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Comparative study of the reliability and accuracy of posterior tooth root angulation measurements in lateral skull teleradiography and CBCT in a group of students of the Faculty of Dentistry of the University of Cuenca

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Abstract

The aim of this article is to analyze the reliability and accuracy of root angulation measurements of posterior teeth in lateral cephalic radiographs and cone beam tomography (CBCT) of a group of students of the Faculty of Dentistry of the University of Cuenca, by means of Nemocast.

A total of 40 individuals were examined, of which, according to the inclusion and exclusion criteria, 12 ondividuals were excluded, having as a final sample 28 individuals, of which 28 cone-beam tomographies and 28 lateral cephalic radiographs were examined, the analysis of the inclination of 336 posterior pieces. The occlusal plane of each patient was identified, determined from the upper incisal edge of the central incisor to the mesiobuccal cusp of the maxillary first molar. Subsequently, lines were drawn at the level of the longitudinal axis of the maxillary and mandibular teeth to determine their inclination in the Nemocast program. Techniques such as observational and statistical were used where data was collected in Microsoft Excel 2010 tables.

Regarding the results, it was determined that the CBCT has greater precision and reliability compared to the lateral teleradiography of the skull, where the average angulation of the posterior teeth is 90.26°. The upper right first premolars presented greater angulation (94.11°). The lower left first molars presented the lowest mesiodistal angulation of 87.83°. On the other hand, in lateral head radiographs the average angulation is 96.2°. The upper right first premolars presented the greatest angulation (105°) and the lower right second premolars presented the lowest angulation of 91.3°.

Keywords: CBCT; Lateral skull teleradiography; Nemocast; Orthodontics

1. Introduction

Orthodontics is a branch of dentistry responsible for preventing, diagnosing, intercepting and treating dental malpositions and maxillofacial disorders. The objective of orthodontics is to achieve dental positioning in the 3 planes of space, with a correct static and functional occlusion, with good dental and facial esthetics, periodontal health, and in balance with the soft tissues. (1) That is why it was considered important to carry out this study to analyze the angulation of the posterior teeth with respect to the occlusal plane and how they behave.

It is important to know that the objectives of orthodontic treatment are to obtain the correct position of the teeth using orthodontic appliances, to create a functional and stable occlusion, and to place the teeth in a correct relationship with each other and in harmony with the cranial soft and hard tissues after treatment. There are 6 parameters that define

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the position of each tooth in the 3 dimensions of space. Three are positional (mesio-distal, vestibulo-lingual and occlusogingival) and three are angular (mesiodistal angulation, vestibulolingual inclination and axial rotation)(3).

In this regard, Angle's classification was implemented in 1972 with the contribution of the Six Keys of Ideal Occlusion by Lawrence F. Andrews, which was the first orientation for angulation and torque values in clinical practice.(5)

- **Key I** refers to the molar relationship. Andrews takes Angle's molar relationship but completes it with a second equally important feature. That is, the distal surface of the distobuccal cusp of the upper first permanent molar contacts and occludes the mesial surface of the mesiobuccal cusp of the lower second permanent molar. Canines and premolars have a cuspid-sternum relationship buccally and cuspid-fossa relationship lingually (5).
- **The key II** defines the angulation of the crown, the so-called mesiodistal tip, which refers to the angulation of the major axis of the crown, in all teeth except molars it is the development lobe, that is the most prominent and vertical portion of the vestibular surface of the dental crown. In molars this angulation is determined by the vestibular vertical groove of the crown. Andrews concluded that the gingival portion of the major axis of each crown is distal to the incisal portion. The degree of coronal angulation is the angle formed between the major axis of the crown and a line perpendicular to the occlusal plane. It is expressed in positive degrees, when the gingival portion is distal to the incisal portion, and negative when the gingival portion is mesial to the incisal portion.
- **Key III** refers to the coronal inclination or torque, which is the angle formed between a line tangent to the place of the bracket in the center of the major axis of the clinical crown and a line perpendicular to the occlusal plane, expressed in positive degrees when the gingival portion is lingual to the incisal, and negative degrees when the gingival portion is labial to the incisal.
- **Key IV** talks about the rotations of the teeth, Andrew postulates that each tooth should have a harmonic and not undesirable rotation.
- **V key** delimits the contact points, which must be tight and without any diastemas between the teeth.
- **Key VI** refers to the occlusal plane, in which untreated patients present a flat to slightly curved curve of Spee(5).

