

## Design and Fabrication of Mechanical Bed-system for Treatment of Adolescent Idiopathic Scoliosis

Tochukwu Nze Ugorji <sup>1\*</sup>, Nwakamma James Ifeanyi <sup>2</sup>

<sup>1</sup>Department of prosthetics and Orthotics, School of Health Technology, Federal University of Technology owerri, Nigeria.

<sup>2</sup>Department of Prosthetics and Orthotics, Federal College of Dental Therapy and Technology, Enugu, Nigeria.

Correspondence to: Nze Ugorji t. (E-mail: [tochukwum43@yahoo.com](mailto:tochukwum43@yahoo.com).)

### Abstract

**Background:** Scoliosis is a sideways curvature of the spine that occurs most often during the growth spurt just before puberty, which poses a postural disorder to individuals and also makes them walk with pain.

**Aim:** the aim of this study is to design and develop a mechanical bed-system that will be used to conservatively manage adolescent scoliosis effectively and efficiently by reducing cobb angle and pain.

**Materials and Methods:** materials needed are; Orthopaedic bed, Metal bars, Orthopaedic Foam, Fabrics, Metal pads, Metal bolts and nuts, Metal pipes. The methods followed are; fabrication of six-spring patient's bed with the metal bars and then fixing six-spring foam on the bed. It was followed by fabrication/formation of metal pads for application of force on the patient's spine, while lying down on the bed-system and then attachment of the foam pads to the metal pads. Three stands with a bolt and nut for attachment of the metal pads were fabricated and the components were fixed together.

**Result:** the mechanical bed-system comprised of a metal bed, mattress, counter pressure pad, adjustable screws and metal stand.

**Discussion:** although, bracing, casting and physiotherapeutic manipulations can reduce the cobb angle of scoliosis over a period of time (months). However, it is now believed that this device had given rise to a new method/technology that can stop and also reduce scoliosis curves more effectively and efficiently.

**Conclusion:** The mechanical bed-system exerts more and tolerable pressure to the spine than the bracing and casting method, hence a better outcome.

**Keywords:** Scoliosis, Adolescence, Treatment, Mechanical Bed-system, Manipulation

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### 1. Introduction

Scoliosis had being defined as a sideways curvature of the spine that occurs most often during the growth spurt just before puberty. Scoliosis can be seen as a 'C or S' shaped curve of the spine that can be caused by conditions such as cerebral palsy and muscular dystrophy,

with majority of it not having a known cause, thereby referred to as idiopathic scoliosis [1].

Scoliosis causes the spine to bend to one side and can affect any part of the spine, but the most common regions are at the level of the chest and the lower back [2]. It often appears in children (adolescent). In most cases, treatment is not needed, as the curve corrects itself with growth. However, based on the degree of curvature and the age of the child, a treatment that



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combines bracing and physical therapy is often recommended [3-5]. Most cases of scoliosis are mild, but some children develop spine deformities that continue to get more severe as they grow. Severe scoliosis can be disabling, as it can reduce the amount of space within the chest, making it difficult for the lungs to function properly and also cause painful conditions [2, 4, 5]. Children who have mild scoliosis are monitored closely, usually with X-rays, to see if the curve is getting worse (increasing Cobb angle). In many cases, no treatment is necessary. Some children will need to wear a brace to stop the curve from worsening. Others may need surgery to keep the scoliosis from worsening and to straighten severe cases of scoliosis. Signs and symptoms of scoliosis may include: Uneven shoulders, one shoulder blade that appears more prominent than the other, uneven waist, one hip higher than the other [2, 4, 6].

Individuals with scoliosis tend to have a postural disorder and also walk with pain. Different treatment options available for rehabilitation of individuals with scoliosis may include; spinal manipulation with braces and various physiotherapeutic procedures. A good result can be achieved in pediatrics and adolescent scoliosis cases than in adult cases because of ossification period/skeletal maturity. However, the combination of spinal manipulation and various physiotherapeutic procedures used to correct the curvatures associated with scoliosis might not give required results most times [6, 7]. In this study, we intend to design a mechanical bed-system that will exert a greater, tolerable and adjustable pressure on the spine, thereby give a faster, easier, effective and efficient correction of abnormal spinal curvatures (scoliosis). The mechanical bed-system is to comprise of an orthopaedic bed, foam, three metal stands with adjustable screws and nuts, and three metal pressure pads padded with foam and leather.

Most individuals with scoliosis face a prolonged rehabilitation period, using conservation method of treatment like braces and casting. The rehabilitation of such patients does not give the desired outcome at times because of less effectiveness and efficiency of bracing system which is prone to abuse of the treatment by patients and also does not apply the required force to the spine, especially in adolescent

cases [2, 8]. Hence, it has become imperative to design and develop a method of conservatively treating scoliosis that will take less time, apply a higher but tolerable force, ensure patient's compliance because the treatment will be administered to patients while on hospital admission and thereby give an effective and efficient treatment/rehabilitation of such individuals.

