

Association of Curve of Spee with Vertical Skeletal Patterns



Saad Abdul Rehman¹

BDS

Sadia Rizwan²

BDS, FCPS

Syed Shah Faisal³

BDS, FCPS

Syed Sheeraz Hussain⁴

BDS, DCPS, MCPS, FCPS

OBJECTIVE: To find the mean curve spee depth and association in three different skeletal vertical patterns (Hypodivergent, Normodivergent and Hyperdivergent).

METHODOLOGY: Orthodontic models of mandibular arch and Lateral cephalogram of 110 patients with the mean age of 17.16±4 years, 26.4% (N=29) males and 73.6% (N=81) females were taken from the patients who visited for the orthodontic treatment, to the Department of Orthodontics of Karachi Medical and Dental College. Skeletal divergence defined by the mandibular plane (Lower border of mandible) to sella-nasion line angle (SN-MP). It was measured on lateral cephalogram and Curve of spee depth measured on mandibular cast.

RESULTS: Out of 110 patients 20.9% (N= 23) were hypodivergent, 29.1% (N=32) were normodivergent and 50% (N=55) were hyperdivergent. The curve of spee among these three groups were 3.39±0.30mm, 2.62±0.23mm and 2.02±0.45mm. One-way ANOVA has been applied and it showed highly significant differences in the value of curve of spee depth among three vertical skeletal patterns with the p-value of 0.000. Moving from Hypodivergent to Hyperdivergent cases, the curve of Spee depth reduces.

CONCLUSION: It has been found that there is a significant difference in curve of spee among hypodivergent, normodivergent and hyperdivergent patients.

KEYWORDS: Dentistry, Curve of Spee, Vertical Skeletal Patterns, Orthodontic Diagnosis.

HOW TO CITE: Rehman SA, Rizwan S, Faisal SS, Hussain SS. Association of curve of spee with vertical skeletal patterns. J Pak Dent Assoc 2020;29(4):254-258.

DOI: <https://doi.org/10.25301/JPDA.294.254>

Received: 16 August 2020, *Accepted:* 04 September 2020

INTRODUCTION

Curvature of occlusion from lateral view is a natural phenomenon in the dentition. In 1890, a researcher named Spee found it in human's dentition, identified and drawn a line of occlusion which was termed as curve of spee. He utilized skulls with rubbed teeth to characterize this line.¹ It is an assumed or visionary line, which is drawn and passes through the posterior teeth's buccal cusp tips, follows the plane of occlusion. In the maxillary arch, usually this curve is convex and concave in the mandibular dentition.²

It is impossible to treat orthodontic cases without proper diagnosis and it requires multiple records in the form of extra oral pictures, intraoral pictures, radiographs which include Lateral cephalogram and panoramic radiograph and

dental casts. Usually curve of spee is reduced and insignificant in the deciduous dentition, it increments to most extreme depth when second molar erupts in the oral cavity and come into the occlusion. Afterward it remained moderately stable till late youth and early adulthood.⁴The arrangement of the teeth along this line, connected to a few anatomical and useful components: joint tendency, overjet, molar cusp, and the quality and quantity of contacts.⁵

Andrew suggested that this curve should be flat to slightly bended. According to him it is one of the principle characteristic of normal occlusion. He also said that, there is always an expected propensity for this curve to exaggerate and deepen as time passes, and the reason behind it is that the mandible grows more and faster than the maxilla which causes the mandibular anterior dentition to be bound by the upper lip and anterior dentition.³ It leads to increase upward and backward forces, resulting in increased curve of spee and deepen the bite. It has been observed that those patients who has short face, will have exaggerated curve of spee depth.

