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ESTIMATION OF DISTANCES IN 3D BY DENTISTRY STUDENTS USING NEMOCAST SOFTWARE (INTERCANINE DISTANCE, INTERMOLARS AND UPPER AND LOWER INCISAL SUM)

ESTIMATIVA DE DISTÂNCIAS EM 3D POR ESTUDANTES DE ODONTOLOGIA UTILIZANDO O SOFTWARE NEMOCAST (DISTÂNCIA INTERCANINA, INTERMOLARES E SOMA INCISAL SUPERIOR E INFERIOR)

ESTIMACIÓN DE DISTANCIAS EN 3D POR ESTUDIANTES DE ODONTOLOGÍA USANDO EL SOFTWARE NEMOCAST (DISTANCIA INTERCANINA, INTERMOLARES Y SUMA INCISAL SUPERIOR E INFERIOR)

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ABSTRACT
Objective: The aim of this study was to assess the ability of dental students to take accurate measurements on digital dental models in STL format, using the Nemocast software, in order to contribute to knowledge about the effectiveness of digital tools in making therapeutic decisions in orthodontics. Methods: A prospective observational project was carried out in which an intraoral scan was performed on a sample of 33 individuals, divided into men and women. This examination was applied to individuals between 20 and 29 years of age. The aim of this study was to evaluate in detail the effect of 3D images and virtual reality on orthodontic treatment in the clinical environment. Results: It can be estimated that the mean of the measurements taken in the NemoCast 3D program end between the male and female sexes of a group of 33 individuals from the city of Cuenca, Ecuador, where the standard deviation of these values was determined, which represents a minimum dispersion of the data analyzed.

KEYWORDS: Intermolar distance. Intercanine distance. Incisal sum.

RESUMO
Objetivo: O objetivo deste estudo foi avaliar a capacidade dos estudantes de Odontologia de realizar medições precisas em modelos dentários digitais no formato STL, usando o *software* Nemocast, a fim de contribuir para o conhecimento sobre a eficácia das ferramentas digitais na tomada de decisões terapêuticas em Ortodontia. Métodos: Foi realizado um projeto observacional prospectivo, no qual foi feito um exame intraoral em uma amostra de 33 indivíduos, divididos entre homens e mulheres. Esse exame foi aplicado em indivíduos entre 20 e 29 anos de idade. O objetivo desse estudo foi avaliar detalhadamente o efeito das imagens 3D e da realidade virtual no tratamento ortodôntico no ambiente clínico. Resultados: Pode-se estimar que a média das medições realizadas no programa NemoCast 3D terminou entre os sexos masculino e feminino de um grupo de 33 indivíduos da cidade de

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Cuenca, Equador, onde foi determinado o desvio padrão desses valores, o que representa uma dispersão mínima dos dados analisados.

PALAVRAS-CHAVE: Distância intermolar. Distância intercanina. Soma incisal.

RESUMEN
Objetivo: El objetivo de este estudio fue evaluar la capacidad de estudiantes de odontología para realizar mediciones precisas sobre modelos dentales digitales en formato STL, utilizando el software Nemocast, con el fin de contribuir al conocimiento sobre la eficacia de las herramientas digitales en la toma de decisiones terapéuticas en ortodoncia. Métodos: Se llevó a cabo un proyecto observacional prospectivo en el que se realizó un examen intraoral a una muestra de 33 individuos, divididos en hombres y mujeres. Este examen se aplicó a individuos de entre 20 y 29 años de edad. El objetivo de este estudio fue evaluar en detalle el efecto de las imágenes 3D y la realidad virtual en el tratamiento de ortodoncia en el entorno clínico.Resultados: Se puede estimar que la media de las mediciones tomadas en el programa NemoCast 3D terminan entre el sexo masculino y femenino de un grupo de 33 individuos de la ciudad de Cuenca, Ecuador, donde se determinó la desviación estándar de estos valores, lo que representa una mínima dispersión de los datos analizados.

