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Original article

SCOLIOSIS THERAPY, A STUDY BETWEEN THE SCHROTH-3D METHOD (HELD IN THE REHABILITATION CENTER) AND SCHROTH-3D TELETHERAPY PROGRAM

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Abstract

Objectives. The purpose of this research was to establish, if the Schroth-3D Teletherapy program can be a solution in Scoliosis Therapy. The study objectives were to observe and evaluate, the progress index, within a scoliosis rehabilitation program, a group of 10 patients with Adolescent Idiopathic Scoliosis, 5 following the program according to the Schroth-3D method held in the rehabilitation center and 5 following the program according to the Schroth-3D method held in a teletherapy program.

Methods. Scoliosis is a three-dimensional (3D) deformity of the spine, being characterized by one or more lateral curves, visible in the frontal plane, accompanied by the rotation of the vertebrae, which occurs most often during the period of growth, even before puberty. The peculiarity of scoliosis is that there is no scoliosis without vertebral rotation. Medical statistics state that in 90% of cases, the factors that cause scoliosis are not known exactly. Schroth-3D Method is the most recognized and respected method, based on a complex of personalized physical exercises, for the treatment of scoliosis. Within the Schroth-3D Method, the treatment program includes specific exercises for scoliosis and breathing techniques, the objectives of the method being to avoid surgery, stabilization of spinal corrections in three dimensions with an increase of respiratory function and restoring muscle symmetry.

Teletherapy is a therapy service offered by an accredited physiotherapist who, through a video / sound connection, leads a personalized recovery program to the patient's home. Through a secure platform, the physiotherapist and the patient can interact in the same way as in a traditional face-to-face therapeutic session, held in a rehabilitation center.

Results. The study showed better progress for the group that followed the Schroth-3D Method than the group that followed the Schroth-3D Teletherapy program.

Conclusions. We believe that the Schroth-3D Teletherapy program can be a solution, within the Schroth-3D Method, only for specific exercises at home, but not a sole solution for the rehabilitation of scoliosis.

Key Words: Schroth-3D method, scoliosis, progress index, teletherapy, Schroth-3D teletherapy program.

Introduction

The term scoliosis includes a heterogeneous group of conditions consisting of changes in the shape and position of the spine, chest, and torso. Scoliosis is a three-dimensional (3D) deformation of the spine, being characterized by one or more lateral curves, visible in the frontal plane, accompanied by vertebral rotation, which distinguishes it from the scoliotic attitude which is a pure lateral inclination without vertebral rotation.

Thus, depending on the functional and structural aspects of scoliosis, the axial deviation of the spine, more or less fixed, is followed by typical deformities of the trunk.

Although scoliosis is defined as a curvature of the spine in the coronary plane, with a degree of curvature measured in the same plane, scoliosis is a three-dimensional problem, involving the following three planes: the coronary plane, the sagittal plane, and the axial plane.

Thus, in the 3D system for scoliosis we have the following three defined planes:

- the coronal plane is a vertical plane, starting from the head to the foot, parallel to the shoulders and dividing the body into frontal and posterior sections;
- the sagittal plane divides the body into the right and left halves;
- the axial plane is parallel to the ground plane and at right angles to the coronal and sagittal planes.

Thus scoliosis:

- in the coronal plane means a lateral deviation towards the convex part of a curve that leads to a lateral flexion of the spine;
- in the sagittal plane means a hypokyphosis in the apical lumbar part with an additional hyperlordosis combined with hypermobility in the lumbosacral junction;

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- in the axial plane a rotation is identified mainly at the top of the curve and in the same direction as the lateral deviation; (Lehnert-Schroth, 2007).

A scoliosis is considered when there is at least 10° of angulation of the spine on the posterior-anterior radiograph necessarily associated with the vertebral rotation. According to (Negrini, Donzelli, Aulisa et al., 2018) from 2016 SOSORT guidelines, for orthopedic treatment and rehabilitation of idiopathic scoliosis during growth the causes of scoliosis are sought in congenital or acquired disorders of the vertebral structure, but the etiopathogenesis of scoliosis is not still elucidated. Although the ancient Greeks made a good anatomical description of the structural changes observed in scoliosis, time has not yet elucidated its pathogenesis.

When the history and clinical and radiological findings do not provide clear evidence for any specific etiology (congenital or syndromic) the condition, through a diagnosis of exclusion, is called idiopathic scoliosis. Idiopathic scoliosis is a deformity of the trunk, characterized by lateral deviation and axial rotation of the spine.

According to (Negrini, Donzelli, Aulisa, et al., 2018) from 2016 SOSORT guidelines, for the orthopedic treatment and rehabilitation of idiopathic scoliosis during growth idiopathic scoliosis is divided according to age at diagnosis into:

- an infantile idiopathic scoliosis (IIS) includes patients aged 0-2 years;
- a juvenile idiopathic scoliosis (JIS) includes patients aged 3-9 years;
- an adolescent idiopathic scoliosis (AIS)) includes patients aged 10-17 years;
- an adult idiopathic scoliosis (AdIS)) includes patients aged 18 years and older.