Flattening or over correction of this curve is one of the

1. FCPS II Resident, Department of Orthodontics, Karachi Medical and Dental College.

2. Assistant Professor, Department of Orthodontics, Dow University of Health Sciences.

3. Professor, Department of Orthodontics, Karachi Medical and Dental College.

4. Principal College of Dentistry, Professor & HOD Department of Orthodontics, Karachi Medical & Dental College.

Corresponding author: "Dr. Saad Abdul Rehman" <saadmemon_786@hotmail.com>

key objective in the treatment. Now a days, it is a very common practice to level and flatten this curve at the end of treatment. Few researches have been published regarding this curve, which evaluated the factors and conditions associated with increased curve of spee.⁶

There are multiple factors which effect this curve including dental and skeletal factors, especially vertical axis of the skeletal factors effect this curve.⁷

The cephalometric analysis helps to evaluate the face, cranium, cranial base, maxilla, mandible, dentition and alveolar process of maxilla and mandible in horizontal as well as vertical axis. The vertical relationship of these structures is as important as the horizontal and transverse relationships because it effects the treatment plan as well as the stability of the treatment.⁸

Vertical facial pattern of a face can be determined by number of linear and angular measurements. One of the important variable which is used to measure the pattern of facial divergence and vertical skeletal pattern is SNMP angle. It is usually formed by taking two horizontal lines which intersect each other to make an angle, those are SN line (Sella-Nasion) and Mandibular plane.⁹ On the basis of this angle, vertical skeletal pattern divided in to Hyperdivergent, Normodivergent and Hypodivergent cases. High angle case presents with hyperdivergent facial type, low angle case present with hypodivergent case and normal angle case present with normodivergent facial type.¹⁰

The key objectives of the study were to determine the curve spee depth in three different skeletal vertical patterns (Hypodivergent, Normodivergent and Hyperdivergent) and find out their association. As curve of spee correction is one of the goal of orthodontic treatment, this study will provide information regarding variation in curve of spee depth in different facial divergences which will definitely help orthodontists in treatment planning.

METHODOLOGY

Non Probability Consecutive method was used for sampling. By using WHO sample size calculator, taking statistics of curve of spee as 2.4052 ± 0.679 mm in margin of error 0.2, the calculated sample size should be atleast 45.²⁰ Lateral cephalogram and Orthodontic models of mandibular arch of 110 patients with the mean age of 17.16 ± 4 years, 26.4% (N=29) males with the mean age of 17.94 ± 4.19 years and 73.6% (N=81) females with the mean age of 16.88 ± 3.94 years, were obtained from the patient which had been visited to the Orthodontic's Department. The ethical approval was obtained from the the institute (065/19).

The participants met the following criteria:

Inclusion criteria includes male and female patients,

patients with second molars erupted. Exclusion criteria include individuals having missing or impacted permanent canines/any teeth other than 3rd molars , any tooth anomaly of number, size, form and position as confirmed on clinical examination, having history of previous orthodontic treatment, any known systemic disease, history of facial trauma, cleft lip and Palate and history of surgical procedure of jaws. All the patients were examined by the researchers. Skeletal divergence defined by the mandibular plane (Lower border of mandible) to sella-nasion line angle (SN-MP). It was measured on lateral cephalogram (Fig I) and subjects were categorized.

Fig I: SN-MP Angle measurement on lateral cephalogram

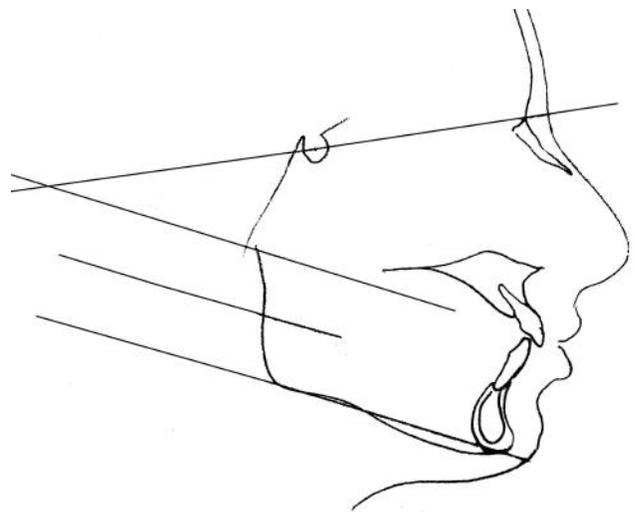


Fig II: Measurement of depth of curve on mandibular cast



1. Hyperdivergent: If candidate having SNMP angle above 36 degree
2. Hypodivergent: If candidate having SNMP angle below 28 degree