PALABRAS CLAVE: Distancia intermolar. Distancia intercanina. Suma incisal.

INTRODUCTION

The use of 3D studies in the area of Dentistry has become a valuable tool for Orthopedics and Orthodontics treatments. Cases have been shown in which 3D studies have allowed cephalometric evaluation with fewer errors than those carried out conventionally. Elis mentions that Virtual Reality (VR) is the human-machine interface that will resemble real environments and allow dynamic participation. Ouramdane et al. defines VR as a technology for immersion in an artificial reality for one or more people that imitates real or fictitious scenarios, which gives the possibility of modifying the properties of the environment (1)(2).

Nowadays, the use of 3D studies in the area of Dentistry has become a valuable tool for Orthopedic and Orthodontic treatments, since it has shown cases in which 3D studies have allowed a diagnosis and a treatment plan with fewer errors than those performed in a conventional way, in fact the storage of 3D models is easy and they can be stored in a computer in the long term compared to the plaster models that their preservation was limited by the use they are given and the space they occupy (1).

Elis mentions that Virtual Reality (VR) is the human-machine interface that will resemble real environments and allow dynamic participation. Ouramdane et al. defines VR as a technology of immersion in an artificial reality for one or several people that mimics real or fictitious scenarios, giving the possibility to modify the properties of the environment (2).

In the surgical field, a remote control can be used to perform procedures on virtual models that will be executed in a digital space allowing the procedure to be tested before being performed on a patient. There are also various applications for the use of surgical simulators and software to explore the human body (2).

Among the clinical applications in the area of dentistry, techniques have been developed to acquire data on the soft and hard tissues of the jaw region in order to generate a 3D virtual preview for analysis and surgical planning. These techniques have overcome the shortcomings of 2D photographs and radiographs. Four types of 3D imaging systems are used to capture dental and orofacial structures: cone beam tomography or CBCT, laser scanners, structured light scanners and stereophotogrammetry. Among these practices, in terms of impact and development, 3D computer-assisted dental arch modeling is the most important. Apart from that, dental arch modeling has proven to be very useful for orthodontists. Allowing these models are an important source of diagnostic information and are used to educate about the original state, design and measure treatment efficacy. (1)(2)

1. THEORETICAL FRAMEWORK

In recent years, plaster models have been used as an important source of diagnostic information used to understand the condition, as well as to design and evaluate the effectiveness of treatment. Dental arch models are the protagonists of orthodontic practice worldwide; since this is a branch of dentistry that specializes in the diagnosis, prevention and treatment of dental and facial alterations, as well as in the correction of the position of the teeth and jaws. The main objective of orthodontic treatment is to achieve a proper closure of the teeth, i.e. a correct bite that promotes oral health and general well-being of the patient.

At the same time, orthopedics is a branch of dentistry that specializes in the diagnosis, treatment, prevention and rehabilitation of musculoskeletal disorders and injuries in the facial system. This system includes bones, joints, ligaments, muscles, tendons and other components involved in the function of the masticatory system.

Recently, prototype casts made from dental arch casts have become the main way to reproduce accurate 3D models of dental arches and malocclusions. These are electronic recordings of the patient's teeth and occlusion, taken with an intraoral optical camera. (2)

The optical impressions of the dental arch are processed by software that draws 3D projections on a computer, obtained from stereolithography (STL) files. The software can be used to change the view, rotate or tilt the image of the model, measure and record the circumference of the dental arch, the diameter of the teeth, etc. (2).

These models play an important role as a primary source of diagnostic information, which is used to understand the underlying condition and to design and evaluate the effectiveness of orthodontic treatment. These models simplify the three-dimensional visualization of tooth axis and position during clinical examination.

In addition, using 3D models allows us to make precise measurements that we want to analyze as orthodontists, such as the intercanine distance, which is the measurement between the tips of the teeth in the upper right and left corners. This measurement is taken horizontally and is usually one of the considerations when analyzing the occlusion of the teeth and the relationship between the teeth of the dental arch.

