

**Original Research Article**

“EVALUATION OF CURVE OF SPEE AND ITS RELATION TO THE CHANGE IN THE POSITION OF UPPER AND LOWER INCISORS, OVERJET, OVERBITE AND IRREGULARITY INDEX IN SUBJECTS WITH SKELETAL CLASS I AND SKELETAL CLASS II DIVISION I MALOCCLUSION”

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Introduction: The purposes of this study was to evaluate and to compare the relationship of different depth of curve of Spee with the position and inclination of upper and lower incisors, overjet, overbite and irregularity index in Angle's Class I and Class II Division 1 malocclusion. **Materials and Methods:** Study material consisted of Pre-treatment study models and Lateral cephalogram of 120 patients reported to Department of Orthodontics and Dentofacial Orthopaedics, Himachal Institute of Dental Sciences, Paonta Sahib (H.P.). Subjects were divided into two groups according to the type of molar relation i.e. Angle's Class I and Angle's Class II Division 1 malocclusion and further divided into three sub group on the basis of depth of curve of Spee. Correlation between the curve of Spee and inclination and position of upper and lower incisors, overjet, overbite and Little's Irregularity index were calculated. **Results:** Overall findings of this study suggested that lower incisor- NB angular and lower incisor-NPog angular had a significant negative correlation with curve of Spee in Angle's Class I flat curve of Spee group and lower incisors crowding had statistically significant positive correlation with curve of Spee in Angle's Class I normal curve of Spee group. **Conclusion:** Overall findings of this study suggested that the position and inclination of upper and lower incisors and anterior crowding were not affected that much by the variation in depth of curve of Spee in most of the groups, because most the values were not statistically significant. However inclination of lower incisors had statistically significant negative correlation with curve of Spee in Angle's Class I flat curve of Spee group.

1. Introduction

A profile view of the dried human skull usually reveals a downward, convex curve in the maxillary dentition extending from the molars to the incisors and a corresponding upward, concave curve in the mandibular teeth[1]. This phenomenon was first described by Ferdinand Graf von Spee in 1890 and has since been referred to as the curve of Spee. Curve of Spee is a naturally occurring phenomenon in the human dentition and it is required for efficient masticatory system[2].

Curve of Spee has a biomechanical function during chewing of food, which increases the efficiency of mastication and this is due to the increased crush-shear ratio between the posterior teeth[3]. Brargar and Osborn related anatomy of the curve of Spee to mandibular morphology and biting force, concluding that in the sagittal plane, the long axis of mandibular molar are tilted in the direction that most efficiently converts muscle force into work. It has been suggested that the deciduous dentition has a curve of Spee ranging from flat to mild, whereas the adult curve of Spee is more pronounced[4].

The purpose of this in vitro study was to find out Curve of Spee in Angle's Class I and Angle's Class II Division 1 malocclusion and to find out correlation between curve of Spee and inclination and position of upper and lower incisors overjet, overbite and Little's Irregularity index[5-7].

2. Material and Methods**Source of data**

The sample consisted of the pre-treatment lateral cephalometric radiographs and study models of Angle's Class I malocclusion and Angle's Class II division 1 malocclusion[8].

Inclusion criterion[9]

- Class I skeletal relationship with ANB angle of 0-4 degrees on cephalometric analysis.
- Class I molar and canine in centric occlusion relationship.

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- Class II skeletal relationship with ANB angle more than 4 degrees on cephalometric analysis.
- Angle's Class II molar relationship.
- Fully erupted incisors, canine, first and second premolars and first and second molars.

2.2 Exclusion criteria

Exclusion criteria for Class I malocclusion and Class II division 1 malocclusion were:

- Patients who have already undergone orthodontic, prosthodontic and/or orthognathic treatment.
- Restoration, abrasion or any surface defect on the occlusal surface of the first and second premolars and first and second molars.
- Crowding, anterior and posterior openbite, crossbite, or scissor bite in the posterior teeth region.

