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DIAGNOSIS OF SAGITTAL AND TRANSVERSAL ASYMMETRY IN DIGITAL ORTHODONTIC STUDY MODELS OF A STUDENT POPULATION BY THE KLO METHOD APPLIED IN DIGITAL SOFTWARE

DIAGNÓSTICO DE ASSIMETRIA SAGITAL E TRANSVERSAL EM MODELOS DE ESTUDO DE ORTODONTIA DIGITAL DE UMA POPULAÇÃO ESTUDANTIL PELO MÉTODO KLO APLICADO EM SOFTWARE DIGITAL

DIAGNÓSTICO DE ASIMETRÍA SAGITAL Y TRANSVERSAL EN ORTODONCIA DIGITAL MODELOS DE ESTUDIO DE UNA POBLACIÓN ESTUDIANTIL POR EL MÉTODO KLO APLICADO EN SOFTWARE DIGITAL

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ABSTRACT

Introduction: Effective diagnosis and treatment of orthodontic patients requires a number of essential ancillary tests. However, some difficulty arises when evaluating dental asymmetries in the hemiarchs of each dental arch. The correct appreciation of these asymmetries is crucial, according to several studies, for the proper final placement of the teeth in their arch at the end of the treatment. The current literature is limited in terms of methods to evaluate and diagnose alterations due to hemiarchs. The KLO method applied in digital software is useful for diagnosing sagittal and transverse asymmetries. Objective: To perform a descriptive cross-sectional study of digital models in STL format through the KLO method and its applicability in digital software, in order to identify the presence of dental alterations and asymmetries; to collect the information, key terms such as: Diagnosis; orthodontics; dental models; asymmetry; molar teeth; Software Application were used. To obtain the results, information was collected from 20 digital models in a Google Drive database, which are part of this study. Results: Seventy-five percent (n=15) of the students presented dental asymmetry, while 25% (n=5) presented dental symmetry. Conclusion: A proper diagnosis is essential to identify dental asymmetries. The KLO method and its application in a digital software allows to identify a dental asymmetry in a simpler way, besides allowing to store the information in a computer.

KEYWORDS: Diagnosis. Orthodontics. Dental models. Asymmetry. Molar teeth. Software application.

RESUMO

Introdução: O diagnóstico e o tratamento eficaz dos pacientes ortodônticos requer uma série de exames complementares essenciais. No entanto, surge alguma dificuldade na avaliação das assimetrias dentárias nos hemiarcos de cada arcada dentária. A correta apreciação dessas assimetrias é fundamental, segundo diversos estudos, para o correto posicionamento final dos dentes na sua arcada ao final do tratamento. A literatura atual é limitada em termos de métodos para avaliar e diagnosticar alterações decorrentes de hemiarcos. O método KLO, aplicado em *software* digital, é útil para o diagnóstico de assimetrias sagitais e transversais. Objetivo: Realizar um estudo transversal descritivo de modelos digitais em formato STL através do método KLO e sua aplicabilidade em *softwares* digitais, a fim de identificar a presença de alterações e assimetrias dentárias; coletar as informações, termos chaves como: Diagnóstico; ortodontia; modelos dentários; assimetria; dentes molares; Aplicação de *Software* foram utilizados. Para a obtenção dos resultados, foram coletadas informações de 20 modelos digitais em um banco de dados do Google Drive, que fazem parte deste estudo. Resultados: Setenta e cinco por cento (n=15) dos alunos apresentaram assimetria dentária, enquanto 25% (n=5)

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apresentaram simetria dentária. Conclusões: Um diagnóstico adequado é essencial para identificar as assimetrias dentárias. O método KLO, através de sua aplicação num *software* digital, permite identificar assimetria dentária de forma mais simples, para além de permitir armazenar a informação num computador.

