Med. J. Cairo Univ., Vol. 90, No. 2, March: 565-571, 2022
www.medicaljournalofcairouniversity.net

Impact of Severity of Adolescent Idiopathic Thoracic Scoliosis on Range of Motion of Neck and Shoulder Complex

MOHAMED F. HELMY, M.Sc.*,**; SAMIR A. SABBAHI, Ph.D.* and MOHAMED I. ABDELHAY, Ph.D.*

The Department of Basic Sciences, Faculty of Physical Therapy, Cairo University and Toukh Health Management Restrict, Toukh, El-Qalubia***

Abstract

Background: Adolescence is a sensitive period of personal and psychological maturity, so many factors like a deformity and physical discomfort can affect the quality of life of patients with AIS. Disability and impaired quality of life are common in people with thoracic scoliosis. For society, work disability results in decreased productivity. The presence of a spinal deformity is a risk factor for psychological depression regardless of the treatment the patient received.

Aim of Study: The purpose of this study was to determine the effect of severity of Cobb angle of thoracic scoliosis in adolescence on the active range of motion of shoulder complex and cervical articulations in people with idiopathic scoliosis.

Material and Methods: The study was conducted on 60 male and female patients and a control group consisting of 60 participants. Their age ranges from 12-18 years. The sample was sub grouped into three groups according to the severity of scoliosis and control group. Group 1 "G1": Twenty participants with Cobb angle 10-20 degree. Group 2 "G2": Twenty participants with Cobb angle 20-40 degree. Group 3 "G3": twenty participants with Cobb angle >40 degree. Group 4 "G4": Sixty participants with cobb angle 0 (control group). The ROM of cervical side bending, shoulder flexion and shoulder abduction on the convex side was recorded by digital camera and then was analyzed by kinovea software program.

Results: There was a significant negative correlation between cobb angle and cervical side bending ROM, shoulder flexion and abduction ROM. However, this negative correlation increases with degree of severity of cobb angle.

Conclusion: Based on the findings of this study, the severity of scoliosis affect the range of motion of shoulder joint and cervical spine.

Key Words: *Adolescent idiopathic scoliosis – Kinovea – Shoulder flexion and abduction – Cervical side bending.*

Introduction

ADOLESCENT idiopathic scoliosis (AIS) is a structural, lateral, rotated curvature of the spine that arises in otherwise healthy children at or around puberty [1].

The anatomic, mechanic and functional interrelationship between upper thoracic vertebrae and lower cervical vertebrae and shoulder complex may illustrate the disability of the neck and shoulder in people with upper thoracic scoliosis. Upper limb dysfunction may cause different disabilities as shoulder function [2], decreased grip strength [3]; proprioceptive deficit [4] and shoulder pain [5] were found especially for adult scoliosis. Altered shoulder kinematics due to myofascial attachment between shoulder and thoracic spine can be a source of pain and dysfunction for subjects with idiopathic scoliosis (IS). Change in shoulder kinematics has been associated with clinical symptoms, reduced functional capacity, and impaired quality of life.

In people with AIS, the scapula is shown to be more internally rotated and anteriorly tilted on the convex side, and more externally, downwardly rotated, and posteriorly tilted on the concave side in participants with AIS as compared to healthy people. Other researchers reported, decreased peak humerothoracic elevation and altered scapular posterior tilt on concave side in the resting position were observed in participants with AIS [6].

The mechanical relationship between neck mobility and thoracic spine was assessed by some researchers [7-10]. They reported that the contribution of the thoracic spine when assessing neck mobility as the two regions are linked anatomically and in motion [11,12,13].

Sharon [14] showed that the upper thoracic spine contributes significantly to overall neck mobility, although the extent depends on the direction of neck movement. The inter-regional coordination between the cervical and thoracic spine during active neck movements was found to be high.

Correspondence to: Dr. Mohamed F. Helmy,
E-Mail: m.fawzy9654@gmail.com

Kinovea is a free software used for the analysis, comparison, and evaluation of sports and training. It is also suitable for physical education teachers and coaches. Kinovea has many advantages; it is easy to use and does not require physical sensors during the analysis. In addition, the software can be used as a measurement tool for motion analysis. Kinovea computer program is a software measuring tool that is able to measure ROM of the joints of the body; the overview function is a summary image of the video. It samples images from the video at regular interval and creates a composite picture where you can see the motion at a glance. The reverse function lets you play the motion back ward [15].