The intercanine distance can vary between individuals and is used in orthodontics to determine the size and shape of the dental arch. In orthodontics, orthodontists can measure the distance between teeth as part of treatment planning and determine if there is enough space for the teeth.

Similarly, another measurement we can analyze is the intermolar distance which refers to the horizontal measurement between the cusps of the first molars in the right and left jaws of the dental arch. This measurement is used in orthodontics and dental occlusal analysis to evaluate molar relationships and size.

The distance between the molars is one of the most important considerations in determining the relationship between arch space and posterior teeth. This can vary from individual to individual and is used to assess the need for adjusting orthodontic treatment, especially in situations where the dental office is overcrowded or lacks space.

These measures can help us to perform a good treatment in case the patient suffers from dental crowding, which is a condition in which the teeth are stuck or blocked in the dental arch, causing a lack of space for them to fit properly. This phenomenon can affect both primary and permanent teeth and can present itself in different forms and degrees of severity.

The aim of this study is to learn about the ability of dental students to make accurate measurements on digital dental models and, in turn, to evaluate the reliability of the Nemocast software when interpreting and analyzing these measurements. This software is used in orthodontics and facilitates the analysis of digital models, diagnosis, digital design up to product impression and presentation of cases to the patient with very useful tools for the orthodontist. This study aims to contribute to the knowledge of the effectiveness and accuracy of digital tools in the therapeutic decision making process in orthodontics, thus supporting the transition to a more digital approach in clinical practice.

2. METHODOLOGY

A prospective observational design was carried out in which an intraoral scan was performed on a sample of 33 individuals divided between males and females. This scan was applied to individuals between 20 and 29 years of age. The aim of this study was to evaluate in detail the effect of 3D images and virtual reality on orthodontic treatment in the clinical setting. Inclusion criteria included STL models made with the same intraoral scanner to avoid differences between different devices and to provide homogeneity of the sample.

Data collection was carried out using the CEREC® intraoral scanner from Dentsply Sirona, which provided digital models in STL format; subsequently, the NemoStudio® software was used to take the intercanine and intermolar distances and the upper and lower incisal sum, using the

Nemocast 3D application for the visualization and manipulation of these models with the respective 3D measurement tool (Figure 1).

The independent variables included malocclusion criteria, mandibular arch crowding and the size of the dental arches; however, the dependent variables required the precision of the observer to take the measurements with the 3D measurement tool provided by the Nemocast® software. The intercanine distance, intermolar distance and incisal sum of the models were taken in STL format for both the upper and lower arches (Figure 2).

Figure 1. Representation of the NemoCast 3D® application and 3D linear measurement tool

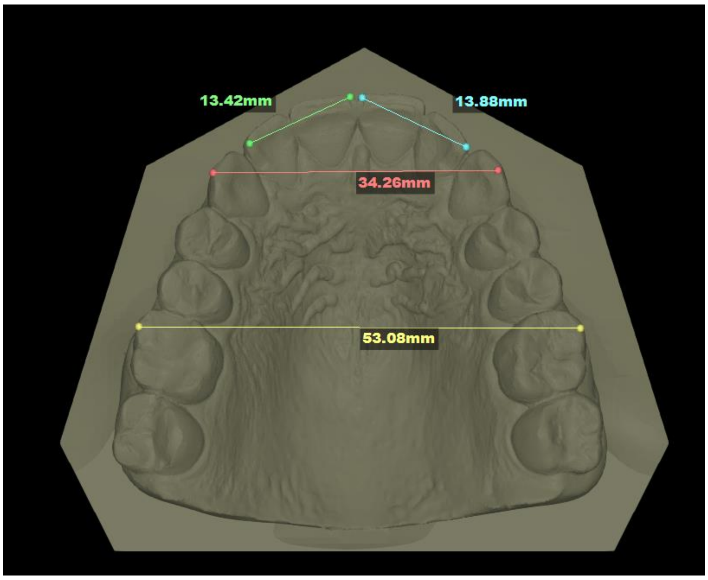

Figure 2. Placement of 3D linear measurements to measure incisal sum, intercanine distance and intermolar distance of an STL model of the upper jaw.

