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Research Article

Determination Of Parallelism Between Constructed Maxillary and Mandibular Planes By Cephalometric Analysis: An In-Vitro Study

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ABSTRACT

Cephalometric variables play a crucial role in orthodontics, serving as angular and linear measurements which are used for diagnosis, treatment planning, and assessing treatment outcomes. However, the reliance on mean values accompanied by significant standard deviations poses challenges in correctly interpreting cephalometric clinical data. This discrepancy has been particularly pronounced in addressing maxillomandibular relationships that evolve over time.

While the literature provides a consensus on the horizontal plane and its relationship to both centric occlusion and centric relation, but the vertical plane remains a topic of debate, especially for individuals with altered posterior tooth height. Historic attempts, such as Willis's concept of "harmonic faces," was given to establish facial harmony across the various thirds of the face i.e. upper, middle, and lower thirds. Various authors have pursued research in defining such standards, yet current studies lack a systematic utilization of facial angles in cephalometric tracing to identify harmonious maxillomandibular relationships.

This study aims to bridge this gap by proposing a methodology for determining parallelism between constructed maxillary and mandibular planes through cephalometric analysis. By utilizing fixed facial landmarks and maintaining facial height, the study will design a system that relies on bone structures, making it adaptable to complete or partially edentulous patients. The intention is for this methodology to be adopted by future researchers in clinical studies to further refine and substantiate its utility in orthodontic practice.

Key words: Maxillary plane, Mandibular plane, Parallelism, Cephalometric analysis, Treatment plan

Introduction

In orthodontics, cephalometric variables are used for both linear and angular measurements. The mean values with standard deviation make up these cephalometric measurements or values. These measurements' values are used by orthodontists for diagnosis, treatment planning, and evaluation of orthodontic treatment results [1-3]. Lately, a number of studies have concentrated on re-establishing or developing maxillomandibular interactions that have evolved throughout time.

The degree of deviation or mal-relationship is determined during diagnosis by comparing the patient's cephalometric measures to the relevant norms. Orthodontists utilize these standards as a guide to help them set goals for their treatments. Orthodontists typically evaluate the effectiveness of orthodontic treatment by comparing the pre- and post-treatment measurements and comparing them to the norms. The standard deviations of several of the mean values are high, though. It could be challenging to accurately assess the cephalometric clinical data as a result.

Regarding the mandible's position in a horizontal plane, there is agreement in the literature [4– 8]. This agreement incorporates evaluation and methods associated with the ideology regarding the centric relation and, ultimately, central occlusion. However, there is still debate in the literature regarding the issue in the vertical plane, especially about individuals whose posterior teeth have undergone alterations in height.

Using cultural standards for "harmonic faces", Willis presented a system that sought to create harmony between upper, lower and middle thirds of the face [5,6]. According to Cerveira Neto, numerous authors have done research with the goal of defining standards that would validate this association [9]. However, no current studies establish the usage of facial angles in cephalometric tracing to identify the harmonic relationship between the maxilla and mandible. This study aims to determine parallelism between constructed maxillary and mandibular planes by cephalometric analysis.

Materials and methodology

From the patient data files of patients undergoing fixed orthodontic treatment at SRM Kattankulathur Dental College and Hospital, 50 lateral teleradiographs measuring 24x30 cm were chosen for this study.

a. INCLUSION CRITERIA:

1. Individuals aged above 18 years who are dentate, irrespective of the presence or absence of the third molar
2. Individuals without previous encounters with orthognathic, surgical, reconstructive, or orthodontic treatments
3. Restorative procedure not more than two posterior teeth in the upper and lower arch
4. Patients who are diagnosed as skeletal class I, and the vertical dimension at occlusion has been maintained

b. Exclusion criteria:

1. Patients who have previously undergone orthognathic, orthodontic, surgical, and reconstructive procedures
2. Restorative treatments in not more than two posterior teeth in upper and lower arch
3. Patients with skeletal Class II, Class III, deep bite, open bite malocclusion

Random selection was used to choose 25 male and 25 female patients, all between the ages of 18 and 29, with the requirement that they reflect a range of ethnicities.
Using adhesive tape, a cephalometric tracing sheet was affixed to each radiograph to get the designs. Graphite pencil was used to mark the anatomical locations under a negatoscope in a dark atmosphere. There were also two tools used: a ruler and a cephalometric protractor (DB Orthodontics Limited).
Anatomical structures which were used and therefore transferred were nasal bone, maxilla, orbit, mandible, palate, frontal bone, external auditory meatus, and pterygomaxillary fissure.
Among these bony structures, the below-mentioned anatomical points were traced (Fig. 1)