PALAVRAS-CHAVE: Diagnóstico. Ortodontia. Modelos dentários. Asimetria. Dentes molares. Aplicação de *software.*

RESUMEN
Introducción: El diagnóstico y tratamiento efectivos de los pacientes de ortodoncia requieren una serie de pruebas auxiliares esenciales. No obstante, surge cierta dificultad al evaluar las asimetrías dentarias en los hemiarcos de cada arcada dentaria. La correcta apreciación de estas asimetrías es crucial, según diversos estudios, para la adecuada ubicación final de los dientes en su arcada al concluir el tratamiento. La literatura actual es limitada en cuanto a métodos para evaluar y diagnosticar alteraciones por hemiarcos. El método KLO aplicado en el software digital es útil para diagnosticar las asimetrías sagitales y transversales. Objetivo: Realizar un estudio descriptivo de corte transversal de modelos digitales en formato STL a través del método KLO y su aplicabilidad en los software digitales, con el fin de poder identificar la presencia de alteraciones y asimetrías dentarias; para recabar la información, se emplearon términos claves como: *Diagnosis; orthodontics; dental models; asymmetry; molar teeth; Software Application.* Para obtener los resultados; se recabó la información de 20 modelos digitales en una base de datos de Google Drive, los cuales forman parte de este estudio. Resultados: El 75 % (n= 15) de los estudiantes presentan una asimetría dentaria, mientras que el 25 % (n=5) presentaron simetría dentaria. Conclusión: Un diagnóstico adecuado es fundamental para identificar asimetrías dentarias. El método KLO y su aplicación en un software digital permite identificar una asimetría dentaria de forma más sencilla, además de permitir almacenar la información en un computador.

PALABRAS CLAVE: Diagnóstico. Ortodoncia. Modelos dentales. Asimetría. Dientes molares. Aplicación de software.

INTRODUCTION

Facial asymmetry is the variation between the two halves of the face, being its etiology congenital, developmental and acquired as a result of injury or disease. (1)

Facial asymmetry is related to dental malocclusion. Bisahara et al. classifies malocclusions as dental, skeletal, muscular or functional; class III being the one that has the greatest association with facial asymmetry. (1)

Clinical examination, study models, radiographs, photographs, electromyogram are indispensable tools to make a good diagnosis of an asymmetry. Especially the study models for obtaining sagittal and transverse asymmetries. In this study we will analyze the KLO method using digital software for the evaluation of sagittal and transversal asymmetries of the canines and molars in the dental arches of the patients' study models. (1)



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Anatomical references

Maxillary arch

- Line extending from the middle raphe at the level of the third crease of the palatine groove passing through the transition zone of the hard and soft palate to the end of the socket of the study model. (1)

Mandibular arch

- Lingual frenulum
- In occlusion, the line of the median raphe is projected to the lower arch with a ruler and joined to the lingual frenulum. (1)

MEASUREMENT METHOD USED

KLO method and its application in digital software

This process can be carried out using any software that has the ability to read digital models. For this purpose, NemoCast software was used in this study. Each model was scanned individually per arch and then in MIC. (2) (3)

To define the functional occlusal plane, the recommendation of Burstone and Marcotte (2000) is followed, which is that the plane should be drawn in relation to the premolars, so it is established from the distal occlusal contact point of the lower molars to the point that bisects the vertical overbite or to an occlusal contact point in the premolar region (Burstone and Marcotte 2000). Once this plane is obtained, the sagittal plane is defined from the medial raphe to the height of the third palatal crease and then extending distally from the second premolar. This line is prolonged passing through the area between the hard and soft palate to the end of the digital model socket (Luu et al, 2012) hoping to obtain a result that is perpendicular to the occlusal plane and in patients with facial symmetry that coincides with the mid-facial line (Melsen 2013), therefore, to obtain this result, the procedure is as follows. (3) (4) (5)

First, two lines should be drawn; the first one should arise from the central fossa of the molar and the other from the cingulum of the canine, with an angle of 90° to the median raphe. This point reports the closest point to the centroid point of the teeth. This, in order to obtain the different dental asymmetries (sagittal, vertical and transversal) of molars and canines. (3) (4) (5)

From the images acquired, two occlusal planes were obtained: the occlusal plane and the sagittal plane of the median raphe. Subsequently, the measurements of canines and molars were taken in each hemiarch, thus obtaining the measurements of the dental asymmetries. (3) (4) (5) (6)

METHODOLOGY

A cross-sectional descriptive observational study was carried out. The data collection was obtained through a database in Google Drive of digital models in STL format of 20 seventh semester students of the Dentistry course of the University of Cuenca, in the academic period 2023-2024, where



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the quality of each of the STL files was evaluated. The seventh semester dental students at the University of Cuenca were chosen because they are representative of the University, since some of them had orthodontics for a period of time and others did not, which helps to diagnose the sagittal and transversal asymmetries present.

