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“Description of the WALA edge measured in STL and DICOM files.”

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Resumen:

El objetivo de este estudio fue describir el borde Wala, mediante la utilización de archivos STL y DICOM para posteriormente contrastar los resultados con los valores dados por los autores Will Andrews y Larry Andrews y de esa manera cuál es el método diagnóstico que más se acerca a la realidad. En este estudio descriptivo observacional se incluyeron 36 participantes, en un rango de edad de 23 a 33 años, estudiantes universitarios, a quienes se les realizó los estudios de tomografías computarizadas CBCT (archivos DICOM) y escaneos intraorales para la obtención de modelos STL. Se usaron 2 software Meshmixer para los STL y 3D Slicer para los CBCT.

En ambos métodos diagnósticos, para la medición del borde WALA se determinó: el punto del eje Facial (FA), ubicado en el parte más prominente del centro coronal vestibular en los premolares y en el centro del surco mesiovestibular en los primeros molares; el punto WALA, ubicado perpendicular al plano oclusal en la unión mucogingival. Los datos de las mediciones obtenidas se guardaron en el programa Microsoft office Excel 2019. El promedio de las mediciones obtenidas en Meshmixer así como en 3D Slicer fue obtenido utilizando el software SPSS. Los resultados se exponen en tablas.

Los valores obtenidos entre el punto FA y la cresta WALA fueron progresivos en sentido anteroposterior, siendo menor para los premolares y mayor en el primer molar. No se encontraron discrepancias estadísticamente significativas para los valores obtenidos en archivos STL del escáner, pero sí para los modelos DICOM de los CBCT en especial porque estos últimos sólo evalúan tejidos duros.

Los valores obtenidos se asemejan en gran medida a los valores descritos por Will Andrews, sin embargo, estos difieren significativamente en relación a la unidad de análisis de archivos DICOM los mismos que carecen de un respaldo científico para ser tomados en cuenta como una medición diagnóstica del borde WALA. Algunas de las diferencias de valores obtenidos para las mediciones del borde WALA entre diferentes poblaciones de estudio pueden deberse a que varios estudios utilizan el

método manual o convencional y otros el método digital e incluso el mismo escáner o software empleado en la medición digital de modelos puede hacer que haya discrepancias en las mediciones.

Palabras claves: Lenguaje estandarizados de triángulos (STL). Comunicación de imágenes digitales en medicina (DICOM). Eje facial (FA). Punto Will Andrews y Larry Andrews (WALA).

Abstract:

The objective of this study was to describe the WALA edge, using STL and DICOM files, contrasting the results with the values given by the authors Will Andrews and Larry Andrews and thus which diagnostic method is the closest to reality.

This descriptive observational study included 36 participants, ranging in age from 23 to 33 years, university students, who underwent CBCT computed tomography studies (DICOM files) and intraoral scans to obtain STL models. Two Meshmixer software were used for the STL and 3D Slicer for the CBCT. In both diagnostic methods, for the measurement of the WALA edge, the following was determined: the point of the facial axis (FA), located in the most prominent part of the vestibular coronal center in premolars and in the center of the mesiovestibular sulcus in first molars; the WALA point, located perpendicular to the occlusal plane at the mucogingival junction. The data of the measurements obtained were saved in the Microsoft office Excel 2019 program. The average of the measurements obtained was analyzed using SPSS software for Meshmixer values as well as in 3D Slicer. The results are presented in tables. Statistically significant discrepancies were found for the values obtained from the STL files compared to the CBCT DICOM files especially because the latter only evaluate hard tissues for WALA edge measurements.

The values obtained largely resemble the values described by Will Andrews, however, these differ significantly in relation to the unit of analysis of DICOM files the same that lack scientific support to be taken into account as a diagnostic measurement of the WALA edge. Some of the differences in values obtained for WALA edge measurements between different study populations may be due to the fact that several studies use the manual or conventional method and others the digital method and even the same scanner or software used in the digital measurement of models may cause discrepancies in the measurements.

Keywords: Standard Triangle Language (STL). Digital Imaging and Communications in Medicine (DICOM). Eje facial (FA). Punto Will Andrews y Larry Andrews (WALA).

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Introduction

Dentistry in the 21st century is supported by constant technological advancement; digital models have eliminated the need for storage space and have facilitated the retrieval and transfer of models. These three-dimensional models can be easily manipulated to collect measurements to facilitate diagnosis and treatment planning. With the many advantages of digital models, they will replace traditional plaster models. A limitation to correct diagnosis is to continue to rely on last century methods of analysis, technological advances encompass every area of our lives, dentistry and/or orthodontics is no exception, 2D measurements and the use of physical models are being replaced by the use of dental scanning and the use of CBCT thus maintaining a true picture of the patient's anatomical and functional conditions.