3. Normodivergent: If candidate having SNMP angle between 28 to 36 degree

The depth of curve of Spee has been measured in such a way that a 6 inches stainless steel scale was placed on the occlusal surface of the dental cast of lower jaw which was making a tangent to the disto-buccal cusp tip of second molar to the incisal edges of the central incisors (Fig.II). It has been measured with the help of digital Vernier caliper. The measurements of right and left sides were noted and their mean was calculated.

STATISTICAL ANALYSIS

IBM SPSS Statistics 20th version used to analyze the data. Shapiro-Wilk's test (p-value >0.05) showed that the curve of spee values were normally distributed for both males and females. The statistical analyses involved calculation of means and standard deviations of quantitative variables like age, curve of spee and frequencies & percentages of qualitative variables like sex and groups of vertical skeletal patterns / facial divergence. Intra-Class Correlation Coefficient has been used to check level of agreement between the measured and re-measured values by a researcher. One Way ANOVA test has been used to fulfill the objective.

RESULTS

The mean value of average depth curve of spee among all the patients was 2.48±0.65mm, the mean value of average depth of curve of spee in male patients was 2.48±0.55mm and in female it was nearly same as in male, 2.48±0.68mm. Out of 110 patients 20.9% (N= 23) were hypodivergent, 29.1% (N=32) were normodivergent and 50% (N=55) were hyperdivergent. The mean values of average depth of curve of spee among these three groups were 3.39±0.30mm, 2.62±0.23mm and 2.02±0.45mm (Table I). One-way ANOVA has been applied and it showed highly significant differences

Table I: Mean values of average depth of curve of spee among three different groups

Facial Divergences	Mean & Std. Deviation	N (%)	f-value	p-value
Hypodivergent	3.39±0.30	23 (20.9%)		
Normodivergent	2.62±0.23	32 (29.1%)	114.242	0.000
Hyperdivergent	2.02±0.45	55 (50%)		
Total	2.48±0.65	110 (100%)		

in the values of curve of spee depth in different vertical skeletal patterns with the p-value of 0.000. Moving from

Table II: Difference between the groups

Facial Divergences		p-value	95% Confidence Interval
Hypodivergent	Normodivergent	0.000	0.5206 – 0.9997
	Hyperdivergent	0.000	1.1457 – 1.5810
Normodivergent	Hypodivergent	0.000	-0.9997 – -0.5206
	Hyperdivergent	0.000	0.4084 – 0.7981
Hyperdivergent	Hypodivergent	0.000	-1.5810 – -1.1457
	Normodivergent	0.000	-0.7981 – -0.4084

*The mean difference is significant at the 0.05 level.

Hypodivergent to Hyperdivergent cases, the curve of Spee depth reduces.

DISCUSSION

The assessment of the association of curve of Spee depth with the vertical skeletal variables was needed to study which leads to the alteration and deviation in the depth of the curve. It has been proven in the literature that the antero-posterior and vertical position of the mandible are co-related to the curve of Spee depth in lower jaw. All the above mentioned variables are directly related to the treatment planning in orthodontics as well as treatment stability. Position and inclination of lower incisors are related to the curve of spee and vertical skeletal patterns of the subjects.¹¹

Cheon et al conducted a study and found that there curve of Spee depth in lower jaw failed to show sexual dimorphism. He also found the significant correlation coefficients between curve of Spee depth in lower jaw and facial angle that is an indicator of mandible's position in sagittal dimension which also effects the vertical facial patterns.¹²

