often caused by congenital liver and kidney deficiency, qi and blood deficiency in adolescents, combined with acquired spleen and stomach disorders. External cold pathogens invade and damage the yang qi, leading to a disruption of the balance between yin and yang in the body, resulting in muscle and bone dislocation, scoliosis, and deformities in the spine. For AIS patients, changes in their spinal structure can affect the corresponding lower back and pelvic tissues. Dysmenorrhea is a common gynecological disease in clinical practice, and it is also one of the most common causes of pelvic pain in women. In modern medicine, dysmenorrhea can be divided into two categories based on its pathogenesis: primary and secondary. Dysmenorrhea without clear organic lesions or identifiable causes is called primary dysmenorrhea (PD) [23], which is commonly seen in adolescent girls or young women who have not given birth. PD is mainly caused by pain due to lack of honor and pain due to obstruction. During treatment, local muscles can be stretched or the position of the lumbar and sacral bones can be adjusted to improve pelvic blood circulation through active or passive, dynamic or static stretching, or the exercise itself can release pain regulating substances, thereby updating, unblocking, and nourishing the body microenvironment, and reducing menstrual discomfort in patients.

3.1 Meridian Perspective

The spine is located in the middle of the back of the human body and is an important position for the circulation of the Du meridian [24]. Traditionally, traditional Chinese medicine has focused on treating spinal related diseases from the perspective of "treating from the perspective of the governor" [25]. Damage to the spine is the surface manifestation, while damage to the governor meridian is the essence. The Du meridian is the "sea of Yang meridians" in the human body, which governs the entire body's Yang energy and combines with the Ren and Dai meridians to form the "one source and three branches", jointly governing the female cells. In clinical practice, PD is often closely related to the Du, Ren, and Chong meridians. In the preface of "The Essential Principles of the Body", it is said: "The limbs are damaged externally... the internal organs are not harmonious." It clearly points out the close relationship between the external damage and changes of the spine and limbs and the internal organs. The main function of the meridians, which belong to the internal organs and the external collaterals to the limbs, is to promote the circulation of qi and blood in the body. The spine establishes

connections with the entire body's qi, blood, body fluids, organs, etc. through the use of the Du meridian, and its physiological and pathological processes also interact with each other in a loop by loop, resulting in subtle changes. Traditional Chinese medicine believes that the spine is the pathway of the Du meridian. The "Qi of the Du meridian" in the "Neijing" clearly indicates where the energy of the fifteen acupoints (the Back Shu point of the human body) opened next to the spine originates, and also indicates the connection between the Du meridian and the brain, facial features, and internal organs in the body cavity. Therefore, it can be recognized that the Du meridian plays an important role in regulating the function of the organs, and spinal lesions may be a potential factor in the occurrence of PD. IS belongs to the category of "bone obstruction" in traditional Chinese medicine. According to "Suwen · Gu Kong Lun", "When the Du meridian is sick, it is treated on the bone". "On the bone" is what modern medicine considers the spine. This is a brief explanation of spinal related diseases. There is a complex relationship between the spine and internal organs, and pathological changes in different segments of the spine will lead to corresponding pathological reactions in internal organs [26]. Professor Wei Guikang pointed out that Jiaji acupoint and Beishu acupoint are often reaction points of internal organ system lesions caused by spinal dislocation. The spine is composed of arranged and combined vertebrae from different segments, and the spinal nerve roots of each segment are also a crucial part of it. The spinal nerve roots of different segments innervate the corresponding muscle system and visceral tissues, which is consistent with the existence of the Back Shu point in the meridian system. This can also serve as a basis for acupuncture at the Back Shu point to treat corresponding visceral diseases. The human body is healthy with a balance of yin and yang. Tan Zhi et al. [27] believe that acupuncture at the Du meridian, Jiaji acupoint, and Beishu acupoint can regulate the imbalance of yin and yang in the human body, integrate spinal structure and function, and promote better growth and development of the spine.

