Original Article

Evaluation of pre and post treatment mandibular dental height related to curve of spee in class-I and class-II malocclusions

Vasanthan P[1], Jaya Shree Mohan[2], Sabitha S[3], Sathiya Jeeva Jeevakarunyam[4], Raja A[5]

[1]Research scholar, Department of Orthodontics, [2]Professor and Head, Department of Prosthodontics, Vinayaka Missions sankarachariyar Dental College, Vinayaka Missions Research foundation(Deemed to be University), Salem, Tamil Nadu, India.- 636308, [3]Professor and Head, [4]Associate Professor, Department of Dentistry, Annapoorana Medical College and Hospital Salem, Tamil Nadu, India.- 636308, [5]Professor and Head, Department of Orthodontics, KSR institute of Dental Science and Research, Thiruchengode, Tamil nadu. 637215, India

ABSTRACT:
Introduction: A flat Curve of Spee is one of the essential criteria for the treatment in orthodontics. Growth and development of orofacial structures mainly contributes for the development of the Curve of Spee. **Aim:**To evaluate the pre and post treatment depth of the curve of Spee (COS) and Mandibular Dental Height (MDH) in Class I and Class II malocclusions. The intention was to assess the contribution of MDH to the depth and flattening of the COS. **Materials and Methods:** This retrospective study consisted of 45 cases of Angle's Class I, Class II Division 1 and Class II Division 2 malocclusions with comprehensive clinical data, pre and post-treatment study models (SM) and lateral cephalograms (LC). On pre and post- treatment SM, depth of the COS was measured on both sides. Similarly, the depth of the COS was measured on LC, by proportioned MDH from incisal edge of the mandibular central incisor (I-MP), distobuccal cusp tip of the mandibular second molar (M_2-MP) and the deepest point of the COS (S-MP) to the Mandibular plane (MP). Paired t-test and correlation coefficient were calculated to analyze the depth of the COS and MDH. **Results:** On pre treatment SM, deepest value was observed in Class II Division 2 (Mean2.587 mm) than Class I (1.967mm) and Class II Division 1 malocclusion (1.467mm). The depth of the COS was almost similar on both sides (p-0.906), but the significant changes were noted between pre and post-treatment groups (p< 0.001).On pretreatment LC, anterior MDH (I-MP) was significantly contributed to depth of the COS than posterior MDH (M_2-MP). In post treatment, the leveling of depth of the COS was significantly contributed by M_2 –MP/S-MP(p<0.05). **Conclusion:** The anterior MDH caused a significant effect on the depth of the COS, but the leveling of COS was substantially contributed by M_2-MP/S-MP.
Key words: Angle's Malocclusion, Anterior and Posterior Dental Height, Depth of Curve of Spee.

Corresponding Author: Dr. Vasanthan P, Research scholar, Department of Orthodontics, Vinayaka Missions sankarachariyar Dental College, Vinayaka missions Research foundation(Deemed to be University), Salem, Tamil Nadu, India.- 636308

INTRODUCTION
A sequential planned treatment and a sound understanding of bio-mechanical principles are essential for a successful orthodontic treatment. The 'goal of orthodontic treatment' should be aimed to achieve the functional and aesthetic results that will remain stable throughout life and these goals can be achieved by targeting Andrews's six keys of occlusion.[1] One of the customary goals of orthodontic treatment is to level a curve of Spee and considered an early treatment goal in the sequence of orthodontic mechanotherapy to acieve an ideal occlusion.[2]

The curve of Spee (COS) was first described by Spee in 1890, who used skulls with abraded teeth to define a line of occlusion and he explains the 'curve of Spee' (COS) remains a naturally occurring phenomenon in the human dentition. The curve of occlusion was first described as the line on a cylinder tangent to the anterior border of the condyle, the occlusal surface of the second molar, and the incisal edges of the mandibular incisors.[3] Spee located the center of this cylinder in the midorbital plane with a

127

radius of 6.5–7.0 cm.[3,4] In an orthodontic perspective, the curve of Spee is differing substantially from original COS defined by Spee and in the prosthodontic literature.[5] Clinically, the COS refers to the occlusalplane of the mandibular dentition that runs tangent from the buccal cusp tips of the molars to the incisal edges of the incisors when viewed in the sagittal plane.[6]

In orthodontics, diverse factors contribute to the development of COS like the growth of orofacial structures, development of the neuromuscular system, and the eruption of teeth.[7] Variation in vertical eruption of teeth can contribute changes in dental height and inclination, which is mainly responsible for depth of the COS.[8,9] Therefore, the objective of this study was to investigate depth of the COS in pre and Post-treatment Class I and Class II malocclusions and to determine the contribution of anterior and/or posterior MDH.

