Nobel Med 2023; 19(3): 174-179

DENTAL AND SKELETAL OCCLUSION IN PATIENTS WITH IDIOPATHIC SCOLIOSIS

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ABSTRACT

Objective: *This study aimed to evaluate dental and skeletal occlusion patterns in patients with idiopathic scoliosis (IS) and to compare these patients to a healthy control group.*

Material and Method: *Ninety-five patients with adolescent IS and 102 control subjects were examined. For each patient, Angle classes of malocclusion, lower midline deviations, posterior crossbite, and increased overbite and overjet examinations were conducted. In addition, the results in the scoliosis group were compared in terms of variables such as Cobb angle, scoliosis site, and trunk shift.*

Results: *The distribution of the Angle classes of malocclusion was significantly different between the two groups ($p<0.001$). In addition, other significant evidence of asymmetrical malocclusion was found, including lower midline deviations ($p=0.02$) and posterior crossbite ($p<0.001$). In the experimental group, no association was found between the site and severity of scoliosis and the appearance or site of the malocclusion features examined.*

Conclusion: *While the presence of Class III malocclusion was significantly higher in the scoliosis group than in the control group, the presence of Class II malocclusion was similarly observed, contrary to the literature. In this sense, additional studies with case and control groups are needed.*

Keywords: *Idiopathic scoliosis, malocclusion, Cobb angle, trunk shift.*

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DELIVERING DATE: 06 / 10 / 2022 • **ACCEPTED DATE:** 13 / 03 / 2023

İDİOPATİK SKOLYOZLU HASTALARDA DENTAL VE İSKELETSEL OKLUZON

ÖZET

Amaç: Bu çalışmanın amacı idiopatik skolyozlu (IS) hastalarda dental ve iskeletsel okluzyonu değerlendirmek ve bu hastaları sağlıklı kontrol grubu ile karşılaştırmaktır.

Materyal ve Metot: Doksan beş adölesan IS hastası ve 102 kontrol grubu birey muayene edildi. Her hasta için, malokluzyonun Angle sınıflaması, orta hat sapması, posterior çapraz kapanış ve artmış overbite ve overjet incelemesi yapıldı.

Ayrıca skolyoz grubunun sonuçları Cobb açısı, skolyozun yeri ve trunk shift varlığı açısından karşılaştırıldı.

Bulgular: Angle sınıflamasına dayalı malokluzyon dağılımı iki grup arasında anlamlı şekilde farklılık gösterdi (p=0,001). Bunun yanında, asimetrik malokluzyonun diğer kanıtları olan olan orta hat sapması (p=0,02) ve posterior çapraz kapanış (p<0,001) iki grup arasında kayda değer farklı bulundu. Hasta grubunda, skolyozun yeri, şiddeti ve görünümü ile malokluzyon karakterleri arasında anlamlı ilişki bulunmadı.

Sonuç: Literatürdeki sonuçların aksine skolyoz ve sağlıklı kontrol grubu arasında sınıf II malokluzon varlığı benzer gözlemlenmişken; sınıf III malokluzyon varlığı skolyoz grubunda daha yüksek idi. Bu anlamda, vaka ve kontrol grubunun bir arada olduğu ilave çalışmalara ihtiyaç duyulduğu kanısındayız.

Anahtar kelimeler: İdiopatik skolyoz, malokluzyon, Cobb açısı, gövde kayması.

INTRODUCTION

Idiopathic scoliosis (IS) is an orthopedic deformity defined as the lateral curvature of the spine. It is the most common structural deformity of the spine.[1,2] IS is a complex curvature that causes deformity in all three planes and a pathology that can cause cardiopulmonary complications in the advanced stage of the disease and deformation in the spine. It also causes emotional disorders and cosmetic deformities.[3] The incidence rate of IS varies between 1-3% globally.[4,5]

The etiology of IS is probably multifactorial. Its components are hormonal and connected with growth, genetics, metabolic disturbances of collagens and proteoglycans, and neurological disturbances, especially of the proprioceptive and equilibration systems, and with biomechanical factors.[6]

To investigate the possible effects of asymmetric orthopedic disorders on dentofacial development and head posture, interdisciplinary clinical studies have been conducted on patients with scoliosis. Ikemitsu *et al*. concluded that there is a correlation between skeletal anomalies of Class I, II, or III, hypo-or hyperdivergent, and scoliosis.[7] Lippold *et al*. found a statistically significant correlation between Class II malocclusion and scoliosis.[8]

In this study, we hypothesized that the incidence of malocclusion in patients with scoliosis would increase compared to healthy individuals. To verify this, adolescents with IS and in comparison with a healthy age-matched population were examined on dental cephalometric radiographs.

