IJRAR.ORG E-ISSN: 2348-1269, P-ISSN: 2349-5138

INTERNATIONAL JOURNAL OF RESEARCH AND ANALYTICAL REVIEWS (IJRAR) | IJRAR.ORG

An International Open Access, Peer-reviewed, Refereed Journal

An overview of Scoliosis and its causes, as well as current treatment options

YASH SRIVASTAV, AKHANDNATH PRAJAPATI, MADHAW KUMAR, ALKA VERMA, RANJANA CHAUHAN

Goel Institute of Pharmacy & Sciences (GIPS), Lucknow, Uttar Pradesh, India.

ABSTRACT

Scoliosis is defined as a deviation from the spine's normal vertical line, characterized by a lateral curvature with vertebral rotation inside the curve. The posterior-anterior radiograph should demonstrate at least 10° of spinal angulation with vertebral rotation to be considered for scoliosis. Scoliosis is the most common spinal condition in children and adolescents. Scoliosis is described as a side-to-side curvature of the spine greater than 10°, frequently in conjunction with vertebral rotation and, in most cases, a reduced kyphosis in thoracic curves. Scoliosis is a spine malformation that often appears in the first two decades of life. Scoliosis is most commonly seen as a back deformity, although it can also be discovered by chance on a radiograph or be associated with a complaint of discomfort or an unrelated condition. To varied degrees, the curve is accompanied with trunk imbalance and an unequal rib prominence or "rib hump." It is a growing child phenomena that appears during growth, deteriorates with growth rate, and stabilizes near the end of growth. In a scoliosis therapy regimen, patients receive individually tailored exercises. Patients are taught an exercise routine that is customized to their medical and physiotherapeutic requirements. In contrast, typical generalist physiotherapy is more generic, consisting of low-impact stretching and strengthening activities such as yoga, but can span a wide range of exercise routines.

Keyword: Scoliosis, Classifications, Pathophysiology, Treatments, Psychosocial, Quality of Life (QoL)

INTRODUCTION

Scoliosis is derived from the ancient Greek word skolios, which means "curve." It is defined as a lateral spine curvature larger than 10, as measured by the Cobb angle on posteroanterior (PA) radiographs (1). Scoliosis was initially mentioned by Hippocrates, who remarked, "There are numerous forms of curvature of the spine even in those who are in excellent condition, for it takes place from natural conformation and from habit, and the spine is liable to be bent from old age and from aches" (2). Scoliosis is described as a deviation from the normal vertical line of the spine, characterized by a lateral curvature with vertebral rotation inside the curve. To be considered for scoliosis, the posterior-anterior radiograph should show at least 10° of spinal angulation accompanied with vertebral rotation (3). Scoliosis is the most prevalent spinal disease in children and teenagers. Scoliosis is defined by a side-to-side curvature of the spine>10°, which is usually combined with vertebral rotation and, in most cases, a reduced kyphosis in thoracic curves (4). Scoliosis is a spine deformity that usually shows itself during the first two decades of life (5). Scoliosis causes vary and are broadly classed as congenital, neuromuscular, syndrome-related, idiopathic, and spinal curvature due to secondary causes. Congenital scoliosis is caused by a vertebral defect, which causes a mechanical deviation from normal spinal alignment. Scoliosis can be caused by neurological disorders (for example, cerebral palsy or paralysis), muscular abnormalities (for example, Duchenne muscular dystrophy), or other syndromes (for example, Marfan syndrome and neurofibromatosis). Significant lateral deviation of the spine can occur with little or no rotation of the spine and without bone deformities on rare occasions (6). Scoliosis usually manifests as a back deformity, although it can also appear as a random discovery on a radiograph or be connected with a complaint of discomfort or an unrelated ailment. The curve is accompanied, to varying degrees, by trunk imbalance and an uneven rib prominence or"rib hump." It is a phenomenon of growing children that appears during growth, deteriorates with growth rate, and stabilizes towards the conclusion of growth (7). Scoliosis is a three-dimensional abnormality of the spine. Congenital abnormalities and neuromuscular illness are two of the most often recognized reasons. However, idiopathic scoliosis is diagnosed in children who have no obvious physical indications of concomitant disease and who do not have a detectable anatomical precipitant on plain radiographs of the spine (8). Scoliosis patients are divided into distinct categories based on their age of onset, aetiology, severity, and curve shape. Each variety has distinct characteristics such as curve advancement rate, degree, and pattern of three-dimensional deformity. Scoliosis is characterized according to its aetiology: idiopathic, congenital, or neuromuscular. Idiopathic scoliosis is the diagnosis when all other reasons are ruled out, and it accounts for roughly 80% of all instances. The most prevalent kind of scoliosis is adolescent idiopathic scoliosis, which is usually diagnosed during puberty. A high rate of curve advancement and an early beginning of scoliosis are risk factors for a bad result in idiopathic scoliosis, such as thoracic insufficiency syndrome (9). Until date, the prevalence in India has been reported only from two limited geographical regions: Patiala, Punjab, and Assam. The current study is the first to look at scoliosis screening and prevalence in the people of J&K, India. Surprisingly, we found a high frequency of scoliosis in our target location, compared to 0.13% in the population of Patiala, Punjab, and 0.2% in Assam. Similarly, studies have found lower rates of scoliosis in nations such as Japan (0.87%), Saudi Arabia (0.78%), and Singapore (0.27-2.49% among 9-13 year old females) (10).

CLASSIFICATIONS OF SCOLIOSIS

Scoliosis is classified into three types: idiopathic, congenital, and neuromuscular (11,12).

In 1954, James in England categorized IS based on the age of onset. Infantile (birth to 3 years), Juvenile (4-9 years), and Adolescent Idiopathic Scoliosis (AIS) (410 years old) are the three types. IS is the most frequent type of scoliosis, accounting for about 80% of all cases (13–15). Congenital scoliosis develops as a result of aberrant spinal column growth and development, most likely as a result of intrauterine events during the sixth week of pregnancy. Neuromuscular scoliosis is frequently found in paediatric patients suffering from neurologic and myopathic illnesses such as cerebral palsy. It has an early onset and rapid progression even beyond skeletal maturity. The curves are frequently lengthy, extend into the sacrum, and are related with pelvic obliquity (16–19). IS classification has shifted slightly in recent years. More attention has been placed on pulmonary development in relation to the onset of scoliosis, with a 5-year age threshold being crucial for lung development. Congenital scoliosis is caused by spinal deformities of the spine that are present at birth. These irregularities, which can occur at numerous levels, are caused by a failure of development or a failure of segmentation (or both) during vertebral formation. Because these spinal abnormalities occur in pregnancy, they are frequently detected on embryonic ultrasonography (20). In up to 60% of cases, organ systems that develop at the same gestational time (fifth to sixth week) may also show abnormalities (21,22). As a result, it is critical to discover related anomalies through a complete evaluation of the neurological, cardiovascular, and genitourinary systems, which includes a thorough neurological and cardiac physical examination, an abdomen ultrasound, and echocardiography. Treatment is determined by the patient's age, the progression of the curve, and the location and type of anomaly. Surgical treatment options include in situ fusion and excision with deformity correction. Scoliosis can be linked to neurological disorders, muscle anomalies, and worldwide diseases. In addition to scoliosis, this broad list of diagnoses would often include other signs, symptoms, and physical manifestations. These various diagnoses are usually treated at tertiary care facilities that have unique competence in managing patients with severe multisystem diseases. The carer who treats these individuals should be conversant with the illnesses' non-spinal symptoms. As previously stated, a curvature in the coronal plane can be seen on radiographs with limited or no rotation of the vertebral bodies. Pain is frequently related with deformity. This isn't real scoliosis, and other causes of the deformity should be looked at. In some aspects, idiopathic scoliosis is an exclusion diagnosis. Idiopathic scoliosis, on the other hand, is by far the most prevalent type of spinal deformity, with a prevalence of one to three per 100 (curves higher than 10°) in a balanced number of boys and girls (23–26).

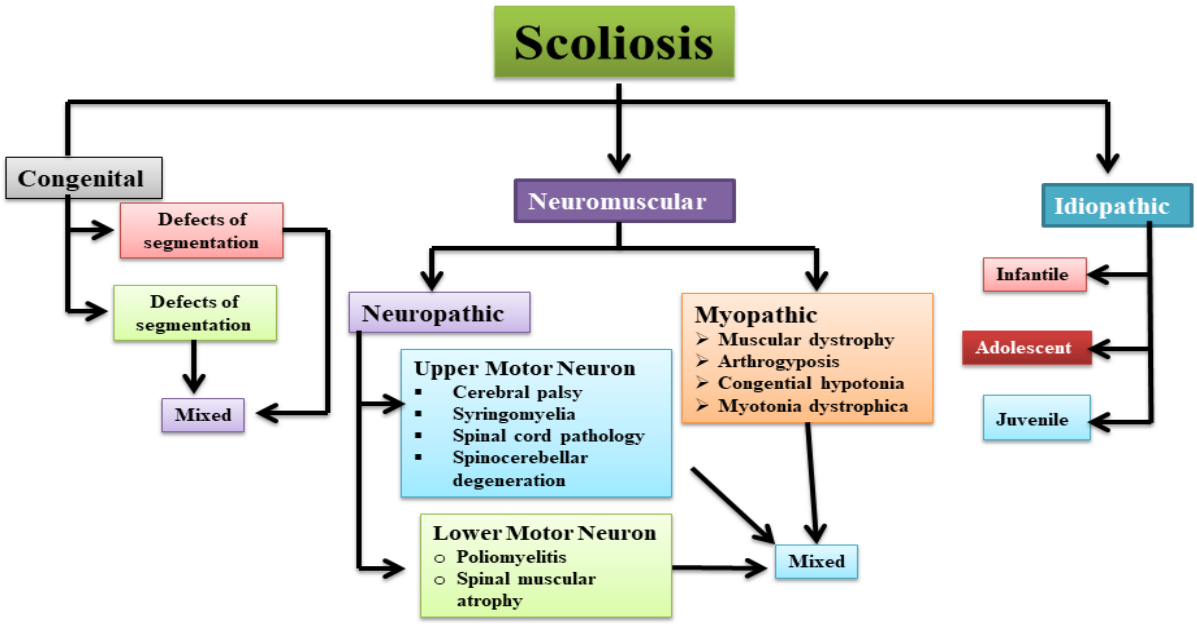

Fig.1: Classifications of Scoliosis (27).

