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Original Research

Post-retention Development of Curve of Spee in Pre-adjusted Edgewise Appliance Cases, Its Correlation to Dentoskeletal Parameters: An *In vitro* Study

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***Abstract*:**

Background: Curve of Spee was first described by Ferdin and Graf Von Spee in 1890. The curve of Spee is an important characteristic of the mandibular dental arch. One of the most frequently encountered problems in the treatment of orthodontic patients is an excessive overbite. Deep bite has been found to be associated with abnormal mandibular function. Temporomandibular joint disorders also have potentially detrimental effects on mandibular development. Andrews advocated leveling the curve of Spee to a flat curve, in order to facilitate construction of an optimal occlusion and that a flat plane should be given as a form of over treatment. There is no reliable information currently available from the literature about the long-term stability of the curve of Spee and the factors influencing the same. The objective of this study was to assess the post-retention development of the curve of Spee and to evaluate the dental and skeletal parameters as predictors of its post-retention stability**.**

Materials and Methods: Pre-treatment (Tl), post-treatment (T2) and post-retention (T3) dental casts and lateral cephalograms of 24 orthodontically treated patients having a mean age of 14.5 years were evaluated. The mean period of the study group after retention was up to 2.6 years (range = 1-5 years). Pre-treatment T1, post-treatment T2, and post-retention T3 casts and radiographs were measured. The data were tabulated and statistically analyzed.

Results: A highly significant positive correlation was observed between the changes in the curve of Spee during treatment (T2-T1) and the net result after retention (T3-T2). This means that much of the treatment results remained stable at T3. However, slight change was noticed in curve of Spee's depth during the time interval T3-T2. This finding was very negligible and was not statistically significant.

Conclusion: The leveling of the curve of Spee during the treatment is a stable treatment objective on long term basis. There was a mild correlation existing between the curve of Spee and the different dental and skeletal parameters.

Key Words: Curve of Spee, deep bite, dental parameters, stability, skeletal parameters

Introduction

Curve of Spee, an important feature of the mandibular dental arch, was first described by Ferdinand Graf Von Spee in 1890. It was derived by studying skills with abraded teeth to define a line of occlusion that lies on a cylinder tangential to the condyle's anterior border, second molar's occlusal surface, and the incisal edges of mandibular incisors.[1,2] The significance of this curve has been investigated by a number of researchers. Ferdinand Graf Von Spee himself suggested that this curve was the most efficient model enabling the teeth to remain in contact during the forward and backward gliding of the mandible while chewing. To establish proper incisal relationships and occlusion in excursive movements, the curve must be relatively mild.[3] Andrews observed that as the growth of the lower jaw is sometimes faster in downward and forward direction and continues longer than that of the upper jaw; there is natural tendency for the curve of Spee to deepen with time. This results in crowded lower anterior teeth as they are forced back and up, or a deeper curve of Spee and a deeper overbite. These findings suggested that the curve of Spee might be related to the inclination and position of the upper and lower incisors, lower arch crowding, overbite and overjet. Thus, the determination of this relationship may be useful to evaluate the feasibility of leveling the curve of Spee by orthodontic treatment.[4]

Literature review shows that there is no reliable information currently available as to which shape of the curve leads to greater stability. Minimal long-term data exist on the stability of the correction of the depth and shape of the curve of Spee and factors influencing it.

Therefore, the present study was conducted to evaluate the post-retention development of the curve of Spee and to assess the dental and skeletal parameters as predictors of its post-retention stability.

Materials and Methods

Collection of materials

Pre-treatment (Tl), post-treatment (T2) and post-retention (T3) dental casts and lateral cephalograms of 24 orthodontically treated patients having a mean age of 14.5 years, with minimum age being 11 years and a maximum being 26 years were evaluated at Department of Orthodontics and Dentofacial Orthopedics, Bapuji Dental College and Hospital, Davangere. The mean period of the study group after retention was up to 2.6 years (range = 1-5 years).

Materials used in the study

Pre-treatment, post-treatment, and post-retention dental casts and lateral cephalograms of orthodontically treated patients. Laptop used in the study (COMPAQ AMD ATHLON X2, WINDOWS VISTA) with Adobe Photoshop CS2-9.0 (Adobe Photoshop windows vista 7, Adobe Systems Co) version installed. Acetate tracing paper of 0.003 inch thickness 0.3 mm lead pencil. Digital camera: Nikon-Coolpix LS, (Optical Zoom 5×, 7.2 Megapixels). A standardized photographic setup was used.

Method of collection of data

Plaster casts were used to make the measurements before starting the treatment (Tl), after completing the orthodontic therapy (T2), and after 2 years (mean) post-retention (T3). To photographically record the right side of Tl, T2, and T3, we made use of a digital camera mounted on a standardized photographic setup; 25 cm was the object to camera distance (Figure 1).

