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MAXILLARY CENTRAL INCISORS' COLLUM ANGLE IN DIFFERENT SKELETAL VERTICAL MALOCCLUSIONS – A CEPHALOMETRIC STUDY

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ABSTRACT

Introduction: The Collum angle can be defined as a crown root supplementary angle of maxillary central incisors. The aim of the study was to assess the maxillary central incisors' collum angle in a sample of Egyptian patients with different vertical malocclusions using cephalometric radiographs.

Methods: Ninety lateral cephalometric radiographs were collected and divided into three groups, with equal size, according to lateral cephalograms (SN-GoGn angle). Group I: consisted of lateral cephalmetric radiographs of 30 who had the strongest predominance of horizontal growth pattern (SN-GoGn ≤28º), Group II: consisted of lateral cephalmetric radiographs of 30 subjects who had the strongest predominance of vertical growth pattern (SN-GoGn ≥35º). Angular and linear parameters on cephalometric radiograph for each subject were measured to identify the facial growth patterns, and Collum angle was then measured.

Results: mean of collum angle for the maxillary central incisor in horizontal growth pattern sample was 7.8°±2.2° with minimum being 5° and maximum 14°. The mean values for vertical growth pattern was 2.1°±2.1° with minimum 0° and a maximum 6°. Paired samples t-test comparison revealed that there was a high significant increase in maxillary central incisor collum angle in horizontal growers than in vertical growers, mean difference being 5.7°±1°.

Conclusion: Maxillary central incisor collum angle in horizontal growers is higher than in vertical growers.

KEY WORDS: Collum angle; horizontal growth pattern; vertical growth pattern.

INTRODUCTION

Seeking orthodontic treatment can be motivated by facial aesthetics improvement, that is considered as one of the most important motivating factors [1]. Smile plays a critical role in dental aesthetics and social behavior[2]. Smiling aesthetics, especially frontal smiling aesthetics, have been frequently studied in dental literature and thus formed the basis of this study[3].

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Facial growth in a sagittal direction is composed of vertical (downward) & horizontal (forward) components. Vertical growth value must be considered by orthodontists as it relates to horizontal growth and how the total growth effect in vertical and horizontal directions produces different facial types and different amounts of vertical overbite [4].

The mandible will rotate backward (vertical growth pattern) if vertical growth at the molars alveolar processes and facial sutures was greater than that at the condyles. On the other hand, if condylar vertical growth was greater than that of both at the facial sutures vertical growth components and the molar areas vertical growth components, the mandible would rotate forward (horizontal growth pattern). So, the result of growth between vertical and horizontal direction leads to the final growth at the chin [5,6].

Variability in tooth morphology, especially maxillary central incisor is of importance in achieving an optimal Class I incisor relationship aesthetically and functionally during orthodontic treatment[7]. The key component of smiling profile is affected by anteroposterior position of maxillary incisors[8,9]. During orthodontic treatment, cosmetic defects caused by gingival recession can be attributed to improper movement of tooth. The extent of recession can be related to the collum angle [9].

Collum angle is defined as an angle formed by the intersection of the crown and root long axis. As normal incisor collum angle [assumed to be zero] has an important role in development of dentition and occlusion, torqueing of roots of these teeth lingually is affected by this angle when related to the bone of maxillary lingual cortical plate. Any variation of root angulation when repositioned may cause encroach of root on the labial or lingual cortical plate [8,9].

Cephalometric radiographs is a common method to investigate the Collum angle [10-12].

Recently CT and CBCT can be used to evaluate this angle but their applicability is reduced as cephalometric radiographs are more easily obtained in dental clinics [8,13,14].

Many studies found that the collum angle differs between different malocclusion groups in an anteroposterior direction, using lateral cephalometric radiographs [10,12].

This study aimed to assess the maxillary central incisors' collum angle in a sample of Egyptian patients with different vertical malocclusions using cephalometric radiographs.

MATERIALS AND METHODS

The present cross sectional study was performed on a selected sample of lateral cephalometric radiographs of sixty Egyptian patients admitted for orthodontic treatment. Based on lateral cephalograms (SN-GoGn angle), the sample of this study was assigned into two equal-sized groups;

Group I: Included lateral cephalmetric radiographs of 30 subjects (19 males and 11 females) who had the strongest predominance of horizontal growth pattern (low angle cases with SN-GoGn ≤28º),

Group II: Included lateral cephalmetric radiographs of 30 subjects (13 males and 17 females) who had the strongest predominance of vertical growth pattern (high angle cases with SN-GoGn ≥35 º). They were selected according to the following criteria: 1) age 8 to 10 years, 2) no anomalies in teeth number (congenital missing or supernumeraries), 3) no severe crowding or mixed dentition in the anterior area for clear assessment of maxillary central incisor axis, 4) no superimposed teeth or incisor rotations for high incisor definition, 5) no inferior image quality, 6) no previous orthopedic or orthodontic treatment and 7) no history of any disease or trauma that may affect the craniofacial growth. The selected lateral cephalometric radiographs were traced on acetate papers. Angular and linear measurements **(Table 1, Fig 2)** were made on each cephalometric radiograph for each subject in order to identify the facial growth patterns by using the following landmarks **(Fig.1)**.