According to (Cheng, Castelein, Chu, et al., 2015) idiopathic scoliosis of adolescents progresses most rapidly during puberty and is the most common deformity of the pediatric spine.

During childhood and adolescence, idiopathic scoliosis can develop at any time, but most commonly occurs during periods of growth, in the first months of life, between 6 and 24 months, then between the ages of 5 and 8 years, there is another peak of growth and puberty, the most important and fastest growing, generally at the age of 11-14 years.

During the growth period, the loss of mechanical stability of the scoliotic spine results in the deformation of the vertebral bodies and ribs, so the deformity will always develop from a straight spine to a curved spine, accompanied by a deformity of the rib cage. In idiopathic scoliosis the extent of changes in the shape of the vertebrae and ribs will be strongly related to the severity of the scoliotic curve, this size varies and is unpredictable.

According to (Wapstra, Veldhuizen, 2012) in the case of idiopathic scoliosis, the progress of the scoliosis curve is different for each patient, so in some patients the progress of the curve is faster, in others it does not progress at all. When the patient's biological growth has been completed, the progression of scoliosis generally stops, with research showing that the risk of curve progression is primarily related to periods of rapid skeletal growth of the patient, most often during pubertal growth. Idiopathic scoliosis of adolescents is a disease with an overall prevalence of 0.47-5.2% in the current literature.

As early as March 2020, when much of the world came to a standstill, the privacy and normality of a treatment room for Schroth's scoliosis treatment procedures became impossible. Thus, the substitute became the virtual teletherapy sessions.

But what is a teletherapy session?

Simply put, the term "teletherapy" refers to physical therapy services that are provided through a technology platform, rather than through personal means in a therapy room. Teletherapy uses a live video synchronization program, such as: Zoom, Skype, or Google Meet, this is called "synchronous" format is used for live interaction between two parties through the video. This format is sometimes called "real-time". Real-time video teletherapy is ideal for medical evaluations and treatments.

Today we face unprecedented times, where the term "social distancing" has become the norm in everyday life. These times have come with questions about whether the medical act of a physiotherapist can be exercised through teletherapy.

Can teletherapy be an alternative to a professional medical act as part of a Schroth idiopathic scoliosis recovery program?

The main platforms that offer services adapted to the medical act are:

- Skype platform combines text, voice, and video signal to create an easy-to-use communication platform. Users can connect a single Skype account on all their devices - desktop, mobile or tablet. In addition to the ability to host one-on-one video calls, Skype provides users with many other tools, from instant messaging to file sharing, to screen sharing. Another service offered by Skype is connecting to an Outlook account, so that users can easily make a video call directly from their inbox. Customized for teletherapy, Skype offers a technology that offers video visits, on several video platforms and a special flexibility in terms of audio and video management on TVs. At the same time, an iPhone user can connect with the physiotherapist via FaceTime on a tablet;
- ZOOM HealthCare platform provides unified communications for healthcare and teletherapy. Zoom HealthCare helps physiotherapists and other medical staff deliver a cost-effective solution of the highest quality to meet the dynamic needs of online healthcare. A variety of applications,

including telehealth, teletherapy, healthcare, medical education and care, for home patients around the world. ZOOM HealthCare can expand patient care and communication with a high-quality video signal, even in low-bandwidth environments, physical therapy sessions can be saved for consultation and examination, and medical devices and telehealth cards can be connected;

- The Google Meet platform is a secure and versatile telehealth platform that provides interconnection services with tools that enable virtual connectivity. Google Meet provides a secure virtual connection between patients and healthcare professionals, enabling organizations to expand care and meet the needs of the community. The medical staff can quickly organize virtual visits to patients, the platform being easy to use. Physiotherapists and patients can join the virtual sessions just by touching the meeting link in the calendar or e-mail from any device you are on. Thus, a recovery program can be implemented at the patient's home, in which the best practices of social distancing will be observed and implemented by providing virtual assistance. Google Meet for Telehealth takes advantage of Google Cloud's secure infrastructure to protect your data and privacy. This includes encrypting video and cloud recording by default;
- SimpleVisit has opened the door for any telemedicine program to securely connect to FaceTime and other regular video calling applications from Apple. SimpleVisit helps expand telemedicine care services. This unique service has implemented a live coordinator that connects doctors and patients by turning almost any video calling application into a virtual and secure telemedicine visit. SimpleVisit is a video medical session service, which connects the virtual medical session with a direct call on regular video platforms such as Zoom, FaceTime, Skype, and Google Duo. Thus, the telemedicine session is accessed on the platform chosen by the patient without the need for downloads, connections, or technical training.

