COMPARISON OF COLLUM ANGLE IN DIFFERENT SKELETAL GROWTH PATTERN USING CEPHALOMETRIC RADIOGRAPHS AMONG ORTHODONTIC PATIENTS IN TERTIARY DENTAL CARE CENTER OF KATHMANDU

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ABSTRACT

Collum angle has been previously studied in different types of sagittal malocclusion but very few studies have focused on vertical malocclusion in our population. Since collum angle is responsible for variation in torque expression, root resorption, fenestration and dehiscence, with prior knowledge of collum angle in high angle and low angle cases, operator can prevent above deleterious effects and accompanied better bracket positioning in future orthodontic treatment. Lateral cephalograms of all the patients of age group 13-30 years attending Department of Orthodontics in Nepal Medical College from October 2023 to March 2024, having clinically harmonious and symmetrical face, full complement of dentition except third molar, minimum crowding were taken. Based on the value of SNMP (Sella-Nasion and Mandipular plane), and Jarabak ratio, the samples were divided into high angle and low angle. Collum angle was drawn and measured in terms of degrees. The data were transferred to SPSS-17 for further analysis. A total of 60 study participants were included in the study with an equal number of male and females. (30 each with age ranging from 13 to 30 years with mean age 19.18±3.89 years) There was an equal distribution of study participants in horizontal and vertical growth patterns (30 each). There was no statistically significant difference in mean collum angle between study participants in horizontal and vertical growth patterns (p = 0.09). No statistically significant difference in mean collum angle between study participants in horizontal and vertical growth patterns in relation to gender was found (Male p = 0.08 and female - p-value 0.55).

KEYWORDS

Collum angle, high angle, low angle, maxillary central incisor, orthodontic treatment

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INTRODUCTION

The improvement of facial aesthetics is one of the most important motivating factors for patients seeking orthodontic treatment.[1] Smile plays an important role in dental aesthetics and social behaviour.[2] Sagittal position of maxillary incisors is also one of the key components of smiling profile.[3] Maintaining maxillary and mandibular incisor alignments is of highest esthetic priority.[4]

Variability in tooth morphology, especially maxillary central incisor is of importance in achieving an optimal Class I incisor relationship. As it affects the relationship of bracket slot to the occlusal plane, during orthodontic treatment optimal occlusion of teeth will be compromised which affects aesthetic and function.[5,6]

The angulation of the root to the crown, particularly of the single rooted anterior teeth is known as collum angle. Collum angle is formed by the intersection of the long axis of the crown and root using the lateral cephalogram.[7] The degree to which the roots of maxillary central incisors can be torqued lingually in relation to the maxillary lingual cortical plate of bone also depends on crown to root angulation of these teeth.[8,9] Deviated root angulation affect intended axial loads for intrusion and extrusion and may cause the root to impinge on the labial or lingual cortical plate when repositioned. It influences the extent to which the roots can be torqued particularly in lingual direction in relation to the cortical plates. [8]

Use of lateral cephalometric radiographs is the most common method for investigating the the collum angle.[10] Although computed tomography (CT) and cone-beam computed tomography (CBCT) can provide three-dimensional spatial structural information, using cephalometric radiographs provides sufficient information about the central incisors.[11] Additionally, in dental clinics, CT and CBCT are not as easy to obtain as cephalometric radiographs which are mandatory for orthodontic treatment, reducing their applicability.[12,13]

Fig. 1: Schematic representation of measurement of the collum angle

Lower lip pressure and genetic factor play role in crown-root angulation of maxillary central incisors. It resulted in the bending phenomenon of collum angle.[10,14] Relapse tendencies are more when there is failure to guide a proper lip closure in skeletal class II malocclusion.[14,15]

Prominent palatal bending of the maxillary incisor crown is present in Angle's Class II Division 2 malocclusion. This retroclination can be assessed quantitatively by determining the collum (crown-root) angle. Studies has shown that increased collum angle of the maxillary central incisor is seen in Angle's class II div 2 malocclusions.[16-18]

Recently, dental implants are widely being used for replacing missing teeth. Previous studies indicated that in cases where angled abutment was used in anterior zone, there is possibility of gingival recession, due to concentration of stresses on turning point between buccal side of fixture and abutment which may lead to esthetic problem.[17]

There are numerous studies in the literature comparing collum angle in various skeletal patterns and different Angle's malocclusion.[19-24] However, literatures on comparison of collum angles in different growth pattern are very limited. This study aims at the comparison of collum angle in different skeletal growth pattern in Nepalese population.

