Wilczyński Jacek, Karolak Przemysław, Janecka Sylwia. Body composition and SEMG amplitude of the spine rectifier in children with scoliotic lesions. Journal of Education, Health and Sport. 2018;8(12):600-612. eISNN 2391-8306. DOI http://dx.doi.org/10.5281/zenodo.2526288
http://ojs.ukw.edu.pl/index.php/johs/article/view/6418

The journal has had 7 points in Ministry of Science and Higher Education parametric evaluation. Part B item 1223 (26/01/2017).
1223 Journal of Education, Health and Sport eISSN 2391-8306 7

The authors declare that there is no conflict of interests regarding the publication of this paper.

Received: 01.12.2018. Revised: 25.12.2018. Accepted: 25.12.2018.

Body composition and SEMG amplitude of the spine rectifier in children with scoliotic lesions

Skład ciała a amplituda SEMG prostownika grzbietu u dzieci ze zmianami skoliotycznymi

Jacek Wilczyński[1], Przemysław Karolak[2], Sylwia Janecka[2]

1. Department Posturology, Hearing and Balance Rehabilitation, Institute of Physiotherapy, Faculty of Medicine and Health Sciences, Jan Kochanowski University in Kielce, Poland;
2. Ph.D. student, Institute of Physiotherapy, Faculty of Medicine and Health Sciences, Jan Kochanowski University in Kielce, Poland

Corresponding author:
Prof nadzw. UJK Jacek Wilczyński, Head of Posturology Department, Hearing and Balance Rehabilitation, Faculty of Medicine and Health Sciences, Jan Kochanowski University, Kielce, Al. IX Wieków Kielc 19, 25-317 Kielce, Poland, Phone: 0048 603-703-926, e-mail: jwilczyński@onet.pl, www.jacekwilczynski.com.pl

Abstract

The aim of the study was to analyze the relationship between body composition and the amplitude of SEMG rectifier spine in children with scoliotic changes. The spine was investigated using optoelectronic Diers formetric III 4D. Body composition was determined using a Tanita Body Composition Analyzer MC 780M. Analysis of the amplitude SEMG rectifier spine was performed using a 12-channel camera Noraxon TeleMyo DTS. The biggest differences in the absolute values of the studied variables related to body composition BMR (kJ). The most important and statistically significant predictors mock for the variable composition of the body spine and amplitude rectifier tested in different positions in the group of scoliosis proved standing position lumbar left (p = 0.01), standing position lumbar right (p = 0.01) and lying front right side of the thoracic (p = 0, 02). The variance explained by the independent variables in the model adopted is 35% of the total variation ($R^2 = 0.35$), indicating a small adjustment for the data, but the expected level of statistical significance ($p = 0.01$) has been fulfilled, and to give the corresponding the value of a statistical test $F = 3.49$. The group scoliotic bases most important and statistically significant predictor model was the torso up right thoracic ($p = 0.0001$), lower limbs up the right side of the lumbar ($p = 0.044$), trunk up the right side of the lumbar ($p = 0.016$) and the top of the torso thoracic left ($p = 0.006$). The model was explained only in 39% ($R^2 = 0.39$), which is low, but the target level of statistical significance ($p = 0.001$) was also satisfied. and give the corresponding value of the statistical test $F = 4.89$. In children with scoliotic changes SEMG amplitude measurement helps identify the muscles need strengthening or relaxation, as well as the selection of appropriate corrective exercises.

Key words: children's body composition, scoliosis, scoliotic posture, SEMG amplitude of the spine rectifier

Introduction

Therapy associated with posture, which include scoliosis, is a long process that requires a lot of commitment from the patient. Only consistently carried out the treatment is effective. Early and rapid diagnosis of scoliosis significantly increases the chances of effective treatment. Diagnosis is based on clinical tests and radiologic evaluation [1]. Scoliosis is most commonly detected in children during growth, which is often associated with numerous studies, which they are subjected during school. The reason can be decreased, increased muscle tension or non-uniform. The asymmetry of the back muscle is not due to morphological changes in muscle but formed under the influence of a change of stimuli central nervous system [2-4].