3.2 Anatomical Perspective

The sacrum and bilateral hip bones form the pelvic structure, which, together with the inner wall ligaments, protects the pelvic organs such as the urinary and reproductive organs, uterus, ovaries, etc. Anatomically, the pelvis carries the human spine and is located at the bottom of the entire spine, supporting the upper spine and connecting the lower limbs. It is an important part of the human body's posture, balance, and stability. Physiologically, the pelvis should be in a neutral position, and the interaction between the pelvis and spine should achieve a good state of maintaining human balance and overall posture. HAN et al. [28] found that thoracic and lumbar scoliosis mainly affect pelvic rotation and tilt, and the pelvis is accompanied by varying degrees of rotation when tilted in the coronal and sagittal planes. With the emergence and aggravation of AIS, the position of the pelvis and lumbar vertebrae changes, and the tension of surrounding ligaments, tendons, muscles and other soft tissues increases [29]. The contraction of blood vessels around the uterus and the conduction of surrounding nerve fibers are blocked [30], leading to pain hypersensitivity and sensory abnormalities, which can cause or worsen menstrual disorders. Anatomical studies on the pelvis and spine have shown that normal

physiological curvature of the spine can protect pelvic organs and tissue structures from direct forces within the abdominal cavity. Based on these research results, some scholars have hypothesized that spinal pelvic abnormalities may affect the transmission of pelvic abdominal power, causing more force on the supporting structures within the pelvic cavity, thereby inducing or exacerbating menstrual discomfort. The occurrence of primary dysmenorrhea is highly correlated with the anatomical structure of the uterus and pelvis. The female pelvic floor support system is mainly composed of ligaments, fascia, and multiple layers of pelvic floor muscles, responsible for maintaining the normal physiological position of pelvic organs such as the bladder, urethra, uterus, vagina, rectum, anus, etc. [31]. Once the supporting function of the above structures is damaged or degraded, it will affect the position of reproductive organs such as the uterus and vagina. Based on this, physical therapy methods are used to treat primary dysmenorrhea, such as spinal massage therapy, muscle stretching therapy, exercise therapy (yoga, fitness qigong, etc.), etc. On the basis of restoring and integrating its physiological structure, it regulates the disordered state of peripheral nerve conduction and blood flow supply. Jiang Yonggui's research [32] found that the use of whole spine massage can correct spinal disorders, adjust pathological manifestations such as sacroiliac joint dislocation and pelvic tilt, make Qi and blood calm, tendons and bones soft and upright, and reduce the degree of dysmenorrhea. Xu Fei et al. [33] found that primary dysmenorrhea muscle stretching is superior to basic oral ibuprofen in improving clinical symptoms. There are studies [34-35] indicating that exercise therapy has better long-term efficacy. Huang Qige et al. [36] proposed based on research results that yoga has a psychological therapeutic effect, which can relax the body and mind, promote the relief of muscle fatigue, reduce the secretion of prostaglandins, and thus alleviate pain symptoms. Lan Cailian et al. [37] found that the Fitness Qigong Yijin Jing can strengthen the muscle strength of the lower back, coordinate and smooth the entire meridian system, and effectively reduce the degree of uterine congestion and contractions during menstruation, maintaining unobstructed Qi and blood in the body. In view of this, alleviate the series of effects caused by pathological structural changes in the spine pelvic cavity, promote local vascular blood circulation, and improve discomfort symptoms.

3.3 Neuromuscular Angle

The nerves that innervate the female reproductive organs are mainly the sympathetic and parasympathetic nerves, and may receive dual innervation if necessary [38]. The discomfort during menstruation is related to the high sensitivity of related nerve conduction in the pelvic cavity. The nerves that innervate the smooth muscle of the uterus are the pelvic nerve plexus. Disorders in the pelvic structure can stimulate peripheral nerves and cause lesions in the reproductive system. Under the secondary influence of AIS, patients may exhibit lumbar spine disorders, pelvic dislocation, and visceral nerve compression or stimulation leading to neuroendocrine reflexes, resulting in menstrual pain. According to the theory of spinal etiology, menstrual disease patients often experience tension in the lower back muscles and signs of pelvic joint dislocation during examination. In clinical practice, spinal treatment can be applied [39]. When treating menstrual

