CORRELATION BETWEEN CURVE OF SPEE AND VERTICAL ERUPTION OF TEETH AMONG VARIOUS GROUPS OF MALOCCLUSION

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ABSTRACT

The aim of this study was to determine the depth of curve of Spee (COS) in different types of malocclusion and find a relationship between depth of COS and vertical eruption of anterior or posterior teeth.

The study was conducted at Department of Orthodontics, Khyber College of Dentistry using the record of 120 patients in the form of lateral cephalograms and dental casts. The patients were divided into 4 equal groups (30 each) based on dental malocclusion as class I, class II div 1, class II div 2 and class III. The depth of COS was measured for each group using a flat plane touching the incisors anteriorly and distal marginal ridges of posterior teeth on mandibular cast. On lateral cephalograms, perpendicular distances from the incisal tip of mandibular central incisor (L1-MP), the deepest point of COS (S-MP) and distobuccal cusp tip of mandibular second molar (L7-MP) to mandibular plane (MP) were measured and proportioned as L1-MP/S-MP and L7-MP/S-MP. Pearson correlation was used to assess the relationship between COS and L1-MP/S-MP and L7-MP/S-MP.

The second premolar cusp tip was the deepest point of COS in all groups with the maximum depth of 2.80 ± 0.417mm in Class II div 2 and minimum depth of 1.40 ± 0.693mm in Class I malocclusion. Significant positive correlations were found between depth of COS and L1-MP/S-MP for Class I (r =0.670) and Class III (r =0.267) groups while L7-MP/S-MP was significant for Class II div 2 (r =0.235).

It was concluded that depth of COS is affected by vertical eruption of anterior teeth in class I and Class III malocclusion while posterior teeth eruption significantly contributed in Class II div 2.

Key Words: Curve of Spee, malocclusion, mandibular plane, vertical eruption, teeth.

INTRODUCTION

Lateral view of the human dentition reveals an anatomic plane which is generally concave with the concavity facing upward. In 1890 Ferdinand Graf Von Spee defined a line of occlusion by using skulls with abraded teeth which is now termed as curve of Spee (COS). The curve of Spee is a line on a cylinder that is tangent to the anterior border of the condyle, the occlusal surface of the mandibular second molar and the incisal edges of the mandibular incisors. Clinically the distal marginal ridges of posterior teeth and the incisal edges of the incisors determine the curve of Spee. The presence of curve of Spee of variable depth is a common finding in the occlusal arrangement of the dentition. From functional perspective COS has a biomechanical function by increasing the crush-shear ratio between posterior teeth and the efficiency of occlusal forces during mastication.

A possible explanation for the development of the curve of Spee is the earlier eruption of mandibular permanent teeth before maxillary counterparts. On average, mandibular first molar erupts 1-2 months earlier than maxillary first molars and eruption of mandibular permanent incisors preceds the maxillary counterparts by 12 months. Due to differential timing of eruption, this could permit the mandibular first molars and incisors to erupt beyond the established occlusal plane. This implies that the development of curve of Spee is a dental phenomenon. However several factors contribute to the development of curve of Spee including dental eruption timing, craniofacial variation and neuromuscular system.

In deciduous dentition the COS is suggested to range from flat to mild whereas curve of Spee in permanent
dentition tends to be deeper. In humans curve of Spee of increasing depth is common to brachycephalic facial pattern and associated with short mandibular bodies.\(^7\)

Andrews\(^8\) described 6 keys to normal occlusion by studying 120 untreated subjects with pleasing appearance and normal occlusion and stated curve of Spee as the sixth key to normal occlusion ranging from flat to mild curve. He further stated that there is a natural tendency for curve of Spee to deepen with time due to continued growth of the lower jaw compared to upper jaw. Therefore, leveling COS during orthodontic treatment is recommended for good intercuspation.

Orthodontics and prosthetics dentistry differ with respect to the clinical significance of COS. Its proper arrangement is critical for fabrication of stable complete dentures.\(^9\) Leveling of the excessive curve of Spee inevitably increases arch length as this leads to incisor protrusion unless molars are moved distally, which is difficult.\(^10\) Baldridge\(^11\) reported that decreasing the depth of the curve of Spee leads to an increase in arch circumference as the lower incisors will procline in direct response.

