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Scoliosis: A Silent Medical Condition

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TABLE OF CONTENTS

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Abstract

Scoliosis is an abnormal sideways curvature of the spine that affects a wide age range within the population. Scoliosis currently affects millions of people in the United States but many are unaware of this medical condition since it is not a disorder that would cause immediate death. The purpose of this research was to discuss and bring awareness to the topic of scoliosis as written by various published articles. Findings show that as scoliosis progresses, risk for a variety of health complications increase which may include but are not limited to: spinal injury, paralysis, back pain, decrease in cardiac and respiratory function, immobility, and more. It was established that scoliosis can be classified into different categories based on how it was developed, severity of the curvature's angle, and age of onset. Various treatment options have been developed and are being implemented but there is ongoing research to provide less invasive treatment for patients. Because research on scoliosis is not as widely known as other medical conditions, this paper was written with the purpose of educating the public about it.

Introduction

Definition

Scoliosis is an abnormal sideways curvature of the spine and has been clinically recognized for over a century. It was defined by the Scoliosis Research Society as a complex three-dimensional deformity with a lateral spine curvature greater than 10 degrees in the coronal plane (as written in Hamad, Ahmed, and Tsirikos, 2017). It is one of the common spinal abnormalities within the spinal deformity category along with kyphosis and lordosis. Humans have natural curvatures in the spine that act as shock absorbers and aid with balance. But in scoliosis, the vertebral rotation in various segments of the spine result in a rib hump, a loin hump, and waist asymmetry. It produces a cosmetic deformity that can be associated with the occasional back pain and imbalance. The cause of scoliosis is variable and multifactorial making it difficult to pinpoint an exact cause for the condition (Hamad et. al, 2017).

Scoliosis can be categorized based on patient age and on the severity of the curve as measured in degrees. Patients are assessed through clinical evaluation and radiography. Various treatment options have also been formulated to aid in preventing scoliosis from progressing, but a cure has not been found. Scoliosis is a lifetime condition that has to be monitored or corrected depending on severity (Hamad et. al, 2017).

Discussion

Diagnosis and Prevalence

Scoliosis is the most common three-dimensional structural abnormality of the spine. It affects 2-3 percent of the US population which is approximately six to nine million people. Each year, more than 600,000 visits to scoliosis orthopedic specialists are made, more than 30,000 patients are put in a body brace, and more than 38,000 patients receive spinal fusion surgery (*National Scoliosis Foundation*, 2018). Scoliosis can develop early in a child's life at any point where a growth-spurt is expected, but the primary onset of the condition is usually around puberty. Increased mortality rate was found to be associated with early and juvenile onset scoliosis. A greater risk for complications occur in patients whose scoliosis is apparent before 5 years old. At or before reaching the middle age range (around 40 years old), these patients can develop disabling or life threatening respiratory complications (Agabegi, Kazemi, Sturm, and Mehlman, 2015).

According to Negrini et. al, progression is more common in girls than in boys during their growth spurt of puberty (2018). The prevalence of curves with higher Cobb angles is also higher in adolescent girls than in adolescent boys. When the scoliosis angle at skeletal maturity exceeds 50°, these patients are at a higher risk of health problems in adult life. The patients can encounter a decreased quality of life, cosmetic deformity, visible disability, pain, and progressive functional limitations (Negrini et. al, 2018). Another study done by Szopa and Domagalska-Szopa suggests that overweight children also tend to have larger curves of scoliosis than their peers (2017). The role of gravitational pull and mass was seen as a factor that could increase progression.

Common available tests that can be ordered to check for scoliosis includes a physical exam, a spinal radiograph, a CT scan, an MRI, or an x-ray. The spinal curvature can then be examined by an orthopedic surgeon. By using the Cobb method on an x-ray plate, the orthopedic surgeon can measure the Cobb angle which determines the severity of the spinal deformity (Hamad et. al, 2017). The Cobb method is a standard assessment indicator for scoliosis.

A standard examination performed on the younger population can indicate if the child is at risk for developing scoliosis or if he or she is already in the early stages of scoliosis. The Adam's Forward Bend Test is a test that can easily be performed. The patient is instructed to bend forward and touch their toes. The observing clinician then scans the back for an unevenness between the two sides of the back. The presence of a rib hump or imbalance is a common indication that a child will need further examination by a scoliosis specialist (Hamad et. al, 2017).