MATERIAL AND METHOD

This study was approved by the local ethics committee (decision number: 5/2018), and all participants submitted written informed consent. All procedures performed in this study were in accordance with the Helsinki Declaration of 1964, as amended.

Study Population

In this randomized research, the study population comprised 97 patients with IS, ranging in age from 11 years, 9 months to 17 years, 5 months (mean age 13.8, standard deviation: 2.2), with 71 females and 24 males patients. The exclusion criteria included a history of orthodontic treatment, cleft lip and palate, maxillofacial fracture, trauma, infection, or any signs of musculoskeletal pathologies based on a physical examination. Two patients were excluded from the study due to kyphosis and cleft lip and palate. In total, 95 IS patients with a curvature of 10 degrees or over (Cobb angle) were included in this study.

The control group comprised healthy volunteers based on the following selection criteria: complete natural dentition, orthopedically healthy, no history of orthodontic treatment, and no maxillofacial deformities. The group consisted of 102 volunteers aged 12 years, 2 months to 18 years, 5 months (mean age 14.7, standard deviation: 1.9), with 74 females and 28 males. Participants who underwent a lateral cephalometric examination for various problems (airway control) were matched by age and sex. All patients were in the permanent dentition stage; most had no caries, or their carious lesions did not affect the interproximal sites.

Orthopedic Examinations

The diagnosis of IS was based on a physical examination conducted by an orthopedic surgeon (S.Y.). This was confirmed by a long-film standing anteroposterior and lateral radiograph of the whole spine. The results are summarized as follows:

1. **Cobb angle:** The Cobb angle is the angle between the line extending parallel to the upper edge of the cephalic end vertebra and the line extending parallel to the lower edge of the caudal end vertebra. An anteroposterior radiograph was used to evaluate the Cobb angle in IS patients. The measurement began with the determination of the end vertebrates. On the concave side of the curvature, the intervertebral spaces were narrower. The levels at which the intervertebral spaces began to expand were at the end vertebrae. Patients with a curvature of 10 degrees or more were diagnosed with scoliosis.[9,10] Patients with IS were classified into three subgroups according to Cobb measurements, as reported by Bridwell and Dewald (Figure 1).[11] These subgroups include:
   - Mild: 10-25 degree cases (10 or more, and less than 25). These patients can be treated with exercise.
   - Moderate: Patients with 25–45-degree curves (25 or more and less than 45). These patients can be treated with bracing.
   - Severe: Patients with an angle of 45 degrees or more. These patients generally require surgery.
2. **Site of scoliosis:** Cervico-thoracic, thoracic, thoracic-lumbar, lumbar.
3. **Lateral trunk shift:** The trunk shift is a distance greater than 2 cm between the vertical trunk reference line (VTRL) and the center sacral vertical line (CSVL). The VTRL differs from the C7 plumb line used to measure coronal balance (distance between the CSVL and C7P) (Figure 2).[12]

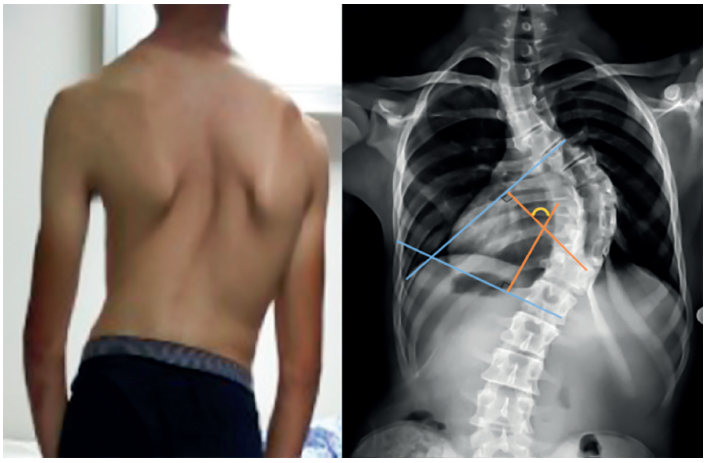

Figure 1. Back side of patient with scoliosis is seen on the right figure. Cobb angle measurement on antero-posterior radiography of patient with scoliosis is seen on the left figure.