For this study we will focus on Andrew's second key, referring to the degree of mesio-distal inclination of dental crowns, which is the angle between the axis of the crown (observing the vestibular surface) and a line of 90 degrees with respect to the occlusal plane. To determine the degree of angulation of each root is necessary the implementation of radiographic studies and the use of digital flow, it is very beneficial because currently the technology is being widely used in more areas such as oral surgery, implantology, endodontics, prosthodontics and aesthetics.

That is why in dentistry we cannot be the exception. The digital flow in our area and clinical practice has had a positive impact since it has streamlined the diagnosis, prognosis and treatment of our patients and has even facilitated the administration and logistics of our clinics (2).

Diagnostic imaging in orthodontics has been fundamentally based on panoramic radiographs, teleradiographs, periapical radiographs and wrist radiographs. They provide us with 2D images of three-dimensional structures that serve to establish a treatment sequence. Some of the most commonly used methods today are orthopantomography, lateral skull teleradiography and CBCT(3).

1.1. Lateral skull teleradiography

It is a radiographic image that allows us to observe the hard tissues of the skull from the side, as its name suggests, and it is usually used to see the craniofacial growth, it should be noted that it is a 2D study (4).

1.2. The CBCT

Or also known as cone beam computed tomography is an imaging study, is a radiological study that allows us to observe soft and hard tissues in the 3 planes of space, which has provided reliability, realism, and therefore has given us a complete diagnosis. In addition, the use of new diagnostic and digital planning software enhances the use of 3D radiology in our daily clinical practice. As in other areas, 3D imaging in orthodontics facilitates the treatment of complex dental and skeletal malocclusions.(2),(3)

The aim of this study was to analyze the reliability and accuracy of posterior tooth root angulation measurements in lateral skull teleradiography and CBCT in a group of students from the Faculty of Dentistry of the University of Cuenca. For this purpose, different radiographic studies of 40 patients were obtained and techniques such as observational and statistical techniques were used where data were collected in Microsoft Excel 2010 tables and each file was analyzed in programs such as nemocast.

2. Material and methods

2.1. Material

The study was carried out in a group of 28 students of the Faculty of Dentistry of the University of Cuenca.

2.2. Sample selection

Different radiographic studies were obtained from an image bank of 40 patients for retrospective purposes, among the studies used were lateral skull teleradiography and CBCT, which had been performed with the same radiographic equipment in all patients for their orthodontic diagnosis.

The handling of the patients' personal data and radiographs were recorded in a file, which is available for possible evaluations, inspections or simply to verify the authenticity of the data collected.

2.3. Inclusion criteria

Inclusion criteria were

- Images in perfect condition to be studied.
- Patients with lateral skull teleradiography and CBCT, taken at the same place and with the same equipment.
- No more than one dental absence per quadrant.
- Presence of first molar.

2.4. Exclusion criteria

Exclusion criteria were

- Patients who for some reason could not be exposed to radiation for radiographic studies.
- Patients with lateral skull teleradiography and CBCT, which have not been taken in the same place and with the same equipment.
- Images that are not in perfect condition to be studied.
- Patients who for some reason have lost their first molar, either upper or lower.
- Absence of more than one tooth per quadrant

2.5. Methods

2.5.1. Record taking

The sample was collected from

Imaging Center of the Faculty of Dentistry of the University of Cuenca.

The measurements obtained for the study were tabulated in an excel table, in order to record them accurately. All patients have reviewed and verified the data, using the Nemocast application personally. The training for the use, definition of planes, CBCT software management and calibration was carried out by the professor in Orthodontics of the University of Cuenca - Faculty of Dentistry.

2.6. Variables studied

Lateral skull teleradiographies and tomographies were saved in .dcm and .jpg formats, respectively. Measurements on these study tools were performed using the Nemocast program.

To determine the occlusal plane in the CT scans, a line was drawn through the mesio-vestibular cusp of the upper first molar and through the incisal edge of the upper central incisors of the teeth of both quadrant one and quadrant two. Subsequently, lines were drawn along the longitudinal axis of the maxillary and mandibular teeth to determine their inclination. In molars, a line was drawn through the vestibular sulcus and the deepest area of the vestibular furcation; in premolars, the line was drawn along the axial axis of the vestibular cusp and the end of the root apex; in the case of biradicular premolars, the vestibular root was considered.