Farella et al¹³ found that there is a significant influence of anterior and posterior facial height ratio on the depth of Spee's curve in lower jaw and this ratio plays a vital role in the vertical skeletal facial patterns. In this study, it has been established that the curve is relatively exaggerated in low angles (Hypodivergent) subjects as compare to the high angle (Hyperdivergent). The finding of lack of sexual dimorphism in curve of spee depth is in agreement with our findings. A possible reason and justification for the change in that curve among different facial divergent cases can be attributed to the occlusal forces exerted by the subjects, with the hypodivergent subjects exhibit comparatively higher occlusal forces.^{14,15}

Patient with the increased SNMP values tend to have less over bite as compare to those with the reduced SNMP value. Batham et al¹⁶ studied that the subjects with deep bite had exaggerated curve of spee depth in the lower arch and reason behind it can be that when anterior teeth does not

have vertical stop which leads to the continued eruption. The continued eruption causes the anterior aspect of the curve to deepen. Open bite cases usually associated with hyperdivergent skeletal pattern and deepbite cases usually come up with hypodivergent skeletal pattern. More or less same findings were observed by Trauten et al¹⁷ which showed that this curve is minimal in cases with open bite or open bite tendency and exaggerated in subjects with increased over bite. Trauten concluded that a reduced curve of Spee seen in the hyper divergent subjects and exaggerated depth was observed in hypodivergent subjects. The results of Trauten and Batham were also supported by multiple studies done by Nanda, Shannon and Orthlieb that worked on the same variables as we did in this study.^{7,18}

Furthermore Kumari et al¹⁹ found a negative correlation between the SNMP value and curve of Spee in lower arch, supporting our study in other way that cases with increased SNMP angle will have reduced curve of spee.

One more study has been done by Halimi et al⁵ and its results were not in favor with our study. They conducted study on 90 patients which were divided into three groups as Hypodivergent, Normodivergent, and Hyperdivergent that there is no significant difference in the curve of Spee among these groups.

The target population of the present study was Orthodontic Patients, therefore, it is not easy to extrapolate the results on the general population. It is highly recommended that further studies should be done with broad and large number of sample size with non-orthodontic cases so it becomes easy to apply the results on general population and other variables must be used for the diagnosis of skeletal pattern like FHMP (Frankfort Horizontal Mandibular Plane Angle) and y-axis angle.

CONCLUSION

There was a significant difference in the depth of curve of spee among hypodivergent, normodivergent and hyperdivergent patients.