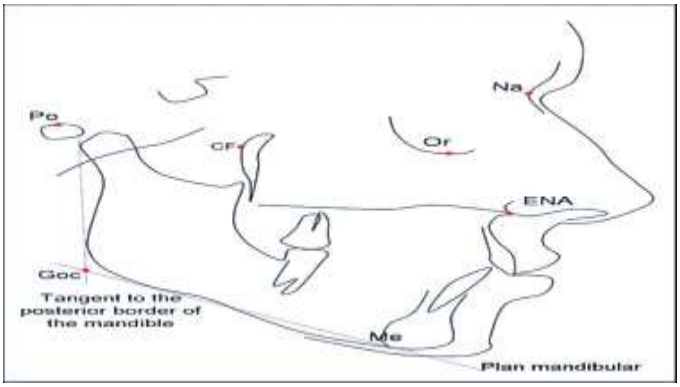

Fig 1 – Straight line design.

1. Nasion (Na): the most anterior point in the midsagittal plane of the frontonasal suture.
2. Menton (Me): the most inferior point in the outline of the symphysis of the mandible in the midsagittal plane.
3. Anatomic porion (Po): the most posteior and superior point in the outer bony surface of the external auditory meatus.
4. Anterior nasal bone (ENA): the most anterior point of the floor of the nasal airway, in the mid sagittal plane.
5. Orbitale (Or): the lowest point on the inferior margin of the orbit.

In case of double images of a point the average distance between the two points obtained is used as the design guideline in radiographs.

1. Facial center (CF): point on the posterior wall of the pterygopalatine fissure, constructed from a line that is perpendicular to the Frankfurt plane (Fig 2)

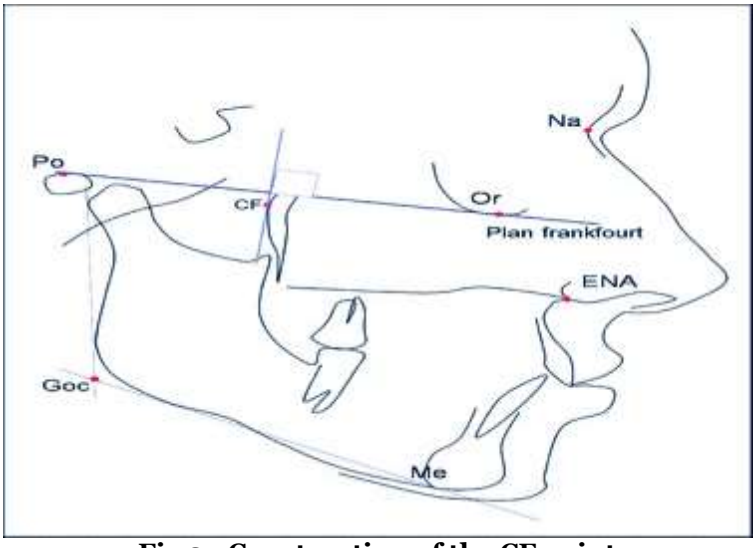

Fig 2 - Construction of the CF point

2. Na–CF: line marked between the nasion points and the facial center
3. CF–ENA: line marked between the anatomical points of the facial center and the anterior nasal bone.
4. Mandibular plane: a plane running through points Menton and Gonion
5. Constructed gonion (Goc): located on the vertex of the angle formed by the intersection of the tangent to the posterior border of the ascending ramus of the mandible, together with the mandibular plane
6. Frankfort plane: a line joining porion to orbitale

Using Na - F and CF-ENA planes as the reference, the UA (Upper angle) of the facial upper third was measured using a protractor (Fig 3)