Voltage determines the transport capabilities of the child and the emerging during the development of motor patterns that have an impact on the setting of the spine. Its amplitude can be measured by using surface electromyography. This measurement is an important tool for assessing the symmetry operations of motor units within the same muscle groups on both sides, as well as determine the many muscles of synergistic or antagonistic operating within the same test area [5-8].

In the treatment of scoliosis in general the idea that if you want to get lasting effect correction regardless of the location of the curve (thoracic, lumbar) you should stretch muscles (rectifiers spine) of the concave curvature and strengthen muscles (spine rectifiers) convex curvature of the page. This has not been conclusively confirmed, because it is not always the dorsal extensor regardless of location is cramped after the rounded shape and stretched on the side of the bulge in the curve. Spine extensors behavior can be observed with the aid of measuring the surface electromyography. In children with changes scoliotic measurement of the amplitude of the SEMG makes it easy to identify the muscles that require strengthening or relaxation, as well as selecting the appropriate exercises.

Material and Methods

The study involved 251 children, including 113 girls (45.02%) and 138 boys (54.98%) aged 7 and 8 years old, from primary schools in Kielce (Poland) (Table. 1). The selection of respondents was mixed, after having established the criteria to be met by each group. The study was conducted between November 2016 and July 2017 Posturology Laboratory at the Faculty of Medicine and Health Sciences, Jan Kochanowski University in Kielce. All test procedures were performed according to the Helsinki declaration in force in 1964 and with the approval of the Bioethics Committee of the University of Jan Kazimierz University in Kielce (Resolution No. 5/2015). Body composition was determined using the analyzer Tanita MC 780M. Body Mass (kg), body mass index, fat mass (%), Fat Mass (kg) Fat Free Mass (kg)

Muscle Mass (kg) Total Body Water (kg) Total Body Water (%) Basal metabolic rate (kJ) Basal Metabolic rate (kcal) Bone Mass (kg) Proteins (kg). The spine was investigated using optoelectronic Diers formetric III 4D. The method allowed for photogrammetric video recording back surface using stereographic process raster. The study was conducted in the DiCam by measuring Average, consisting in the execution sequence of twelve pictures, which by creating the average value of the variances reduced the attitudes and thereby improve the value of clinical research. The occurrence of scoliosis and attitudes scoliotic was observed by considering the value of three parameters: the pelvic obliquity (mm) lateral deviation (mm) and a surface of rotation (°). Idiopathic scoliosis attitude skew occurred when the pan had <5 mm, lateral deviation of <5 mm and a rotation surface was <5 degrees. While scoliosis occurred when the pelvic obliquity was ≥

5 mm, lateral deviation was ≥ 5 mm and the rotation surface has been ≥ 5 degrees. To assess the incidence of idiopathic scoliosis or scoliosis posture all three conditions had to be met. Analysis of the amplitude of the dorsal extensor muscle SEMG was performed using a 12-channel camera Noraxon TeleMyo DTS. Erector spinae muscles were examined in the thoracic and lumbar, both on the left and the right. Each test lasted 10 seconds. Raw recording electromyographic signal was presented in the form of a bar chart. Considering the average frequency of the voltage dorsal extensor muscle, expressed in hertz (Hz) and the median. On Y-axis is a frequency of the voltage, while the X-axis - the recording time in seconds. The test results consider the scale of the intensity of the voltage interval that was 100 milliseconds. The study used a mode of continuous recording track. SEMG recording was performed directly on the skin. Action potentials recorded from the rectifier spine in the thoracic and lumbar curvature curves at the top:

1. habitual in the standing position (Standard anatomical position).
2. in the rest position: lying in the front (the lower limbs straight in the knee joints, the legs extend along the upper body),
3. the isometric contraction under:

- lying in the front (the lower limbs straight in the knee joints, the legs extend along the upper torso, pelvis stabilized) test floating body within the spine mobility and maintained it in this position for 10 seconds.
- lying in the front and the stable upper body (shoulders and chest, legs arranged as before) rises tested both lower limbs at the maximum possible height and kept for 10 s.