3. ANALYSIS OF DATA

The data analysis included simple tables using the excel program to analyze the data provided. The data collection of the 33 participants was carried out with 10 male and 23 female participants and they were classified in two groups coding the genders with 0 for the male and 1 for the female (Table 1) and thus making an average of the incisal sum, intercanine distance and intermolar distance.

Subsequently, using Excel, we first calculated the mean according to gender for each variable (Table 2), and finally we calculated the mean for all the participants (Table 3).

#	Upper intercanine distance (mm)		Lower intercanine distance (mm)		Upper intermolar distance (mm)		Lower intermolar distance (mm)		Upper incisal sum (mm)		Lower incisal sum (mm)	
	0	1	0	1	0	1	0	1	0	1	0	1
1	39.42	33.31	37.40	24.31	61.21	53.09	52.49	45.51	32.49	27.66	21.94	19.96
2	37.93	35.44	27.28	28.56	61.74	48.51	55.07	45.02	29.40	27.38	21.42	21.05
3	36.15	35.48	29.40	30.78	57.12	57.62	51.66	52.50	29.24	28.60	22.57	23.24
4	34.93	37.04	27.89	27.64	52.33	53.63	48.46	47.27	28.15	26.53	21.12	19.55
5	36.70	33.94	28.77	25.35	57.33	54.62	50.77	45.77	29.70	27.33	20.58	21.67
6	35.13	33.31	27.60	23.83	56.26	43.86	49.67	43.86	24.73	29.24	19.36	19.14
7	37.74	36.10	29.82	28.55	63.79	56.54	60.53	45.93	27.85	31.08	21.42	23.39
8	37.17	35.40	30.28	27.67	57.84	54.05	52.75	47.13	29.90	30.24	20.09	20.45
9	37.90	38.14	28.19	29.47	60.32	55.21	51.35	50.61	28.72	31.67	21.34	23.06
10	37.40	35.71	29.67	28.56	55.67	52.10	57.96	49.53	29.45	29.99	21.46	21.05
11		34.63		27.68		55.15		49.36		29.14		21.42
12		32.35		27.54		49.90		41.62		26.33		19.82
13		34.15		27.06		54.63		47.33		27.30		20.38
14		35.02		27.17		52.77		45.60		28.96		21.46
15		35		26.33		50.92		46.98		29.57		22.13
16		39.87		27.88		51.28		45.88		30.38		21.77
17		33.42		23.03		50.55		43.22		26.98		20.14
18		34.47		26.35		48.15		41.14		29.19		21.07
19		33.57		24.34		47.41		40.36		27.45		18.93
20		34.13		26.61		54.15		47.50		27.98		19.33
21		35.77		26.64		53.66		47.98		27.65		19.32
22		33.99		25.87		54.88		47.12		26.09		18.35
23		34.11		26.04		39.98		45.97		27.85		20.81

Table 1. Compilation of measurements performed in Nemocast on 33 participants, 10 male and 23 female coded with 0 and 1 respectively

Average in each gender											
Upper intercanine distance (mm)		Lower intercanine distance (mm)		Upper intermolar distance (mm)		Lower intermolar distance (mm)		Upper incisal sum (mm)		Lower incisal sum (mm)	
0	1	0	1	0	1	0	1	0	1	0	1
37.04	34.97	29.63	26.83	58.36	51.85	53.07	46.22	28.96	28.46	21.13	20.76

Table 2. Mean result of measurements according to each corresponding variable according to gender

General measure					
Upper intercanine distance (mm)	Lower intercanine distance (mm)	Upper intermolar distance (mm)	Lower intermolar distance (mm)	Upper incisal sum (mm)	Lower incisal sum (mm)
35.60	27.68	53.82	48.30	28.61	20.87

Table 3. Average overall measurements in the 33 individuals, both male and female

4. RESULTS

Table 4 shows the mean of the measurements taken in the final NemoCast 3D program between the male and female sexes of a group of 33 individuals from the city of Cuenca, Ecuador, where the standard deviation of these values was determined, which represents a minimum dispersion of the data analyzed.