The WALA rim is an acronym of Will Andrews and Larry Andrews who collaborated in its discovery. (1)(2)(3) The WALA ridge is defined as the junction between the basal bone and the alveolar bone. It corresponds clinically to the mucogingival line, (Figure1). This analysis compares the distances between the center of the clinical crown of the teeth with the distance between the projections of these points on the mucogingival line. (4)(5) However, the thickness of the soft tissue, which varies between teeth, can affect the positions of the WALA points. Wala analysis helps us to evaluate changes in the lower arch and determine the amount of transverse development that will be obtained with orthodontic treatment(5) . This anatomical reference is also identified on plaster models, as the most prominent part of the vestibular face where it corresponds to the bone. (6)



Figure 1. The WALA rim is the junction between the basal bone and the alveolar bone.

Source: Authors

From their earliest years of use cephalograms were widely applied as a tool for clinical, developmental and treatment effects and outcomes research. Beyond its use as a diagnostic tool, the errors inherent in 2D cephalometry and subsequent analysis are well documented. Significant errors are associated with ambiguity in the localization of anatomical structures, due to the lack of well-defined anatomical features, contours, shadows and variation in patient position. The use of 3D diagnostic methods greatly improves the definition of the anatomical structures to be studied, providing greater efficiency in studies based on the same. (7)(8) Cone beam computed tomography (CBCT) is widely used in the oral and maxillofacial region, due to its lower effective radiation dose and lower cost in relation to CT. (9)

The objective of this study was to describe the WALA edge in students of the seventh cycle of the Faculty of Dentistry of the University of Cuenca using digital models and CBCT, as well as to determine which diagnostic tool is the closest to reality, contrasting with the values given by the authors William and Andrews.

2. Materials and methods:

Descriptive observational study. The sample consisted of 49 men and women from the dental school of the University of Cuenca, in the age range between 23 and 33 years. Of the 49 participants, 36 were chosen because they met the inclusion criteria:

1. Patients with intact first premolars, second premolars and lower permanent first molars
2. Who presented DICOM models without image defects in the CBCT acquisition.
3. Who signed informed consent. 3 who have signed the informed consent form.

The digital models were acquired in October 2021 by one operator with a Sirona CAD CAM scanner (Cerec OMNICAM, Sirona Dental GmbH, Wals Bei Salzburg, Austria) and exported in STL format for WALA edge analysis. CBCT CT scans were taken by another operator in November 2021 with 3D J Morita Accuitomo 170 equipment with the following technical parameters: field of view (FOV) 170 mm x 120 mm, slice thickness 0.33 mm and slice interval 0.66 mm exported in DICOM format. The DICOM files were imported into the 3D Slicer radiological software (US National Institutes of Health, Version 4.11.20) for WALA edge analysis. (Figure 2)

To describe the WALA edge, the Facial Axis (FA) point was determined (Figure 4) located at the most prominent point of the vestibular coronal center in premolars and at the center of the mesiovestibular sulcus in first molars; the WALA point was located perpendicular to the occlusal plane at the mucogingival junction. The unit of measurement was in mm using two decimal places. The measurement data obtained were saved in Microsoft office Excel 2019 (Microsoft, Redmond, WA, USA). The measurements were performed by one operator for the STL files and another for the DICOM files.

The average of the measurements obtained in Meshmixer as well as in 3D Slicer were processed using SPSS Statistical Packages for the Social Sciences version 20 software (IBM Corp.; Armonk, NY, USA). Figure 3. The results were reflected in tables. The statistical analysis of the data was processed through the SPSS program by means of Student's t-test calculations for related samples, where 95% confidence intervals were applied. (Table 3).



Figure 2: WALA border on CBCT, FA point pink; WALA point green.

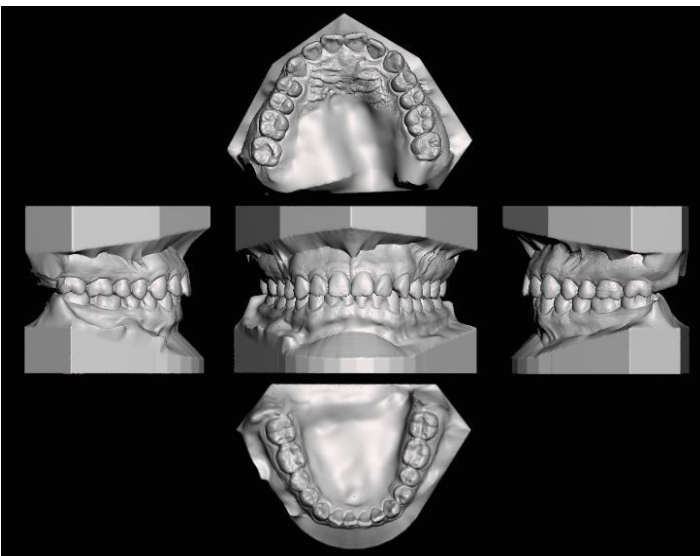


Figure 3: View of the Meshmixer digital model of one of the patients.