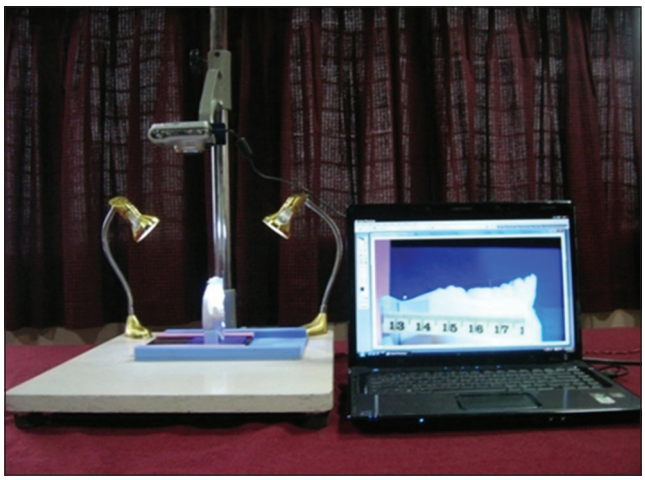

Figure 1: A standardized photographic set up used to capture the right side of the lower cast and connected to the laptop to measure the curve of Spee using Adobe Photoshop CS2-Version 9.

The photographs were analyzed using Adobe Photoshop CS2-9.0 version software to determine the steepness of the curve of Spee in pre-treatment, post–treatment, and post-retention casts.[5,6]

On each of the photo present on the right side of the lower cast, an orientation line was made from the incisal edge of central incisor up to the distal cusp tip of the last erupted the molar. Perpendicular line was drawn from this reference line to the mesiobuccal cusp of the first molar, which gives the depth of the curve of Spee. Pre-treatment, post-treatment, and post-retention radiographs were traced[7] (Figure 2).

Each cephalogram was taken with the patient's teeth in habitual occlusion and lips at rest position. Cephalograms were taken in the same machine in order to maintain the standardization.[8] Profile cephalograms were taken in occlusion under standardized conditions with a cephalostat. Various angular and linear parameters of different cephalometric analysis were employed in this study (Figure 3).

The various hard tissue landmarks included skeletal parameters

Subspinale (Point A), supramentale (Point B), gonion (Go), menton (Me), nasion (N): Sella (S): Anterior nasal spine

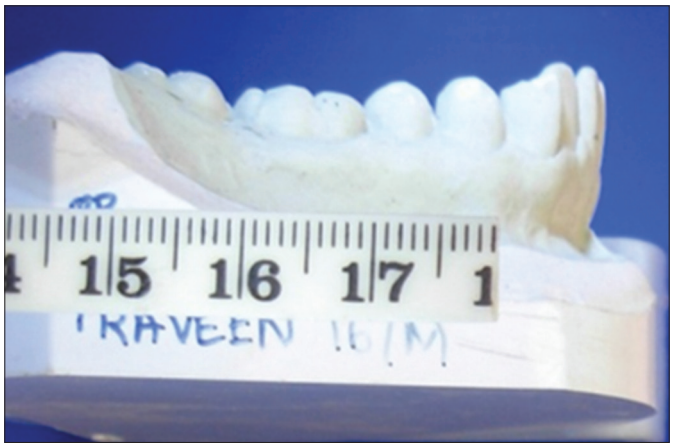

Figure 2: A standardized photographic set up used to capture the right side of the lower cast.

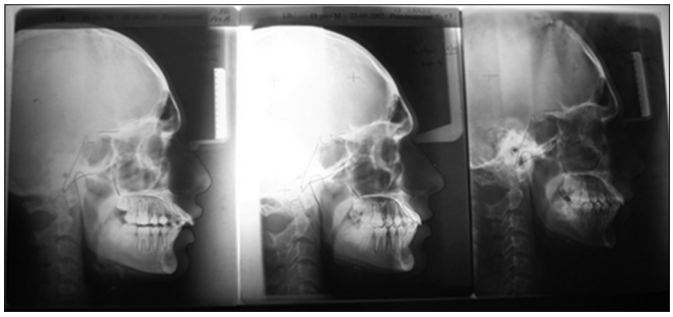

Figure 3: Pre-treatment, post-treatment, and post-retention cephalograms.

(ANS), posterior nasal spine. ANB angle. The WITS appraisal. PPMP - angle between the palatal plane and the mandibular plane. Lower anterior facial height - distance between ANS and Menton.[9] Basal plane angle (palatal plane to the mandibular plane) mandibular incisor position (Figure 4).