CAUSES OF SCOLIOSIS

There is debate about whether scoliosis is simply inherited or has certain contributing elements, such as exercise and environment. According to Zhuang et al., individuals with adolescent idiopathic scoliosis (AIS) displayed an alteration in five bone growth-related proteins, notably pyruvate kinase M2, annexin A2, heat shock 27 k protein, β-actin, and γ-actin (28). Furthermore, linkage analysis revealed that mutations in the MAPK7 gene locus and allele marker DS 1034 on chromosome 19p13.3 lead to AIS (29). A genome-wide association study (GWAS) specifically looked into AIS by analysing single nucleotide polymorphisms (SNPs) and symptoms, as well as copy number variants (CNV). Ogura et al. discovered that ladybird homeobox 1 (LBX1) and CNV of chromosomes 1q21.1, 2q13, 15q11.2, and 16p11.2 harbour AIS (30). Furthermore, Mao et al. investigated DNA methylation levels and discovered an inverse link between cartilage oligomeric matrix protein (COMP) promotor and COMP gene expression. Over-methylation reduced the expression of this gene, which is involved in bone formation. Positive methylation of the pituitary homeobox 1 gene in its promotor region resulted in greater spine curve angles (31). Similarly, Chan discovered that chromosome p13.3 is a critical determinant in the development of AIS in Asian children (32). Gender is closely associated with scoliosis prevalence, with females experiencing significantly greater rates. Surprisingly, the female-to-male ratio of spinal curvature of 30 degrees or more is 10:1. Scoliosis is caused by a region on the X-chromosome that has just been found. In 2003, Justice et al. examined 15 X chromosomal markers in 202 families. It was determined that regions Xq23 and Xq26.1 play a significant role in the increased occurrence of AIS in females (33–35). Although the precise causal association between exercise and scoliosis is unknown, specialized study has been undertaken to investigate this. Athletes between the ages of 12 and 15 were evaluated, both male and female. As a result, the prevalence of AIS was 2-3 times greater in athletic adolescents compared to non-athletic adolescents. Swimming was found to have the strongest link

with developing AIS among other exercises, while dancing, skating, horseback riding, gymnastics, and karate were less so. The study concluded that there were no additional statistically significant data impacting the occurrence of AIS among adolescent athletes based on age, height, weight, or BMI (36). There has also been some evidence of a relationship between vertebral deformities and maternal insulin-dependent diabetic mellitus, as well as anticonvulsant drugs like valproic acid and dilantin during pregnancy. Although no direct investigations have been conducted to determine the causal association between environmental teratogens and vertebral deformities, animal research shows that there may be some influence (37).

PATHOPHYSIOLOGY OF SCOLIOSIS

Scoliosis pathophysiology is poorly known. It is not implausible to suppose that an existing abnormality could create uneven loading of the growing spine, resulting in asymmetrical vertebral growth.

Several explanations based on these facts have been proposed, some of which are included below.

Thillard discovered that pinealectomized chickens developed scoliosis in 1959 (38). This was duplicated with bipedal rats, and melatonin insufficiency was proposed as a cause of Idiopathic scoliosis IS (39,40). However, additional studies indicated that melatonin levels in teenage IS patients were normal, and pinealectomized monkeys did not develop scoliosis (41,42). A melatonin-signaling pathway failure affecting only specific cell types, specifically osteoblasts, was postulated instead (43,44). Calmodulin is a calcium-binding receptor protein that affects platelet and muscle contractility as well as melatonin. When compared to healthy controls, IS patients had greater levels of calmodulin in platelets and an unequal distribution of calmodulin in paraspinal muscles (45,46). Dickson et al. discovered that in IS patients, vertebral bodies were jammed in the sagittal plane, generating an apical lordosis in thoracic curvatures. They hypothesized that this lordosis in a usually kyphotic region caused a rotation of the spine and, secondarily, a lateral spinal curvature. When MRI scans of IS patients were compared to controls, it was discovered that the spinal cord is shorter in relation to the vertebral column, that there is an increased prevalence of cerebellar tonsillar ectopia, and that the vertebral bodies grow uncoordinatedly in relation to the dorsal elements. As a result, theories positing a relative anterior spinal overgrowth (RASO) or uncoupled neuroosseus growth as the origin of IS have emerged (13,47–50). As previously stated, the likelihood of curve progression in IS is associated to skeletal immaturity; also, girls with adolescent IS are taller and have a faster growth velocity during puberty when compared to healthy controls (51–56). Gerdhem et al. reported a reduced level of COMP, cartilage oligomeric matrix protein, in the serum of IS patients compared to controls. COMP has previously been associated to growth velocity in juvenile rheumatoid arthritis (57,58). Furthermore, greater levels of growth hormone (GH) and insulin-like growth factor 1 (IGF-1) have been related to IS, as have lower levels of leptin, the "satiety" hormone (59–61). Oestrogen levels have also been investigated, however the outcomes have been unclear (62).

THE BIOMECHANICS OF SCOLIOSIS

Scoliosis is a biomechanically significant deviation in the typical vertical spine. An excessive curvature in the frontal plane is caused by an aberrant distortion between or inside the vertebrae. The sagittal plane curves are normal. Secondary compensating balancing curves typically form above and below the first curve. The most dramatic vertebral change occurs at the curve's apex, where pedicles and laminae shorten and thicken on the concave side while the vertebral canal becomes asymmetrical and narrower on the convex side (63,64). When the thoracic vertebrae twist, the ribs become angulated, generating a vertical ridge known as "Razor back" that is best seen when the patient bends forward. This is the amount of spinal rotation. The observation of left convex curvature in left handed people adds weight to the theory that hand dominance causes scoliosis (65–67).

SIGNIFICANT SCOLIOSIS TREATMENT OPTIONS

- **Conservative treatment (non-surgical)**

Individually tailored exercises are provided to patients in a scoliosis treatment programme. Patients are taught an exercise routine that is tailored to their specific medical and physiotherapeutic needs. Typical generalist physiotherapy, on the other hand, is more generic, consisting of low-impact stretching and strengthening activities such as yoga, but can encompass a wide range of exercise regimes (68). The central nervous system (CNS) automatically corrects irregularities during the early stages of scoliosis, but as time passes, habituation increases and the CNS perceives it as something normal. When there is a sustained departure in alignment, compensatory mechanisms kick in to restore balance. However, these compensations do not restore appropriate body alignment, but rather distort it further. It is critical to halt the curve's advancement and avoid the formation of aberrant postural patterns. This can be accomplished by early intervention, which includes exercises and postural retraining (69). Several recent studies from around the world have found that conservative treatment of scoliosis (including outpatient physiotherapy including electrical stimulation, traction, and postural training; intensive patient rehabilitation; and bracing) is effective in preventing its progression and is recommended as the first line of scoliosis treatment to avoid and prevent surgery (70–74). Exercises have been proven to slow the course of scoliosis, particularly in early adolescence, by increasing Cobb angles and reducing brace prescription in patients through improving strength, mobility, respiratory function, and balance. An orthopaedic surgeon, an orthotist, a nurse, and a physiotherapist work together to successfully manage such patients (74–76). Brace treatment dates back to the 16th century, when Paré pushed for metal braces fashioned by an armourer to treat scoliosis; nevertheless, these braces were not widely employed. Traction had been a popular method for repairing spinal abnormalities since Hippocrates' time. Blount and Schmidt theoretically designed the Milwaukee brace (CTLSO: cervico-thoraco-lumbo-sacro orthosis) for postoperative poliomyelitis in 1946, and it was later adopted for AIS treatment. Following that, brace treatment became popular, and other thoraco-lumbo-sacro orthoses (TLSOs) were devised and used in place of CTLSO, which has some drawbacks such as visible design, difficulty in wearing, compression of the mandible, and so on (77,78). The purpose of brace treatment for AIS is to slow the evolution of a curve and enhance cosmetic appearance while

maintaining whole-body alignment and balance throughout a growing period. The efficacy of brace treatment in AIS has remained disputed, with some writers reporting that bracing controls curve advancement and others stating that bracing does not change the natural history (79). When it comes to neuromuscular and congenital scoliosis, conservative (non-surgical) treatment and its limitations are well documented. For the former, the treatment has little influence on the advancement of the scoliosis but is frequently required to help the patient maintain a suitable seated position in cases of substantial hypotonia and maintain effective chest expansion. Starting at a very young age, the Garches brace remains the favoured treatment (80). Although these braces may not prevent the progression of the spinal congenital deformity, they can help manage the counter curves that may develop on their own. Conservative treatment is still appropriate for syndrome-associated and idiopathic scoliosis. The amount of time dedicated to it should be proportional to the prognosis of EOS, especially for infantile scoliosis. The Milwaukee brace has long been thought to be the gold standard treatment for young kids, yet it does not adequately stabilize many scoliosis problems and is poorly tolerated by patients, in our opinion. It is now possible to deploy more effective braces right away, namely an adjustable multi-shell brace with enough modularity to adapt to growth while not obstructing rib cage development. Plaster casts are still the most effective approach to gently cure developing infantile scoliosis. This treatment breaks the vicious spiral of self-aggravating scoliosis (HueterVolkmann law) and places the spinal column in a mechanical environment conducive to spontaneous resolution (Frost law). To avoid neurological issues, casts can be created under general anaesthesia while the youngster is completely relaxed. Premedication can be utilized to reduce anesthesia-related problems, although good distraction is required. techniques to decrease the stress that such a process can cause to a youngster. An MRI is required prior to these treatments to rule out any anomalies in the central nervous system.The casts are normally equipped with windows and are updated every two months until the best possible correction is accomplished. To avoid advancement that would necessitate surgery in the medium term, this intense treatment requires buy-in from a committed team, the child, and the child's family (81,82).

- **Kinesitherapy**

Hippocrates reported longitudinal traction as the first treatment for scoliosis in the fifth century BC. This was a cruel and barbaric treatment that lasted until the 2nd century AD and used a scamnum (akin to a torture rack). Ambrose Pare, a French army surgeon, invented the first torso brace in the 16th century. He hypothesised that spinal deformity was caused by spine dislocation. Pare created a padded iron corset for patients to wear in order to slow the advancement of the curve. Following that, other treatment procedures were developed, and the Milwaukee brace was released in 1946, becoming a dominant alternative for treating scoliosis (78,83). There are currently several braces available, as well as alternative therapy methods such as acupuncture. Aside from bracing and surgery, which will be addressed further below, alternative methods, such as acupuncture, have been investigated. A 10 degree correction in curvature was described in a case report when acupuncture was performed three times a week for six weeks. In another study, 24 AIS patients between the ages of 14 and 16 underwent a 25-minute acupuncture session. It was determined that AIS patients with curvature less than 35 degrees benefited. More research and follow-up examination, however, are required to support this therapeutic choice (84–86). G. Dean MacEwen invented the low-profile thoracic lumbar spinal orthosis (TLSO) brace in 1969, making it lighter,

more comfortable, and less noticeable for patients. The Wilmington brace was the first TLSO brace. It was made of moldable plastic and was semi-rigid. Because of the difficulties in custom-molding these braces, John Hall and William Miller developed another TLSO known as the Boston brace in 1972. Prefabricated braces were custom-modified rather than custom-fitting each patient. Boston braces, like the Milwaukee brace, used both passive and active correction forces (83).

