Clinical Analysis of Molar Fissures by Cone-Beam Tomography

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This study aimed to validate clinical analysis of 20 pediatric dentists on occlusal groove-fossa-system of molar depth comparing to Cone-beam tomography. The 48 sound third molars were visually classified from the shallowest to the deepest. Images were taken from the Accuitomo 3DX. There was a fair correlation between clinical analysis and the tomographic scorings (rs= 0.238; P=0.103). It was concluded that pediatric dentists were not able to classify the fissures depth by visual analysis correctly.
Key words: *molar fissures, tomagraphy, fissure depth*
J Clin Pediatr Dent 31(4):235-239, 2007

INTRODUCTION

The emergence and progression of occlusal caries is related to the morphology of the groove-fossa system of the posterior teeth.[1,2] The high susceptibility to caries has been attributed to the accumulation of plaque, especially in newly-erupted teeth[3] and to the incomplete coalescence of the enamel in that region.[4]

The concern about the occlusal morphology in relation to predisposition to caries, refering to grooves as susceptible areas, is not recent. Microscopic studies demonstrate that grooves vary according to the shape and depth, in relation to the onset and to the development of carious lesions.[2,5,6,8]

Occlusal caries diagnosis is still mainly performed by visual / tactile examination and supported by bite-wing radiography. The traditional methods have shown low sensitivity and high specificity.[8-10] The use of a probe does not increase the accuracy of the visual examination,[8] and may produce traumatic defects in the demineralized enamel when used carelessly.[11]

New methods have been proposed to improve the traditional diagnosis of incipient occlusal caries, with the use of non invasive devices like dyes, fiber-optic transillumination, digital radiographies, electronic caries detectors and, recently, the DIAGNOdent laser fluorescence device.[12-14] However, the divergent results found in the literature in relation to the sensitivity and specificity, show the need of new studies that could demonstrate diagnostic accuracy on scientific evidence based literature.[15] The results of these findings could lead to the conclusion that conventional methods used are unable to reveal the presence or extension of the caries in the fissures and grooves with high precision.[16]

Considering the difficulties of clinical diagnostic accuracy due to the complexity of occlusal surfaces, in order to classify the risk factor and the indication for treatment, this study aimed to validate the clinical analysis performed by pediatric dentists, concerning anatomic depth of the groove-fossa system of third molars, compared with examination performed by computed volumetric tomography.

METHODS

The Ethics Committee of University of Brasília, College of Medicine, approved this study.

Forty-eight sound third molars, newly erupted or retained, extracted for orthodontic reasons or due to impaction, were selected and stored in distilled water. The teeth were cleaned, mounted in a stone die and numbered from 1 to 48.

Clinical Analysis

The specimens were analyzed by 20 non-calibrated pediatric dentists, with heterogeneous ages and clinical practice time. Each tooth was classified according to the apparent depth of the groove-fossa-system. The diagnosis was performed only by visual examination under natural light. The teeth were classified according to the clinical appearance of the occlusal surfaces and placed in a 9 column system similar to a Gauss Curve, ranged from the "shallowest" to the "deepest". According to each column, the teeth received a respective score, which was recorded in a table. The examinations were repeated after two or three weeks for the intra-examiner correlation test. The median of the 20 evaluations was calculated for the first and for the second analysis. A total of 40 evaluations were obtained.

After clinical analysis, each clinician answered an objective questionnaire, to verify which were the criteria used for the classification and if there was any diversion from the examiners about age and professional experience. The data of each clinician and date of the first and second evaluation were recorded. For the analysis of the answers, the clinicians were divided into 2 groups,

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with 10 clinicians in each group: (group 1) up to 9 years of clinical practice and (group 2) more than 9 years of clinical practice.

