Wilczyński Jacek, Habik Natalia, Paprocki Michał. Body posture in the sagittal plane and scoliotic variables in girls aged 7-18. Journal of Education, Health and Sport. 2018;8(02):174-185. eISNN 2391-8306. DOI http://dx.doi.org/10.5281/zenodo.1173092
http://ojs.ukw.edu.pl/index.php/johs/article/view/5283

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

Received: 05.01.2018. Revised: 10.01.2018. Accepted: 14.02.2018.

Body posture in the sagittal plane and scoliotic variables in girls aged 7-18

Postawa ciała w płaszczyźnie strzałkowej a zmienne skoliotyczne u dziewcząt w wieku 7-18 lat

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ABSTRACT

Introduction. The aim of the study was to analyze the correlation between the variable posture in the sagittal plane and the scoliotic variables. **Material and methods**. The study involved 28 girls aged 7-18 years with scoliotic posture and scoliosis. Body posture as well as the spine were examined using Moiré's spatial photogrammetry and the Exhibeon digital radiography method. Based on the size of the spinal curvature, the following were distinguished: scoliotic postures: 1-9° and scoliosis: ≥10°. **Results**. There were 21 (75%) with scoliotic posture and 7 (25%) with scoliosis. The size of the thoracic kyphosis and lumbar lordosis was normal. **Conclusions**. Between the body postural variables in the sagittal plane and the scoliotic variables, both positive (direct proportional) and negative (inversely proportional) correlations occurred. In the selection of scoliosis treatment method, the size of the postural variables in the sagittal plane should be taken into account, and each patient's case should be individually considered.

Key words: Body posture in the sagittal plane, scoliotic variables, Moiré method, Exhibeon digital radiology method

INTRODUCTION

In the second half of the 20th century, works on distal spine deformities in scoliosis patients appeared [1]. The physiological kyphosis of the chest in the course of idiopathic scoliosis has been described [2]. The term "rotational lordosis" has also been referred to as the pathological backbone of the spine, which over time, changes into lateral distortion under the influence of vertebral rotation [3,4]. In large scoliosis, the pathogenic significance of spinal anatomy increases [5,6]. The column of the spine is called the inner hump [7,8]. From a functional point of view, it is more important than the external hump as it occupies the space required for internal organs [9,10]. It increases with the progression of scoliosis and is responsible for distant chest complications [11,12]. At present, scoliosis is considered a multi-faceted distortion, in which, apart from deviation in the frontal plane, changes in the size of the curvatures in the sagittal plane as well the rotation and torsion of the vertebrae occur [13,14]. Spinal curvature and its rotation are secondary and the reduction of thoracic kyphosis is primary, leading to progression of scoliosis [1,15,16]. However, there are opinions about the size of lumbar lordosis. Some people think that it deepens in children with scoliosis [17,18]. Others claim the total opposite, i.e. that is becomes shallower [19,20]. These are not purely theoretical considerations as the size and shape of these curvatures should be considered in the selection of treatment methods [1, 21]. Based on the PNF (Proprioceptive Neuromuscular Facilitation) method used in scoliosis treatment, we use shoulder-blade movement patterns depending on the location and direction of the curvature, which causes the shoulder to be lowered or raised, and deepening or shallowing of chest kyphosis [1,22]. Properly chosen pelvic patterns result in lowering or raising the hips and deepening or shallowing lumbar lordosis [1,23]. The aim of the study was to analyze the correlation between the variable posture in the sagittal plane and the scoliotic variables.

