Evaluation of the relationship between curve of Spee and dentofacial morphology in different skeletal patterns

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ABSTRACT

Background: Curve of Spee (CS) is an anteroposterior anatomical curve established by the occlusal alignment of the teeth viewed in the sagittal plane. This occlusal curvature has clinical importance in orthodontics and other fields of dentistry. This study aimed to evaluate the relationship between the CS and dentofacial morphology of different skeletal patterns in both genders.

Materials and Methods: Eighty six Iraqi Arab subjects (44females,42 males) their age ranged from 17 -30 years, classified into: Skeletal I with normal occlusion(15 females and 15 males), skeletal II with Cl II div 1 malocclusion (15 females and 15 males) and skeletal III with Cl III malocclusion (14 females and 12 males). Forty one variables measured using direct dental cast measurements , dental cast photographs and cephalometric radiographs with the aid of AutoCAD program version 15 (2006).

Results: No significant differences in the CS depth between males and females or between right and left sides in both arches of different skeletal patterns. No significant differences in the maxillary CS among the 3 skeletal patterns, the mandibular CS in Cl II div 1 malocclusion was larger than normal occlusion and Cl III malocclusion. Maxillary CS significantly correlated to arch length, inter canine distance and inter second premolar distance in normal occlusion and overbite in Cl III malocclusion. Mandibular CS significantly correlated with overbite and overjet in Cl II div 1 and Cl III malocclusions.

Conclusions: CS was not influence by sides and gender in both arches of different skeletal patterns. CS was concave in the mandibular arch with the maximum concavity at the mesio-buccal cusp tip of the mandibular first molar and convex in the maxillary arch with the maximum convexity at the buccal cusp tip of the maxillary second premolar, in different skeletal patterns.

Key words: Curve of Spee, arch length, overbite, overjet, dentofacial morphology. (J Bagh Coll Dentistry 2015; 27(1):164-168).

INTRODUCTION

The curve of Spee was described firstly in 1890 by F. Graf von Spee, a German anatomist (1855-1937), who used skulls with abraded teeth to define the line of occlusion 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[1]. Spee located the center of this cylinder in the midorbital plane so that it had a radius of 6.5 to 7.0 cm.[2].The curve of Spee depth is minimal in the deciduous dentition, it increases to maximum depth with eruption of the permanent second molars and then remained relatively stable into late adolescence and early adulthood [3].

The functional significance of the curve of Spee depth has not been completely understood [4]. However, it had been suggested that it had a biomechanical function during food processing by increasing the crush-shear ratio between the posterior teeth and the efficiency of occlusal forces during mastication [5].

An increased curve of Spee was seen in brachycephalic facial patterns [6] and associated with short mandibular bodies [7]. The curve of Spee was influenced by the ratio between posterior and anterior facial heights [4].

Certain cephalometric and dental factors were associated with individual variations in the curve of Spee [8]. Little information's were found regarding the curve of Spee in different skeletal patterns in Iraqis, specially by using computerized method of assessment, so it is intended to implement this study to establish a baseline data regarding:

1. The features of the curve of Spee in different skeletal patterns in Iraqis.
2. Gender difference of the curve of Spee in different skeletal patterns.
3. The relations between the curve of Spee and dentofacial morphology.

MATERIALS AND METHODS

Fifty females and forty six males of Iraqi Arab subjects with an age range between 17 - 30 years and full permanent teeth excluding the third molars were selected from College of Dentistry, Baghdad University after clinically examining 312 subjects (152 females, 160 males) because of the following exclusion criteria: cast restoration or cuspal coverage, TMJ disorder [9], severe craniofacial disorders [10], previous orthodontic, orthopedic or facial surgical treatments[11], active periodontal diseases [1],supernumerary tooth or teeth, transposition of teeth, microdontia and/or macrodontia and history of systemic diseases.

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The following records were taken for every subject included in this study:

1- Dental casts (86 pairs of dental casts).
2- Three photographs for every dental cast (occlusal, left side and right side for upper and lower dental cast photographs).
3- Eighty six digital lateral cephalometric radiographs.

The sample sub divided into:-Skeletal I with normal occlusion, skeletal II with Cl II div 1 malocclusion and skeletal III with Cl III malocclusion.