Tomographic Analysis

The teeth were imaged by a computed volumetric technique using the Cone-beam X-ray Computed Tomograph (CBCT) [Accuitomo 3D J. Morita Corporation – Kyoto, Japan][17] which was used as a gold standard, because of a high image resolution. The image area size (Fov-field of view) was reduced to a 3x4 cm cylinder. The voxel size (tridimensional pixel – smaller image unity) was 0.125 x 0.125 x 0.125mm. This tomographic device generated an image volume that could be rotated to any direction and seen in the X (sectional), Y (sagittal) and Z (axial) planes. Its radiation dose is similar to a panoramic X-ray or to 3 periapical radiographies (0.006 – 0.0014 msv). The maximum exposure time was 17 seconds. The space between each image was of 1 millimeter (mm). The X-ray voltage was set at 60Kv, current at 1 mA and the images saved in Bitmap format (bmp).

The 3D Tomo X software, allowed the visualization of the X, Y and Z images at the same time and, with the help of its mobile guide – a continuous line which moves all the image planes – it was possible to identify the image section corresponding to the deepest fissure in each one of the 48 teeth (Figure 1).

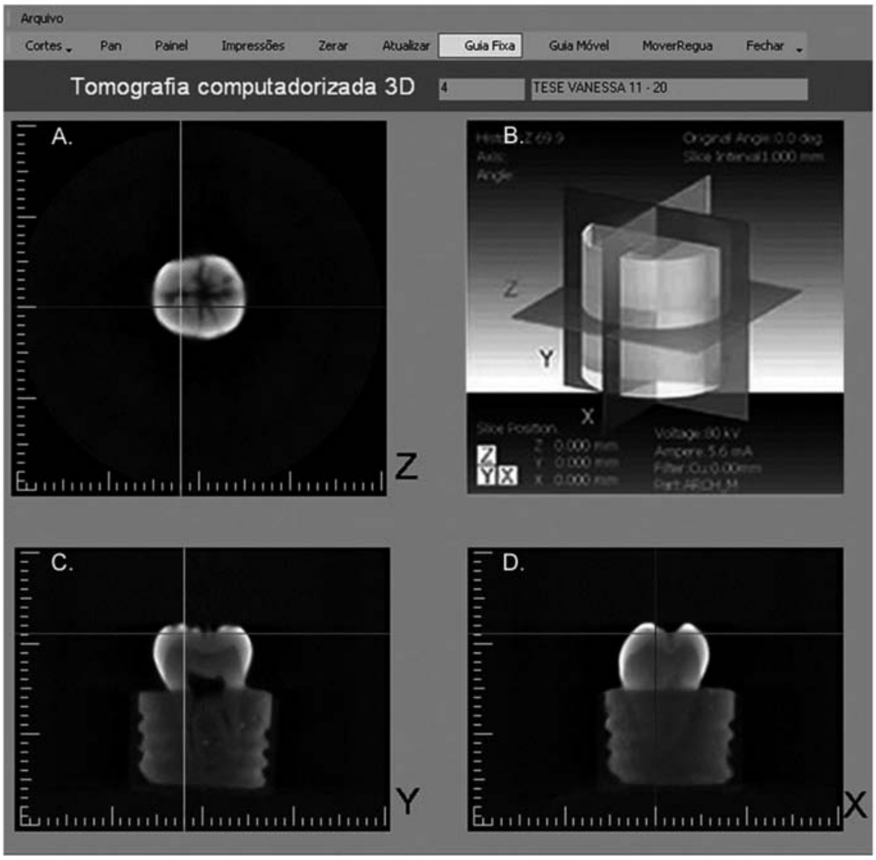

Figure 1: (A) Tomographic tooth image section corresponding to the Z (axial) plane. (B) Figure showing the planes X, Y, and Z. (C) Tomographic tooth image section corresponding to the Y (sagittal) plane. (D) Tomographic selected image section corresponding to the deepest fissure visualized in the X (sectional) plane.

Figure 2 (A) shows the selected image of one of the 48 teeth, representing a deeper fissure. Through Corel Draw 11 software, the amount of enamel in the lateral wall (Figure 2 B and C) and the depth of the fissure were taken in relation to the medium crown height and measured in millimeters. The structure angles were calculated by measuring the distance between the lateral wall and the bottom of the fissure (Figure 2 D). The percentage of the fissure in relation to the enamel thickness was calculated. The obtained values were categorized into three groups, according to the depth: G1 – the shallowest 25%; G2 – intermediate values; G3 – the deepest 25%.

