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Research on Correlation between Spee Curve Depth and Malocclusion, Overbite and Overjet

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Abstract: *To study the relationship between the depth of the curve of spee (COS) and different Angle classifications of malocclusion, overbite, overjet. The dental 3D models of 200 patients with malocclusion were selected as samples from Shenzhen Stomatology Hospital (Pingshan) of Southern Medical University from January 2021 to October 2022,Data are expressed as mean ± standard deviation (SD). SPSS 26.0 statistical software was used to conduct statistical analysis. The depths of the COS in the different categories of malocclusion, overbite, and overjet were compared by One-way analysis of variance (ANOVA) of the Duncan method. The correlation between the depth of the COS and dental diseases, including malocclusion, overbite, and overjet was analyzed by Pearson correlation analysis.Results. There was statistically significant difference between different types of Angle's classification ,overbite, overjet in the depth of COS.There was correlation between the depth of COS and overbite ,overjet of front teeth, overjet showed the highest correlation with the depth of COS.*

Keywords: *the curve of spee, overbite, different class of malocclusion, overjet*

1. Introduction

When designing fixed prostheses, the curve of occlusion is an essential factor to be considered. The elongation of the mandibular anterior teeth can lead to a deep mandibular sagittal curve of occlusion in a deep overbite. The overjet and overbite of the posterior teeth will result in anomalies in the transverse curve of occlusion. The overly steep and flat curve of occlusion may cause difficulty in the placement of the fixed prostheses or defective occlusion.

The curve of occlusion is considered to have functional significance during chewing[1-4] .it considered as an important factor in diagnosis and treatment in oral disease.[5-13] The curve of occlusion consists of the transverse and sagittal curves of occlusion. And the sagittal curve of occlusion includes the compensate curve and mandibular sagittal curve of occlusion.[14-16] The latter is also known as the curve of Spee (COS). The COS is a critical indicator of vertical tooth positions.[17] The COS harmonizes with the compensate curve, allowing the teeth to maintain uniform contact during chewing, and the forward and lateral movements of the lower jaw, which guarantee the proper functioning of the teeth.[18] The morphology of COS is related to craniomandibular structures.[19] The COS extends posteriorly to the anterior edge of the condyle so that the position of the condylar correlates with the morphology of the COS. The more anterior the mandibular dentition, the depth of the Spee curve decreases[20]. This study aimed to investigate the relationship between the depth of the COS and dental diseases, including three types of malocclusion and the varying degrees of overbite and overjet.

2. Materials and methods Objects

A total of 200 patients (105 cases of Angle's class I malocclusion, 45 cases of Angle's class II malocclusion, and 50 cases of Angle's class III malocclusion), aged 11 to 20 years, attending the Shenzhen Dental Hospital of Southern Medical University (Pingshan) from January 2021 to October 2022 were enrolled. The inclusion criteria for patients were described as followed, (1) no history of orthodontic treatment; (2) complete permanent dentition with fully built-up occlusion of second molars and no defective dentition; (3) no history of trauma; (4) no history of nocturnal grinding and clenching of teeth; (5) no craniomaxillofacial anomalies, odontodysplasia, and severe periodontal disease.

Measurement of the depth of the COS

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The patients were scanned by a 3Shape R700 scanner (3Shape A/S, Copenhagen, Denmark), and the 3D models were reconstructed using 3Shape Scan it Orthodontics software. The depths of the Spee curves on the left and right sides were measured separately using the 3shape Ortho Analyzer system, and the average of the two side depths was calculated. The measurements were conducted by the same operator and repeated three times. A straight line from the highest point of the incisal edge of the lower anterior incisor to the tip of the second molar was drawn,and the distance from the lowest point of the COS to the straight line was measured as shown in Figure 1.

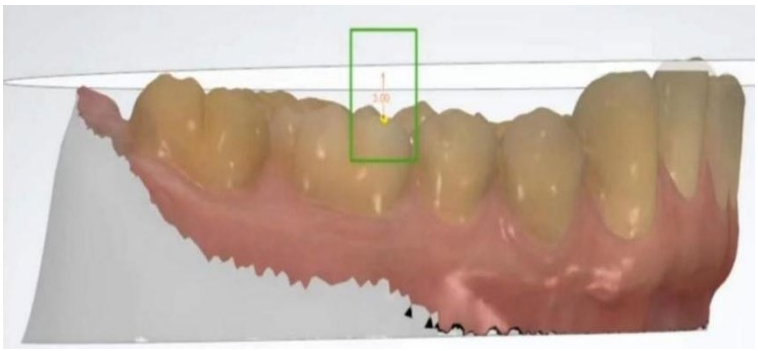

Figure 1: The depths of the Curve of Spee

The depth of the COS was defined as the average distance on the left and right sides. The patient's maxillary and mandibular central incisors were measured separately using the 3-shape Ortho software for overlay, overjet shown in Figure 2.

Figure 2: The length of the overjet, the length of the overbite

Angle's Classification uses the relationship of the first molar teeth relative to the line of occlusion to determine the type of malocclusion. Divided into class I (neutroclusion), class II (disoclusion), class III (mesioclusion).

Deep overjet: The distance between the anterior and posterior incisor ends of the upper and lower anterior teeth is more than 3mm, which is called deep overjet. It is divided into three degrees: degree I: 3mm-5mm; II degree: 5mm ~ 8mm; Grade III: more than 8mm.