TABLE (1) Definitions of cephalometric measurements

Angular measurements	
1) SN-GOGN:	This angle relates the mandibular plane to the anterior cranial base [15] **.** It denotes the anterior facial height and the steepness of the mandibular plane as well.
2) N-S-GN:	This angle determines the position of the mandible in the space relative to the cranial base [16].
3)Frankfort mandibular plane angle (FMPA):	This angle relates the mandibular plane to the Frankfort horizontal plane[17]**.** It indicates the steepness of the mandibular plane and the chin position in the space.
4) Facial axis angle (Ba-Ptm-Gn)	This angle was determined by constructing N-Ba line and the Ptm-Gn. The angle was measured from Ba to Ptm to Gn [18]**.**
Linear and ratio measurements	
5)Total anterior facial height (TAFH) (N-Me):	It was determined by constructing a sagittal axis through (S) point at an angle of 8° downward to SN line and referred to as SN\. A vertical axis was drawn perpendicular to SN\ through nasion and referred to as (SNP\). A line was drawn perpendicular to the vertical axis (SNP\) through Me. Distance denoting the anterior facial height measured along the vertical axis (SNP\) from N to Me [19].
6)Lower anterior facial height (LAFH)(ANS-Me)	Distance from the ANS to Me [20]**.** It was measured along the vertical axis (SNP\).

Measurement of Collum angle

The most convenient Collum angle measurement **(Fig.3 -5)** was derived by connecting the superius point of the incisal edge with the middle point of the cementoenamel junction (the crown axis), and then the middle point of the cementoenamel junction with the root apex (the longitudinal axis).

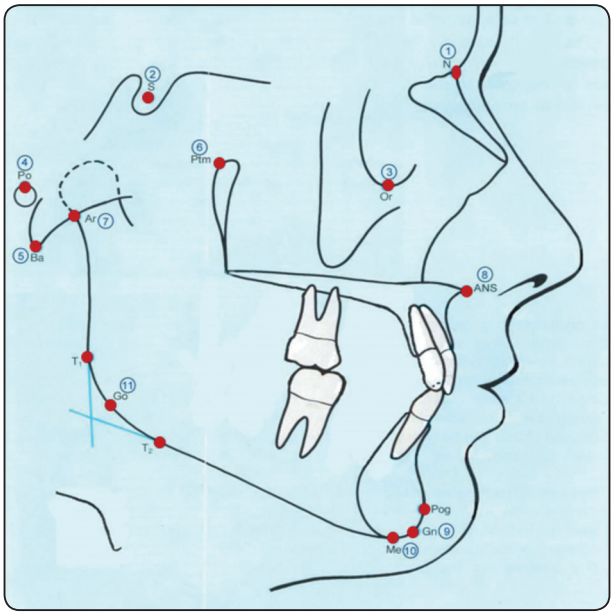

Fig (1): Cephalometric reference points:

1) N: Nasion, 2) S: Sella, 3) Or: Orbitale, 4) Po: Porion, 5) Ba: Basion, 6) Ptm, 7) Ar: Articulare, 8) ANS: Anterior nasal spine, 9) Gn: Gnathion, 10) Me: Menton and 11) Go: Gonion.

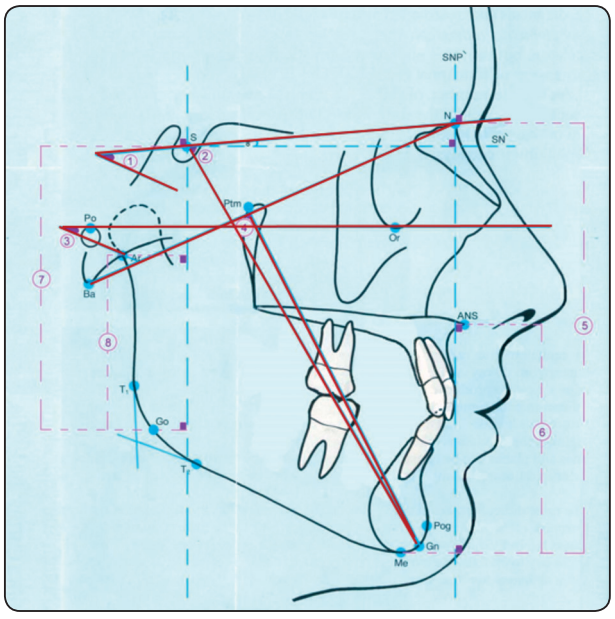

Fig. (2): Cephalometric angular and linear measurements

The variables were re-measured after a period of 2 weeks, and the readings of the first estimation were compared to the second one. Casual errors were calculated according to Dahlberg's formula[14]