MATERIALS AND METHODS

Lateral cephalograms of all the patients of age group 13-30 years attending department of orthodontics in Nepal Medical College from October 2023 to March 2024, having clinically harmonious and symmetrical face, full complement of dentition except third molar, minimum crowding were included. Each patient selected for the study was explained about the study and each patient was instructed to sign written consent form. Consent from guardians also was taken from patients of age below 18 years. Ethical clearance was obtained from Research and Institutional Review Committee, Nepal Medical College (Ref. No: 33-080/081).

A single calibrated examiner traced all the cephalometric radiographs, located all points, and measured all angles. Based on the value of SNMP (Sella-Nasion and mandibular plane),

and Jarabak ratio, the samples were divided into high angle (SN-MP > 37°, FH-MP > 30°) and low angle SN-MP < 28°, FH-MP < 21°).[10,18]

Collum angle measurement: Collum angle was drawn and measured in terms of degrees on a proforma for each patient. This angle is formed by the longitudinal axis of the crown and the root. The longitudinal axis of the incisor is a line passing through the midpoint of the cutting edge of the incisor to the radiographic center point of the crown at cementoenamel junction (CEJ). The longitudinal axis of the root is a line passing through the radiographic apex to the midpoint between the lingual and facial projection of the cementoenamel junction (Fig. 1).

Patients having clinically harmonious and symmetrical face, full complement of dentition except third molar, minimum crowding was included in the study. Patient with supernumerary teeth, hypodontia, fixed or removable prostheses, orofacial clefts or other craniofacial syndromes, poor incisor definition due to superimposed teeth, incisor rotations, dilacerations, any surgical treatment history, or inferior image quality of lateral cephalogram were excluded.

Convenience sampling technique was applied and sample size was calculated using the formula for comparison of two means:

Sample size (n) $=2(Z\alpha+Z\beta)^2 S^2/d^2$

$=29.6$ (30 approximately) per group

Where,

$Z\alpha$ = Z value for α level = 1.96 at 95% confidence interval

$Z\beta$ = Z value for β level = 0.84 for 80% power

S = average standard deviation = (S1 + S2)/ 2 = 8.14

d = difference between the two means = 5.92

{S1 (Standard deviation in horizontal growers) = 7.33 and S2 (Standard deviation in vertical growers) = 8.94, mean1 (mean in horizontal growers) = 6.15 and mean 2 (mean in vertical growers) = 0.23, taken from a study.[10,18,25] So minimum sample size would be 60 (30 x 2).

Data was entered, coded and edited using Microsoft Excel and transferred to SPSS-17 for further analysis. Descriptive statistics was presented in the form of frequency, percentage, mean and standard deviation. Independent t-test was done to compare the mean difference of collum angle between vertical and horizontal growth pattern (high and low angle) of the patients and between male and female. Level of significance will be set at p value < 0.05.

RESULTS

A total of 60 participants were included in the study with an equal number of male and females (30 each). The age of the study participants ranged from 13 to 30 years with mean age 19.18±3.89 years. There was an equal distribution of study participants in horizontal and vertical growth patterns (30 each). There was no statistically significant difference in mean collum angle between study participants in horizontal and vertical growth patterns (p = 0.09) as shown in Table 1. There was no statistically significant difference in mean collum angle between study participants in horizontal and vertical growth patterns in male (p = 0.08) and female (p = 0.55) as shown in table 2.

Table 1: Comparison of mean collum angle between horizontal and vertical growth patterns

Growth pattern	Collum angle Mean±SD	p-value
Horizontal (n=30)	6.07±3.56	0.09
Vertical (n=30)	7.90±4.62	

*Independent t-test, p-value <0.05 statistically significant**

Table 2: Comparison of mean collum angle between male and female

Gender	Growth pattern		p -value
	Horizontal mean±SD	Vertical mean±SD	
Male	5.73±2.69	8.47±5.18	0.08
Female	4.34±1.12	4.08±1.05	0.55

*Independent t-test, p-value <0.05 statistically significant**

DISCUSSION

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

Few authors have explained that bending of the maxillary central incisor forms the collum angle whereas others stated that it is due to the force generated by lower lip affecting the maxillary central incisor growth.[15] It has also been proposed that genetics and heredity play an important role in this phenomenon.[26,30]

Previous studies have proven that collum angle varies with different types of Angle's malocclusion with increased angle in Class II Division 2. Few studies have shown the association between collum angle and skeletal malocclusion in sagittal plane. It was found that collum angle of maxillary central was increased in skeletal class II and mandibular central incisors in skeletal class III malocclusion.[19] This study was performed to determine if there are any correlations between collum angle and facial growth pattern.