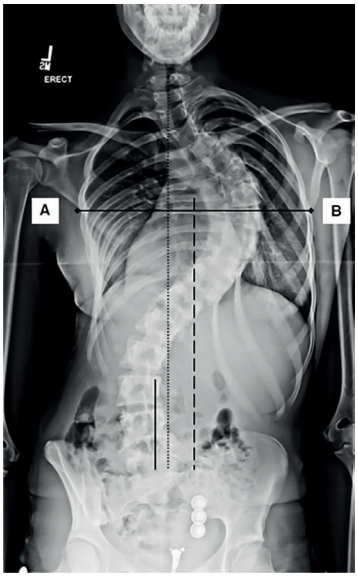

Figure 2. Trunk shift is defined as a distance greater than 2 cm between the vertical trunk reference line (VTRL) and the center sacral vertical line (CSVL). The VTRL differs from the C7 plumb line that is used to measure coronal balance (distance between CSVL and C7P).

Orthodontic Examinations

Conditions caused by early tooth loss and complicating occlusions in both the scoliosis and control groups were not included in the study. In addition, the individuals in the control and scoliosis groups did not receive orthodontic treatment. Intraoral orthodontic examination of all patients was conducted simultaneously by an oral and orthognathic surgeon (Z.B.) and an oral radiologist (Ö.M.). However, when examiners failed to reach a decisive opinion, they discussed the case and consulted with an orthodontist specialist. All cases established a consensus.

The lateral cephalometric films were traced, and the anterior skeletal relationship of the maxilla and mandible were classified as skeletal Class I, II, or III using measurements of the ANB angle (Class I: ANB angle between 0° and 4°; Class II: ANB > 4°; Class III: ANB < 0°).

In an extraoral examination, facial features were assessed in relation to the three spatial planes: sagittal, frontal, and Frankfort horizontal planes. An intraoral examination was conducted to examine occlusion conditions, including the following:

- In the anteroposterior dimension, molar and canine relationships, Angle classification, posterior crossbite, and excess overjet.
- In the transverse dimension, the lower midline is in relation to the facial midline and posterior crossbite.
- In the vertical dimension, excess overbites.
- In another examination, crowding and spacing.

Statistical Analysis

The study population of 88 was determined using a G*power analysis, based on an impact size of 0.362, α=0.05, power (1-β)=0.80, and a confidence level of 95%. A substitute group of 7 individuals was added.[13]

The variables were analyzed using the Statistical Package for the Social Sciences (SPSS) (version 28.0.1; Chicago, IL). The Kolmogorov–Smirnov test was used to determine the homogeneity of the distribution. The Chi-square test was used to determine potential differences in the distribution of various occlusal variables because the results of the Kolmogorov–Smirnov test showed normal distribution. A *p*-value of <0.05 was considered statistically significant.

RESULTS

Tables 1 and 2 present the occlusion conditions determined from the cephalometric analysis and clinical examination of all patients. Although Class II malocclusion was similar in scoliosis and control patients, normocclusion, or Class I malocclusion, was detected at a higher rate in control patients (51.0%) than in scoliosis patients (28.4%). Class III malocclusion was predominant in scoliosis patients (39.0 versus 17.6), and the difference between the two groups was statistically significant (p=0.001). In the transverse dimension, lower midline deviations were encountered significantly more often in the scoliosis group (p= 0.02). The posterior crossbite was also significantly higher in the scoliosis group than in the control group (p=0.0001).