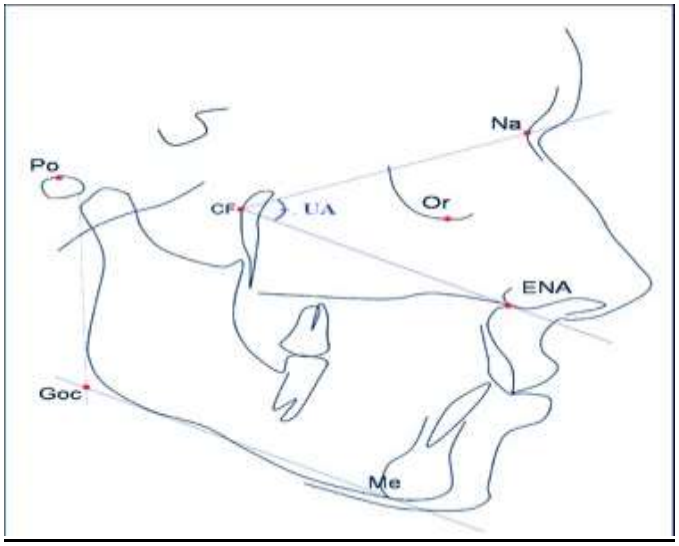

Fig 3 - Construction of the upper angle.

Value discovered in the Upper Angle (thus generating a new angle called TLA [Transferred lower angle]) was then computed, with the protractor's center placed at the point Goc (Fig. 4).

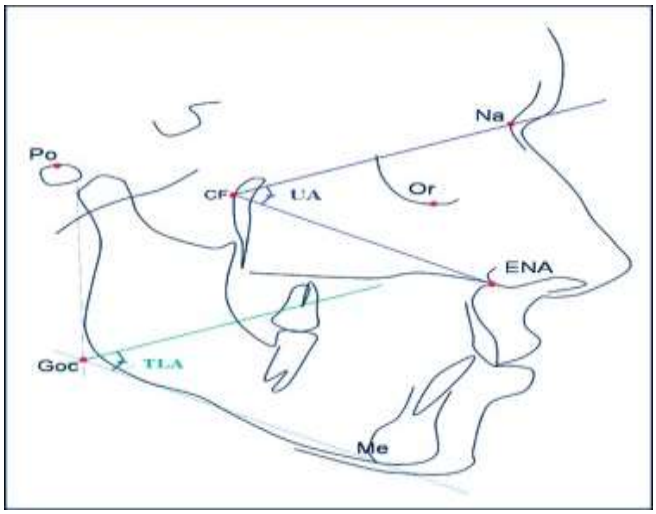

Fig 4 - Construction of the transferred lower angle

This angle's top edge crosses the Upper angle's lower edge. A third angle, known as the MA (middle angle), was created at the intersection (Fig. 5).

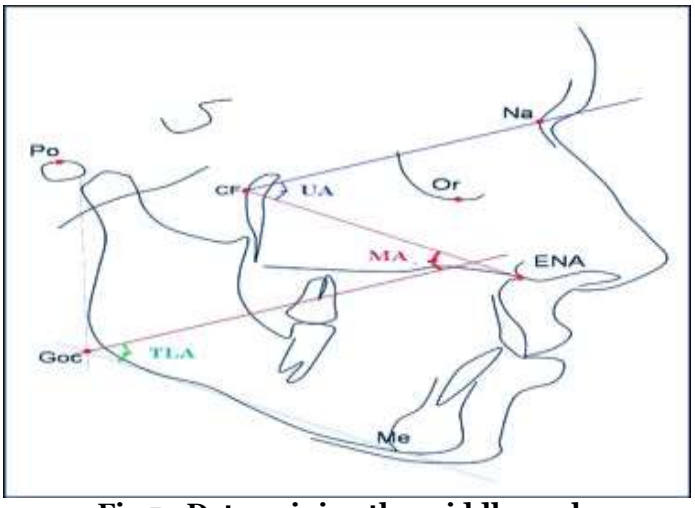

Fig 5 - Determining the middle angle

The CF - ENA, and Goc – Me were almost parallel as seen in Figure 6, which may be seen after forming the third angle. The measurement acquired for the UA and MA in each of the 51 designs were appropriately recorded for a subsequent comparison between the statistical and cephalometric studies.