Patients and Methods

Participants:

All participants were recruited from hospitals of metropolitan area in cairo from 2020 to 2021. They were diagnosed and radiologically evident of Cobb angle variation through specialists. The study will be conducted on 60 male and female patients and a control group consisting of 60 participants. Their age range from 12-18 years. Each participant was informed about the nature, purpose, and benefits of the study, the right to refuse or withdraw at any time, and the confidentiality of any obtained data. All participants signed an informed consent form before being assigned randomly into four equal groups (A,B,C&D). The participants were blinded to their allocation. The study was approved by the Ethics and Research Review Committee.

Inclusion and exclusion criteria:

Inclusion criteria:

The inclusion criteria were 60 adult females with Cobb angle >10 degrees and <50 degrees and control group consist of 60 participants with cobb angle zero, their age ranged from 12-18 years, body mass index (BMI) ranged from 18-25kg/m ^{2}.

Exclusion criteria:

The exclusion criteria were any subject with history of musculoskeletal or neurological problems of the examined upper limb, Any subject with previous examined upper limb surgery, Any subject with thoracic kyphosis, Scheuermann's disease, COPD, MFP with trigger points.

Assessment:

Detailed medical and orthopedic histories were taken from each male and female before starting the study to confirm absence of any contraindications that may interfere with the study.

Kinovea software program: Kinovea is a video analysis software dedicated for kinisiological studies. It targets primarily medical professionals, the coaches and athletes. The supported files are displayed. It can save the videos easily and access it later in need. The video can be analyzed in slow motion, so the video can be seen by frame by frame. Lines and arrows can be added on the video with the drawing tool [15]. Kinovea 0.8.15 free computer software will be downloaded from www.kinovea.org and installed on the computer before applying the measurement procedure. Kinovea software is a reliable tool for measuring shoulder flexion, abduction [16]. The Kinovea software program was valid method in measuring active cervical range of motion in frontal plane [17]. The Kinovea software program was reliable in both intrarater and interrater reliability in measuring active cervical range of motion in frontal plane [18].

Markers: Round markers of 1.5cm in diameter will be glued on special bony land marks. In shoulder, the bony land marks will be (acromion process, coracoid, olecranon process, the lateral epicondyle, midthoracic line, and midshaft of the humerus). In cervical spine, it will be the sternal notch, the vertex and center of the forehead on the same line with the vertex.

Methods:

For the shoulder complex:

Flexion-AROM: A cross mark will be placed on the lateral aspect of the humeral head approximately below the acromion process (fulcrum). One cross mark will be placed along the midshaft of the humerus aligned with the greater tuberosity and the lateral epicondyle of the humerus; one additional cross mark will be placed along the midline of the thorax [19]. Flexion-AROM will be assessed with the participant in standing position [20]. The arm will be actively elevated in a strict sagittal plane with the thumb pointed up toward the ceiling.

Abduction-AROM: Across mark will be placed on the coracoid process (fulcrum). One cross mark will be placed along the shaft of the humerus, and an additional cross mark will be placed along the midline of the thorax [19]. Abduction-AROM will be assessed with the participant in standing position [20]. The arm will be actively elevated in the strict coronal plane with the thumb pointed up toward the ceiling. This allowed for the required ER necessary to avoid impingement of the greater tuberosity on the acromion process.

Instruments:

Images of each participant were captured using a digital camera (Nikon Coolpix S3200, effective pixels 16 MB; Nikon Corp., Tokyo, Japan) to capture the sagittal and the frontal plane profile of the dominant shoulder. The camera was placed 1.5m away from the participants on a tripod at a height of 80cm. To maintain the same distance between the camera and the participants; the tripod was placed on taped markers on the floor. All images were imported into a laptop and analyzed using Kinovea software, which is a free, open-source software created for movement analysis.

All movements were converted into angles using the virtual goniometer of the software.

Flexion-AROM:

To measure shoulder flexion angle, a line was drawn from the fulcrum point to bisect the midthorax line (stationary arm). Another line was drawn bisecting the point demarking the midshaft of the humerus (movable arm). The angle of the intersection of the two lines was measured in degrees.