MATERIAL AND METHODS

The study included 28 girls aged 7-18 with scoliotic posture or idiopathic scoliosis. The selection of test subjects was deliberate. Children attended therapy at the Intramural Centre for Corrective and Compensatory Gymnastics in Starachowice (Poland). The study was conducted in June 2011. All procedures performed in test involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. The guardians of the children were informed about the purpose of the study and expressed written consent for their children's participation in the study. The study was non-invasive and free of charge. The patients willingly participated in the study, and perceived it as a concern about their state of health. The photogrammetric Moiré method was used in postural tests. Spinous processes from C7 to S1 were marked on the back of tested subject using a marker, as well as the acromion, lower angles of the shoulder blades and the posterior superior iliac spine. The subject assumed a habitual position at the rear of the device at a distance of 3.2 m. Stripes were projected onto the back, and the focusing of the lens allowed the Moiré image to be obtained. The image of the spine was received by an optical system with a camera, then it was passed onto to the analogue monitor and finally, to the computer. In this way, a three-dimensional image of the back was formed. The following parameters of the posture in the sagittal plane were analysed: total spine length (MM), trunk inclination angle (°), absolute trunk inclination angle (°), alpha angle (°), beta angle (°), gamma angle (°), length of chest kyphosis (MM), length of chest kyphosis/total spine length (%), angle of chest kyphosis (°), actual angle of chest kyphosis (°), actual angle of chest kyphosis/total spine length (%), depth of chest kyphosis (mm), depth of chest kyphosis/total spine length (%), absolute value of chest kyphosis depth/total spine length (%), length of lumbar lordosis (mm), length of lumbar lordosis/total spine length (%), lumbar lordosis angle (°), actual angle of lumbar lordosis (°), actual angle of lumbar lordosis/total spine length (%), depth of lumbar lordosis (mm), depth of lumbar lordosis/total spine length (%). Next, primary and secondary spinal curvature parameters were analysed: shoulder asymmetry – right higher (mm), shoulder asymmetry - left higher (mm), shoulder line angle (°), shoulder blade asymmetry – right higher (mm), shoulder blade asymmetry – left higher (mm), pelvis tilt angle (°), absolute value of pelvis tilt angle (°), pelvis rotation angle (°), pelvis rotation (°), shoulder/pelvis asymmetry coefficient (%), shoulder asymmetry coefficient - KK point (%), shoulder/C7 asymmetry coefficient (%), length of curvature (mm), length of curvature/total spine length (%), depth of curvature (mm), depth of curvature/total spine length (%), curvature angle (°), absolute value of curvature angle (°) [1]. The study also used Exhibeon digital radiographs. Based on them, the Cobb curve was plotted. Variables were verified in terms of normality using the Shapiro-Wilk test. The Pearson correlation coefficient was used to determine the relationship between body posture variables in the sagittal plane and scoliotic variables. Significant levels were assumed at $p < 0.05$.

