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The Curve of Spee- A Diagnostic Tool

KEYWORDS: Curve of Spee, Y- axis.

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ABSTRACT *Introduction: F Graf Von Spee, who used skulls with abraded teeth to define a line of occlusion, first described the Curve of Spee in 1890. The functional significance of the curvature has not been completely understood. However, it has been suggested that the Curve of Spee has a biomechanical function during food processing by increasing the crush-shear ratio between the posterior teeth and the efficiency of occlusal forces during mastication.*

Aim of the study: To analyse a possible co-relation between different depths of Curve of Spee with the position and inclination of the upper and lower incisors, overjet, overbite, lower arch crowding and growth pattern.

Material and methods: Lateral head films and dental casts of 60 untreated adolescent subjects, 30 female and 30 male, aged between 13 to 17 years, were obtained. The subjects were divided into three groups with normal Curve of Spee, flat Curve of Spee, and deep Curve of Spee. Comparisons between the three groups were made. Casts were photographed using a 1100D DSLR Canon camera with a 100mm f2.8, 1:1macro lens. The depth of the curve was measured with help of Adobe Photoshop CS5 software.

Results and conclusion: Data was analyzed, using Statistical Package program SPSS Version 10.0 (SPSS Inc., Chicago, III). Descriptive statistics, including the mean and standard deviation (SD) values were calculated for all variables in each Spee group. The results of the Least Significant Difference Test, showed significant differences of overjet between the normal and flat Curve of Spee groups and between the flat and deep Curve of Spee groups. However, overbite demonstrated significant differences between the normal and deep Curve of Spee groups and between the flat and deep Curve of Spee groups. Y- axis demonstrated significant differences between all three groups.

Introduction

F Graf von Spee, who used skulls with abraded teeth to define a line of occlusion, first described the Curve of Spee in 1890. That line lies on a cylinder that is tangent to the anterior border of the condyle, the occlusal surface of the second molar and the incisal edges of the mandibular incisors. Spee located the center of this cylinder in the mid orbital plane so that it had a radius of 6.5 to 7.0 cm.[1] However, clinically, the distal marginal ridges of the posterior teeth in the arch and the incisal edges of the central incisors determine the Curve of Spee.[2]

The functional significance of the curvature has not been completely understood.[3] However, it has been suggested that the Curve of Spee has a biomechanical function during food processing by increasing the crush-shear ratio between the posterior teeth and the efficiency of occlusal forces during mastication.[4,5] Recently, the Curve of Spee and/or leveling of this curve has been related to incisor overbite,[6-9] lower arch circumference,[7,10-13] lower incisor proclination[10,13-16]and craniofacial morphology.[3,8] A deep Curve of Spee is usually associated with an increased overbite. Orthodontic correction of the overbite often involves leveling the Curve of Spee by anterior intrusion, posterior extrusion or a combination of these actions. The process of proclining the lower incisor has been used in some cases to decrease the relative vertical overlap of the lower incisors by the upper incisors.[16]Leveling of the Curve of Spee represents a routine procedure in orthodontic practice. Clinicians have been concerned for some time with the degree of reduction in arch circumference that accompanies leveling because this could lead to incisor protrusion.[17]

On the other hand, Andrews[18] stated that there is a natural tendency for the Curve of Spee to deepen with time because the lower jaw's growth downward and forward sometimes is faster and continues longer than that of the upper jaw. This causes the lower anterior teeth which are confined by the upper anterior teeth and lips to be forced back and up, resulting in crowded lower anterior teeth and/ or a deeper overbite and deeper Curve of Spee. These findings suggested that the Curve of Spee might be related to the position and inclination of the upper and lower incisors, lower arch crowding, overjet and overbite. Thus, the determination of this relationship may be useful to assess the feasibility of leveling the Curve of Spee by orthodontic treatment.

The aim of the study is to co-relate different depths of Curve of Spee with the position and inclination of the upper and lower incisors, overjet, overbite, lower arch crowding and growth pattern, and to assess whether it can be of use as a diagnostic parameter in evaluating prognosis.

Materials and methods

Lateral cephalometric head films and dental casts were obtained from a sample of 60 adolescent subjects aged between 13 to 21 years (30 male and 30 female). All the subjects were healthy with complete dentition and had no history of orthodontic treatment. The sample investigated consisted of a group with skeletal and dental Class I malocclusion and slight Class II or Class III malocclusions (ANB angle between 1 and 5°). Severe Class II and Class III malocclusions were not included.

