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Comparative study of reliability in three software meshmixer, 3d slicer and nemocast of the intercanine and intermolar spaces of digital models

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Abstract

Aim: Observe the measurements of the intercanine and intermolar space of digital models and compare the reliability of different software, Meshmixer, 3D Slicer and Nemocast.

Methods: Inclusion and exclusion criteria were used to obtain the study sample. Thus, a sample made up of 29 patients obtained from a database with their respective digital models was obtained.

Results: In the results of the measurement in the three programs we obtained that the difference in the upper intercanine space is 1.43 mm, in the lower intercanine space it is 0.26 mm, in the upper intermolar space it is 0.11 mm and the lower intermolar space is 0.25mm.

Conclusion: There was no significant difference between the results obtained in the three Meshmixer, Nemocast and 3D Slicer programs, thus providing reliable and safe data for diagnostic and planning studies in orthodontics.

Keywords: Nemocast; Meshmixer; 3D Slicer; Intercanine; Intermolar; Reliability

1. Introduction

Software-assisted cephalometric tracings and analysis of three-dimensional models and images have become routine in orthodontic diagnosis and treatment planning. The determination of the biological limits of orthodontic treatment and the evaluation of the temporomandibular joints and the respiratory tract became part of the orthodontic evaluation (1).

There are many advantages to this mode of diagnostic logging. Scans are stored electronically with patient records, eliminating model storage and allowing authorized users to view patient records when they are not physically present in the office. Files are sent electronically to licensed dental labs, eliminating concerns about proper disinfection and saving delivery time. Virtual diagnostic setups can be completed digitally and treatment plans viewed by multiple clinicians simultaneously without being physically present when multidisciplinary case management is planned (1).

3D images in dentistry play an essential role in diagnosis and treatment planning. Transform digital images into a real object that can be experienced by providing new opportunities for professionals regarding patient communication, skills training, and treatment planning (2).

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The software used in the following study, we have 3D Slicer, it is a software application whose purpose is the visualization of biomedical images. One of the main characteristics, which also constitutes the main source of software versatility, is the availability of several extensions that can be installed, allowing the execution of specific analyzes depending on the research needs (3).

The second software used is Autodesk Meshmixer, the name of the software originates from its first functionality, Meshmix, that is, it is based on triangular meshes that consist of three elements: vertices, edges, and faces or triangles. Vertices correspond to points in 3D space, edges connect two vertices together, and faces correspond to the association of three vertices (4).

Finally, the latest software is NemoCast, an orthodontic software that allows from the analysis of digital models, diagnosis and digital planning, to the export and printing of products (5).

Within the software, intercanine and intermolar distance can be analyzed, which are necessary in model analysis:

Intercanine Distance: It is the linear distance between the tops of the cusps of the central canines, or in the case of a wear facet, it is taken at the center of the wear surface, produced by the masticatory function (3).

Intermolar distance: according to Facal-García M (6) and Shapiro (7) they considered it as the distance between the vertices of the mesiobuccal cusps of the first molars.

The objective of this study was to determine the intercanine and intermolar space of digital models of patients from the University of Cuenca with the three software mentioned above (Meshmixer, Nemocast, 3D Slicer), in order to determine their reliability to offer an accurate diagnosis. and suitable for the patient.

2. Material and methods

The universe of study consisted of a database of 40 patients, who are studying Dentistry, Orthodontics I area, at the University of Cuenca. Inclusion and exclusion criteria were used to obtain the sample. Within the inclusion criteria were those who presented their digital model with complete permanent dentition and good resolution and digitization. The exclusion criteria were those that presented digital models with severe crowding or gyroversions, models that presented canines or first molars with defects in the cusps that made it impossible to visualize the reference point, and models that were modified. Thus, a sample composed of 29 patients from the database was obtained.

All the models were opened in the 3 software: nemocast, meshmixer and 3D Slicer, where the width or intercanine space was measured, which is the distance between the tips of the cusp on both sides. (Figure 1) (8). According to Facal-García M (6) and Shapiro (7) to measure the intermolar space they considered the distance between the vertices of the mesiobuccal cusps of the first molars (Fig.2).

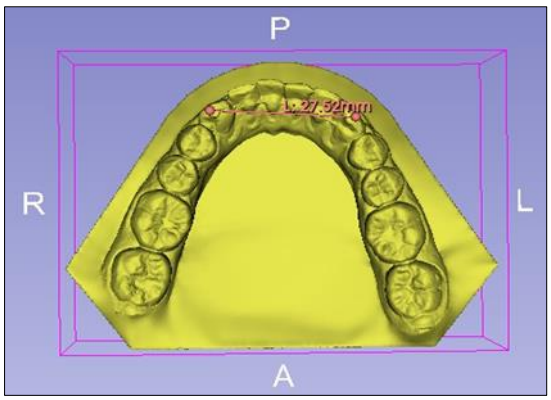


Figure 1 Intercanine space measurement, digital measurement (27.52 mm) Screenshot of an example in 3D Slicer

The information obtained was captured and the measurements were transferred to an Excel spreadsheet for subsequent comparative analysis and interpretation of results.