RESULTS

There were 21 (75%) with scoliotic posture and 7 (25%) with scoliosis. Between the body postural variables in the sagittal plane and the scoliotic variables, both positive (direct proportional) and negative (inversely proportional) correlations occurred. Directly proportional correlations concerned: Trunk inclination angle and Absolute shoulder line angle (R= 0,4774), (p= 0,0100), Abs value of trunk inclination angle and Shoulder asymmetry- left higher (R= 0,3998), (p= 0,0350), Abs value of trunk inclination angle and Absolute shoulder line angle (R= 0,4229), (p= 0,0250), Beta angle and Shoulder blade asymmetry – right higher (R= 0,4226), (p= 0,0250), Length of chest kyphosis /Total spine length and Shoulder blade asymmetry – right higher (R= 0,3946), (p=0,0380), Length of lumbar lordosis / Total spine length and Absolute pelvis tilt angle (R= 0,4523), (p=0,0160), Actual angle of lumbar lordosis and Absolute pelvis tilt angle (R= 0,5081), (p=0,0060), Actual angle of lumbar lordosis / Total spine length and Absolute pelvis tilt angle (R= 0,4939), (p=0,0080) (tab. 2); Length of chest kyphosis and Length of primary curvature (R= 0,4447), (p=0,0180), Depth of chest kyphosis and Length of primary curvature (R= 0,4228), (p=0,0250), Depth of chest kyphosis / Total spine length and Length of primary curvature / Total spine length (R= 0,3756), (p=0,0490), Absolute depth of chest kyphosis / Total spine length and Length of primary curvature / Total spine length (R= 0,4110), (p=0,0300), Length of lumbar lordosis and Length of primary curvature (R= 0,4155), (p=0,0280) (tab.3); Trunk inclination angle and Length of secondary curvature (R= 0,4625), (p=0,0130), Trunk inclination angle and Length of secondary curvature / Total spine length (R= 0,4599), (p=0,0140), Length of chest kyphosis and Secondary curvature angle RTG (R= 0,4352), (p=0,0210), Length of lumbar lordosis and Primary curvature angle RTG method (R= 0,4704), (p=0,0120), Length of lumbar lordosis and Secondary curvature angle RTG method (R= 0,5382), (p=0,0030) (tab.4). On the other hand, there were 16 inversely proportional correlations: Alpha angle and Shoulder blade asymmetry – right higher (R= -0,3861), (p=0,0420), Beta angle and Shoulder asymmetry- left higher (R= -0,4992), (p=0,0070), Beta angle and Absolute shoulder line angle (R= -0,6860), (p=0,0000), Beta angle and Shoulder blade asymmetry – left higher (R= -0,3837), (p=0,0440); Depth of chest kyphosis and Shoulder asymmetry- left higher (R= -0,4560), (p=0,0150); Depth of chest kyphosis and Absolute shoulder line angle (R= -0,6632), (p=0,0000); Depth of chest kyphosis / Total spine length and Shoulder asymmetry- left higher (R= -0,4800), (p=0,0100); Depth of chest kyphosis / Total spine length and Absolute shoulder line angle (R= -0,7009), (p=0,0000); Absolute depth of chest kyphosis / Total spine length and Shoulder asymmetry- left higher (R= -0,4407), (p=0,0190); Absolute depth of chest kyphosis / Total spine length and Absolute shoulder line angle (R= -0,6850), (p=0,0000) (Tab.1); Actual angle of chest kyphosis / Total spine length and Absolute pelvis tilt angle (R= --0,5111), (p=0,0050); Depth of chest kyphosis / Total spine length and Absolute pelvis tilt angle (R= -0,4187), (p= 0,0270) (Tab.2); Trunk inclination angle and Length of primary curvature / Total spine length (R= -0,4478), (p= 0,0170) (Tab. 3); Depth of chest kyphosis / Total spine length and Length of secondary curvature / Total spine length (R= -0,3832), (p= 0,0440); Absolute depth of chest kyphosis / Total spine length and Length of secondary curvature (R= -0,3877), (p= 0,0420); Absolute depth of chest kyphosis / Total spine length and Length of secondary curvature / Total spine length (R= -0,4194), (p= 0,0260) (Tab. 4).

DISCUSSION

