ORIGINAL RESEARCH PAPER

Orthodontics

KEY WORDS: Growth pattern, Curve of spee, Vertical eruption of the mandibular teeth, Effective mandibular length, Mandibular base length.

CURVE OF SPEE AND ITS RELATIONSHIP TO VERTICAL ERUPTION OF TEETH AMONG DIFFERENT GROWTH PATTERN

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ABSTRACT

Curve of Spee is a naturally occurring phenomenon in the human dentition. This normal occlusal curvature required for an efficient masticatory system. It has been suggested that an imbalance between the anterior and posterior components of occlusal force may result in supraeruption of lower incisors, infra-eruption of premolars, and mesial inclination of lower molars. 1.To assess the factors influencing the depth of the COS among different skeletal growth pattern. 2.To access the effective mandibular length and mandibular base length in different skeletal growth pattern. 3.Compare factors influencing the depth of COS with effective mandibular length and base length in different skeletal growth pattern.This retrospective cross-sectional study was done using Pretreatment lateral cephalograms and dental model of 60 patients. All the lateral cephalograms were traced digitally on NEMOCEPH software and COS was measured on casts with digital caliper. Statistical analysis was performed. **Results:** Revealed that the cusp tip of the second premolar was the deepest part of the COS in all groups, COS is deeper in Horizontal growth pattern. And results showed a positive correlation between linear measurements from L7, L6, L5, L4, L3, and L1 to the mandibular plane to COS in both vertical and average growth patterns. Conversely, in the horizontal growth pattern, this correlation was negative. Mandibular basal length and Mandibular effective length did not show statistical significance mean differences among the vertical, average, and horizontal growth patterns. **Conclusions:** The depth of the COS was greatest in the Horizontal grower followed by Average and vertical. The depth of COSwas influenced by Growth pattern and vertical eruption of teeth. The height of mandibular second premolar, Mandibular base length, effective base length significant decrease with increase in the depth of COS.

INTRODUCTION

Curve of Spee is a naturally occurring phenomenon in the human dentition. This normal occlusal curvature required for an efficient masticatory system. Orthodontists eventually deal with the COS in virtually every patient they treat. Curve of Spee (COS) is defined as the line on a cylinder which is tangent to incisal edges of lower anterior, occlusal surface of lower second molar and anterior border of condyle.

Several theories have been proposed to elucidate the occurrence of COS in natural dentition. It has been suggested that an imbalance between the anterior and posterior components of occlusal force may result in supraeruption of lower incisors, infra-eruption of premolars, and mesial inclination of lower molars. Addressing this altered condition demands specialized skills from practitioners. A comprehensive understanding of the development and timing of COS is essential for effective treatment planning. The growth of orofacial structures, the eruption of different teeth, and the development of the neuromuscular system significantly influence the alignment of occlusion and the curvature of Spee. Additionally, the mandibular sagittal and vertical positions in relation to the cranium also impact the COS. Furthermore, variations in facial patterns among humans contribute to the diversity in the curvature of Spee.

It is widely accepted that vertical growth pattern patients have relatively weak mandibular muscles compared with horizontal growth pattern, it is still not known whether the strength of the mandibular muscles determines craniofacial morphology or vice versa. Bite-force differences between horizontal growth pattern and vertical growth pattern subjects have been claimed to be related to the strength or the mechanical advantage of the mandibular muscles.

Exaggerated COS alters muscle balance, ultimately leading to improper functional occlusion. Levelling of COS is considered ideal goal of treatment in malocclusions. which is done by anterior intrusion, posterior extrusion, or a combination of the two.

The growth pattern is influenced genetically, environmental. These have long been considered as vital factors in determining the success or failure of orthodontic treatment. The influence of craniofacial morphology on the COS has been systematically investigated in very few studies and with conflicting findings. So, the purposes of this study were to determine the depth of the COS in different growth pattern and to investigate the relationship of the depth of the COS with the vertical eruption of anterior and posterior teeth, aiming to contribute to the knowledge about the development of the COS.

Objectives Of The Study

1. To evaluate the skeletal growth pattern using lateral cephalogram.
2. To evaluate the curve of spee using mandibular study model.
3. To evaluate the correlation between different growth pattern and curve of spee.
4. To evaluate the correlation between the effect of vertical position of lower teeth, mandibular basal length and mandibular effective length on Curve of spee in different growth pattern.

MATERIAL AND METHODS

This was retrospective study consisting of pre-treatment lateral Cephalograms and dental casts of 60 patients reported to department of orthodontics and dentofacial orthopaedics. Subjects age ranged between (18-25) years. The cephalometric radiographs were taken using standard procedure. A single investigator performed the cephalometric tracings on NEMOCEPH. High quality orthodontic impressions for diagnostic casts were taken.