Before starting the analytical process performed Kolmogorov-Smirnov test to determine the normality of distribution. This served to pursue a parametric method in statistical analysis. To assess the significance of anthropometric variables and body composition between girls' and boys' groups scoliosis attitudes scoliotic and the standard used one-way ANOVA. To assess differences in body posture Chi2 test was chosen because of the binominal system most of the analyzed variables. For the evaluation of collinearity between the variables under consideration Pearson Correlation analysis was used. Multiple regression models, and progressive stepwise were used to determine the relationship and to determine the predictors for the dependent variables: anthropometry, body composition, and the amplitude of SEMG rectifier back. Before a multiple regression analysis was carried out cross validation. Verifying a parameter used to evaluate models built was the coefficient of determination, adjusted coefficient of determination and the test statistic and the level of statistical significance, which clearly helped choose the models wearing the level of statistical significance of $p < 0.05$.

Results

The test spine by Diers formetric III 4D shown in 103 (41%) children scoliosis. Attitude idiopathic scoliosis diagnosed in 141 (56.17%) children. With the proper attitude were 7 (3.0%) children (Table. 1). The biggest differences in the absolute values of the variables examined in girls concerned BMR (kJ). In the group of scoliosis differentiation BMR (kJ) was (S = 452) in the group of attitude variation scoliotic BMR (kJ) was (S = 440) in the group with the standard variation BMR (kJ) was (S 352). In boys in the group also we observed scoliosis largest absolute differences in values for the variable BMR (kJ) (S = 649.5) and group attitudes scoliotic (S = 487) and standard (S = 440). One-way analysis of variance scoliosis group showed significant differences in the level of proliferation (kJ) between boys and girls. In boys with scoliosis BMR (kJ) (F =21.64) (P =0.001), BMR (kcal) (F =21.87) (P =0.001) And Bone Mass (kg) (F =7.12) (P =0.01) Were significantly higher. Analysis of variance group attitudes scoliotic showed that boys were significantly taller (F =6.39) (P =0.01) Had a significantly higher Fat Mass (%) (F =15.85) (P =0.001), Fat Free Mass (kg) (F =5.32) (P =0.02) Muscle Mass (kg) (F =5.32) (P =0.02) Total Body Water (%) (F =16,13) (P =0.001), BMR (kJ) (F =62.74) (P =0.001), BMR (kcal) (F =61,88) (P =0.001) Bone Mass (kg) (F =20.50) (P =0.001) And bone mass (kg). There were no significant differences between girls and boys in children normal. There were also significant differences in the level of intra-changing body composition in girls and boys (Tab. 2). Regression Model for the group the standard assumed not reach statistical significance, and therefore not shown and is not recognized as valid in the modeling of the relation between body composition and the amplitude of the test rectifier spine in various positions. The most important and statistically significant predictors for the mock-body composition and the amplitude of the test rectifier spine in various positions in the group of scoliosis proved standing position lumbar left ($p = 0.01$), standing position lumbar right ($p = 0.01$), and lying in the front right side of the thoracic ($p = 0.02$). The variance explained by the independent variables in the model adopted is 35% of the total variation (R^2 = 0.35), indicating a small adjustment for the data, but the expected level of statistical significance ($p = 0.01$) has been fulfilled, and to give the corresponding the value of a statistical test $F = 3.49$ (tTab. 3). The group bases skoliotycznychscoliotic most important and statistically significant predictor variables torso model has been in the top right thoracic ($p = 0.0001$), lower limbs up the right side of the lumbar ($p = 0.044$), trunk up the right side of the lumbar ($p = 0.016$) and the top of the torso thoracic left ($p = 0.006$). The model was explained only in 39% (R^ 2 = 0.39), which is low, but the target level of statistical significance ($p = 0.001$) was also satisfied.

