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Original Article

Relationship Between Crown-to-Root Angulation of Maxillary Central Incisor and Lower Lip Line In Different Malocclusions

Sameera Jamshed[1*], Zubair Hassan Awaisi[1] and Zubair Ahmed[1]

[1]Department of Orthodontics, Nishtar Institute of Dentistry, Multan, Pakistan

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***Corresponding Author:**

Sameera Jamshed

Department of Orthodontics, Nishtar Institute of Dentistry, Multan, Pakistan

sameera.Jamshed11@gmail.com

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ABSTRACT

Collum angle, supplementary angle between longitudinal axis of crown-to-root, is an important consideration in patients receiving orthodontic treatment This angulation in labio-lingual direction is a key factor for proper occlusion and is greatly affected by lower lip line levels in different malocclusions. **Objective:** To find the relationship between collum angle of maxillary central incisor and lower lip line in patients presenting with different malocclusions. **Methods:** Cross-sectional, Comparative Study conducted in Orthodontics department of Nishtar Institute of Dentistry, Multan.From September 2020 to February 2021. Lateral cephalometric radiographs of 105 patients (39 males and 66 females)were selected with age range of 9-30 years. Patients were divided in 4 groups i.e Class I, Class II div I, Class II div II and class III. Collum angle was measured along with assessing lower lip-line level with central incisor. One-way ANOVA test was applied to compare level of lower lip and collum angle. **Results:** Mean value of collum angle was 5.82˚±5˚ for class I, 3.68˚ ± 9˚ for class II div I, 11.7˚± 5˚ for class II div II, and 6.88˚± 7 ˚for class III. Collum angle of maxillary central incisor was greatly increased in patients with class II div II malocclusion than other groups. **Conclusions:** Collum angle found to be highest in class II div II malocclusion group. Lower lip line resting on middle third level of maxillary central incisor crown in div II group explains this exceeding value of collum angle.

INTRODUCTION

A competent smile is part and parcel of attractive facial esthetics and stable occlusion. For the development and maintenance of occlusal integrity and stability, anterior dentition especially maxillary incisors play a pivotal role [1]. Smile attractiveness can be enhanced by the adequate labiolingual inclination of maxillary incisors as per the third key of Andrews's keys to normal occlusion [2]. Morphological disparity and variability of permanent incisor were first studied and analyzed by Bryant *et al.*,. in 1984, who established an important anatomic feature COLLUM ANGLE (CA) and investigated it in different malocclusions [3]. This Crown-to-root angulation in a labiolingual direction, known as Collum angle, is constructed by the intersection of the line along the long axis of the crown and root of a tooth [4]. It is also known as Supplementary angle [5, 6] Ideal collum angle, that is supposed to be zero, plays a vital role and is of great interest to orthodontists during the tooth movement as well as retention phase of orthodontic treatment. This longitudinal axis angulation might act as a limiting factor for lingual root torque added to central incisors within the confinement of the lingual cortical plate of bone [7]. According to R.M. Taylor, the specific supplemental angle between crown and root is widely diversified [8]. Both anatomic structures are liable to different curvature as crowns are bound to be under genetic control & root

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morphology is influenced by environmental factors [9]. These substantially deviated angulations lead to unpredictable force application during orthodontic tooth movements, especially in the vertical plane such as Intrusion and extrusion. Cosmetic defects such as apical migration of gingival margins, and gingival recession, occurring during orthodontic tooth movement, can also be attributed to collum angle. Besides orthodontic considerations, the crown-root angle needs pronounced attention for restorative tooth build-ups as well. During the Prosthetic implant replacement of the tooth with an initially increased crown-to-root angle, using an angulated abutment is essential to reduce the bending stress and prevent a gingival recession. Hence, knowledge of the collum angle and its relation to labial soft tissue in different malocclusions is important. In previous studies, the collum angle has been investigated by using lateral cephalometric radiographs and has been measured in different malocclusion but the relationship of collum angle with lower lip line in patients with different types of malocclusion has not been considered. The current study aimed to determine the relationship between crown-to-root angulation of the maxillary central incisor lower lip line in different malocclusions. Malocclusion was categorized on basis of British standard incisor classification [10]. Establishment of the effect of labial soft tissue on maxillary central incisor will help in planning and execution of tooth movements to maintain stable labiolingual inclination and soft tissue equilibrium.