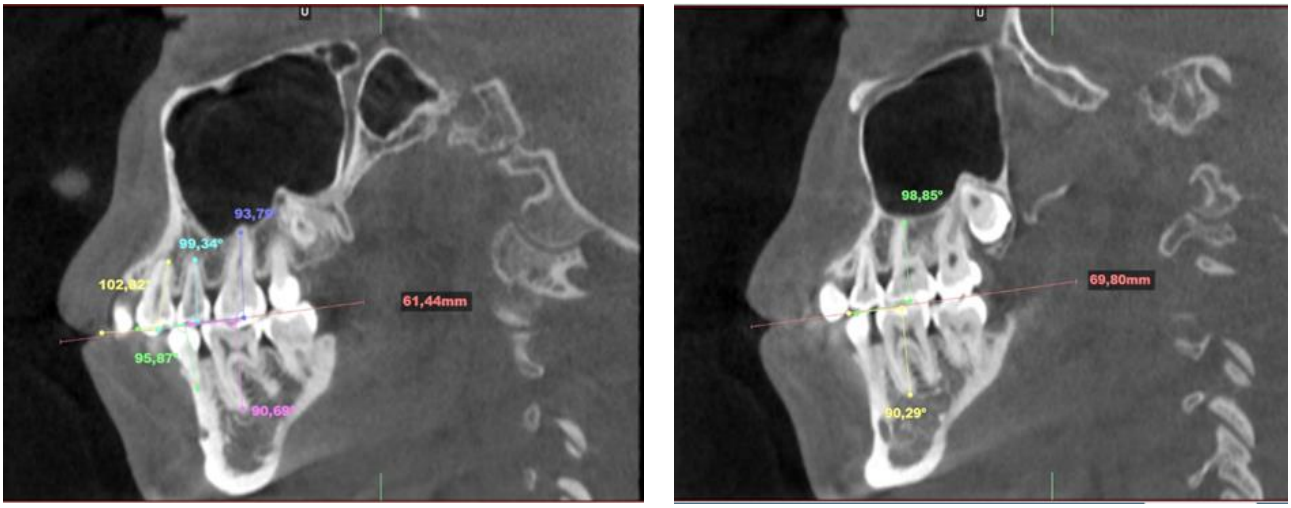

Figure 1 Image of the axial axes of the posterior teeth of patient #8, in which the mesiodistal angulation was measured and the occlusal plane line was plotted in the Nemocast program

On the other hand, the determination of the occlusal plane in the lateral cephalic teeth was made by drawing a line passing through the incisal edge of the upper incisors and the mesial cusp of the upper first molar. Subsequently, lines were drawn at the level of the upper and lower incisors from the apex end to the incisal edge.