- **Surgical methods**

Growing rods, which apply a distraction force to the spine and/or ribs, guided growth systems, which keep the spine in its reduced position without restricting its growth, and compression-based systems, which apply a compressive force to the convexity of the curve to inhibit its growth, are the three broad categories of surgical methods (87).

- **Growth guidance systems**

These are surgical instruments used to guide the straightening of the vertebral column. They enable passive distraction during development and stretching motions without the necessity for surgery. McCarthy et al. described the Shilla approach for growth guiding (88). Both the modified Luque Trolley technique and spinal fixation implants slide freely along the rod to allow for progressive migration. These implants necessitate a significant number of anchoring sites on the spine and can be placed at the site of fusion, which can be voluntary at the scoliosis's tip in the Shilla operation or involuntary despite an extraperiosteal approach in the Luque Trolley technique. The creators of these procedures have only reported medium-term results on a small number of patients, but in both cases, far fewer surgeries were required than with developing rods (89,90). These devices appear to be especially significant for cases of scoliosis because they have enough flexibility to allow for adequate reduction during instrumentation. Before these technologies can be deployed on a larger scale, they must undergo independent review with longer follow-up. Because metallosis has been reported with these devices, this potential consequence must be investigated and addressed (91).

- **Growing rods**

Moe and colleagues first described a procedure that involved inserting rods into the concavity of the curve, exposing the spine only at the extremities of the construct, and then making a first correction by distraction during implantation. This necessitates regular additional surgical procedures to lengthen the rod in order to maintain the outcome attained during the index surgery and to monitor spine growth, which is measured and compared to the Dimeglio growth curves (92). Because of the work of Akbarnia and others, growing rods are now regarded the gold standard (87,93). The rods can now be extended non-invasively using a magnetic process. This increases the frequency and progressiveness of lengthening, lowering the risk of the surgery while boosting tolerance and effectiveness. The recently developed Magec® system is currently being assessed; preliminary results are more promising than those of the Phenix® system, which suffered from internal mechanism lock-up. However, the follow-up is still very short, and the device's technology

does not protect against the risk of gradual stiffening of the spine between lengthening sessions, as well as the possibility that the magnetic distraction force will be ineffective after one or two years of use (94–98). Growing rods achieve their purpose of curve stabilisation and T1-S1 segment growth, although they are plagued with problems. The frequency of these problems varies between studies but rises linearly with the number of procedures performed. The proportion of unscheduled surgical procedures required to manage these problems provides an indicator of their frequency and severity (93,99–102).

Complications

Mechanical complications:

Breakage of the rod occurs in at least 15% of cases; it primarily occurs near the connection points or in an area where the rod is significantly bent, particularly in cases of hyperkyphosis; the rod is more likely to break if its diameter is too small and only one rod is used (99). In 95% of cases, implant dislodging happens at the upper end of the construction. It is more common in hyperkyphosis and can be avoided by applying strong fixation over two or three vertebrae, which is supplemented with local bone graft application. Screw application appears to produce the most solid proxim However, if the screw fixation fails, the neurological implications can be disastrous. This issue has only been noticed in structures held together by a single screw. There is currently no agreement on the best superior anchoring strategy. Most surgical teams secure the rod's inferior end by screwing it into two adjacent vertebrae. The anchoring points must be placed so that the rod is as parallel to the support vertebrae at that level as feasible to reduce strains and prevent induction of a fixed angle, which will hinder gradual correction with each distraction (103,104).

Infection

Mackenzie et al. observed a 6.7% infection rate in their patients, with surgical revision required in 69% of cases. Infections become increasingly common as more surgical operations are performed. To avoid subcutaneous impingement, the rods must be inserted beneath the muscle layers. This is especially typical in young, hypotrophic patients. We believe that making one lengthy incision to attain the ideal rod location is preferable to making many minor incisions at the anchoring sites and inserting the rod blindly. One patient died as a result of an intra-thoracic erroneous trajectory (105,106).

Neurological complications

There have been no reports of neurological problems during rod lengthening. Intra-operative monitoring has primarily been indicated during rod or equipment implantation or replacement. Although no recommendations exist for systematic monitoring during lengthening procedures, there is agreement on the need to be alert and assess at-risk individuals by completing a spinal cord MRI at the commencement of treatment (107).

Psychological and social complications

According to Acaroglu et al., the overall period of hospitalisation was 101 days between the initial surgical treatment and the final fusion, with an average of 4.6 lengthening sessions conducted by the patient.These findings demonstrate the financial burden of scoliosis care as well as the potential psychological and social effects for patients and their families (108,109).

Final fusion after growing rods

This treatment has not yet been standardized, although it is used when there has been sufficient development or when difficulties are too frequent or severe to continue utilizing the growing rods. Because of the stiffness of the vertebral column and the presence of auto-fusion sites in the spine away from the anchoring points, this technique is difficult (110). This necessitates posterior osteotomy treatments. Some authors have reported stiffness in the area bridged by the equipment after removing the developing rods without performing a fusion (111).

Convexity compression devices

These approaches involve limiting the progression of the curvature convexity in the same way that epiphysiodesis does, but using implants that, in theory, eliminate the necessity for definitive asymmetric spinal fusion. Shape memory staples, which are inserted through a small incision to compress and bridge the growth plates, have only been shown to be effective for curvatures less than 35; their rigidity raises concerns about stiffening of the instrumented area, which must be long enough to be effective (112,113). Stretching a tether over the convexity is anticipated to increase mobility and, as a result, reduce the chance of spontaneous fusion. The only published case report was in a patient with a 40 Cobb angle who was operated on at 8.5 years of age; the Cobb angle was 25 immediately after the tethering surgery and was 6 after 4 years of follow-up with partially sustained mobility. The tether stopped the convexity from growing in this patient. Its usage before the age of eight years is not advised because there is no proof in a wider group of individuals that spinal growth returns to normal when the tether is severed. There have been no reports of this procedure being employed in more severe cases of scoliosis (114,115).

PSYCHOSOCIAL PROBLEMS IN SCOLIOSIS PATIENTS

According to Payne et al, scoliosis, independent of treatment status, is a risk factor for psychiatric disturbance during adolescence, as seen by greater rates of suicidal ideation and alcohol usage among patients compared to healthy controls. Orthopedists are concerned about patient psychological discomfort because it might negatively effect the patient's adjustment to treatment through noncompliance with bracing programmes or psychosocial difficulties following surgery (116–120). Prior study looked at the impact of diagnosis and treatment variables on adolescent patients, adult scoliosis limits, and psychosocial risk and protective factors linked with scoliosis. Regardless of therapy approach, adolescents treated after the age of 16 appear to have poorer psychosocial results than individuals treated in early adolescence (121–124). The first diagnosis and treatment period are stressful experiences for adolescents and their families, with feelings of isolation, denial, and distress expressed by at least 40% of patients and their guardians during the

early phases of treatment (125–127). During adolescence, either surgery or bracing is a burden, and each option appears to present unique obstacles. A treatment-specific survey conducted by Danielsson et al (123) found that feelings of loneliness or depression, as well as limited participation in leisure activities or dating, were reported by 25% to 43% of patients, regardless of treatment type. However, up to 40% of those polled said their treatment "didn't bother them much," while 48% of bracing patients and 50% of surgical patients said it helped them gain independence and maturity. Although the impact of surgery on adolescence has received less attention in the literature than the impact of bracing, surgical treatment is also difficult for adolescents due to the potentially stressful hospital environment, the possibility of complications or disability following surgery, and absence from school and subsequent loss of social interaction due to recovery (128–131). However, self-consciousness, together with fear of harm and physical difficulty, is still a factor in limiting social activities in 50% of surgically treated patients and 35% of brace-treated patients (132,133). For similar reasons, women with scoliosis have fewer and less pleasant sexual relationships than those without scoliosis. Although scoliosis does not appear to hinder career chances, patients in Danielsson and Nachemson's follow-up investigations were more likely to have taken sick leave owing to back difficulties than people without scoliosis. Although psychological interventions on adults with scoliosis have not been studied, involvement in a support group has been demonstrated to promote psychosocial health in adults with scoliosis (132–136).

QUALITY OF LIFE (QOL) WITH SCOLIOSIS

The Scoliosis Research Society (SRS) patient questionnaire, an adolescent idiopathic scoliosis (AIS) specific health related quality of life HRQL tool, has allowed orthopedists to quantify HRQL before and after scoliosis correction surgery. The SRS is made up of 24 components separated into two portions (SRS-24). The first component is for everyone and includes the domains Pain, General Self Image, General Function, and General Level of Activity. The second half is only pertinent to postsurgical patients, with Postoperative Self Image and Function assessments comparable to general measures, as well as Satisfaction, a measure of satisfaction with surgery outcome (137–139). The most recent SRS format has 22 items (SRS-22) and includes domains for Function, Pain, Self Image, and Mental Health, as well as a Subtotal score. Because nonoperative and surgical scoliosis patients, as well as healthy control groups, can complete all portions of the SRS-22, it is more versatile than the SRS-24. Despite the fact that the SRS scales were created in English, recent transcultural studies have resulted in Spanish, Japanese, and Turkish14 versions of the questionnaire. In studies comparing adolescents with AIS to healthy controls, the SRS Patient Questionnaires were found to be capable of discriminating between patients and healthy controls, as well as variable curvature severity and satisfaction levels among surgically treated patients (140–143). While the SRS Patient Questionnaires have been used to measure surgical outcomes in adolescent patients, with the exception of transcultural studies that include adolescent patients, there has been minimal use of the SRS Patient Questionnaire among nonsurgically treated patients. The Scoliosis Quality of Life Index (SQLI), a simplified version of the SRS-22, the Quality of Life Profile for Spinal Deformities (QLPSD), the Paediatric Outcomes Data Collection Instrument (PODCI), the Child Health Questionnaire (CHQ), or the Berner Questionnaire for Well Being2 (BQWB) have instead been used in studies. Studies that elicit responses from patients rather than

their parents show that some aspects of HRQL are disrupted, which appears to be aggravated by treatment considerations such as pending surgery or wearing a Milwaukee brace (122,130,144,145).

ACKNOWLEDGEMENT

Authors would like to thank, Goel Institute of Pharmacy & Sciences (GIPS), Lucknow, Uttar Pradesh, India for extending their facilities.