Source: Authors

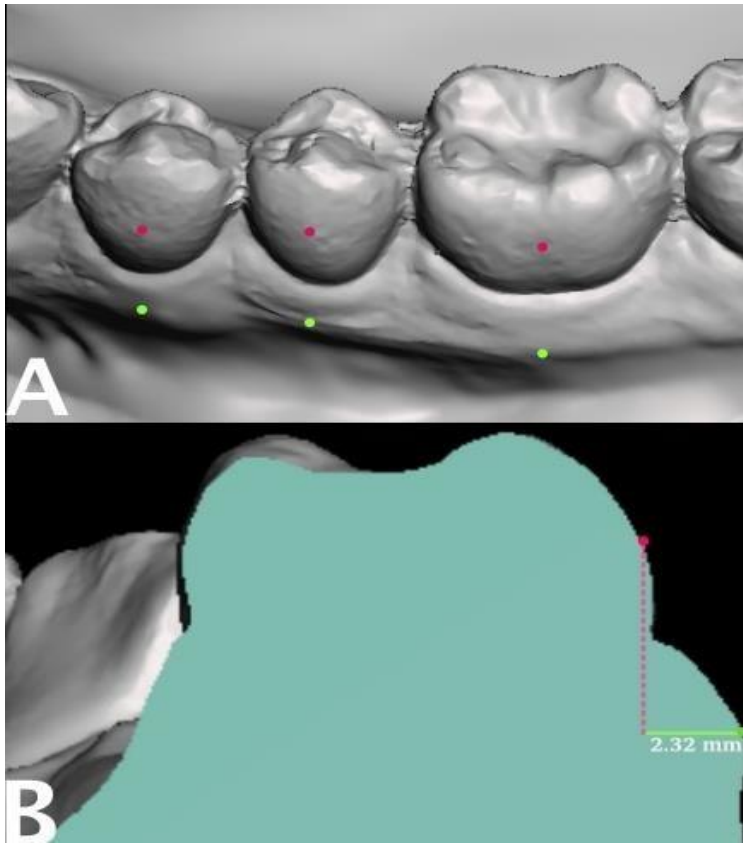


Figure 4: WALA angle measurement in STL. (A) FA point in pink and WALA point in green; (B) Transverse distance between FA and WALA points.

3. Results:

Once the data were analyzed, it was observed that the study population consisted of 72.2% (N=26) of females and 27.8% (N=10) of males (Table 1).

Table 1. Characterization of the study population according to sex.

		Frequency	Percentage
Valid	FEMALE	26	72,2
	MALE	10	27,8
	Total	36	100,0

Source: Authors

The age of the participants ranged from 23 to 33 years; their average age was 25.8 years (SD= 2.2 years) (Table 2).

Table 2.

Statistics		
Age of patients		
N	Valid	36
	Lost	0
Media		25,83
Deviation Deviation		2,236
Minimum		23
Maximum		33

Source: Authors

As for the statistical data on the age of the patients, the mean age was 25.8 years, the minimum was 23 years and the maximum was 33 years, there was a deviation of 2.2.

Table 3. Comparison of means.

		PAIRED SAMPLES TEST MATCHED DIFFERENCES		
		95% confidence interval of the difference		Sig (Bilateral)
		Inferior	Superior	
Par 1	FIRST MOLAR #46 – FIRSTMOLAR 46	-1,09513	-0,87876	,000
Par 2	SECOND PREMOLAR #45 SECOND PREMOLAR 45	-0,88791	-0,63543	,000
Par 3	FIRST PREMOLAR #44 – FIRSTPREMOLAR 44	-0,84326	-0,69397	,000
Par 4	FIRST PREMOLAR #34 – FIRSTPREMOLAR 34	-0,85887	-0,64613	,000
Par 5	SECOND PREMOLAR #35 SECOND PREMOLAR 35	-0,93754	-0,76857	,000
Par 6	FIRST MOLAR #36 – FIRSTMOLAR 36	-1,05842	-0,87103	,000

Source: Authors

The paired difference values were within the pairwise calculation: 1 pair, first molar 4.6(-1.05, -0.8); 2 pair, second premolar 4.5 (-0.8, -0.6); 3 pair, first premolar 4.4 (0.8, -0.6); 4 pair, first premolar 3.4 (-0.8, -0.6); 5 pair, second premolar 3.5 (-0.9, -0.7) and 6 pair, first molar 3.6 (-1.05, -0.8). Values obtained with 95% reliability.