Types and Causes

Scoliosis can be classified by etiology or cause of condition. The three categories of scoliosis are idiopathic, congenital, and neuromuscular. Idiopathic scoliosis is the most common of the three since 80% of scoliosis cases are of this category. In adolescent idiopathic scoliosis (AIS), scoliosis is classified based on the Cobb angle. The Cobb method of measuring the scoliosis curve angle on the standing frontal radiograph is one of the factors that doctors use in determining and managing idiopathic scoliosis. Treatment decisions are correlated to the use of Cobb angles. If the Cobb angle is less than 10°, a diagnosis is not made. AIS is graded as mild when the Cobb angle is between 10° and 29°, moderate when between 30° and 44°, and

severe when greater than 45° (Lee, Kang, and Kim, 2017). The AIS threshold of 50° indicates that if exceeded, it is almost certain that scoliosis is going to progress in adulthood and cause health problems. Patients with mild AIS typically possess a normal physical appearance and has no noticeable symptoms like pain or neurological complications. Mild AIS is difficult to diagnose if only physical appearance and function is examined. On the other hand, an abnormal appearance usually accompanies moderate and severe adolescent idiopathic scoliosis. Some cases of severe AIS can lead to reduced lung function, pressure on the heart, restriction to patients' physical activities, and poorer quality of life (Lee, Kang, and Kim, 2017).

Idiopathic scoliosis can be further classified according to anatomical site of the spinal deformity in the frontal plane (Agabegi et. al, 2015). Curves in the thoracic area of the spine is the most vulnerable to progression. According to Agabegi et. al, curves measured between 50° - 80º in 1968 increased approximately 30.3° in the 10 year observational period (2015). Spinal fusion is recommended to patients who reach a Cobb angle of 50° at skeletal maturity. Thoracolumbar curves are another class of idiopathic scoliosis. This class has a high inclination or tendency for developing translateral shifts or lateral listhesis, which is a displacement of one vertebra onto another causing rigidity in the area (Agabegi et. al, 2015). Back pain is more prominent in patients with this idiopathic class. As the condition progresses, the spinal curve becomes more rigid and makes it difficult to treat surgically. Spinal fusion is also recommended to these patients if the Cobb angle reaches 50º. Another vertebral area that idiopathic scoliosis affects is the lumbar segment. Lumbar curves do not progress as quickly as the other subtypes of idiopathic scoliosis. A mean

progression of 16° occurs over 29 years (Agabegi et. al, 2015). Lateral listhesis can also develop at the L3-L4 portion of the spine. Another class of idiopathic scoliosis is termed the double curve or the S-curve. Precise prediction is difficult because there is great variation between cases. This subtype has a slow progression of the spinal curvature. Some cases have a thoracic component, meaning the main curve is in the thoracic segment of the vertebrae. Other cases will have a lumbar component. This means that the main curve occurs in the lumbar area of the spine. As degeneration and osteoporosis develops, curve deterioration and worsening can occur, and this rapidly increases the rate of progression of the scoliosis curve (Agabegi et. al, 2015). Surgery is recommended to skeletally mature patients or to patients whose Cobb angle is greater than 55° because a high risk of quick progression in adulthood can occur.

Another major type of scoliosis is congenital scoliosis. Patients with congenital scoliosis have to be constantly monitored because they are at high risk to suffer from health abnormalities such as asymmetrical structure of the brain stem, sensory impairment, blood platelet disorders, collagen function disorders, and balance impairment. Congenital scoliosis is developed at birth and caused by a defect present at that time. It occurs in 1 out of 10,000 newborns. It is less common than idiopathic scoliosis. Children with this condition often have other health issues such as kidney or bladder problems (Agabegi et. al, 2015). Even though congenital scoliosis is developed at birth, spinal problems sometimes do not appear until adolescence.

Scoliosis is categorized as neuromuscular in cases where scoliosis developed as a side effect of neurological or muscular diseases. Scoliosis can be developed as a

side effect of cerebral palsy, spinal cord trauma, muscular dystrophy, spinal muscle atrophy, and spina bifida (Negrini et. al, 2018). Neuromuscular scoliosis progresses more rapidly than idiopathic scoliosis and most cases will require immediate surgery.