Sample size and design

The sample was divided into two groups:-

Group 1: - Angle's Class I malocclusion (n=60)

Group 2: - Angle's Class II Division 1 malocclusion (n=60)

Group		
Angle's Class I malocclusion	Flat curve of Spee	n =20
	Normal curve of Spee	n =20
	Deep curve of Spee	n =20
Angle's Class II Division 1 malocclusion	Flat curve of Spee	n =20
	Normal curve of Spee	n =20
	Deep curve of Spee	n =20

The depth of curve of Spee was measured as described by Al Qabandi *et al.* It was measured as 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. The measurement was made on both side and the mean values of these two measurements were used as the depth of curve of Spee.



Figure No. 1: Measuring curve of Spee

Following linear and angular measurements were taken:-



Figure No. 2: Diagrammatic representation of angular and linear measurements taken on lateral cephalogram.

- (1). Upper incisor–NA, (2). Upper incisor–SN, (3). Lower incisor–NB, (4). Lower incisor–SN, (5). Lower incisor–MP, (6). Lower incisor–NPg, (7). Lower incisor–OP, (8). Lower incisor–PP, (9). Interincisal angle, (10). Upper incisor–NA, (11). Lower incisor–NB, (12). Lower incisor– NPg

Overbite was measured as the amount of vertical overlap of the mandibular incisor in millimeters. This maximum overbite involving a maxillary central incisor was recorded.

Overjet was measured in millimeters from the labial surface of the mandibular incisor to the labial surface of the maxillary incisor. In case of different labial inclination of the maxillary incisors, the maximum overjet was recorded. Overjet and overbite were measured with a digital verniercaliper, to the nearest 0.1 mm.

For determining the Little's irregularity index, the linear displacement of the anatomic contact points of each mandibular incisor from the adjacent anatomic point was measured. Each of five measurements was taken on the mandibular cast.

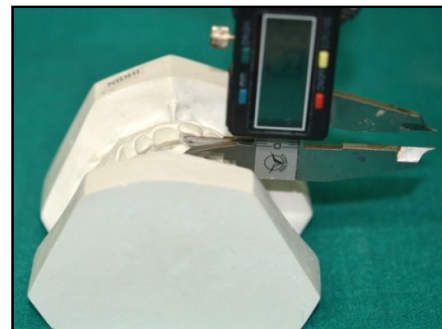


Figure No. 3: Measuring the overjet



Figure No. 4: Measuring the overbite

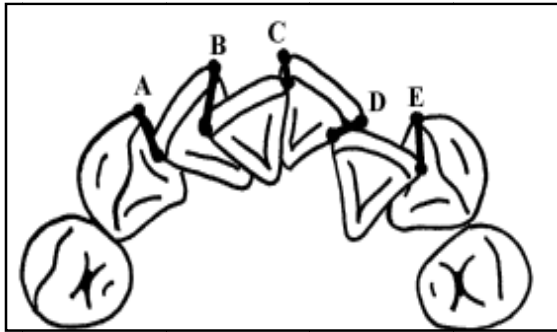


Figure No. 5: Measuring the overjet
Diagrammatic representation of Little's Irregularity Index.

Data collected was statistically analysed. The data base analysed with the Statistical package for Social Science version 16.0 for Windows (SPSS Inc, Chicago, III).

Result

In Angle's Class I flat curve of Spee group, curve of Spee had statistically significant negative correlation with lower incisor-NB angular and lower incisor-NPog angular. Curve of Spee also have a statistically significant positive correlation with lower incisor-OP angular.

A positive correlation was found between curve of Spee and lower incisor-PP, interincisal angle, overbite and crowding. A negative correlation was found between curve of Spee and upper incisor-NA angular, upper incisor-SN angular, lower incisor-MP angular, upper incisor-NA linear, lower incisor-NB linear, lower incisor-NPog and overjet.

In Angle's Class I normal Spee group, curve of Spee had a statistically significant positive correlation with lower incisor crowding.

A positive correlation was found between curve of Spee and lower incisor-NPog angular, lower incisor-OP angular, interincisal angle, lower incisor NB linear, lower incisor NPoglinear and overbite. A negative correlation was found between the curve of Spee and upper incisor-NA angular, upper incisor-SN angular, lower incisor-NB angular, lower incisor-MP angular, lower incisor-PP angular, upper incisor-NA linear and overjet.