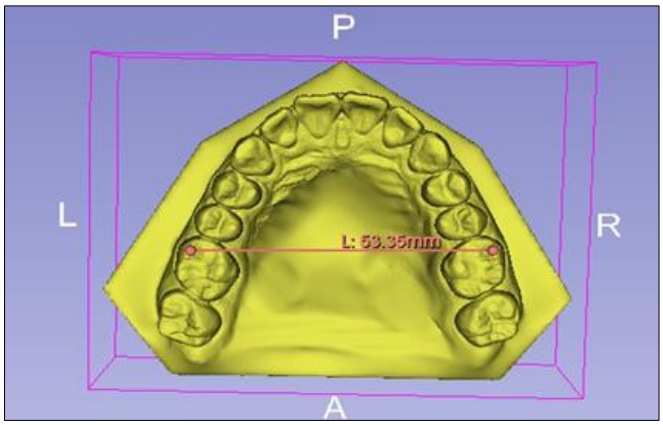
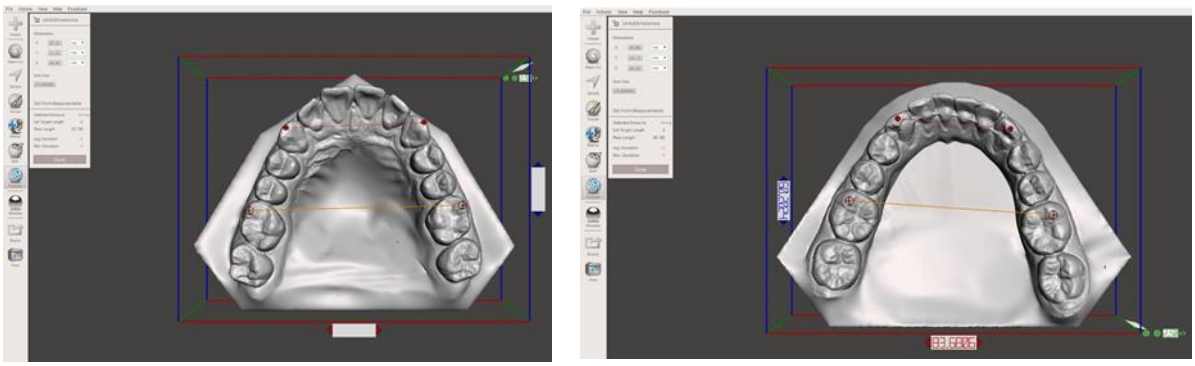


Figure 2 Intermolar space measurement, digital measurement (53.35 mm) Screenshot of an example in 3D Slicer

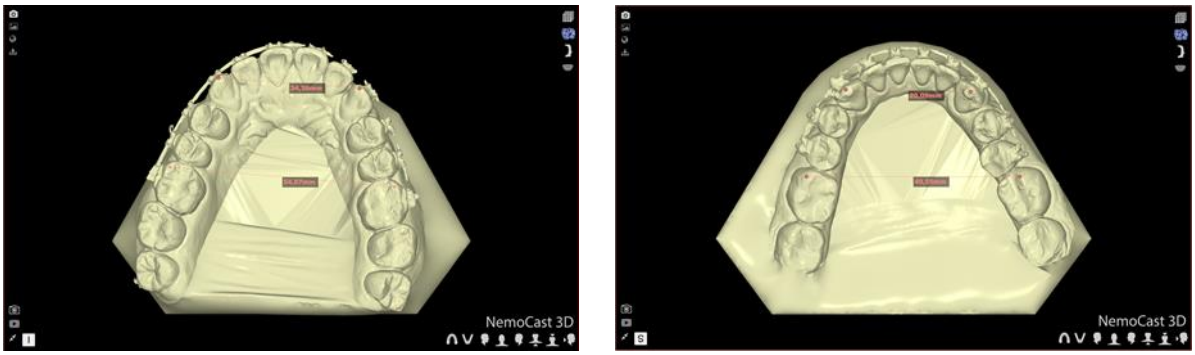
3. Results

In the following work we took the measurements of the intercanine and intermolar space in both the upper and lower model, the study sample was 29 patients obtained from a database, the measurements were obtained in the three programs: Nemocast, Meshmixer and 3d Slicer.