Discussion

Surface Electromyography a non-invasive diagnostic method which allows to determine their muscle biomechanics in terms of both static and dynamic [9]. It allows monitoring the activity of muscle motor units [10-12]. It is used both in research and in clinical use to evaluate neuromuscular in several different areas, such as sports, neurophysiology or rehabilitation [13-17]. In the physiotherapy it is the most frequently applied when examining the changes in the muscles of the trunk and lower limbs [18]. It enables diagnosing disorders of motor asymmetry, muscle tension or dystonia [19]. It also allows the detection of defects such as tearing of muscle fibers [20]. The values measured by electromyography are also the only, practical alternative for biofeedback training trial in which subjects receive real-time aural or visual feedback about the state of contraction of the muscle [21]. The effectiveness of electromyographic measurements within the paraspinal muscles in people with scoliosis has been confirmed by numerous scientific studies [22]. Other authors in their analysis concluded that surface EMG is an effective testing in determining differences in muscle tone in the course of their activity, both the concave and convex in patients with scoliosis. It represents a valuable addition to clinical studies [23, 24]. By measuring the mean amplitude EMG activity can monitor the motor units in the muscle [25]. Diagnosis electromyographic also found its use in the assessment of morphological muscle consisting of the biochemical analysis [26, 27]. In healthy people, without deviation of the spine, electromyographic measurement shows a highly organized, symmetrical patterns of activity of the back muscles [28].

Conclusions

The most important and statistically significant predictors of the mock for the composition of the body and amplitude ridge rectifier test in various positions in the group of scoliosis proved to standing position lumbar left side, standing position right side of the lumbar and thoracic lying in the front right side. The group bases scoliotic most important and statistically significant predictor model was the torso up right thoracic, lower limbs up the right side of the lumbar, trunk up the right side of the lumbar and torso upwards thoracic left. In children with changes scoliotic SEMG amplitude measurement helps identify the muscles need strengthening or relaxation, as well as the selection of appropriate exercise.

References

1. Schmid AB, Dyer L, Böni T, Held U, Brunner F. Paraspinal Muscle Activity During Symmetrical and Asymmetrical Weight Training in Idiopathic Scoliosis. Journal of Sport Rehabilitation 2010; 19: 315-327.
2. Wilczyński J, Karolak P, Janecka S. Anthropometric variables and body composition and SEMG frequency of the spine rectifier in children with scoliosis and scoliotic posture. Journal of Education, Health and Sport 2018; 8 (12): 558-574. eISNN 2391-8306. DOI http://dx.doi.org/10.5281/zenodo.2525742.
3. Cifrek M, Medved V , Tonković S, Ostojić S. Surface EMG based muscle fatigue evaluation in biomechanics. Clinical Biomechanics 2009; 4: 327-340.
4. Lenke LG, Edwards CC, Bridwell KH. The Lenke classification of adolescent idiopathic scoliosis: how it organizes curve patterns as a template to perform selective fusion of the spine. Spine, 2003; 28: 199-203.