Abduction-AROM:

To measure shoulder abduction angle, a line was drawn from the fulcrum point bisecting the point of the midthorax line (stationary arm), and another line bisected the point demarking the shaft of the humerus (movable arm). The angle of the intersection of the two lines was measured in degrees.

For the cervical region:

Application of markers:

The participant wears 2 elastic headbands to affix head markers. Markers will be placed on sternal notch, the vertex and center of the forehead on the same line with the vertex **[21]**.

Measurement procedure:

Each subject was sitting on a stool close to a wall while maintaining good upright balanced posture, with both feet on the floor, with normal lumbar lordosis, hands on thighs, and with 90 degrees in the hip and knee joints.

Each subject was requested to assume a neutral head position, with the purpose of positioning the head's center of mass in a vertical plane through the atlantooccipital joints with the nose pointing forward in line with the sternum and bellybutton **[22,23]**. Each subject was given full explanation, verbal instruction concerning the purpose and procedure of the study. The digital camera was steady to record the movements before the start of the measurements.

Measuring cervical side bending ROM using KCP:

For the purpose of this study, participants were simply asked to perform maximal (end-range) neck side bending to the convex side with hold 5 seconds then neutral position.

These movements are done on a frontal plane. Sternal notch is the axis of the angle between two lines. The first is the line segment between the sternal notch marker and the forehead marker. The second is the vertical line on the sternal notch marker. Cervical side bending movements were done to the convex side.

The position for each marker was indicated with a washable ink pen for accurate replacement then the marker was glued on the ink pen **[24]**.

The examiner was sitting behind the camera taking the video.

- The examiner asked the participant to do lateral flexion on the convex side then hold 5 seconds at the end of the range. The examiner asked the participant to return to the neutral position.
- Cervical AROM was calculated as angular displacement from neutral to the convex side.
- The examiner recorded the measured angles after doing the KCP measurement analysis of each video for each participant using KCP.
- Analysis the range of motion using KCP as follow:
  - The examiner connected the camera with the labtop in which the KCP was installed.
  - The examiner apply the analysis for each cervical AROM measurements in frontal plane.
  - The procedure was repeated three times then the mean average of the measured angles using KCP were recorded.
  - The analysis of each participant were saved on computer in a separate file.

Data analysis:

Statistical analysis was conducted using SPSS for windows, version 26 (SPSS, Inc., Chicago, IL). Prior to final analysis, data were screened for normality assumption, homogeneity of variance, and presence of extreme scores. This exploration was done as a pre-requisite for parametric calculations of the analysis of difference. Preliminary assumption checking revealed that data was not normally distributed for all measured variables, as assessed by Shapiro-Wilk test (p<0.05). There was homogeneity of variances ($p>0.05$) and covariances ($p>0.05$), as assessed by Levene's test of homogeneity of variances. Accordingly, non-parametric statistics were used. Quantitative variables were presented as mean ± standard deviation (X ± SD) and qualitative variables were presented as percent (%). The Spearman rank correlation coefficient was used to investigate the relationship between Cobb angle of thoracic scoliosis, shoulder abduction and flexion ROM, cervical side bending ROM. The alpha level was set at 0.05 and the correlation coefficients were interpreted as 0-0.1 = Very low, 0.10-0.30 = Low, 0.30-0.50 = Moderate, 0.50-0.70 = High, 0.70-0.90 = Very high, and 0.90-1.0 = Strong.

Results

Demographic data and general characteristics of participants:

A total of 60 adolescents with idiopathic scoliosis (15 males and 45 females) were randomly allocated into 3 groups of equal number according to severity of Cobb angle into (Mild scoliosis, Moderate scoliosis and Severe scoliosis) compared to 60 typically developed adolescents were included in this study.

Group A (Mild Scoliosis):

Twenty patients (4 males and 16 females) were included in this group. The mean values of their age, height and weight were 15.4±1.69 years, 161.1 ±3.17cm and 53.55±4.21kg respectively.

Group B (Moderate Scoliosis):

Twenty patients (5 males and 15 females) were included in this group. The mean values of their age, height and weight were 14.85±1.81 years, 158.6±6.01cm and 52.05±2.98kg respectively.

Group C (Severe Scoliosis):

Twenty patients (6 males and 14 females) were included in this group. The mean values of their age, height and weight were 15.0±1.91 years, 159.95±5.84cm and 53.75±4.50kg respectively.