Between the body postural variables in the sagittal plane and the scoliotic variables, both positive (direct proportional) and negative (inversely proportional) correlations occurred [1]. Correct chest kyphosis guarantees proper statics of the spine and the entire trunk, including the body's centre of gravity. It rotationally stabilizes the spine, provides cushioning and allows the physiological movement of the spine [24]. Correctly developed thoracic kyphosis affects respiratory function. This is possible by providing the right anterior-posterior thoracic dimension and lung capacity. In addition, chest kyphosis allows the proper movement of the chest, depending on the correct axis of rotation of the ribs and vertebrae and the amplitude of the rib movement. The major morphological defect in idiopathic scoliosis is the excessive length of the frontal spinal column relative to the length of the posterior ones. Within the area of the primary curvature of chest scoliosis, each vertebra is in a lordotic position with respect to the vertebra above and below. This results in the reduction of kyphosis or even its lordosization [25]. Turning the spine around the long axis causes pathological frontal tilt leading to lateral curvature. Since idiopathic trunk scolioses are lordo-scolioses, it is necessary to explain the observation that many patients are diagnosed with gyperhyphosis [4]. Actual kyphosis occurs on the combination of two structural bends. Within each of them, the axial rotation of the vertebrae is directed in opposite directions. On the combination of the two bends, the rotation of the stems causes the continuity of the frontal column of the spine, which leads to the kyphotic bend of both lobotically stiffened areas relative to each other [1,26]. The progression of thoracic scoliosis can occur to such large values of the axial rotation angle that lateral flexion is revealed in the sagittal plane as kyphosis. Despite the superficial image of kyphoscoliosis, the vertebrae remain in a lordotic position with respect to each other [1]. Kyphosis is a natural component of the spine torsion process in lumbar and chest-lumbar scoliosis. Kyphosis may occur in the proximal thoracic spine as postural compensation of the lower lordotic part. In ways different from thoracic scoliosis, lumbar-chest and lumbar scoliosis develop. Initially, the lateral movement of the spine (lateral flexion of the spine in the shape of an arch) is greatest. Then, the rotation of the vertebrae around the long axis of the spine enlarges the curvature in the frontal plane, causing the lumbar muscle or thoracic lobe to be prominent, which is accompanied by a decrease in lumbar lordosis [27]. Curvature of chest kyphosis (flat back), scoliosis with reduced lateral mobility, scoliosis with short arch curvature, high rotation and structural changes in vertebral bodies cannot be attributed a positive outcome. The formation of chest scoliosis involves the displacement of 4-6 thoracic vertebrae initially in the sagittal plane (front tilt of thoracic spine) [1,28]. In this way, physiological kyphosis of the chest is reduced, the back becomes clinically flat. It should be noted that a flat back may occur as a so-called single-plane postural defect, not heading in the direction of scoliosis. Scoliosis is also accompanied by rotational and lateral displacement [1]. At this stage, there is no change in the shape of the vertebrae (vertebrae torsion), but only a three-plane change in their spatial orientation (spinal torsion). The frontal, core-disc column of the spine becomes relatively too long in relation to the two rear columns. One-plane (frontal) flexion of the spine may occur. This is qualified as scoliotic posture that does not develop into scoliosis. Occasionally, segmental rotation of the vertebrae without lateral curvature (single-plane defect in the transverse plane) is also encountered. A rib-bone hump occurs during bending but the radiograph does not show any curvature [1,29].

