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(RESEARCH ARTICLE)

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Angular and linear mandibular measurements: Comparison between 2D and 3D using digital software

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Abstract

Aim is to compare the external gonial angle, ramus length, body length and total length in two dimension from lateral cephalogram and three dimensional model from CBCT using digital software. Materials - A total of 30 samples were selected between the age group of 18 to 30 years who fit into the inclusion criteria, their three dimensional model was constructed using CBCT slices in nemoceph and two dimension image was standardized with three dimensional model by selecting two fixed points on scale. Linear and angular measurements were performed on right and left side of three dimensional model and a mean value is obtained which will be compared with two dimension and arrive at results from statistical analysis. Results showed significant difference in the mean values of mandibular body length and total length in two dimension and three dimension. Showed no significant difference in the mean values of gonial angle and ramal length in two dimension and three dimension. Conclusion - the three dimensional model provided a more realistic image to determine the linear and angular measurements. The mandibular body length and total length showed significant difference due to more accurate and reliable marking of menton in three dimension. The symphyseal shadow was selected as menton in two dimension while in three dimension inferior most point in midline was selected.

Keywords: Mandibular ramal length; Gonial angle; Lateral cephalogram; Nemoceph; CBCT

1. Introduction

The cephalometric technique for studying dental malocclusions and skeletal discrepancies was introduced by Broadbent in 1931 [1]. To measure the desired linear and angular values conventional analysis is performed by tracing radiographic landmarks manually and hence may be prone to error and is time consuming. Hence, to avoid errors and make it less time consuming rapid advances in computers has led to the digitalization of cephalometric analysis [2].Cephalometric analysis is one of the key tools in undertaking an accurate diagnosis in orthodontics, it presents a number of limitations given that it is reduced into two dimensional image of a three-dimensional (3D) object by projecting all structures onto a single plate, technical limitations such as the images obtained can be distorted because of mistakes associated with the X-ray apparatus or errors in the positioning of the patient's head [3,4].Lateral cephalogram is considered as supplementary diagnostic aid and because of superimposition of left and right sides determination of gonial angle and other linear and angular parameters is difficult.The gonial angle on lateral cephalograms is important in forecasting growth which represents mandibular morphology with respect to the mandibular ramus and mandibular body[5-9].

The AIM of the study was to compare the measurement of external gonial angle , ramus length , body length and total length in 2D from lateral cephalogram and 3D model from CBCT using digital software .

Need for the study is to Check accuracy in linear and angular mandibular measurement in 2D and 3D.

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1.1. Research question

Is there any differences in accuracy in measurement of linear and angular mandibular measurements in 2D and 3D using digital software?

1.2. Null hypothesis

There is no differences in accuracy in measurement of linear and angular mandibular measurements in 2D and 3D using digital software.

1.3. Alternate hypothesis

There is differences in accuracy in measurement of linear and angular mandibular measurements 2D and 3D using digital software.

2. Materials and method

The study was approved by the institutional ethical committee, A.J Institute of Dental Sciences. The study was conducted at department of Orthodontics and Dentofacial Orthopaedics, A.J Institute of Dental Sciences, using pretreatment CBCT and lateral cephalogram records. 30 samples were selected by universal sampling method which is time bond (January 2016 to January 2022) based on the following inclusion and exclusion criteria.

2.1. Inclusion criteria

- Adult patients
- Age 18 to 30 years.
- All teeth present with or without third molars.
- No gross facial asymmetry.

The subjects with facial fractures, history of orthodontic treatment, orthognathic surgey and TMJ disorders were excluded.

Table 1 List of Landmark Definitions From Athanasiou (1995)

Landmark	Definition
Condylion (Co)	The most superior point on the head of the condylar head.
Gonion (Go)	A point on curvature of angle of mandible located by bisecting the angle formed by lines tangent to the posterior ramus and inferior border of mandible.
Menton (Me)	The most inferior midline point on the mandibular symphysis, the lowest point on the symphyseal shadow of mandible seen on a lateral cepahalogram.