MATERIALS AND METHODS

Data collection
This retrospective study design was carried out after institutional, ethical consent (VMSDC/IEC/Approval No.070)fromVinayaka Mission's Sankarachariyar Dental College, Salem. The samples retrieved from the Department of Orthodontics with comprehensive clinical data, pre and post-treatment SM and conventional LC between the year September 2000 and June 2016.The sample of 45 cases (21 Males ,24 Females) was selected equally from three groups according to Angle's categorization of dental malocclusions: Class I(60% Males (9/15) and 40% Females(6/15)), ClassII Division1(33.3% Males (5/15) and 66.7% Females (10/15)) and ClassII Division2 (46.7% Males(7/15)and 53.3% Females(8/15)) malocclusions.

Inclusion criteria:
- Complete clinical data with standardized pre and post-treatment SM and LC.
- Age group from 13 to 17 years.
- Completely erupted permanent dentition except third molars.

Exclusion criteria:
- Partially erupted and mixed dentition.
- Extraction cases.
- Class III malocclusion.
- Previous history of trauma and Facial asymmetry

To measure depth of the COS on lower Study Model:
Depth of the COS was measured on SM using the method advocated by Baldridge et al[11]in whichmeasurment made from the perpendicular distance of the buccal cusp tip to the sagittal reference line tangent to the incisors and second molar. (Figure:1)
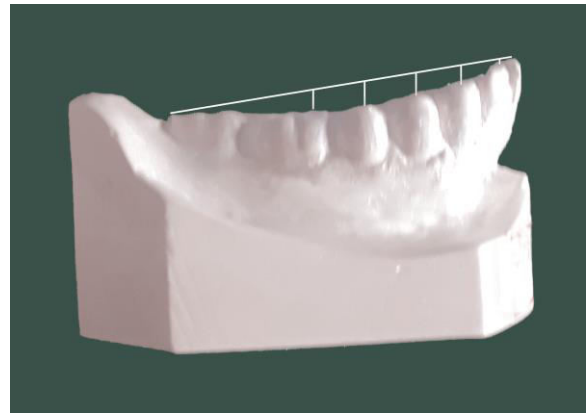
Figure 1: Measurement of depth of the Curve of Spee.

To measure MDH on Lateral Cephalogram:
All cephalograms were traced manually and the anatomical landmarks taken to measure the dental height were: the tip of the mandibular central incisor (I) and the distobuccal cusp of the second molar (M_2), the deepest point on COS (S) and the Mandibular plane (MP).The MDH was measured from the perpendicular distance of Mandibular plane (Go-Me) to incisal edge of the mandibular central incisor (I-MP), distobuccal cusp tip of the mandibular second molar (M_2-MP) and the deepest point of the COS (S-MP) (Figure: 2).

Figure 2: Measurement of Mandibular Dental Height.

Statistical analysis
Paired sample t-test was used for side comparison of depth of the COS and MDH in pre and post-treatment groups. Pearson correlation coefficient was calculated to determine the relationship between depth of the COS and I-MP,S-MP, M_2-MP in pre and post treatment groups. All statistical analysis were performed using the statistical package for social science 15.0 software and the level of significance was set as <0.005.

RESULTS

Analysis of depth of the curve of Spee on lower Study Model:

The descriptive analysis of depth of the COS for pre and post-treatment samples were presented (Table I). Depth of the COS was expressed diversely in all pretreatment groups as follows: deeper in Class II Division 2 (right side 2.587mm and left side 2.433mm) than Class I (right side 1.967mm and left side 2 mm) and Class II Division 1(right side 1.467 mm and left side 1.533mm) with a maximum depth of 4.0 mm in Class I malocclusion. The deepest point of the COS falls on second premolar in Class I malocclusion and first molar in Class II Division1 and Class II Division2. In post- treatment SM, the COS is nearly flat with mild depth was noted in Class 1 (right side 0.800 and left side 0.800), Class II division 1(right side 0.867 and left side 0.700) and Class II division 2 (right side 0.540 and left side 0.647), Paired t-test for pre and post-treatment depth of the COS revealed that significant alterations ensured in all teeth (p<0.005) except incisor position in Class II Division 1(P Value- 0.093) and

Division 2(Pvalue-0.508) malocclusions. It also showed, no significant differences in depth of the COS between right and left side in all malocclusion groups (Table II).