In Angle's Class I deep curve of Spee group, curve of Spee had positive correlation with lower incisor-NPog angular, lower incisor-PP angular, interincisal angle, lower incisor-NB linear, lower incisor-NPog linear, overbite. A negative correlation was found between the curve of Spee and upper incisor-NA angular, upper incisor-SN angular, lower incisor-NB angular, lower incisor-MP angular, lower incisor-OP angular, upper incisor-NA linear, overjet and crowding.

In Angle's Class II Division 1 flat curve of Spee group, positive correlation was found between curve of Spee and upper incisor-NA angular, upper incisor-SN linear, lower incisor-MP angular, upper incisor-NA linear, overjet, overbite and crowding. A negative correlation was found between the curve of Spee and lower incisor-NB angular, lower incisor-

NPog angular, lower incisor-OP angular, lower incisor-PP angular, interincisal angle, lower incisor-NB linear, lower incisor-NPog linear.

In Angle's Class II division 1 normal curve of Spee group, curve of Spee had positive correlation with lower incisor-NB angular, lower incisor-MP angular, lower incisor-NPog angular, lower incisor-OP angular, lower incisor-PP angular interincisal angle, upper incisor-NA linear, lower incisor-NPog linear, overbite and crowding. A negative correlation was found between the curve of Spee and upper incisor-NA angular, upper incisor-SN angular, lower incisor-NB linear and overjet.

In Angle's Class II division 1 deep curve of Spee group, curve of Spee had positive correlation with upper incisor-NA angular, upper incisor-SN angular, lower incisor-PP angular, upper incisor-NA linear and overjet. A negative correlation was found between the curve of Spee and lower incisor-NB angular, lower incisor-MP angular, lower incisor-NPog angular, lower incisor-OP angular, interincisal angle, lower incisor-NB linear, lower incisor-NPog linear, overbite and crowding.

Table No. 1: Pearson correlation with Curve of Spee in Angle's Class I Spee group

Angular measurement	Pearson correlation		
	Flat Spee Group	Normal Spee group	Deep Spee group
U1 NA	-0.97	-0.20	-0.10
U1 SN	-0.12	-0.218	-0.14
L1 NB	-0.48*	-0.24	-0.11
L1 MP	-0.41	-0.50	-0.25
L1 NPog	-0.56**	0.10	0.03
L1 OP	0.57**	0.13	-0.01
L1 PP	0.39	-0.20	0.02
U1 L1	0.18	0.18	0.15
Linear measurements			
U1 NA	-0.33	-0.08	-0.01
L1 NB	-0.39	0.31	0.03
L1 NPog	-0.38	0.35	0.037
Overjet	-0.25	-0.01	-0.15
Overbite	0.73	0.29	0.14
Crowding	0.30	0.46***	-0.11

p = 0.029 (*), p = 0.009 (**), p = 0.039 (***)

Table No. 2: Pearson correlation with Curve of Spee in Angle's Class II Division 1 group.

Angular measurement	Pearson correlation		
	Flat Spee Group	Normal Spee group	Deep Spee group
U1 NA	0.16	-0.02	0.37
U1 SN	0.34	-0.24	0.29
L1 NB	-0.13	0.04	-0.21
L1 MP	0.05	0.17	-0.38
L1 NPog	-0.12	0.09	-0.18
L1 OP	-0.17	0.13	-0.70

L1 PP	-0.01	0.15	0.20
U1 L1	-0.14	0.12	-0.23
Linear measurements			
U1 NA	0.14	0.14	0.43
L1 NB	-0.001	-0.23	-0.06
L1 NPog	-0.05	0.01	-0.29
Overjet	0.03	-0.03	0.10
Overbite	0.004	0.38	-0.13
Crowding	0.039	0.10	-0.12

Discussion

Andrews *et al.*, in describing the six characteristics of normal occlusion, found that the curve of Spee in subjects with good occlusion ranged from flat to mild, noting that the best static intercuspation occurred when the occlusal plane was relatively flat. He proposed that flattening the occlusal plane should be a treatment goal in orthodontics[6]. Balridge *et al.*, 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[8] found an association between lower incisor proclination and reduction in lower intercanine width[7]. However, other clinicians have attributed this incisor proclination to the treatment mechanics used for orthodontic treatment.