If a scoliosis curve gets worse, the spine will also rotate or twist, in addition to curving side to side. This causes the ribs on one side of the body to stick out farther than on the other side. The cause of most common type of scoliosis is not known (idiopathic), although it appears to involve hereditary factors; because the disorder tends to run in families. Less common types of scoliosis may be caused by: Neuromuscular conditions; such as cerebral palsy or muscular dystrophy, Birth defects affecting the development of the bones of the spine, Injuries to or infections of the spine [5, 7, 10].

However, risk factors for developing the most common type of scoliosis include: Age, sex, family history and occupation. Signs and symptoms of scoliosis typically manifest during the growth spurt that occurs just prior to puberty. Although both genders develop mild scoliosis at about the same rate, research has shown that the female gender have a much higher risk of the curve worsening and requiring treatment. Scoliosis like some other medical conditions can run in families, but most children with scoliosis might not have a family history of the disease. People whose daily job involves prolonged standing or standing in a wrong ergonomic position may be predisposed to scoliosis.

The Scoliosis Association of the United Kingdom describes five main types of scoliosis as: Congenital scoliosis; which when the spine does not form correctly before birth. Early-onset scoliosis appears between birth and 10 years, adolescent idiopathic scoliosis; which occurs as the child grows, leading to a curving and twisting of the spine without a known medical cause, degenerative scoliosis; this can affect adults due to wear and tear of the skeletal system, whether or not they already have scoliosis, Neuromuscular scoliosis stems from a problem with

the muscles or nervous system, Scheuermann's kyphosis, where the front sections of the vertebrae grow more slowly than the back sections, making them smaller, Syndromic scoliosis is linked to one of a range of syndromes, including Marfan's syndrome and trisomy 21.

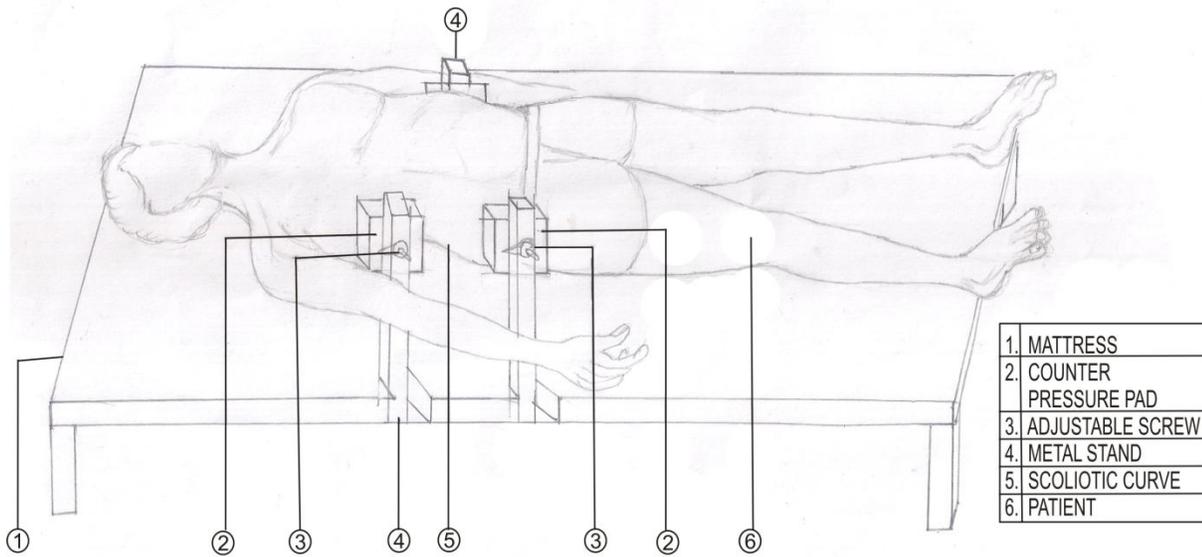
While most people with scoliosis have a mild form of the disorder, scoliosis may sometimes cause complications which may include: lung and heart damage occurring in severe scoliosis where the rib cage may press against the lungs and heart, making it more difficult to breathe and harder for the heart to pump. Scoliosis can also predispose adults who had scoliosis during childhood to chronic back pains and other postural problems involving the back. As scoliosis worsens, it can cause more noticeable changes in appearance like: unlevel shoulders, prominent ribs, uneven hips, and a shift of the waist and trunk to the side. Individuals with scoliosis often become self-conscious about their appearance.

Most children with scoliosis have a mild curve that may not require treatment. The professional caregiver usually recommend following up every 4 to 6 months to monitor the curve (cobb angle) of the spine in clinic and periodically with X-rays [1, 2]. However, scoliosis presenting with large curves (cobb angle) tend to get worse with time and hence require immediate intervention/treatment before skeletal maturity is attained by the individual. The sex of the patient is also taken into consideration, as scoliosis is likely to gradually get worse in females than males. The location of the curve is also considered during treatment plan, as curves located in the center part of the spine are likely to get worse compared with curves in the lower or upper sections of the spine. Age of the patient is another important factor of consideration during scoliosis treatment because the risk of the curve worsening is lower if the person had attained skeletal maturity (bones have stopped growing).