A deep curve of Spee is usually associated with increased overbite.\(^12\) Orthodontic correction of deep bite involves leveling of curve of Spee by anterior intrusion, posterior extrusion or a combination of these.\(^13\) Schudy\(^14\) proposed the correction of deepbite and deep curve of Spee by posterior extrusion because intrusion of anterior teeth tends to relapse. The aim of this study was to evaluate the correlation between vertical pattern of teeth and curve of Spee in various malocclusion groups in order to better understand the contribution of anterior or posterior tooth eruption to development of curve of Spee in individual malocclusion type.

**METHODOLOGY**

This retrospective, cross-sectional study was carried out at Department of Orthodontics, Khyber College of Dentistry between May 2016 to August 2016, using lateral cephalograms and dental casts of patients. The records of 120 patients were selected on the basis of inclusion criteria:

1. Presence of all permanent teeth except third molar
2. Patients having class I, class II div 1/div 2, class III dental malocclusion
3. Mild crowding or spacing with well aligned arches
4. Cephalograms of high clarity.

Those patients with previous history of orthodontic therapy, prosthetic replacement of missing teeth and fractured dental casts were excluded. Pretreatment lateral cephalograms and dental casts were obtained and divided into 4 equal groups according to type of dental malocclusion: class I (mean age 19.8±3.6 years), class II div 1 (mean age 17.3±3.9 years), class II div 2 (mean age 16.43±2.82 years) and class III (mean age 21.4±5.5 years). The depth of curve of Spee was measured on dental casts as advocated by Marshall et al\(^7\), i.e. the perpendicular distance between the deepest cusp tip and a flat plane touching the incisal edges of the incisors and distobuccal cusp tip of most posterior teeth of the mandibular arch as shown in Fig 1.

Pretreatment lateral cephalograms of patients were obtained by using Kodak - 9000 C machine with film size of 11×14\(\)\(^7\). Measurements were made by a single operator after tracing the landmarks manually using illuminator. The reference points on lateral cephalogram were: L1 (the incisal tip of mandibular central incisor), M7 (the distobuccal cusp tip of mandibular second molar) and point S (the deepest point of COS). The planes used were: mandibular plane (the line between gonion and gnathion); L1-MP (the perpendicular distance from L1 to mandibular plane); L7-MP (the perpendicular distance from L7 to mandibular plane) and S-MP (the perpendicular distance from deepest point of COS to the mandibular plane) Fig 2. The mean values of COS and cephalometric measurements were recorded for each patient.

**STATISTICAL ANALYSIS**

The data was analyzed using SPSS version 20.0. Mean ±SD was calculated for numerical variables like curve of Spee and age according to malocclusion type. The correlation between curve of Spee and vertical eruption of anterior/posterior was assessed by Pearson correlation test and coefficients were determined for curve of Spee and LI-MP/S-MP and L7-MP/S-MP. The level of significance was set at 0.05 (p-value).

**RESULTS**

The sample of 120 patients was divided into four malocclusion classes and their mean ages stratified by gender are given in Table 1. Class III male subjects had advanced mean age (23.56 ± 6.02 years) as compared to other classes of malocclusion. Our sample curve of Spee ranged from 1.40mm to 2.80mm (Table 2). The maximum value for COS was found in class II div 2 (2.80±0.41mm while minimum depth of 1.40±0.69 mm was in class I malocclusion. The second premolar cusp tip was found to be the deepest part of COS while the curve varied in depth as class II div 2 >class II div 1>class III>class I.

The statistical results for Pearson correlation revealed significant association between COS and LI-MP/S-MP and L7-MP/S-MP. The correlation between LI-MP/S-MP and COS was significant for class I (r= 0.610) and class III (r= 0.267) malocclusion groups. Also, a significant positive correlation between L7-MP/S-MP was found for class II div 1 (r = 0.19) and class II div 2 (r =0.23). The mean value for L7-MP/S-MP was 0.8 for all classes of malocclusion.
DISCUSSION

The objective of this cross-sectional study was to determine depth of COS among different classes of malocclusion and contribution of vertical eruption of anterior or posterior teeth to its development. The COS is a naturally occurring phenomenon and is routinely leveled during the first phase of comprehensive orthodontic treatment. The depth of COS varies and depends on several factors, one factor being the dental eruption pattern.