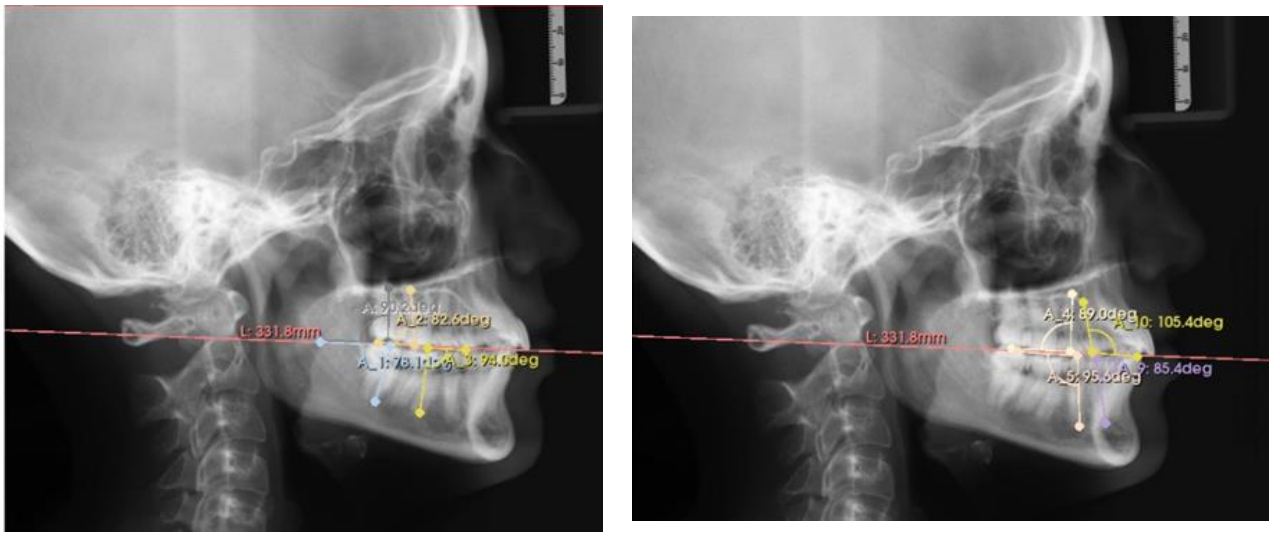

Figure 2 TeleRx image of patient #1 with axes and mesiodistal inclination measurements of molars and premolars

On lateral skull teleradiography and CBCT images, the following measurements were performed:

- Mesio-distal inclinations of upper and lower molar roots
- Mesio-distal inclinations of the roots of the upper and lower premolars

A total of 28 angular measurements were obtained.

2.7. Sample distribution

Each tooth was measured using the NemoStudio version 2021 Nemocast tool. Each tooth was assigned a coding.

Table 1 Coding of all variables and their numbering FDI

Variable	Group
1st Upper Right Molar (1.6)	1-MOL_SD
1st Upper Left Molar (2.6)	1-MOL_SI
Lower Right 1st Molar (4.6)	1-MOL_ID
Lower Left 1st Molar (3.6)	1-MOL_II
2nd Upper Right Premolar (1.5)	2-PMOL_SD
2nd Upper Left Premolar (2.5)	2-PMOL_SI
2nd Right Lower Premolar (4.5)	2-PMOL_ID
Lower Left 2nd Premolar (3.5)	2-PMOL_II
1st right upper premolar (1.4)	1-PMOL_SD
1st upper left premolar (2.4)	1-PMOL_SI
Lower Right 1st Premolar (4.4)	1-PMOL_ID
Lower Left 1st Premolar (3.4)	1-PMOL_II

3. Results

After the analysis of the different inclusion and exclusion criteria, 28 patients were included in the sample, i.e., 12 patients were excluded from the total sample because they did not meet the different criteria requested to be included in the study.

Measurements were performed in the NemoStudio Nemocast program version 2021 in both CBCT and lateral cephalic teleradiography of each individual involved in the study, where the following results were obtained:

Table 2 shows the values of the mesio-distal angulations of the posterior teeth that were measured in the CBCT through the Nemocast program of NemoStudio version 2021, the individual average of the mesio-distal angulation of each individual involved in the study was obtained. This individual average obtained indicates that the majority of patients present mesiodistal angulation of the posterior teeth in an interval ranging from (90°:95°).

It is important to note that after the corresponding analysis in this study group the average mesiodistal angulation of the posterior teeth is 90.26°.

The teeth that presented the greatest angulation on average were the upper right first premolars with a mesiodistal angulation of about 94.11°, compared to the lower left first molars, which presented the least mesiodistal angulation of 87.83° on average.