CONCLUSION AND FUTURE DIRECTION

Our review articles begin with an introduction of Scoliosis Classifications, Scoliosis Causes, and Scoliosis Treatments. The scoliosis biomechanics, Treatment options for severe scoliosis, Scoliosis Patients' Psychosocial Issues, Quality of Life (QoL) With Scoliosis, our review concluded that medicine does not cure entirely and has harmful side effects on the body, whereas non-pharmacological (Excercies and Yoga) treatment provides a decent result but takes time and has no harmful consequences on the human body. More randomized controlled trials on the treatment of scoliosis are required. We intend to do a preliminary investigation into Scoliosis sickness in the future. In our location, we are doing a counselling-based research project to analyze patient mental and physical health and provide improved statistics on Scoliosis disease and therapy.

Table.1: Summary of patents on Scoliosis

Patent Number	**Year**	**Disease**	**Inventor/Applicant/Country**	**Title of Invention**	**Ref.**
WO2011/012055A1	**2011**	Scoliosis	Zheng/The Hong Kong Polytechnic University/Australian	Three-dimensional (3D) ultrasound imaging system for assessing scoliosis	(146)
WO2012/045176	2012	Scoliosis	Moreau/Wong/Canada	Biomechanical-based methods of diagnosing scoliosis	(147)
WO 2014/201557	2014	Scoliosis	MOREAU, Alain	GI PROTEIN PHOSPHORYLATION AS MARKER FOR SCOLIOSIS AND SCOLIOSIS PROGRESSION, METHODS OF INCREASING GIPCR SIGNALING IN SCOLIOTIC SUBJECTS	(148)
US8,066,653B2	2011	Scoliosis	Dong Yun Seon/US	SCOLIOSIS BRACE HAVING ANGLE ADJUSTMENT UNIT	(149)
US8,652,791B2	2014	Scoliosis	Alain Moreau/ Hopital Sainte-Justine/United States	METHOD OF CLASSIFYING HUMAN SUBJECTS HAVINGADOLESCENT IDIOPATHIC SCOLIOSIS (AIS) AND METHOD FORSCREENING FOR A COMPOUND USEFUL IN THE TREATMENT OFAIS AND RELATED SYNDROMES CAUSING SPINAL DEFORMITES	(150)
US9,989,531B2	2018	Scoliosis	Alain Moreau/ Chu Sainte – Justine/ United States	COMPOSITION COMPRISING A CELL SAMPLE FROM A SUBJECT WITH SCOLIOSIS AND A REAGENT FOR DETECTING PTPU OR PIPKIY	(151)
US10,143,417B2	2018	Scoliosis	Mats Danielsson/ Prismatic Sensors AB/ United States	X - RAY IMAGING FOR ENABLING ASSESSMENT OF SCOLIOSIS	(152)
US 10,620,222 B2	2020	Scoliosis	Alain Moreau/ CHU Sainte – Justine/ United States	ELECTRIFIED COMPOSITIONS FOR DETERMINING THE RISK OF DEVELOPING ADOLESCENT IDIOPATHIC SCOLIOSIS THROUGH THE USE OF GI PROTEIN RECEPTOR	(153)
US 11,020,147 B2	2021	Scoliosis	James W. Ogilvie/ Predictive Therapeutics/United States	METHOD OF TREATING SCOLIOSIS USING A BIOLOGICAL IMPLANT	(154)

US 11,179,096 B2	2021	Scoliosis	Satoshi Kanai/ National University/ United States	SCOLIOSIS DIAGNOSIS ASSISTANCE DEVICE , SCOLIOSIS DIAGNOSIS ASSISTANCE METHOD , AND PROGRAM	(155)
US2009/0035768A1	2009	Scoliosis	Lesa M. Nelson/ United States	METHOD OF DETERMINING PREDISPOSITION TO SCOLOSS AND USES THEREOF	(156)
US2013/0237447A1	2013	Scoliosis	Lesa M. Nelson/ Lesa M. Nelson/ United States	GENETIC MARKERS ASSOCATED WITH SCOLOSS AND USES THEREOF	(157)
US2013/0288913A1	2013	Scoliosis	Michael R. Schramm/ Michael R. Schramm/ United States	METHOD OF DETERMINING PREDISPOSITION TO SCOLOSIS	(158)
US2013/0310261A1	2013	Scoliosis	Michael R. Schramm/ Michael R. Schramm/ United States	SIMPLIFED METHOD OF DETERMINING PREDISPOSITION TO SCOLOSIS	(159)
US2016/0053322A1	2016	Scoliosis	Lesa M./ Lesa M. Nelson/ United States	GENETIC MARKERS ASSOCATED WITH SCOLOSS AND USES THEREOF	(160)
US2017/0079828A1	2017	Scoliosis	Andrew C. Pedtke/ LIM Innovations/ United States	SCOLIOSISTREATMENT SYSTEM AND (52) U.S. Cl.METHOD	(161)
US2018/0207048A1	2018	Scoliosis	Matthew I. Janzen/ ScoliWRx Inc/ United States	SCOLIOSIS TREATMENT PLATFORM AND METHOD	(162)
US10,073,101B2	2018	Scoliosis	Alain Moreau/ CHU Sainte – Justine/ United States	METHODS FOR THE PREVENTION OR TREATMENT OF SCOLIOSIS	(163)
US2018/0220932A1	2018	Scoliosis	Hwisu Jung/ Hwisu Jung/ United States	CHEST MEASURING DEVICE , SCOLIOSIS CORRECTION SYSTEM , SYSTEM FOR REMOTELY DIAGNOSING SPINE , AND WEARABLE MEASURING DEVICE	(164)
US 2019 / 0178896 A1	2019	Scoliosis	Alain Moreau/ Chu Sainte – Justine/ United States	MARKER FOR THE CLASSIFICATION , DIAGNOSIS AND TREATMENT OF SCOLIOSIS	(165)

Table.2: Current status of clinical trials on Scoliosis.

S.no.	Drug	Mode of administration	Disease	Enrollment	Allocation/Intervention model/Masking	Official Title of the study	status	Clinical trial	Year
1.	virtual reality	Interventional	**Scoliosis**	50	NA/Single group assignment/None	Virtual Reality's Effect on Decreasing Pain and Subsequent Opioid Use in Pediatric Patients in the Post-Operative Period Following Scoliosis Repair	NA	NCT05888038	2023
2.	MID-C	Interventional	**Scoliosis**	60	NA/Single group assignment/None	Safety and Effectiveness Evaluation of the Minimal Invasive Deformity Correction (MID-C) System in Early Onset Scoliosis	**NA**	NCT03519321	2021
3.	Scoliosis Specific Corrective Exercises and Physical Activity Counseling/Scoliosis Specific Corrective Exercises	Interventional	**Scoliosis**	**27**	Randomized/Parallel Assignment/Single (Participant)	Effects of Physical Activity Counselling in Addition to Scoliosis-Specific Corrective Exercises in Patients With Adolescent Idiopathic Scoliosis	**NA**	NCT05454800	2022
4.	Conventional Brace/ Optimized Brace/	Interventional	**Scoliosis**	**58**	Randomized/Parallel Assignment/Double (Participant)	Validation of a New Optimized Nighttime Providence Brace for Personalized Treatment of Adolescent Idiopathic Scoliosis	**NA**	NCT05001568	2022
5.	Survey + Physical exam	Observational	**Scoliosis**	**108**	Randomized/Parallel Assignment/Double (Participant)	Body Structure and Capacity Evaluation of Adults With Scoliosis	**NA**	NCT05538871	2022
6.	Yoga poses	Interventional	**Scoliosis**	**100**	N/A/Sequential Assignment/	Yoga in the Treatment of Adolescent Idiopathic and Degenerative Scoliosis	**NA**	NCT03110965	2022

					None (Open Label)				
7.	aerobic exercise/combined exercise/treadmill	Interventional	**Scoliosis**	**40**	Randomized/Parallel Assignment/Double (Investigator Outcomes Assessor)	Impact of Aerobic Training and Combined in Inflammatory Markers in Patients With Adolescent Idiopathic Scoliosis	**NA**	NCT02413788	2019
8.	The evocation of reproducible motor evoked potential according to the different BIS levels	Observational	**Scoliosis**	**150**	**NA**	Advanced Methods for Improving Anesthesiologic Management and Their Effect on Perioperative Outcome in Scoliosis Surgery, Especially in Childhood (SCOL Study): a Prospective Observational Study	**NA**	NCT04423146	2023
9.	**Prediction**	Observational	**Scoliosis**	**140**	**NA**	Predictive Progressive Factors of Adolescent Idiopathic Scoliosis	**NA**	NCT02862392	2022
10.	Evaluation of Muscle Activation	Observational	**Scoliosis**	**40**	**NA**	Evaluation of Lateral and Medial Part Activations of Latissimus Dorsi Muscle During Isometric Exercises in Individuals With Scoliosis	**NA**	NCT05836116	2023
11.	Virtual Reality (VR) technique/Analgesic protocol	Interventional	**Scoliosis**	**102**	NA	Use of Virtual Reality to Reduce Morphine Consumption in Adolescents Undergoing Scoliosis Surgery: A Prospective Randomized Open-label Study. Virtual Reality for Analgesia in Spine Surgery	**NA**	NCT04892940	2022
12.	Active Bodysuits	Interventional	**Scoliosis**	**15**	**NA**	Effectiveness of Active Bodysuits for Adult Degenerative Scoliosis	**NA**	NCT04509310	2021

13.	Osteoblast sample	Interventional	**Scoliosis**	**45**	NA	Ghrelin Cellular Resistance Study in Adolescents With Idiopathic Scoliosis	**NA**	NCT02829476	2017
14.	procedure1/procedure2	Interventional	**Scoliosis**	**840**	Non-Randomized/ Parallel Assignment/ None (Open Label)	Screening and Prevalence of Adolescent Idiopathic Scoliosis in Selected Urban and Countryside Schools in Egypt	**NA**	NCT03894865	2019
15.	Exercise programme 1/exercise programme 2	Interventional	**Scoliosis**	**40**	Non-Randomized Interventional/ Sequential Assignment/None (Open Label)	The Effect of Schroth Method on Pain, Body Awareness and Quality of Life in Adolescent Individuals With Idiopathic Scoliosis	**NA**	NCT04689295	2022
16.	ERAS program	Observational	**Scoliosis**	**150**	**NA**	Assesment of Enhanced Recovery After Pediatric Idiopathic Scoliosis Surgery	**NA**	NCT04012528	2020
17.	**NA**	Observational	**Scoliosis**	**1**	**NA**	Surgical Guide for Thoracic Pedicle Screw Instrumentation in Scoliosis Correction Surgery	**NA**	NCT04753905	2021
18.	Video recording of clinical visit	Observational	**Scoliosis**	**25**	**NA**	Scoliosis Shared Decision Making	**NA**	NCT03107533	2023
19.	Flexible brace	Interventional	**Scoliosis**	**100**	N/A Interventional / Single Group Assignment/ None (Open Label)	Trial of Flexible Bracing Treatment of Adolescents Idiopathic Scoliosis	**NA**	NCT04116723	2022
20.	Ultrasound	Observational	**Scoliosis**	**55**	Cohort	Ultrasound Measured Epidural Depth for Midline Approach in Pediatric Patients	**NA**	NCT04877964	2021

