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Measuring curve of spee using digital methods and defining its relationship to different angle classes

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Abstract
Aim of the study: This cross-sectional study is aiming for investigating the relationships of the depth of curve of Spee with different Angle classes.
Materials and Methods: A sample of 240 study models were collected and scanned digitally to measure the depth of curve of Spee. The sample has been divided into 4 groups including: Angle Class I, Angle Class II Division 1, Angle Class II Division 2 and Angle Class III with 60 study models in each group. The depth of the curve of Spee has been measured from the left and right sides and the mean value of both sides was calculated.
Results: The measurement of curve of Spee showed significant differences between different classes (p<0.05). The highest measurements of curve of Spee are seen in Angle class II division 2 subjects followed by Angle class II division 1then Angle class I and the smallest measurements were seen in Angle class III subjects.
Conclusion: Curve of Spee can differ significantly with different Angle classes. Deep curve of Spee is usually anticipated in Angle Class II Division 2 followed by Angle Class II Division 1. Thus, it is important to anticipate the space requirement for levelling of curve of Spee in these cases.

Keywords: Space requirement, modern orthodontics, treatment planning, orthodontic treatment

Introduction
The curve of Spee in modern orthodontics is believed to be one of the important considerations in cast analysis and treatment planning in most of cases requiring orthodontic treatment. The importance of this curve lies in its effect on space requirements during levelling of teeth [1, 2].
In 1899 Edward Angle published his famous classification of malocclusion. He classified the antero-posterior relationships of dental arches into three classes which included: Class I, Class II (which was further subdivided into Division 1 and Division 2) and finally Class III [3]. It was reported that different curves of Spee depths may be correlated with different Angle classes. This mean that curve of Spee can alter the space requirement during levelling and alignment in different Angle classes [4, 5]. Thus, the aim of the study was to investigate the relationship of the depth of curve of Spee with different Angle classes.

Materials and Methods
This cross-sectional study was conducted on study models of 240 patients with varying malocclusions. They were randomly collected from the previous records of Egyptian (male and female) patients.

The samples were selected according to the following criteria
1. All teeth present excluding the third molars.
2. No obvious loss of tooth material mesio-distally as a result of caries, fractures, inter-proximal wear or congenital defects.
3. Patient`s age ranging from 17-25 years old.

Exclusion criteria

1. Mixed or deciduous dentition.
2. Severe caries or periodontal disease.
3. Dental restorations which cover cusps.
4. History of current or previous orthodontic treatments or orthognathic surgery.
5. History of temporomandibular joint or Craniocervical disorders.

Impressions of upper and lower dental arches have been made with alginate impression material for duplication. Then the impressions were poured using a Type IV dental stone.

Samples were separated into 3 groups in accordance with dental malocclusion type; criteria used for Angel's classification as adopted from *Garbin, et al.* [6].

Class I: 60 dental models with Class I malocclusion having a molar relation in centric occlusion with the mesio-buccal cusp of the maxillary first permanent molar in occlusion with the mesio-buccal groove of the mandibular first permanent molar.

Class II division 1: 60 dental models with Class II division 1 malocclusion having bilateral molar relations in centric occlusion with the mesio-buccal cusp of the maxillary first permanent molar occludes anterior to mesio-buccal groove of the mandibular first permanent molar with upper incisors proclination and increased overjet.

Class II division 2: 60 dental models with Class II division 2 malocclusion having bilateral molar relations in centric occlusion with the mesio-buccal cusp tip of the maxillary first permanent molar occludes anterior to mesio-buccal groove of the mandibular first permanent molar with retro lined upper incisors and minimal overjet.

Class III: 60 dental models with Class III malocclusion having molar relations in centric occlusion with the mesio-buccal cusp tip of the maxillary first permanent molar occludes posterior to the mesio-buccal groove of the mandibular first permanent molar.

A laboratory 3-dimensional laser scanner was used to digitize all dental models. (Zirkon Zahn, S 600 (ARTI), Italy).

Curve of Spee was evaluated by measuring perpendicular distances from the occlusal plane which is from the central incisors to the most distal cusp tip of the most posterior tooth in the lower arch, and the deepest point of the curve of Spee was calculated for left and right sides Figure (1) using 3D Builder® software (Microsoft, USA). The average of both sides was used to obtain the depth.