Genetic factors in scoliosis are currently being explored. Researchers have suggested that scoliosis is hereditary since it tends to run in families. According to Negrini et. al, the role of genetic factors in spinal disorders are also being researched closely (2018). Many researchers have also indicated that scoliosis is caused by systemic disorders of polysaccharide and lipoprotein synthesis. Other researchers have suggested that melatonin plays a secondary role in the onset of scoliosis as it interacts with calmodulin, a protein that is receptive to calcium ions. Other studies have also introduced the idea of gene variants playing a role in the genetic predisposition of scoliosis (as written in Negrini et. al, 2018). The previously mentioned studies are a few examples of the research being implemented on scoliosis etiology. Due to the wide variety of research on scoliosis development, scoliosis has no single explanation and is therefore suggested to be multifactorial hence the term "idiopathic" meaning a disease or condition that rises up spontaneously and the cause is unknown.

Risks

Cardiopulmonary Function and Mortality

It was assumed by clinicians and anatomical specialists that spinal deformities in its severe form leads to pulmonary complications. Complications that may arise secondary to scoliosis include pulmonary hypertension with subsequent right ventricular hypertrophy and cor pulmonale (Agabegi et. al, 2015). Pulmonary

hypertension (PHT) is defined as a type of high blood pressure associated with narrowing of arteries in the lungs. Right ventricular hypertrophy (RVH) occurs when blood does not flow well from the heart to the lungs and the extra stress is placed on the right ventricle. The abnormal enlargement and alteration in function of the right ventricle of the heart is termed cor pulmonale. It is also known as a right-sided heart failure. Reduced inspiratory muscle strength as a result of the abnormal shape and movement of the rib cage is proposed to be responsible for increased risk of developing pulmonary complications (Agabegi et. al, 2015). Since the spine is a main factor of body alignment, a deformity in the spine causes disarrangement of body organs and structures which consequently lead to affected normal body organ functions. Due to the misalignment of the spine, body cavities are forced to adjust in order to comply with the abnormal body trunk formation. This adjustment may cause a decrease in body cavity space needed for organs to function properly, as can be observed with the lungs' function to inspire. Severe scoliosis results in a limited range of movement and stiffness in the chest rib cage. Accelerated progression of scoliosis also increases the inflexibility of the rib cage with aging. The most common pulmonary function that is affected by severe scoliosis is the restrictive pattern of lung volume. Johari et. al researched the correlation between spirometric values, scoliosis curvature degree, and age (2016). Lung volume, forced respiratory volume, and chest wall compliance are inversely related to curvature degree severity. Impairment of pulmonary function is seen in more severe scoliosis cases, in patients with proximally located curvatures, and in older patients (Johari et. al, 2016).

Back Pain

Pain occurs or arises in patients with scoliosis as a result of asymmetrical disk degeneration or facet degeneration. Pain of this type is most common in the thoracolumbar or lumbar spine of scoliosis patients. Adults with scoliosis often present with back pain which can occur from spinal imbalance, facet arthropathy, muscle fatigue, or central or foraminal stenosis. Asymmetric disks and facet joints leads to a weaker performance of the spinal segment where it occurs and segmental instability either in the sagittal plane, in a 3-dimensional rotatory misalignment, or in a coronal plane such as what occurs in a lateral listhesis. An increase in curvature size has been associated with more severe pain; with the worst degenerative changes at the curve apex or where the curve angle is the greatest. Asymmetric disks and facet joints can cause osteophytes, or bony outgrowth associated with joint degeneration, to grow. Enlargement of ligaments in the spine and joints also leads to the narrowing of space between joints and can lead to painful experiences such as nerve pinching (Agabegi et. al, 2015).