Our patients suffered from the thoracic (51.6%), lumbar (24.2%), thoracic-lumbar (18.9%), and cervicothoracic (5.1%) regions, respectively. No correlation between the site of scoliosis and malocclusion was statistically significant. According to our investigations, the incidence of normocclusion or Class I malocclusion decreased as the Cobb angle increased. This was especially predominant in the scoliosis group with an angle of 45 degrees or more and requiring surgical treatment. However, this difference was not statistically significant (Table 3).

Table 1. Malocclusion type and incidence in scoliotic children and in the control group according to Angle's classification.

OCCLUSAL CATEGORY	Scoliosis patients		Control group		*p* value
	n	(%)	n	(%)	
Normocclusion + Class I	27	28.4	52	51.0	0.001
Class II	31	32.6	32	31.4	
Class III	37	39.0	18	17.6	

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

	Scoliosis patients		Control group		*p* value
	n	(%)	n	(%)	
Lower midline deviation	54	56.8	41	40.2	0.02
Posterior crossbite	33	34.7	11	10.8	p<0.001
Excess overjet	28	29.5	24	23.5	0.33
Excess overbite	39	41.1	50	49.0	0.26

Table 3. The prevalence of types of scoliosis and mean Cobb angle of each type of curve, site of scoliosis and lateral trunk shift.

		n (%)	Normocclusion + Class I	Class II + Class III	*p* value
Subgroup of Cobb Angle	$10^{o} \leq n < 25^{o}$	28 (29.5)	15 (53.6)	13 (46.4)	0.32
	$25^{o} \leq n < 45^{o}$	26 (27.4)	13 (50.0)	13 (50.0)	
	$45^{o} \leq n$	41 (43.1)	15 (36.6)	26 (63.4)	
Site of Scoliosis	cervico-thoracic	5 (5.3)	1 (20.0)	4 (80.0)	0.59
	thoracic	49 (51.6)	24 (49.0)	25 (51.0)	
	thoracic-lumbar	18 (18.9)	7 (38.9)	11 (61.1)	
	lumbar	23 (24.2)	11 (47.8)	12 (52.2)	
Lateral Trunk Shift	available	21 (22.1)	6 (28.6)	15 (71.4)	0.08
	not available	74 (77.9)	37 (50.0)	37 (50.0)	

DISCUSSION

Scoliosis is the most common deformity of the spine and includes curves exceeding 10 degrees observed through direct radiography from both the anterior and the posterior.[9] IS corresponds to around 80.0% of structural coronal deformities.[10] IS may develop at any stage of the growth period. It is classified into four subgroups according to age: 1) infantile (0-3 years), 2) juvenile (4-9 years), 3) adolescent (10-18 years), and 4) adult (above 18 years). The etiology is unknown, but genetic factors are mentioned, and hormonal, neurological, biochemical, and possibly biomechanical factors interact.[12] Lateral deviation of the spine, typically discovered in childhood, is the first finding and is progressive. Studies have shown a relationship between spinal posture and vertical aspects of the face, and that maxillary and mandibular morphology is affected by cervical posture.[14,15]

The concept of postural influence on dental occlusion was put forward by Robin, who described glossopytosis syndrome.[16] According to Robin's theory, these children have craniofacial features typical of Angle Class II, Division 1 malocclusion.[17] A specific interest in orthopedic conditions was presented by Huggare *et al.*, who found that children affected by

scoliosis have more Angle Class II malocclusions and lateral crossbites.[18] Lippold *et al*. examined preschool children and found a high incidence of Angle Class II malocclusion in scoliotic children.[8] Saccucci *et al*. reported a higher incidence of malocclusion in individuals with scoliosis compared to a healthy subject group.[19] Considering Angle's malocclusion classification, both Ben-Bassat *et al*. and Segatto *et al*. reported a higher incidence of unilateral Class II in cases with scoliosis than the control group, suggesting a relationship between asymmetric malocclusion and scoliosis.[20,21] Both researchers suggested that anteroposterior asymmetry may be a clinical manifestation of scoliosis.

Unlike the studies described above, in this study, while disto-occlusion (Angle Class II) was at a similar frequency in IS cases and the control group, the rate of Class III malocclusion (39.0/17.6%) was higher in the scoliosis group than in the control group. There may be different reasons for this difference.

