Original Clinical Article

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Evaluation of a relationship between malocclusion and idiopathic scoliosis in children and adolescents

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Abstract

Purpose Idiopathic scoliosis is a developmental deformation of the vertebral column of an unknown aetiology. Its clinical symptoms and hypothetical causative factors may affect the stomatognathic system. The aim of this study was to analyse the relationships between the prevalence and type of malocclusions, and the presence of idiopathic scoliosis, its location and severity.

Methods This was a prospective longitudinal study. The study group consisted of 80 patients with idiopathic scoliosis and the control group of 61 healthy individuals. Standard standing long-cassette radiographs were taken of all of the patients in the idiopathic scoliosis group in order to confirm diagnosis, to determine localization and the Cobb angle of the curve. Both groups underwent standard clinical dental examination.

Results The most commonly observed types included right main thoracic (R-MT) and thoracolumbar or left lumbar scoliosis (Cobb angle 11° to 125°). In the idiopathic scoliosis group, prevalence of malocclusions was greater than in the control group (95% *versus* 82%). In the idiopathic scoliosis group more than one type of malocclusion was observed with a higher incidence than that in the control group (63.8% *versus* 37.7%; p = 0.002). A correlation between the left proximal thoracic (L-PT) curve with anterior partial open bite was demonstrated (p = 0.323), between thoracic dextroscoliosis main thoracic with lateral partial cross bite (p = 0.230) and a correlation between scoliosis severity and malocclusion in the event of L-PT and anterior partial open bite (p = 0.330) and R-MT and scissors bite *(p = 0.248)*.

Conclusion The incidence of malocclusions is greater in children with idiopathic scoliosis than in their healthy peers.

Level of Evidence: III

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Keywords: scioliosis; idiopathic scioliosis; malocclusion

Introduction

Malocclusions and vertebral column defects frequently occur in individuals at the developmental age. The incidence of malocclusions in the Polish population ranges from 26% to 69.61%.[1,2] The incidence of idiopathic scoliosis is evaluated at 2% to 3% of the adolescent population.[3] This accounts for 80% to 85% of the total number of diagnosed scoliosis cases.[3,4] Idiopathic scoliosis is a 3D developmental deformation of the vertebral column and trunk.[3] The cause of idiopathic scoliosis remains unknown, and, recently, a theory of its multi-factor aetiology has been accepted.[3]

Both the clinical symptoms of idiopathic scoliosis and its hypothetic causative factors may affect the development and the morphologic as well as the functional status of the stomatognathic system. The literature reports that postural defects have an impact on the prevalence of malocclusions and temporomandibular joint dysfunctions.[5-7] It is also believed that the development of the stomatognathic system may have a pathogenic connection to disorders of the growing spine. The risk of prevalence of malocclusions in individuals with scoliosis is probably higher than in general population. However, scientific evidence of such risk does not exist yet.[8,9]

The aim of this study was to determine the incidence of malocclusions in the population of Polish children and adolescents with idiopathic scoliosis in comparison with a

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healthy age-matched population and to analyse the relationships between malocclusions and idiopathic scoliosis.

Patients and methods

Patients

The study comprised 80 consecutive Mid-Eastern European Caucasian patients with idiopathic scoliosis, aged from 8 years and 4 months to 18 years and 2 months, (mean age 14.2 (SD 2.03)) with 71 female and 9 male patients. Diagnosis of idiopathic scoliosis was based on physical examination conducted by an orthopaedic surgeon (M.T.) and confirmed by a long-film standing anteroposterior and lateral radiograph of the whole spine. The diagnosis of scoliosis was made according to Scoliosis Research Society definition i.e. a curve ≥ 10° measured with Cobb method was treated as scoliosis.[3]

The control group consisted of 61 volunteers aged from 8 years and 11 months to 17 years (mean age 12.6 (SD 1.9)) including 29 female and 32 male volunteers attending two Warsaw schools. These children and adolescents were qualified to the control group by the same orthopaedic surgeon, who excluded any signs of musculoskeletal pathologies by physical examination.