Inclusion Criteria:

1. Age range - 18-25 years.
2. Patients who have all their teeth erupted except for 3rd molar.
3. Mild crowding cases were acceptable.

Exclusion Criteria:

1. Congenitally missing or extracted permanent teeth.
2. History of any congenital facial defects and facial surgery.
3. Patients with severe attrition.
4. Patients with anterior or lateral crossbite.

Based on FMA Angle (TWEED ANALYSIS) 60 subjects, were divided into 3 groups 20 Vertical, 20 Average and 20

Horizontal growth patterns will be included in the study.

Group A:- Vertical Growth Pattern – V.G.P (>30 degree)
Group B:- Average Growth Pattern – A.V.P (20-30 degree)
Group C:- Horizontal Growth Pattern- H.G.P (<20 degree)

The following measurements were taken on the Lateral cephalogram (Figure 1)

SI. No.	Measurements	
01	L7-MP	Linear measurement from Lower 2nd molar to mandibular plane
02	L6-MP	Linear measurement from Lower 1st molar to mandibular plane
03	L5-MP	Linear measurement from Lower 2nd Premolar to mandibular plane
04	L4-MP	Linear measurement from Lower 1st Premolar to mandibular plane
05	L3-MP	Linear measurement from Lower canine to mandibular plane
06	L1-MP	Linear measurement from Lower incisor to mandibular plane
07	FMA	Lower border of the mandible to Frankfort horizontal plane
08	Go-Pog	Linear measurement point Gonion to point Pogonion
09	Co-Gn	Linear measurement point Condylion to point Gnathion
10	Po-Or	Horizontal line from Porion to Orbitale

Measurement Of The Curve Of Spee:-
The depth of curve of Spee was measured by measuring the perpendicular distance between the deepest cusp tip of premolar and a flat plane that was placed 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 will be made on the right and left side of the arch and the mean value of these two measurements was used as the depth of curve of Spee. (Right side + Left side)/2. The depth of curve of Spee was measured with digital caliper (Figure 2). For intra-examiner variability, five pair of radiographs were traced again by same examiner.

Statistical Analysis:
1. The data was analyzed using SPSS for Windows, version 26.0; IBM, Armonk, NY.
2. The data was checked for Normality using Kolmogorov Smirnov and Shapiro Wilk tests.
3. Paired t-test was used to assess the variables such as L7, L6, L5, L4, L3, L1, Mandibular Basal Length, Mandibular effective length, Curve of Spee, and FMA.
4. Pearson correlation coefficients were calculated to explore linear associations among skeletal growth patterns (GROUP) and the depth of the COS (COS), as well as other variables like Age and Gender.
5. Linear multiple regression analysis, using the enter method, was conducted to assess the contribution of individual variables (L7, L6, L5, L4, L3, L1, Go-Pog, Co-Gn , FMA) to the depth of the COS.

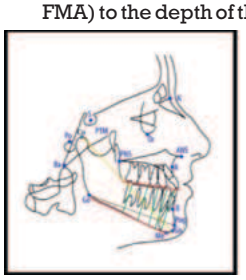
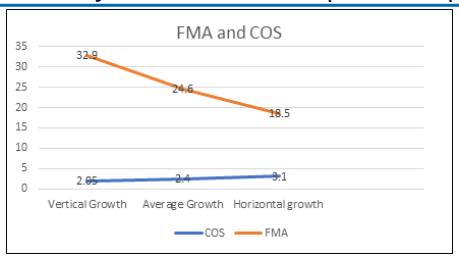


Figure 1: Centro graphic Measurements.
Figure 2: Measurement of curve of spee with digital caliper

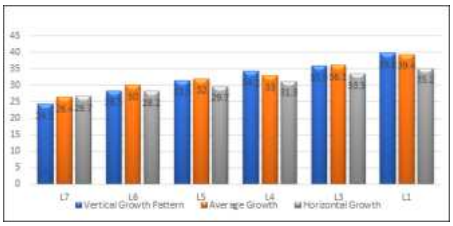
RESULTS

Table 1:- Multiple Comparisons Of Cephalometric Measurements For Curve Of Spee Across Growth Patterns For Dental Linear Measurements Using Bonferroni Correction