Analysis of MDH on Lateral Cephalogram

The descriptive analysis and pearson correlation coefficient were calculated among depth of the COS and MDH. The result indicated I-MP significantly contributed for depth of the COS than M2-MP in all pre treatment groups.Pearson correlation showed a significant positive relationship between I-MP/S-MP,I-MP/M_2-MP and M_2-MP/S-MP in all pre and Post treatment groups(p<0.005). but negative correlation was found between depth of COS and I-MP, S-MP, M_2–MP in all pre and post treatment groups.

Paired sample t test was calculated for pre and post treatment MDH in all groups (Table III). The result observed that statistically significant differences in S-MP, M_2-MP (P<0.001) between pre and post treatment groups. Whereas, I-MP (p > 0.08) showed not significant changes in all groups.

Table I: Comparision of Pre and Post treatment depth of the curve of Spee measured on study model.

Pre and post treatment comparision of measured Tooth	Side	ClassI Malocclusion					Class II Division 1Malocclusion					Class II Division 2Malocclusion				
		MD	SD	SE	t	p	MD	SD	SE	t	p	MD	SD	SE	t	p
Incisor	Right	0.280	0.452	0.116	2.398	0.031*	0.240	0.515	0.133	1.804	0.093	0.053	0.304	0.078	0.679	0.506
	left	0.300	0.527	0.136		2.201 0.045*	0.206	0.395	0.102	2.024	0.062	-0.033	0.228	0.059	- 0.564	0.582
Canine	Right	0.700	0.727	0.187	3.729	0.002*	0.366	0.639	0.165	2.219	0.044*	0.573	0.404	0.104	5.491	0.000*
	Left	0.686	0.644	0.166	4.126	0.001*	0.466	0.611	0.157	2.956	0.010*	0.880	0.510	0.131	6.680	0.000*
First Premolar	Right	0.853	0.870	0.224	3.799	0.002*	0.866	0.549	0.142	6.104	0.000*	1.364	0.715	0.191	7.136	0.000*
	Left	0.840	0.840	0.217	3.870	0.002*	0.746	0.716	0.184	4.039	0.001*	1.173	0.735	0.189	6.180	0.000*
Second Premolar	Right	1.240	0.866	0.223	5.541	0.000*	0.653	1.043	0.269	2.425	0.029*	1.553	0.769	0.198	7.815	0.000*
	Left	1.453	0.969	0.250	5.806	0.000*	0.793	0.791	0.204	3.882	0.002*	1.780	0.728	0.188	9.467	0.000*
First Molar	Right	1.073	0.734	0.189	5.661	0.000*	0.600	1.038	0.268	2.238	0.042*	2.053	0.886	0.228	8.973	0.000*
	Left	1.200	1.065	0.275	4.361	0.001*	0.833	0.698	0.180	4.620	0.00*	1.786	0.825	0.213	8.384	0.000*

MD: Mean Difference, SD: Standard Deviation, SE: Standard Error, t: t-value, p: p-value, * p<0.05

Table II: Right and Left side comparision of depth of the curve of Spee measured on study model.

Group of malocclusions		Mean		Standard Deviation		Standard Error	t-value	p-value
		Right	Left	Right	Left			
Class I Malocclusion	Pretreatment Post treatment	2.153 1.033	2.133 0.900	1.043 0.611	0.895 0.507	0.166 0.103	0.12 1.29	0.906 0.217
Class II Division 1 Malocclusion	Pretreatment Post –treatment	1.633 1.033	1.667 0.933	0.667 0.480	0.587 0.320	0.059 0.121	-0.564 0.823	0.582 0.424
Class II Division 2 Malocclusion	Pretreatment Post –treatment	2.713 0.760	2.860 0.860	0.789 0.266	0.643 0.308	0.071 0.047	-2.067 -2.092	0.058 0.055