To compare the clinical analysis with the gold standard, the median of the 40 evaluations were calculated. This value was also categorized into three groups, distributed in 9 columns: G1 - shallow fissures: scores 1, 2 or 3; G2 – intermediate fissures: scores 4, 5 or 6; and G3 – deep fissures: scores 7, 8 and 9.

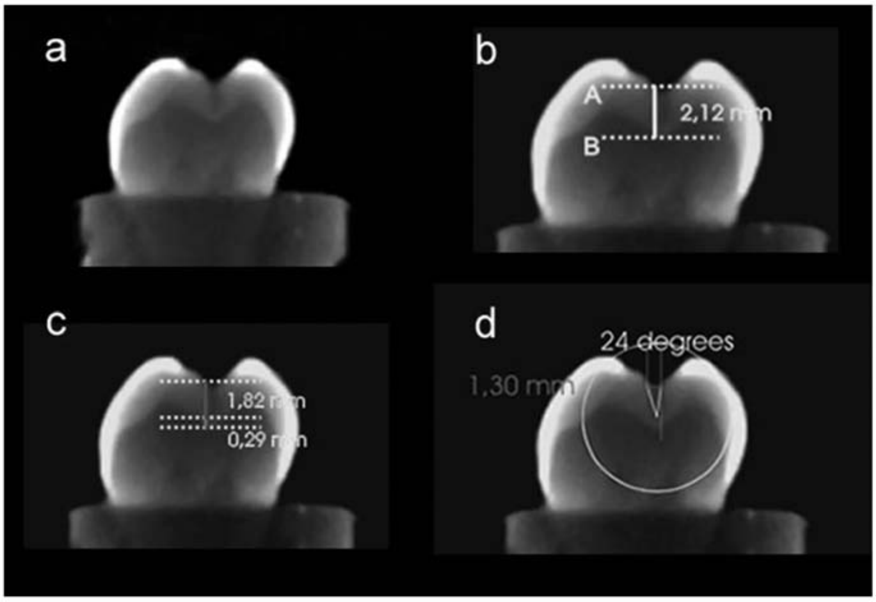

Figure 2: (A) Tomographic selected image representing one of the deepest fissure. (B) The amount of enamel in the lateral fissure wall measured in mm from A-B points. (C) Length of the fissure, distance from the fissure bottom until the enamel dentin junction (EDJ). (D) The structure angle was calculated measuring the distance between the lateral wall and the bottom of the fissure.

Statistical Methods

The data was statistically analyzed by using Spearman Correlation Coefficient tests to evaluate the agreement between the two clinical analysis; Kendall Correlation Coefficient tb

