Location, direction, number of arches and spinal curvature angles in younger school-age children

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Abstract

The aim of the study was to analyse the location, direction, number of arches and sizes of spinal curvature angles in younger school-age children. The location, direction and angles of spinal curvature were determined using the Diers formetric III 4D optoelectronic method. Research was carried out at the Posturological Laboratory of the Faculty of Medicine and Health Sciences, Jan Kochanowski University in Kielce (Poland). We examined 251 children, 113 girls (45.02%) and 138 boys (54.98%) aged 7-8 years from Świętokrzyskie primary schools. The spinal examination performed using the Diers formetric III 4D method demonstrated scoliosis in 103 (41%) children. The scoliotic posture was diagnosed in 141 (56.17%) children. In the groups with scoliosis, kyphotic-type curvature occurred most common. Left-sided, single-arch curvature prevailed. One-way analysis of variance showed significant intergroup differences regarding spinal curvature angle measurements. In the treatment of scoliosis, each case has to be considered independently. Pathogenesis and pathomechanics of the curvature have to be determined, as well as its progression (extent), location, direction and curvature angle size.

Key words: location, direction, number of arches, curvature angle, scoliosis, Diers formetric III 4D

Introduction

Proper and precise diagnosis is the basis for therapeutic treatment of scoliosis [1-4]. In addition to learning about the symptoms of disease, we tried to determine its causes, which is extremely difficult; thus, the reproduction of its pathogenesis on the basis of clinical symptoms and subjective examination was attempted [5-9]. Firstly, anatomical and functional relationships of the body as a whole were determined, comparing the deviations within its individual segments, and then the parts of the musculoskeletal system were evaluated in detail [10-15]. In the treatment of scoliosis, each case must be considered individually. Pathogenesis and pathomechanisms of the curvature should be taken into account, its progression (extent) should be determined, including the location, direction and sizes of curvature angles [16-23]. One of the recent methods used for assessment of the spine and body posture is the photogrammetric video recording using the raster stereography process, i.e. the Diers formetric III 4D optoelectronic method. The aim of the study was to analyse the location, direction, number of arches and spinal curvature angles in younger school-age children.

Material and Methods

In the study, we examined 251 children,113 girls (45.02%) and 138 boys (54.98%) aged 7-8 years from Świętokrzyskie primary schools. The subjects were randomly selected. Research was carried out at the Laboratory of Posturology of the Faculty of Medicine and Health Sciences, Jan Kochanowski University in, Kielce in 2017. All of the research procedures were performed in accordance with the 1964 Declaration of Helsinki and approved by the Jan Kochanowski University Bioethics Committee in Kielce (Resolution No. 5/2015). The location, direction and spinal curvature angles were determined using the Diers formetric III 4D optoelectronic method. This method allows photogrammetric video analysis of the spine using the raster stereography process. According to the Diers formetric III 4d manufacturer guidelines, scoliotic posture occurs when pelvic skewness is ≥ 5 mm, lateral deviation is ≥ 5 mm and surface rotation is ≥ 5 degrees while scoliosis is observed when pelvic skewness is > 5 mm, lateral deviation is > 5 mm and surface rotation is > 5 degrees. All three conditions have to be met to diagnose scoliosis or scoliotic posture. Normality of distribution of variables was determined using the Kolmogorov-Smirnov test. One-way analysis of variance (ANOVA) was used to analyse the angle of spinal curvature.

Results

As already mentioned, the selection of subjects was deliberately random. Spinal examinations using the Diers formetric III 4D method demonstrated scoliosis in 103 (41%) children. Scoliotic postures were diagnosed in 141 (56.17%) children. The correct posture was detected in 7 (3.0%) children. In the group with scoliosis, kyphotic curvature was most frequent (62% in girls, 56% in boys, 50% in 7-year-olds and 67% in 8-year-olds). In the group with scoliotic posture, the kyphotic curvature location was also most commonly observed (49% in girls, 45% in boys, 49% in 7-year-olds and 45% in 8-year-olds).

However, in the group with correct postures, the thoracolumbar location of curvature traces was most common, i.e. 75% in girls and 89% in 8-year-olds. The lumbar location of the curvature was most often found in the group with correct postures - 67% in boys and 100% in7-year-olds (Table 1).