CBCT were obtained from NewTomeVGi with exposure set at 120kvp, 4.2mA exposure time of 20s and field of view 15x15 and Carstream 8100 SC machine is used for lateral cephalogram, performed with patient's head immobilized by a cephalostat guided by the Frankfort horizontal plane , parallel to ground and perpendicular to mid-saggital plane .After sample selection , The radiographs soft copy is exported to the (NEMOCEPH FALL EDITION 2021) software after opening the software , The raw data and slices of patients CBCT were imported into 3D option of nemoceph where 3D reconstruction was undertaken. The digital tracing of lateral cephalogram was done in 2D section. All 2D images are standardized with the 3D model by selecting two standard points on the scale .The 1st step (digitization) which is an auto recognition of anatomical landmarks on the x-ray the clinician is able to modify the digitized land marks before the second step (analysis) the tracing is done in systematic manner. When necessary, images were enhanced with brightness, contrast and magnification to identify areas with greater accuracy. The program illustrates all points and their tracing sequence. Once the landmarks were traced on the lateral cephalogram the gonial angle ramus length , body length and total length value is noted, then gonial angle, ramus length , body length and total length value of right and left mandible is measured on 3D model generated from CBCT and its values are note.

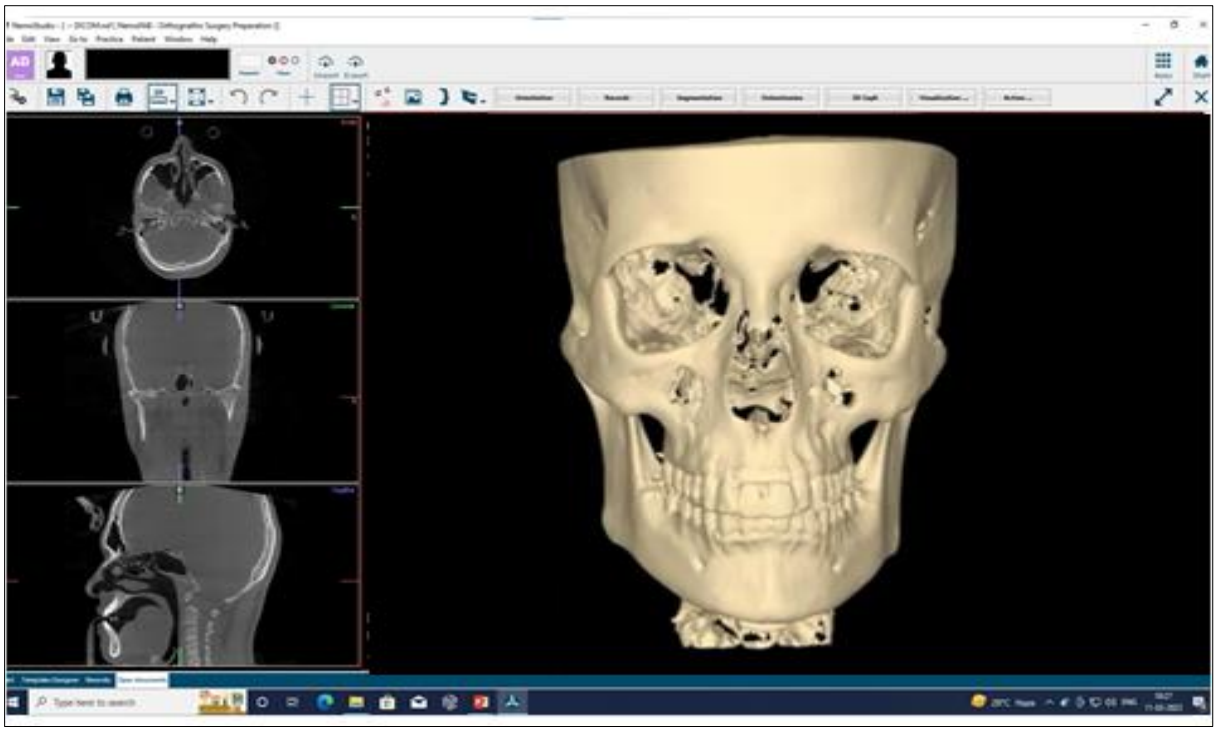

Figure 1 CBCT reconstructed 3D model

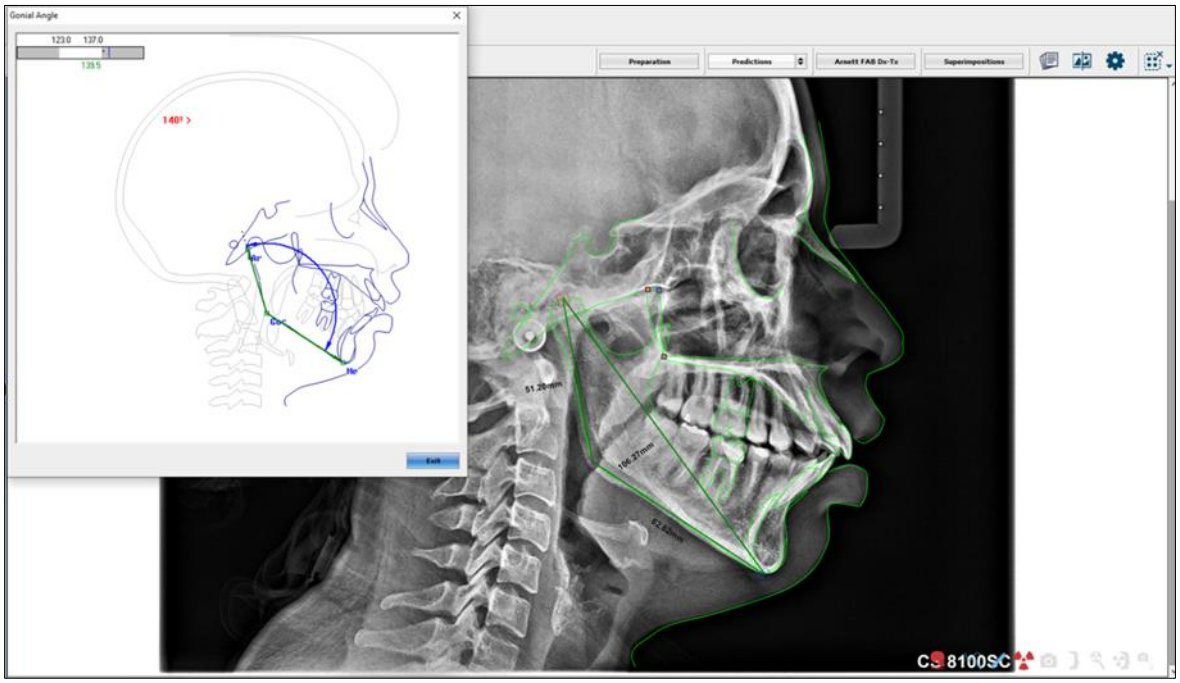

Figure 2 Linear and anguar measurement on 2D using digital scale

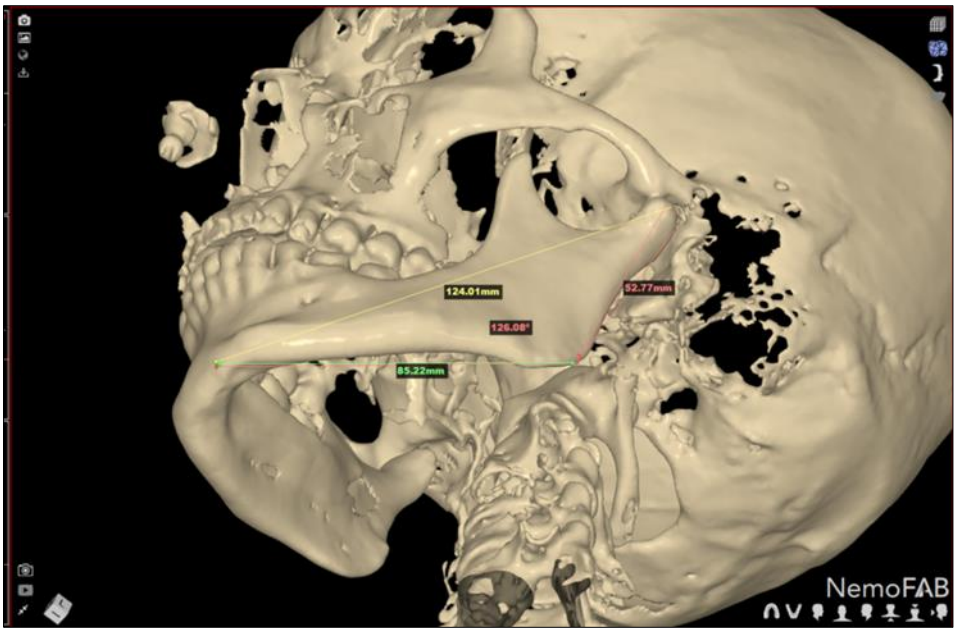

Figure 3 Linear and angular measurement on 3D model using digital scale

3. Results

Table 2 Means and SD of all the values for 2D and 3D

	Mean	Std. deviation
GO-ME 2D	69.5033 mm	3.52640 mm
GO-ME 3D	79.5400 mm	5.23309 mm
CO-ME 2D	113.7533 mm	6.49667 mm
CO-ME 3D	122.1700 mm	7.60423 mm
GONIAL 3D	124.45°	5.05376°
GONIAL 2D	124.7667°	5.16075°
CO-GO 3D	59.08 mm	5.733 mm
CO-GO 2D	58.86 mm	5.427 mm