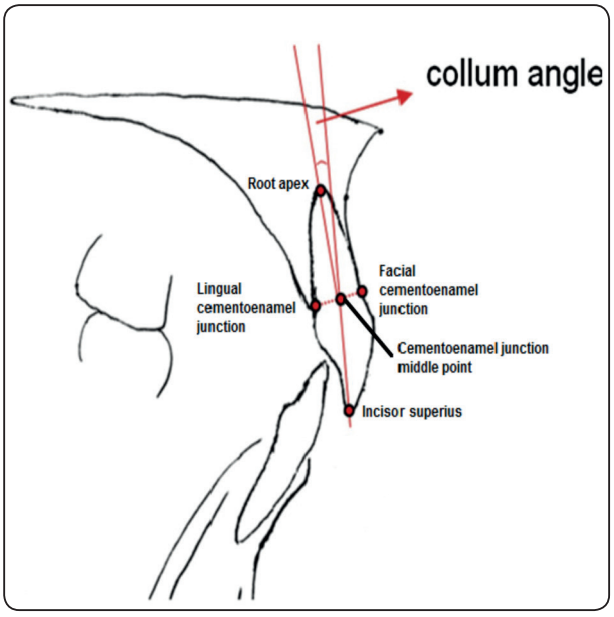

Fig. (3) Measurement of Collum angle

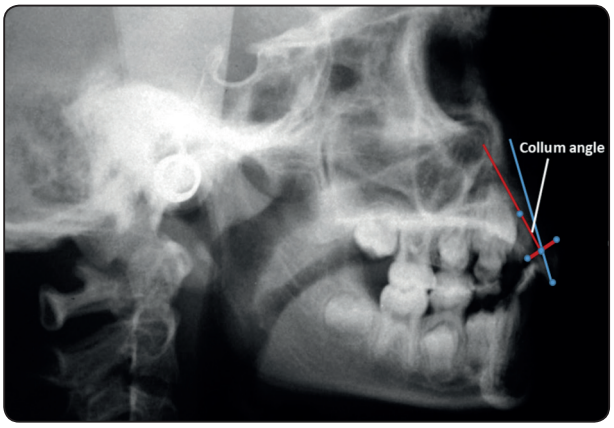

Fig. (4) Measurement of Collum angle in horizontal growth pattern

Fig. (5) Measurement of Collum angle in vertical growth pattern

$Se^2=\sum d^2/2n$ where (Se^2) is the error variance, (d) was the mean difference between repeated measurements, and (n) was the number of measurements.

Statistical analysis: All data and measurements, obtained from this study, were collected, tabulated and statistically analyzed using SPSS version 22 for Windows (SPSS, Inc; Chicago, Illinois). Mean and standard deviation were calculated for numerical variables. Paired sample t-test was used to compare between horizontal growth pattern and vertical growth pattern Collum angle.

RESULTS

Both horizontal and vertical growth patter n groups had a sample size of 30 subjects each. The age range was from 8 to 10 years. The mean was 9.06±0.67 in group I and 9±0.65 in group II. Meanwhile, subjects with horizontal growth pattern consisted of 63.3% males and 36.7% females **(Fig. 6)**, while 43.3% of the subjects with vertical growth pattern were males and remaining 56.7% were females **(Fig. 7)**.

The mean collum angle for the maxillary central incisor in horizontal growth pattern sample was 7.8° ± 2.2° with minimum being 5° and maximum 14°. The mean values for vertical growth pattern was

