Content available at: https://www.ipinnovative.com/open-access-journals

IP Annals of Prosthodontics and Restorative Dentistry

Journal homepage: https://www.aprd.in/

Original Research Article

Study of the relationship between the spee curve and the height of the internal arch of the foot arch

Dabo Papa Sidy[1]*, Sow Massaer Malick[1], Bouassalo Komlan Mawabah[2], Thioune Néné[1], Mbodj El Hadj Babacar[1], Djérédou Benjamin[3]

[1]Institut d'Odontologie et de Stomatologie-FMPOS-Université Cheikh Anta Diop-Dakar, Sénégal
[2]Département d'odontologie-stomatologie-FSS- Université de Lomé, Togo
[3]UFR Odontostomatologie-Université Félix Houphouët Boigny-Abidjan, Côte d'Ivoire

Abstract

Introduction: The curve of Spee constitutes one of the parameters of a balanced and sustainable occlusion which is part of a more global framework of postural balance. The objective of this work was to study the relationship between the parameters of the curve of Spee and the height of the inner arch of the plantar arch.
Materials and Methods: This was a cross-sectional descriptive study with analytical aim carried out at the Institute of Odontology and Stomatology of Cheikh Anta Diop University from November 2023 to October 2024. The study population consisted of students. The cephalometric determination of the radius of the curve of Spee and the arrows was carried out with the imaging software of Carestream Dental CS 9600.To determine the medial arch height, a caliper was used to determine the highest point along the soft tissue margin medial to the plantar curvature curve. This point was marked and measured.
Results: The mean radius of the SPEE curve was 99.65±3.9 mm. The mean right foot arch height (PHVD) of the study subjects was 29.9±4.4 mm; that of the left foot arch (HVPG) was 29.23±4.4 mm.The correlation coefficient between RCS-HVPD was 0.62; that between RCS-HVPG was 0.52.
Conclusion: As part of occluso-prosthetic rehabilitations, as well as postural balancing, the curve of Spee and the internal arch of the plantar vault should be integrated into therapeutic strategies for aesthetic and functional sustainability.

Keywords: Curve of Spee, Internal arch, Arch relationship

Received: 15-05-2025; **Accepted** 13-06-2025; **Available Online**: 20-06-2025

1. Introduction

The curve of Spee was first described by Ferdinand Graf Von Spee in 1890 as the sagittal curve of occlusion connecting the buccal cusps of the mandibular canine, premolars, molars and the tangent to the anterior border of the condyle.[1] The literature identifies the curve of Spee as the result of the interaction between the growth of orofacial structures, dental eruption and the development of the neuromuscular system.[2] Anatomically, the curve of Spee is dependent on the location of the occlusal plane in relation to the hinge axis but also on the sagittal inclination of the cuspid teeth which influence its depth.[3,4] The curve of Spee is one of the parameters of a balanced and sustainable occlusion. This balance is part of a more global framework of postural balance. Since the posture is cephalocaudal, the foot adapts to descending imbalances.[5] Several studies have focused on the relationship between occlusion and the sole of the foot.[6-8] To our knowledge, no study has addressed the relationship between the curve of Spee and the plantar arch despite their great geometric and evolutionary similarity.

The objective of this work was to study the relationship between the parameters of the Spee curve and the height of the inner arch of the plantar arch.

2. Materials and Methods

This was a cross-sectional descriptive study with analytical aims carried out at the Institute of Odontology and

*Corresponding author: Dabo Papa Sidy
Email: papasidydabo@gmail.com

https://doi.org/10.18231/j.aprd.2025.031

Stomatology of Cheikh Anta Diop University from November 2023 to October 2024. The study population consisted of students. The study included melanoderm subjects with complete permanent dentition, with or without the 3rd molar, free from carious lesions, without occlusal restorations, who had not undergone previous orthodontic treatment.