						With Scoliosis: Prospective Observational Study			
21.	**Scoliosis**	International	**Scoliosis**	**164**	N/A/Interventional/Single Group Assignment/None (Open Label)	Multicenter Study on the Contribution of Surgical Treatment by ST2R Technique (Simultaneous Translation on Two Rods) in Scoliosis of the Children and Adolescents	**NA**	NCT02820012	2022
22.	Brace therapy	Observational	**Scoliosis**	**115**	Cohort	Retrospektive Analyse Der Konservativen Skoliosetherapie - Doppelkorsettversorgung Mittels Tag- Und Nachtorthese Versus Ganztagesorthese	**NA**	NCT05424419	2022
23.	**Protocol**	Observational	**Scoliosis**	**35**	Cohort	Blood and Fluid Management During Scoliosis Surgery: A Single Center Retrospective Analysis	**NA**	NCT03814239	2019
24.	Scoliosis brace	Interventional	**Scoliosis**	**30**	N/A Interventional / Single Group Assignment/None (Open Label)	The Effect of Peak Scoliosis Spinal Bracing System on Gait and Pain Level in Adult Scoliosis Patients	**NA**	NCT03572855	2018
25.	Physical	Observational	Scoliosis	**30**	**NA**	Diagnostic Accuracy of Low-dose Dual-energy CT for the Pre-surgical Planning of Patients With Progression of Scoliosis	**NA**	NCT03483844	2019

REFERENCES:

1. Goldberg CJ, Moore DP, Fogarty EE, Dowling FE. Scoliosis: A review. Pediatr Surg Int. 2008;24(2):129–44.

2. Nikolova S, Dikova M, Savov A, Kremensky I. Genetics of idiopathic scoliosis. Pediatriya. 2012;52(4):16–9.

3. Morrissy, Raymond T., and Stuart L. Weinstein. "Lovell and winters: pediatric orthopaedics." Lovell and winters: pediatric orthopaedics . 1996. xxv-624. 1996;1996.

4. Grivas TB, Vasiliadis E, Chatziargiropoulos T, Polyzois VD, Gatos K. THE EFFECT OF A MODIFIED BOSTON BRACE WITH ANTIROTATORY BLADES ON THE PROGRESSION OF CURVES IN IDIOPATHIC SCOLIOSIS. AETIOLOGIC IMPLICATIONS. Orthop Proc [Internet]. 2004;86-B(SUPP_II):192–3. Available from: https://doi.org/10.1302/0301-620X.86BSUPP_II.0860192e

5. Fernandes P, Weinstein SL. Natural history of early onset scoliosis. J Bone Jt Surg. 2007;89(SUPPL. 1):21–33.

6. Janicki JA, Frcsc BA. Scoliosis : Review of diagnosis and treatment. Paedriatric Child Heal. 2017;12(9):771–6.

7. Bradford DS. Moe's textbook of scoliosis and other spinal deformities. 1987.

8. Singhal R, Perry DC, Prasad S, Davidson NT, Bruce CE. The use of routine preoperative magnetic resonance imaging in identifying intraspinal anomalies in patients with idiopathic scoliosis: A 10-year review. Eur Spine J. 2013;22(2):355–9.

9. Campbell, Robert M. Jr. MD; Hell-Vocke AKM. Growth of the Thoracic Spine in Congenital Scoliosis After Expansion Thoracoplasty. 2003;85(March):2003.

10.Singh H, Shipra, Sharma V, Sharma I, Sharma A, Modeel S, et al. The first study of epidemiology of adolescent idiopathic scoliosis shows lower prevalence in females of Jammu and Kashmir, India. Am J Transl Res [Internet]. 2022;14(2):1100–6. Available from: http://www.ncbi.nlm.nih.gov/pubmed/35273713%0Ahttp://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=PMC8902575

11.Scollosls AI, Labelle HB. Between Children With C. 1987;(Bleck).

12.LA G. Classification and terminology of scoliosis. 1973.

13.Guo X, Chau WW, Chan YL, Cheng JCY. Relative anterior spinal overgrowth in adolescent idiopathic scoliosis. J Bone Jt Surg - Ser B. 2003;85(7):1026–31.

14.Machida M, Hasegawa A, Iizuka S, Nagoshi N, Miyake A, Fujiyoshi K, et al. Idiopathic scoliosis. IRYO - Japanese J Natl Med Serv. 2012;66(8):398–406.

15.Kim HJ, Blanco JS, Widmann RF. Update on the management of idiopathic scoliosis. Curr Opin Pediatr. 2009;21(1):55–64.

16.Tsirikos AI, Chang WN, Dabney KW, Miller F, Glutting J. Life expectancy in pediatric patients with cerebral palsy and neuromuscular scoliosis who underwent spinal fusion. Dev Med Child Neurol. 2003;45(10):677–82.

17.McCarthy RE. Management of neuromuscular scoliosis. Orthop Clin North Am. 1999;30(3):435–49.

18.Hedequist, Daniel MD; Emans JM. Congenital Scoliosis. J Am Acad Orthop Surg 12(4)p 266-275. 12(July):1–3.

19.Lonstein JEA. Operative treatment of spinal deformities in patients with cerebral palsy or mental retardation. An analysis of one hundred and seven cases. JThe J Bone Jt Surg 65(1)p 43-55, [Internet]. 1983;1(1):1–8. Available from: https://www.scopus.com/inward/record.uri?eid=2-s2.0-85025834183&partnerID=40&md5=84a6211723ab734721e05760926ef180

20.Pinto SN, Chasen ST, Heier LA. Imaging of the Fetal Brain and Spine. In: Greenfield JP, Long CB, editors. Common Neurosurgical Conditions in the Pediatric Practice: Recognition and Management [Internet]. New York, NY: Springer New York; 2017. p. 201–31. Available from: https://doi.org/10.1007/978-1-4939-3807-0_16

21.S Basu, Partha FRCS Orth*; Elsebaie, Hazem FRCS†; Noordeen, MHH ChM F. . Congenital Spinal Deformity: A Comprehensive Assessment at Presentation. Oxford Univ Press. 2002;27(20):649.

22.Beals, Rodney K. MD; Robbins, James R. MD; Rolfe BM. Anomalies Associated with Vertebral Malformations. Археология. 1993;1(August):117–25.

23.Montgomery, Fredrik MD; Willner SM. The Natural History of Idiopathic Scoliosis: Incidence of Treatment in 15 Cohorts of Children Born Between 1963 and 1977. Synthesis (Stuttg). 1997;11(March):1273–6.

24.Philip Willner M. Recurrent dislocation of the patell. J Penelit Pendidik Guru Sekol Dasar. 2016;6(August):128.

25.STIRLING, ALASTAIR J. F.R.C.S.†; HOWEL, DENISE M.SC.†; MILLNER, PETER A. F.R.C.S.(ORTH)†; SADIQ, SAFA'A M.PHIL.†; SHARPLES, DAVID B.SC.†; DICKSON RADS. Late-Onset Idiopathic Scoliosis in Children Six to Fourteen Years Old. A Cross-Sectional Prevalence Study. J Bone Jt Surg 78(9)p. 1996;78:5–24.

26.Rogala, E J; Drummond, D S; Gurr J. Scoliosis: incidence and natural history. A prospective epidemiological study. J Bone Jt Surg. 1978;88(3):309--352.

27.Raudenbush B, Simela A, Joseph H. A review of the evaluation, diagnosis, and nonsurgical treatment of adolescent idiopathic scoliosis. Osteopath Fam Physician [Internet]. 2013;5(4):158–68. Available from: http://dx.doi.org/10.1016/j.osfp.2013.01.009

28.Zhuang Q, Li J, Wu Z, Zhang J, Sun W, Li T, et al. Differential proteome analysis of bone marrow mesenchymal stem cells from adolescent idiopathic scoliosis patients. PLoS One. 2011;6(4).

29.Peng Y, Wang SR, Qiu GX, Zhang JG, Zhuang QY, Wang NN. Research progress on the etiology and pathogenesis of adolescent idiopathic scoliosis. Chin Med J (Engl). 2020;133(4):483–93.

30.Wang W, Ma J, Li S yuan, Wu X, Hu B, Wang X feng, et al. [Advance on genetic mechanism of adolescent idiopathic scoliosis and genetic relationship map]. Zhongguo Gu Shang [Internet]. 2015 Sep;28(9):854—860. Available from: http://europepmc.org/abstract/MED/26647570

31.Mao S hu, Qian B ping, Shi B, Zhu Z zhang, Qiu Y. Quantitative evaluation of the relationship between COMP promoter methylation and the susceptibility and curve progression of adolescent idiopathic scoliosis. Eur Spine J [Internet]. 2018;27(2):272–7. Available from: https://doi.org/10.1007/s00586-017-5309-y

32.Raggio CL, Giampietro PF, Dobrin S, Zhao C, Dorshorst D, Ghebranious N, et al. A novel locus for adolescent idiopathic scoliosis on chromosome 12p. J Orthop Res. 2009;27(10):1366–72.

33.Inoue M, Minami S, Nakata Y, Kitahara H, Otsuka Y, Isobe K, et al. Association between estrogen receptor gene polymorphisms and curve severity of idiopathic scoliosis. Spine (Phila Pa 1976). 2002;27(21):2357–62.

34.Justice CM, Miller NH, Marosy B, Zhang J, Wilson AF. Familial Idiopathic Scoliosis. Spine (Phila Pa 1976). 2003;28(6):589–94.

35.Helenius I, Remes V, Yrjönen T, Ylikoski M, Schlenzka D, Helenius M, et al. Does gender affect outcome of surgery in adolescent idiopathic scoliosis? Spine (Phila Pa 1976). 2005;30(4):462–7.

36.Kenanidis E, Potoupnis ME, Papavasiliou KA, Sayegh FE, Kapetanos GA. Adolescent idiopathic scoliosis and exercising: Is there truly a liaison? Spine (Phila Pa 1976). 2008;33(20):2160–5.

37.Giampietro PF, Blank RD, Raggio CL, Merchant S, Jacobsen FS, Faciszewski T, et al. Congenital and idiopathic scoliosis: clinical and genetic aspects. Clin Med Res. 2003;1(2):125–36.

38.MJ T. Vertebral column deformities following epiphysectomy in the chick. CR Hebd Seances Acad Sci. 1959;248:1959.

39.Machida M, Dubousset J, Imamura Y, Iwaya T, Yamada T, Kimura J. Role of of Deficiency in the Development Scoliosis in Pinealectomised. J Bone Joint Surg Br. 1995;77(1):134–8.