As a data collection modality, students were asked to perform intraoral scans to obtain the digital models in a respective dental office and then uploaded in STL format in the database in Google Drive, to be later analyzed in the NemoCast software.

The sample size was set at 20 students who met the inclusion criteria: being of legal age, being enrolled in Orthodontics I in the seventh semester of Dentistry at the University of Cuenca, presence of the permanent dentition dental model scanned and in STL format; and those who met the exclusion criteria: not being of legal age, presence of dental plaster models and students from other semesters were rejected. This study has a confidence level (CN) of 95%.

Regarding the presentation of results, the study regrouped the studied models into symmetric and asymmetric using the KLO method applied in a digital software (NemoCast) for a better understanding.

RESULTS

Table 1. The measurements that were plotted from the cingulum of the canine to the medial raphe and from the central fossa of the first molar in each hemiarch of the maxilla of the 20 study models are shown

Patient	Canine-rafe (Quadrant I)	Canino-rafe (Quadrant II)	Molar-rafe (Quadrant I)	Molar-raphe (Quadrant II)	Result
1	25mm	25mm	32mm	32mm	Symmetrical
2	22mm	21mm	30mm	32mm	Asymmetric
3	25 mm	28mm	32mm	39mm	Asymmetric
4	25mm	24mm	38mm	36mm	Asymmetric

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5	24mm	25mm	34mm	36mm	Asymmetric
6	24mm	26mm	35mm	37mm	Asymmetric
7	26mm	26mm	39mm	39mm	Symmetrical
8	27mm	27mm	36mm	39mm	Asymmetric
9	16mm	14mm	25mm	26mm	Asymmetric.
10	18mm	16mm	28mm	25mm	Asymmetric
11	16mm	15mm	23mm	21mm	Asymmetric
12	16mm	14mm	23mm	22mm	Asymmetric.
13	19mm	19mm	30mm	30mm	Symmetrical
14	18mm	16mm	25mm	28mm	Asymmetric
15	16mm	18mm	26mm	28mm	Asymmetric
16	20mm	20mm	35mm	35mm	Symmetrical

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17	**15mm**	**17mm**	**23mm**	**25mm**	**Asymmetric**
18	**14mm**	**15mm**	**25mm**	**24mm**	**Asymmetric**
19	**14mm**	**15mm**	**21mm**	**21mm**	**Asymmetric**
20	**17mm**	**17mm**	**25mm**	**25mm**	**Symmetrical**

Table 1. Summary of results

In this study carried out in a group of 20 students of the Faculty of Dentistry of the University of Cuenca, 75% (n=15) presented dental asymmetry, while 25% (n=5) presented dental symmetry (Fig 1) (Tab 2).

	Number of patients	**Percentage**
Symmetry	**5**	**25 %**
Asymmetry	**15**	**75 %**
TOTAL	**20**	**100 %**