Dental parameters - Lower central incisor to line NB (mm), lower incisor to line NB (degree), over jet (mm), overbite (mm) (Figure 5).

All patients' pre-treatment, post–treatment, and post-retention cephalograms were hand traced on acetate paper and measured by the same person. Linear and angular parameters were used in the study.

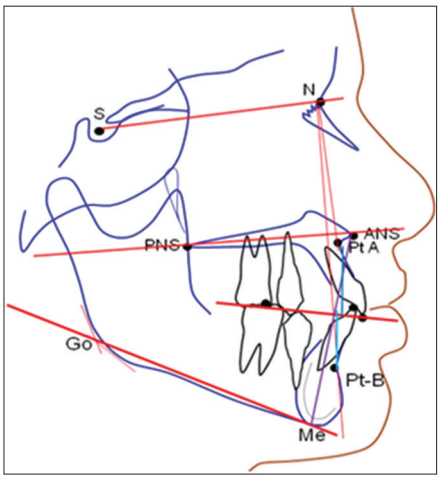

Figure 4: Skeletal parameters.

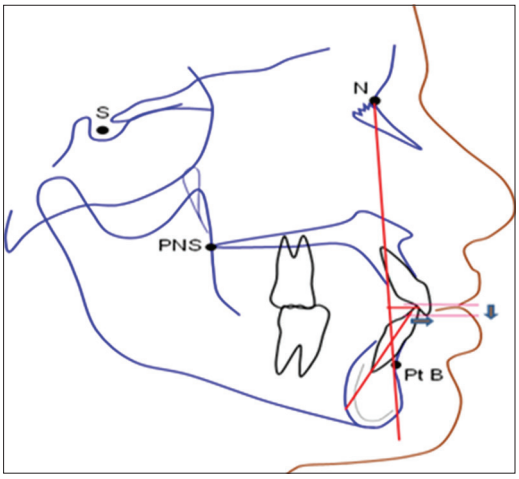

Figure 5: Dental parameters.

Statistical analysis

Paired *t*-test was used to compare the skeletal and dental parameters (comparison between pre-treatment T1, post-treatment T2, and post-retention T3 values). The Pearson's correlation coefficient was used to correlate the differences in the curve of Spee from T2-T1 and T3-T1 and also to correlate the changes in the different skeletal and dental parameters with the curve of Spee at T2-T1 and T3-T1. Linear measurements were in millimeters, and angular measurements were in degrees.[10]

Results

Evaluation of long-term stability of the curve of Spee

The descriptive statistics for changes in the curve of Spee during treatment (T2-T1) and its effect at T3 (T3-T1) are summarized in the Table 1.

The mean value difference for changes in the curve of Spee during the treatment (T2-T1) was −1.31 mm ($P < 0.01$) which was significant, and the mean value for the changes after the completion of the orthodontic treatment (T3-T1) was −1.44 ($P < 0.01$) and was significant.

A highly significant positive correlation was seen in between the changes in the curve of Spee during treatment (T2-T1) and the net result after retention (T3-T1), meaning that much of the treatment result was still present at T3, indicates that the −1.44 (T3-T1) changes in the depth of curve of Spee during the time interval T3-T1 were due to the changes in the curve of Spee during treatment T2-T1 (Table 2).

This indicates that leveling of the curve of Spee during the treatment is a stable treatment objective. This is depicted with the help of a scatter diagram.

Comparison of changes in the curve of Spee to the changes in the Dental and Skeletal parameters during the orthodontic treatment and following the completion of treatment:

The descriptive statistics compare changes in the depth of the curve of Spee with the changes in the skeletal and dental parameters during the time interval T2-T1 and at the time interval T3-T1 were as follows.

The mean value for the changes in the curve of Spee depth, Lower incisor to NB distance, overjet and overbite during the

Table 1: Changes in the curve of Spee during treatment (T2-T1) (T3-T1) (Paired *t*-test).

	T1	T2	T2-T1	Significance		T3	T3-T1	Significance	
	Pre	Post	Post-Pre	*t* value	*P* value	Retention	Retention-Pre	*t* value	*P* value
Curve of Spee depth (mm)									
Mean	2.04	0.74	−1.310	6.15	<0.01 s	0.610	−1.440	5.94	<0.01 s
SD	1.120	0.870	1.040			0.680	1.190		

SD: Standard deviation

time interval T2-T1 were −1.31 (<0.01 s), 0.08 ($P > 0.05$ ns) −2.13 ($P < 0.01$ s) and −1.21 ($P < 0.01$ s), respectively. There was a significant changes observed in the curve of Spee depth, overjet and overbite at T2-T1. There was a decrease in the curve of Spee depth, and reduction was seen in the overjet and overbite.