disorders, the spinal massage technique can actively regulate the skin temperature of the body, accelerate blood flow, promote local tissue metabolism, and thus stimulate the pelvic nerves in the lumbosacral region. The pelvis serves as the intersection area between the trunk and lower limb motor muscle groups, while the iliopsoas muscle shoulders the dual flexion task of the lumbar spine and hip joint. The bones and muscles in the lumbosacral region are the structures that support the entire body and enable it to move. Whether their structure and function are normal not only affects local activity, but also affects overall health. Zeng Rong et al. [40] confirmed that patients with primary dysmenorrhea often experience muscle tension in the lower back, and some may also have signs of dislocation of the thoracolumbar and pelvic joints. These pathological manifestations are based on abnormalities in the spinal and pelvic structures, which directly or indirectly stimulate or compress the spinal cord, nerves, etc., causing local microenvironment nerve hypersensitivity and causing pain or other discomfort symptoms in related tissues and organs.

4. Discussion

The growth and development of adolescence mainly rely on the innate essence hidden in the human kidneys, and the production of menstruation is also based on the premise of "kidney qi is abundant, and the day is coming". The primary cause of menstrual disorders in adolescence is kidney deficiency, and clinical menstrual disorders are often caused by kidney qi deficiency. The occurrence of AIS is mainly due to congenital liver and kidney deficiency, qi and blood deficiency in adolescents, combined with acquired spleen and stomach disorders, weak defense of qi, and damage to yang qi, resulting in muscle and bone dislocation and rotation displacement. Zhao Mingyu [41] believes that the balanced state of the interaction between muscles and bones is a reflection of the coordinated physiological structure and function of healthy individuals. The author believes that the liver governs the tendons, the kidneys govern the bones, and the muscles and bones work together to complete human movements. The occurrence of menstrual disorders and AIS is often related to the liver and kidneys, which to some extent also indicates a certain correlation between the two. Research has found that AIS patients are prone to progressive exacerbation of scoliosis as their bodies grow and develop, making it the third most common disease after myopia and obesity. AIS is a common musculoskeletal disease among adolescents, with a certain degree of progression. Generally, patients with greater bone growth potential are more prone to progression. At present, it is believed that the onset of AIS is related to multiple factors such as genetics, endocrine disorders, central nervous system abnormalities, and vestibular dysfunction [42]. Although the etiology is not yet clear, biomechanical factors play an important role in the progression of AIS. There is a certain pattern in the growth and development of adolescents. After entering puberty, secondary sexual characteristics appear, and the peak period of female growth and development arrives. During this period, factors such as decreased bone density, increased joint strength, and muscle imbalance are combined to accelerate the development of scoliosis. AIS can occur at any segment of the spine. Based on the structural integrity of the spine, changes in any segment can cause compensatory changes in the upper

and lower segments. Therefore, during treatment, the focus should be on adjusting the overall structural force line between the spine and pelvis to restore the balance of the physiological structure. The Pelvic incidence (PI), as a relatively stable anatomical parameter, represents the relative thickness of the pelvis. Before skeletal maturity, PI increases to a certain extent with pelvic growth during adolescence. Research has shown that the size of PI is related to the angle, curvature, and other factors of the sacrum and sacroiliac joint. Adolescent women have immature bone growth and development, and due to the overall nature of the spine and pelvis, scoliosis can cause displacement of the sacroiliac joint, causing changes in related muscles and nerves in the pelvis, leading to neuroendocrine disorders and potentially triggering primary dysmenorrhea. The female reproductive organs that produce menstruation are the most important organs in the female pelvis. Clinical trials have found that the occurrence of primary dysmenorrhea is related to abnormal anatomical changes in the sacroiliac joint and pelvis. In acupuncture and moxibustion Classics A and B, visceral diseases were specifically related to the spinal governor vessel and the foot Taiyang bladder meridian, which also showed the possibility of correlation between primary dysmenorrhea and AIS. Taking the spine as the core, understanding and explaining the possible changes in the entire human body's movement system driven by the spine from different dimensions can provide reverse guidance for the treatment of pathological changes in the body. A series of treatments guided by a holistic view of the spine have also validated the validity of the hypothesis [43]. At present, most scholars have not conducted in-depth exploration and research on the relationship between menstrual disorders and AIS. Based on reading a large amount of literature, it can be concluded that there are some direct or indirect connections between the two, and the specific mechanisms still need further systematic research.

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