Each subject was clinically examined (intraorally and extraorally) to check his/her fulfillment of the required criteria. Impression of the dental arches was taken before taking lateral cephalometric radiograph. Each dental cast would be numbered on the artistic portion on the left side, right side and occlusal view to be ready for photograph. Then cephalometric radiograph was taken under rigidly standardized conditions using DIMAX3 digital x-ray unit system machine.

The standardization of the dental casts photographs that was used in this study was similar to the standardization method used by Saadi [13]. Once the picture of the photographs and radiographs imported to the AutoCAD program, it would be divided by scale for each picture to overcome the magnification. Linear and angular measurements would be obtained by using the AutoCAD measuring tools, on the lateral view the occlusal plane was determined, then perpendicular distances from the occlusal plane to the buccal cusp tip of each lateral tooth were measured. CS of the particular dental arch was determined by taking the average of the points located at the maximum concavity in the lower arch (below occlusal plane) with its contralateral tooth and the points located at the maximum convexity in the upper arch (above occlusal plane) with its contralateral tooth, while on the occlusal view Inter canine distance (ICD), Inter second premolar distance (ISPD), Inter first molar distance (IFMD), Inter second molar distance (ISMD) and Arch length (AL) were measured.

The overbite and overjet were directly measured on the study cast using dental vernier [14]. Cephalometric skeletal and dental measurements used in this study were Frankfort Mandibular plane Angle, ANB angle, Gonial angle, Inter incisal angle, incisor mandibular plane angle, Lower anterior facial height and Posterior facial height.

Data of the sample were subjected to computerized statistical analysis using SPSS version 15 (2006) computer program. Descriptive Statistics included mean values and standard deviations. Inferential Statistics included Paired t-test, Independent- samples t-test, Analysis of variance (ANOVA) test, least significant difference (LSD test) and Pearson's correlation coefficient (r) were done.

RESULTS

Table1 showed the descriptive statistics (means and standard deviations) and side differences for the depth of each lateral tooth relative to occlusal plane in Cl I, Cl II and Cl III respectively. Statistically no significant side difference was found in both arches.

Table1: Depth of each lateral tooth relative to occlusal plane

Teeth No.	Side	CI I (d. f. = 28)				CI II (d. f. = 28)				CI III (d. f. = 24)			
		Descriptive Statistics		Side difference		Descriptive Statistics		Side difference		Descriptive Statistics		Side difference	
		Mean	S.D.	t-test	p-value	Mean	S.D.	t-test	p-value	Mean	S.D.	t-test	p-value
Upper 2	L	-0.02	0.61	0.22	0.824	0.53	0.94	0.32	0.748	0.09	1.10	-1.51	0.143
	R	-0.04	0.66		(NS)	0.46	1.48		(NS)	0.43	0.91		(NS)
Upper 3	L	1.34	0.89	0.46	0.650	2.01	1.62	1.71	0.097	1.17	1.54	1.67	0.108
	R	1.28	0.89		(NS)	1.70	2.04		(NS)	0.43	2.05		(NS)
Upper 4	L	2.08	0.96	0.97	0.340	2.52	1.30	1.70	0.100	2.18	0.92	0.91	0.370
	R	1.94	1.14		(NS)	2.30	1.35		(NS)	1.98	1.40		(NS)
Upper 5	L	2.13	0.93	1.04	0.305	2.64	1.35	1.42	0.165	2.33	1.02	-0.03	0.973
	R	1.96	1.10		(NS)	2.37	1.22		(NS)	2.32	1.34		(NS)
Upper 6	L	1.69	0.80	0.39	0.6991	2.05	1.28	1.12	0.270	1.94	0.89	0.93	0.363
	R	1.63	0.86		(NS)	1.86	1.07		(NS)	1.75	1.18		(NS)
Lower 2	L	0.51	0.36	0.64	0.527	0.28	0.62	-1.00	0.324	0.33	0.70	-1.02	0.319
	R	0.45	0.51		(NS)	0.40	0.68		(NS)	0.45	0.59		(NS)
Lower 3	L	0.66	0.70	-0.83	0.416	0.40	1.12	-0.78	0.440	0.73	0.92	-1.00	0.327
	R	0.77	0.81		(NS)	0.50	1.22		(NS)	0.91	0.96		(NS)
Lower 4	L	-0.43	0.79	-1.31	0.201	-0.78	1.41	-1.44	0.160	-0.09	1.31	-1.46	0.156
	R	-0.25	0.83		(NS)	-0.56	1.55		(NS)	0.20	1.07		(NS)
Lower 5	L	-1.03	0.96	-0.78	0.441	-1.50	1.19	-1.24	0.224	-0.79	1.20	-1.17	0.254
	R	-0.94	1.06		(NS)	-1.25	1.62		(NS)	-0.52	1.19		(NS)
Lower 6	L	-1.57	0.83	-0.54	0.596	-1.76	1.02	-1.61	0.119	-1.08	1.05	-1.93	0.065
	R	-1.50	1.09		(NS)	-1.57	1.30		(NS)	-0.73	0.88		(NS)