Aim of the study

The aim of this study was to observe and evaluate, the progress index, within a scoliosis rehabilitation program, a group of 10 patients with Adolescent Idiopathic Scoliosis, 5 following the program according to the Schroth-3D method held in the rehabilitation center and 5 following the program according to the Schroth-3D method held in a teletherapy program.

Materials and methods

The present study consists of three separate parts:

- a section on the collection and analysis of theoretical information in the literature on scoliosis and rehabilitation of adolescent idiopathic scoliosis by the Schroth-3D method;
- a study on a group of 5 children with adolescent idiopathic scoliosis, who followed an individual rehabilitation program, based on Schroth-3D Scoliosis therapy, a program held in a rehabilitation center. Within the recovery center, the program was held 4 days a week, 60 minutes each, for 24 weeks;
- a study on a group of 5 children with adolescent idiopathic scoliosis, who followed an individual rehabilitation program, based on Schroth-3D Scoliosis therapy, a program held as part of a teletherapy program. Within the rehabilitation center, the program was held 4 days a week, 60 minutes each, for 24 weeks.

We evaluated the patients' progress index before treatment and after 8 weeks, 16 weeks and 24 weeks, after which we compared all the results.

Preamble

The absolute goal for all patients with idiopathic scoliosis in any clinical situation is to avoid surgery (Negrini, Donzelli, Aulisa, et al., 2018). The purpose of medical rehabilitation of spinal deformities is to maintain function, prevent secondary symptoms and prevent the progression of the disease. Medical rehabilitation is the process that helps a patient, with a disease or injury that has caused functional limitations, to regain lost function.

Over time, rehabilitation programs for scoliosis have developed in terms of content but also in terms of location and rehabilitation system, inpatient system, in outpatient or mixed system along with additional exercise program for home. In Germany, thanks to the pension insurance system, a program of practice guides on inpatient rehabilitation has been developed. Numerous papers have provided evidence that outpatient rehabilitation can be as effective as inpatient rehabilitation (Weiss, 2010).

We must not forget that one of the objectives of rehabilitating scoliosis is to prevent the progression of the curve, thus trying to correct the deformity of the spine and torso in the long term and prevent deterioration of quality of life related to health.

The model of idiopathic scoliosis rehabilitation consists of:

- a correct evaluation of the patient, followed by a pertinent diagnosis that proposes a personalized rehabilitation program for him;
- a curve progression monitor and a specific exercise program, and / or corset;
- a final module of the rehabilitation of idiopathic scoliosis that contains the

evaluation of the results, as well as their quality.

According to (Negrini, Donzelli, Aulisa, et al., 2018) the 2016 SOSORT guidelines, specified the importance of several rehabilitation schools in several European countries, such as Germany, Spain, France, Italy, Poland, and others in proposing rehabilitation programs based on specific exercises for idiopathic scoliosis, as well as medical corset.

According to (Weiss, Negrini, Rigo et al., 2006) the 2005 SOSORT guide, for Exercise in the Treatment of Idiopathic Scoliosis, at Risk of Medical Corset Treatment, state that most physiotherapists for the rehabilitation of scoliosis have agreed that there are currently standard features in the rehabilitation of patients with scoliosis.

These features can be grouped as follows:

- stabilizing the corrected posture, through corrective exercises, and educating the patient;
- exercise program for automatic correction in 3D;
- training program in the activities of daily living.

In their own scoliosis rehabilitation strategy, the main rehabilitation schools involved in International Society on Scoliosis Orthopaedic and Rehabilitation Treatment (SOSORT), propose exercise programs based on the principles stated above. At the same time, the various scoliosis rehabilitation schools propose a multidisciplinary approach, considering that most of the proposed scoliosis rehabilitation methods work regularly in a multidisciplinary team consisting of a specialist, a physiotherapist, and a specialist in orthosis.

In conclusion, the main scoliosis rehabilitation schools consider that the proposed methods are not effective on their own, but only in a multidisciplinary team within an organized medical setting.

Systematic literature search

"Systematic literature search" is an important function for medical specialists, and not only, to understand the subject of their field of interest, to be updated on recent, relevant evidence in their medical field and to be able based on this professional search. to develop one's own studies.

The purpose of this systematic search in the literature is to identify the papers that have debated the subject of our paper. In the relevant literature, from the Cochrane Library, PubMed, Medline databases, we entered the following search terms: "spine", "adolescent idiopathic scoliosis", "telehealth", "teletherapy", AND "Schroth-3D method for scoliosis" without applying any language restrictions. The proposed time interval was from the date of establishment until February 2021, and we set the editorial limits, guide, meta-analysis, and randomized controlled study. The selection of the specialized literature was mainly the one from the last 15 years, but the older studies but relevant for our topic were not excluded.

In the final selection we included randomized controlled trials and good quality prospective observation studies, practice guides, books, and medical journals.