Table 2 Results of CBCT measurements in Nemocast

PATIENT	1-PMOL-SD	2-PMOL-SD	1-MOL-SD	1-PMOL-SI	2-PMOL-IS	1-MOL-SI	1-PMOL-II	2-PMOL-II	1-MOL-II	1-PMOL-ID	2-PMOL-ID	1-MOL-ID	$\bar{X}$
A.V.P.D	97.64°	79.14°	85.25°	95.59°	91.20°	91.04°	88.33°	95.56°	88.26°	92.93°	91.16°	94.07°	90.85
A.V.M.D	99.53°	96.15°	89.47°	99.53°	95.25°	89.07°	102.3°	104.93°	87.17°	99.63°	88.37°	94.15°	95.58
A.Y.A.D	103.74°	100.98°	87.69°	100.50°	103.74°	83.12°	94.38°	92.10°	88.18°	92.10°	88.93°	93.42°	94.07
A.P.P.A	77.44°	82.48°	74.54°	91.67°	102.34°	98.49°	92.56°	81.17°	85.70°	100.53°	95.27°	95.6°	89.82
A.N.J.T.	106.41°	85.86°	75.84°	100.76°	86°	96.32	99.16°	81.94°	103.24°	99.87°	77.96°	83.67°	91.42
A.O.K.O	91.28°	77.26°	91.45°	89.14°	86.17°	106.17°	95.87°	87.10°	97.10°	94.66°	101.39°	89.64°	92.3
B.E.M.E.	81.2°	85.3°	91.5°	99.4°	93.5°	102.6°	76.5°	74.6°	86.3°	91.5°	76.9°	77.5°	86.4
C.F.A.L.	101.36°	94.47°	98.85°	102.82°	99.34°	96.67°	95.87°	94.49°	90.69°	88.94°	97.64°	90.29°	95.95
C.C.M.I.	95.81°	97.25°	96.64°	95.81°	97.37°	96.55°	93.64°	97.25°	93.19°	96.37°	94.25°	87.17°	95.11
E.D.D.A	82.8	89.9	80.8	83.3	81.1	82.2	81.2	84.9	90.2	81.7	77.1	88.8	83.67
F.S.M.B	84.8	94.1	79.8	88.0	84.4	74.7	86.7	84.5	81.1	75.6	85.5	81.3	84.38
G.A.M.B	78.8	80.5	78.0	75.5	83.0	87.0	83.8	81.5	75.5	88.6	80.6	77.1	80.83
H.O.G.S	80.5	93.3	81.3	65.7	76.3	79.1	69.5	78.1	78.7	79.0	75.5	74.6	77.63
I.E.P	95.23°	96.14°	91.62°	94.25°	97.24°	92.52°	97.68°	112.49°	87.08°	97.28°	111.39°	86.98°	96.66
J.B.V.A	71.9	72.3	86.9	79.5	83.3	84.5	76.1	64.8	81.7	78.5	84.6	81.9	78.83
J.C.V.N	72.4	81.9	77.1	75.7	78.6	86.0	81.4	76.2	78.1	81.5	76.6	84.1	79.13
L.A.P.A.	93.06°	86.04°	77.82°	104.14°	92.55°	105.66°	100.22°	99.59°	88.49°	98.10°	93.76°	107.22°	95.55
P.H.P	96.64°	103.12°	96.67°	99.90°	102.68°	96.75°	106.79°	100.20°	101.83°	100.51°	100.64°	94.49	100.02
P.B.P.G	119.76°	100.30°	90.71	121.71	98.27°	99.02°	105.53°	104.70°	98.57°	106.34°	100.33°	107.11°	104.36
P.P.J.R	117.06°	98.70°	96.90°	103.24°	91.22°	96.54°	103.74°	102.71°	95.09°	107.54°	101.70°	108.66°	101.93
S.Z.B.E	79.5	78.9	78.0	75.4	87.0	81.3	80.0	79.1	81.3	85.3	78.9	80.3	80.42
U.L.D	101.5	79.4	90.2	66.3	82.9	93.4	70.0	76.9	76.0	76.3	80.6	71.6	80.43
V.N.M.F	101.05°	101.03°	103.51°	101.04°	101.02°	103.21°	101.93°	102.82°	81.54°	102.82°	102.82°	81.54°	98.69
V.N.M.S	97.27°	94.79°	92.21°	97.27°	94.59°	94.79°	94.78°	94.16°	92.21°	93.68°	93.06°	92.21°	94.25
V.P.J.E	105.8°	85.5°	99.8°	72°	84.4°	95.7°	96°	96°	95°	72°	90.7°	98.5°	90.95
M.J.S	96.1°	83.0°	100.1°	100.1	78.5°	100.6°	84.4°	87.3°	82.0°	99°	92.6°	91.2°	91.24
Z.C.A.S	112.52°	79.47°	82.17°	67.5°	68.2°	86.9°	81.71°	93.44°	87.13°	96.7°	89.8°	94.9°	86.70
$\bar{X}$ dient	94.11	88.79	87.96	90.58	89.64	92.59	90.37	89.95	87.83	92.19	89.93	89.19	

Table 3 shows the values of the mesio-distal angulations of the posterior teeth that were measured in the lateral teleradiographs of the skull using the NemoStudio Nemocast program version 2021, and as in Table 2, the individual average mesiodistal angulation of each individual involved in the study was obtained. When analyzing the results of the mesiodistal angulation, it was obtained that most of the teeth presented an angulation of an interval of (90-95°).

It is important to note that after the corresponding analysis in this study group the average mesiodistal angulation of the posterior teeth is 96.2°.

The teeth that presented the greatest angulation on average were the upper right first premolars with a mesiodistal angulation of about 105.0°, compared to the lower right second premolars, which presented on average the least mesiodistal angulation of 91.3°.