Group D (Normal group):

Sixty patients (18 males and 42 females) were included in this group. The mean values of their age, height and weight were 14.85±1.68 years, 158.55±5.39cm and 53.45±4.03kg respectively.

Baseline comparison between groups:

Comparing the general characteristics of participants of all groups revealed that there were no significant differences found between groups in the demographic characteristics, including age, weight and height ($p>0.05$) as shown in Table (1).

Gender distribution:

As shown in Table (2), the frequency distribution of gender in all groups (group A, B, C and D) revealed that group A included 4 males with percentage of 20% and 16 females with percentage of 80%. Group B included 5 males with percentage of 25% and 15 females with percentage of 75%. Group C included 6 males with percentage of 30% and 14 females with percentage of 70%. Group D included 18 males with percentage of 30% and 42 females with percentage of 70%. Comparing the frequency distribution of gender in all groups revealed that there were no significant differences found between all groups ($p>0.05$).

Table (1): Demographic characteristics of patients in all groups.

	Group A X ± SD	Group B X ± SD	Group C X ± SD	Group D X ± SD	*f* -value	*p*-value	Sig.
Age (years)	15.4±1.69	14.85±1.81	15.0±1.91	14.85±1.68	0.530	0.663	NS
Height (cm)	161.1±3.17	158.6±6.01	159.95±5.84	158.55±5.39	1.382	0.252	NS
Weight (kg)	53.55±4.21	52.05±2.98	53.75±4.50	53.45±4.03	0.790	0.505	NS

X: Mean. *p*-value: Probability value. NS: Non-significant. SD: Standard Deviation. f-value: One way ANOVA test.

Table (2): The frequency distribution of gender in all groups.

Group	Gender					
	Male No. (%)	Female No. (%)	Total	χ^2	*p*-value	Sig.
Group A	4 (20%)	16 (80%)	20	0.878	0.831	NS
Group B	5 (25%)	15 (75%)	20			
Group C	6 (30%)	14 (70%)	20			
Group D	18 (30%)	42 (70%)	60			
Total	33 (27.5%)	87 (72.5%)	120			

$\chi 2$ = Chi square test. NS = Non-significant.

Statistical analysis of all measured variables between groups:

Table (3) represents the mean values of the cobb angle, cervical side-bending, shoulder flexion and shoulder abduction scores for all groups, as well as multiple pairwise comparison tests among all groups. One-way ANOVA test revealed that there were significant differences in the cervical side-bending, shoulder flexion and shoulder abduction scores between all groups.

Table (3): The mean values of the cobb angle, cervical side-bending, shoulder flexion and shoulder abduction scores for all groups.

	Group A X ± SD	Group B X ± SD	Group C X ± SD	Group D X ± SD	*f*-value	*p*-value	Sig.
Cobb angle(degrees)	14.55±3.48	30.4±5.48	55.2±11.59	0.0±0.0	578.5	0.000	S
Cervical side ending (degrees)	48.45±5.89	31.65±6.85	20.45±8.78	43.01±2.85	117.6	0.000	S
Shoulder flexion (degrees)	151.3±7.29	115.4±10.28	107.85±10.75	180.73±2.82	782.9	0.000	S
Shoulder abduction (degrees)	137.9±5.71	129.8±14.46	126.16±16.09	175.03±3.98	215.6	0.000	S

X: Mean. *p*-value: Probability value. Value S: Significant. SD: Standard Deviationf-value: one way ANOVA test.

Discussion

This study was conducted to investigate the effect of severity of Cobb angle of thoracic scoliosis in adolescence on the active range of motion of shoulder complex and cervical articulations in people with idiopathic scoliosis.

In the current study, there was a significant negative correlation between cobb angle and cervical side bending ROM, shoulder flexion and abduction ROM.

However, this negative correlation increases with degree of severity of cobb angle.

Adolescent idiopathic scoliosis (AIS) is a structural, lateral, rotated curvature of the spine that arises in otherwise healthy children at or around puberty [1]. This spinal deformity is characterized by a curved spine and is usually accompanied by geometric and morphologic changes in the trunk and thoracic cage deformity [25,26].

Most studies regarding AIS focused on the effect of scoliosis on the position of scapula, muscles of the shoulder and neck pain. No study so far specifically focused on the influence of AIS on ROM of the shoulder during elevation movements and on the ROM of the cervical during side bending movement.