At the end, the final documents were selected, including relevant review articles and book chapters, which were read in search of important, relevant and useful information to be introduced in our paper.

Assessment of scoliosis

The physical evaluation of a scoliosis is done with Adam's forward bend test, where the patient bends forward at the waist and the examiner evaluates the back symmetry from behind and beside the patient. From the examination of the patient's back, a possible scoliosis can be observed, if a lateral bending of the spine is observed completed by a curve that can cause the rotation of the spine, the result being a hump of the rib visible on visual examination.

A scoliometer is used to measure the asymmetry of the torso in scoliosis or the angle of rotation of the torso (see Figure 1).

Figure 1. Scoliometer. Angle of trunk rotation
(source: Liang, J., Zhou, X., Chen, N. *et al.* (2018) https://doi.org/10.1186/s13063-018-2834-x)

The scoliometer is a small, non-invasive device that is placed above the spine while the patient is bent forward can indicate the degree of asymmetry of the torso (rotation). Scoliometer measured value, namely the rotation of the spine, may be a potential indicator of

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scoliosis and helps in the selection of patients that may require an x-ray.

The final diagnosis of scoliosis is officially confirmed by an X-ray, which will be used to measure the degree of the curve angle by measuring the Cobb angle (see Figure 2).

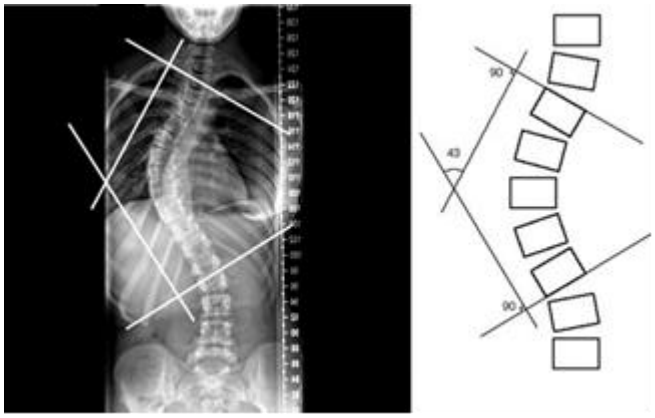

Figure 2. Diagram showing the measurement of the Cobb angle (right) in the patient's radiograph (left)

In the evaluation of a scoliosis, the most used method of measuring the size of the curve is the use of the Cobb angle on the patient's radiographs. The model of the scoliotic curve is described by the apical vertebra (vertebra at the top of the curve) being important to evaluate the overall balance of the spine in a patient with scoliosis.

The lines in the diagram are drawn along the apex of the upper inclined vertebra (vertebrae inclined maximum above the apex of the scoliotic curve) and the base of the lower vertebra inclined (vertebrae inclined below the apex of the scoliotic curve), after which two more lines are drawn at an angle of 90 degrees to the first lines, the perpendicular lines intersecting to form an angle. The minor angle formed is called the Cobb angle, its value being expressed in degrees.

In the case of a patient who has double curves, the major curve will be calculated for analysis.

Schroth-3D Scoliosis Method

The Schroth-3D method is a non-surgical option for the rehabilitation of scoliosis, a method based on typical physiotherapeutic principles developed by Katharina Schroth since 1920 and continued by her daughter Christa at the Asklepios Spinal Deformation Rehabilitation Center where Katharina Schroth annually in Germany treats, through hospitalization, with the help of an intensive rehabilitation program over 3,000 cases of scoliosis per year.

Schroth Academy through the training and empowerment program for licensed scoliosis rehabilitation therapists Schroth-3D has created an international network to implement the scoliosis treatment program, worldwide for example: in Germany, Spain, Italy, and other European countries as well as in Canada, the United States, Australia, and several Asian countries.

The Schroth-3D method is a therapy to correct idiopathic scoliosis which involves using the affected body positions to activate the affected muscles; at the same time this method contains a unique breathing technique that helps to extend the ribs inside the rib cage and then by pushing the ribs "sideways and back" to bring the vertebrae closer to their normal position. In this unique breathing technique, the activation of the main basic muscle groups helps to stabilize and maintain the extended ribs and de-roted vertebral bodies.

The Schroth-3D system for classifying the scoliosis curve (Lenhert-Schroth, 2007) is the result of the Schroth principle of dividing the body into "body blocks", blocks that help explain scoliosis changes as compensatory adaptations. The phrase "body blocks" describes the deformation of the torso as a change in their geometric shape from a rectangle to a trapezoidal shape, so that in the static standing position, the "body blocks" will have to be aligned perpendicular to their center of gravity. integrated in the central sacral line.

The classification of the scoliosis curve in the Schroth-3D method provides the direction of lateral deviation, rotation of the main "body blocks" (major curves) and provides a clear conclusion on the organization of the customized rehabilitation plan, program that includes a rehabilitation diagram and program personalized outpatient exercises.