All measurements are in millimeters, L: Left side, R: Right side, t-test: Paired t-test, NS: None significant p-value > 0.05.

Table 2 showed the descriptive statistics and gender difference of the CS in Cl I, Cl II and Cl III respectively, however (t-test and p-value) showed no significant gender differences in both arches in all 3 classes.

Table 2: Gender difference of the mean depth of contra-lateral teeth relative to occlusal plane.

		CI I 15Females 15 males d.f.=28				CI II 15 Females 15 males d.f.=28				CI III 14 Females 12 males d.f.=24			
		Mean	S.D.	t-test	p-value	Mean	S.D.	t-test	p-value	Mean	S.D.	t-test	p-value
Upper 2	Males	0.01	0.66	0.580	0.564 (NS)	0.53	1.14	0.551	0.584 (NS)	0	1.24	-1.765	0.084 (NS)
	Females	-0.08	0.61			0.35	1.37			0.48	0.72		
Upper 3	Males	1.46	0.81	1.270	0.209 (NS)	2.33	1.67	1.595	0.116 (NS)	0.94	1.75	0.483	0.631 (NS)
	Females	1.17	0.94			1.66	1.62			0.69	1.93		
Upper 4	Males	2.06	0.99	0.412	0.682 (NS)	2.33	1.61	0.112	0.912 (NS)	1.85	1.03	-1.295	0.201 (NS)
	Females	1.95	1.12			2.29	1.09			2.27	1.27		
Upper 5	Males	2.01	0.98	-0.256	0.799 (NS)	2.23	1.42	-1.655	0.103 (NS)	2.24	1.01	-1.663	0.103 (NS)
	Females	2.08	1.06			2.78	1.09			2.71	1.01		
Upper 6	Males	1.62	0.82	-0.403	0.688 (NS)	1.91	1.26	-0.278	0.782 (NS)	1.74	0.73	-1.6	0.116 (NS)
	Females	1.70	0.85			2.00	1.10			2.16	1.10		
Lower 2	Males	0.58	0.39	1.740	0.087 (NS)	0.18	0.73	-1.978	0.053 (NS)	0.46	0.41	0.649	0.519 (NS)
	Females	0.38	0.47			0.50	0.51			0.36	0.71		
Lower 3	Males	0.79	0.71	1.720	0.091 (NS)	0.17	1.51	-1.492	0.141 (NS)	0.80	0.92	-0.176	0.861 (NS)
	Females	0.50	0.65			0.66	0.97			0.84	0.97		
Lower 4	Males	0.08	1	1.526	0.132 (NS)	-0.89	1.48	-1.898	0.063 (NS)	-0.14	1.23	-1.093	0.280 (NS)
	Females	-0.30	0.96			-0.16	1.52			0.22	1.15		
Lower 5	Males	-0.68	0.95	1.793	0.078 (NS)	-1.44	1.36	-0.709	0.481 (NS)	-0.84	1.22	-1.042	0.302 (NS)
	Females	-1.15	1.06			-1.18	1.57			-0.50	1.16		
Lower 6	Males	-0.99	0.97	1.101	0.275 (NS)	-1.43	1.22	0.234	0.815 (NS)	-1.09	1.18	-1.233	0.223 (NS)
	Females	-1.34	1.44			-1.50	1.33			-0.75	0.76		

All measurements are in millimeters, t-test: Independent samples t-test, NS: None significant p-value > 0.05.