All subjects with any chronic diseases (other than idiopathic scoliosis) and taking any medicines were excluded from both the study and the control group.

Written consent of a legal guardian as well as that of patients at the age of 16 years or over was obtained. The study protocol was approved by the local ethical committee on 11 January 2011.

Methods

The study included an orthopaedic evaluation and clinical dental examination.

Orthopaedic evaluation: retrospective analysis of medical documentation and radiographs

The age at onset of the scoliosis as well as its treatment (timing and method) were recorded.

One orthopaedic surgeon (M.T.) analysed all of the standing antero-posterior and lateral radiographs of the spine, defined the location and direction of scoliosis and classified the curves as: left proximal thoracic (L-PT), right proximal thoracic (R-PT), left main thoracic (L-MT), right main thoracic (R-MT), left thoracolumbar scoliosis or left lumbar scoliosis (L-ThL/L), right thoracolumbar scoliosis or right lumbar scoliosis (R-ThL/L). Cobb angle of each curve was measured.[10,11]

Orthodontic evaluation

In an extraoral examination, the facial features were assessed with relation to the three spatial planes: sagittal, frontal and Frankfort horizontal plane. Intraoral examination was conducted to examine occlusion conditions, i.e. occlusion of the dental arches in the transverse direction (medial line, lateral tooth positions), anteroposterior (overjet, Angle Class), vertical (excess overbite, lateral tooth contact). Malocclusions as well as dental anomalies were diagnosed in anteroposterior, transverse and vertical planes.

Statistical analysis

Mean values and standard deviations were used in descriptive statistics of continuous data. For categorized variables, observation numerical strengths and fractions (percentage shares) were presented. Test for independent variables (*t*-test, chi-squared test and Spearman's rank correlation) were used in statistical analysis.

A p-value of < 0.05 was considered as statistically significant.

Statistical analysis was performed with the use of STATISTICA 8 (StatSoft, Poland, Warsaw) statistical software.

Results

Orthopaedic evaluation: retrospective analysis of medical documentation and radiographs

The age of the patients at the onset of scoliosis ranged from 3 years to 18.2 years (mean age 10.8 years (SD 3.4)). The mean time of treatment of scoliosis was 4.8 years (SD 5.6) and included: physiotherapy, bracing (Cheneau-type thoracolumbar orthosis), surgery or combined methods. The prevalence of each type of scoliotic curve is presented in Table 1. The mean Cobb angles for different type of scoliosis were: L-PT: 31.5° (SD 11.2°), R-PT: 49° (SD 0°), L-MT: 27° (SD 28.0°), R-MT: 49.15° (SD 27.2°), L-TH/L: 33.63° (SD 20,1°), R-TH/L: 27° (SD 18.4°) (Table 1).

Orthodontic evaluation: occlusal and functional conditions

Statistically relevant orthognathic occlusal and functional conditions (normal occlusion) had a higher incidence in the control group than in the scoliotic patients (18% *versus* 5%; p = 0.013) (Table 2). With a higher incidence

Table 1 The prevalence of types of scoliosis and mean Cobb angle of each type of curve

Type of scoliosis	n (%)	Mean Cobb angle (SD)
L-PT	10 (*12.5*)	31.5° (11.2°)
R-PT	1 (*1.25*)	49° (0°)
L-MT	4 (*5*)	27° (28.0°)
R-MT	54 (*67.5*)	49.15° (27.2°)
L-THL/L	47 (*58.75*)	33.63° (20.1°)
R-THL/L	2 (*2.5*)	27° (18.4°)

L-PT, left proximal thoracic; R-PT, right proximal thoracic; L-MT, left main thoracic; R-MT, right main thoracic; L-THL/L, left thoracolumbar scoliosis or left lumbar scoliosis; R-THL/L, right thoracolumbar scoliosis or right lumbar scoliosis