There are several potential mechanisms that may result in shoulder kinematic alterations, including postural disturbances, altered scapular muscle activation, and soft tissue tightness [2,27].

Subjects with thoracic curve idiopathic scoliosis (IS) demonstrated moderate shoulder dysfunction on the convex side of the scoliosis curve. This shoulder dysfunction was also associated with scapula kinematics and muscular activities. The scapula on the convex side of curvature was in a more anteriorly tipped position. A more anteriorly tipped position would leave the anterior acromion in nearer proximity to the rotator cuff tendons and increase the likely for impingement. Although posterior tipping of the scapula occurred during arm elevation to prevent impingement under the anterior acromial edge, inadequate posterior tipping movement would result in impingement of the rotator cuff tendons [28].

The scapula plays a critical role in supporting shoulder function. Considering the closed anatomical relationship between the scapula and the thoracic cage, the presence of postural disturbances could be linked to alterations in the scapular position and orientation in adolescent idiopathic scoliosis (AIS) [29].

The inter-regional movement coordination between the cervical spine and upper thoracic spine in all three planes of movement was found to be high, as determined by cross-correlation analysis of the movements of the regions. The upper thoracic motion showed a sizeable contribution to overall neck mobility and the movements of the cervical and thoracic spines were highly coordinated, as revealed by the cross-correlation analysis [14].

Neck problems are more common and more often coexist with back problems in individuals with idiopathic scoliosis than in the general population [30].

Furthermore, no study has been conducted to examine the effect of the AIS on the cervical region, despite the close relationship between the thoracic and cervical regions anatomically and biomechanically. It has been reported that the extent of cervical lordosis is affected by the alignment of the thorax and the sagittal angulation of the cervico-thoracic junction [31,32] . This suggests strong linkage between the cervical and thoracic spines for movement performance in these spinal regions. This inductive hypothesis is further strengthened by the previous findings which revealed the influences of the thoracic mobility level on neck movement. Restriction of neck mobility was found to be associated with the extent of hypomobility related to thoracic scoliosis [33] .

Some studies have reported that a hypokyphotic thoracic spine coexists with kyphosis in the cervical spine in AIS patients. Using sagittal plane X-rays, Hilibrand [34] was the first to confirm a relationship between the thoracic and cervical spines in AIS patients. They reported a straight lordotic or kyphotic cervical alignment in 34 of 39 patients (89%) and concluded that patients with idiopathic scoliosis develop lordosis within the thoracic spine and compensatory kyphosis within the cervical spine.

Based on the findings of this study, the severity of scoliosis affect the range of motion of shoulder joint and cervical spine. So, shoulder and cervical spine range of motion exercises should be an important part of scoliosis rehabilitation program.

Acknowledgements: All participants are should be thanked by the writers.

References

1- WEINSTEIN S.L., DOLAN L.A., CHENG J.C.Y., DANIELS SON A. and MORCUENDE J.A.: Adolescent idiopathic scoliosis. Lancet, 371: 1527-1537, 2008.

2- LIN J.-J., CHEN W.-H., CHEN P.-Q. and TSAUO J.-Y.: Alteration in shoulder kinematics and associated muscle activity in people with idiopathic scoliosis. Spine, 35: 1151-1157, 2010.

3- MARTINEZ-LIORENS J., RAMIREZ M., COLOMINA M., BAGO J., MOLINA A., CACERES E. and GEA J.: Muscle dysfunction and exercise limitation in adolescent idiopathic scoliosis. Eur. Respir. J., 36: 393-400, 2010.

4- KEESSEN W., CROWE A. and HEARN M.: Proprioceptive accuracy in idiopathic scoliosis. Spine, 17: 149-155, 1992.

5- GRUBB S.A. and LIPSCOMB H.J.: Diagnostic findings in painful adult scoliosis. Spine, 17: 518-527, 1992.

6- ELIF TURGUT, GOZDE GUR, CIGDEMAYHAN, YAVUZ YAKUT and GUL BALTACI: Scapular kinematics in adolescent idiopathic scoliosis: A threedimensional motion analysis during multiplanar humeral elevation. Journal of Biomechanics, 2017.