METHODS

The respective cross-sectional, comparative study was conducted in the Department of Orthodontics of Nishtar Institute of Dentistry (MULTAN) for a duration of 6 months. The period of study was from September 2020 to February 2021.Lateral cephalometric radiographs of 105 individuals (66 female & 39 male) were included in the study. To ensure the standardized accuracy of point identification, all lateral cephalometric radiographs were taken using the natural head position as a reference. Age range of patients included in the study was 9-30 years. Based on British standard incisor classification, patients were divided into four groups: Class I, Class II div I Class II div II & Class III malocclusion. The collum angle and the lower lip line position were assessed on the lateral cephalometric radiograph. Patients with history of orthodontic treatment, prostheses in the anterior zone (implants, posts, dentures), crowding, severe rotation of incisors, trauma, craniofacial anomalies & abnormal central incisor morphology were excluded. Acetate tracing sheet of 0.003-inch thickness and lead pencil of 0.7mm pointer thickness were used for tracing the maxillary central incisor & lower lip. Points were marked on the incisal edge, cementoenamel junction and root apex. The long axis of the crown was drawn by joining a point incisor superius (IU) & mid-point of cementoenamel junction(CEJ). whereas long axis of the root was drawn by extending a line from cementoenamel junction to the root apex(RA). The collum angle was measured between the crown and root axes. All the data collected for study were statistically analysed in SPSS version-20.0 for Windows. After entering values in the software, the analysis of variance (ANOVA) test was used to compare collum angle in different malocclusions & lower lip levels.

RESULTS

Within the sample of 105 patients, 39 (37%) were male patients and 66(63%)were females(Table 1).

Table 1: Demographics with gender and dental class

Gender	Dental Class			III	Mean angle ± SD	N
	I	II	Div II			
Male	11	13	5	10	7.79 ± 4.617	39
Female	12	42	4	8	5.56 ± 4.23	66
Total	23	55	9	18	6.39 ± 4.49	105

Mean age of patients was 16.34 ± 4.99 years Descriptive statistics of Collum angle with age and dental class shown (Table 2).

Table 2: Descriptive statistics of Collum angle with age and dental class

Parameters	N	Minimum	Maximum	Mean angle ± SD
Age(Yrs)	105	9	30	16.34 ± 4.99
Dental Class	105	1.00	4.00	2.12 ± .85
Col Angle	105	.00	16.00	6.39 ± 4.49

Statistical Analysis showed the mean value of collum angle as 6.78 ˚± 3.5˚ for class I, 5.14˚ ± 4.1˚ for class II div I, 12˚ ± 4.2˚ for class II div II and 6.88˚ ± 4.7 ˚for class III malocclusion. The greatest value of the collum angle was found in the class II div II group.(Table.3.)

Table 3: Mean values of collum angle (in degrees)in different malocclusions

Dental Class	N	Mean Collum angle(degrees) ± SD
I	23	6.78 ± 3.53
II	55	5.14 ± 4.13
Div II	9	12.00 ± 4.21
III	18	6.88 ± 4.75
Total	105	6.39 ± 4.49

The location of lower lip line on maxillary central incisor (at incisal third, middle third, or apical third of the incisor) was analyzed in four groups by using the X^2 comparison test. According to this test, lower lip line was shown to significantly contact the middle third of the central incisor in Class II division II group (Table.4).

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Table 4: X^2-comparison test showing Lower lip line position on maxillary central incisor

Dental Class	Lower Lip Position			Total
	Incisal Third	Middle Third	No Contact	
I	22	0	1	23
II	49	5	1	55
Div II	2	6	1	9
III	14	1	3	18
Total	87	12	6	105

ANOVA test showed the mean collum angle to become greatly increased when the lower lip line is in contact at the middle third ($p < .05$) of the central incisor (Table.5).

Table 5: ANOVA test comparing collum angle and lower lip levels in different groups

Parameters		Sum of Squares	df	Mean Square	F	Sig.
Collum Angle	Between Groups	376.46	3	125.49	7.367	.000
	Within Groups	1720.53	101	17.035		
	Total	2096.99	104			
Lower Lip Position	Between Groups	7.539	3	2.513	5.088	.003
	Within Groups	49.89	101	.494		
	Total	57.43	104			

Means plot between Dental class, lower lip line and Collum angle shown in figure 1 and 2.