The cephalometric determination of the radius of the curve of Spee was inspired by the geometric method proposed by Orthlieb 9 with the imaging software of Carestream Dental CS 9600 (**Figure 1**). This method consisted of identifying the hinge axis (geometric center of the condyle) and the lower incisal point, followed by tracing the major axis of the posterior pillar (MAP) on the last permanent molar (C7 or C8). On the MAP, the posterior occlusal contact point (POC) was identified, followed by tracing the COP-hinge axis and COP-lower incisal point segments. From these two segments, two mediators were drawn and intersected at a point. This point of intersection was the center of a circle that passed through the three points previously identified (hinge axis, COP and lower incisal point). The radius of the curve of Spee was then immediately measured. The depth of the curve was defined by the arrow (F). This was the distance measured from the point in the middle of the chord (arch length) from which a perpendicular was lowered to the occlusal dental point (**Figure 2**). The deflections at all molars were measured (F6, F7, F8).To determine the height of the medial arch of the foot, a caliper was used to determine the highest point along the soft tissue margin medial to the plantar curvature curve. This point was marked and measured (**Figure 3**).The data were analyzed using R 4.2.2 statistical software. A descriptive analysis of sociological variables was performed. Quantitative variables such as the radius, the arrow of the curve of Spee and the height of the internal arch of the foot arch were described in mean/standard deviation or median/interquartile range with determination of maxima and minima. The Student t test was used to compare means. The Pearson test and linear regression were used to determine the nature of the relationships between the variables of the curve of Spee and those of the internal arch of the foot arch. The significance threshold was 0.05.

3. Results

The sample consisted of 109 individuals, including 80 men (73.34%) and 29 women (26.66%), giving a sex ratio of 2.76. The mean age was 22.4±4 years with a minimum of 18 years and a maximum of 26 years. The mean radius of the SPEE curve was 99.65±3.9 mm (**Table 1**). The mean deflection of F6 was 1.75±1.09 mm, that of F7 was 2.43±1.34 and 3.3±1.67 for F8 (**Table 1**). The mean height of the internal arch of the right plantar vault (HVPD) of the study subjects was 29.9±4.4 mm; that of the left plantar vault (HVPG) was 29.23±4.4 mm (**Table 1**). Individuals with a right foot strike were 103 while those with a left foot strike were 6. The right foot arch height was 31mm in men and 27.36mm in women with $p < 0.05$.The correlation coefficient between F6-HVPD was -0.172, that between F7-HVPD was -0.12 and -0.22 for F8-HVPD. The correlation coefficient between F6-HVPG was -0.01; that between F7-HVPG was -0.02 and -0.13 for F8-HVPG. The correlation coefficient between RCS-HVPD was 0.62; that between RCS-HVPG was 0.52 (**Table 2**).

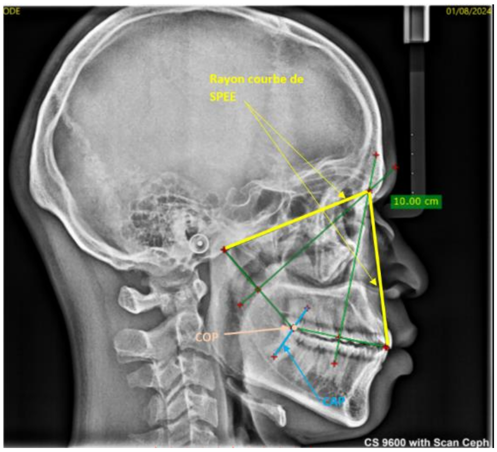

Figure 1: Determination of the radius of the curve of Spee

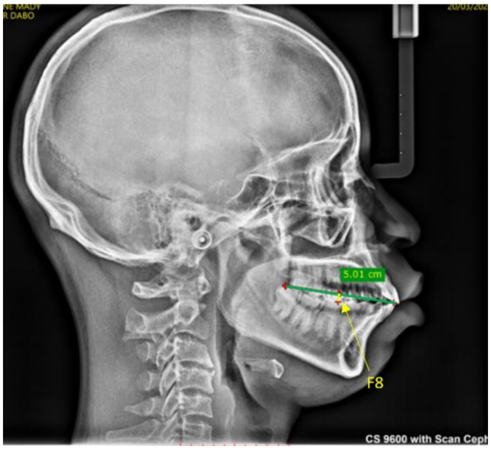

Figure 2: Determination of the deflection at the 3rd molar

Figure 3: Measurement of the depth

Table 1: Characteristics of the curve of Spee and the internal arch of the plantar vault