p<0.05

Table III: Pre and Post treatment Dental Height Changes

Malocclusion	Dental height	Mean	MD	SD	t-value	p-value
Class I Malocclusion	I-MP Pretreatment I-MP Post-treatment	42.000 42.067	0.066	1.265	-0.204	0.841
	S-MP Pretreatment S-MP- Post-treatment	32.033 33.533	-1.500	0.886	-6.554	0.000*
	M2-MP Pretreatment M2-MP Post-treatment	32.467 33.900	-1.433	0.942	-5.891	0.000*
Class II Division 1 Malocclusion	I-MP Pretreatment I-MP Post-treatment	44.667 45.000	-0.333	1.397	-0.924	0.371
	S-MP Pretreatment S-MP Post-treatment	34.533 36.867	-2.333	0.816	-11.068	0.000*
	M2-MP Pretreatment M2-MP Post-treatment	34.333 35.533	-1.200	1.373	-3.384	0.004*
Class II Division 2 Malocclusion	I-MP Pretreatment I-MP Post-treatment	46.633 46.467	0.166	1.096	0.589	0.565
	S-MP Pretreatment S-MP-Post-treatment	35.667 37.900	-2.233	0.798	-10.828	0.000*
	M2-MP Pretreatment M2-MP Post-treatment	35.467 37.067	-1.600	1.183	-5.237	0.000*

MD: Mean Difference; SD: Standard Deviation Difference ;*p<0.05

DISCUSSION

Leveling a deep COS is an essential criterion to establish proper biomechanical function, muscular balance, occlusal force resistance and maintain functional movement of the mandible. Flat COS is one of the major Andrew's six keys to normal occlusion and this is a challenging task for the long-term stability and success of orthodontic treatment. To date, sparse publications have investigated the relationship of depth of the COS and MDH. Hence, in this study, we aimed to evaluate the relationship between depth of the COS, MDH quantitatively in class I, class II Division 1 and Class II Division 2 malocclusions. Plethora of studies stated that the lack of sex dimorphism was not significantly related with COS, hence the study subjects were not categorized based on the gender.[8,12,13] Angle's Class III malocclusion was excluded from the study, with a determined data in the literature with a flat COS.[12] A study inference suggested the COS was stable in both the adolescence and adult groups, even though our study groups were restricted to adolescence group with criteria of all completely erupted permanent teeth except third molars and non-extraction cases.[8,13,14] The COS was influenced by craniofacial morphology to a lesser extent[7], therefore, our samples were based primarily on dental malocclusions and any form of facial asymmetry was excluded.

In the pre treatment SM evaluation, the deepest point of the COS was noted mainly at the mesiobuccal cusp of the mandibular first molar in Class II Division 1and ClassII Division 2 malocclusion. There are several reports in the literature also accordance with the deepest point at mandibular first molar.[8,15,16] On the other hand, it also falls on the second premolar in Class I malocclusion and these outcomes also par with Koyoma et al [18]

In literature, it was stated that differential sequence of eruption of permanent teeth or deciduous second molar in a flush terminal plane or the maxillary deciduous second molars with small distolingual cusps allow unopposed mandibular permanent first molar and incisors to erupt beyond the occlusal plane. This unopposed eruption anticipated to be even more exaggerated and producing deepest COS in a class II malocclusion.[8,12,15,17,19,21] The study results also consistent with the maximum depth of the COS in the Class II Division 2, tracked by Class II Division 1 and Class I malocclusions. On another hand, it controverts with Braun and Schmidt et al [20], they stated that Class I and Class II malocclusions possess the similar depth of the COS.

Veli et al [8] and Haq AU [15] found that depth of the COS was nearly same on both right and left side mandibular arch in all malocclusions, in the same way, the result observed in the study indicated no significant differences in depth of the COS.

Remarkably, in this study, anterior MDH(I-MP) offered a greater contribution for depth of the COS than posterior MDH (M$_2$-MP) in all malocclusion groups, but studies by Veli et al [8] and Haq AU et al [14] revealed that posterior MDH contribution was significant than anterior MDH. However, in our post-treatment groups, posterior MDH (M$_2$-MP/S-MP) contribution is more significant for flattening of the COS than anterior MDH (I-MP/S-MP). This might due to the combination of dental changes occurred; proclination with minimal extrusion in Class II Division 2, retraction with minimal intrusion in Class I

and Class II Division 1 malocclusions in post-treatment groups.

The study inferences suggested that anterior MDH showed greater contribution for depth of the COS than posterior MDH, but the leveling of COS was occurred predominantly by extrusion of mandibular premolars and molars with minimal changes in anterior MDH.