Parameters	(I) GROUP	(J) GROUP	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Curve of Spee	V.G.P	A.G. P	-.3500	.21985	.351	-.8923	.1923
		H.G. P	-1.0500*	.21985	.000	-1.5923	-.5077
	A.G. P	V.G. P	.3500	.21985	.351	-.1923	.8923
		H.G. P	-.7000*	.21985	.007	-1.2423	-.1577
	H.G. P	V.G. P	1.0500*	.21985	.000	.5077	1.5923
		A.G. P	.7000*	.21985	.007	.1577	1.2423
L7-MP	V.G.P	A.G. P	-2.0130	.90592	.091	-4.2476	.2216
		H.G. P	-2.3785*	.90592	.033	[illegible]	[illegible]
	A.G. P	V.G. P	2.0130	.90592	.091	-.2216	4.2476
		H.G. P	-.3655	.90592	1.000	-2.6001	1.8691
	H.G. P	V.G. P	2.3785*	.90592	.033	.1439	4.6131
		A.G. P	.3655	.90592	1.000	-1.8691	2.6001
L6-MP	V.G.P	A.G. P	-1.6415	0.893	0.073	-3.4501	0.1661
		H.G. P	0.1365	0.965	0.888	-1.8178	2.0908
	A.G. P	V.G. P	1.6420	0.893	0.0738	-0.1661	3.4501
		H.G. P	1.7785	0.972	0.0751	-0.1889	3.7459
	H.G. P	V.G. P	-0.1365	0.965	0.888	-2.0908	1.8178
		A.G. P	-1.7785	0.972	0.0751	-3.7459	0.1889
L5-MP	V.G.P	A.G. P	-0.5165	0.979	0.6009	-2.4987	1.4657
		H.G. P	1.8010	1.027	0.0004	-0.2781	3.8801
	A.G. P	V.G.P	-3.8975	0.993	0.0876	-5.9081	-1.8868
		H.G. P	2.3175	0.937	0.0180	0.4208	4.2141
	H.G. P	V.G. P	-1.8010	1.027	0.0876	-3.8801	0.2781
		A.G. P	-2.3175	0.937	0.0180	-4.2141	-0.4208
L4-MP	V.G.P	A.G. P	0.3145	1.097	0.2867	-1.9060	2.5350
		H.G. P	2.8235	1.187	0.0225	0.4203	5.2266
	A.G. P	V.G. P	-0.3145	1.097	0.7759	-2.5350	1.9060
		H.G. P	2.5090	0.979	0.0145	0.5273	4.4906
	H.G. P	V.G. P	-2.8235	1.187	0.0225	-5.2266	-0.4203
		A.G. P	-2.5090	0.979	0.0145	4.4906	-0.5273
L3-MP	V.G.P	A.G. P	-0.1625	1.165	0.8898	-2.5201	2.1951
		H.G. P	2.3910	1.107	0.0372	0.1492	4.6327
	A.G. P	V.G.P	0.1625	1.165	0.8898	-2.1951	2.5201
		H.G. P	2.5535	1.180	0.0368	0.1655	4.9414
	H.G. P	V.G.P	-2.3910	1.107	0.0372	-4.6327	-0.1492
		A.G. P	-2.5535	1.180	0.0368	-4.9414	-0.1655
L1-MP	V.G.P	A.G. P	.4635	1.2245	1.000	-2.5570	3.4840
		H.G. P	4.6540*	1.2245	.001	1.6335	7.6745
	A.G. P	V.G. P	-.4635	1.2245	1.000	-3.4840	2.5570
		H.G. P	4.1905*	1.2245	.003	1.1700	7.2110
	H.G. P	V.G. P	-4.6540*	1.2245	.001	-7.6745	-1.6335
		A.G. P	-4.1905*	1.2245	.003	-7.2110	-1.1700
Mandibular Basal Length	V.G.P	A.G. P	-3.2235	1.8498	.260	-7.7865	1.3395
		H.G. P	-3.3740	1.8498	.220	-7.9370	1.1890
	A.G. P	V.G. P	3.2235	1.8498	.260	-1.3395	7.7865
		H.G. P	-.1505	1.8498	1.000	-4.7135	4.4125
	H.G. P	V.G. P	3.3740	1.8498	.220	-1.1890	7.9370
		A.G. P	.1505	1.8498	1.000	-4.4125	4.7135
Mandibular Effective Length	V.G.P	A.G. P	-1.0715	2.5691	1.000	-7.4088	5.2658
		H.G. P	2.8430	2.5691	.819	-3.4943	9.1803
	A.G. P	V.G. P	1.0715	2.5691	1.000	-5.2658	7.4088
		H.G. P	3.9145	2.5691	.399	-2.4228	10.2518
	H.G. P	V.G. P	-2.8430	2.5691	.819	-9.1803	3.4943
		A.G. P	-3.9145	2.5691	.399	-10.2518	2.4228



Graph 1: - Correlation between FMA to COS



Graph 2: - Mean distance comparison from L7, L6, L5, L4, L3, L1 to Mandibular plane in vertical, average and horizontal growth pattern

DISCUSSION

The COS 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. The morphologic arrangement of the teeth in the sagittal plane has been related to the slope of the articular eminence, the incisal vertical overlap, the molar cusp height, and the amount of posterior contact.