Table 3 showed the descriptive statistics and classes difference for the maxillary and mandibular CS among the 3 classes. The maxillary CS had larger value than the mandibular CS in all 3 Classes. The mean value of the maxillary CS was largest in CI II div 1 malocclusion and smallest in normal occlusion. While, the mean value of the mandibular CS was largest in CI II div 1 malocclusion and smallest in CI III malocclusion.

Table 3: Comparison among classes regarding curve of Spee and depth of the teeth relative to occlusal plane.

Arches	Classes	Descriptive Statistics		Classes' differences				
				ANOVA		LSD		
		Mean	S.D.	F-test	p-value	I-II	I-III	II-III
Maxillary CS	I	2.14	0.79	1.857	0.163 (NS)	-	-	-
	II	2.58	1.22					
	III	2.57	0.97					
Mandibular CS	I	-1.15	1.27	3.138	0.049 (S)	0.041 (S)	0.815 (NS)	0.028 (S)
	II	-1.80	1.37					
	III	-1.08	0.84					

All measurements are in millimeters, CS: Curve of Spee, S: Significant, HS: Highly Significant, NS: None significant.

Table 4 showed the Pearson's correlation coefficient factor and p- value among the Maxillary and Mandibular CS with the other measured variables in the 3 skeletal classes.

DISCUSSION

In this study attempt was made to separate the sample according to gender, skeletal patterns and select a limited range of age to evaluate the variables more precisely. Data obtained in this study showed no significant gender and side differences in the mean of the mandibular CS depth that agreed with the results of Currim and Wadkar [15]. No significant gender difference in the maxillary CS depth that agreed with the result of Cheon et al. [9].

There was no significant side difference in the maxillary CS depth that disagreed with the result of Cheon et al. [9] possibly due to racial difference or the sample of a right handed subjects. Data showed an upward concave CS relative to occlusal plane in the mandibular arch that was agreed with Garcia [16] and a downward convex CS relative to occlusal plane in the maxillary arch that was agreed with the result of Shannon and Nanda[9].

The present findings showed that, the maximum concavity in the mandibular CS was the mesio-buccal cusp tip of the first molar that was agreed with the results of Ferrario et al. [17] but disagreed with Koyoma [18] who found that the deepest point of the CS in the mandibular arch was in the second premolar. The buccal cusp tip of the maxillary second premolar was the maximum convexity in the maxillary CS, agreed with Cheon et al. [9]. The convexity of the maxillary CS was larger relative to occlusal plane than the concavity of the mandibular CS in all 3 classes that was agreed with Cheon et al.[9] but, in contrast to the result of Xu et al. [19] who determined anterior point of the maxillary CS from the tip of the canine. The mandibular curve of Spee in skeletal CI II was significantly deeper when compared with skeletal CI I and skeletal CI III subjects, that was agreed with Shannon and Nanda [8]. However, no significant differences in the depth of the CS between skeletal CI I and skeletal CI III.