CONFLICT OF INTEREST

None declared

REFERENCES

1. Sayar G, Oktay H. Assessment of curve of Spee in different malocclusions. *Eur Oral Res.* 2018;52:127. <https://doi.org/10.26650/eor.2018.475>
2. Marshall SD, Kruger K, Franciscus RG, Southard TE. Development of the mandibular curve of Spee and maxillary compensating curve: A finite element model. *PloS one.* 2019;14(5). <https://doi.org/10.1371/journal.pone.0221137>
3. Andrews LF. The six keys to normal occlusion. *Am J Orthod.* 1972;62:296-309. [https://doi.org/10.1016/S0002-9416\(72\)90268-0](https://doi.org/10.1016/S0002-9416(72)90268-0)
4. Al-Amiri HJ, Al-Dabagh DJ. Evaluation of the relationship between curve of Spee and dentofacial morphology in different skeletal patterns. *J Baghdad Coll Dentis.* 2015;325(2218):1-1. <https://doi.org/10.12816/0015282>
5. Halimi A, Benyahia H, Azeroual MF, Bahije L, Zaoui F. Relationships between facial divergence and DMD parameters. *International orthodontics.* 2017;15:698-707. <https://doi.org/10.1016/j.ortho.2017.09.017>
6. Nazruddin N, Tan YY. Evaluation of the Depth of the Curve of Spee, Overjet, and Overbite in Class I, Class II, and Class III Malocclusion Among Patients at University of North Sumatera Dental Hospital. In 11th International Dentis Sci Meet (IDSM 2017) 2018 May. Atlantis Press. <https://doi.org/10.2991/idsm-17.2018.27>
7. Orthlieb JD. The curve of Spee: understanding the sagittal organization of mandibular teeth. *Cranio* 1997; 15: 333-340. <https://doi.org/10.1080/08869634.1997.11746028>
8. Livas C, Delli K, Spijkervet FKL, Vissink A, Dijkstra PU. Concurrent validity and reliability of cephalometric analysis using smartphone apps and computer software. *Angle Orthod.* 2019;89:6:889-96 <https://doi.org/10.2319/021919-124.1>
9. Khan WA, Faisal SS, Hussain SS. Correlation of Craniofacial Measurements between Cephalometric Radiographs and Facial Photographs. *Annals Abbasi Shaheed Hosp Kar Medi Dent Coll.* 2018;23:37-45.
10. Kakadiya JK, Kambalyal P, Singla M, Jingar J, Vishnoi P. Comparison of Incisor, Molar & Lower Anterior Facial Divergence in Hypodivergent, Hyperdivergent And Normodivergent Patient: A Study Modeland Cephalometric Study. *Dent J Advan Stud.* 2016;4:104-12. <https://doi.org/10.1055/s-0038-1672054>
11. Laird MF, Holton NE, Scott JE, Franciscus RG, Marshall SD, Southard TE. Spatial determinants of the mandibular curve of Spee in modern and archaic Homo. *Am J Phys Anthropol.* 2016;161: 226-36. <https://doi.org/10.1002/ajpa.23020>
12. Cheon SH, Park YH, Paik KS, Ahn SJ, Hayashi K, Yi WJ, Lee SP. Relationship between the curve of Spee and dentofacial morphology evaluated with a 3-dimensional reconstruction method in Korean adults. *Am J Orthodont Dentofac Orthopedics.* 2008;133:640-e7. <https://doi.org/10.1016/j.ajodo.2007.11.020>
13. Rozzi M, Mucedero M, Pezzuto C, Cozza P. Leveling the curve of Spee with continuous archwire appliances in different vertical

- skeletal patterns: A retrospective study. *Am J Orthodont Dentofac Orthopedics*. 2017;151:758-66.
<https://doi.org/10.1016/j.ajodo.2016.09.023>
14. Proffit WR, Fields HW, Nixon WL. Occlusal forces in normal and long-face adults. *J Dent Res* 1981; 62: 566-571.
<https://doi.org/10.1177/00220345830620051201>
15. Amjad N, Mahmood A, Masood RT, Nazir R. COMPARISON OF INCISORS INCLINATION IN HYPERDIVERGENT AND HYPODIVERGENT PATIENTS. *Pak Oral Dent J*. 2019;39:125-8.
16. Batham PR, Tandon P, Sharma VP, Singh A. Curve of Spee and its relationship with dentoskeletal morphology. *J Indian Orthodontol Soci*. 2013;47:128-34.
<https://doi.org/10.1177/0974909820130303>
17. Trouten JC, Enlow DH, Rabine M, Phelps AE, Swedlon D. Morphologic factors in openbite and deepbite. *Angle Orthodont* 1983;53:192-211.
18. Shannon KR, Nanda R. Changes in the curve of Spee with treatment and at years post-treatment. *Am J Orthodontofacial Orthop* 2004;125:589-96.
<https://doi.org/10.1016/j.ajodo.2003.09.027>
19. Kumari N, Fida M, Shaikh A. Exploration 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*. 2016;28:7 66-72.
20. Imai H, Yakushiji M, Shintani S. Longitudinal observation of the changes of the consecutive curve of the incisal edge, tip and cusp tip from deciduous and permanent dentition-Comparison between normal and crowded dental arch. *Pediatric Pediatr Dent* 2010;20:130-51.
[https://doi.org/10.1016/S0917-2394\(10\)70205-6](https://doi.org/10.1016/S0917-2394(10)70205-6)
-