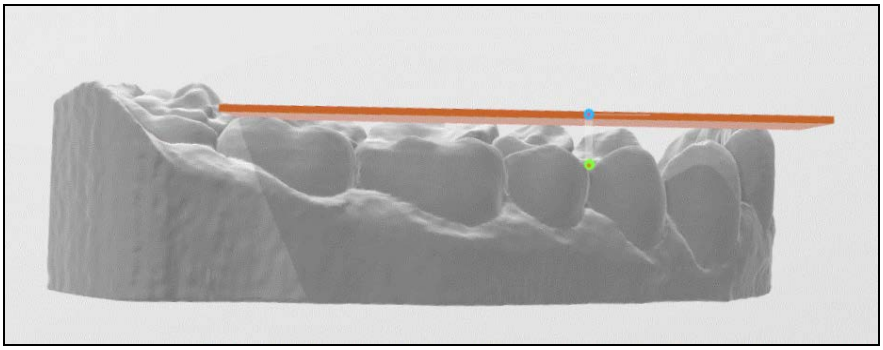

Fig 1: Digital 3D measurement of Curve of Spee

Statistical analysis

The Statistical Package for Social Sciences (SPSS) software version 24, was utilized to gather, tabulate, and statistically analyze all the measures and data from this investigation at a level of significance of 0.05%.

Results

The sample enrolled in this study consisted of two hundred and forty dental models randomly selected from the patients admitted for treatment of various malocclusions. Their age has been between 17 - 25 years and the mean age was 19.5 ± 2.13 years which are illustrated in Figure (2) and Table (1).

Table 1: Descriptive statistics of patients' age range (years)

	N		Mean	SD	Minimum	Maximum
	Males	Females				
Patient Age	117	123	19.5	2.13	17.15	23.43

N = Number of patients
SD = Standard Deviation

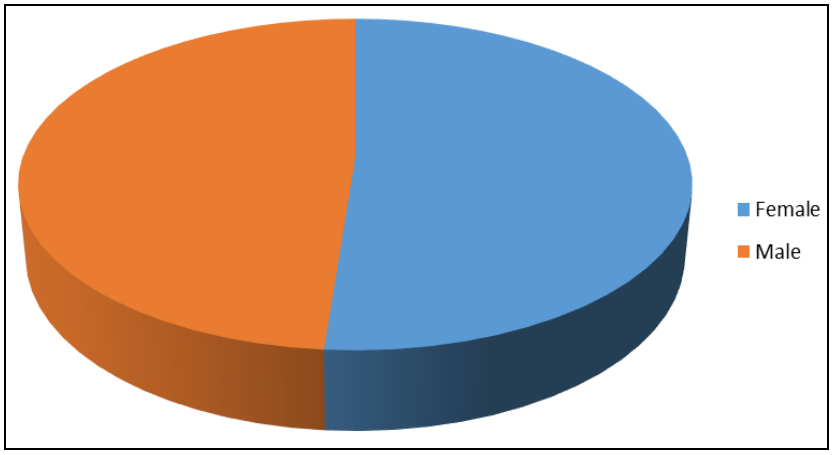

Fig 2: Sexual distribution of the study sample

Table 2: Curve of Spee values of Angle Class I, Angle Class II division 1, Angle Class II division2 and Angle Class III measured from the right and left sides and their mean values

		Range	Mean ± SD	F. Test	p. value
COS R	Class I	1.228-3.867	1.855±0.622	39.810	0.001*
	Class II Div 1	1.081-4.880	2.902±0.803		
	Class II Div 2	1.301-4.880	3.912±0.705		
	Class III	0.351-3.27	1.117±0.813		
COS L	Class I	1.01-3.634	1.551±0.742	33.528	0.001*
	Class II Div 1	1.148-4.805	2.712±0.985		
	Class II Div 2	1.211-4.901	3.799±0.909		
	Class III	0.423-2.956	1.263±0.735		
COS mean	Class I	1.338-3.589	2.029±0.810	25.288	0.001*
	Class II Div 1	1.264-4.451	2.757±0.943		
	Class II Div 2	1.295-4.899	3.801±0.852		
	Class III	0.491-2.589	1.604±1.148		

COS R=Curve of Spee of the right side.
COS L=Curve of Spee of the left side.
COS mean= Mean Curve of Spee of the right & left side.

SD = Standard Deviation.
***** = Statistically Significant (p<0.05).

