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Development of Precision Measurement Technologies for Early Diagnosis of Postural Disorders

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Abstract – Nowadays, precise measurement technologies based on position sensors are needed for early diagnosis of posture disorders. It is aimed for healthcare professionals to use these technologies for screening purposes. In addition, following the results of the community-based screening program in the pilot regions and gathering the data obtained in a centralized system, making predictions about the country in general and the development of coefficients related to the sensitive measurement technology produced by age group, gender and body structure, and the sensitivity of posture disorders in health workers and society, it is aimed to create. The scientific report on the outputs of the project will be shared with health authorities, and sensitive and practical measurement technologies related to posture disorders, especially adolescent spine disorders, will be developed and recommendations for future strategies for a healthy generation will be made. The project will bring innovative insights into the musculoskeletal health screening programs of adolescents who are particularly at risk from spinal disorders with modern technologies and increasing cumulative trauma.

Keywords – posture, posture analysis, early detection of posture, posture analysis with sensors, inclination sensors

I. Introduction

Today, the most common method used for posture analysis is X-rays. The most detailed diagnosis can be made by this method. However, exposure to x-rays during x-ray is not good for human health. For this reason, it is not possible to use in health screenings for young children [1].

Although not widely used, the other method is image processing [2],[3]. Posture analysis can be performed with the filters and procedures to be applied on the image of the photographed posture. Moiré Pattern is used in image processing methods. With the Moiré Pattern, depth can be added to a photograph taken in a two-dimensional plane.

Static posture analysis with spinal mouse is also performed. By moving the mouse sensor on the spine plane, the shape of the spine is revealed. However, this technique does not allow measurement during movement [4],[5].

In this study, measurement techniques with sensors that can be used in health screening for widespread use have been studied.

Inclinations on the body spine are used for posture analysis. There are 3 curves in the sagittal plane. These are cervical lordosis, thoracic kyphosis, and lumbar lordosis curves. All these curves should be within a certain angle value.

Cervical lordosis occurs between C1 vertebra and C7 vertebrae. Thoracic kyphosis occurs between the T1 and T12 vertebrae. The lumbar lordosis is between the L1 and the L5 vertebra. In our study, measurements were made on the slopes of the vertebrae where the curvatures begin and end.

The accepted curvature values in the literature are 30º-35º for cervical lordosis, 40º for thoracic kyphosis, 45º for lumbar lordosis. [6]

There should be no curvature for a healthy individual on the spine in the frontal plane. Curvatures on the frontal plane cause scoliosis.

II. Materials and Method

The gyroscope was used to measure all of these curvatures. A vest is designed for easy attachment and removal on the back.

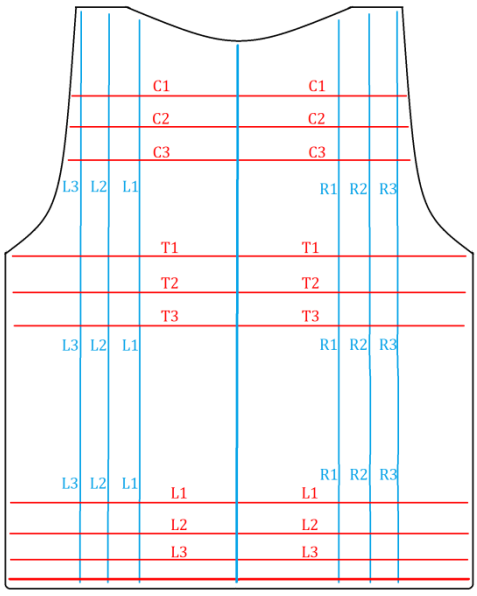

Figure 1 Measuring points on vests

The front and back of this vest were made of different fabrics. In the front part was used non-stretch fabric. Stretch fabric was used on the back to flex and fit perfectly on the back.

Fig. 2 Front of designed vest

Fig. 3 Back of designed vest

Figures 2 and 3 show the visual appearance of the vest. Measurements were made on anatomical model.

Matrices were created to allow measurements over the spine line at the level of the C7-T1 vertebrae where the thoracic region at which the cervical region ends. Two sensors were placed in the frontal plane for the right and left sides.