Table 2 Types and incidence of occlusal patterns in children with scoliosis and in the control group

Occlusal patterns	Study group, n (%) (N = 80)	Control group, n (%) (N = 61)	p-value*
Normal occlusion	4 (*5*)	11 (*18*)	**0.013**
Distocclusion	21 (*26.3*)	13 (*21.3*)	0.497
Complete (with protrusion)	3 (*3.8*)	3 (*4.9*)	0.734
Complete (with retrusion)	8 (*10*)	2 (*3.3*)	0.124
Partial	2 (*2.5*)	2 (*3.3*)	0.783
Mesiocclusion	1 (*1.3*)	0 (*0*)	0.381
Cross bite (complete)	2 (*2.5*)	0 (*0*)	0.214
Cross bite (partial lateral)	17 (*21.3*)	7 (*11.5*)	0.126
Cross bite (complete anterior)	4 (*5*)	3 (*4.9*)	0.982
Open bite (complete)	1 (*1.3*)	0 (*0*)	0.381
Open bit (complete anterior)	3 (*3.8*)	5 (*8.2*)	0.258
Deep bite	5 (*6.3*)	0 (*0*)	**0.047**
Linguocclusion	5 (*6.3*)	1 (*1.6*)	0.179
Dental anomalies	70 (*87.5*)	40 (*65.6*)	**0.002**
Lateral mandibular deviation (functional)	2 (*2.5*)	0 (*0*)	0.214
Lateral mandibular deviation (morphological)	1 (*1.3*)	0 (*0*)	0.381
Morphological mandibular prognathism	1 (*1.3*)	0 (*0*)	0.381

*chi-squared test
Bold values indicating occurrence of statistically significant dependencies ($p < 0.05$)

Table 3 Incidence of occurrence of more than one malocclusion type in the study group and control group

	Scoliotic group, n (%) (N = 80)	Control group, n (%) (N = 61)	p-value*
More than one malocclusion	51 (*63.8*)	23 (*37.7*)	**0.002**
Distocclusion + dental anomalies	20 (*25.0*)	14 (*23.0*)	0.778
Distocclusion + transversal + dental anomalies	5 (*6.3*)	0 (*0*)	**0.047**
Distocclusion + transversal	1 (*1.3*)	0 (*0*)	0.381
Distocclusion + vertical + dental anomalies	3 (*3.8*)	0 (*0*)	0.126
Distocclusion + vertical + transversal + dental anomalies	1 (*1.3*)	0 (*0*)	0.381
Transversal + vertical + dental anomalies	1 (*1.3*)	0 (*0*)	0.381
Transversal + dental anomalies	17 (*21.3*)	5 (*8.2*)	**0.037**
Distocclusion + transversal	0 (*0*)	2 (*3.3*)	0.103
Vertical + dental anomalies	3 (*3.8*)	2 (*3.3*)	0.881

*chi-squared test
Bold values are statistically significant

Table 4 Malocclusion type and incidence in scoliotic children and in the control group according to Angle's classification. Statistically insignificant differences (chi-squared test, $p < 0.05$)

Malocclusions	Study group, n (%)	Control group, n (%)	p-value
Class I	41 (*53.9*)	30 (*60*)	0.503
Class II	34 (*44.7*)	20 (*40*)	0.599
Class III	1 (*1.3*)	0 (*0*)	0.415
Total	76 (*95*)	50 (*81.9*)	0.013

Table 5 Incidence of symmetric and asymmetric Angle's classes and canine classes

Malocclusion with:	Scoliotic group, n (%)	Control group, n (%)	p-value*
asymmetric Angle's class	20 (*25*)	7 (*11.4*)	**0.043**
symmetric Angle's class	55 (*68.7*)	53 (*86.8*)	**0.012**
asymmetric canine class	21 (*26.2*)	8 (*13.1*)	0.056
symmetric canine class	59 (*73.7*)	53 (*86.8*)	0.056
Angle's class not available for assessment	5 (*6.2*)	1 (*1.6*)	0.179