1. The difference may be related to the number of samples examined.
2. While this study was conducted only on patients with IS, in other studies, individuals with congenital scoliosis were included in the patient group. Moreover, it is possible to come across general studies in which kyphosis and Scheuermann's disease are included in the scoliosis group.
3. Spinal deformity was frequently diagnosed by clinical examination.

The gold standard for assessing malocclusion and spine deformity-the full-spine standing radiograph in a long cassette and cephalogram-was not conducted in all studies.

In general, left–right asymmetries are among the most common anomalies in patients with scoliosis.[8] However, they can also be seen in the craniofacial complexes of patients with certain malocclusions, such as crossbite, lower midline deviations, and facial asymmetries. This study found midline deviations in 56.8% of IS patients. Ben-Bassat *et al*., Lippold *et al*., and Pedrotti *et al*. reported a predisposition to crossbite in scoliotic individuals.[8,20,22] In studies by Ben-Bassat *et al*., unilateral crossbite was found in as many as 28.1% of scoliotic patients and 18.1% of those without scoliosis.[20] In a study by Lippold *et al*., unilateral crossbite was diagnosed in 3 out of 28 scoliotic children, while bilateral in one child.[8] In the control group, two patients with bilateral crossbite and three with unilateral crossbite were reported. In a study group of 428 patients, Pedrotti *et al*. diagnosed bilateral crossbite in 9.5% of scoliotic patients.[22] These findings confirm that, in scoliotic patients, more asymmetric malocclusion features were found than in the control group and that there was a higher rate of malocclusion in patients with scoliosis, especially crossbite. These results are consistent with the studies presented in the article and previous studies reporting an increased incidence of partial lateral crossbite in scoliotic children.[18,22,23] This study could not find any relationship between the location, direction, or severity of scoliosis and the presence of the investigated malocclusion features, consistent with Ben-Bassat *et al*.[20]

Śmiech-Słomkowska and Jamiołkowska did not report a correlation between the prevalence of malocclusions and lateral deviations of the vertebral column (however, they did not assess the severity of scoliosis).[24] In the study quoted above, most malocclusions (primarily disto-occlusion) occurred in patients with scoliosis degrees ranging from 0° to 19°, according to Cobb. According to Mazurkiewicz, however, malocclusions occur with the highest incidence in subjects with severe thoracic scoliosis.[25] In this study, the most significant difference was the increase in malocclusion in patients with cervicothoracic scoliosis.

Muscular balance between the neck and the masticatory system has been demonstrated to play an essential role in the relationship between asymmetric malocclusion and scoliosis.[26,27] Kondo found that early improvement in occlusion, combined with physiotherapy to achieve muscular balance of the neck and masticatory system, was effective in improving muscular function asymmetry.[28] Thus, early correction of muscular torticollis should be considered to prevent the progression of facial asymmetry in congenital muscular torticollis patients.[29] These findings indicate the possibility of an interaction effect between the masticatory system and body posture.

The results of this study indicate that, because the features of asymmetry were evident in both the sagittal and transverse dimensions, orthodontic patients with IS might present more challenging problems than other patients who are not orthopedically involved. The asymmetry underlying idiopathic scoliosis and asymmetric malocclusion originates from the same etiology. Therefore, from a clinical point of view, it might be difficult to correct all malocclusion features or maintain full correction. This difficulty was observed, for example, in patients with posterior crossbites in whom relapse of lower midline deviations

or a tendency toward crossbites was also evident after orthodontic treatment. Furthermore, the possibility of a connection between the reverse cycle in masticatory movements and asymmetrical posture should be evaluated. From an orthodontic and orthopedic point of view, all the observed frequent and severe dentofacial deviations in the scoliotic group draw attention to the necessity of early examination in this patient group. However, whether scoliosis affects mandibular dentoalveolar symmetry (whether there is a causal relationship) needs further study.

CONCLUSION

This study found that the occurrence of malocclusion, midline deviation, and crossbite was significantly higher in patients with IS than in the control group. Contrary to the literature, the presence of increased Class III malocclusion was higher in patients with scoliosis. Authors of the current study believe there is a need for additional studies with a case–control group on this subject.

*The authors declare that there are no conflicts of interest.

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