Low costs technology alternative for diagnosing scoliosis utilizing computerized technologies

By: Udoka Okoye
Mentor: Dr. Cecilia Vigil
Truckee Meadows Community College
Department of Biology
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Introduction

Scoliosis makes up 20 percent of spinal deformity diseases in the United states. Scoliosis is a sideways curvature of the spine that occurs most often during the growth spurt just before puberty. While scoliosis can be caused by conditions such as cerebral palsy and muscular dystrophy, the cause of most scoliosis is unknown (idiopathic). This spinal deformity is difficult to accurately diagnose, and appropriate treatment relies heavily on the severity. While X Rays are cost effective, it is difficult to label and identify affected vertebrae in the spine and to then apply Cobb angle, the current leading diagnostic tool. Abdullah-Al-Zubaer, et al, 2020 have developed a fully automated method that algorithmically can accurately identify affected vertebra. Our goal is to replicate this process, methodology, and form of diagnosis, which is a low technology alternative.

Figure 1. Xray spinal scoliosis

Diagnosis and Treatment

Scoliosis is usually confirmed through a physical examination, an x-ray, spinal radiograph, CT scan or MRI. The curve is measured by the Cobb Angle Method, this technique is used internationally and aids in intensifying spinal deformities and following the progression of the curvature. This method is performed by pinpointing the most tilted vertebrae at the beginning and end of the spinal curvature and illustrating a converging line from both vertebral end plates to create an angle. The angle identified is determined to be the Cobb angle and is diagnosed in terms of severity by the number of degrees. Adult scoliosis is defined as a spinal deformity in a skeletal mature patient with a Cobb angle of more than 10°. With this method, doctors are able to determine a treatment plan appropriate for their patient based on the angle obtained. Depending on the severity of the angle, some patients will not require treatment, however some may require a back brace and in extreme cases surgery may need to be performed to correct the spinal curvature using spinal fusion.

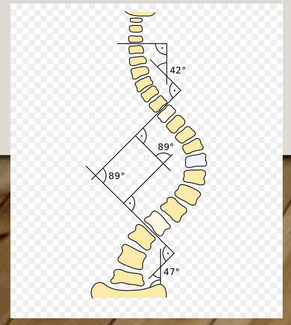

Figure 2. Dx & Tx Chart from American Academy of Family Physicians

Table 3. Treatment and Referral Guidelines for Patients with Scoliosis

Cobb angle (degrees)	*Risser grade*	*Radiography/referral*	*Treatment*
10 to 19	0 to 1	Radiography every six months, no referral	Observe
10 to 19	2 to 4	Radiography every six months, no referral	Observe
20 to 29	0 to 1	Radiography every six months, referral	Brace after 25 degrees
20 to 29	2 to 4	Radiography every six months, referral	Observe or brace*
29 to 40	0 to 1	Referral	Brace
29 to 40	2 to 4	Referral	Brace
> 40	0 to 4	Referral	Surgery†

Figure 3. Xray photography to convert to jpeg for computer use.

Methods

In the beginning of this research study, we proposed that images of cadavers suffering from scoliosis derived from a virtual dissecting table, were going to be utilized in applying the techniques from the Abdullah-Al-Zubaer, et al, 2020 study. However, we acquired X-ray negatives of patients with scoliosis, each with varying severities of deformity, and converted these to Jpeg via photography. The diagnosis method next performed, utilized ImageJ, a Java-based image processing program developed at the National Institutes of Health and the Laboratory for Optical Computational Instrumentation. This program allowed us to generate the intersecting lines within the affected scoliotic area by drawing a line perpendicular to the superior rim of the top most affected vertebral body and a second to the inferior rim of the bottom most affected vertebrae, which gave us the Cobb angle; and yet like in the case of manual measurements, this technique became cumbersome when identifying and measuring affected vertebra. Our next step is to replicate the binary segmentation process (see simulation below using photoshop to crop out each vertebra) utilized by Abdullah-Al-Zubaer, et al, 2020, and then the second algorithmic program which measures slope and angulations (see spine geometry formula that is used when finding the Cobb angle calculated by Dr. Kurt Ehlers) to then correlate results with radiographic measurements of deformity on patient-based measures of adult scoliosis. Dr. Kurt Ehlers is developing spine geometry formula that is used when finding the Cobb angle to compare with our results.