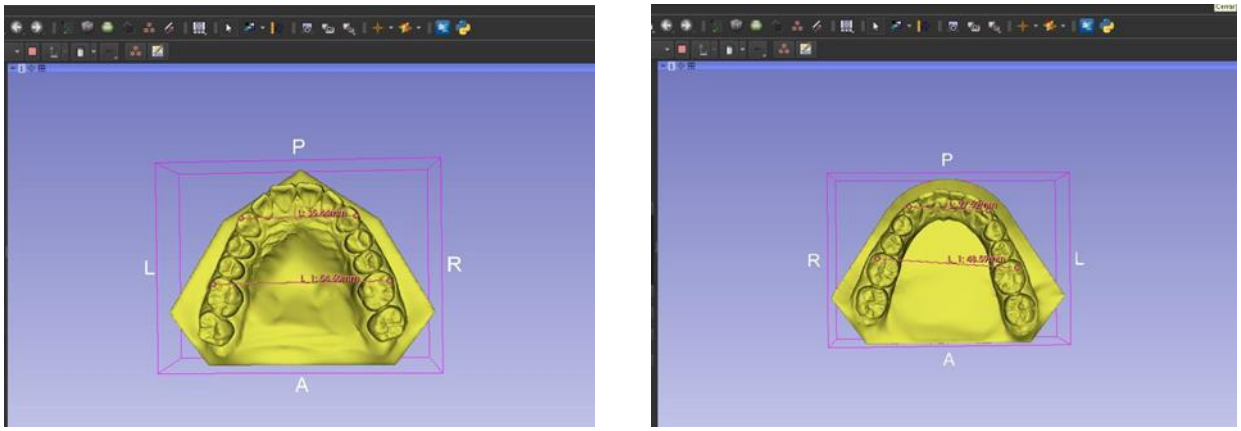
A B

Figure 3 Digital calibration in Meshmixer: A) intercanine space of the upper model B) intermolar space of the lower model.



A B

Figure 4 Digital calibration in Nemocast: A) intercanine space of the upper and lower model B) intermolar space of the upper and lower model.



A B

Figure 5 Digital calibration in 3D Slicer: A) intercanine space of the upper and lower model B) intermolar space of the upper and lower model.

Variations were found in the measures of the three programs, however, the differences were not significant. The programs presented the following results: in Nemocast the mean for the upper intercanine space is 34.87mm, the upper intermolar space is 52.30mm, the lower intercanine space is 27.07mm and the lower intermolar space is 45.33mm. in Meshmixer the average for the upper intercanine space is 35.5 mm, the upper intercanine space is 52.33 mm, the lower intercanine space is 26.85 mm and the lower intermolar space is 45.08 mm, finely in the 3D Slicer the mean for the upper intercanine space is 34.94 mm, the upper intermolar space is 52.22 mm, the lower intercanine space is 26.81, and the lower intermolar space is 45.24 mm (Table 1).

Table 1 Measurement results in the programs

Software	Upper Intercanine space	Lower Intercanine space	Upper Intermolar space	Lower Intermolar space
NEMOCAST	34.07 mm	27.07 mm	52.30 mm	45.33 mm
MESHMIXER	35.50 mm	26.85 mm	52.33 mm	45.08 mm
3D SLICER	34.94 mm	26.81 mm	52.22 mm	45.24 mm

From the data obtained, we can see that there was a greater coincidence of the upper intermolar space in the three programs. On the other hand, there is a greater discrepancy in the results of the upper intercanine space, but this is not so significant as to deduce that one of the programs is not reliable or accurate.

4. Discussion

In this study, the reliability and precision of the measurements of the intercanine and intermolar spaces in three Meshmixer programs, 3D Slicer and Nemocast, were compared.

The study carried out by Noha et al that analyzes the validity and reliability of the digital models generated from the CBCT scanner found that the measurements provided by Autodesk Meshmixer were reliable as in our study (9).

Likewise, the study carried out by Eid et al., compares the measurements of the intercanine and intermolar width through the use of the Meshmixer and OrthoAnalyzer programs, the authors did not find significant differences in the measurements obtained, therefore they conclude that the meshmixer program is reliable and valid for the diagnosis and planning of orthodontic treatments (8). In the same way, Camardella et al. obtained as a result that the measurements obtained by the digital payment programs are reliable (10).

The results of this study are similar to those obtained by Eid et al, since, although variations were found in the intercanine and intermolar space measurements in the three programs (Nemocast, Meshmixer, and 3D Slicer), these were not significant.

Pacheco et al mention in their thesis that the measurements obtained in the 3D Slicer software were reliable and safe. The results of our investigation coincide with the one mentioned, since there is not much difference between 3D Slicer and the other two programs (11).

The research by Salinas et al, as well as the thesis by Bravo et al, agree that the measurements obtained from the digital programs are reliable (3) (12).

5. Conclusion

There was no significant difference between the results obtained in the three Meshmixer, Nemocast and 3D Slicer programs, thus providing us with reliable and safe data for diagnostic and planning studies in orthodontics. However, it is important to consider that the Nemocast program has more tools that are an advantage when performing a treatment.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

All authors declare that they have no conflict of interest for publishing this original manuscript.

Statement of ethical approval

'The present research work does not contain any studies performed on animals/humans subjects by any of the authors'.

Statement of informed consent

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

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