According to (Hennes, 2019) Schroth Body Blocks are showing the development from an anatomical description of different body parts to a curve specific definition (see Figure 3).

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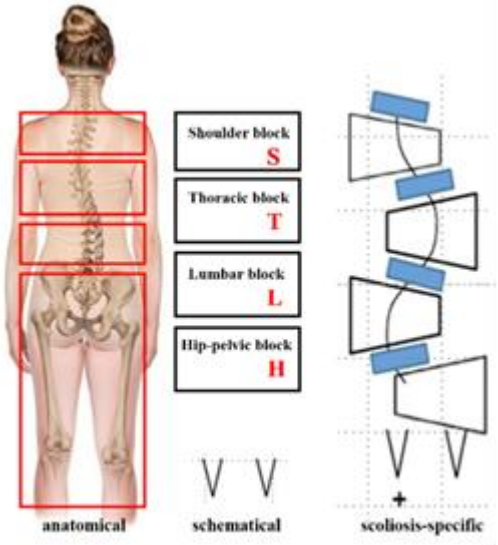

Figure 3. Schroth Body Blocks

In Figure 3, according to (Hennes, 2019) the capital letters name the body blocks as follows:

- H represents the hip-pelvic block including the lower limbs that reach the lower end vertebra (LEV) or lower end of the thoracic curve respectively (T H - Type);
- L represents the closed lumbar block of the upper end vertebra (UEV) and the lower end vertebra (LEV) of the lumbar curve or of the thoracolumbar curve, respectively;
- T represents the thoracic block between the upper end vertebra (UEV) and the lower end vertebra (LEV) of the thoracic curve;
- S is the block of the shoulder represented by the cervical thoracic curve located between the upper end vertebra (UEV) of the thoracic curve and the upper end vertebra (UEV) of the proximal thoracic curve.

According to the Schroth classification, for the scoliosis curve, different types of scoliosis always start with a major curve, followed by relevant secondary curves.

The rehabilitation program for Schroth-3D scoliosis is mainly dedicated to idiopathic scoliosis, where the rehabilitation of juvenile idiopathic scoliosis (JIS) involves a less intense and modified Schroth-3D scoliosis program, and the rehabilitation of adolescent idiopathic scoliosis (AIS) uses a rehabilitation with special Schroth exercises aimed at preventing the progression of the curve before the end of growth.

The Schroth-3D scoliosis rehabilitation method is a personalized therapy where physiotherapists work individually with the patient on a personalized program of exercises specific to rehabilitation. Thus, the Schroth exercise program is chosen based on age, medical history, postural imbalance and the severity of the Cobb angle of scoliosis.

The first phase of the rehabilitation program focuses on correcting body position with five pelvic corrections that are learned before performing the main correction exercises.

These five pelvic corrections are:

- correction in sagittal plane, in standing positions;
- correction in frontal plane, medial shift and weight shift;
- correction in sagittal plane and basic tension;
- correction in transverse plane with rotation;
- correction in frontal plane and adjustment of the iliac crest.

A physiotherapist will exemplify the alignment of the position, starting with the legs, pelvis, showing you how to set your pelvis and adjust your weight and body angles. The emphasis is on aligning the rib cage on the pelvis and then positioning the head above the ribs. During the application of these corrections, the patient is taught how to de-stress the concave areas of the trunk and how to reduce the protrusions.

The method uses equipment such as: mirrors that help patients visualize their corrections, the stair wall and elongation strips to lengthen the spine and support elements such as rice bags to help position the torso.

In the second phase, the program focuses on activating newly acquired corrections, this being called the muscular endurance training phase. The physiotherapist will follow the active elongation and extension of the patient's body using the concepts of traction that stretch the body upwards, lengthening the high and less compressed areas. By extending these areas the scoliotic curve is drawn closer to the midline.

After the phase of active elongation and expansion, the exercises will be dedicated to rotation, rotation that shapes the ribs in a way that leaves some areas of the rib cage relatively flat, using active

diaphragmatic breathing techniques, emphasizing breathing in areas that are more concave. to help them expand and help de-rotate the spine.

