ORIGINAL ARTICLE

CORRELATION BETWEEN CURVE OF SPEE AND VERTICAL ERUPTION OF ANTERIOR OR POSTERIOR TEETH IN CLASS- II DIVISION I MALOCCLUSION

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ABSTRACT

The objective of this crossectional study was to relate the depth of curve of Spee to the eruption of anterior or posterior teeth quantitatively, and to determine whether the depth of the Curve of Spee is affected by the vertical eruption of anterior or posterior teeth. The study was conducted at Department of Orthodontics, de'Montmorency College of Dentistry, Lahore; in which two hundred fifty lateral cephalograms and models of untreated Class II Division 1 malocclusion patients (127 boys, mean age:15.4 ±1.4 years; 123 girls, mean age: 17.1 ± 1.8 years) were included. The depth of the Curve of Spee was measured on lateral cephalograms as perpendicular distance from incisal tip of the mandibular central incisor to the mandibular plane (L1-MP), distobuccal cusp tip of the mandibular second molar (M7-MP) to the mandibular plane, the deepest point of the Curve of Spee to the mandibular plane (S-MP), and proportioned with each other. Right and left side Curve of Spee was measured on models. Results showed that the mesiobuccal cusp of the first molar was the deepest part of the Curve of Spee, and eruption of mandibular molars (M7-MP/S-MP) was more significantly related to depth of Curve of Spee as compared to eruption of mandibular incisors (L1-MP/S-MP). There was no significant difference between Right and left side Curve of Spee. It was concluded that vertical eruption of the posterior teeth made a significant effect on the depth of the Curve of Spee in Class II Division I malocclusion patients.

Key Words: *Curve of Spee, Vertical eruption, Class II Division 1.*

INTRODUCTION

The Curve of Spee (COS) is curve of occlusion and defined as the line on a cylinder tangent to the anterior border of the condyle, the occlusal surface of the mandibular second molar, and the incisal edges of the mandibular incisors.[1] It is named for the German embryologist Ferdinand Graf von Spee (1855-1937), who was first to describe the anatomic relationship of human teeth in the sagittal plane. 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.[1] Different factors such as growth of orofacial structures, development of the neuromuscular system, and eruption of teeth, has been suggested for development of the COS.[2] On average, eruption of the mandibular permanent first molars precedes that of the maxillary permanent first molars by one to two months, and eruption of the mandibular permanent central incisors precedes that of the maxillary permanent central incisors by twelve months.[2] Moreover, the mean age for the eruption of the mandibular second molars is six months before the maxillary second molars. This differential timing allows unopposed mandibular permanent first molar and incisor eruptions beyond the established mandibular occlusal plane.[3,4] On the other hand, Andrews[5] mentioned a natural tendency for deepening of the COS with aging. With the growth of the mandible beyond that of the maxilla, the mandibular incisors are restricted by the maxillary incisors and forced to move backward upward, and this causes deepening of the bite and the COS at the same time.[5] Regarding significance of COS, Andrews described the six keys of occlusion and found that the COS ranged from flat to mild curvature in subjects with ideal occlusion. Furthermore he advised that leveling and flattening

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of the COS should be the goal of treatment.[5] Hemley[6] described the COS as mesial tipping of the mandibular molar and distal tipping of the mandibular canine with the two premolars locked below the line of occlusion. He indicated that these conditions create an exaggerated COS; by distally up righting the molar and mesially up righting the canine, the two premolars will be free to erupt into the line of occlusion. Strang and Thompson[7] described a deep COS as a result of elevated anterior teeth, depressed premolars, and mesially inclined molars. It has been reported that an excessive COS is associated with deep bite malocclusions. Burstone[8] stated that an excessive COS is associated with deep bite malocclusions and the treatment of deep bite might involve intrusion of maxillary anterior teeth, intrusion of mandibular anterior teeth, extrusion of maxillary and mandibular posterior teeth, or any such combination. However, Schudy[9] advocated that a deep bite and a deep COS should be corrected by extrusion of the molars because intrusion of anterior teeth has a high potential for relapse. Since there is no consensus on this issue, developmental characteristics of the COS needs to be evaluated in terms of differential vertical eruption of anterior or posterior teeth.