CONCLUSIONS

Between the body postural variables in the sagittal plane and the scoliotic variables, both positive (direct proportional) and negative (inversely proportional) correlations occurred. In the selection of scoliosis treatment method, the size of the postural variables in the sagittal plane should be taken into account, and each patient's case should be individually considered.

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Table 1. Correlations between body postural variables in the sagittal plane and variables scolio

Body posture in the sagittal plane variables	**Shoulder asymmetry – right higher**	**Shoulder asymmetry- left higher**	**Shoulder line angle**	**Absolute shoulder line angle**	**Shoulder blade asymmetry – right higher**	**Shoulder blade asymmetry – left higher**
Trunk inclination angle	-0,0943	0,3713	0,2821	0,4774	-0,0967	0,2106
	0,6330	0,0520	0,1460	**0,0100**	0,6240	0,2820
Abs value of trunk inclination angle	-0,1642	0,3998	0,2923	0,4229	-0,1935	0,2152
	0,4040	**0,0350**	0,1310	**0,0250**	0,3240	0,2710
Alpha angle	-0,0607	0,2757	0,1075	0,1698	**-0,3861**	-0,0038
	0,7590	0,1560	0,5860	0,3880	**0,0420**	0,9850
Beta angle	-0,0678	-0,4992	-0,1684	-0,6860	0,4226	-0,3837
	0,7320	**0,0070**	0,3920	**0,0000**	**0,0250**	**0,0440**
Gamma angle	0,0297	0,083	0,1631	0,1014	0,221	0,0866
	0,8810	0,6750	0,4070	0,6080	0,2590	0,6610
Delta angle	-0,0458	0,0594	0,0681	-0,1609	0,005	-0,0779
	0,8170	0,7640	0,7310	0,4140	0,9800	0,6940
Compensation index	0,0602	-0,1269	0,0495	-0,0564	0,4074	0,0735
	0,7610	0,5200	0,8030	0,7760	**0,0310**	0,7100
Absolute value of compensation index	0,0285	0,1577	0,0111	0,2513	-0,293	-0,0097
	0,8850	0,4230	0,9550	0,1970	0,1300	0,9610
Length of chest kyphosis	0,143	0,0021	-0,119	0,0451	0,2518	0,138
	0,4680	0,9920	0,5460	0,8200	0,1960	0,4840
Length of chest kyphosis / Total spine length	-0,0056	0,1177	0,0975	0,06	0,3946	0,1224
	0,9770	0,5510	0,6220	0,7620	**0,0380**	0,5350
Angle of chest kyphosis	-0,0224	0,1607	0,0245	0,3384	-0,2926	0,1072
	0,9100	0,4140	0,9020	0,0780	0,1310	0,5870
Actual angle of chest kyphosis	-0,0441	-0,0293	-0,0431	-0,1718	0,2631	0,1337
	0,8240	0,8820	0,8280	0,3820	0,1760	0,4980
Actual angle of chest kyphosis / Total spine length	-0,1879	-0,0159	0,0786	-0,2722	0,2631	0,1114
	0,3380	0,9360	0,6910	0,1610	0,1760	0,5730
Depth of chest kyphosis	0,0353	-0,4560	-0,2795	**-0,6632**	0,2797	-0,2443
	0,8580	**0,0150**	0,1500	**0,0000**	0,1490	0,2100
Depth of chest kyphosis / Total spine length	0,0025	-0,4800	-0,2705	**-0,7009**	0,2901	-0,2717
	0,9900	**0,0100**	0,1640	**0,0000**	0,1340	0,1620
Absolute depth of chest kyphosis / Total spine length	-0,0227	-0,4407	-0,2221	**-0,6850**	0,2764	-0,3211
	0,9090	**0,0190**	0,2560	**0,0000**	0,1550	0,0960
Length of lumbar lordosis	0,2108	-0,0084	-0,1089	0,1607	-0,0374	0,0416
	0,2820	0,9660	0,5810	0,4140	0,8500	0,8330
Length of lumbar lordosis / Total spine length	0,0869	0,0684	0,072	0,2235	-0,3048	-0,1159
	0,6600	0,7290	0,7160	0,2530	0,1150	0,5570
Angle of lumbar lordosis	0,0708	0,0159	0,0677	0,3061	0,1753	0,1798
	0,7200	0,9360	0,7320	0,1130	0,3720	0,3600
Actual angle of lumbar lordosis	0,2684	0,0015	-0,1564	0,2705	-0,176	-0,0011
	0,1670	0,9940	0,4270	0,1640	0,3700	0,9960
Actual angle of lumbar lordosis / Total spine length	0,1653	0,0339	-0,0581	0,2718	-0,3002	-0,0993
	0,4010	0,8640	0,7690	0,1620	0,1210	0,6150
Depth of lumbar lordosis	0,1408	-0,168	-0,1853	-0,369	0,0654	-0,1541
	0,4750	0,3930	0,3450	0,0530	0,7410	0,4340
Depth of lumbar lordosis / Total spine length	0,072	-0,1511	-0,1328	-0,36	0,0371	-0,198
	0,7160	0,4430	0,5010	0,0600	0,8510	0,3130

Table 2. Correlations between body postural variables in the sagittal plane and variables scoliotic