Usual exercises that are part of the scoliosis rehabilitation program by the Schroth-3D method

Although in the rehabilitation program, Schroth exercises are customized for each patient, there is a group of four exercises that are used more frequently. These are:

- the "50 x Pezziball" exercise. The patient sits on a stability ball in front of a corrective mirror. The principles used by the exercise are self-elongation and activation of the trunk muscles that force the convexities of the trunk forward and inward, and the concavities of the trunk outward and backward. During the exercise, a wall trellis is used that helps the patient to actively self-correct his spine in 3D;
- the "Prone" exercise. The patient lies face down on a carpet. During the exercise, objects such as: tubes, belts, bags of rice are used and techniques are applied to correct the thoracic curve, by the traction and counter-traction of the shoulder, and the lumbar curve by activating the iliopsoas muscle;
- the "Sail" exercise. The patient sits on half a roll of foam and holds two vertical poles and performs an active stabilization. The upper shoulder area represents the weak concavity according to Schroth principles. During active stabilization, the patient consciously expands the left rib cage with right directional breathing, opening the collapsed left lung, while maintaining 3D postural correction. This is an effective stretching exercise that helps to lengthen the chest cavity;
- the "Muscle-cylinder" exercise. The patient is on his side with the convex curve of the lower spine facing down. This exercise focuses on correcting the lumbar scoliosis curve by using the quadratus lumborum muscle. The patient's right arm is supported on a chair, and the patient's right leg is supported by a smaller chair during the exercise, the lumbar convexity is supported by a bag of rice for horizontal alignment of the spine.

As part of the Schroth-3D rehabilitation program, a personalized session lasts one hour in the rehabilitation center.

Hypothesis of the research

In recent years, due to the appearance in guide 2016 SOSORT (Negrini, Donzelli, Aulisa, et al., 2018), as well as due to high quality studies that support the effectiveness of exercises specific to scoliosis physiotherapy, the method of rehabilitation of Schroth-3D one of the most widely used specific exercise programs for scoliosis (Berdishevsky, Lebel, Bettany-Saltikov, et al., 2016).

In the last year, due to the appearance of the COVID 19 virus, a large part of the world has become blocked, the intimacy and normality of a therapeutic room for the procedures of the Schroth method, for the treatment of scoliosis, has become impossible. Thus, the substitute was proposed to be virtual teletherapy sessions.

Our research has studied the effectiveness of the Schroth-3D scoliosis rehabilitation method in a rehabilitation center and the proposal of a teletherapy scoliosis rehabilitation program, a program supported by the patient online at home.

Research Methods

From the study group, a group of 5 patients (three girls and two boys) with Adolescent Idiopathic Scoliosis aged between 11 and 17 years followed, within a rehabilitation center, a specific individual scoliosis rehabilitation program based on the method Schroth-3D, for 6 months.

Another study group, consisting of 5 patients (three girls and two boys) with Adolescent Idiopathic Scoliosis aged between 11 and 16 years, followed, through teletherapy, a specific individual program for the rehabilitation of scoliosis based on the Schroth-3D method, for 24 weeks.

The study included the following inclusion criteria: a diagnosis of Adolescent Idiopathic Scoliosis, an age of 10-18 years, a Cobb angle of 10^0 to 60^0, a Risser sign of 0-3, and patients are under no circumstances. another treatment that could affect the rehabilitation of scoliosis.

At the start of the study, no patient was wearing a corset.

Patients agreed to participate in our study.

The following measurements were made in this study:

- Cobb angle measurement;
- measuring the rotation angle using the scoliometer;
- measuring waist asymmetry.

All measurements were centralized before treatment and then in the 8th, 16th and 24th weeks.

The measurements used:

- Adam's test was used to check for prominence and changes in the ribs and spine. During the test, the maximum height of the hump was measured with a ruler, three times after which the average value of the measurements was made;
- Before the study, each patient had an X-ray of the entire spine, in the anterior-posterior direction of the legs. After each radiograph, the Cobb angle was measured as in Figure 2;
- an asymmetry of the waist was calculated standing, the difference between the distance between the trunk and the arm being measured, with a rigid ruler, on the same

horizontal line at the midpoint of each concavity of the waist.

After selecting the patients, they were examined and measured: height, weight, Cobb angle, after which the results together with the patient's age generated the patient's observation sheet. Based on the patient observation sheet, the physiotherapist created a personalized Schroth-3D scoliosis rehabilitation program for the first 4 weeks at the rehabilitation center.

The program included specific Schroth exercises for spine elongation, de-rotation, de-flexion, stretching, strengthening, and active diaphragmatic breathing techniques to maximize correction and maintain spine alignment. Under the supervision of the physiotherapist, the program was supported by 4 weekly sessions of one hour each.

The patients from the "teletherapy" group were examined and measured: height, weight, Cobb angle, after which the results together with the patient's age generated the patient's observation sheet. Based on the patient observation sheet, the physiotherapist created a customized Schroth-3D scoliosis rehabilitation program for the first 4 weeks of the teletherapy program at home. A minimum of objects was required: bags of rice, a ball of different sizes, support sticks and necessarily a vertical mirror, for the correction of the exercise.

All subjects were examined every four weeks for a period of 24 weeks. All measurements performed at the beginning of the study were repeated in the 8th, 16th and 24th weeks, the results being compared between the two study groups.