*chi-squared test
Bold values are of statistical significance ($p < 0.05$)

than in the control group, scoliotic patients suffered from such malocclusions as distoclusion (retrognathism, overjet) (42.6%), cross bites (28.8%), deep bite (6.3%), scissors bite (6.3%), mesiocclusion (prognathism, negative overjet) (1.3%) and dental anomalies (87.5%). In patients without scoliosis a higher incidence was observed only with relation to a complete distoclusion with protrusion of the upper incisor teeth (4.9%), partial distoclusion (3.3%) and partial anterior open bite (8.2%) (Table 2). The incidence of more than one malocclusion was significantly higher in the scoliotic patients (Table 3).

No statistically significant differences were found between the scoliotic and control groups with regard to the incidence of malocclusions according to Angle's classification[5] ($p > 0.05$)[5] (Table 4). However, statistically relevant higher incidence of asymmetric Angle class was found in the scoliotic patients (Table 5). The incidence of deviation of the mesial line in the upper dental arch was also significantly higher in patients with scoliosis than in controls (36.3% *versus* 13.1%) (Table 6).

Association between malocclusion and scoliosis

A significant correlation was revealed between L-PT and anterior partial open bite as well as between R-MT and

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Table 6 Position of the medial lines in the upper and lower dental arches in patients with scoliosis and in the control group

	Displacement of medial line			
Group	**Upper, n (%)**	**Lower, n (%)**	**Upper and lower, n (%)**	**Compliant medial lines, n (%)**
Study (N = 80)	*29 (36.3)*	*36 (45.0)*	*11 (13.8)*	*26 (32.5)*
Control (N = 61)	*8 (13.1)*	*19 (31.1)*	*2 (3.3)*	*36 (59.0)*

Table 7 Spearman's rank correlation indices between scoliosis and occlusal patterns

	Scoliosis type					
Occlusal patterns	**L-PT**	**R-PT**	**L-MT**	**R-MT**	**L-THL/L**	**R-THL/L**
Normal occlusion	0.260*	-0.026	-0.053	-0.086	0.192	-0.037
Complete distocclusion	-0.054	0.189	0.124	-0.193	-0.135	0.086
Complete distocclusion with protrusion of upper incisors	-0.075	-0.022	-0.045	0.137	0.032	-0.032
Complete distocclusion with retrusion of upper incisors	-0.126	-0.038	-0.076	0.053	0.025	-0.053
Partial distocclusion	-0.061	-0.018	-0.037	-0.060	0.134	-0.026
Complete cross bite	-0.061	-0.018	-0.037	0.111	-0.028	-0.026
Mesiocclusion	-0.043	-0.013	-0.026	0.078	0.094	-0.018
Partial lateral cross bite	0.173	-0.058	-0.119	0.230*	-0.123	0.083
Partial anterior cross bite	0.087	-0.026	0.211	0.037	-0.157	-0.037
Complete open bite	-0.043	-0.013	-0.026	0.078	-0.134	-0.018
Partial anterior open bite	0.323*	-0.022	-0.045	0.137	-0.102	-0.032
Deep bite	0.059	-0.029	-0.059	0.069	0.007	-0.041
Linguocclusion	-0.098	-0.029	-0.059	0.179	0.007	-0.041
Dental anomalies	-0.086	0.043	0.087	0.061	-0.086	0.061
Lateral mandibular deviation (functional)	-0.061	-0.018	-0.037	-0.060	-0.028	-0.026
Lateral mandibular deviation (morphological)	-0.043	-0.013	-0.026	0.078	0.094	-0.018
Morphological mandibular prognathism	-0.043	-0.013	-0.026	0.078	0.094	-0.018