5. King HA, Moe JHY, Bradford DS, et al. The selection of fusion levels in thoracic idiopathic scoliosis. J Bone Joint Surg Am 1983; 65-A: 1302-1313.
6. Dayer R, Haumont T, Belaieff W, et al. Idiopathic scoliosis: etiological concepts and hypotheses. J Child Orthop. 2013; 7 (1): 11-6.
7. Girardo M, Bettini N, Dema E, et al. The role of melatonin in the pathogenesis of adolescent idiopathic scoliosis (AIS). Eur Spine J. 2011; 20 (1): S68-74.
8. Porte M, Patte K, Dupeyron A, et al. Exercise therapy in the treatment of idiopathic adolescent scoliosis: Is it useful? Arch Pediatr. 2016; 23 (6): 624-8.
9. Abelin-Genevois K, Sassi D, Verdun S, Roussouly P. Sagittal classification in adolescent idiopathic scoliosis: original description and therapeutic implications. Eur Spine J. 2018; 10. doi: 10.1007/s00586-018-5613-1.
10. Farina D, Fosci M , Merletti R. Motor unit recruitment strategies investigated by surface EMG variables. Journal of Applied Physiology 2002; 1: 235-247.
11. Sanchez M, Valdivieso A,Villanueva MÁM, Salazar AFZ. Potential clinical application of surface electromyography as indicator of neuromuscular recovery during weaning tests after organophosphate poisoning. Revista Brasileira de Terapia Intensiva 2017; 29: 253–258.
12. Shiner CT, Pierce KD,Thompson-Butel AG, Trinh T, Schofield PR, McNulty PA. BDNF genotype interacts with motor function to influence rehabilitation responsiveness poststroke. Frontiers in Neurology 2016; 7: 69.
13. Borysiuk Z, Rogowska A. The relationship between the components of sensorimotor responses measured by EMG and personality current research in motor control II. Publishing House of University of Physical Education, Katowice 2004; 1: 89-94.
14. Konrad P, ABC EMG Practical introduction to kinesiology electromyography. Technomex, Gliwice 2007; 1: 5-12.
15. Michoński J, Walesiak K, Pakuła A, Glinkowski W, Sitnik R. Monitoring of spine curvatures and posture during pregnancy using surface topography - case study and suggestion of method. Scoliosis and Spinal Disorders 2016; 11: 31.
16. Van Damme B, Stevens V, Van Tiggelen D, Perneel C, Crombez G, Danneels L. Performance based on sEMG activity is related to psychosocial components: differences between back and abdominal endurance tests. Journal of Electromyography and Kinesiology 2014; 24: 636–644.

17. Xiao J, Gao J, Wang H,LIU K, Yang X. The Surface EMG Characteristics between Erector Spinae and Vastus Lateralis during Bending Forward and Squatting Down Tasks. Physiology Journal 2015; 5: 1-6.
18. Kim JW, Kwon OY, Kim TH, An DH, Oh JS . Effects of external pelvic compression on trunk and hip muscle EMG activity during prone hip extension in females with chronic low back pain. Manual Therapy 2014; 19: 467–471.
19. Wilczyński J, Karolak P, Karolak J, Wilczyński I, Pedrycz A. Electromyographic analysis of erector spinae muscle for a child with cerebral palsy. Polish Hyperbaric Research 2016; 3: 43-52.
20. Gentempo P. Evaluating soft tissue injuries with electromyography: case studies. Today's Chiropractic 1988; 2: 83.
21. Neblett R, Brede E, Mayer TG, Gatchel RJ. What is the best surface EMG measure of lumbar flexion-relaxation for distinguishing chronic low back pain patients from pain-free controls? Clinical Journal of Pain 2013; 29: 334–340.
22. Spencer GS, Eccles MJ. Spinal muscle in scoliosis. Part 2. The proportion and size of type 1 and type 2 skeletal muscle fibers measured using a computer-controlled microscope. *Journal* of the Neurological Sciences 1976; 30: 143-154.
23. Du HG, Ye SL , Xu JY, Jiang Z, Song HQ, Yu JW. Application of surface electromyography in the treatment of adolescent idiopathic scoliosis with traditional spinal balanced therapy**.** Zhongguo Gu Shang 2013; 11: 914-917.
24. Dutton M. Ortopedia Duttona. PZWL, Warszawa 2014; 1: 211-214.
25. Hopf C, Scheidecker M, Steffan K, Bodem F, Eysel P . Gait analysis in idiopathic scoliosis before and after surgery: a comparison of the pre- and postoperative muscle activation pattern. European Spine Journal 1998; 7: 6-11.
26. Travis LA, Arthmire SJ , Baig AM, Goldberg A, Malek MH. Intersession reliability of the electromyographic signal during incremental cycle ergometry: quadriceps femoris. Muscle Nerve 2011; 44: 937-946.
27. Gaudreault N, Arsenault AB , Larivière C, DeSerres SJ, Rivard CH. Assessment of the paraspinal muscles of subjects presenting an idiopathic scoliosis: an EMG pilot study.BMC Musculoskeletal Disorders 2005; 10: 6-14.
28. Gaudreault N. Assessment of the paraspinal: an EMG pilot study. BMC Musculoskeletal Disorders 2004; 5: 18.