Woods *et al.*, showed that incisor flaring might be primarily related to the mechanics of levelling the curve of Spee and not necessarily because of the differential in arch circumference. Braun *et al.*, confirmed this in a study with computer-supported technology[9]. Al Qabandi *et al.*, reported that there is no significant correlation between reduction in the depth of curve of Spee and proclination of the lower incisors[11].

However, they found lower incisor proclination significantly correlated with reduction in intercanine width and reduction of crowding. The positions and inclinations of the upper and lower incisors and anterior lower crowding showed no statistically significant differences between Spee groups, whereas significant differences in the measurements of overjet and overbite were found between the groups.

Troutenet al *et al.*, and Orthlieb *et al.*, 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[12,5]. On the other hand, Farella *et al*[13] found that the curve of Spee is more marked in short-face subjects and less marked in long-face subjects.

Dusek *et al.*, concluded that there were significant correlations between the curve of Spee and the positions and inclinations of lower incisors. Dusek *et al.*, also found that the more protrusively the lower incisor is positioned, the less marked the depth of curve of Spee[14].

Bulent Baydas *et al.*, investigated the relationship between the depth of the curve of curve of Spee and positions of upper and lower incisors, overjet, overbite, and anterior lower crowding and found that there were no statistically significant differences in the positions of upper and lower incisors and anterior lower crowding among the Spee groups[15].

However, overjet and overbite demonstrated significant differences among the groups. Statistically significant correlations were found between the depth of curve of Spee and overjet and overbite.

Depth of curve of Spee in various malocclusions

The maximum depth of curve of Spee was found in Angel's Class II Division 1 deep curve of Spee (4.46 ± 0.33 mm) group while the least depth was observed in Angle's Class I flat curve of Spee group (1.64 ± 0.35 mm). The mean curve of Spee in study did by Baydas *et al.*, was 1.5 ± 0.5 mm for flat curve of Spee group, 3.1 ± 0.5 mm for normal curve of Spee group, and 4.4 ± 0.5 mm for deep curve of Spee group. However the relationship between the curve of Spee and malocclusion was not specified in this study[11].

Curve of Spee and its correlation to the position and inclination of upper incisors

Finding of current study suggested that curve of Spee had a negative correlation with inclination and position of upper incisors in Angle Class I flat curve of Spee group. Angle Class I normal curve of Spee group and Angle Class I deep curve of Spee group.

In Angle Class II Division 1 flat curve of Spee group and Angle Class II Division 1 normal curve of Spee group, curve of Spee had a negative correlation with angulation and position of upper incisors. But in Angle Class II Division 1 deep curve of Spee group there was a positive correlation with angulation and position of upper incisors.

Bayads *et al.*, reported negative correlation between the inclination and position of upper incisor with the curve of Spee. Cheonet *et al.*,[23] also found negative correlation between the curve of Spee and upper incisor-SN angular[11].

Curve of Spee and its correlation to the position and inclination of lower incisors

In Angle Class I flat curve of Spee group correlation coefficient of curve of Spee with angulations of lower incisor i.e. lower incisor-NB angular, lower incisor-MP angular, lower incisor-NPog angular, lower incisor-OP angular, lower incisor-P Pangular was -0.488, -0.410, -0.568, 0.571, 0.397 respectively. And the correlation coefficient with positions of lower incisor i.e. lowers incisor-NB linear and lower incisor-NPog linear was -0.391 and -0.383. There was statically significant negative correlation between the curve of Spee and lower incisor-NB and lower incisor-NPog and a positive correlation with lower incisor-OP.

In Angle Class I normal curve of Spee group correlation coefficient of curve of Spee with angulations of upper incisor i.e. lower incisor-NB, lower incisor-MP, lower incisor-NPog, lower incisor-OP, lower incisor-PP was -0.240, -0.050, 0.103, 0.138, -0.206 respectively. And the correlation coefficient with positions of lower incisor i.e. lower incisor-NB and lower incisor-NPog was 0.313 and 0.353.

In Angle Class I deep curve of Spee group correlation coefficient of curve of Spee with angulations of lower incisor

i.e. lower incisor-NB, lower incisor-MP, lower incisor-NPog, lower incisor-OP, lower incisor-PP was -0.117, -0.254, -0.030, 0.008, 0.022 respectively. And the correlation coefficient with positions of lower incisor i.e. lower incisor-NB and lower incisor-NPog was -0.035 and -0.037.