*correlation coefficient indicating statistical significance ($p < 0.05$)
L-PT, left proximal thoracic; R-PT, right proximal thoracic; L-MT, left main thoracic; R-MT, right main thoracic; L-THL/L, left thoracolumbar scoliosis or left lumbar scoliosis; R-THL/L, right thoracolumbar scoliosis or right lumbar scoliosis

Table 8 Spearman's rank correlation indices between Cobb angle and occlusal patterns

	Scoliosis					
Occlusal patterns	**L-PT**	**R-PT**	**L-MT**	**R-MT**	**L-THL/L**	**R-THL/L**
Normal occlusion	0.242*	-0.026	-0.053	-0.130	0.059	-0.037
Complete distocclusion	-0.050	0.189	0.127	-0.212	-0.193	0.089
Complete distocclusion with protrusion of upper incisors	-0.074	-0.022	-0.045	0.197	0.095	-0.032
Complete distocclusion with retrusion of upper incisors	-0.126	-0.038	-0.076	0.193	0.107	-0.053
Partial distocclusion	-0.060	-0.018	-0.037	-0.111	0.108	-0.026
Mesiocclusion	-0.042	-0.013	-0.026	0.131	0.139	-0.018
Complete cross bite	-0.060	-0.018	-0.037	-0.046	-0.079	-0.026
Partial lateral cross bite	0.180	-0.058	-0.119	0.152	0.019	-0.083
Partial anterior cross bite	0.080	-0.026	0.201	0.027	-0.129	0.037
Complete open bite	-0.042	-0.013	-0.026	0.082	-0.119	-0.018
Partial anterior open bite	0.330*	-0.022	-0.045	0.189	-0.074	-0.032
Deep bite	0.049	-0.029	-0.059	0.057	0.060	-0.041
Linguocclusion	-0.097	-0.029	-0.059	0.248*	0.096	-0.041
Dental anomalies	-0.074	0.043	0.087	0.102	-0.028	-0.061
Lateral mandibular deviation (functional)	-0.060	-0.018	-0.037	-0.118	-0.065	-0.026
Lateral mandibular deviation (morphological)	-0.042	-0.013	-0.026	-0.032	0.008	-0.018
Morphological mandibular prognathism	-0.042	-0.013	-0.026	0.131	0.139	-0.018

*correlation indices indicating occurrence of statistically significant dependencies for $p < 0.05$
L-PT, left proximal thoracic; R-PT, right proximal thoracic; L-MT, left main thoracic; R-MT, right main thoracic; L-THL/L, left thoracolumbar scoliosis or left lumbar scoliosis; R-THL/L, right thoracolumbar scoliosis or right lumbar scoliosis

lateral partial cross bite (Table 7). Statistically relevant correlation between Cobb angle and the type of malocclusion was found for L-PT and anterior partial open bite as well as for R-MT and scissors bite (Table 8).

Discussion

We present a current analysis of malocclusion in Mid-Eastern European children and adolescents with idiopathic scoliosis. Such an analysis has not been published

within the last 40 years. Since the methods of treatment of idiopathic scoliosis have evolved we found it relevant to perform such an analysis in the current population.

The relationship between idiopathic scoliosis and facial asymmetry or malocclusions of a transverse character has been reported by Huggare et al[12] and Lippold et al[13].

In the idiopathic scoliosis group of patients presented in this study, a functional lateral mandibular displacement was observed solely in two individuals, and a lateral mandibular displacement in one subject. There were no subjects with facial asymmetry in the control group.