Matrices were created for the right and left parts to be measured on the frontal axis as in the thoracic region at the level of the T12-L1 vertebrae where the lumbar region began.

The last 0 point was created in the region where the L4-L5 vertebrae of the lumbar region were formed and matrices were formed in these regions as in the thoracic and lumbar regions.

Pelvic curve measurements were not performed in this period. For the cervical region studies, the standard of the vertically standing head was set in all measurements to be performed so that the position of C1 vertebra is 90º relative to the ground plane.

If measurements are only on the spine plane, it is not possible to compare the scapulas of the body and the angles of kyphosis and lordosis. Simultaneous measurements are made on the right and left sides of the body. Thus, differences between the right and left sides are detected.

For a healthy individual, measurements on the left side will also apply to the right side. All these measurements were performed on the anatomical model. These measurements were made in order to use as a reference in the programming stage.

Scoliosis curvatures were determined in single row spine measurements. But two-sided measurements were needed to measure the degree of curvature.

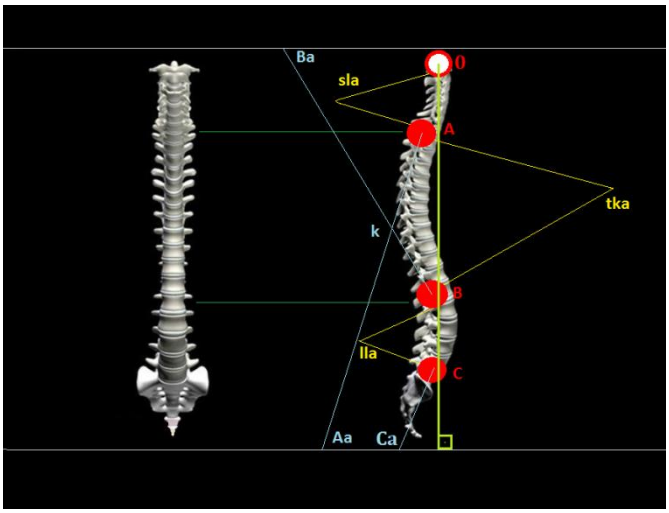

Fig. 4 Angular measurements for cervical, thoracic and lumbar regions

Shown in the Fig. 4 sla: cervical lordosis, tka: Trokal Kyphosis Angle, lla: Lumbal Lordosis Angle, Aa: Angle A, Ba: Angle B, Ca: C Angle, 0: Angular location where the vertebra of C1 is 90º in the cervical region.

The measurements can be carried out at 54 different points in 6 regions. There are 9 different points within a region depending on the body measurements of the person to be measured.

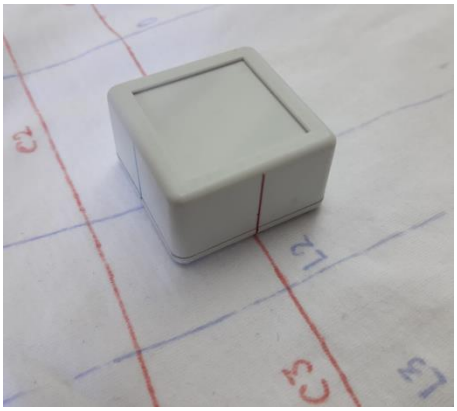

Fig. 5 Sensor on vest

There are guide lines on the measurement locations and sensors. Angular values were obtained for sagittal and frontal planes in 6 different regions. Box design was made to allow easy measurement of sensors. Digital gyroscopes were used in the measurements. The received data is transferred to the program on the computer via Bluetooth. It can be easily mounted and removed at the desired point. Right and left symmetrical measurements of scoliosis curves occurring in the frontal plane are determined. Trials for Cobb angle measurements are in progress. [7]