Statistically significant discrepancies were found for values obtained from STL files compared to CBCT DICOM files especially because the latter only evaluate hard tissues for WALA edge measurements.

Table 4: FA distance and WALA edge averages.

Study sample report in STL

	1st Premolar	2nd Premolar	1st Molar
Media	0,7532	1,1692	2,0135
Deviation	0,40261	0,48600	0,48908
Minimum	-0,63	-0,33	0,73
Maximum	1,65	2,16	3,13

The present study reflected values of the WALA ridge measured in the STL models of 0.75 mm for first premolars, 1.16 mm for second premolars and 2.01 mm for lower first molars. The values obtained between the FA point and the WALA crest were progressive in the anteroposterior direction, being lower for the premolars and higher in the first molar. The table was obtained by adding the right and left values of each tooth corresponding to the dental arch.

4. Discussion:

In the present study the WALA-FA values of 36 patients were obtained in digital models in STL format and contrasted with CBCT of the same patients to determine their differences and whether one method is more reliable than the other; the WALA edge is of great importance in orthodontics since this analysis has been taken as a diagnostic reference to determine the amount of expansion that will be achieved at the end of orthodontic treatment. (10) This method indicates the ideal dental position without exceeding the expansion limits during orthodontic treatment to avoid periodontal problems and unstable orthodontic treatment. (11)(4)(12)

Formerly WALA edge measurements were performed on plaster models, but among the disadvantages of this method, only linear measurements could be performed on

these models, other disadvantages are that these models presented deterioration with the passage of time, the reliability of the material used was not the best and they require physical storage space. (6)(12)

Currently this has been evolving and they have been replaced by three-dimensional digital models that are obtained by intraoral scans and are managed by software that allows their manipulation and also allows greater accuracy. (5)(13) 3D management software is constantly changing, one study showed that a scan from two years ago may yield different results if repeated today. (14)

According to Sibert et al. in their study they mention that the ideal Andrews distances at the level of the first premolars is 0.8 mm/side, 1.3 mm/side in second premolars and 2 mm/side in lower first molars. (15) Our study applied to a group of Ecuadorian nationals obtained values very close to those mentioned above, being 0.75 mm for first premolars, 1.16 mm for second premolars and 2.01 mm for lower first molars. However, other studies such as that of Bhandari et al. in an Indian population showed results of 1.17 mm for first premolars, 1.53 mm for second premolars and 2.04 mm for lower first molars. (16) Also Kong et al. in their study of a Peruvian population obtained values of 0.96 mm for first premolars; 1.45 mm in second premolars and 2.12 mm in lower first molars (17). On the other hand, Tribiño et al. in their study of a Brazilian population showed values of 0.88 for first premolars; 1.55 mm in second premolars and 2.21 mm in lower first molars. (3) The values higher than those established by Andrews show a clear lingualization of the posterior teeth in the populations studied. An important fact that should be taken into account is that the thickness of the soft tissues varies between teeth, therefore, this may affect the positions of the WALA points. (18)

Cone beam computed tomography (CBCT) has become a rapidly evolving imaging technique in orthodontics, since due to its more advanced diagnostic capabilities, it has allowed us to obtain treatment planning in a three-dimensional (3D) format. (19) Although this method is very effective, it has caused controversy, since the patient must be exposed to radiation to obtain the results. (20) In this study we sought to compare the DICOM and STL files, but a statistically significant difference was found,

which lies in the way of tracing the WALA points, since in the STL file software dental tissue, bone tissue and soft tissue can be measured, whereas in the DICOM format the soft tissue points were not considered in the images, therefore this makes it difficult to properly identify the above mentioned points using CBCT and hence the measurement results differ greatly between the two diagnostic methods. However, some studies have used CBCT to trace the trajectory that describes the arc generated by the points of the root center (RC) that corresponds to the WALA point, but located in the basal bone. (5)(21)

5. Conclusions:

The following conclusions were drawn from this study:

From the measurements obtained from the analysis sample it was concluded that the values in the STL models largely resemble the values described by Will Andrews, however, they differ significantly in relation to the unit of analysis of DICOM files which lack scientific support to be taken into account as a measurement of the WALA edge.

Some of the differences in values obtained for WALA edge measurements between different study populations may be due to the fact that several studies use the manual or conventional method and others the digital method and even the same scanner or software used in the digital measurement of models may cause slight discrepancies in the measurements.

It would be useful to carry out future studies taking into account larger populations to confirm the results we have obtained, in addition to following up the present study in terms of the results obtained and taking into account interobserver reliability in a prudent time frame, since this study could not be carried out in this study.

1. Ethical Statement

This paper has never been published before and is not being considered for publication elsewhere.

2. Conflicts of Interest

The authors have no conflicts of interest relevant to this article

Índice

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