Media en cada sexo											
Upper intercanine distance (mm)		Lower intercanine distance (mm)		Upper intermolar distance (mm)		Lower intermolar distance (mm)		Upper incisal sum (mm)		Lower incisal sum (mm)	
0	1	0	1	0	1	0	1	0	1	0	1
37.04	34.97	29.63	26.83	58.36	51.85	53.07	46.22	28.96	28.46	21.13	20.76
Desviación estándar											
1.46		1.97		4.60		4.84		0.35		0.26	

Table 4. The mean of the measurements made in NemoCast 3D of the permanent dentition models of 33 individuals grouped into 10 males and 23 females can be determined, in which the standard deviation of the results could be obtained, which does not represent a greater dispersion of the data.

5. DISCUSSIONS

The present study provides relevant information on the use of calibrated software in orthodontic practice, emphasizing its potential use as a diagnostic tool that would allow a more accurate individualized treatment plan.

In 2020 Aswani et al. mention that intraoral systems for scanning the mouth can be safely used for diagnostic and short-term scans as scanning the entire dental arch may be more susceptible to deviations. Accordingly, it is possible to determine the mean of the measurements performed in the NemoCas 3D program on the permanent dentition models seen in this study, which allows visualizing the clinical relevance of the deviations obtained, where the results showed that it does not represent a greater dispersion of the data (4).

For Rabe et al. in 2021 points out that, although there are differences in the measurements of conventional models and 3D models, these variations are clinically acceptable, even mentioning that there are discrepancies of up to 1.5 mm during the measurement in a conventional plaster model where a slight crowding is evident when using a digital caliper. The mean and standard deviation of the measurements in NemoCast 3D allows analysis of the magnitude of the differences in the clinical practice setting (5).

The study by Motamedi et al. in 2015 also describes that the differences in intercanine and intermolar distance during orthodontic treatment were statistically significant, however the changes were not clinically relevant, in this study the distances were measured with a digital caliper on models already made before, during and after treatment, it should be noted that the author mentions that there were difficulties during the measurement process and that the selection of the incisal edges of the canines and the cuspid edges of the molars was taken from a subjective point of view. Comparing these results with those found in NemoCast 3D, it can be assessed that the difficulties indicated by Motamedi also apply in this investigation (6).

For Jedliński at al. in 2021 he further mentions that, although intraoral scanning may be more time consuming in practice, it is highlighted that it is less uncomfortable for patients compared to standard impression-taking procedures and that the choice of scanner may influence the accuracy of the results. The inclusion of the mean and variance of NemoCast 3D measurements accesses a higher accuracy and efficiency of this software compared to an intraoral scanner (7).

In tune with the efficiency of digital scanning, Jabri et al. (2021) highlight the elimination of errors associated with conventional impressions, as well as the improvement in treatment planning and ease of data transfer to the laboratory. Contextualizing these results with those obtained in NemoCast 3D provides a valuable comparative perspective for evaluating the efficacy of the software in clinical practice (8).

Despite these advances, Warnecki et al. warn about the subjectivity in measuring distances in digital models, highlighting the influence of the practitioner's expertise and the degree of dental crowding. The inclusion of the mean and standard deviation of measurements in NemoCast 3D makes it possible to evaluate the robustness and reliability of this software under various conditions (9).

6. CONCLUSIONS

According to the present study, it has been determined that the use of a properly calibrated software can be a very useful tool and perhaps in the future it can be used as a gold standard to perform different diagnoses not only in the area of orthodontics, but also in different areas of dentistry, in addition, its diversity of functions even allows researchers to carry out scientific studies of great interest and usefulness, which, compared to measurements on conventional models, is superior in terms of precision, time and easy manipulation, which allows the operator or researcher to have greater accuracy in data analysis, better storage of models and great savings in time and resources.

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