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Correlation Between Mobile Application Postural Changes and Radiological Findings in Adolescent Idiopathic Scoliotic Patients around the Head

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Abstract:

Background: In adolescence the idiopathic scoliosis is evident to occur in about 1.3% to 13% of the young population. Where a pathological lateral curvature appears on both young boys and girls, but obviously targeting more girls than boys. Scoliotic patients tends to make compensations to maintain the horizontal gaze including head compensations that might lead to deformities as the forward head and lateral tilt and rotational shifts about the cervical axis. Specifically, forward head posture, has been linked to compensatory mechanisms in patients with spinal deformities, including scoliosis especially in the thoracic region and the lumbar region.

Aim: This study investigates the correlation between mobile application postural changes and radiological findings in adolescent idiopathic scoliotic patients around the head

Subjects and Methods: Thirty adolescent females with age ranges from 14 to 17 years participated in this study. Translation and rotation of the head around the x and y axis of the head was measured by the Biotonix posture assistant mobile application and the spine was measured by the full spine x-ray to detect the radiological changes of the spine.

Results: There was a statistically significant correlation between posture changes of the head using the Biotonix posture assistant mobile application and the radiological findings using the x-ray

Keywords: Adolescent idiopathic scoliosis, Biotonix posture assistant mobile application

1. Introduction

In adolescence the idiopathic scoliosis is evident to occur in about 1.3% to 13% of the young population. Where a pathological lateral curvature appears on both young boys and girls, but obviously targeting more girls than boys (1,2,3,4). Scoliosis is a complicated deformation of the spine causing not only torsion, but also angulation and translation of the deformed spine that is simultaneously occurring in all the three plans (transverse, coronal, and sagittal). (5,6,7).

Untreated Scoliosis can create additional problems that do impair functioning and create postural imbalance where the head is no longer centered over the pelvis. This imbalance can force back muscles to work harder to maintain an erect posture that lead to muscle fatigue and pain and may lead to arthritic changes in the spine (2,8.9).

As scoliosis is a complex deformity it needs a precise evaluation that requires an erect antero-posterior radiograph of the full spine. Regarding the antero-posterior image, it reveals the internal bony configuration and shows to how extent the spine has been laterally deviated. Besides the radiograph can show various other measurements such as pedicle rotations; although, the method mostly advocated by the Scoliosis Research Society has been the Cobb's angle method.

When using the Cobb method, the angle that is calculated reveals to how extent the lateral curvature has been deviated within the affected region of the spine. Although the findings obtained by the Cobb method does not satisfy the whole description of the geometry of the spine and the associated complications and deviations (2, 10,11).

In this regard, there are several methods and trials to assess scoliosis and assess posture changes that may associate with scoliosis such as Computed Tomography (CT), Magnetic resonance imaging (MRI) and using three-dimensional reconstructed image so as to overcome the shortage of radiography as well as the dangers of this method that expose the child to the danger of radiation in every attempt to evaluate the degree of scoliosis (2, 12).

Therefore, this study was conducted to investigate the correlation between radiological assessments represent in Cobb angle and posture changes that may associated with scoliosis by using Biotonix posture assistant mobile application that provide analysis of posture for head, trunk and hip due to the lack of relation between scoliosis and changes that may occur and these may affect the treatment plan.

Materials and Methods:

Patients were recruited from varieties of orthopaedic departments belonging to Ministry of Health and the approach was performed in a private clinic and the ethical committee was obtained from Badr University in Cairo number IRB0001P4233-9.
Thirty patients, with age ranges from 14 to 17 years participated in this study.

Method:

Translation and rotation of the head around the x and y axis of the head was measured by two methods the Biotonix posture assistant mobile application and the full spine x-ray to detect the radiological changes of the spine

Participants of the study:

a. The number of participants: 30

b. Important characteristics

- Children (< 18 years):
- Gender: females
- Diagnosis: scoliosis

c. Inclusion criteria

Adolescents diagnosed with moderate to severe scoliotic curvature (Cobb's angle ranging from 40 to 60 degrees

d. Exclusion criteria

Previous surgical procedures of the spine.