Body posture in the sagittal plane variables	**Pelvis tilt angle**	**Absolute pelvis tilt angle**	**Pelvis rotation angle**	**Absolute pelvis rotation angle**	**Coefficient of shoulder asymmetry - KK**	**Coefficient of shoulder asymmetry relative to C_7**
Trunk inclination angle	0,1324	-0,1146	-0,0826	0,2793	-0,0254	-0,2268
	0,5020	0,5610	0,6760	0,1500	0,8980	0,2460
Abs value of trunk inclination angle	-0,0630	0,0251	-0,1163	0,2333	0,0260	-0,0498
	0,7500	0,8990	0,5560	0,2320	0,8950	0,8010
Alpha angle	0,1843	0,1053	0,1465	-0,0996	0,0775	-0,2868
	0,3480	0,5940	0,4570	0,6140	0,6950	0,1390
Beta angle	-0,2165	-0,2557	0,0653	-0,2713	-0,1782	0,0938
	0,2690	0,1890	0,7410	0,1630	0,3640	0,6350
Gamma angle	-0,0457	-0,2539	0,1503	0,0949	-0,1808	-0,1549
	0,8170	0,1920	0,4450	0,6310	0,3570	0,4310
Delta angle	-0,0455	-0,2209	0,1816	-0,0700	-0,1162	-0,232
	0,8180	0,2590	0,3550	0,7230	0,5560	0,2350
Compensation index	-0,1967	-0,2686	0,0287	0,1357	-0,1720	0,1113
	0,3160	0,1670	0,8850	0,4910	0,3810	0,5730
Absolute value of compensation index	0,3705	0,2938	-0,242	-0,0407	0,3223	0,1056
	0,0520	0,1290	0,2150	0,8370	0,0940	0,5930
Length of chest kyphosis	0,1384	0,0635	0,2770	-0,0817	-0,2678	-0,1307
	0,4820	0,7480	0,1540	0,6800	0,1680	0,5070
Length of chest kyphosis / Total spine length	0,1277	-0,0795	-0,0172	0,1598	0,1732	-0,0368
	0,5170	0,6870	0,9310	0,4170	0,3780	0,8520
Angle of chest kyphosis	0,2036	0,3574	-0,1333	0,0180	0,2198	0,0565
	0,2990	0,0620	0,4990	0,9280	0,2610	0,7750
Actual angle of chest kyphosis	0,0214	-0,2916	0,2527	-0,0082	-0,2684	-0,2286
	0,9140	0,1320	0,1950	0,9670	0,1670	0,2420
Actual angle of chest kyphosis / Total spine length	-0,0645	-0,5111	0,1073	0,1257	-0,1020	-0,2304
	0,7440	**0,0050**	0,5870	0,5240	0,6060	0,2380
Depth of chest kyphosis	-0,2686	-0,3561	0,2179	-0,1742	-0,3016	-0,0642
	0,1670	0,0630	0,2650	0,3750	0,1190	0,7450
Depth of chest kyphosis / Total spine length	-0,2892	-0,4187	0,1634	-0,1310	-0,2706	-0,075
	0,1360	**0,0270**	0,4060	0,5070	0,1640	0,7040
Absolute depth of chest kyphosis / Total spine length	-0,1701	-0,2807	0,1791	-0,2048	-0,2068	-0,0812
	0,3870	0,1480	0,3620	0,2960	0,2910	0,6810
Length of lumbar lordosis	0,2799	0,3394	0,2872	-0,2047	-0,2255	-0,0951
	0,1490	0,0770	0,1380	0,2960	0,2480	0,6300
Length of lumbar lordosis / Total spine length	0,3275	0,4523	0,0231	-0,1739	0,1875	0,0798
	0,0890	**0,0160**	0,9070	0,3760	0,3390	0,6860
Angle of lumbar lordosis	0,0056	0,0769	-0,1053	0,1912	0,0143	0,1760
	0,9770	0,6970	0,5940	0,3300	0,9430	0,3700
	0,1150	0,5081	0,1302	-0,1857	-0,1468	0,1164
Actual angle of lumbar lordosis	0,5600	**0,0060**	0,5090	0,3440	0,4560	0,5550
Actual angle of lumbar lordosis / Total spine length	0,0470	0,4939	-0,0914	-0,1215	0,1123	0,2545
	0,8120	**0,0080**	0,6440	0,5380	0,5690	0,1910
Depth of lumbar lordosis	-0,0642	0,0891	0,0657	-0,2172	-0,0007	0,1535
	0,7450	0,6520	0,7400	0,2670	0,9970	0,4360
Depth of lumbar lordosis / Total spine length	-0,0407	0,0745	0,0067	-0,2135	0,0886	0,1671
	0,8370	0,7060	0,9730	0,2750	0,6540	0,3950

Table 3. Correlations between body postural variables in the sagittal plane and variables scoliotic