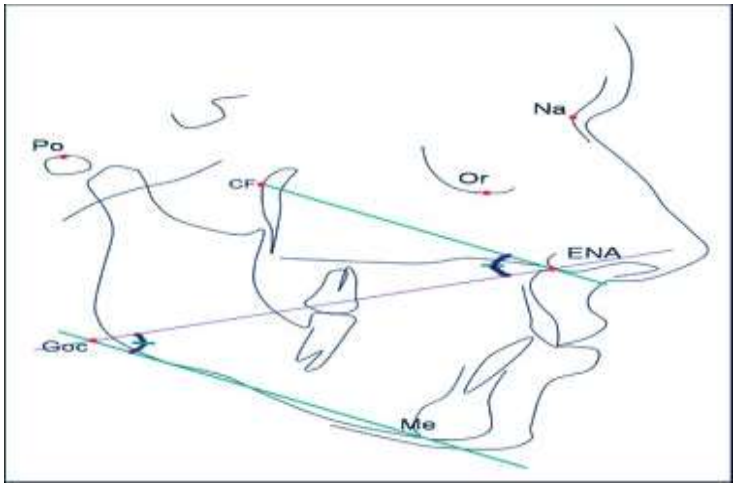

Fig 6 - Parallelism confirmed

Following the collection of the data, appropriate documentation was made, and statistical analysis was carried out. To find out if there was a difference in the angles' measured according to gender (male and female) and angle type (upper and middle), the analysis of variance (ANOVA) test was employed. The middle and upper angle measurements were compared statistically using the paired t-test.

Results

All 50 radiographs examined in this study had their UA determined; the values ranged from 45 to 52 degrees, with an average of 49.294 degrees. It should be emphasized that no statistically significant disparity could be found between the genders; in male patients, obtained values varied from 45° - 52°, with an average value of 49.628°, in female individuals, the values were in the range of 47°- 52°, with average value of 48.96°.
Considering these details, the transference of values was used to determine the TLA. According to statistics it was found that there was no difference between the TLA and the UA. In all of the teleradiographs, the third angle (MA) can likewise be found by taking into account these two angles.
TABLE 1 describes the values that were discovered.

TABLE 1

AGE/SEX	UA	MA
18/F	50	50
24/F	51	51
20/F	55	55
21/F	50	50
24/F	48	48
28/F	51	51
21/F	47	48
23/F	49	48.5
22/F	50	50
19/F	49	48
22/F	51	51
23/F	50	50
18/F	50	49
20/F	50	51
22/F	52	51

21/F	50	49
25/F	47	47
22/F	48	48
22/F	48	48
24/F	48	48
21/F	50	50
21/F	50.2	51
18/F	49	49
21/F	48.5	48.5
18/F	49	49
18/M	50	50
18/M	46.5	47
18/M	51	51
29/M	50	50
18/M	49	49.5
18/M	47	47
18/M	50	50
18/M	48	48
21/M	48.5	48
24/M	49	49
20/M	50	50
28/M	52	51.5
21/M	50	51
20/M	48.5	48
19/M	52	52
23/M	45	46
19/M	45	45
18/M	51	50.5
25/M	49	49
19/M	51	50.5
18/M	46	45
19/M	47	46.5
19/M	50	48.5
20/M	47	47
18/M	51.5	52

As can be seen in Table 2, there were no discernible variations between the two angles in the descriptive statistics between the Upper and Middle angles. The paired t-test was the statistical method employed to compare the MA and UA measurements. In this test, a CI of 95 % was employed (CI – Confidence interval). The p-value came as 0.034 which shows that there was no statistically significant difference between the UA and MA.

Table 2. Descriptive Statistics between the Upper and Middle angles

Sample	N(Sample size)	Mean	Standard Deviation	SE Mean
Upper Angle	50	49.294	1.903	0.269
Middle Angle	50	49.220	1.898	0.268

A regularly distributed difference between the variables validated the t test. A normal distribution of the UA and MA was seen. (Fig. 7)