Table 4: Correlations between the curve of Spee and the measured variables

Variables	Pearson's correlation coefficient	Class I		Class II		Class III	
		Maxillary CS	Mandibular CS	Maxillary CS	Mandibular CS	Maxillary CS	Mandibular CS
Upper LAL	R	- 0.461	- 0.325	- 0.317	- 0.278	- 0.267	- 0.213
	p-value	0.010 (HS)	0.080 (NS)	0.087 (NS)	0.136 (NS)	0.187 (NS)	0.296 (NS)
Upper RAL	R	- 0.406	- 0.349	- 0.306	-0.351	- 0.360	- 0.047
	p-value	0.026 (S)	0.059 (NS)	0.100 (NS)	0.057 (NS)	0.071 (NS)	0.820 (NS)
Upper ICD	R	-0.540	-0.217	-0.083	-0.015	-0.209	-0.113
	p-value	0.002 (HS)	0.250 (NS)	0.664 (NS)	0.937 (NS)	0.306 (NS)	0.582 (NS)
Upper ISPD	R	-0.389	-0.240	-0.044	-0.253	-0.227	-0.093
	p-value	0.034 (S)	0.201 (NS)	0.819 (NS)	0.177 (NS)	0.265 (NS)	0.650 (NS)
Upper IFMD	R	-0.353	-0.130	-0.168	-0.086	-0.325	-0.102
	p-value	0.056 (NS)	0.493 (NS)	0.375 (NS)	0.651 (NS)	0.105 (NS)	0.621 (NS)
Upper ISMD	R	-0.347	-0.008	-0.047	-0.049	-0.142	-0.168
	p-value	0.060 (NS)	0.967 (NS)	0.804 (NS)	0.799 (NS)	0.490 (NS)	0.412 (NS)
Lower ICD	R	-0.203	-0.224	-0.132	-0.015	-0.079	-0.416
	p-value	0.282 (NS)	0.235 (NS)	0.488 (NS)	0.939 (NS)	0.702 (NS)	0.035 (S)
Lower ISPD	R	-0.089	-0.184	-0.052	-0.092	-0.023	-0.149
	p-value	0.641 (NS)	0.330 (NS)	0.784 (NS)	0.628 (NS)	0.912 (NS)	0.469 (NS)
Lower IFMD	R	-0.235	-0.145	-0.024	-0.213	-0.129	-0.039
	p-value	0.212 (NS)	0.444 (NS)	0.899 (NS)	0.259 (NS)	0.531 (NS)	0.851 (NS)
Lower ISMD	R	-0.253	-0.059	-0.012	-0.066	-0.239	-0.097
	p-value	0.177 (NS)	0.757 (NS)	0.949 (NS)	0.730 (NS)	0.239 (NS)	0.639 (NS)
Lower LAL	R	- 0.292	- 0.406	- 0.169	-0.194	-0.316	- 0.175
	p-value	0.118 (NS)	0.026 (S)	0.373 (NS)	0.304 (NS)	0.116 (NS)	0.394 (NS)
Lower RAL	R	- 0.302	- 0.342	- 0.253	-0.282	0	- 0.084
	p-value	0.105 (NS)	0.064 (NS)	0.178 (NS)	0.130 (NS)	1 (NS)	0.683 (NS)
FMA	R	- 0.085	-0.041	- 0.520	- 0.087	-0.001	-0.174
	p-value	0.656 (NS)	0.828 (NS)	0.003 (HS)	0.646 (NS)	0.995 (NS)	0.395 (NS)
ANB	R	-0.186	-0.139	-0.204	-0.268	-0.231	-0.203
	p-value	0.326 (NS)	0.464 (NS)	0.279 (NS)	0.152 (NS)	0.256 (NS)	0.320 (NS)
GA	R	- 0.054	- 0.168	- 0.334	- 0.097	- 0.193	- 0.087
	p-value	0.775 (NS)	0.375 (NS)	0.072 (NS)	0.609 (NS)	0.344 (NS)	0.673 (NS)
IIA	R	0.222	0.169	0.337	0.121	0.122	0.093
	p-value	0.238 (NS)	0.371 (NS)	0.069 (NS)	0.524 (NS)	0.553 (NS)	0.652 (NS)
IMPA	R	-0.152	-0.075	-0.367	-0.094	- 0.140	- 0.423
	p-value	0.422 (NS)	0.695 (NS)	0.046 (S)	0.622 (NS)	0.496 (NS)	0.031 (S)
LAFH	R	- 0.041	0	- 0.196	-0.039	-0.120	-0.012
	p-value	0.829 (NS)	0.998 (NS)	0.300 (NS)	0.839 (NS)	0.558 (NS)	0.955 (NS)
PFH	R	0.320	0.090	0.248	0.065	0.372	0.184
	p-value	0.085 (NS)	0.636 (NS)	0.187 (NS)	0.735 (NS)	0.061 (NS)	0.368 (NS)
Overbite	R	0.046	0.154	0.259	0.673	0.527	0.664
	p-value	0.810 (NS)	0.415 (NS)	0.167 (NS)	0.000 (HS)	0.006 (HS)	0.000 (HS)
Overjet	R	0.263	0.210	0.030	0.565	0.208	0.391
	p-value	0.160 (NS)	0.266 (NS)	0.873 (NS)	0.001 (HS)	0.308 (NS)	0.048 (S)

LAL: Left arch length, RAL :Right arch length NS: None significant, S: Significant, HS: High significant,(r):Pearson'scorrelation coefficient.

No significant differences in the depth of the maxillary CS among the 3 skeletal classes, possibly because of the high variability in incisors positions relation of maxillary and mandibular relationships , that was agreed with Shannon and Nanda[8]. Significant correlation was found between FMA and CS depth in skeletal CI II, that came in agreement with Shannon and Nanda [8].