The growth of orofacial structures, the eruption of teeth, and the development of the neuromuscular system significantly influence the alignment of occlusion and the curvature of Spee. Additionally, the mandibular sagittal and vertical positions in relation to the cranium also impact the COS. Furthermore, variations in facial patterns among humans contribute to the diversity in the curvature of Spee. However, understanding why and how the COS develops is limited. In this study, we aimed to evaluate the depth of the COS in terms of vertical eruption of the anterior and posterior teeth quantitatively and to determine whether depth of the COS is affected by vertical eruption of the anterior or posterior teeth. It has been suggested that the depth of the COS is stable throughout adolescence and into adulthood. Because of this, adolescents and young adults with all teeth present except third molars were included in the study. Clinically, the COS is determined by the distal marginal ridges of the most posterior teeth in the arch and the incisal edges of the central incisors.20 However, some authors do not include the incisors in the depth measurements because super erupted incisors result in a greater depth of the curve obtained than when excluding the incisors. Hence, to determine the anterior vertical eruption on depth of the COS, rational measurements were performed among the different malocclusion groups in this study.

In our study, depth of the COS was greatest in the horizontal, followed by average, vertical growth pattern with the least amount of depth. However, the depth did not differ significantly between average and vertical growth pattern. Similarly, depth of the COS had no significant differences between horizontal and vertical growth pattern. A differential eruption sequence of the maxillary and mandibular teeth alone or accompanied by the deciduous second molars in aflush terminal plane or the maxillary deciduous second molars with small distolingual cusps could result in an unopposed mandibular permanent first molar and incisor eruption beyond the mandibular occlusal plane. 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. Consistent with literature, the COS is deeper in those with horizontal growth pattern.

L7 -MP , L5-MP and L1-MP to COS in different growth pattern : The present study showed statistically significant and positive correlation between L7 -MP , L5-MP and L1-MP to COS in different growth pattern . It may be due to differential vertical eruption. This is in accordance with previous study which also found a statistically significant and positive correlation of COS an L7 to MP distance.

L7-MP, L5-MP and L1-MP The mean values were found to be increased with increase in curve of Spee depth. Similar findings were also reported by Shannon and Nanda and Lie F who suggested that deepening of curve of Spee can occur as the axial inclination of the teeth increases. Osborn also showed similar findings and related forward tilting of molars to the inclination of masseter muscle thus increasing crush-shear ratio, also supported by Hemley and Thompson and Strang.

L6-MP, L4-MP, L3-MP to COS in different growth pattern: did not show statistical difference in any of the growth pattern.

Mandibular Basal Length

The mandibular basal length was measured from Go-Pog. The mean distance from Go-Pog was 67.22mm in group A, 70.44mm in group B and 70.57mm in Group C. The study shows no statistical difference in any of the growth pattern. Similar results were obtained by the study done by Bernstein RL et al.

Mandibular Effective Length

The effective mandibular length was measured from Condylion to Gnathion. The mean distance from Co-Gn is 99.38mm in group A, 100.90mm in group B and 96.99mm in group C. The study found no statistically significant mean differences among the vertical, average, and horizontal growth patterns. This was in accordance to the study by Mangla R et al. which had found no statistically significant difference in vertical, average, and horizontal growth pattern.

Limitation

The cross-sectional design of our study caused a limitation. Further studies with a longitudinal follow-up would be beneficial to better understand the development of the COS. Moreover, the relationships between the COS and the vertical eruption of teeth were determined on conventional lateral cephalograms. The errors in using intersection of points in case of double images and the 2-dimensional characteristics of conventional lateral cephalograms were other tomography.

CONCLUSION

1. The curve of Spee was influenced by the growth pattern, with the curve of spee being most pronounced in individuals with a horizontal growth pattern, followed by average and vertical growth pattern.
2. The analysis showed that the vertical position of teeth L7, L5, and L1 influenced the curve of Spee. An increase in the distance from L7/L1 to the mandibular plane (L7-MP) corresponded to an increase in the curve of Spee. Conversely, as the distance from L5 to the mandibular plane (L5-MP) decreased, the depth of the curve of Spee increased.
3. Mandibular basal length and effective mandibular length did not show any influence on the curve of spee.

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