Similarly to findings of Saccucci et al,[14] a higher incidence of malocclusions was reported in individuals with scoliosis compared with the group of healthy subjects. Taking into account Angle's classification of malocclusions, our results are similar to those obtained by Ben-Bassat et al.[15] In the study of Ben-Bassat et al[15] the incidence of Class I malocclusions amounted to 50% (control group 56.5%), Class II symmetric defects to 25% (control group 34.3%), Class III to 3.1% (control group 0.7%) and unilateral Class II to 21.9% (control group 8.5%). Both Ben-Bassat et al[15] and Segatto et al[16] reported a higher incidence of unilateral Class II in subjects with scoliosis in relation to the control group, which suggests a relationship between an asymmetric malocclusion and scoliosis. Both researchers suggest that anteroposterior asymmetry may be a clinical sign of scoliosis. In contrast to these studies, in our study the unilateral distocclusion was found with a similar incidence in subjects with idiopathic scoliosis and in the control group. An analysis of correlation between occlusion type and scoliosis type demonstrated, however, dependence between partial lateral cross bite and R-MT scoliosis and also between partial anterior cross bite and L-PT scoliosis. A relationship was also found between the L-PT scoliosis severity degree (with the use of Cobb angle) and partial anterior cross bite, and between the main thoracic scoliosis and scissors bite. Śmiech-Słomkowska and Jamiołkowska[17] did not report a correlation between the prevalence of malocclusions and lateral deviations of the vertebral column (they did not, however, assess the severity of scoliosis). In the studies quoted above[17], most malocclusions (mainly distoclusions) occurred in patients with scoliosis degree ranging from 0° to 19° according to Cobb. According to Mazurkiewicz,[18] however, malocclusions occur with the highest incidence in subjects with a severe thoracic scoliosis. The author supposes that malocclusions are associated with incorrect occlusal conditions of the masticatory organ in subjects with severe scoliosis. In patients with untreated scoliosis, she noticed asymmetry in the area of the brachial band and, as a consequence, a compensating scoliosis of the cervical spine and a hyperkyphosis in the thoracic spine. It leads to an ante-thoracic position of the head, laterally relative to the median bodyline. Such results are consistent with studies presented in the paper and prior studies of other authors reporting an increased risk of partial lateral cross bite in scoliotic children.[12,19-23] In our study group, partial lateral cross bite was observed with twice the incidence occurring in subjects with idiopathic scoliosis.

Ben-Bassat et al,[15] Lippold et al,[13] and Pedrotti et al[24] reported a predisposition to cross bite in scoliotic individuals. Complete cross bite was found only in scoliotic patients (2.5%), partial lateral cross bite in 21.3% of scoliotic *versus* 11.5% of controls and partial anterior in 5% *versus* 4.9%, respectively. In studies by Ben-Bassat et al,[15] unilateral cross bite was found in as many as 28.1% of scoliotic patients, in 18.1% in those without any scoliosis and partial anterior cross bite was diagnosed in 16.6 % and 9.3% healthy individuals, respectively. In a study by Lippold et al[13] unilateral cross bite was diagnosed in 3 out of 28 scoliotic children, while bilateral in 1 child. In the control group, two patients with bilateral cross bite and three patients with unilateral cross bite were reported. In a study group of 428 patients, Pedrotti et al[24] diagnosed bilateral cross bite in 9.5% of scoliotic patients. The study results presented above confirm that in scoliotic patients more asymmetric malocclusion features are found than in the control group. In the study by Ben-Bassat et al,[15] those differences were slightly greater compared with those obtained in our study. For that reason, the author suggested that occlusion asymmetry in a patient may have a concomittant orthopaedic problem that may have caused that type of malocclusion. In this study, a more frequent Angle Class asymmetry was found in an analysis of the positioning of the first molars as well as that of the canines of the scoliotic patients than in the control group. The canine asymmetry difference was not statistically relevant, though. These results do not comply with those obtained by Ben-Bassat et al,[15] who demonstrated a similar incidence of asymmetry in molars in 26.6% of subjects from the scoliotic study group and 28.9% of those from the control group. The difference relative to canine asymmetry was definitely more noticeable. It was present in 31.5% of subjects in the study group and in 22.1% of those in the control group.