Variables	Terms and conditions	Minima	Median	Average	Standard deviation	Maxima	p-value
Curved ray of Spee	RCS (mm)	90.1	99.30	99.65	3.9	109	
Curved arrows of Spee	F6 (mm)	00	1.8	1.75	1.09	4.8	< 0.01*
	F7 (mm)	00	2.7	2.43	1.34	5.3	< 0.01**
	F8 (mm)	00	3.1	3.3	1.67	7.3	< 0.01***
Height of the inner arch of the foot	HVPD (mm)	17.8	29.7	29.9	4.4	39.9	<0.05
	HVPG (mm)	16	29.7	29.23	4.4	39.8	

Table 2: Correlation between the characteristics of the curve of Spee and the internal arch of the right and left plantar vault

Correlations	*r*	*p*
F6- HVPD	-0.175	0.06
F7- HVPD	-0.12	0.18
F8- HVPD	-0.22	<0.05
F6- HVPG	-0.01	0.9
F7- HVPG	-0.02	0.8
F8- HVPG	-0.13	0.16
RCS- HVPD	0.62	< 0.05
RCS- HVPG	0.52	< 0.05

4. Discussion

The measurements were carried out by two calibrated people with a coefficient of concordance greater than 0.81.There was a positive correlation between the radius of the curve of Spee and the height of the medial arch of the left and right foot, with a statistically significant difference. The radius of the curve of Spee and the height of the medial arch increased in the same direction. This biomechanical regulation was consistent with the work of Valentino et al.[10,11] This work had shown that the transformation of a normal foot into a flat foot leads to hyperactivity of the elevator muscles. The author concluded that there was a relationship between the plantar arch and the occlusal plane. Variations in the occlusal plane could be a consequence of the evolution of the curve because they share the same topography and are all sagittal data of a geometric nature. Regulation of this hyperactivity could involve compensation, with less excessive contacts between the maxillary and mandibular occlusal tables. This would be possible thanks to a reduction in the radius of the curve of Spee. These results corroborate the work of Greenbergs et al. according to which the foot adapts the modifications that come from the head.[12] A negative correlation between deflections and arch heights was found with a significant difference between F8 and HVPD. These results would suggest that deflections increased inversely with the height of the internal arch of the foot. These results could consolidate this logic of compensation. Angle class II and III malocclusions tended to follow Ballard skeletal classes II and III more, with an influence on brachy and dolichocephalic typologies. These typologies seem to influence the characteristics of the curve of Spee even if this was not always the case in our work. Angle class II and III malocclusions which lead to a modification of the Clarke angle of the foot which is closely linked to the height of the arch.[13] Angle class malocclusion was correlated with scaphoid height of the foot, which could have an impact on the arch height.[14] The strong correlation between F8 and HVPD could be explained by the fact that it was the supporting foot of almost all individuals and the height of its internal arch was higher than on the left. Indeed, the lateral teleradiography records the mandible on the left side, there seems to be a contralateral compensation between the occlusion on the left side and the plantar arch on the right side. This observation corroborates the results of Aishwarya et al.[15] An experimental asymmetric malocclusion produces early changes in plantar pressure that in the long term could influence the geometry of the internal arch of the vault, evidence of compensatory mechanisms induced by a secondary postural imbalance.[16] The radius of the curve of Spee was greater in men as was the height of the plantar vault. This could be explained firstly by the masticatory activity of men being greater, which would lead to wear followed by a flattening of the occlusal tables and secondly, by the fact that physical activity would maintain the musculo-ligamentous complex of the palatal vault which would allow to maintain a more stable frame shape.

5. Conclusion

Our study showed that there appears to be a positive correlation between the radius of the curve of Spee and the height of the internal arch of the right and left foot. This correlation was negative between the arrows of the curves of Spee and the heights of the internal arches. Similarly, this study showed a difference between the sexes regarding the measured parameters of the curve of Spee and the heights of the internal arches of the foot. The radius of the curve of Spee should therefore be a reality in the context of postural balance. In the context of occluso-prosthetic rehabilitations as well as postural equilibration, the curve of Spee and the internal arch of the foot should be integrated into therapeutic strategies for aesthetic and functional sustainability.