Psychosocial Issues and Appearance

In early studies in the 1920s, it was reported that many patients received disability benefits and that a large number of women with scoliosis were unmarried (Agabegi et. al, 2015). As further research was conducted in the following decades, it was proposed that patients with scoliosis perceived themselves as less healthy than their peers in activities that require physical movement such as lifting, walking long distances, or standing and sitting for long periods. Although scoliosis may affect strength of back muscles, most studies in the present time note no significant difference between people with scoliosis and control subjects regarding quality of life

or ability to perform daily activities, which is why scoliosis is not as widely known as other medical conditions. The clinical deformity associated with scoliosis is variable. Some patients with milder curves may appear to have more prominent deformities than patients with severe curves. Body build, along with body fat distribution, may play a role in the appearance of curvatures. A common visible deformity resulting from scoliosis is the presence of a rib hump on one side of the body in comparison to the other side of the back. Psychological condition also influences the patient's dissatisfaction with their appearance. Some patients accept their deformity while others possess significant cosmetic concerns. Patients below the middle age range tend to have more cosmetic concerns compared to older patients. However, it was reported that adolescents and young adult patients are more self-conscious about their scoliosis deformity (Agabegi et. al, 2015)

Treatment

Non-surgical

As of yet, the goal of non-surgical treatment of scoliosis is to prevent the scoliosis curves from progressing more than they already have. Non-surgical treatment commonly includes body bracing for AIS patients with a Cobb angle of 25° to 40° and immature spines (Negrini et. al, 2018**)**. There are generally two main types of braces: thoracolumbosacral orthosis (TLSO) and the Milwaukee brace. The TLSO is made of modern plastic materials (fiberglass) and is contoured to conform to the patient's body. It is invisible under clothing since it is close-fitting under the arms and around the rib cage, lower back, and hips. TLSO are not made for curves in the cervical area or the neck. The Milwaukee brace, on the other hand, is a full-torso brace that

has a neck rest for the chin and back of the head. Usually, these braces are to be worn 24/7, only to be taken off during baths or similar circumstances. Patient compliance plays a very important role when it comes to bracing. The preventative effects of the braces are only effective if the patient complies with the 24/7 rule. The more modern close-fitting designs of braces increased patient compliance since braces can be hidden under clothing as opposed to the first brace designs that were bulky and large (Hamad et. al, 2017). With the rapid technological advancements within the last 50 years, bracing and compliance has been easier for both the patient and the doctor (Negrini et. al, 2018). Other non-surgical treatments include physical therapy, scoliosis-friendly exercise, and doctor approved activities such as yoga and swimming.

Surgical

Multi-segmental spinal fusion is recommended to children with scoliosis when the Cobb angle is greater than 40° along with signs of continuous progression (Hamad et. al, 2017). In spinal fusion, two or more vertebrae are connected. Allografts or crushed bone are placed between the vertebrae. Metal rods and screws are also placed to immobilize hold the spine straight while the vertebrae and allograft fuse together over time.

Patients who received treatment as children may need surgery revision **(**Hamad et. al, 2017**)**. Surgery for adults is recommended when spinal curve is greater than 50° with nerve damage to lower extremities and the patient is experiencing unusual bowel or bladder symptoms. Decompression surgery may also

be needed for adults with degenerative scoliosis and spinal stenosis. Surgery and recovery time will take longer for older adults with scoliosis.

With the rapid advancement in technology, minimally-invasive surgery became possible. Instead of making a large incision on the patient's back, smaller incision sites can be made. Spinal fusion can be performed through the use of fluoroscopy and endoscopy (Hamad et. al, 2017). Creation of better surgical instruments allow surgeons to make more accurate incisions and hardware placement. Overall, tissue trauma is minimized.

Summary

Scoliosis is a disorder in which the exact cause is unknown since it is multifactorial and variable. It requires multidisciplinary research and treatment. Non-profit organizations like the National Scoliosis Foundation and the Scoliosis Research Society uses its resources to educate the public about scoliosis, fund research for scoliosis, act as a mediator between patient and physician, and implement free screenings for scoliosis at schools throughout the nation to help with early detection of scoliosis. Through early detection and advances in research, the severe effects of scoliosis may be prevented. Since certain types of scoliosis are difficult to determine, many people are unaware that they have a spinal abnormality. If left untreated, scoliosis can increase an individual's risk of developing other health complications such as decreased cardiopulmonary function and nerve pinching. By increasing awareness towards scoliosis, funds may be used in research and furthering the technological advancements of scoliosis treatment and prevention.

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