The subjects were divided into three groups according to

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the depth of Curve of Spee. The three Spee groups were classified as follows:

A. Normal Spee group: the depth of Curve of Spee was >2 mm but ≤4 mm
B. Flat Spee group: the depth of Curve of Spee was ≤2 mm
C. Deep Spee group: the depth of the Curve of Spee was >4mm

The depth of Curve of Spee was measured with the help of Adobe Photoshop CS5 software. Photographs of the casts were taken with help of a 1100D DSLR camera with a 100mm macro lens. The perpendicular distance between the deepest cusp tip and a flat plane that was laid on top of the mandibular dental cast, touching the incisal edges of the central incisors and the distal cusp tips of the most posterior teeth in the lower arch was measured. The measurement was made on the right and left sides of the dental arch and the mean value of these two measurements was used to obtain the depth of Curve of Spee. The cephalometric radiographs were exposed using standard methods. A single investigator performed the cephalometric tracings on tracing paper.

The cephalometric and dental cast measurements used in the study are described in Tables 1 and 2 respectively. Five angular and two linear measurements were performed on lateral cephalometric head films. The measurements of the depth of Curve of Spee, overjet, overbite and lower anterior crowding were made on dental casts (Figs. 1-3).

Statistical analysis
Data was analyzed using Statistical Package program SPSS Version 10.0 (SPSS Inc., Chicago, Ill). Descriptive statistics including the mean and standard deviation (SD) values were calculated for all variables in each Spee group. Analysis of variance was used to determine if significant differences were present in the measurements used in the study between the groups with different depths of Curve of Spee and between sexes. If significant differences were present, the least significant difference (LSD) post hoc multiple comparison test was used to determine which of the means were significantly different from one another. P values of .05 or less were considered statistically significant.

Results
The means and standard deviation of the chronological ages and the depth of Curve of Spee for each group and the F values are presented in Table 3. No statistically significant differences between the chronological age among the Spee groups were found, whereas there were statistically significant differences in Spee measurements among the groups (P <.001).

Descriptive statistics, including the mean and SD values were determined for each Spee group and are shown in Table 4.

These results indicated that the overjet and overbite measurements were significantly different among the Spee groups.

The results of the least significant difference test post hoc test are shown in Table 5. According to these results, overjet showed significant differences between the normal and flat Spee groups and between the flat and deep Spee groups. However, overbite demonstrated significant differences between the normal and deep Spee groups and between the flat and deep Spee groups. Growth axis or Y-axis demonstrated significant differences between all three groups.

Discussion
Although leveling the Curve of Spee is an everyday occurrence in orthodontic practice, little research has been dedicated to examination of relationships between depth of the Curve of Spee and dentofacial structures. In the present study, relationships between the depth of Curve of Spee and positions of upper and lower incisors, growth axis, overjet, overbite, and lower anterior crowding were investigated.

The data obtained indicated that there were no significant differences in positions and inclinations of lower and upper incisors and lower anterior crowding among subjects with different depths of Curve of Spee. However, statistically significant differences in overbite and overjet were found between different Spee groups.

Balridge[10] reported that decreasing the depth of Curve of Spee leads to an increase in arch circumference and that often, the lower incisors will be proclined in direct response to this increase. Braun and Hnat[19] found an association between lower incisor proclination and reduction in lower intercanine width. However, other clinicians have attributed this incisor proclination to the treatment mechanics used for orthodontic treatment.

Woods[15] showed that incisor flaring might be primarily related to the mechanics of leveling Curve of Spee and not necessarily because of differential in arch circumference.

Braun et al[7] confirmed this in a study with computer-supported technology. Al Qabandi et al[16] reported that there was no significant correlation between reduction in the depth of Curve of Spee and proclination of lower incisors. However, they found lower incisor proclination significantly correlated with reduction in intercanine width and reduction of crowding. In the present study, the positions and inclinations of upper and lower incisors and anterior lower crowding showed no statistically significant differences between Spee groups, whereas significant differences in the measurements of Y- axis, overjet and overbite were found between the groups. In addition, significant correlation coefficients were found between the depth of Curve of Spee and overjet and overbite. It was interesting to observe the statistically significant changes in the overjet and overbite among the Spee groups without significant changes in the positions and axial inclinations of the upper and lower incisors. These findings support the results of Braun et al[7] and Woods,[15] who have shown that the reduction of the Curve of Spee and overbite may be achieved without flaring of the incisors by using appropriate mechanics.

Trauten et al[6] and Orthlieb[8] reported that there was a negative Curve of Spee in open-bite cases, whereas a deep Curve of Spee in deep-bite cases was found. On the other hand, Farella et al[3] found that the Curve of Spee is more marked in short-face subjects and less marked in long-face subjects. Similarly, we found that the overbite and horizontal growth pattern in the deep Spee group was significantly larger than in the normal and flat Spee groups.

Dusek[20] and Celik[21] concluded that there were significant correlations between the Curve of Spee and the positions and inclinations of lower incisors. Dusek[20] also found that the more protrusively the lower incisors are positioned, the less marked the depth of Curve of Spee is. In our study, the positions and inclinations of lower and upper incisors showed no statistically significant differences among the Spee groups. However, there were some significant, but low, correlations between the depth of Curve of Spee and the position of lower incisors.