6. Conflict of Interest

None.

7. Source of Funding

None.

References

1. Spee FG. Die Verschiebungsbahn des Unterkiefers am Schädel. *Arch Anat Entwicklungsgeschichte*. 1890;285–94.
2. Marshall SD, Caspersen M, Hardinger RR, Franciscus RG, Aquilino SA, Southard TE. Development of the curve of Spee. *Am J Orthod Dentofacial Orthop*. 2008;134(3):344–52.
3. Djérédou KB, N'dindin AC, N'dindin-Guinan BA, Acoupo ME, Assi KD, Djaha K. Evolution of the distance between the occlusal plane and the hinge axis and depth of the SPEE curve during the different stages of dentition in African melanoderm subjects: biomechanical considerations and occluso-prosthetic interest. *Rev Col Odonto-Stomatol Afr Chir Maxillo-Fac*. 2003;10(2):24–30.
4. Djérédou KB, N'dindin AC, Konaté NY, Kouamé RS, Touré S. Study of the influence of the inclination of the mandibular molars on the depth of the SPEE curve in the African melanoderm subject. *Rev Col Odonto-Stomatol Afr Chir Maxillo-Fac*. 2006;13(3):28–34.
5. Greenberg MS. Mandibular position and upper body strength. *J Am Dent Assoc*. 1981;103(4):576–9
6. Baldini A, Nota A, Tripodi D, Longoni S, Cozza P. Evaluation of the correlation between dental occlusion and posture using a force platform. *Clinics*. 2013;68(1):45–9.
7. Cuccia AM. Interrelationships between dental occlusion and plantar arch. *J Bodywork Mov Ther*. 2011;15(2):242–50
8. Maurer C, Holzgrevea F, Erbe C, Wankea EM, Koppc S, Groneberga DA, et al. Influence of dental occlusion conditions on plantar pressure distribution during standing and walking – A gender perspective. *Med Eng Phys*. 2021;88:47–5
9. Orthlieb J D. Interest of the SPEE curve in the search for an occlusal plane in fixed prosthesis. 3rd cycle thesis for the doctorate in odontological sciences. Marseille, March 1983
10. Valentino B, Fabozzo A, Melito F. The functional relationship between the occlusal plane and the plantar arches. An EMG study. *Surg Radiol Anat*. 1991;13(3):171–4
11. Valentino B, Melito F, Aldi T, Valentino T. Correlation between interdental occlusal plane and plantar arches. An EMG study. *Bull Group Int Search Sci Stomatol Odontol*. 2002;44(1):10–13.
12. Greenberg MS. Mandibular position and upper body strength. *J Am Dent Assoc*. 1981;103(4):576–9
13. Rodríguez AM, Morales AN, Parga ER, Manzanares MTL, Suárez AL, Nogueron GG. Relationship between foot posture and dental malocclusions in children aged 6 to 9 years. *Medicine (Baltimor)*. 2018;97(19):e0701.
14. Domínguez MEC, Reyes AD, Carrasco MP, Belloso AJP, Jiménez MC, González AFG. Dental Malocclusion and Its Relation to the Podal System. *Front Pediatr*. 2021;9:1–8.
15. Aishwarya D, Shwetha KP, Prafulla T. An observational analysis to evaluate the influence of occlusion on body posture and plantar pressure – An in vivo study. *J Indian Prosthodont Soc*. 2024;24(3):273–8.
16. Iacob SM, Chisnoiu AM, Buduru SD, Berar A, Fluerasu MI, Iacob I, et al. Plantar Pressure Variations Induced by Experimental Malocclusion. A Pilot Case Series Study. *Healthcare*. 2021;9(5):599

Cite this article: Sidy DP, Malick SM, Mawabah BK, Néné T, Babacar MEH, Benjamin D. Study of the relationship between the spee curve and the height of the internal arch of the foot arch. *IP Ann Prosthodont Restor Dent*. 2025;11(2):163-166