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Deep overbite: a deep overbite with the upper anterior teeth covering more than 1/3 of the labial surface of the lower anterior teeth or the incisor edge of the lower anterior teeth biting more than 1/3 of the lingual surface of the upper anterior teeth, can be divided into three degrees. Degree I: the upper anterior teeth with the crown covering more than 1/3 of the lower anterior teeth and lacking half of the crown; Grade II: the crown of the upper anterior teeth covered the lower anterior teeth more than 1/2 of the crown but lacked 2/3 of the crown. Degree III: the crown of the upper anterior teeth covered the lower anterior teeth by more than 2/3 of the crown.

3. Statistical analysis

Data are expressed as mean ± standard deviation (SD). SPSS 26.0 statistical software was used to conduct statistical analysis. The depths of the COS in the different categories of malocclusion, overbite, and overjet were compared by One-way analysis of variance (ANOVA) of the Duncan method. The correlation between the depth of the COS and dental diseases, including malocclusion, overbite, and overjet was analyzed by Pearson correlation analysis. For this study, the significance level α was set to 0.05**.**

4. Results

The relationship between the depth of the COS and the different Angle's classThe depth of the COS was (2.21 ±0.61) mm for the Angle's class I malocclusion, (3.07 ± 0.64) mm for the Angle's class II malocclusion, and (1.98 ± 0.70) mm for the Angle's class III malocclusion, with statistically significant difference (F = 27.59, P = 0.00). The depth of the COS was significantly higher for Angle's class II malocclusion than for Angle's class III malocclusion malformation (Table 1). However, the correlation between Angle's class and the COS was not statistically significant (Table 2).

The relationship between the depth of the COS and different levels of overbite and overjet

There are statistically significant differences between the depth of the COS and the different levels of overbite (F = 20.40, P = 0.00) and overjet (F = 10.07, P = 0.00) as shown in Table 1.

Moreover, positive correlations between the depth of the COS and different levels of overbite (R = 0.64, P = 0.00) and overjet (R = 0.39, P = 0.00) were described in our study (Table 2).

Table 1(A): The difference between the depth of COS and dental diseases.

Names	The depth of COS (mm)	F value	P value
Angle's class I malocclusion	2.22 ± 0.60		
Angle's class II malocclusion	3.07 ± 0.64	27.59	0.000
Angle's class III malocclusion	1.98 ± 0.70		
Normal overbite	1.71 ± 0.47		
Degree I overbite	2.38 ± 0.63	20.40	0.000
Degree II overbite	2.86 ± 0.65		
Degree III overbite	3.36 ± 0.81		
Normal overjet	2.62 ± 0.78		
Degree I overjet	2.28 ± 0.65	10.07	0.000
Degree II overjet	2.82 ± 0.44		
Degree III overjet	3.20 ± 0.65		

Table 1(B): The difference between the depth of COS and dental diseases.

Names	The depth of COS(mm)	Z value	P value
overjet		66.731	<0.001
I	2.0(1.38, 2.63)		
II	2.50(2.0, 4.0)*		
III	5.0(4.0, 6.0)*#		
malocclusion		42.876	<0.001
I	2.0(1.75, 3.0)		
II	4.75(2.75, 5.0)*		
III	1.0(0.5, 2.0)*#		
overbite		45.480	<0.001
I	2.0(1.75, 3.0)		
II	4.0(3.0, 5.0)*		
III	5.0(5.0, 6.0)*#		

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Table 2: The Correlation between the depth of COS and dental diseases.

Names	R value	P value
Angle's malocclusion	-0.270	0.780
Overbite	0.636	0.000
Overjet	0.391	0.000

5. Discussion

Overall, the development of the COS is likely due to the Multiple series of factors, including dental eruption timing, the neuromuscular factors，and the craniofacial variations .The reason perhaps for the mandibular molar and the incisors Is erupt beyond the original occlusal plane[21] .

Andrews [22]described six features of normal occlusion and found that good-occlusion subjects had the COS ranging from flat to mild, noting the best intercuspation when the occlusal plane was relatively flat. He proposed that leveling the COS should be the target of orthodontic treatment. This concept is particularly relevant to deep overbite patients [23-26].

Orthodontic aim often involves leveling the COS .By the means of anterior intrusion, posterior extrusion, or a combination of these actions. The process of proclining the lower incisors has been used in some cases to decrease the COS[27,28].

COS is an important factor in diagnosis [29].Although leveling COW is a common treatment in orthodontics In practice, little research is devoted to the The depth of COW relationship with different malocclusions.

The 3D digital model scanned by a 3Shape D250 scanner proved reliable in our study, in which accurate and reproducible data can be obtained. The quantitative evaluation of this stud through 3Shape measurements concludes that the procedure of the 3D model is effective and feasible, avoiding errors in manual point selection and simplifying the operational process.

Analysis of the COS can help the dentist determine the sagittal plane. You can use the COS as a reference for prosthetic restoration and orthodontic treatment.The management of the COS is crucial to achieve the stability of the complete denture[30-35].

The COS is a vital factor in maintaining tooth solid and masticatory function. The COS, one of the six indicators of occlusion, affects physiological properties such as mastication and locomotion.[36-38] The positional relationship between the COS, overbite, overjet, and Angle's classification form the biomechanical three-dimensional structure of the dentition together.[39,40]

The present study observed a significant difference in the depths of COS in dental diseases, including three types of malocclusions and the varying degrees of overbite and overjet. The depth of COS in Angle's class II malocclusion, the deepest in all Angle's classification in our study, suggest that the Spee curve is directly related to the anterior-posterior position of the maxilla and mandible. Furthermore, the COS is proportional to the overbite with a more significant correlation of the overjet, thus corroborating that clinical flattening of the COS can be achieved by opening the overbite.

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