The mean value for the changes in the curve of Spee depth, Lower incisor to NB distance, overjet and overbite at time interval T3-T1 were −1.44 ($P < 0.01$ s), −0.17 ($P > 0.05$ ns), −1.88 ($P > 0.05$ ns) and −1.08 ($P < 0.01$ s), respectively. There were significant changes observed in the curve of Spee depth and overbite at T3-T1. This indicates that the following leveling of the curve of Spee, overbite was reduced, and it is remained stable. Rest of the parameters shows no significant changes.

Pearson's correlation coefficient test was done to find out the correlation between different dental and skeletal parameters and curve of Spee depth, following results were observed.

Dental linear parameters

The descriptive statistics for the changes in the curve of Spee during treatment (T2-T1) its correlation to Lower incisor to NB distance, over jet and overbite at T2-T1 were $r = -0.07$ ($P > 0.05$ ns), $R = 0.16$ ($P > 0.05$ ns) and $R = -0.05$ ($P > 0.05$ ns), respectively. However, there was a mild correlation between the changes in the depth of the curve of Spee and the changes in the over jet T2-T1 (Table 3).

The descriptive statistics for the changes in the curve of Spee during treatment its correlation to Lower incisor to NB distance, over jet and overbite at T3-T1 were $r = -0.05$ ($P > 0.05$ ns), $r = 0.18$ ($P > 0.05$ ns) and $r = -0.31$ ($P > 0.05$ ns), respectively. However, a positive correlation was found between the changes in the depth of the curve of Spee and the changes in the overjet at T3-T1. Rest of the parameters does not show any significance.

Discussion

An accentuated curve of Spee is commonly seen in a malocclusion characterized by deep bite, which presents a diagnostic and therapeutic challenge.[10-12]

Carter and McNamara reported no difference in the depth of the curve of Spee between males and females when measured from the dental casts taken before the treatment. Lie *et al.* reported similar trends in post-treatment changes in male and female patients after orthodontic treatment with edgewise appliance with or without extractions.[13] Lie *et al.* investigated the post-treatment advancement of the curve of Spee and its post-treatment stability on the basis of cephalometric parameters and showed that more stability might be expected after relatively large leveling changes of deep curves during treatment, while there seems to be a tendency toward less stability and more spontaneous changes when treatment involves small changes.[14]

Relapse of curve of Spee is usually associated with the deepening of the bite post-retention. This difference between the study performed by Lie *et al.* and the present study can be explained on the basis of the mechanism of leveling.[15]

De Praeter *et al.* in their study stated that the correlation between relapse of the curve of Spee and that of the overjet and overbite was mild. The mechanism for relapse of overbite could be that the bite was deepened by the extrusion of the maxillary anterior dentition rather than the lower anterior dentition. As the curve of Spee in the present study was measured only in the mandible, this explains the stability of the measured curve of Spee.[16]

Overall, within the limits of the study, it can be recommended that curve of Spee is stable after treatment. A mild correlation was observed in the changes in the curve of Spee and the changes in the overbite and overjet during and mean (2.6) years

Table 2: Changes in the curve of Spee during treatment (T2-T1) (T3-T2) (Paired *t*-test).

	T1	T2	T2-T1	Significance		T3	T3-T2	Significance	
	Pre	Post	Post- Pre	*t* value	*P* value	Retention	Retention-Post	*t* value	*P* value
Curve of Spee depth (mm)									
Mean	2.04	0.74	−1.310	6.15	<0.01 s	0.610	−0.13	0.80	0.43 NS
SD	1.120	0.870	1.040			0.680	0.80		

s: Significant, NS: Not significant

Table 3: Changes in the curve of Spee to the changes in the dental and skeletal parameters.

	T1	T2	T2-T1	Significance		T3	T3-T1	Significance	
	Pre	Post	Post-Pre	*t* value	*P* value	Retention	Retention-Pre	*t* value	*P* value
Overbite									
Mean	3.38	2.17	−1.21	4.10	<0.01 s	2.29	−1.08	3.76	<0.01 s
SD	1.47	0.64	1.44		0.86	1.41			

s: Significant, SD: Standard deviation

following orthodontic treatment completion. The present study reveals a strong relationship between the leveling of the curve of Spee at (T2-T1) and the net result after retention (T3-T1). Hence, the leveling seems to be a relatively stable treatment objective.[17]

Conclusion

The results of the present study evaluated long-term stability of the leveled curve of Spee. The differences in the curve of Spee here were compared with the alterations in the different skeletal and dental parameters. Hence, it can be concluded that the curve of Spee was stable after treatment on a long-term basis. Mild correlation was noticed between the changes in the curve of Spee's depth and the different dental and skeletal parameters during and 2.6 years (mean) at the end of orthodontic treatment.

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