Body posture in the sagittal plane variables	**Length of primary curvature**	**Length of primary curvature / Total spine length**	**Depth of primary curvature**	**Depth of primary curvature / Total spine length**	**Primary curvature angle**	**Absolute secondary curvature angle**
Trunk inclination angle	-0,3744	-0,4478	-0,3142	-0,3409	0,1194	-0,1826
	0,0500	**0,0170**	0,1030	0,0760	0,5450	0,3520
Abs value of trunk inclination angle	-0,1763	-0,2889	-0,1616	-0,2184	0,0358	-0,1437
	0,3700	0,1360	0,4110	0,2640	0,8560	0,4660
Alpha angle	-0,1754	-0,1437	-0,2017	-0,2203	-0,0377	-0,1488
	0,3720	0,4660	0,3030	0,2600	0,8490	0,4500
Beta angle	0,3065	0,3473	0,0121	0,0325	-0,2219	-0,1075
	0,1130	0,0700	0,9510	0,8700	0,2560	0,5860
Gamma angle	-0,0047	-0,1742	-0,1279	-0,1731	0,0071	-0,1168
	0,9810	0,3750	0,5170	0,3780	0,9710	0,5540
Delta angle	-0,041	-0,0721	-0,1974	-0,2145	-0,0942	-0,1842
	0,8360	0,7160	0,3140	0,2730	0,6340	0,3480
Compensation index	0,1287	-0,0268	0,0444	0,02	0,0369	0,009
	0,5140	0,8920	0,8220	0,9200	0,8520	0,9640
Absolute value of compensation index	-0,2279	-0,1026	-0,1812	-0,1635	-0,099	-0,1101
	0,2440	0,6040	0,3560	0,4060	0,6160	0,5770
Length of chest kyphosis	0,4447	0,0295	0,1974	0,0636	-0,1026	0,0226
	0,0180	0,8810	0,3140	0,7480	0,6030	0,9090
Length of chest kyphosis / Total spine length	0,0878	0,0582	0,1072	0,123	0,1655	0,1224
	0,6570	0,7690	0,5870	0,5330	0,4000	0,5350
Angle of chest kyphosis	-0,0913	-0,0155	0,1102	0,1238	0,0971	0,1412
	0,6440	0,9380	0,5770	0,5300	0,6230	0,4730
Actual angle of chest kyphosis	0,3423	0,0168	0,179	0,0846	-0,1299	0,0382
	0,0750	0,9320	0,3620	0,6690	0,5100	0,8470
Actual angle of chest kyphosis / Total spine length	0,1173	0,0168	0,1234	0,113	-0,057	0,0811
	0,5520	0,9330	0,5320	0,5670	0,7730	0,6820
Depth of chest kyphosis	0,4228	0,3625	0,0942	0,0801	-0,1456	-0,0429
	0,0250	0,0580	0,6340	0,6850	0,4600	0,8280
Depth of chest kyphosis / Total spine length	0,3469	0,3756	0,0819	0,0985	-0,1418	-0,0253
	0,0710	**0,0490**	0,6780	0,6180	0,4720	0,8980
Absolute depth of chest kyphosis / Total spine length	0,3645	0,4110	0,0666	0,0881	-0,1126	-0,0474
	0,0560	**0,0300**	0,7360	0,6560	0,5680	0,8110
Length of lumbar lordosis	0,4155	0,0437	0,1389	-0,0058	-0,2208	-0,049
	0,0280	0,8250	0,4810	0,9770	0,2590	0,8040
Length of lumbar lordosis / Total spine length	-0,0243	0,0305	-0,0888	-0,103	-0,0781	-0,0962
	0,9020	0,8780	0,6530	0,6020	0,6930	0,6260
Angle of lumbar lordosis	0,042	-0,0525	0,1591	0,1464	0,1543	0,1574
	0,8320	0,7910	0,4190	0,4570	0,4330	0,4240
Actual angle of lumbar lordosis	0,2319	0,0051	0,021	-0,0837	-0,0619	-0,0862
	0,2350	0,9790	0,9160	0,6720	0,7540	0,6630
Actual angle of lumbar lordosis / Total spine length	-0,104	-0,0183	-0,1465	-0,1483	0,0845	-0,1101
	0,5980	0,9260	0,4570	0,4510	0,6690	0,5770
Depth of lumbar lordosis	0,1727	0,159	0,0093	0,001	-0,1253	-0,0601
	0,3790	0,4190	0,9630	0,9960	0,5250	0,7610
Depth of lumbar lordosis / Total spine length	0,0424	0,136	-0,0403	-0,0108	-0,107	-0,0597
	0,8300	0,4900	0,8390	0,9560	0,5880	0,7630

Table 4. Correlations between body postural variables in the sagittal plane and variables scoliotic