7- FEIPEL V., RONDELET B., LE PALLEC J-P. and ROOZE M.: Normal global motion of the cervical spine: An electrogoniometric study. Clinical Biomechanics, 14 (7): 462e70, 1999.

8- KOERHUIS C.L., WINTERS J.C., VAN DER HELM F.C.T. and HOF A.L.: Neck mobility measurement by means of the 'flock of birds' electromagnetic tracking system. Clinical Biomechanics, 18 (1): 14e8, 2003.

9- JORDAN K., HAYWOOD K.L., DZIEDZIC K., GARRATT A.M., JONES P.W., ONG B.N., et al.: Assessment of the 3-dimensional Fastrak measurement system in measuring range of motion in ankylosing spondylitis. The Journal of Rheumatology, 31 (11): 2207e15, 2004.

10- SASSO R.C. and BEST N.M.: Cervical kinematics after fusion and bryan disc arthroplasty. Journal of Spinal Disorders and Techniques, 21 (1): 19e22, 2008.

11- WHITE A. and PANJABI M.: The basic kinematics of the human spine. A review of past and current knowledge. Spine, 3 (1): 12e20, 1978.

12- EDMONDSTON S.J. and SINGER K.P.: Thoracic spine: Anatomical and biomechanical considerations for manual therapy. Manual Therapy, 2: 132e43, 1997.

13- EDMONDSTON S.J., CHAN H.Y., NGAI G., WARREN M.L.R., WILLIAMS J.M., GLENNON S., et al.: Postural neck pain: An investigation of habitual sitting posture, perception of “good” posture and cervicothoracic kinaesthesia. Manual Therapy, 12 (4): 363e71, 2007.

14- SHARON M.H. TSANG, GRACE P.Y. SZETO and RAYMOND Y.W. LEE: Normal kinematics of the neck: The interplay between the cervical and thoracic spines. Manual Therapy 18 (2013) 431e437.

15- ABDULHASSAN Z.M. and ABBAS S.J.: Kinematic analysis of human Climbing up and down stairs at different inclinations. Engineering and Technology Journal, 31(8 Part (A) Engineering), pp. 1556-1566, 2013.

16- ELRAHIM R.M.A., EMBABY E.A., ALI M.F., et al.: Inter-rater and intra-rater reliability of Kinovea software for measurement of shoulder range of motion. Bull Fac Phys. Ther., 21: 80-87, 2016.

17- SHEREEN H. ELWARDANY, WADIDA H. EL-SAYED and MOHAMMAD F.: Validity of Kinovea Computer Program in Measuring Cervical Range of Motion in Frontal Plane.Med. J. Cairo Univ., Vol. 84, No. 1, June: 579-587, 2016.

18- SHEREEN H. ELWARDANY, WADIDA H. EL-SAYED and MOHAMMAD F.: Interrater and Intrarater Reliability of Kinovea Computer Program in Measuring Cervical Range of Motion in Frontal Plane.Med. J. Cairo Univ., Vol. 84, No. 2, June: 55-62, 2016.

19- NARAYANAN S.: Textbook of therapeutic exercises. New Delhi, India: Jaypee Brothers, 2005.

20- Lee SH, Yoon C, Chung SG, Kim HC, Kwak Y, Park H-w, et al.: Measurement of Shoulder Range of Motion in Patients with Adhesive Capsulitis Using a Kinect. PLoS ONE, 10 (6): e0129398, 2015.

21- REBOLLEDO J.P., PINCHEIRA P.A., BITTNER V. and FRUGONE R.E.: Occlusal plane inclination in children between 9 and 10 years old with postural asymmetry. Study on the frontal plane. Rev. Fac. Odontol. Univ. Antioq., 24 (1): 76-83, 2012.

22- SEVERINSSON Y., ELISSON L. and BUNKETORP O.: Reliability of Measuring the Cervical Frontal Translation Mobility with a Simple Method in a Clinical Setting.

Rehabilitation Research and Practice, Article ID: 629104, 2012.

23- TOUSIGNANT M., De BELLEFEUILLE L., O'DONOUGHUE S. and GRAHOVAC S.: Criterion Va-lidity of the Cervical Range of Motion (CROM) Goniom-eter for Cervical Flexion and Extension. Spine, 25: 324- 30, 2000.

24- BURNS D.K. and WELLS M.R.: Gross Range of Motion in the Cervical Spine: The Effects of Osteopathic Muscle Energy Technique in Asymptomatic Subjects. The Journal of the American Osteopathic Association, 106: 137-42, 2006.