Therefore, the objective of this study was to investigate the relationship of the depth of the COS with the vertical eruption of anterior and/ or posterior teeth, and also difference between right and left side COS in Class II Division I malocclusion aiming to contribute to the knowledge about the development of Curve of Spee.

METHODOLOGY

This study was conducted after institutional approval at the Department of Orthodontics, de,Montmorency College of Dentistry, Lahore in which two hundred fifty lateral cephalograms and models from records of untreated Class II Division I malocclusion patients (127 boys, mean age: 15.4 ± 1.4 years; 123 girls, mean age: 17.1 ± 1.8 years) were included as per laid down criteria. Duration of this crossectional study was January 2015 to June 2015. Sample was collected by using non probability convenience sampling technique. No ethical approval was sought because of the retrospective characteristics of the study design.

Inclusion Criteria

Dental crowding or spacing less than 2 mm with well-aligned dental arches

All teeth present except the third molars

Class II Division 1 malocclusion (on cast analysis)

Good quality pretreatment Lateral cephalograms and models.

Exclusion Criteria

History of trauma or facial asymmetry

Previous orthodontic or prosthodontic treatment

Previous maxillofacial/ plastic surgery.

Data Collection Procedure

All cephalograms were traced manually by one examiner. In case of double images, the two points were joined by an intersecting line, and midpoint was considered as reference point. The following reference points and planes on lateral cephalograms were used: L1, the incisal tip of the mandibular central incisor; M7, the distobuccal cusp tip of the mandibular permanent second molar; mandibular plane (MP), the line between gonion and gnathion; L1-MP, the perpendicular distance from the tip of L1 to the mandibular plane; M7-MP, the perpendicular distance from the distobuccal cusp tip of M7 to the mandibular plane; and S-MP, the perpendicular distance from the deepest point of the COS to the mandibular plane (Fig 1).[10] The depth of the COS was measured on models by method advocated by Veli et al[10] in which horizontal reference plane comprising a line between the central incisors and the distobuccal cusp tips of the mandibular second molars was constructed. The perpendicular distance from the buccal cusp tips of the involved teeth to the constructed line through the horizontal reference plane were measured and the deepest points of the COS were calculated for the right and left sides (Fig 2).

Statistical Analysis

The data was analyzed in Statistical Package for the Social Sciences software package (SPSS) 20. A paired t-test was used for side comparisons of dental cast values and quantitatively determine the contribution

TABLE 1: CONTRIBUTION OF VERTICAL ERUPTION OF INCISORS AND MOLARS TO COS DEPTH ON LATERAL CEPHALOGRAMS

Measurements	Minimum	Maximum	Mean mm	SD	t-value	P value
L1-MP	43.2357	47.7245	45.5530	1.7608	—	
M7-MP	37.4456	41.5622	39.4820	1.5631	4.59	<0.001
S-MP	35.7899	38.4456	37.0649	1.2106	2.80	<0.05

<0.001= statistically highly significant <0.05 = statistically significant

TABLE 2: CORRELATION BETWEEN VERTICAL ERUPTION OF INCISORS AND MOLARS WITH COS DEPTH ON LATERAL CEPHALOGRAMS

Measurement	Deviation Scores	Coefficient of Determination (r- value)
L1-MP/S-MP	-57.69	-0.111
M7-MP/S-MP	-12.22	-0.026

r= or near to 1 — strong positive correlation
r= or near to -1 — strong negative correlation
Strong negative correlation (r- value near to -1) inversely related to more vertical eruption of teeth.