In Angle Class II Division 1 flat curve of Spee group correlation coefficient of curve of Spee with angulations of upper incisor i.e. lower incisor-NB, lower incisor-MP, lower incisor-NPog, lower incisor-OP, lower incisor-PP was -0.134, -0.056, -0.126, 0.176, 0.014 respectively. And the correlation coefficient with positions of lower incisor i.e. lower incisor-NB and lower incisor-NPog was -0.001 and -0.050.

In Angle Class II Division 1 normal curve of Spee group correlation coefficient of curve of Spee with angulations of lower incisor i.e. lower incisor-NB, lower incisor-MP, lower incisor-NPog, lower incisor-OP, lower incisor-PP was -0.042, -0.173, -0.099, 0.136, 0.156 respectively. And the correlation coefficient with positions of lower incisor i.e. lower incisor-NB and lower incisor-NPOG was -0.233 and -0.018.

In Angle Class II Division 1 deep curve of Spee group correlation coefficient of curve of Spee with angulations of upper incisor i.e. lower incisor-NB, lower incisor-MP, lower incisor-NPog, lower incisor-OP, lower incisor-PP was -0.219, -0.382, -0.189, 0.070, 0.205 respectively. And the correlation coefficient with positions of lower incisor i.e. lower incisor-NB and lower incisor-NPog was -0.063 and -0.290.

Bayadset *et al.*, [11] reported the negative correlation between the curve of Spee and inclination of lower incisor i.e. lower incisor-NB, lower incisor-NPog and lower incisor-OP. There was a positive correlation between the lower incisor-SN and lower incisor-MP. With the position of lower incisor curve of Spee had a significant negative correlation.

Curve of Spee and its correlation and interincisal angle

In Angle's Class I flat, normal and deep curve of Spee group curve of Spee had a positive correlation with interincisal angle. In Angle's Class II Division I flat, normal and deep curve of Spee group, curve of Spee had a positive correlation with interincisal angle.

Curve of Spee and its correlation with overjet, overbite and Little Irregularity Index

In Angle's Class I flat curve of Spee group, curve of Spee had a negative correlation with overjet of -0.256 while with overbite and crowding it had a positive correlation of 0.073 and 0.309. In Angle's Class I normal curve of Spee group curve of Spee had a negative correlation with overjet of -0.010 while with overbite and crowding it had a positive correlation of 0.291 and 0.464. In this group the correlation between curve of Spee and crowding was statistically significant. In Angle's Class I deep curve of Spee group curve of Spee had a negative correlation with overjet and crowding of -0.159 and -0.117 while with overbite had a positive correlation of 0.147.

In Angle's Class II Division 1 flat curve of Spee group, curve of Spee had a positive correlation with overjet, overbite and crowding of 0.030, 0.004 and 0.395 respectively. In Angle's

Class II Division 1 normal curve of Spee group curve of Spee had a negative correlation with overjet of -0.037 while with overbite and crowding it had a positive correlation of 0.385 and 0.109. In Angle's Class II Division 1 deep curve of Spee group, curve of Spee had a positive correlation with overjet of 0.106 while with overbite and crowding it had a negative correlation of -0.133 and -0.124.

Bayadset *et al.*, reported the positive correlation between the curve of Spee and overjet and overbite of 0.30 and 0.42 respectively and both the values were statistically significant. Curve of Spee had a negative correlation with the lower anterior crowding of -0.06 [14]. Cheonetal found a positive correlation between the curve of Spee and overjet and overbite of 0.51 and 0.44 and both the values statically significant [15].

Conclusion

Overall findings of this study suggested that the position and inclination of upper and lower incisors and anterior crowding were not affected that much by the variation in depth of curve of Spee in most of the groups, because most the values were not statistically significant. However inclination of lower incisors had statistically significant negative correlation with curve of Spee in Angle's Class I flat curve of Spee group.

It was concluded that position and inclination of upper and lower incisors and anterior crowding were not affected that much by the variation in depth of curve of Spee in most of the groups, because most the values were not statistically significant.

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