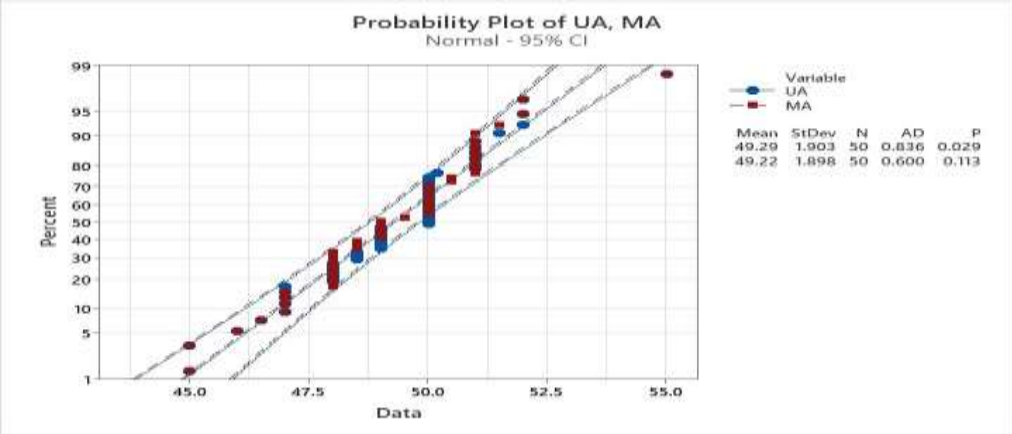

Fig. 7 Validated t-test

Discussion

During orthodontic treatment, the orthodontist must ensure that all the thirds of the face are harmonious. The quality of life of the patient depends on the harmonious stomatognathic system, which is severely compromised when the lower third of the face height is not restored. Developing a system that would function for all adults irrespective of gender or ethnic origin, was the aim of the current study.

After examining multiple reliable cephalometric evaluations, fixed maxillary relations were identified, that can be translated to the mandible. As a result, an angular correlation, in the vertical plane, might be possibly used to construct a maxillomandibular relationship. Thus, it was possible to observe that an Upper Angle was established from the nasion, facial center and anterior nasal bone (Na-CF-ENA). In addition, as previously mentioned, the UA was renamed the TLA and moved to the mandibular plane. A third angle known as the MA was also formed when the higher edge of the TLA crossed the lower edge of the UA. Results for the aesthetic analysis indicated that for every person under study, the UA equaled the Middle Angle and the Middle Angle equaled the Transferred Lower Angle. As a result, it is possible to draw the conclusion that the upper edge of the Upper Angle and the lower edge of the Transferred Lower Angle are parallel to the upper edge of the TLA and the mandibular plane, respectively.

Tales de Mileto's theorem of parallel straight lines can be used to build the inverse path, which entails finding the UA and creating the mandibular plane parallel to its lower border. In all dentate adult cases, these lines appeared to be parallel. For individuals whose back tooth crown height has changed or disappeared, the mandible can be adjusted to maintain the parallelism of these previously mentioned straight lines. The lowest third facial height was finally determined by the parallelism between these straight lines. Since the alternate angles are equal, the Upper Angle value remains unchanged.

According to Brzoza et al. soft tissue reference points are ill-defined and unstable. Because of this, using bone references improves the precision of these measures [9]. Nevertheless, the study's findings are predicated on predefined average values that do not show the possibility of individualization. Regardless of whether teeth are present or not, the anglular values pertaining to the upper and middle facial thirds should show a relationship with the anglular values found within the lower facial third [10].

Stomatognathic system, as well as the patients' quality of life, are adversely affected when lower facial height is not restored, according to authors such as Ciftci et al. [7], Sheppard and Sheppard [8], Miyasaki et al., and Shimizu et al. [11]. The gonial angle must be included in the construction method used for this study, although it need not be used. This indicates that in order to apply the methodology outlined in our study to edentulous patients, who have lost their vertical dimension at occlusion, the mandibular plane should be used instead of the gonial angle in order to properly position the jaw. It is not possible to compare this research's methodology

with other established cephalometric techniques since it uses cephalometric analysis to establish the parallelism of a created maxillary and mandibular plane. Nonetheless, an attempt was made to demonstrate the effectiveness of the Seraidarian-Tavano approach by contrasting the study's findings with those of a related study conducted by Tavano et al. [12].

It should be mentioned that there were still not enough samples used in this work. However, the statistical outcome was quite favourable, indicating the need for additional research using the same methods in certain nations to ultimately enhance a highly applicable dentistry measurement system.

Conclusion

In order to find fixed facial landmarks to compare and maintain the face height using a lateral cephalometric analysis, this study was able to design a system to establish parallelism between the constructed maxillary plane and mandibular plane. The bone structures were used in the development of this new cephalometric methodology, which may be used with or without teeth, whole or partial. It is intended that additional writers would use this methodology in clinical research in order to refine and strengthen it.

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Presentation at Conference: Nil

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