Any pathologies that might affect the maintenance of an erect standing posture like in inner ear infections and problems or cerebellar damages.

Any deformity or pathology of the lower extremity that may interfere with the good posture such as discrepancy of the leg length or deformities of the hip, knee and ankle.

Instrumentation

The measurement in this study was done using two different types of instrumentation.

1- **Biotonix posture assistant mobile application** : it is anew posture **mobile application**, that is used to analyze postural changes. In this research the choice of the Biotonix posture assistant was based on the highly validity and reliability of the Biotonix video system which is proved to give accurate outcomes with the difference being of the mobile camera instead (21,)

2- X-ray of the spine as radiography where full spine PA x-ray was performed = for all patients. X-ray is the most common radiograph used to evaluate patients with scoliosis in the standing (PA) utilizing full length cassettes (14x36 inches).

Assessment procedures

A. Setting Up the Portable Calibration Canva

1. Assemble the aluminum frame by inserting each end into its respective number.

2. Slide the calibration canva on top and ensure the gray frame surrounding the calibration canva is even all around.

B. Setting Up the Standard Calibration Canva

1. Use 3 of the provided Velcros to first secure the top of the canva (one in each corner and one in the center) and let it unroll towards the ground.

2. Then, stretch the canvas tightly on each side and place a Velcro at the height of each calibration marker on the vertical border on each side.

3. Make sure the bottom edge of the canvas touches the ground and that the lower calibration markers are 12 inches or 30 centimeters from the ground, and place a Velcro in each corner.

C. Optimize the Picture Environment For Optimal Results

The following specifications will ensure precision of the Artificial Intelligence in detecting patients' deviation points.

- Distance between calibration canva and practitioner: 8 feet – 96 inches – 244 centimeters
- Distance between patient and calibration canva: 9 inches – 23 centimeters
- Distance between the ground and the camera lens: 33 inches – 84 centimeters
- Ensure the floor is level (not crooked) and perfectly perpendicular to the floor;
- Ensure the bottom (gray border) of the calibration canva is as close as possible to the ground;
- Ensure the patient isn't wearing socks and wearing tight clothes and that the color of the floor isn't similar to the skin color of the patient
- Take the photos from anterior , lateral and posterior view
- Image of participant are obtained from three directions : anterior , posterior , and lateral
- Digital markers are positioned on anatomic reference points by using software
- The software calculates distances and angles between digital markes
- The application will give the final results in a report

Results

General characteristics of subjects

The mean age of the patient group with adolescent idiopathic scoliosis (AIS) was 13.45 years, the mean values of their weight and height were 60.1 kilograms and 155.22 centimeters.

The standard deviation of age of the study group with adolescent idiopathic scoliosis was 1.123 and the standard deviation values of their weight and height were 8.32 and 6.66 (table 1).

Table 1: Mean and Standard deviation of the age, height and weight of the patient groups.

Variable	Number	Mean	Standard Deviation
Age	30	13.45	1.123
Weight	30	60.1	8.32

Height	30	155.22	6.66

The head with Cobb angle

Correlation analysis was performed in order to examine the relationship between head posture and radiological Cobb angle.

Regarding X axis: the statistical analysis showed there is an average positive correlation between head postural changes around rotation X axis and Cobb angle, as well as an average positive correlation between head postural changes around translation X axis and Cobb angle.

As for Y axis: the statistical analysis showed a strong positive correlation between head postural changes around rotation Y axis and Cobb angle, as well as a strong positive correlation between head postural changes around translation Y axis and Cobb angle (table 2).

Table 2: The correlation coefficient values around different axes of head region

Variable	Number	Correlation Coefficient	P Value
Rotation x	30	0.6001	0.037
Translation x	30	0.5556	0.022
Rotation y	30	0.8258	0.001
Translation Y	30	0.9023	0.001

P: probability value, P<0.05* = significant, P>0.05 = Non-significant

Discussion:

The relationship between head posture and Cobb's angle in the population of adolescent females with idiopathic scoliosis is a significant area of interest, as posture compensations often occur in response to spinal deformities. The current study examined this relationship in details, exploring the correlation between head postural changes and the Cobb's angle in patients with adolescent idiopathic scoliosis (AIS).