Results

The study group included 10 patients, 6 girls and 4 boys, with Adolescent Idiopathic Scoliosis, divided into two study groups:

- the group of patients, with rehabilitation within the center, consisting of a number of 5 people, aged between 11 and 17 years, with a weighted average, for the age of 13,8 ± 2.31 years, for a weight of 50,6 ± 7,17 kg, for the height of 1,61 ± 0,09 and for the Cobb angle of the curves was 28,6° ± 4,02° (between 24° and 35°) according to Table 1;

Table 1. The physical characteristics of patients, with Schroth-3D program in the rehabilitation center

	Characteristics		Mean ± SD
1	**Age**	(year)	**13,8 ± 2,31**
2	**Weight**	(kg)	**50,6 ± 7,17**
3	**Height**	(cm)	**1,61 ± 0,09**
4	**Cobb angle**	(degree)	**28,6 ± 4,02**

- group of patients, with rehabilitation by teletherapy, consisting of a number of 5 people, aged between 11 - 16 years, with a weighted average, for age of 13,8 ± 1,93 years, for weight of 48,2 ± 8,84 kg, for the height of 1,64 ± 0,09 and for the Cobb angle of the curves was 28,0° ± 4,89° (between 22° and 36°) according to Table 2.

Table 2. The physical characteristics of patients, with Schroth-3D teletherapy program

	Characteristics		Mean ± SD
1	**Age**	(year)	**13,8 ± 1,93**
2	**Weight**	(kg)	**48,2 ± 8,84**
3	**Height**	(cm)	**1,64 ± 0,09**
4	**Cobb angle**	(degree)	**28,0 ± 4,89**

The assessment of the basic comparability of the study groups did not show significant differences in terms of demographic characteristics. It can be seen that the basic clinical feature, the Cobb angle, was similar among the selected study groups.

Following the centralization of the results obtained after 8 weeks, 16 weeks and 24 weeks, a decrease in the Cobb angle was observed in patients who followed the Schroth program, held in a scoliosis rehabilitation center, but also, the Cobb angle decrease, in the case of the Schroth program by teletherapy, as can be seen from the data in Tables 3 and 4.

Thus, we can see that in the case of the group of patients who followed the Schroth program, held in a scoliosis rehabilitation center, the Cobb angle, on average, was 28,6º before treatment, decreased to 26,8º after 8 weeks, then it decreased to 24,7º after 16 weeks, and at the end of the study period, respectively 24 weeks, it reached the value of 21,4º.

In the case of the group of patients who followed the Schroth program by teletherapy, the Cobb angle was on average 28,0, before treatment, decreased to 27,2º after 8 weeks, then decreased to 25,3º after 16 weeks, and at the end of the study period, respectively 24 weeks, it reached the value of 23,1º.

Table 3. Cobb angle variation, for the Schroth program group, in the rehabilitation center (0, 8, 16, 24 weeks)

Parameter (N=5)	Pre-treatment (Mean ± SD)	After 8 weeks (Mean ± SD)	After 16 weeks (Mean ± SD)	After 24 weeks (Mean ± SD)
Cobb angle (degree)	**28,6 ± 4,02**	**26,8 ± 4,27**	**24,7 ± 4,41**	**21,4 ± 4,89**

Table 4. Cobb angle variation, for the group with Schroth program, by teletherapy (0, 8, 16, 24 weeks)

Parameter (N=5)	Pre-treatment (Mean ± SD)	After 8 weeks (Mean ± SD)	After 16 weeks (Mean ± SD)	After 24 weeks (Mean ± SD)
Cobb angle (degree)	**28,0 ± 4,89**	**27,2 ± 4,60**	**25,3 ± 4,51**	**23,1 ± 4,50**

In today's society isolated from the spread of COVID 19, there is little evidence that teletherapy rehabilitation helps in the treatment of patients with scoliosis. The question we asked ourselves is whether the rehabilitation of Schroth through teletherapy can be a solution in the rehabilitation of the patient with scoliosis.

For many years, the effectiveness of different types of exercise in the treatment of scoliosis has not been investigated in medical studies, but with the advent of guide 2011 SOSORT (Negrini, Aulisa, Aulisa, et al., 2012), the importance of exercise therapy with specific scoliosis (PSSE) has been validated in the treatment of adolescent idiopathic scoliosis (AIS). Thus, if the curvature of scoliosis is sufficiently mobile and the patient is able to change posture, the condition could be defined as unstructural or functional scoliosis, a situation in which we could be more effective with a conservative treatment of scoliosis and expect much better improvements. than in cases of scoliosis presented with a rigid spine (Kuru, Yeldan, Dereli, et al., 2016).

Our results in the group of patients who followed the Schroth program, held in a scoliosis rehabilitation center were consistent with the results of previous studies in the literature showing that the Cobb angle decreased in the rehabilitation program by the Schroth method- 3D.

I want to emphasize that the rehabilitation program by Schroth method is a personalized program of specific exercises coordinated only by a Schroth certified physiotherapist, so by this study we understood the importance of the direct relationship between the patient and the Schroth certified physiotherapist.