Body posture in the sagittal plane variables	Length of secondary curvature	Length of secondary curvature / Total spine length	Secondary curvature angle	Absolute secondary curvature angle	Primary curvature angle RTG method	Secondary curvature angle RTG method
Trunk inclination angle	0,4625	0,4599	-0,0684	0,0502	-0,0154	0,0721
	0,0130	**0,0140**	0,7290	0,8000	0,9380	0,7160
Abs value of trunk inclination angle	0,3168	0,3047	-0,1144	-0,0599	0,1296	0,0176
	0,1010	0,1150	0,5620	0,7620	0,5110	0,9290
Alpha angle	0,0918	0,1572	0,2217	0,2236	0,3161	0,2388
	0,6420	0,4240	0,2570	0,2530	0,1010	0,2210
Beta angle	-0,3565	-0,3531	0,1248	-0,1794	-0,1471	-0,1812
	0,0630	0,0650	0,5270	0,3610	0,4550	0,3560
Gamma angle	0,255	0,1822	-0,0392	-0,0388	-0,0648	0,0215
	0,1900	0,3540	0,8430	0,8450	0,7430	0,9130
Delta angle	0,0647	0,0821	0,1748	0,086	0,0885	0,061
	0,7440	0,6780	0,3740	0,6630	0,6540	0,7580
Compensation index	0,1268	0,025	-0,1862	-0,1846	-0,2697	-0,1653
	0,5200	0,9000	0,3430	0,3470	0,1650	0,4010
Absolute value of compensation index	0,0473	0,1152	0,2518	0,1621	0,3507	0,3092
	0,8110	0,5590	0,1960	0,4100	0,0670	0,1090
Length of chest kyphosis	0,2135	-0,0164	-0,0155	-0,0122	0,3653	0,4352
	0,2750	0,9340	0,9380	0,9510	0,0560	**0,0210**
Length of chest kyphosis / Total spine length	-0,0103	-0,0685	-0,1699	0,0292	0,0704	0,1629
	0,9590	0,7290	0,3870	0,8830	0,7220	0,4070
Angle of chest kyphosis	-0,0241	0,0118	-0,0603	0,0687	0,1144	0,0841
	0,9030	0,9530	0,7600	0,7280	0,5620	0,6700
Actual angle of chest kyphosis	0,1753	-0,0095	0,0549	0,0266	0,2408	0,1796
	0,3720	0,9620	0,7810	0,8930	0,2170	0,3600
Actual angle of chest kyphosis / Total spine length	0,0541	-0,0214	0,0474	0,0563	0,0378	-0,0913
	0,7840	0,9140	0,8110	0,7760	0,8490	0,6440
Depth of chest kyphosis	-0,2878	-0,365	0,0756	-0,1481	-0,0342	-0,1645
	0,1380	0,0560	0,7020	0,4520	0,8630	0,4030
Depth of chest kyphosis / Total spine length	-0,3465	-0,3832	0,0885	-0,1509	-0,0969	-0,2431
	0,0710	**0,0440**	0,6540	0,4430	0,6240	0,2130
Absolute depth of chest kyphosis / Total spine length	-0,3877	-0,4194	0,0579	-0,1881	-0,0566	-0,1843
	0,0420	**0,0260**	0,7700	0,3380	0,7750	0,3480
Length of lumbar lordosis	0,1643	-0,02	0,1532	0,004	0,4704	0,5382
	0,4030	0,9200	0,4360	0,9840	**0,0120**	**0,0030**
Length of lumbar lordosis / Total spine length	-0,0645	-0,014	0,1914	0,0601	0,2196	0,2804
	0,7440	0,9440	0,3290	0,7610	0,2620	0,1480
Angle of lumbar lordosis	0,1259	0,0463	-0,2846	-0,1418	-0,1889	-0,0772
	0,5230	0,8150	0,1420	0,4720	0,3360	0,6960
Actual angle of lumbar lordosis	0,1138	0,0152	-0,0158	-0,0716	0,2402	0,3672
	0,5640	0,9390	0,9360	0,7170	0,2180	0,0550
Actual angle of lumbar lordosis / Total spine length	-0,0396	0,0289	-0,0559	-0,0563	-0,0233	0,0926
	0,8420	0,8840	0,7780	0,7760	0,9060	0,6390
Depth of lumbar lordosis	-0,1526	-0,1541	0,1481	0,0671	0,0838	0,1668
	0,4380	0,4340	0,4520	0,7340	0,6720	0,3960
Depth of lumbar lordosis / Total spine length	-0,196	-0,135	0,1722	0,0858	-0,0004	0,0761
	0,3170	0,4940	0,3810	0,6640	0,9980	0,7000