The CS had no significant correlation with GA, LAFH and PFH , that agreed with Cheon et

al.[9] but disagreed with Farella et al.[4] who found that the CS was more marked in short-face subjects and less marked in long-face subjects because in this study generally, the sample was of a normal or long face type. There were statistically high significant correlation between CS and overbite and overjet in skeletal CI II and skeletal CI III which agreed with the results of Baydas et al. [10]. The ANB angle had no significant correlation to the CS this was agreed with the result of Shannon and Nanda[8]and disagreed with Cheon et al. [9] possibly because of the great variations in incisor positions, irrelative to maxillary and mandibular relationships. It was clear that the CS was influence more by dental factors than skeletal factors so, it is preferable to evaluate the CS in relations to soft tissues and biting force.

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الخلاصة

الخلفية: منحنى سبي هو منحني تشريحي أمامي خلفي , ينشأ بمحاذاة إطباق الأسنان ويظهر في المستوى السهمي . هذا الانحناء في الإطباق له أهمية سريريه في تقويم الأسنان ومجالات طب الأسنان الأخرى. أطباء تقويم الأسنان يتعاملون مع منحنى سبي تقريبا في كل مريض يتم معالجته . هدفت هذه الدراسة إلى تقييم منحنى سبي وعلاقته بالتشكل السني ألوجهي لأنماط مختلفة الهيكل العظمي في كلا الجنسين عن طريق قياس (41) من المتغيرات في أساليب مختلفة باستخدام قياسات مباشرة لإطباق الأسنان ؛ وقياسات لصور الأسنان و أشعة الرأس بمساعدة برنامج أوتوكاد نسخة 2006.

العينة و المواد: تكونت عينة الدراسة من " 86 " شخص من العراقيين العرب (الذكور = 42، الإناث = 44) تراوحت أعمارهم بين 17-30 سنة ، تصنف على النحو التالي :
- الهيكل العظمي الصنف الأول مع إطباق الأسنان الطبيعي (15 إناث و 15 ذكور) ، الهيكل العظمي الصنف الثاني مع الدرجة الثانية شعبة 1 سوء الإطباق الأسنان (15 إناث و 15 ذكور) و الهيكل العظمي الصنف الثالث مع الدرجة الثالثة سوء الإطباق الأسنان (14 إناث و 12 ذكور) .
باستخدام التحليل الإحصائي للبيانات

النتائج :لا توجد فروق ذات دلالة إحصائية في عمق منحنى سبي بين الذكور والإناث أو بين الجانبين الأيمن و الأيسر في كلا الفكين من أنماط الهيكل العظمي المختلفة. كان منحنى سبي مقعرة في قوس الفك السفلي مع أقصى التقعر في طرف أعتاب إنسي شدقي من الرحى الأولى للفك السفلي ومحدبة في قوس الفك العلوي مع أقصى تحدب في طرف أعتاب الشدق من الضاحك الثاني للفك العلوي ،في أنماط الهيكل العظمي المختلفة.
لا توجد فروق ذات دلالة إحصائية في منحنى سبي للفك العلوي من بين أنماط الهيكل العظمي الثلاثة في حين ، كان منحنى سبي في الفك السفلي في الدرجة الثانية شعبة 1 سوء الإطباق أكبر بالمقابلة من إطباق الأسنان الطبيعي و الدرجة الثالثة سوء الإطباق. لا يوجد فرق كبير في منحنى سبي في الفك السفلي بين إطباق الأسنان الطبيعي و الدرجة الثالثة سوء الإطباق .

الاستنتاجات: منحنى سبي في الفك العلوي مترابط بشكل كبيرمع طول القوس العلوي والمسافة العرضية بين النابين و الضاحك الثاني في الإطباق الطبيعي، و تراكب العضة في الدرجة الثالث سوء الإطباق. منحنى سبي في الفك السفلي مترابط بشكل كبيرمع تراكب العضة في الإطباق الطبيعي و سوء الإطباق الدرجة الثالث . بينما ، في الدرجة الثانية شعبة 1 سوء الإطباق كان هناك ارتباط كبير بين منحنى سبي مع بروز الأسنان وتراكب العضة .