Wilcoxon Signed Ranks Test

a. GONIAL3D < GONIAL2D

b. GONIAL3D > GONIAL2D

c. GONIAL3D = GONIAL2D

d. COGO3D < COGO2D

e. COGO3D > COGO2D

f. COGO3D = COGO2D

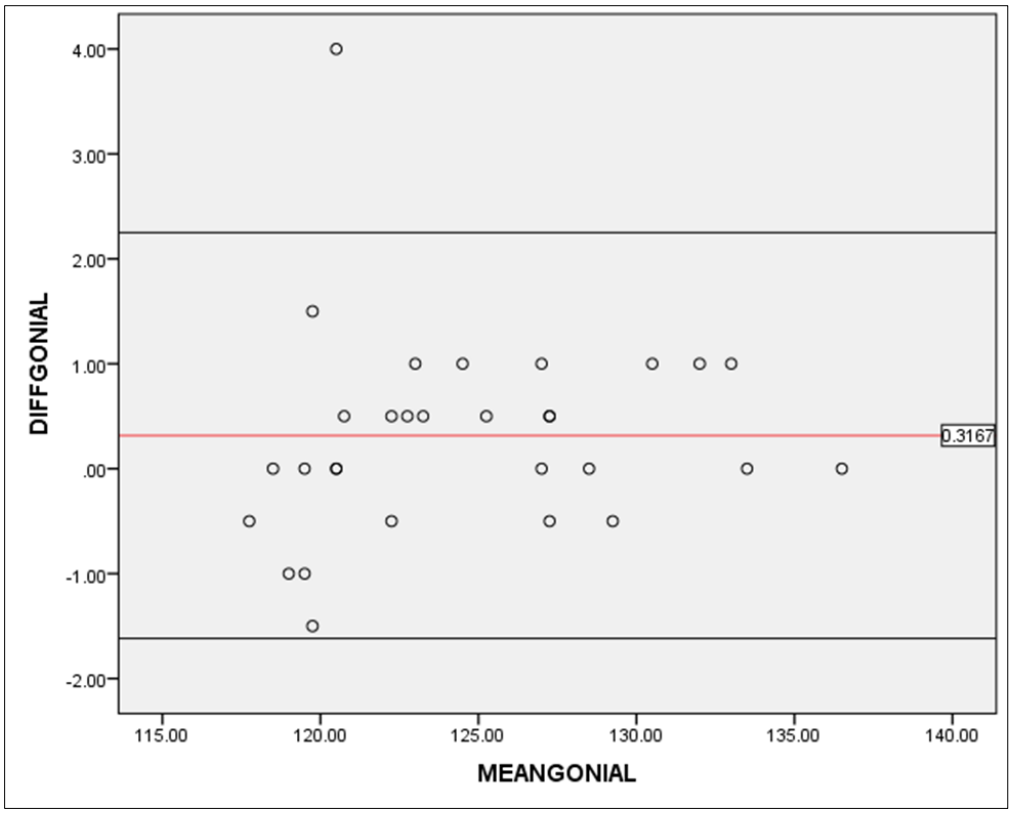

Figure 4 Plot representing mean of Gonial angle in 2D and 3D

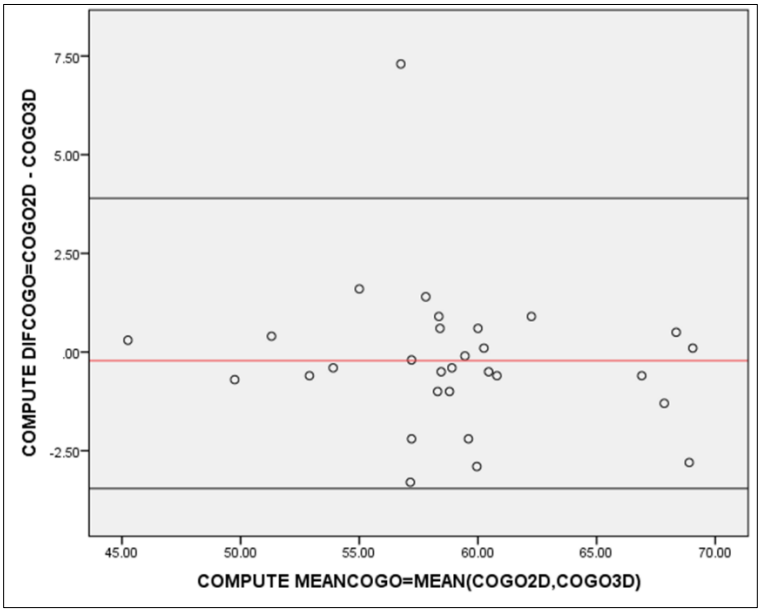

Figure 5 Plot representing mean of Co-Go in 2D and 3D

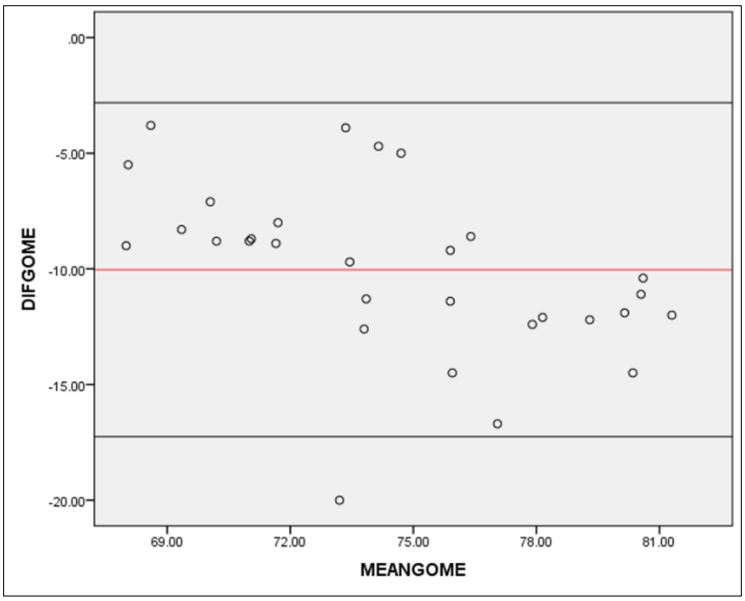

Figure 6 Plot representing mean of Go-Me in 2D and 3D

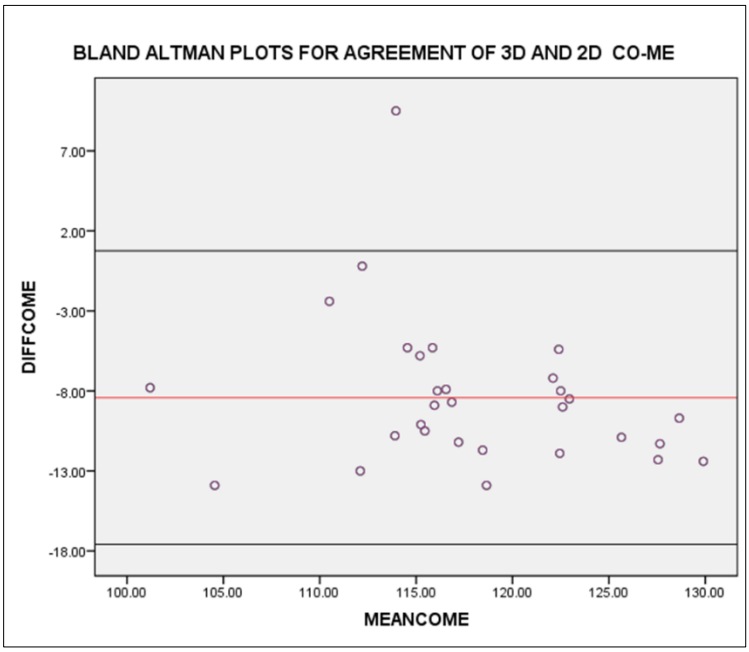

Figure 7 Plot representing mean of Co-Me in 2D and 3D

- Showed significant difference in
  - The values of mandibular body length in 2D and 3D is respectively 69.50 ±3.5 and 79.54 ± 5.2 .
  - The value of total length in 2D and 3D is 113.7 ±6.4 and 122.17 ± 7.6.
- Showed NO significant difference in-
  - The values of gonial angle in 2D and 3D is 124.76 ± 5.1 and 124.45 ± 5.0 resp.
  - The values of ramal length in 2D and 3D is 58.86 ± 5.4 and 59.08 ± 5.7 resp.

4. Discussion