The conclusions after analyzing the results for the Cobb angle variation for the two study groups were as follows:

- in the case of the group of patients who followed the Schroth program, held in a Cobb angle scoliosis rehabilitation center, it was on average 28,6º before treatment, and decreased after 24 weeks to 21,4º;
- in the case of the group of patients who followed the Schroth program through teletherapy, the Cobb angle was on average 28,0º before treatment, and decreased after 24 weeks to 23,1º.

In conclusion, the Schroth rehabilitation program, held in a scoliosis rehabilitation center, proved superior to the Schroth program by teletherapy, in terms of analyzing the results of the evolution of the Cobb angle in patients in the groups studied.

We believe that this teletherapy exercise program can be integrated into the classic Schroth exercise program, held in a scoliosis rehabilitation center, as an alternative to the exercises proposed for home, on days when the patient does not come to the recovery center.

Author's contribution

All authors contributed equally to this study and should be considered as main authors.

References

Berdishevsky H., Lebel, V. A., Bettany-Saltikov, J. Rigo, M., Lebel, A., Hennes, A., Romano, M., Białek, M., M'hango, A., Betts, T., de Mauroy, J. C., Durmala, J., 2016, Physiotherapy scoliosis-specific exercises - a comprehensive review of seven major schools. *Scoliosis Journal*. https://doi.org/10.1186/ s13013-016-0076-9.

Cheng J. C., Castelein, R. M., Chu, W. C., Danielsson, A. J., Dobbs, M. B., Grivas, T. B., Gurnett, C. A., Luk, K. D., Moreau, A., Newton, P. O., Stokes, I. A., Weinstein, S. L., Burwell, R. G., 2015, Adolescent idiopathic scoliosis. *Nature reviews*. Disease primers, 1, 15030. https://doi.org/10.1038/nrdp. 2015.30.

Hennes A., 2019, International Schroth 3D Scoliosis Therapy, Training Manual Part I and Part II. Asklepios.

Kuru T., Yeldan, İ., Dereli, E. E., Özdinçler, A. R., Dikici, F., & Çolak, İ., 2016, The efficacy of three-dimensional Schroth exercises in adolescent idiopathic scoliosis: a randomised controlled clinical trial. *Clinical rehabilitation*, 30(2), 181–190. https://doi.org/10.1177/0269215515575745.

Lehnert-Schroth, C., 2007, Three-Dimensional Treatment for Scoliosis: A Physio therapeutic Method for Deformities of the Spine. Palo Alto: The Martindale Press.

Liang J., Zhou, X., Chen, N. *et al.*, 2018, Efficacy of three-dimensionally integrated exercise for scoliosis in patients with adolescent idiopathic scoliosis: study protocol for a randomized controlled trial. *Trials* **19,** 485 https://doi.org/10.1186/s13063-018-2834-x

Negrini S., Aulisa, A. G., Aulisa, L. Circo, A. B., de Mauroy, J. C., Durmala, J., Grivas, T. B., Knott, P., Kotwicki, T., Maruyama, T., Minozzi, S., O'Brien, J. P., Papadopoulos, D., Rigo, M., Rivard, C. H., Romano, M., Wynne, J. H., Villagrasa, M., Weiss, H. R., Zaina, F., 2012, 2011 SOSORT guidelines: Orthopaedic and Rehabilitation treatment of idiopathic scoliosis during growth. *Scoliosis* 7:3 https://doi.org/10.1186/1748-7161-7-3.

Negrini, S., Donzelli, S., Aulisa, A. G., Czaprowski, D., Schreiber, S., de Mauroy, J. C., Diers, H., Grivas, T. B., Knott, P., Kotwicki, T., Lebel, A., Marti, C., Maruyama, T., O'Brien, J., Price, N., Parent, E., Rigo, M., Romano, M., Stikeleather, L., Wynne, J., Zaina, F., 2018, 2016 SOSORT guidelines: orthopaedic and rehabilitation treatment of idiopathic scoliosis during growth. *Scoliosis* 13, 3 https://doi.org/10.1186/s13013-017-0145-8.

Wapstra F. H., Veldhuizen, A. G., 2012, Hypothesis on the Pathogenesis of Idiopathic Scoliosis, Recent Advances in Scoliosis. IntechOpen, DOI:10.5772/ 38307.

Weis, H. R., Negrini, S., Rigo, M., Kotwicki, T., Hawes, M. C., Grivas, T. B., Maruyama, T., Landauer, F., 2006, Indications for conservative management of scoliosis (guidelines). *Scoliosis* 1, 5 https://doi.org/10.1186/1748-7161-1-5.Weiss H. R. (2010). Spinal deformities rehabilitation - state of the art review. *Scoliosis*, 5, 28. https://doi.org/10.1186/1748-7161-5-28.