Conclusion

Overall, the findings of the present study suggested that the positions and inclinations of the lower and upper incisors and lower anterior crowding were not affected by the variation of the depth of Curve of Spee, whereas the amount of overjet and overbite was significantly influenced by the variation of the curve. The overjet, overbite and horizontal growth pattern in the deep Spee group were significantly larger than in the normal and flat Spee groups.

Fig 1. Measurement of the depth of Curve of Spee

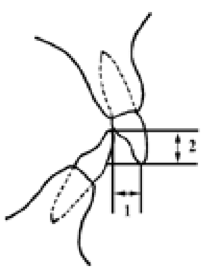

Fig 2. Measuring overjet and overbite

(1) Overjet (mm): the horizontal distance between the buccal surface of the mandibular central incisor and the incisal tips of the maxillary central incisor.

(2) Overbite (mm): the vertical distance between the incisal tips of the maxillary and mandibular central incisor.

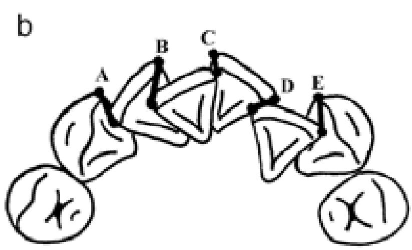

Fig 3. Measurement of lower anterior crowding

The linear displacement of the anatomic contact points of each mandibular incisor from the adjacent tooth anatomic contact point, the sum of these five displacements represent the lower anterior crowding.

TABLE 1

S.NO	The cephalometric landmarks and measurements used in the study are as follows
1.	**Upper incisor–NA (°):** the angle between the long axis of the maxillary central incisor and N-A line.
2.	**Lower incisor–NB (°):** the angle between the long axis of the mandibular central incisor and N-B line.
3.	**Lower incisor–MP (°):** the angle between the long axis of the mandibular central incisor and mandibular plane.
4.	**Interincisal angle (°):** the angle between the long axes of the maxillary and mandibular central incisors.
5.	**Y-axis(°):** the angle between the SN plane and S-Gn
6.	**Upper incisor–NA (mm):** the horizontal distance between the buccal surface of the maxillary central incisor and N-A line.
7.	**Lower incisor– NB (mm):** the horizontal distance between the buccal surface of the mandibular central incisor and N-B line.

TABLE 2

S.NO	**Dental cast measurements**
1	**Overjet (mm):** the horizontal distance between the buccal surface of the mandibular central incisor and the incisal tips of the maxillary central incisor.
2	**Overbite (mm):** the vertical distance between the incisal tips of the maxillary and mandibular central incisor.
3	**The measurement of the lower anterior crowding-** The linear displacement of the anatomic contact points of each mandibular incisor from the adjacent tooth anatomic contact point, the sum of these five displacements representing the anterior lower crowding.

Table 3. Sample Description and P Values Found By Analysis of Variance

	Group I Normal Spee	Group II Flat Spee	Group III Deep Spee	P
Number of subjects	20	18	22	
Male	10	9	11	
Female	10	9	11	
Age Mean (years)	17.3	14.8	14.1	
SD	4.3	3.2	3.5	0.020[a]
Curve of Spee (mm)	2.9	1.6	4.6	
Mean SD	0.5	0.	0.	<.001*

a NS indicates not significant.* P<.001

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Table 4. The Mean and Standard Deviation Values for Each Spee Groups

Measurements	Normal Spee, Group I (n=20)		Flat Spee, Group II(n=18)		Deep Spee Group III(22)	
	Mean	SD	Mean	SD	Mean	SD
Angular Measurements						
Upper incisor–NA	31.4	5.5	30.7	6.1	29.3	4.9
Lower incisor–NB	28.6	5.1	29.9	4.7	28.1	5.2
Interincisal angle	128.2	8.2	129.7	9.1	132.4	7.1
Lower incisor–MP	94.8	5.9	93.9	6.8	92.7	6.7
Y-axis	66.2	2.5	69.3	4.2	63.5	7.1
Linear Measurements						
Upper incisor–NA	5.9	1.8	5.8	1.6	6.0	2.2
Lower incisor–NB	5.4	1.8	5.6	1.6	5.6	1.7
Linear dental cast Measurements						
Overjet	4.2	1.9	2.9	2.1	4.8	2.0
Overbite	2.9	1.6	1.8	1.1	3.8	1.8
Lower anterior crowding	4.3	1.8	4.5	1.6	5.2	2.1

Table5. The Results of the Least Significant Difference Test

	Group Means			Mean Differences		
Measurements	GROUP I	GROUP II	GROUP III	I-II	I-III	II-III
Overjet	4.2	2.9	4.8	1.9*	0.6[a]	1.3*
Overbite	2.9	1.8	3.8	1.1*	0.9[a]	2*
Y-Axis	66.2	69.3	63.5	3.1*	3*	5.8*

a NS indicates not significant.* P<.001

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