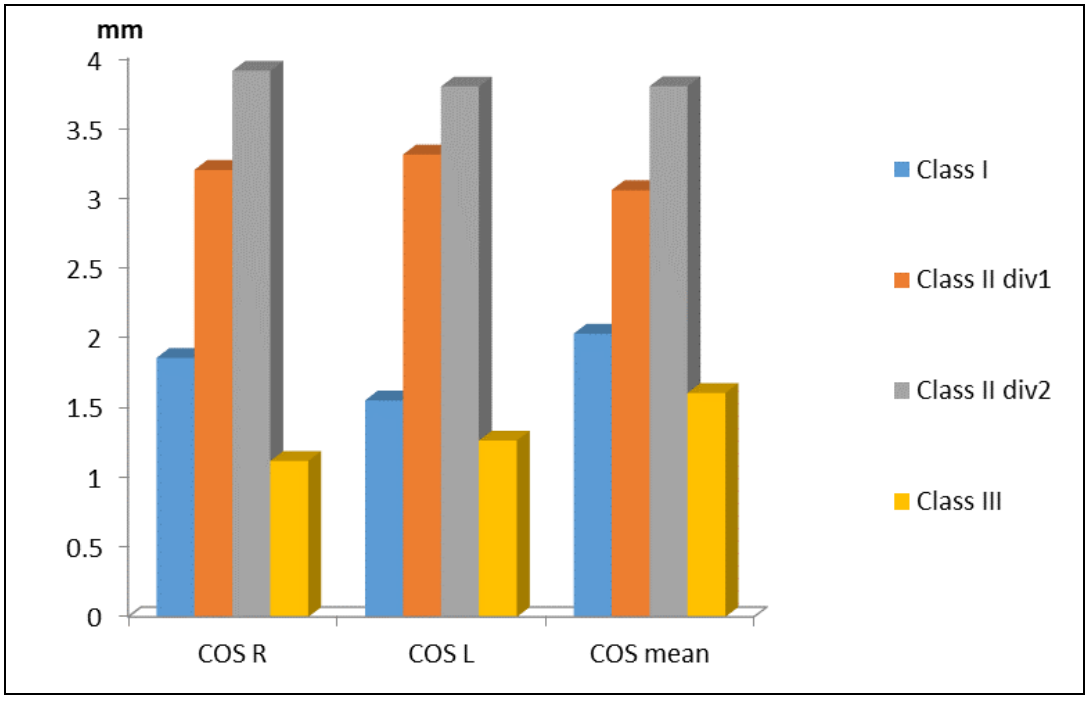

Fig 3: Difference in the curve of Spee between Angle class I, Angle class II division 1, Angle class II division 2 and Angle class III measured from the right and left sides and their mean values.

The measurements of curve of Spee showed a significant difference between different classes (p<0.05) as shown in Figure (3) and Table (2). The highest measurements of curve of Spee are seen in class II division 2 subjects followed by class II division 1then in class I and the smallest measurements were seen in class III subjects.

Discussion

This cross-sectional study has been conducted on dental cast models of 240 patients having different Angle classes. The study results showed that the depth of curve of Spee showed significant differences between different classes. The highest measurements of curve of Spee are seen in class II division 2 subjects followed by class II division 1then class I and the smallest measurements were seen in class III subjects.

This was in accordance with Nayar and Sanjna who conducted a cross sectional study to evaluate the depth of the curve of Spee in class I, class II, and class III malocclusion. They found that the greatest depth of curve of Spee was in class II subjects followed by class I and the least depth was found in class III subjects. They also noted that there was a correlation between the depth of the curve of Spee and incisal guidance, whereas a deep curve of Spee is regularly accompanied by a steep incisal angle and deep bite [7]. So according to these findings it is not surprising to find that class II division 2 cases would have the deepest curve of Spee (due to the inherently developed severe skeletal and dental deep bite) followed by class II division 1.

A study by Ahmed *et al.* also confirmed that class II division 2 malocclusion showed to have the deepest curve of Spee with an average depth of 4.3 mm and a mean depth of 2.5 mm in class II division 1 [8]. This coincides with my findings which found a positive correlation in depth of curve of Spee and class II division 2 followed by class II division 1 having a mean of 3.8 mm and 2.7 mm respectively. On the other hand, a contradicting result was found by Veli who assumed that class II division 1 had a deeper curve of Spee than that of class II division 2 [9]. An obvious observation about this study is the relatively small mean age of the sample selected (16.4 years for males and 18.1 years for females) which indicate that most of the sample was in the adolescent age group with some mandibular growth remaining which may alter the

results afterward. However, it is important to mention that all the previously mentioned studies including ours found that the least depth in the curve of Spee was found in class I followed by class III.

Also, our current findings did not find any potential relation between the ages incorporated in the sample which ranged from 17-25 years old and the curve of Spee. These findings support the results obtained by Farella who also found similar results with a sample having an age ranging from 18 to 20 years old [10]. This also confirms the results of Marshall who found that the curve of Spee usually remains stable during early adulthood [11]. It is also important to mention that the curve of Spee is not affected by the amount of wear and it usually maintains its depth even after the occurrence of a considerable amount of wear [12, 13].

Conclusion

Curve of Spee can differ significantly with different Angle classes. Deep curve of Spee is usually anticipated in Angle Class II Division 2 followed by Angle Class II Division 1. Thus, it is important to anticipate the space requirement for levelling of curve of Spee in these cases.

Conflict of Interest: Not available

Financial Support: Not available

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