Scoliosis can be treated with Casting, bracing and therapeutic manipulations of the spine. Casting instead of bracing is sometimes used for infantile scoliosis to help the infant's spine to go back to its normal position as it grows. This can be done with a cast made of plaster of Paris. The cast is attached to

the outside of the patient's body and will be worn at all times. Because the infant is growing rapidly, the cast is changed regularly to avoid compactment syndrome/ischemia.

If the patient has moderate scoliosis and the bones are still growing, the professional caregiver may recommend a brace. A brace is a molded/laminated plastic from the model of patient's torso/spine used to prevent the curve from progression or getting worse prevent but will not cure or reverse it. Braces are usually worn all the time, even at night. The more hours per day the patient wears the brace, the more effective it tends to be. The brace does not normally restrict what the child can do. If the child wishes to take part in physical activity, the braces can be taken off. The common braces used for treatment of scoliosis are; Thoracolumbosacral orthosis (TLSO) known as Boston brace, Cervicothoraciclumbosacral orthosis (CTLSO) known as Milwaukee brace and Charleston bending brace. Boston brace is a molded plastic from the user's body (torso) mold, used to treat adolescent idiopathic scoliosis. It wraps round the trunk from under the armpit, to the thorax (rib cage), down to the lower back and hip. It aims at positioning the spine in normal biomechanical alignment. It is normally used for patient whose spine curvature is within  $25-40^{\circ}$  to halt the progression of the curve, till patient attains skeletal maturity. It is advised to be worn for about 18-23hours per day to be effective and minimize the possibility of the curve's progression. Milwaukee brace has a similar design with TLSO but the difference is that CTLSO includes a neck ring in addition to TLSO, which is held in position by vertical bars attached to the brace. It is used to support/stabilize the neck and the spine, but though less comfortable to wear especially in hot or humid time. It is used to treat scoliosis and kyphosis. Charleston brace is designed to hold the patient in maximum side bending correction and only worn at night, hence known as night-time brace for the treatment of idiopathic scoliosis. However, according to Christian Nordqvist and William Morrison, Bracing is commonly recommended for children with a scoliosis curve measuring 25 to 40 degrees. Scoliosis braces cause the muscles to weaken or atrophy because they aren't used



**Figure 1:** Mechanical bed-system for treatment of adolescent idiopathic scoliosis

## 2. Materials and Methods:

The materials needed to achieve this work are; Orthopaedic bed, Metal bars, Orthopaedic Foam, Fabrics, Metal pads, Metal bolts and nuts, Metal pipes.

The methods to achieve this study are:

1. Fabrication of iron six-spring patient's bed with the metal rods and pipes (stainless-steel).
2. Fixing six-spring foam on the bed.
3. Fabrication/formation of metal pads for application of force on the patient, while lying down on the bed-system.
4. Attachment of the foam pads to the metal pads.
5. Fabrication of three metal uprights/stands with a bolt and nut for attachment of the metal pads
6. Fixing of all the components together

The diagram in figure1 shows the schematic diagram of the mechanical bed-system, comprising of mattress, counter pressure pad, adjustable screws,

metal stand and a patient with scoliosis curve fit on it. The mattress is to give comfort when the patient is lying down. The counter pressure pads are to give a counter pressure to the pressure applied by the pressure pad on the metal stand labeled [4]. The adjustable screws make provision to move the pressure pads up and down as may be wanted. The metal stands make provision for attachment of the pressure pads. The parameters for evaluation of the effectiveness of the device will include; associated pain before and after use of the designed mechanical bed-system, degree of associated curve (cobb angle) before and after use of the mechanical bed-system, postural appearance before and after use of the mechanical bed-system.

## 3. Results and Discussion

Scoliosis is one of the major postural challenges associated with the skeletal system. It at times affects the functional abilities of affected individuals due to associated pain and discomfort. Effective management/rehabilitation of affected individuals is not usually easy, especially in adolescent and adults.

Studies have shown that bracing, casting and physiotherapeutic manipulations can reduce the cobb angle over a period of time (months). It is now believed that this device had given rise to a new method/technology that can stop and also reduce scoliosis curves more effectively and efficiently.

#### 4. Conclusion

Studying the effectiveness and efficiency of methods/technologies used in rehabilitation of individuals with scoliosis is very pertinent as this will give rise to advancement of existing methods and development of new methods/technologies that will give a better outcome and make life easy for affected individuals. This study looked at developing a mechanical bed-system will exert more and tolerable pressure to the spine than the bracing and casting method, hence give a better treatment outcome.

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