40.Machida, Masafumi, Stuart L. Weinstein and JD. Pathogenesis of idiopathic scoliosis. Springer. 2018;2018.

41.Fagan, Andrew B. MBBS, FRCS Glas*; Kennaway, David J. PhD†; Sutherland ADM. Total 24-Hour Melatonin Secretion in Adolescent Idiopathic Scoliosis: A Case-Control Study. Spine 23(1):p 41-46. 23(Mi):5–24.

42.Cheung KMC, Wang T, Poon AMS, Carl A, Tranmer B, Hu Y, et al. The effect of pinealectomy on scoliosis development in young nonhuman primates. Spine (Phila Pa 1976). 2005;30(18):2009–13.

43.Azeddine, Bouziane et a. Molecular determinants of melatonin signaling dysfunction in adolescent idiopathic scoliosis. Clin Orthop Relat Res. 2007;вы12y(235):245.

44.Wang WWJ, Man GCW, Wong JH, Ng TB, Lee KM, Ng BKW, et al. Abnormal response of the proliferation and differentiation of growth plate chondrocytes to melatonin in adolescent idiopathic scoliosis. Int J Mol Sci. 2014;15(9):17100–14.

45.Lowe, Thomas MD; Lawellin, David PhD; Smith, David MSc; Price, Charles MD; Haher, Thomas MD; Merola, Andrew MD; O'Brien MM. Platelet Calmodulin Levels in Adolescent Idiopathic Scoliosis: Do the Levels Correlate With Curve Progression and Severity? Spine 27(7):p 768-775. 27(Mi):5–24.

46.Acaroglu E, Akel I, Alanay A, Yazici M, Marcucio R. Comparison of the melatonin and calmodulin in paravertebral muscle and platelets of patients with or without adolescent idiopathic scoliosis. Spine (Phila Pa 1976). 2009;34(18):3181.

47.Abul-Kasim K, Overgaard A, Karlsson MK, Ohlin A. Tonsillar ectopia in idiopathic scoliosis: Does it play a role in the pathogenesis and prognosis or is it only an incidental finding? Scoliosis. 2009;4:1–7.

48.Chu WCW, Lam WWM, Chan YL, Ng BKW, Lam TP, Lee KM, et al. Relative shortening and functional tethering of spinal cord in adolescent idiopathic scoliosis? Study with multiplanar reformat magnetic resonance imaging and somatosensory evoked potential. Spine (Phila Pa 1976). 2006;31(1):20764.

49.Dickson RA, Lawton JO, Archer IA, Butt WP. The pathogenesis of idiopathic scoliosis. Biplanar spinal asymmetry. J Bone Jt Surg - Ser B. 1984;66(1):8–15.

50.Chu WCW, Lam WMW, Ng BKW, Tze-ping L, Lee KM, Guo X, et al. Relative shortening and functional tethering of spinal cord in adolescent scoliosis - Result of asynchronous neuro-osseous growth, summary of an electronic focus group debate of the IBSE. Scoliosis. 2008;3(1):1–24.

51.Wang WJ, Hung VWY, Lam TP, Ng BKW, Qin L, Lee KM, et al. The association of disproportionate skeletal growth and abnormal radius dimension ratio with curve severity in adolescent idiopathic scoliosis. Eur Spine J. 2010;19(5):726–31.

52.STIG WILLNER MD. a study of growth in girls with adolescent idiopathic structural scoliosis. J Penelit Pendidik Guru Sekol Dasar. 1974;6(August):128.

53.Cheung CSK, Lee WTK, Tse YK, Lee KM, Guo X, Qin L, et al. Generalized osteopenia in adolescent idiopathic scoliosis-association with abnormal pubertal growth, bone turnover, and calcium intake? Spine (Phila Pa 1976). 2006;31(3):330–8.

54.Cheung CSK, Lee WTK, Tse YK, Tang SP, Lee KM, Guo X, et al. Abnormal peri-pubertal anthropometric measurements and growth pattern in adolescent idiopathic scoliosis: A study of 598 patients. Spine (Phila Pa 1976). 2003;28(18):2152–7.

55.Normelli H, Sevastik J, Ljung G, Aaro S, Jönsson-Söderström AM. Anthropometric data relating to normal and scoliotic scandinavian girls. Vol. 10, Spine. 1985. p. 123–6.

56.Chazono, Masaaki et al. . "Height velocity curves in female patients with idiopathic scoliosis." Stud Health Technol Inform 176 (2012): 202-5. 2012;176:2012.

57.Bjørnhart B, Juul A, Nielsen S, Zak M, Svenningsen P, Müller K. Cartilage oligomeric matrix protein in patients with juvenile idiopathic arthritis: Relation to growth and disease activity. J Rheumatol. 2009;36(8):1749–54.

58.Gerdhem, P. et al. "Serum level of cartilage oligomeric matrix protein is lower in children with idiopathic scoliosis than in non-scoliotic controls." European Spine Journal 24 (2015): 256-261. 2015;24:2015.

59.Qiu Y, Sun X, Qiu X, Li W, Zhu Z, Zhu F, et al. Decreased circulating leptin level and its association with body and bone mass in girls with adolescent idiopathic scoliosis. Spine (Phila Pa 1976). 2007;32(24):2703–10.

60.Willner S, Johnell O. Study of biochemical and hormonal data in idiopathic scoliosis in girls. Arch Orthop Trauma Surg. 1981;98(4):251–5.

61.Sanders JO, Browne RH, Cooney TE, Finegold DN, McConnell SJ, Margraf SA. Correlates of the peak height velocity in girls with idiopathic scoliosis. Spine (Phila Pa 1976). 2006;31(20):2289–95.

62.Lombardi G, Akoume MY, Colombini A, Moreau A, Banfi G. Biochemistry of adolescent idiopathic scoliosis. Adv Clin Chem. 2011;54:165–82.

63.Stokes IAF, Burwell RG, Dangerfield PH. Biomechanical spinal growth modulation and progressive adolescent scoliosis - A test of the "vicious cycle" pathogenetic hypothesis: Summary of an electronic focus group debate of the IBSE. Scoliosis. 2006;1(1):1–21.

64.Sevastik B, Xiong B, Sevastik J, Lindgren U, Willers U. The rib vertebral angle asymmetry in idiopathic, neuromuscular and experimentally induced scoliosis. Stud Health Technol Inform. 1997;37:107–10.

65.Feng Q, Zhou Y, Wang M, Zhang Y feng, Wang F. A corrective functional exercise program for postural thoracic kyphosis in teenagers: study protocol for a randomized, controlled clinical trial. Clin Trials Orthop Disord. 2016;1(4):158.

66.Houghton GR. Scoliosis and Its Effect on Shape. 1988;70(2).

67.Orth, DP MOORE FRCSI MCh. "Handedness and spinal deformity." Research Into Spinal Deformities 5 5 (2006): 442. 2006;5:2006.

68.Hr W, Chockalingam N, Taranu R, Srinivas S, Hogg J, Whittaker V, et al. Bettany-Saltikov J, Weiss HR, Chockalingam N, Taranu R, Srinivas S, Hogg J, Whittaker V, Kalyan RV, Arnell T. 2015;

69.Negrini, Stefano et al. Physical exercises as a treatment for adolescent idiopathic scoliosis. A systematic review. Pediatr Rehabil. 2003;4:2003.

70.Wei HR. Die konservative Behandlung der idiopathischen Skoliose durch Krankengymnastik und Orthesen. Der Orthopäde 232. 2003;32:2003.

71.Negrini, Stefano et al. Characteristics of patients with more than 20 of improvement or worsening during conservative treatment of adolescent idiopathic scoliosis. Stud Heal Technol Inf 176. 2012;66:37–9.

72.Weiss HR, Negrini S, Hawes MC, Rigo M, Kotwicki T, Grivas TB, et al. Physical exercises in the treatment of idiopathic scoliosis at risk of brace treatment - SOSORT consensus paper 2005. Scoliosis. 2006;1(1):1–7.

73.Weiss HR, Goodall D. The treatment of adolescent idiopathic scoliosis (AIS) according to present evidence. A systematic review. Eur J Phys Rehabil Med [Internet]. 2008 Jun;44(2):177—193. Available from: http://europepmc.org/abstract/MED/18418338

74.Negrini S, Fusco C, Minozzi S, Atanasio S, Zaina F, Romano M. Exercises reduce the progression rate of adolescent idiopathic scoliosis: Results of a comprehensive systematic review of the literature. Disabil Rehabil. 2008;30(10):772–85.

75.Fusco C, Zaina F, Atanasio S, Romano M, Negrini A, Negrini S. Physical exercises in the treatment of adolescent idiopathic scoliosis: An updated systematic review. Physiother Theory Pract. 2011;27(1):80–114.

76.Hall MCc john e. Current treatment approaches in the nonperative and operative management of ALS. Transcommunication [Internet]. 1991;53(1):1–8. Available from: http://www.tfd.org.tw/opencms/english/about/background.html%0Ahttp://dx.doi.org/10.1016/j.cirp.2016.06.001%0Ahttp://dx.doi.org/10.1016/j.powtec.2016.12.055%0Ahttps://doi.org/10.1016/j.ijfatigue.2019.02.006%0Ahttps://doi.org/10.1016/j.matlet.2019.04.024%0A

77.BLOUNT, WALTER P.; SCHMIDT, ALBERT C.; KEEVER, E. DUDLEY; LEONARD ET. The Milwaukee Brace in the Operative Treatment of Scoliosis. J Bone Jt Surg [Internet]. 2018;3(1):10–27. Available from: https://medium.com/@arifwicaksanaa/pengertian-use-case-a7e576e1b6bf

78.Kuroki H. Brace treatment for adolescent idiopathic scoliosis. J Clin Med. 2018;7(6).

79.2010-brace wear control curve progression in AIS.

80.Morillon S, Thumerelle C, Cuisset JM, Santos C, Matran R, Deschildre A. Effect of thoracic bracing on lung function in children with neuromuscular disease. Ann Readapt Med Phys. 2007;50(8):645–50.

81.Cunin V. Early-onset scoliosis-Current treatment. Orthop Traumatol Surg Res [Internet]. 2015;101(1):S109–18. Available from: http://dx.doi.org/10.1016/j.otsr.2014.06.032

82.Mehta MH. Growth as a corrective force in the early treatment of progressive infantile scoliosis. J Bone Jt Surg - Ser B. 2005;87(9):1237–47.

83.Fayssoux RS, Cho RH, Herman MJ. A history of bracing for idiopathic scoliosis in north America. Clin Orthop Relat Res. 2010;468(3):654–64.