Table 1. Location of curvature

Location of curvature in girls						
Location of curvature	Scoliosis		Scoliotic posture		Correct posture	
	N	%	N	%	N	%
Thoracic	**24**	**62**	**34**	**49**	0	0
Thoracolumbar	8	21	24	34	**3**	**75**
Lumbar	7	18	12	17	1	25
Location of curvature in boys						
Location of curvature	Scoliosis		Scoliotic posture		Correct posture	
	N	%	N	%	N	%
Thoracic	**36**	**56**	**32**	**45**	0	0
Thoracolumbar	19	30	26	37	1	33
Lumbar	9	14	13	18	**2**	**67**
Location of curvature in 7-year-olds						
Location of curvature	Scoliosis		Scoliotic posture		Correct posture	
	N	%	N	%	N	%
Thoracic	**26**	**50%**	**37**	**49%**	0	0%
Thoracolumbar	18	35%	26	34%	0	0%
Lumbar	8	15%	13	17%	**2**	**100%**
Location of curvature in 8-yaer-olds						
Location of curvature	Scoliosis		Scoliotic posture		Correct posture	
	N	%	N	%	N	%
Thoracic	**34**	**67%**	**29**	**45%**	0	0%
Thoracolumbar	9	18%	24	37%	**4**	80%
Lumbar	8	16%	12	18%	1	20%

The left-sided direction of curvature was most often found in girls from the scoliosis group (41%) and in the group with scoliotic posture (33%), as well as among the 7-year olds from the scoliosis (37%) and scoliotic posture (33%) groups. The right-sided direction of curvature was most frequently detected in boys from the scoliotic posture group (28%) and in correct posture group (67%), as well as in 7-year-olds from the group with correct postures (100%). In turn, the left-sided/right-sided direction of curvature was found most often in girls from the group with correct posture (75%), as well as in boys with scoliosis (36%) and 8-year-olds from the scoliosis group (37%), scoliotic posture group (37%) and those with correct postures (60%) (Table 2).

One arch was most frequently found in girls from the scoliosis (77%) and scoliotic posture (63%) groups, in boys in the scoliosis (56%) and scoliotic posture (52%) groups, and in the correct posture group (67%), as well as in 8-year-olds in the scoliosis group (63%), and 7-year-olds from the scoliosis (65%) and scoliotic posture (64%) groups, as well as in the correct posture group (100%). Two arches were most frequently noted among girls in the correct posture group (75%), in 8-year-olds from the scoliotic posture group (51%) and in the correct posture group (80%) (Table 3).

Table 2. Direction of curvature

Direction of curvature in girls						
Direction of curvature	Scoliosis		Scoliotic posture		Correct posture	
	N	%	N	%	N	%
Left	**16**	**41%**	**23**	**33%**	0	0%
Right	14	36%	21	30%	1	25%
Left/Right	3	8%	6	9%	0	0%
Right/Left	6	15%	20	29%	**3**	**75%**
Direction of curvature in boys						
Direction of curvature	Scoliosis		Scoliotic posture		Correct posture	
	N	%	N	%	N	%
Left	18	28%	18	25%	0	0%
Right	18	28%	**20**	**28%**	**2**	**67%**
Left/Right	5	8%	15	21%	1	33%
Right/Left	**23**	**36%**	18	25%	0	0%
Direction of curvature in 7-year-olds						
Direction of curvature	Scoliosis		Scoliotic posture		Correct posture	
	N	%	N	%	N	%
Left	**19**	**37%**	**25**	**33%**	0	0%
Right	15	29%	24	32%	**2**	**100%**
Left/Right	8	15%	13	17%	0	0%
Right/Left	10	19%	14	18%	0	0%
Direction of curvature in 8-yar-olds						
Direction of curvature	Scoliosis		Scoliotic posture		Correct posture	
	N	%	N	%	N	%
Left	15	29%	16	25%	0	0%
Right	17	33%	17	26%	1	20%
Left/Right	0	0%	8	12%	1	20%
Right/Left	19	37%	24	37%	3	60%

Table 3. Number of curvatures

Number of curvatures in girls						
Number of curvatures	Scoliosis		Scoliotic posture		Correct posture	
	N	%	N	%	N	%
One arch of the curvature	**30**	**77%**	**44**	**63%**	1	25%
Two curvatures	9	23%	26	37%	**3**	**75%**
Number of curvatures in boys						
Number of curvatures	Scoliosis		Scoliotic posture		Correct posture	
	N	%	N	%	N	%
One arch of the curvature	36	56%	37	52%	2	67%
Two curvatures	28	44%	34	48%	1	33%
Number of curvatures in 7-year-olds						
Number of curvatures	Scoliosis		Scoliotic posture		Correct posture	
	N	%	N	%	N	%
One arch of the curvature	34	65%	49	64%	2	100%
Two curvatures	18	35%	27	36%	0	0%
Number of curvatures in 8-year-olds						
Number of curvatures	Scoliosis		Scoliotic posture		Correct posture	
	N	%	N	%	N	%
One arch of the curvature	**32**	**63%**	32	49%	1	20%
Two curvatures	19	37%	**33**	**51%**	**4**	**80%**

The position and dispersion measurements for scoliosis angles showed diverse distributions of variables comparing girls versus boys as well as 7- and 8-year-olds from the scoliosis, scoliotic posture and correct posture groups (Table 4).