Table 3 Results of the Nemocast measurements of the lateral cranial Teleradiographies

PATIENT	1-PMOL-SD	2-PMOL-SD	1-MOL-SD	1-PMOL-ID	2-PMOL-ID	1-MOL-ID	$\bar{X}$
A.V.P.D	105.4°	89.0°	82.6°	85.4°	95.6°	94°	92
A.V.M.D	106.4°	80.9°	92.5	109.6°	74.5°	94.5°	93.07
A.Y.A.D	112.2°	71.2	99°	94.8°	92.9°	92.2°	93.72
A.N.J.T.	104.7°	87.2°	96.1°	103°	73.4°	89.5°	92.32
A.O.K.O	106.2°	83.9°	93°	94.7	87.5°	103.5°	94.80
B.E.M.E.	98.4°	86.8°	83.7°	97.3	79.8°	92.6°	89.77
C.F.A.L.	89.9°	88.6°	106.4°	111.6°	76.11°	86.2°	93.14
C.C.M.I.	67.95	84.5°	100.6°	100.3°	89.8°	100.2°	90.56
E.D.D.A	111.6°	71.1°	92.5°	89.9°	88.6°	88.9°	90.43
F.S.M.B	105.4	86°	99.2°	100.3°	90.2°	88.7°	94.97
G.A.M.B	101.6°	82.7°	89.7°	96.7°	82.8°	91.2°	90.78
H.O.G.S	104.4°	72.7°	98.2°	93.7°	92.4°	76.4°	89.63
I.E.P	92.7°	80.8°	89.8	103.8°	84.1°	91°	90.37
J.B.V.A	109.6°	106.4°	96°	96.3°	98°	96.8°	100.52
J.C.V.N	115.7°	112.4°	99.9°	88.5°	101°	93.8°	101.88
L.A.P.A.	113.2°	107.3°	99°	101.5°	98.6°	96°	102.60
P.H.P	103.2°	101.5°	93.9	94.5°	97.1°	94.5°	97.45
P.B.P.G	119.5°	110.9°	97.8°	102°	100.6°	106.9°	106.28
P.P.J.R	108.6°	99°	95.4°	100.9°	99.6°	95.2°	99.78
S.Z.B.E	108.4°	103.1°	93.6°	102.6°	96.5°	102.6°	101.13
U.L.D	107.6°	102.4°	92.3°	106.7°	101°	99.6°	101.44
V.N.M.F	113.9°	112.8°	105.8°	100.4°	98.7°	89.6°	103.53
V.N.M.S	101.3°	99.5°	97.1°	98.5°	94.7°	95.7°	97.80
V.P.J.E	111.7°	103.3°	93.3°	95.9°	89.7°	87.9°	96.97
V.M.J.S	98.9°	98.3°	91.7°	104.7°	96.7°	91.7°	97.00
Z.C.A.S	111.4°	107.2°	98.1°	92.7°	94.3°	92.3°	99.33
$\bar{X}$ tooth	105.0	93.1	95.3	98.7	91.3	93.5	

Table 4 shows the values of the arithmetic mean of the mesio-distal angulations of the posterior teeth that were measured in the lateral teleradiographs of the skull and in the CBCT using the Nemocast program of NemoStudio version 2021. After performing the corresponding analysis we can observe that the first premolars present a more mesial angulation compared to the first molars that present a more distal angulation, taking into account that the reference was the occlusal plane of each individual included in the study.

In addition, a difference was observed in the values obtained with CBCT and lateral skull teleradiography, the values obtained with CBCT being more precise and accurate, since a Cronbach's alpha of 0.99 was obtained.

Table 4 Arithmetic mean results of each of the posterior tooth angulations in the CBCT and lateral skull teleradiography

TYPE OF RX	1-PMOL-SD	2-PMOL-SD	1-MOL-SD	1-PMOL-SI	2-PMOL-IS	1-MOL-SI	1-PMOL-II	2-PMOL-II	1-MOL-II	1-PMOL-ID	2-PMOL-ID	1-MOL-ID
CBCT	94.11	88.79	87.96	90.58	89.64	92.59	90.37	89.95	87.83	92.19	89.93	89.19
LATERAL CEPHALIC		93.1	95.3	-	-	-	-	-	-	98.7	91.3	93.5

3.1. Statistical analysis

To evaluate the degree of accuracy of the measurements taken in the tomographies and analyzed in Nemocast, a Cronbach's alpha of 0.99 was obtained, which shows a high degree of accuracy and reproducibility of the measurements taken. As for the teleradiographies analyzed in Nemocast, a Cronbach's alpha of 0.98 was also obtained, which indicates a high degree of accuracy and reproducibility.