Cobb's angle is widely recognized as reliable method quantifying the magnitude and severity of the spinal deformities, particularly scoliosis. It measures the degree of curvatures that occurs laterally in the spine and is used for diagnosing and monitoring scoliosis progression. A higher Cobb angle generally correlates with more severe spinal deformity and potentially altered head and neck posture.

Because of the possible connection between head posture and musculoskeletal abnormalities, notably in the cervical and thoracic regions. Unusual head posture has been linked to compensating mechanisms across the spinal column, which may affect the Cobb angle and other spinal curvatures (Kendall et al., 2005) (13). Any association with head position could have significant consequences for both diagnostic and therapeutic approaches in disorders like

scoliosis, since the Cobb's angle measures the quantity and the amount lateral spinal curvature in degrees.

Head posture, specifically forward head posture, has been linked to compensatory mechanisms in patients with spinal deformities, including scoliosis. As the spine curves, especially in the thoracic region and the lumbar region, the body adapts to maintain horizontal gaze and balance by altering head and cervical spine alignment (Harrison et al., 2002) (14). The results of the current study showed a [positive/negative/moderate] correlation between forward head posture and Cobb's angle, suggesting that the greater the lateral curvature of the spine, the more the head tilts forward as part of a compensatory mechanism.

These findings are consistent with Lau et al. (2010) (15) ., who noted that AIS patients often exhibit forward head posture to counterbalance spinal curvatures, particularly when deformities are severe. The need for visual equilibrium leads to this compensatory posture, which could exacerbate symptoms such as neck pain, fatigue, and muscular strain.

In this study, a correlation between the x-ray obtained Cobb' angle and cervical spine alignment, particularly in patients with mild to moderate degrees of scoliosis was conformed. This relationship has been highlighted in previous literature as well.

Berdishevsky et al. (2016) (16) found that patients with more pronounced spinal curvature often exhibit alterations in cervical spine alignment, including forward head posture and lateral tilting. These changes are thought to be compensatory in nature, as the body adjusts to maintain posture and functionality despite the spinal deformity.

Smith et al. (2019) (17) similarly observed that changes in head posture are more prominent in patients obtaining a Cobb angles more than 30 degrees. The cervical spine often shifts to accommodate the imbalance caused by the thoracic or lumbar curvature. This compensatory behavior is a biomechanical adaptation to maintain upright posture and reduce energy expenditure during daily activities.

Head posture, including lateral tilt and rotational shifts, are correlated with changes in the Cobb angle. The given outcomes of this research are similar with previous researches that explored the three-dimensional (3D) nature of scoliosis. Weinberg et al. (2020) (18) highlighted that scoliosis is not merely a lateral deviation but involves rotational deformities, which are often mirrored in the cervical spine and head posture.

Recognizing that forward head posture and cervical spine alignment are associated with scoliosis severity suggests that early postural assessments could help in identifying scoliosis progression. Moreover, Negrini et al. (2018) (19) proposed that addressing postural compensations through exercises and bracing could help reduce the progression of spinal deformities in AIS patients.

While some studies suggest a relationship, others report inconsistent findings or fail to show a clear correlation between head posture and Cobb's angle. This could be due to differences in study populations, methodologies, or the degree of spinal deformity.

Vasavada et al. (2015) (20). studied a large sample of patients with mild to moderate scoliosis but did not find a significant relationship between FHP and the Cobb angle. They hypothesized that

head posture may not always be directly affected by spinal deformity, particularly in milder cases where compensatory mechanisms might not be fully engaged.

Conclusion

The outcomes and findings of this study, revealed that *there is a positive correlation between posture changes of the head and the outcomes of the Biotonix postural assistant and the radiographical x-ray findings*.

Further studies should be conducted on different types of scoliosis

Further studies should be conducted to investigate the effect of (AIs) on changes of lower exremities.

Abbreviations

AIS *: adolescent idiopathic scoliotic ;BPA:* *Biotonix posture assistant*

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