84.Liu CT, Chen KC, Chiu EHH. Adult degenerative scoliosis treated by acupuncture. J Altern Complement Med. 2009;15(8):935–7.

85.Choi SK, Jo HR, Park SH, Sung WS, Keum DH, Kim EJ. The effectiveness and safety of acupuncture for scoliosis: A protocol for systematic review and/or meta-analysis. Med (United States). 2020;99(50):E23238.

86.Weiss HR, Bohr S, Jahnke A, Pleines S. Acupucture in the treatment of scoliosis - A single blind controlled pilot study. Scoliosis. 2008;3(1):1–9.

87.Skaggs DL, Akbarnia BA, Flynn JM, Myung KS, Sponseller PD, Vitale MG. A classification of growth friendly spine implants. J Pediatr Orthop. 2014;34(3):260–74.

88.McCarthy RE, Luhmann S, Lenke L, McCullough FL. The shilla growth guidance technique for early-onset spinal deformities at 2-year follow-up: A preliminary report. J Pediatr Orthop. 2014;34(1):1–7.

89.Ouellet J. Surgical technique: Modern Luqué Trolley, a self-growing rod technique. Clin Orthop Relat Res. 2011;469(5):1356–67.

90.Pratt, Roland K. MA, FRCS*; Webb, John K. FRCS†; Burwell, R. Geoffrey MD F. Luque Trolley and Convex Epiphysiodesis in the Management of Infantile and Juvenile Idiopathic Scoliosis. Spine 24(15):p. 24(Mi):5–24.

91.Singh V, Simpson J, Rawlinson J, Hallab N. Growth Guidance System for Early-Onset Scoliosis. Spine (Phila Pa 1976). 2013;38(18):1546–53.

92.Mukrimaa SS, Nurdyansyah, Fahyuni EF, YULIA CITRA A, Schulz ND, غسان د, et al. Harrington Instrumentation Without Fusion Plus External Orthotic Support for the treatment of Difficult Curvature Problems in Young Children. JMoe, John H MD*; Kharrat, Khalil MD; Winter, Robert B ,MD**; Cummine, John L MD†. 2016;6(August):128.

93.Akbarnia BA, Marks DS, Boachie-Adjei O, Thompson AG, Asher MA. Dual growing rod technique for the treatment of progressive early-onset scoliosis: A multicenter study. Spine (Phila Pa 1976). 2005;30(17 SUPPL.):46–57.

94.Dannawi Z, Altaf F, Harshavardhana NS, El Sebaie H, Noordeen H. Early results of a remotely-operated magnetic growth rod in early-onset scoliosis. J Bone Jt Surg - Ser B. 2013;95 B(1):75–80.

95.Samartzis D, Orth K cheung MF. Non-invasive out-patient treatment for severe spinal deformity in children using a magnetically controlled growing rod implant. 2012;6736(12):1967–74.

96.Miladi, Lotfi, and Jean F. Dubousset. “Magnetic powered extensible rod for thorax or spine.” The growing spine: management of spinal disorders in young children (2010): 585-591. 2010;2010.

97.Takaso M, Moriya H, Kitahara H, Minami S, Takahashi K, Isobe K, et al. New remote-controlled growing-rod spinal instrumentation possibly applicable for scoliosis in young children. J Orthop Sci. 1998;3(6):336–40.

98.Meeting A. 2011 Corporate supporters.

99.Yang JS, Sponseller PD, Thompson GH, Akbarnia BA, Emans JB, Yazici M, et al. Growing rod fractures: Risk factors and opportunities for prevention. Spine (Phila Pa 1976). 2011;36(20):1639–44.

100. Sankar WN, Acevedo DC, Skaggs DL. Comparison of complications among growing spinal implants. Spine (Phila Pa 1976). 2010;35(23):2091–6.

101. Bess S, Akbarnia BA, Thompson GH, Sponseller PD, Shah SA, El Sebaie H, et al. Complications of growing-rod treatment for early-onset scoliosis: Analysis of one hundred and forty patients. J Bone Jt Surg. 2010;92(15):2533–43.

102. Bekmez S, Afandiyev A, Dede O, Karaismailoglu E, Demirkiran HG, Yazici M. Is Magnetically Controlled Growing Rod the Game Changer in Early-onset Scoliosis? A Preliminary Report. J Pediatr Orthop. 2019;39(3):E195–200.

103. Skaggs KF, Brasher AE, Johnston CE, Purvis JM, Smith JT, Myung KS, et al. Upper thoracic pedicle screw loss of fixation causing spinal cord injury: A review of the literature and multicenter case series. J Pediatr Orthop. 2013;33(1):75–9.

104. Mahar AT, Bagheri R, Oka R, Kostial P, Akbarnia BA. Biomechanical comparison of different anchors (foundations) for the pediatric dual growing rod technique. Spine J [Internet]. 2008;8(6):933–9. Available from: http://dx.doi.org/10.1016/j.spinee.2007.10.031

105. Klemme, William R. MC, USA; Denis, Francis M.D.*; Winter, Robert B. M.D.*; Lonstein, John W. M.D.*; Koop SEMD. Spinal Instrumentation Without Fusion for Progressive Scoliosis in Young Children. J Pediatr Orthop 17(6)p 734-742. 17(Mi):5–24.

106. Mackenzie WGS, Matsumoto H, Williams BA, Corona J, Lee C, Cody SR, et al. Surgical Site Infection Following Spinal Instrumentation for Scoliosis. J Bone Jt Surg. 2013;95(9):800–6.

107. Sankar WN, Skaggs DL, Emans JB, Marks DS, Dormans JP, Thompson GH, et al. Neurologic risk in growing rod spine surgery in early onset scoliosis: Is neuromonitoring necessary for all cases? Spine (Phila Pa 1976). 2009;34(18):1952–5.

108. Acaroglu, Emre M.D.; Yazici, Muharrem M.D.; Alanay, Ahmet M.D.; Surat AMD. Three-Dimensional Evolution of Scoliotic Curve During Instrumentation Without Fusion in Young Children. J Pediatr Orthop 22(4)p 492-496. 22(July):649.

109. Matsumoto H, Williams BA, Corona J, Comer JS, Fisher PW, Neria Y, et al. Psychosocial effects of repetitive surgeries in children with early-onset scoliosis: Are we putting them at risk? J Pediatr Orthop. 2014;34(2):172–8.

110. Cahill PJ, Marvil S, Cuddihy L, Schutt C, Idema J, Clements DH, et al. Autofusion in the immature spine treated with growing rods. Spine (Phila Pa 1976). 2010;35(22):1199–203.

111. Yazici M, Olgun ZD. Growing rod concepts: State of the art. Eur Spine J. 2013;22(SUPPL.2):118–30.

112. Betz RR, Ranade A, Samdani AF, Chafetz R, D'Andrea LP, Gaughan JP, et al. Vertebral body stapling: A fusionless treatment option for a growing child with moderate idiopathic scoliosis. Spine (Phila Pa 1976). 2010;35(2):169–76.

113. Hunt KJ, Braun JT, Christensen BA. The effect of two clinically relevant fusionless scoliosis implant strategies on the health of the intervertebral disc: Analysis in an immature goat model. Spine (Phila Pa 1976). 2010;35(4):371–7.

114. Newton PO, Upasani V V., Farnsworth CL, Oka R, Chambers RC, Dwek J, et al. Spinal growth modulation with use of a tether in an immature porcine model. J Bone Jt Surg. 2008;90(12):2695–706.

115. Crawford CH, Lenke LG. Growth modulation by means of anterior tethering resulting in progressive correction of juvenile idiopathic scoliosis: A case report. J Bone Jt Surg. 2010;92(1):202–9.

116. Clayson D, Mahon B, Levine DB. Preoperative personality characteristics as predictors of postoperative physical and psychological patterns in scoliosis. Vol. 6, Spine. 1981. p. 9–12.

117. Clinical Orthopaedics and Related Research. p. ppg 99-102.

118. Matsunaga S, Hayashi K, Naruo T, Nozoe SI, Komiya S. Psychologic management of brace therapy for patients with idiopathic scoliosis. Spine (Phila Pa 1976). 2005;30(5):547–50.

119. Payne, William K. III MD*,#,**,††; Ogilvie, James W. MD†§; Resnick, Michael D. PhD‡§; Kane, Robert L. MD‖; Transfeldt, Ensor E. MD¶; Blum, Robert W. MD P. Does Scoliosis Have a Psychological Impact and Does Gender Make a Difference. Spine 22(12):p 1380-138. 1997;11(March):1273–6.

120. Koch, Karl D. PhD‡; Buchanan, Renee MA†; Birch, John G. MD, FRCS(C)*†; Morton, Anne A. PhD*†; Gatchel, Robert J. PhD*; Browne RHP. Adolescents Undergoing Surgery for Idiopathic Scoliosis: How Physical and Psychological Characteristics Relate to Patient Satisfaction With the Cosmetic Result. Spine 26(19):p 2119-2124. 26(Mi):5–24.

121. Andersen, Mikkel Ø. M.D.*; Andersen, Gert Rahbek M.D. Dr.med.Sci†; Thomsen, Karsten M.D.*; Christensen SBMDD med. S. Early Weaning Might Reduce the Psychological Strain of Boston Bracing: a Study of 136 Patients with Adolescent Idiopathic Scoliosis at 3.5 Years after Termination of Brace Treatment. J Pediatr Orthop B 11(2)p 96-99,. 35(13):84–5.

122. Ugwonali OF, Lomas G, Choe JC, Hyman JE, Lee FY, Vitale MG, et al. Effect of bracing on the quality of life of adolescents with idiopathic scoliosis. Spine J. 2004;4(3):254–60.

123. Danielsson AJ, Wiklund I, Pehrsson K, Nachemson AL. Health-related quality of life in patients with adolescent idiopathic scoliosis: A matched follow-up at least 20 years after treatment with brace or surgery. Eur Spine J. 2001;10(4):278–88.

124. MacLean, William E. Jr. Ph.D.; Green, Neil E. M.D.; Pierre, Claudette B. Ph.D.; Ray DCM. Stress and Coping with Scoliosis: Psychological Effects on Adolescents and Their Families. J Pediatr Orthop 9(3)p 257-261 [Internet]. 1989;58(58):99–104. Available from: https://www.unhcr.org/publications/manuals/4d9352319/unhcr-protection-training-manual-european-border-entry-officials-2-legal.html?query=excom 1989

125. FÄLLSTRÖM, KERSTIN PhD*; COCHRAN, THOMAS MD†; NACHEMSON, ALF MD P. Long-Term Effects on Personality Development in Patients with Adolescent Idiopathic Scoliosis: Influence of Type of Treatment. Spine 11(7):p 756-758. 1986;9(6):123–8.