4. Discussion

This research project aims to compare and quantify the differences in dental root angulation measurements using lateral cephalic radiographs and tomography (CBCT) using tools such as Nemocast.

A review of the literature was carried out where a study by Jung and collaborators was found, who carried out an imaging analysis to measure the angulation of the posterior teeth with CBCT, for this research they exclusively took into account the first and second premolars to show their angulation with respect to the maxillary sinus, where 587 maxillary first premolars and 580 second premolars of 303 individuals were considered. It was verified that the first premolars are vestibularized in most of the cases, consequently the bony table is thinner, the second premolars have their roots in the middle and are closer to the maxillary sinus while the first premolars are farther away. (6)

In the area of orthodontics, the study of images is of great importance because they demonstrate the success and progress of orthodontic movements. In another study where 155 subjects were analyzed, the mesiodistal root angulations of central incisors, lateral incisors, canines, first, second premolars and first molars were compared. In this study there were significant differences in the mesiodistal angulation of the teeth in 75% of the maxillary teeth and 67% of the mandibular teeth. Although there was no mean difference for replicate CBCT measurements it was statistically significant (PAG .0.05). (7)

At the University of Texas San Antonio Health Science Center School of Dentistry, 40 individuals were taken for analysis, 18 males, 22 females in an age range of 15 years, who underwent imaging studies (CBCT) in which panoramic slices were made, also taking as reference the occlusal plane and the angulation of the teeth, where they obtained as a result that the panoramic CBCT images should be manipulated with care and knowledge due to the variation between methods in specific areas of the arches. The images can be useful in assessing mesiodistal root angulations if the volume is properly manipulated to create a panoramic image.(8)

One of the limitations of lateral cephalic radiographs is that the images only project one of the two incisors, and since it is a superimposed image, there is no exact measurement for each side of the arch. However, CBCT stands out for being a more precise technology and does not superimpose images, for this reason a more reliable measurement was achieved for each of the teeth studied.

When the value of the measured inclination is greater than 90°, as is the case in our study, it can be determined that in these teeth there is a marked inclination towards the mesial, these values shown in Table 3, were taken in the lateral cephalic radiographs and the results obtained demonstrate this information. If we make a comparison with the CBCT we can deduce that the angulations in the majority of teeth are less than 90°, as can be seen in Table 2, showing a distal inclination, which leads us to think that there is a great discrepancy between the two types of images studied.

In fact according to Hong Hong Wang et al. who has developed a similar study, in which he evaluates the angulation and inclination of the complete tooth and the clinical crown, he has used CBCT tomography as the main tool for the development of his study. CBCT allows an effective radiographic approach, which in addition to providing a highly accurate 3D reconstruction, shows good reproducibility of the root and crown in three dimensions.(9)

In Peck's study, a comparison was made of inclination measurements in both CBCT and panoramic radiographs, in which inclinations toward the mesial were detected in the panoramic radiograph and more distal inclinations in the CBCT, as in the case of the present study, especially in posterior teeth. He states that panoramic radiography is a good screening tool, as well as lateral cephalic radiographs, but they do not provide accurate and reliable information related to root angulation. (10)

The measurements found in the present article were different when measured on lateral cephalic radiographs and CBCT tomography; in all the teeth greater angles were found on the radiographs.

5. Conclusion

- After analyzing the results, it can be seen that there are significant differences in the angulation measurements of CBCT and lateral skull teleradiography, concluding that CBCT offers greater accuracy, reliability and a better image to obtain the angulations and be able to reach a diagnosis and future treatment.
- The mesiodistal angulation of the teeth of each tooth varies in all cases, so it can be an important indication for orthodontic treatment. However, further study needs to be done in younger people, children or adults to see if the degree of angulation is related to the age of each individual.
- The Nemoceph program is very useful for analyzing the angulations of the teeth in tomographies and teleradiographies with greater accuracy.
- The teeth with the greatest angulation are the upper premolars with an angulation of 90.6° in CT scans and 105° in teleradiography.
- The teeth with the lowest angulation of 91.3° are the lower second premolars in teleradiography,
- The teeth with the lowest angulation of 87.83° are the lower first molars in CT.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors agree no conflict of interest

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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