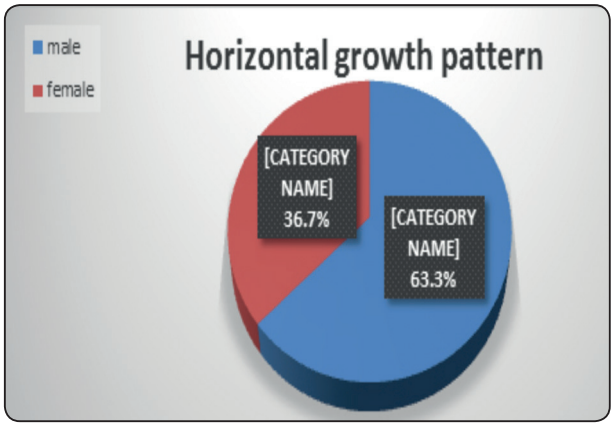

Fig. (6): Pie distribution of subjects with horizontal growth pattern by gender

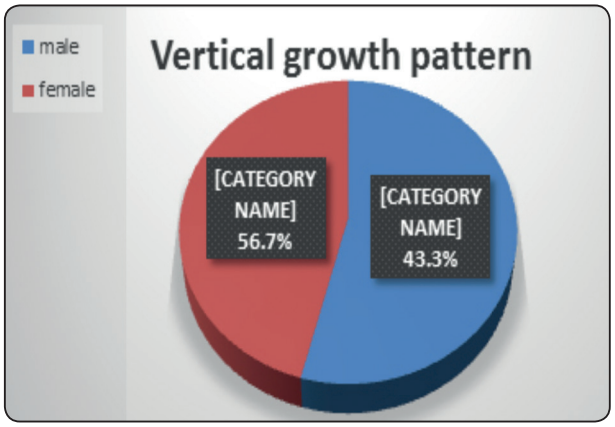

Fig. (7): Pie distribution of subjects with vertical growth pattern by gender

2.1°±2.1° with minimum 0° and a maximum 6° **(Table 2)**. Paired samples t-test comparison revealed that the maxillar y central incisor collum angle was highly significant increase in horizontal grower than in vertical grower with a mean difference being 5.7° ± 1°.

TABLE (2) Comparison of collum angle between group1 and group 2

Malocclusion type	Sample number	Mean ± SD	Range	T test	P value
GI (horizontal growth pattern)	30	7.8 ± 2.2	5 – 14	10.275	0.001*
GII (vertical growth pattern)	30	2.1 ± 2.1	0 – 6		

p ≤ 0.001 (Highly significant)

DISCUSSION

The present study was done to evaluate the maxillary central incisor collum angle in a sample of Egyptian patients with different vertical malocclusions using cephalometric radiographs.

The subjects' ages were 8-10 years with a mean of 9.06±0.67 in group I and 9±0.65 in group II. Some of them had mixed dentition but the maxillary teeth were permanent. So, results of this research was not affected by age differences.

This study results revealed that, maxillary central incisor collum angle in horizontal growers was highly significant increased than in vertical growers.

Formation of Collum angle had been explained by some reasons. Backlund [21] and Logan [22]indicated that the lower lip force and hereditary affect the crown-root angulation of the maxillary central incisors, causing bending phenomenon and Collum angle.

Previous researches studied the maxillary central incisors collum angle in different skeletal malocclusions.

Patients with class II division 2 malocclusion are considered as horizontal growers. Results of this study go in line with previous study who stated that, the maxillary central incisor collum angle in horizontal growers differs from that different classes of malocclusion. This can be attributed to lingual bending of roots of maxillary central incisors in class II division 2 malocclusion [9].

On the other hand, other study found a difference in maxillary central incisors collum angle in Class III patients compared to Class I and Class II division 1 patients but they excluded class II division 2 subjects from their research sample [10].

A significant difference was found in Collum angle of horizontal grower group from other malocclusion group types [23]. They attributed that to hereditary differences between Western and Oriental races. Oriental races have greater bimaxillary protrusion in bone development than Western races. This protrusion can be compensated by increasing bending of tooth axis. These findings were in accordance with those found by other researches [7,24,25].

Srinivasan et al; 2013 inferred the increase of Collum angle in horizontal growth pattern may be due to change of lower lip line in various malocclusion types [26].

Aslam et al; 2010 stated that, class II is the most common type of malocclusion in Pakistani patients, with the highest significant increase of maxillary incisors collum angle in class II division 2 patients. Retracted incisors with shorter roots, longer crowns, increased axial curvature and reduced labiolingual thickness can complicate orthodontic treatment [27].

From orthodontic view point, intrusion forces exerted by teeth with large collum angle are lower than that exerted by those with small collum angle. During retraction, periodontal ligament of maxillary central incisor experiences more stress if the Collum angle is large and vice versa [28].

The contributing factor in the development of the deep bite seen in Class II, Division 2 patient which is considered as horizontal grower is the lingual "bending" of the crown on the root. The central incisor crowns extreme retroclination can be attributed to an abnormal crown-root angulation and improper positioning of the tooth within the maxilla. This extreme retroclination may cause impingement of the root on palatal cortical bone during torqueing in a palatal direction. So, the position of the central incisor roots and the anatomic form of the surrounding bone in horizontal grower patients must be evaluated more closely [9].

CONCLUSION

- The maxillary central incisor collum angle in horizontal grower is higher than in vertical grower.
- From orthodontic view point, intrusion forces exerted by teeth with large collum angle are lower than that exerted by those with small collum angle.
- During retraction, periodontal ligament of maxillary central incisor experiences more stress if the Collum angle is large and vice versa.

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