25- LEBLANC R., LABELLE H., RIVARD C.-H. and POITRAS B.: Relation between adolescent idiopathic scoliosis and morphologic somatotypes. Spine, 22: 2532-2536, 1997.

26- STOKES I.A.: Three-dimensional terminology of spinal deformity: A report presented to the scoliosis research society by the scoliosis research society working group on 3-D terminology of spinal deformity. Spine, 19: 236-248, 1994.

27- LUDEWIG P.M. and REYNOLDS J.F.: The association of scapular kinematicsand glenohumeral joint pathologies. J. Orthop. Sports Phys. Ther., 39: 90-104, 2009.

28- LIN, J.-J., CHEN, W.-H., CHEN, P.-Q. and TSAUO, J.-Y.: Alteration in shoulder kinematics and associated muscle activity in people with idiopathic scoliosis. Spine, 35: 1151-1157, 2010.

29- ELIF TURGUT, GOZDE GUR, CIGDEMAYHAN, YAVUZ YAKUT and GUL BALTACI: Scapular kinematics in adolescent idiopathic scoliosis: A threedimensional motion analysis during multiplanar humeral elevation. Journal of Biomechanics, 2017.

30- TOPALIS C., GRAUERS A., DIARBAKERLI E., et al.: Neck and back problems in adults with idiopathic scoliosis diagnosed in youth: An observational study of prevalence, change over a mean four-year time period and comparison with a control group. Scoliosis, 12: 20, 2017.

31- HARDACKER J.W., SHUFORD R.F., CAPICOTTO P.N. and PRYOR P.W.: Radiographic standing cervical segmental alignment in adult volunteers without neck symptoms. Spine, 22: 1472-1479, 1997.

32- LODER R.T.: The sagittal profile of the cervical and lumbosacral spine in Scheuermann thoracic kyphosis. J. Spinal Disord., 14: 226-231, 2001.

33- FLOMAN Y.: Thoracic scoliosis and restricted neck motion: A new syndrome? European Spine Journal, 7 (2): 155-157, 1998.

34- HILIBRAND A.S., TANNENBAUM D.A., GRAZIANO G.P., LODER R.T. and HENSINGER R.N.: The Sagittal Alignment of the Cervical Spine in Adolescent Idiopathic Scoliosis. Journal of Pediatric Orthopaedics, 15 (5): 627-632, 1995.

تأثير شدة الجنف الصدرى فى المراهقين على مدى الحركة فى الرقبة والكتف

الغرض من هذه الدراسة: هو تحديد تأثير شدة زاوية الجنف الصدرى فى سن المراهقة على المدى لحركى لمفصل الكتف والرقبة فى الأشخاص المصابين بالجنف مجهول السبب.

المنهجية: أجريت الدراسة على ٦٠ شاب وفتاة وتألفت المجموعة الضابطة من ٦٠ مشاركاً. تتراوح أعمارهم بين ١٢ و ١٨ سنة. تم تقسيم العينة إلى ثلاث مجموعات حسب شدة الجنف والمجموعة الضابطة.

- المجموعة ١: (مجموعة الدراسة) عشرون مشاركاً بدرجة كوبب زاوية ١٠–٢٠ درجة.
- المجموعة ٢: (مجموعة الدراسة) عشرون مشاركاً بزاوية ٢٠–٤٠ درجة.
- المجموعة ٣: (مجموعة الدراسة) عشرون مشاركاً بزاوية كوب >٤٠ درجة.
- المجموعة ٤: (المجموعة الضابطة) ستون مشاركة بزاوية كوب. تم تسجيل ذاكرة القراءة فقط الخاصة بانحناء جانب انثناء الكتف وتبعيد الكتف على الجانب المحدب بواسطة كاميرا رقمية ثم تم تحليلها بواسطة برنامج كينوفيا.

النتائج: كان هناك ارتباط سلبى بين زاوية الانحناء والمدى الحركى للكتف والرقبة. ومع ذلك، يزداد هذا الارتباط السلبى مع درجة شدة زاوية كوب.

الخلاصة: بناءً على نتائج هذه الدراسة ، فإن شدة الجنف تؤثر على مدى حركة مفصل الكتف والرقبة.