With the advent of CBCT, similar studies could be conducted for every tooth using analogous measurements. Since CT and CBCT are not as mandatory as cephalometric radiographs for orthodontic diagnosis and treatment planning, the present study was conducted using lateral cephalograms. It has been proven that cephalometric radiographs provide sufficient information about the position and angulation of central incisors.[11]

For orthodontic tooth movement, ideal bracket positioning (to obtain ideal tip and torque) is necessary. The anterior torque expressed in the bracket is important to attain the normal overjet, overbite, optimum esthetic, and ideal occlusal relationship. However, the ideal torque is difficult to express because of variation in morphology of each tooth, different wire material properties and slots sizes, ligation methods, and clinician experience.[24]

The relationship between collum angle and sagittal skeletal relationship were studied by various authors. Shailaja *et al*[8] and Delivanis[16] observed that the incisal angulation of crowns was more in Class II division 2 patients with positive collum angle. However, there are very few studies showing comparison of collum angle in horizontal and vertical growers.

Khan *et al*[13] performed a study to compare the collum angle of maxillary central incisors in Class II Division 1 and 2. They mentioned that the amount of torque expressed during treatment to achieve dental compensation should be taken into account. It was mentioned that the cephalometric techniques proposed in their study could also be applied to a Class I and III samples.[13] The present study was performed in Class I patients as Class I malocclusion being the most common malocclusion among Nepalese population.[31,32]

The comparison of mean collum angle with growth pattern in few studies suggests that there is a tendency towards increased collum angle in horizontal growth pattern among Nepalese and Egyptian populations.[5,10] However, in this study no statistically significant results were found in mean collum angle between horizontal and vertical growers, which is different from the study done by Shrestha *et al*.[10] in same population. Since Nepal is a country with many racial subgroups and interracial mixtures which might affect the growth pattern of the jaw and the collum angle.[33] In the previous studies, the sagittal relationship of the samples included have not been mentioned, but the present study was performed among skeletal class I patients only due to which results might be contradicting.

Before CBCT was invented lateral cephalometry was the only way to investigate labial surface angle and collum angle.[20-22] Collum angle of maxillary central incisor in sagittal malocclusion has been studied previously in western population[3,6,10,24,25] as well in Asian population[13,24] but studies showing collum angle in vertical skeletal malocclusion using lateral cephalogram in Nepalese population are limited, which was the reason this study was chosen.

CBCT analysis of collum angle of the maxillary central incisors was performed in different types of malocclusion among Saudi, Jordan and Egyptian population. Males sample showed greater value of collum angle for each group as compared to the females and this difference was statistically significant for all the groups other than for Class I.[29] In the present study, no statistically significant differences were seen among gender.

In contrast to the present study, Behroz *et al*[25] reported that the collum angles of vertically growing patients were significantly higher than horizontal growing patients suggesting that morphology of maxillary central incisor play an important role in root resorption, dehiscence, fenestration and torque variation because of the root bending phenomenon and showing ethnic and racial predisposition to collum angle. However, no significant differences were found among gender, which is in concurrent with the present study. Clinically crown root morphology need to be assessed before positioning the brackets.

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. In the present study,

only patients having Class I malocclusion were taken into account, which could be the reason for statistically insignificant results among vertical and horizontal growers.[5]

In this study the mean collum angle in horizontal growth pattern and in vertical growth pattern were 6.07º±3.56º and 7.90º±4.62º respectively, which is a bit higher in vertical growth pattern but not statistically significant. Wang *et al.*[19] measured the collum angle of the maxillary central incisor in different vertical malocclusions and reported the value to be 0.94º±4.62º in high angle, -1.02º± 6.03º average, and 1.74º±5.28º in low angle cases. However no statistically significant results were found, which is similar to the present study.

Resorption of maxillary central incisor root is influenced by changes in the treatment and biomechanics. In few other studies done previously, it was reported that root translation or torquing into the palatal cortex significantly increases the chances of root resorption.[18,25] In order to achieve better predictability in root position, and to overcome the difficulties and consequences with intrusion, extrusion, or torquing mechanics, a good knowledge of crown-root relationships in the bucco-lingual plane is needed.[20]

Since the study population was taken from a single dental teaching hospital, lack of generalizability of the results may occur. Future researches must be also directed to investigate, by means of cone beam computed tomographic evaluations, not only maxillary central incisors collum angle but also its pretreatment position and its surrounding alveolar bone characteristics as potentially predictive factors for palatal cortical plate perforation and external root resorption. Comparison of collum angle between the younger and older age group, to see if the angle changes due to constant strain from the lip as the age progresses could be done in future.

This study concluded that there is no statistically significant difference in mean collum angle between horizontal and vertical growth pattern and gender. Although the mean collum angle for vertical growers was slightly more than horizontal grower, but the results were not statistically significant results. Similarly, male population had higher collum angle compared to female population, which was also not statistically significant.

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