The highest absolute differentiation of scoliosis angle values was found in the group of girls with scoliosis (S=10.72), in boys (S=8.42), 7-year-olds (S=9.74) and 8-year-olds (S=9.06). One-way analysis of variance showed significant intergroup differences in measurements, both for girls and boys and 7- and 8-year-olds, which means that the values of scoliosis angles significantly differed between the groups with scoliotic posture, scoliosis and correct postures, and the significance level was less than 0.5 ($p<0.05$) (Table 4).

Discussion

Technological progress has enabled the use of computers in the diagnosis and treatment of postural defects. Thanks to an appropriate card and programme, the computer performs postural analysis, which eliminates time-consuming calculations and creates the possibility for accurate and comprehensive analysis of the images obtained as well as proper documentation of each individual examined. Computer methods are precise and non-invasive. Since their findings are highly consistent with the results of clinical and radiological tests, some unnecessary and detrimental X-ray examinations can be eliminated, and individuals affected by postural disturbances can undergo more frequent and objective check-ups. . Scoliosis is more common in girls than in boys. In general, its direction is more often right- rather than left-sided. The predominant pattern is right-sided kyphotic and double curvature (right-sided kyphotic and left-sided lumbar) [24,25].

In our study, kyphotic curvature occurred most frequently in the group of children with scoliosis. The single-arch, left-sided curvature direction predominated. One-way analysis of variance

Table 4. Distribution of scoliosis angle variables

Scoliosis angle in girls							
Variables	Mean	Confidence		Min	Max	SD	ANOVA (F; p)
		-95.00%	95.00%				
Scoliosis	22.64	19.17	26.12	9.00	51.00	10.72	46.6; p = **0.0001**
Scoliotic posture	10.27	9.65	10.90	400	18.00	2.62	
Correct posture	6.25	4.25	8.25	5.00	8.00	1.26	
Scoliosis angle in boys							
Variables	Mean	Confidence		Min	Max	SD	ANOVA (F; p
		-95.00%	95.00%				
Scoliosis	20.59	18.49	22.70	11.00	47.00	8.42	61.81; p = **0.0001**
Scoliotic posture	9.27	8.66	9.88	2.00	15.00	2.57	
Correct posture	6.33	4.90	7.77	6.00	7.0	0.58	
Scoliosis angle in 7-year-olds							
Variables	Mean	Confidence		Min	Max	SD	ANOVA (F; p
		-95.00%	95.00%				
Scoliosis	21.58	18.87	24.29	11.00	51.00	9.74	48.85; p = **0.0001**
Scoliotic posture	10.20	9.56	10.84	5.00	18.00	2.79	
Correct posture	5.50	-0.85	11.85	5.00	6.00	0.71	
Scoliosis angle in 8-year-olds							
Variables	Mean	Confidence		Min	Max	SD	ANOVA (F; p
		-95.00%	95.00%				
Scoliosis	21.16	18.61	23.70	9.00	47.00	9.06	57.41; p = **0.0001**
Scoliotic posture	9.26	8.68	9.85	2.00	15.00	2.37	
Correct posture	6.60	5.49	7.71	6.00	8.00	0.89	

showed significant intergroup differences in spinal curvature angles. In the treatment of scoliosis, each case ought to be considered individually. The pathogenesis and pathomechanics of the curvature should be considered, its progression (extent),, the location, direction and sizes of curvature angles should be determined. The significant risk factors in curvature progression are age, gender, first menstruation and family history. The greater and earlier the curvature appears, the more likely its further and rapid progression. Progressive curvature requires active treatment (corsets, surgical treatment).

Conclusion

In our study, kyphotic curvature occurred most frequently in the group of children with scoliosis. The single-arch, left-sided curvature direction was predominant. In the treatment of scoliosis, each case should be be considered individually. The pathogenesis and pathomechanics of the curvature should be considered, its progressivity, the location, direction and sizes of curvature angles should be determined.

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