TABLE 3: DESCRIPTIVE STATISTICS FOR AVERAGE PERPENDICULAR DISTANCE (MM) ON MODELS (RIGHT SIDE)

Tooth	Mean	Standard Deviation	Minimum	Maximum
Lower lateral incisor	-0.032	0.283	-0.983	-0.987
Lower canine	0.254	0.652	-1.824	1.556
Lower first premolar	1.639	0.781	0.000	4.111
Lower second premolar	2.319	0.851	0.523	4.666
Lower First molar	2.399	0.831	0.318	4.588

TABLE 4: DESCRIPTIVE STATISTICS FOR AVERAGE PERPENDICULAR DISTANCE (MM) ON MODELS (LEFT SIDE)

Tooth	Mean	Standard Deviation	Minimum	Maximum
Lower lateral incisor	-0.031	0.282	-0.981	-0.985
Lower canine	0.251	0.650	-1.822	1.554
Lower first premolar	1.635	0.781	0.001	4.114
Lower second premolar	2.315	0.850	0.523	4.662
Lower First molar	2.391	0.832	0.313	4.589

TABLE 5: SIDES COMPARISON OF DEPTH OF THE COS ON MODELS

Mean	Standard Deviation	Side Difference	Standard Error	t value	P
2.354	0.835	-0.081	0.095	-0.877	0.384

p<0.05 = statistically significant

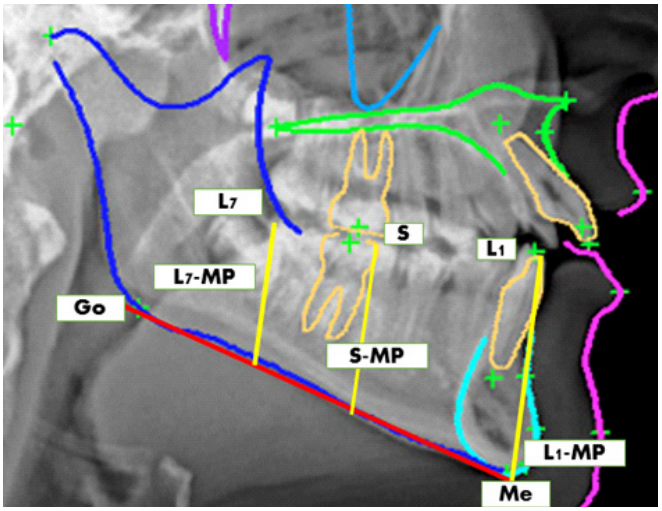

Fig 1: Cephalometric measurements used in this study. Fig courtesy from Veli et al[10]

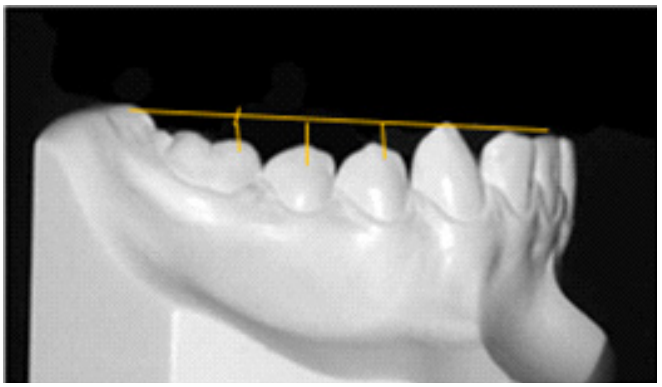

Fig 2: Depth of COS measured on models. Fig courtesy from Veli et al[10]

of eruption of mandibular molars (M7-MP/S-MP) and eruption of mandibular incisors (L1-MP/S-MP) to the depth of COS on lateral cephalograms. P<0.05 was set as statistically significant value. Linear regression analysis was used to calculate Pearson's correlation coefficient for determination of correlation between two variables as depth of COS (S-MP) to eruption of mandibular molars (M7-MP/S-MP) as well as depth of COS (S-MP) to eruption of mandibular incisors (L1-MP/S-MP).

Fifteen cephalograms and models were randomly selected and all variables were re-evaluated for casual error by applying paired t-test to determine significance of difference. None of the variables showed an error of statistical significance at p<0.05.