29. Bazrgari B, Xia T. Application of advanced biomechanical methods in studying low back pain - recent development in estimation of lower back loads and large-array surface electromyography and findings. Journal of Pain Research2017; 10: 1677-1685.

Table 1. Characteristics of the posture of the subjects

Children 7 years old							p
Types of posture	Girls		Boys		Total		
	N	%	N	%	N	%	
Correct posture	1	0.77	1	0.77	2	1.54	0,26
Scoliotic posture	41	31.54	35	26.92	76	58.46	0,20
Scoliosis	21	16.15	31	23.85	52	40.00	0,056
Together	63	48.46	67	51.54	130	100	
Children 8 years old							p
Types of posture	Girls		Boys		Total		
	N	%	N	%	N	%	
Correct posture	3	2.48	2	1.65	5	4.13	0,34
Scoliotic posture	29	23.97	36	29.75	65	53.72	0,21
Scoliosis	18	14.87	33	27.27	51	42.15	0,07
Together	50	41.31	71	58.67	121	100	

Table 2. Analysis of ANOVA differences for body composition variables between girls and boys in the scoliosis, scoliotic posture and correct posture

Variable	Scoliosis		Scoliotic posture		Correct posture	
	F	p	F	p	F	p
Body height (cm)	0,02	0,88	6,39	0,01	0,66	0,45
Body mass (kg)	1,07	0,30	0,59	0,44	0,14	0,72
BMI	1,78	0,19	0,41	0,52	0,02	0,89
Fat Mass (%)	0,14	0,71	15,85	0,001	3,87	0,11
Fat Mass (kg)	0,59	0,44	1,79	0,18	0,53	0,50
Fat Free Mass (kg)	1,16	0,28	5,32	0,02	0,84	0,40
Muscle Mass (kg)	1,19	0,28	4,59	0,03	0,80	0,41
Total Body Water (kg)	1,04	0,31	3,63	0,06	0,85	0,40
Total Body Water (%)	1,52	0,22	16,13	0,001	3,67	0,11
BMR (kJ)	21,64	0,001	62,74	0,001	6,12	0,06
BMR (kcal)	21,87	0,001	61,88	0,001	6,11	0,06
Bone Mass (kg)	7,12	0,01	20,50	0,001	2,05	0,21
Proteins (kg)	0,68	0,41	3,17	0,08	0,63	0,46

Table 3. Stepwise regression model between the anthropometric variables and body composition and the amplitude of the rectifier ridge group scoliosis and scoliotic posture

Stepwise regression model in a group of scoliosis[1]

Variable b*	Variable b*	Variable b*	Variable b*	Variable b*	Variable b*	Variable b*
Intercept			137,87	1,73	79,73	**0,001**
Standing position lumbar segment left side	-0,35	0,13	-0,19	0,07	-2,77	**0,01**
Standing standing lumbar section right side	0,35	0,14	0,06	0,03	2,57	**0,01**
Lying in front of the chest segment right side	-0,35	0,15	-0,12	0,05	-2,28	**0,02**
R= 0,35 R^2= 0,12 Corrected R^2= 0,09 F(4,98)=3,49; p=0,01						
Stepwise regression model in a group of scoliotic posture						
Variable b*	Variable b*	Variable b*	Variable b*	Variable b*	Variable b*	Variable b*
Intercept			137,42	2,90	47,40	**0,0001**
Torso up chest segment right side	-0,41	0,11	-0,15	0,04	-3,77	**0,0001**
Lower limbs up the lumbar segment right side	-0,26	0,13	-0,06	0,03	-2,03	**0,044**
Torso up the lumbar section of the right side	0,36	0,15	0,08	0,03	2,43	**0,016**
Torso up chest segment left side	0,38	0,14	0,12	0,04	2,80	**0,006**
R= 0,39 R^2= 0,15 Corrected R^2= 0,12 F (5,135)=4,89; p=0,001						

1 * b - constant regression, Std. Error Z b* - standard error of the regression constant; b – the partial regression coefficients, Std. Error Z b - standard error of the partial regression coefficient, t – statistical test, p - level of significance