126. S. M, T. S, S. N. Psychological effects of brace therapy on patients with idiopathic scoliosis. J Orthop Sci [Internet]. 1997;2(6):391–5. Available from: http://www.embase.com/search/results?subaction=viewrecord&from=export&id=L28145676%5Cnhttp://elvis.ubvu.vu.nl:9003/vulink?sid=EMBASE&issn=09492658&id=doi:&atitle=Psychological+effects+of+brace+therapy+on+patients+with+idiopathic+scoliosis&stitle=J.+Ortop.

127. Gratz RR, Papalia-Finlay D. Psychosocial adaptation to wearing the Milwaukee brace for scoliosis. A pilot study of adolescent females and their mothers. J Adolesc Heal Care. 1984;5(4):237–42.

128. LaMontagne, Lynda; Hepworth, Joseph T.; Salisbury, Michele H.; Cohen F. Effects of Coping Instruction in Reducing Young Adolescents' Pain After Major Spinal Surgery. Orthop Nurs 22(6)p 398-403,. 22(Mi):5–24.

129. LL, LAMONTAGNE. "Adolescent scoliosis: effects of corrective surgery, cognitive-behavioural intervention, and age on activity outcome." Appl Nurs Res 17 (2004): 168-177. 2004;17:2004.

130. Rinella A, Lenke L, Peelle M, Edwards C, Bridwell KH, Sides B. Comparison of SRS Questionnaire Results Submitted by Both Parents and Patients in the Operative Treatment of Idiopathic Scoliosis. Spine (Phila Pa 1976). 2004;29(3):303–10.

131. LaMontagne, Lynda L.; Hepworth, Joseph T.; Cohen, Frances; Salisbury MH. Cognitive-Behavioral Intervention Effects on Adolescents' Anxiety and Pain Following Spinal Fusion Surgery. Nurs Res 52(3)p 183-190 [Internet]. 3(1):10–27. Available from: https://medium.com/@arifwicaksanaa/pengertian-use-case-a7e576e1b6bf

132. Lykissas MG, Jain V V., Nathan ST, Pawar V, Eismann EA, Sturm PF, et al. Mid- to long-term outcomes in adolescent idiopathic scoliosis after instrumented posterior spinal fusion: A meta-analysis. Spine (Phila Pa 1976). 2013;38(2):113–9.

133. Danielsson AJ, Nachemson AL. Back pain and function 22 years after brace treatment for adolescent idiopathic scoliosis: A case-control study - Part I. Spine (Phila Pa 1976). 2003;28(18):2078–85.

134. Danielsson, Aina J. MD, PhD; Nachemson, Alf L. MD PC. Curve Progression, and Sexual Function in Women 22 Years After Treatment for Adolescent Idiopathic Scoliosis: A Case–Control Study. Spine 26(13):p 1449-1456. 2001;26(1):1–27.

135. ORVOMAA E. Psychological evaluations of patients operated for idiopathic scoliosis by the Harrington method. Int J Rehabil Res 21(2)p 169-178. 1998;43(March):1–9.

136. Hinrichsen GA, Revenson TA, Shinn M. Does Self-Help Help? An Empirical Investigation of Scoliosis Peer Support Groups. J Soc Issues. 1985;41(1):65–87.

137. Asher M, Lai SM, Burton D, Manna B. The Influence of Spine and Trunk Deformity on Preoperative Idiopathic Scoliosis Patients' Health-related Quality of Life Questionnaire Responses. Spine (Phila Pa 1976). 2004;29(8):861–8.

138. Wilson PL, Newton PO, Wenger DR, Haher T, Merola A, Lenke L, et al. A multicenter study analyzing the relationship of a standardized radiographic scoring system of adolescent idiopathic scoliosis and the Scoliosis Research Society outcomes instrument. Spine (Phila Pa 1976). 2002;27(18):2036–40.

139. Haher, Thomas R. MD*; Gorup, John M. MD†; Shin, Tae M. MD†; Homel, Peter PhD‡; Merola, Andrew A. MD†; Grogan, Dennis P. MD§; Pugh, Linda RN§; Lowe, Thomas G. MD‖; Murray MM. Results of the Scoliosis Research Society Instrument for Evaluation of Surgical Outcome in Adolescent Idiopathic Scoliosis. 2004;(1):1–14.

140. Bago J, Climent JM, Ey A, Perez-Grueso FJS, Izquierdo E. The Spanish version of the SRS-22 Patient Questionnaire for idiopathic scoliosis: Transcultural adaptation and reliability analysis. Spine (Phila Pa 1976). 2004;29(15):1676–80.

141. Alanay A, Cil A, Berk H, Acaroglu RE, Yazici M, Akcali O, et al. Reliability and validity of adapted Turkish version of Scoliosis Research Society-22 (SRS-22) questionnaire. Spine (Phila Pa 1976). 2005;30(21):2464–8.

142. Watanabe K, Hasegawa K, Hirano T, Uchiyama S, Endo N. Use of the Scoliosis Research Society Outcomes Instrument to evaluate patient outcome in untreated idiopathic scoliosis patients in Japan. Part I: Comparison with nonscoliosis group: Preliminary/limited review in a Japanese population. Spine (Phila Pa 1976). 2005;30(10):1197–201.

143. Climent JM, Bago J, Ey A, Perez-Grueso FJS, Izquierdo E. Validity of the Spanish version of the Scoliosis Research Society-22 (SRS-22) patient questionnaire. Spine (Phila Pa 1976). 2005;30(6):705–9.

144. Feise RJ, Donaldson S, Crowther ER, Michael Menke J, Wright JG. Construction and validation of the Scoliosis Quality of Life Index in adolescent idiopathic scoliosis. Spine (Phila Pa 1976). 2005;30(11):1310–5.

145. Climent, José M. MD*; Sánchez JM. the Group for the Study of Quality of Life in Spine Deformities. Impact of the Type of Brace on the Quality of Life of Adolescents With Spine Deformities. Spine 24(18):p 1903,. 1999;24(18):1999.

146. Data P. Three-dimensional (3D) ultrasound imaging system for assessing scoliosis. Vol. 0070783. 2016.

147. Procedes Biomecaniques de diagnostic de scoliose.

148. Akoume MY, Franco A, Moreau A. Cell-based assay protocol for the prognostic prediction of idiopathic scoliosis using cellular dielectric spectroscopy. J Vis Exp. 2013;1(80).

149. Application F, Data P. (12) United States Patent. Vol. 2. 2011.

150. Alain Moreau M. METHOD OF CLASSIFYING HUMAN SUBJECTS HAVINGADOLESCENT IDIOPATHIC SCOLIOSIS (AIS) AND METHOD FORSCREENING FOR A COMPOUND USEFUL IN THE TREATMENT OFAIS AND RELATED SYNDROMES CAUSING SPINAL DEFORMITES. 2014;2(12).

151. lain Moreau , Montréal (CA) ; Marie - Yvonne Akoume Ndong , Montréal (CA) ; Mohamed Elbakry M(C). COMPOSITION COMPRISING A CELL SAMPLE FROM A SUBJECT WITH SCOLIOSIS AND A REAGENT FOR DETECTING PTPU OR PIPKI. 2018;2.

152. Mats Danielsson , Taby (SE) ; Xuejin Liu , Taby (SE) ; Martin Sjolin S(S). X - RAY IMAGING FOR ENABLING ASSESSMENT OF SCOLIOSIS. 2018;2.

153. Alain Moreau , Montreal (CA) ; Marie - Yvonne Akoume Ndong M(C). ELECTRIFIED COMPOSITIONS FOR DETERMINING THE RISK OF DEVELOPING ADOLESCENT IDIOPATHIC SCOLIOSIS THROUGH THE USE OF GI PROTEIN RECEPTOR. New York. 2(12):1–29.

154. James W. Ogilvie , Brighton , UT (US) ; Kenneth Ward , Salt Lake City , UT (US) ; Lesa M. Nelson , Park City U(U). METHOD OF TREATING SCOLIOSIS USING A BIOLOGICAL IMPLANT. 2021;2.

155. Satoshi Kanai , Hokkaido (JP) ; Hideki Hokkaido (JP) ; Hiroshi Nagaeda , Sudo , Hokkaido (JP) ; Yuichiro Abe H(J). SCOLIOSIS DIAGNOSIS ASSISTANCE DEVICE , SCOLIOSIS DIAGNOSIS ASSISTANCE METHOD , AND PROGRAM. Vol. 2. 2021.

156. Lesa M. Nelson, Park City, UT (US); Kenneth Ward, Salt Lake City U (US. METHOD OF DETERMINING PREDISPOSITION TO SCOLOSS AND USES THEREOF. 2009;1(19):1–6.

157. Lesa M. Nelson, Park City, UT (US); Kenneth Ward, Salt Lake City U (US). GENETIC MARKERS ASSOCATED WITH SCOLOSS AND USES THEREOF. 2013;1(19):2–6.

158. Michael R. Schramm, Perry, UT (US); James W. Ogilvie, Brighton, UT (US); Lesa M. Nelson, Park City, UT (US); Kenneth Ward, Salt Lake City, UT (US); Rakesh N. Chettier, West Jordan U (US). METHOD OF DETERMINING PREDISPOSITION TO SCOLOSIS Applicants: 2013;1(19).

159. Michael R. Schramm, Perry, UT (US); James W. Ogilvie, Brighton, UT (US); Lesa M. Nelson, Park City, UT (US); Kenneth Ward, Salt Lake City, UT (US); Rakesh N. Chettier, Salt Lake City U (US). SIMPLIFED METHOD OF DETERMINING PREDISPOSITION TO SCOLOSIS. 2013;1(19).

160. Lesa M. Nelson, Park City, UT (US); Kenneth Ward, Salt Lake City U (US), (21). GENETIC MARKERS ASSOCATED WITH SCOLOSS AND USES THEREOF. 2016;1(19):1–5.

161. Andrew C. Pedtke, San Francisco C (US); LMB, Sebastopol, CA (US); Jesse Robert Williams, San Francisco C (US). SCOLIOSISTREATMENT SYSTEM AND METHOD. 2017;1(19):2015–8.

162. Matthew I . Janzen , Campbell C(U. SCOLIOSIS TREATMENT PLATFORM AND METHOD. 2018;1.

163. Alain Moreau M(C). METHODS FOR THE PREVENTION OR TREATMENT OF SCOLIOSIS. 2018;2.

164. Hwisu Jung B(K). CHEST MEASURING DEVICE , SCOLIOSIS CORRECTION SYSTEM , SYSTEM FOR REMOTELY DIAGNOSING SPINE , AND WEARABLE MEASURING DEVICE. 2018;1.

165. Alain Moreau M(C) ; M, Yvonne Akoume Ndong M(C). MARKER FOR THE CLASSIFICATION , DIAGNOSIS AND TREATMENT OF SCOLIOSIS. 2019;1.