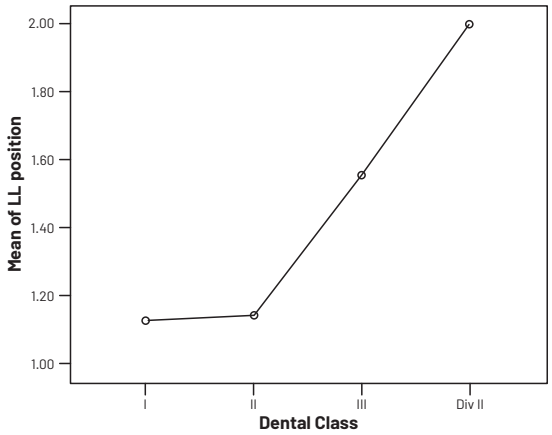

Figure 1: Means Plot between Dental class and Collum angle

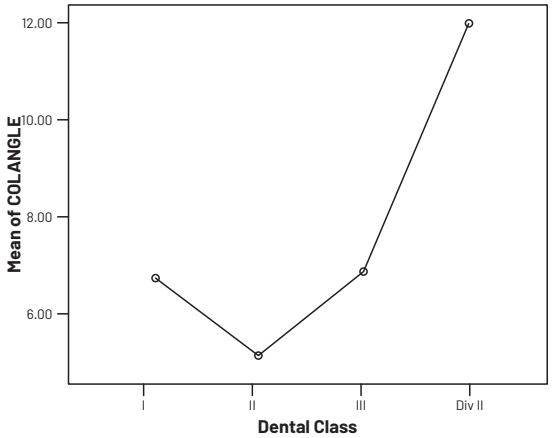

Figure 2: Means plot between Dental class and lower lip line

DISCUSSION

Proper interdigitation is important not only for stable occlusion but also for an esthetic and attractive social smile. As an ideal smile plays a key role in boosting an individual's self-esteem, it has been considered the ultimate goal of orthodontic treatment. Bryant et.al studied the morphological variations and deviations in maxillary central incisor in different malocclusions and came up with the identification of an anatomical feature known as Collum angle. Previously, the long axis of a tooth was considered to be a line from a point on the incisor edge to the root apex but with the identification of the collum angle, a new method has been adopted. The labio-lingual inclination of maxillary central incisors, described as Andrews's third key to normal occlusion, is impacted by the angle between the crown axis and root axis [11]. Our study aimed to compute the value of collum angle in different types of malocclusions and to find out the association between crown-to-root angle and the underlying malocclusion. We aimed to asses the relationship between the location of lower lip line on maxillary central incisors with the associated malocclusion and it's influence on the collum angle. In our study the mean value of collum angle was 6.78° ± 3.5° for class I, 5.14° ± 4.1° for class II div I, 12° ± 4.2° for class II div II and 6.88° ± 4.7° for class III malocclusion. Israr *et al.*, studied the difference in collum angle between class II div-I and class II div-II groups [7]. The average value for the Collum angle in their study showed Class II division 1 sample to be 3.65° ± 3.79° and for Class II division 2, it was 10.03° ± 4.37°. The results of this study were similar to ours. A previous study by Williams and Woodhouse also suggested the crown-to-root angle of the Class II Division-II group to be greater than that of Class I, Class II Division 1, and Class III groups [9]. These results were consistent with our study. Our study showed a significantly increased crown-to-root angle in Class II div II malocclusion group when compared to other malocclusions. A study by Patel showed results similar to ours when crown-to-root angle was calculated for subjects with Class II div II malocclusion [12]. Shailaja *et al.*, reported similar findings stating that crown-to-root shape of maxillary central incisor significantly alters the supplemental angulation and this explains the greater axial angle in the div II group of malocclusion [13]. A cephalometric study in Egypt found the collum angle to be greatly increased in patients with horizontal growth pattern when compared to the vertical growers. Class II div II malocclusion was noted to have a predominant horizontal pattern of growth [14]. This may indicate a genetic influence on the collum angle. According to our study the lower lip line was shown to significantly contact the middle third of the central incisor in Class II division II group when the location of lower lip line on

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maxillary central incisor was analyzed in all four groups of malocclusion. Srinivasan also reported the lower lip line to contact the middle third of the central incisor most frequently in Class II, division 2 malocclusion [15]. The study reported that the labial soft tissue pressure on the maxillary central incisor is also closely related to an increase in collum angle. Patients having malocclusion categorized as class II div II, have their mandible compressed within the maxilla and tongue postured downward. This pattern results in an equilibrium that is in favour of labial soft tissue. Backlund and Logan indicated in their respective studies that lower lip pressure and also genetic pattern considerably affect the collum angle [16, 17]. Lapatki also concluded in his study that lower lip pressure is an influencing external factor resulting in increased angle between the crown-to-root of the maxillary anterior dentition [18, 19]. The results of these studies were consistent with ours. It has been indicated that since the lower lip rests on the middle third of maxillary central incisor in the class II div II malocclusion this may be the reason for an elevated angle in this group. Care must be excersized when incorporating torque in the maxillary central incisors in Class II div II malocclusion where the root lies in close contact with a thin palatal cortical plate. From an orthodontic perspective, the collum angle plays a pivotal role in treatment planning. Forces in vertical dimensions such as intrusion and extrusion in different malocclusions are greatly influenced by the magnitude of angle between the crown and root axis [20]. In the present times, dental implants are considered a more esthetic means of replacing a missing tooth, especially in the maxillary anterior zone. Since collum angle differs greatly among various malocclusions, attention should be paid to morphology and angles of abutment used. Due to the increased bending angle in class II div II malocclusion, certain specifications must be added to the abutment in the anterior zone. Angulated abutments are essential while replacing a tooth with an initial large collum angle. This will help prevent unwanted & damaging cosmetic effects [21].

CONCLUSIONS

Patients with Class II Divison II malocclusion exhibit a greater value of Collum Angle as compared to other groups of malocclusion. The lower lip position largely affects the labiolingual inclination of maxillary anterior teeth. Lower lip line resting on middle third of the crown of maxillary anterior teeth in the class II div II group is an important contributing factor for the significantly greater collum angle in this group.

Authors Contribution

Conceptualization: AK
Methodology: HA, IU, AK
Formal analysis: AA
Writing-review and editing: AF, IK

All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

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