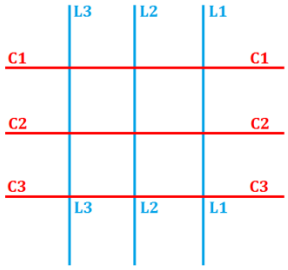

Fig. 6 Left cervical region

Table 1 Left Cervical Sagittal Plane Measurements

	L3	L2	L1	0
C1	25^0	23^0	22^0	0^0
C2	23^0	22^0	21^0	0^0
C3	20^0	19^0	19^0	0^0
0	0^0	0^0	0^0	0^0

Table 2 Left Cervical Frontal Plane Measurements

	L3	L2	L1	0
C1	3^0	2^0	1^0	0^0
C2	3^0	2^0	0^0	0^0
C3	2^0	1^0	0^0	0^0
0	0^0	0^0	0^0	0^0

These measurements were made in line with the T1 and T2 vertebrae where the thoracic region began. The same results were obtained on the anatomical model in the measurements on the right side as in Tables 1 and 2.

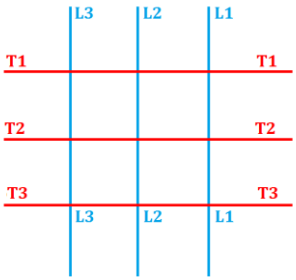

Fig. 7 Left Thoracic Region

Table 3 Left Thoracic Sagittal Plane Measurements

	L3	L2	L1	0
T1	-10^0	-9^0	-9^0	0^0
T2	-10^0	-9^0	-9^0	0^0
T3	-12^0	-11^0	-11^0	0^0
0	0^0	0^0	0^0	0^0

Table 4 Left Thoracic Frontal Plane Measurements

	L3	L2	L1	0
T1	1^0	1^0	1^0	0^0
T2	0^0	0^0	0^0	0^0
T3	0^0	0^0	0^0	0^0
0	0^0	0^0	0^0	0^0

These measurements were made at the level of t11 and t12 vertebrae where the thoracic region ends. The same results were obtained on the anatomical model in the measurements on the right side as in Tables 3 and 4.

III. Results

Thanks to digital instantaneous data, sensor measurement method is presented as an alternative to static posture techniques applied today. In this way, it is possible to perform dynamic posture analysis.

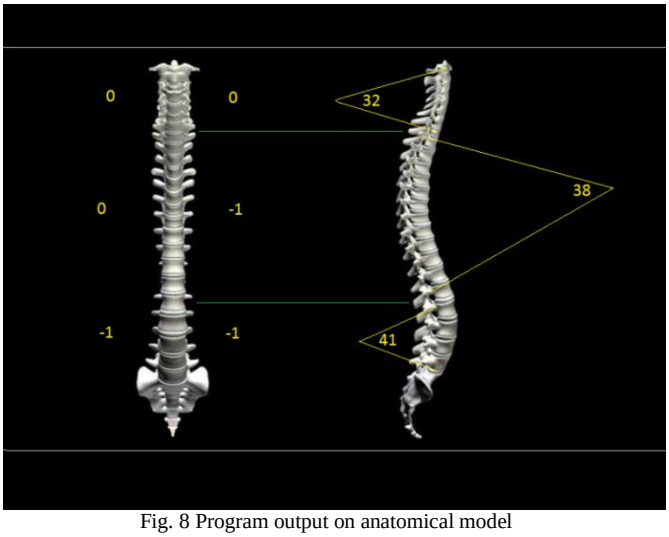

Fig. 8 Program output on anatomical model

As shown in Fig. 8, measurements were made close to the actual angle values. With this method, X-ray measurements can only be applied to patients with curvature of the body. Through this system, which is easy to use in health screening, it is possible to detect or predict spine curvatures in young children.

IV. DISCUSSION

The measurements made with this method are made with sensors mounted on the body back. Therefore, there are many parameters in the way when measuring the position angle of the vertebra from the point where the sensors are located. There are many factors such as the position error of the sensor on the vest, the failure of the vest to fit the body, the thickness of the skin and fat layer in the body. It is very important to choose the right vest that will fully enclose the body.

V. CONCLUSION

This method performs measurements on spine curvatures. In order to make the most accurate measurement, the height-weight index of the people to be measured is important. The results obtained are uncertain. Rather, it can be used to predict curvatures on the spine and to find out when curvatures begin in children. X-rays can be consulted if more detailed results are needed.

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