The displacement of the median bodyline was reported more frequently in scoliotic subjects than in those from control groups.[13,15,16] This is in conformity with the results obtained in our study. Ben-Bassat et al[15] demonstrated a statistically significant, more frequent displacement of the median body line both in the upper and lower dental arch in scoliotic subjects compared with the control group (21% *versus* 9.5% and 53.7% *versus* 32.9%, respectively). The authors did not find any relevant relationship among the location, direction or severity of scoliosis and the location of malocclusion features studied. A statistically relevant difference found in our study concerned solely a displacement of the median body line in the upper dental arch.

Most researchers indicate that there is a predisposition to distoclusions and transversal occlusion in scoliotic children and adolescents.[13,15,24-26] In our study, in scoliotic subjects it was precisely distoclusions and transversal occlusion defects that were diagnosed (not including dental anomalies). Although a relationship was demonstrated between thoracic location of scoliosis with cross bite and open bite, the scoliosis severity degree correlated with open bite and scissors bite. Thus, the relationship between location and scoliosis severity degree and malocclusion types is not explicit. However, the researchers have noted a statistically significant occurrence of more than one type of malocclusion in the scoliotic study group, particularly a combination of a distocclusion with a transversal malocclusion with dental anomalies, and of transversal malocclusion with dental anomalies.

In addition, malocclusions are found also in other spine deformations. Végh et al[27] analyzed dentofacial anomalies in children diagnosed with scoliosis and Scheuermann's disease (SD). In both groups there was a significantly higher incidence of unilateral distal occlusion than bilateral distal occlusions (30.4% in SD, 22.4% in scoliosis *versus* 21.7% and 10.7%, respectively). Unilateral crossbite was diagnosed in one child with SD and three children with scoliosis, bilateral crossbite was equally 1-1 in both conditions. Facial asymmetries were found significantly more frequently in patients with SD than scoliosis and were proportional to the severity of the spine deformation.

In our study malocclusions presented 81.9% of control group and 95% of the scoliotic patients. According to the literature the prevalence of malocclusions in children and adolescents varies a lot in different ethnic groups from 39% (Finnish population) to 93% in a study of a Chinese population.[28] In a Polish population the incidence has ranged from 67.5% to 97% in various studies.[29,30] In most of the studies from different countries the incidence of malocclusion is reported to be between 65% and 90%, and is similar to our findings.[28-30]

Conclusions

In children and adolescents with idiopathic scoliosis there is a significantly higher incidence of malocclusions than in control group. The most common malocclusion in children and adolescents with idiopathic scoliosis were: distoclusions and cross bites, asymmetric Angle's Class and canine class, dental anomalies and when the maxillary dental midline and the mandibular dental midline doesn't coincide. Children and adolescents with idiopathic scoliosis have more frequently more than a single type of malocclusion in comparison to their peers. Because of the higher incidence of dental anomalies early orthodontic screening is suggested in children with idiopathic scoliosis.

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COMPLIANCE WITH ETHICAL STANDARDS

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ETHICAL STATEMENT

Ethical approval: All procedures performed in studies 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 study protocol was approved by the local ethical committee on 11 January 2011.

Informed consent: A written consent of a legal guardian as well as patients at the age of 16 years or over was obtained.

ICMJE CONFLICT OF INTEREST STATEMENT

None declared.

AUTHOR CONTRIBUTIONS

ML: Study design, Data collection, Statistical Analysis, Data interpretation, Manuscript preparation, Literature search.
DO-K: Study design, Statistical Analysis, Data interpretation, Manuscript preparation, Literature search.
MZ: Study design, Data interpretation, Manuscript preparation, Literature search.
JC: Manuscript preparation.
MC-W: Manuscript preparation, Literature search.
MW: Manuscript preparation, Literature search.
MT: Study design, Data collection, Manuscript preparation, Literature search.

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