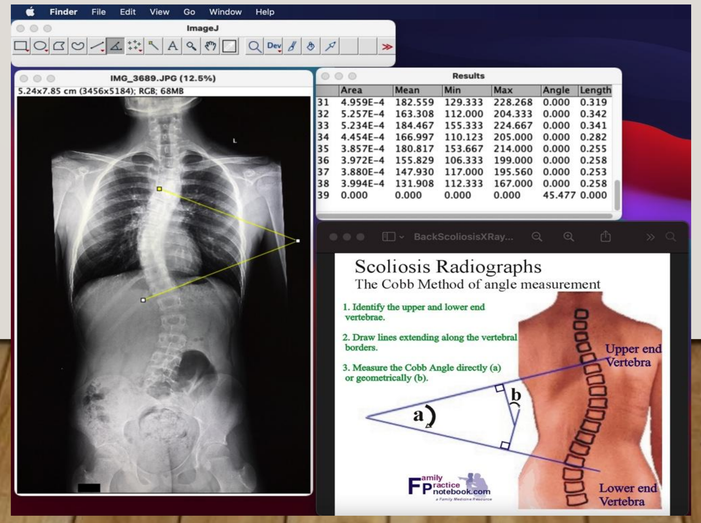

Figure 4. Cobb angle calculation utilizing ImageJ

Future Research

Ongoing research to continue in the fall, as methodologies are developed.

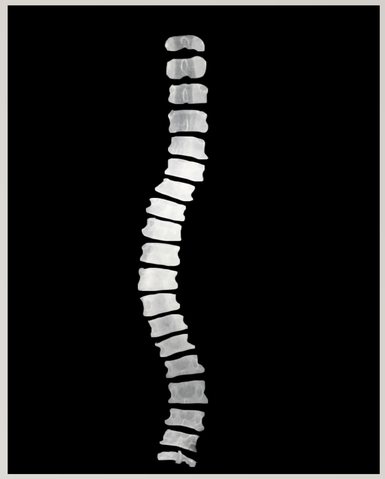

Figure 5. Vertebrae segmentation using photoshop

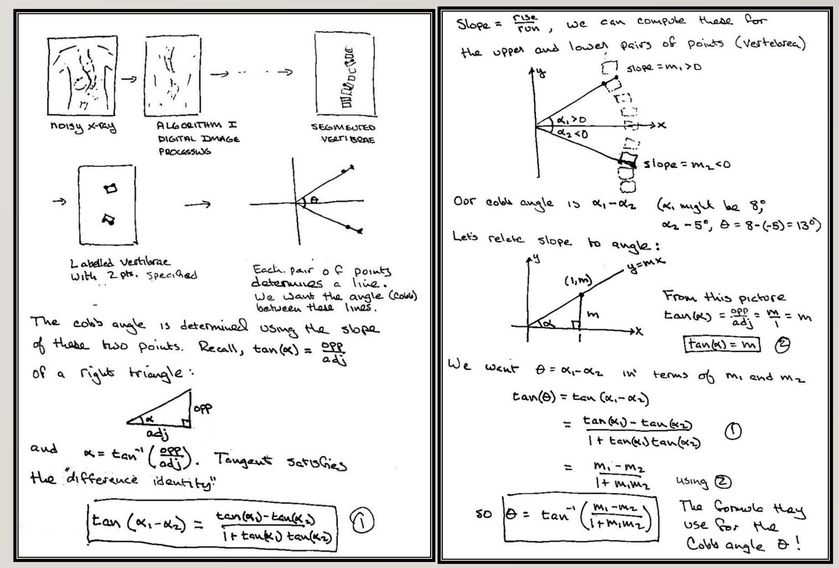

Figure 6. Dr. Ehlers Spine Geometry

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