It has been found that COS is minimal in primary dentition; its depth increases in the mixed dentition with the eruption of permanent molars and incisors. Maximum depth is acquired with the eruption of second molar and remains stable throughout adolescence and adulthood. Therefore due to its stable nature in adolescence and adulthood sample was selected on the basis of full set of permanent dentition except third molars.

Different methods have been advocated by different researchers regarding its measurement. Baldridge\textsuperscript{11} used the perpendicular distances from all teeth to the occlusal plane on both sides while Sondhi et al\textsuperscript{1} employed the same method but for right side only. Bishara et al\textsuperscript{16} measured the COS as the average of the sum of the perpendicular distances to each cusp tip. Braun et al\textsuperscript{17} used the sum of right and left side maximum depth while Marshall et al\textsuperscript{7} employed the same with the difference being average of the sum of maximum depth of both sides. In our study we measured COS as advocated by Veli et al\textsuperscript{5} and Marshall et al.\textsuperscript{7}

**correlation is significant at 0.01 level (2-tailed)
results. A positive correlation was found in a study by Batham et al.\(^4\) whereas Kumar and Tamizharas\(i\)\(^5\) reported a minor influence of cranioskeletal morphology on COS. Hence patients in this study were included on the basis of dental malocclusion rather than skeletal malocclusion.

In this study the curve of Spee was deepest for class II div 2 and minimal for class I with the depth varied as class II div 2>class II div 1>class III>class I. The finding of deeper COS in class II div 2 compared to class II div 1 is consistent with the findings of Ahmed et al.\(^3\) However Veli et al.\(^6\) found class II div 1 to be greater in the depth compared to class II div 2. This difference may be attributed to difference in ethnicity and population being studied. Shanon and Nanda\(^2\) found that class II malocclusion had significantly greater COS than in class I malocclusion supporting our study.

The deepest point of the curve was consistently found to be the second premolar cusp which is similar to the findings of and Batham et al.\(^4\), Hoyama\(^7\) and Lie F.\(^8\). Our study disagree the study conducted by Veli et al.\(^6\) and Garcia\(^9\) who found mesiobuccal cusp tip of first permanent molar as the deepest point.

In this study a correlation between vertical eruption of anterior or posterior teeth and COS was evaluated. It was found that eruption of anterior teeth was positively correlated to COS in class I and Class III malocclusion with a striking correlation of 0.670 for class I. This finding is very close to 0.541 found in another study.\(^3\) Among class II malocclusion, posterior eruption of teeth was found to significant contributor to the depth of COS. Consistent with other studies, COS was found deeper in class II malocclusion.

The cross sectional design of this study has a limitation regarding development of COS which should be studied longitudinally. Moreover small sample size was used and the effect of skeletal pattern on COS was not assessed as the literature shows conflicting results.

This study provides a valuable data on depth of COS among different malocclusion classes and compares it with other studies for possible differences. It also provides an insight to contribution of vertical eruption to COS development as no data is available in this region and emphasis has been put to consider the contribution of vertical eruption of teeth to its development during diagnosis and treatment planning.

**CONCLUSION**

This study concludes its results as:

I The curve of Spee is deepest in class II div 2 malocclusion with the depth varying as: Class II div 2>Class II div 1>Class III>Class I.

II Second premolar cusp tip is the deepest point in all types of malocclusion.

III Class I and Class III malocclusion has more anterior eruption of teeth compared to other classes.

IV Posterior eruption was significant among Class II malocclusion than in other classes.

**REFERENCES**


**CONTRIBUTIONS BY AUTHORS**

1 Tayyaba Bibi: Paper writing, data collection, statistical analysis.

2 Ahsan Mahmood Shah: Topic selection, proof reading.