Digital tracing may substantially eliminate the need for hard copies of cephalometric films. Benefits of such applications include ease of processing, no hard copies, no scanning procedure, faster method of analysis and reduction in radiation

exposure [10]. Each of the measurements used in this study were measured on the 2D and on the 3D reconstruction of CBCT using the NEMOCEPH software (FALL EDITION 2021).The measured values in 3D was measured on either sides and then their mean values was obtained . Significant difference was seen in the mean values of mandibular body length and total length in 2D and 3D . The difference in the determination of linear cephalometric measurements in this study was supposed to be the anatomic landmark identification as symphyseal shadow was selected as menton in 2D while in 3D inferior most point in midline was selected. In the present study linear and angular measurements were selected based on the Landmark Definitions From Athanasiou (1995).The mean values of gonial angle and ramal length in 2D and 3D Showed NO significant difference in

5. Conclusion

The 3D model provided a more realistic image to determine the linear and angular measurements . The mandibular body length and total length showed significant difference due more accurate and reliable marking of menton in 3D. Hence, 3D tracings would not be recommendable for undertaking longitudinal studies where pretreatment records had been recorded in 2D. However, measurements undertaken on a single patient who has 3D records would be of use for comparing pre- and post treatment changes or changes due to growth.

Guidelines for future research

One of the limitations of the study is small sample size, therefore a well organised prospective study with larger sample size and more parameters can be conducted in the future studies.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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