LIMITATIONS:

This study has few limitations with conventional methods of measuring data and sample size. The study carried out with conventional methods from SM and LC to assess pre and post treatment depth of the COS and MDH. Further studies with digitalized method would be beneficial to minimize the error of measuring data. The pattern of growth and its influence on COS are subjected to asses in further study.

CONCLUSION:

In pretreatment, the depth of the COS was greater in class II Division 2 followed by class II Division 1 and class I malocclusions and nearly similar on both right and left sides in all selected group of malocclusions. Anterior MDH contribution is greater for depth of the COS than Posterior MDH in all groups, but the leveling of the COS mainly influenced by posterior MDH.

REFERENCES

1. Andrews LF. The six keys to normal occlusion. Am J Orthod 1972 Sep; 62(3):296-309.
2. Proffit WR, Fields HW, Sarver DM. Contemporary orthodontics. 4th ed. St. Louis, Mo.: Mosby Elsevier; 2007.
3. Spee FG. The gliding path of the mandible along the skull. J AM Dent Assoc 1980;100:670-5
4. Hitchcock HP. The curve of Spee in Stone Age man. Am J Orthod 1983; 84:248-53.
5. SushmaDhiman. Curve of Spee –from orthodontic Perspective. Indian Journal of Dentistry 2015 Dec: Vol 6(4):199-202.
6. FuadLutfAlmotareb. Curve OfSpee in Orthodontics. ISOR Journal of Dental and Medical Science.2017;16(5):76-79.
7. Kumar KP, Tamizharasi S. Significance of curve of Spee: An Orthodontic Review. J Pharm BioalliedSci 2012; Aug;4(Suppl 2): S323-S328.
8. Veli I, Ozturk, MA, Uysal T. Curve of spee and its relationship to vertical eruption of teeth among different malocclusion groups. Am J OrthodDentofacialOrthop. 2015 Mar; 147(3):305-12.
9. Nita Kumari, MubassarFida, AttiyaShaikh.Explorarion of variations in positions of upper and lower incisors,overjet, overbite, and irregularity index in orthodontic patients with dissimilar depths of curve of Spee. J Ayub Med Coll Abbottabad. 2016;28(4): 766-772.
10. Tweed CH. The Frankfort-mandibular plane angle in orthodontic diagnosis, classification, treatment planning, and prognosis. Am J Orthod Oral Surg. 1946; 32:175–230.
11. Balridge DW. Levelling the curve of Spee: Its effect on mandibular arch length. JPO J PractOrthod 1969; 3:26-41.
12. Ahmed I, Nazir R, Gul-e-Erum, Ahsan T. Influence of malocclusion on the depth of curve of spee. J Pak Med Assoc. 2011 Nov; 61(11):1056-9.
13. Carter GA, McNamara JA Jr. longitudinal dental arch changes in adults. AM J OrthodDentofacialOrthop 1998; 114:88-99.
14. Bishara SE, Jakobsen JR, Treder JE, Stasi MJ. Changes in maxillary and Mandibular tooth size-arch length relationship from early adolescence to early childhood. A longitudinal study. Am J OrthodDentofacialOrthop. 1989; 95:46-59.
15. Haq AU, Azeem M. Correlation between curve of Spee and vertical eruption of anterior or posterior teeth in Class II Division I. Pak Oral Dent J. 2015; 35(4):610-4.
16. Garcia R.levelling the curve of spee: a new prediction formula. J Tweed Found 1984; 13:65-72.
17. Marshall SD, Caspersen M, Hardinger RR, Franciscus RG, Aquilino SA, Southard TE. Develoment of the curve of spee. Am J OrthodDentofacialOrthop 2008; 134:344-52.
18. Koyama T. A comparative analysis of the curve of spee (Lateral aspects) before and after orthodontic treatment-with particular reference to overbite patients. J Nihon UnivSch Dent 1979;21:25-34.
19. Shannon KR, Nanda R. Changes in the curve of spee with treatment and at 2 years post treatment. Am J Orthod Dentofacial Orthop 2004; 125:589-96.
20. Braun ML, Schmidt WG. A Cephalometric appraisalof the curve of Spee in Class I and Class II Division 1 occlusion for malesans females. Am j Orthod 1956;42:255-78.
21. Nardone J. levelling ofthe curve of spee [thesis]. Toronto, Ontario, Canada:University of Toronto;2012.

131