RESULTS

The means, standard deviations, minimum and maximum values, t-vales and p-values of the average perpendicular measurements on lateral cephalogram are presented in Table 1. The value M7-MP was significantly more than LI-MP showing highly significant

difference. The multiple linear regression analysis showed that M7-MP/S-MP had a significant correlation to the depth of the COS in the Class-II Division I malocclusion (Table 2). The means, standard deviations, and minimum and maximum values of the average perpendicular distance of right and left sides on model are presented in Table 3 and 4. The mesiobuccal cusp of the first molar was the deepest part of the COS with a maximum depth of 2.33 ± 0.37 mm and a minimum depth of 1.67 ± 0.49 in Class II Division I malocclusion subjects. The results of the paired t- test showed no significant difference in the depth of the COS between the right and left sides (Table 5).

DISCUSSION

The COS is a common feature of patients presenting for orthodontic treatment with different malocclusion groups; however, the depth of COS has to be evaluated for proper diagnosis and treatment planning.[11] In this study, we aimed to determine the depth of the COS in terms of vertical eruption of the anterior and/ or posterior teeth quantitatively and to find out whether depth of the COS is affected by vertical eruption of the anterior or posterior teeth in Class II Division I malocclusion. The influence of skeletal morphology on COS has been investigated in the literature. Kumar and Tamizharasi[12] reported that COS was influenced by craniofacial morphology to very minimal extent; therefore we selected patients of Class II Division I according to dental malocclusion on pretreatment models. No attempt was made to separate the sample according to sex in this study because of lack of sex dimorphism in the depth of the COS as already reported in the literature.[13,14,15,16] It has been suggested that the depth of the COS remain almost stable throughout adolescence and into adulthood.[15,17] Because of this stability of COS, adolescents and young adults with all teeth present except third molars were included in the study.

There is little consensus in the literature concerning measurement of the depth of the COS. Baldridge[18] used the perpendicular distance on both sides, and Bishara et al[17] used the average of the sum of the perpendicular distance to each cusp tip. Braun et al[19] and Braun and Schmidt[20] used the sum of the maximum depth on both sides on plaster models. Marshall et al[2] and Veli et al[10] found no significant difference in depth of the COS between the right and left sides of the mandibular arch. Similarly, the data obtained in this study indicated no significant difference in depth of the COS between the right and left sides in Class II Division I malocclusion. The deepest point of the COS was found at the mesiobuccal cusp of the first molar which is in accordance to Veli et al[10] and Garcia[21] but in contrast to Koyoma[22] who reported the deepest point of COS at the second premolar area.

As maxillary and mandibular teeth show differential eruption sequence of the teeth that could result in an unopposed mandibular permanent first molar and incisor eruption beyond the mandibular occlusal plane.[2] It was proposed that this unopposed eruption would be expected to be even more exaggerated in a Class II dental or skeletal relationship, leading to excessive deepening of the COS.[11] According to study conducted by Veli et al[10] the curve of Spee was deepest in Class II Division 1 and Division 2 malocclusion associated with vertical eruption posterior teeth. Our study also showed similar correlation between vertical eruption of posterior teeth and deep COS in Class II Division 1 malocclusion.

Limitations of this study are crossectional study and small sample size; further studies with a longitudinal follow-up would be beneficial to better understand the development of the COS. Moreover, the relationships between COS and the vertical eruption of teeth were determined on conventional lateral cephalograms which is having 2-dimensional characteristics therefore; future studies using 3-D computerized tomography may be conducted to evaluate relationships between COS and the vertical eruption of teeth in more detail.

CONCLUSION

1 The vertical eruption of the posterior teeth made a significant contribution to the depth of COS in Class II Division 1 malocclusion patients.

2 The mesiobuccal cusp of mandibular first molar was deepest point of COS. There was no significant difference in the maximum depth of the COS between the right and left sides of the mandibular arch in Class II Division I malocclusion patients.

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