Table 2. Percentage of symmetries and asymmetries in the study group

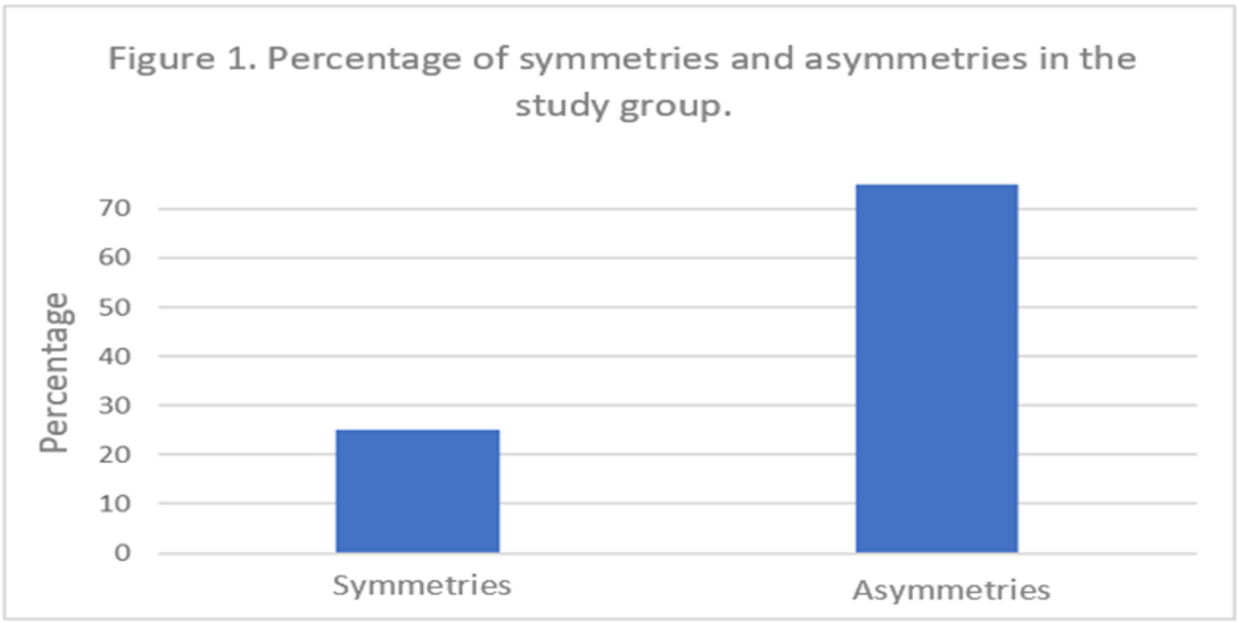


Figure 1. Percentage of symmetries and asymmetries in the study group

DISCUSSION

Ahmad Hasan et al. consider that the asymmetry of the canine and molar relationship is related to the coincidence of the dental midlines and asymmetry. They analyzed the dental asymmetry of 177 models and concluded that 39.5% presented molar asymmetry and 23.2% presented a non-coincident midline. (2)

This study aims to find out what is the prevalence of asymmetrical and symmetrical occlusion existing in the mentioned population. The best way forward with orthodontics is symmetry, having clinical and diagnostic implications. (8)

In order to prevent possible transverse malocclusions with maxillary expansion, it is essential to perform an early analysis of the transverse dimension of the models, since there must be a transverse alveolar width with optimal dental inclinations for an ideal functional occlusion. (1) (7)

Study models and postero-anterior cephalograms are the most commonly used tools for diagnosis and treatment planning of transverse asymmetries, but both have limitations. Nowadays CBCT tomography has become the standard tool for the diagnosis of transverse problems. (9) (6)

Don-Soon Choi mentions that plaster models have been a fundamental part of the diagnosis in orthodontic treatment, and in the study of 3D digital models, the surface of the palate should be taken as a reference to measure tooth movements, since it is considered that the palate and the wrinkles are



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formed in the 12th and 14th week of intrauterine life and are maintained during the growth of the person, being the third wrinkle the most maintained. (4)

The KLO method allows the quantification of the lack of dental symmetry in each arch in an easy and reproducible way to be stored in a file. (9)

Nowadays, esthetics requires an accurate diagnosis of a malocclusion, considering that molars and canines play a fundamental role in the molar and canine key. The molar helps as an anchor in the treatments and the canine is important in the conformation of the arch contour, that is why this method is proposed to have an adequate location of the molar and canine in relation to the middle raphe (from the third palatal groove) which in symmetrical patients coincides with the facial midline. But, when the upper midline is displaced to one side, the mid raphe line in the premaxilla is affected. (5)

Finally, Sawchuk assures that all the indexes that study cross-sectional problems are necessary to demonstrate the expansion required in each case, considering that they are inaccurate, biased and clinically invalid for planning and diagnosis. (3)

CONCLUSIONS

Orthodontics allows us to establish in the patient a functional, esthetic, stable occlusion and a symmetrical smile, so we must give a very detailed approach in the diagnostic stage with the help of study models to identify dental asymmetries.

Thanks to advances in technology such as the use of digital models and the NemoCast software, it has been possible to measure the dental asymmetry of an arch by the KLO method in a faster, easier, reproducible and simple way with computer storage.

The purpose of this study was to identify dental asymmetries in a group of 20 students, in which it was concluded that 75% presented such asymmetries. Therefore, we can evidence a high prevalence of asymmetries in the group of students.

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