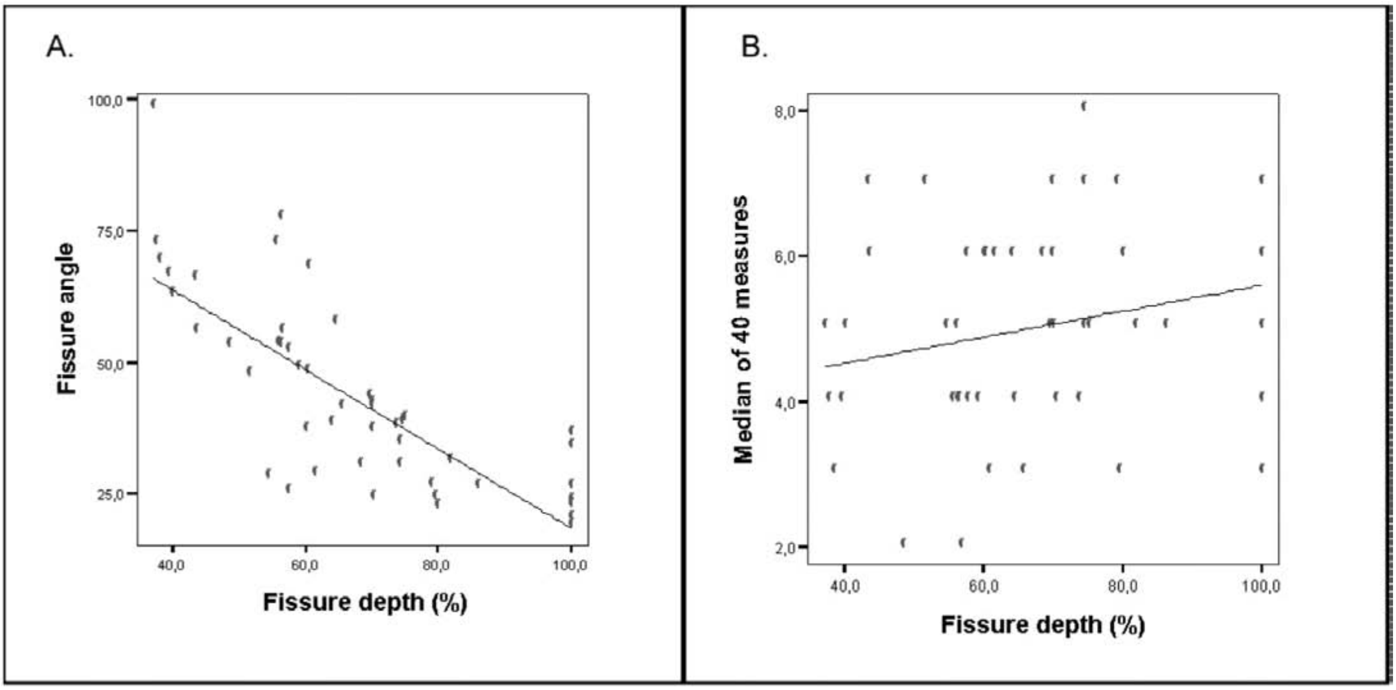

Figure 3: (A) – Fissure Angle x Fissure depth. r = -0,771; P < 0,01 (B) Fissure depth x Median of 40 clinical evaluations. rs = 0.238, P = 0.103

Table 1: Descriptive statistics of variables classified by the Accuitomo 3D

Variables	Minimum	Maximum	Mean	Std. Deviation
Amount of enamel	1.479	2.317	1.81506	0.18017
Fissures depth	0.641	1.923	1.22138	0.36693
Distance of the bottom of the fissure until the DEJ	0.000	1.232	0.59369	0.33446
Distance between the fissures walls	0.543	1.766	0.89525	0.25142
Structure angle	18.4	98.2	43.232	18.040
Percentage of fissure depth inside the enamel	37.1	100.0	67.097	18.409

to compare the fissure depth percentage from the tomograph to the clinical analysis; Mann-Whitney non-parametric test to compare the ages and professional experience; Interclass Correlation Coefficient (ICC) to perform an intra-examiner comparison between the two analysis; and Pearson Correlation Coefficient to compare the angle and the depth of the fissures, obtained by the tomography. The significance level adopted was P<0.05.

RESULTS

In the intra-examiner analysis, it was obtained ICC = 0.923, P < 0.001 for the first clinical analysis and ICC = 0.907, P < 0.001 for the second. In the inter-examiner analysis, the Spearman correlation coefficient obtained was rs = 0.910, P < 0.001 achieving a highly significant agreement. Table 1 shows the descriptive evaluation of the variables of the fissures depth, distance of the bottom of the fissure until the Dentin Enamel Junction (DEJ), percentage of depth inside the enamel, total amount of enamel and the structure angle.

The teeth in which the fissures presented penetration percentage below 56% were classified as shallow (G1), between 56% and 78% as intermediate (G2), and between 78% and 100 % as deep (G3).

A high negative correlation was observed (r = -0.771; P < 0.01) between the angle and the depth of the fissure (Figure 3A). Comparing the depth variables of the fissure (clinical and tomographic analysis), it was noticed that there is little correlation between these variables rs = 0.238, P = 0.103 (Figure 3B).

Similar results can be observed when comparing the above-mentioned variables categorized in three groups. The corrected answer percentage of the examiners was 50%. The Kendall coefficient tb obtained to evaluate the association of the variables was equal to 0.05 (P=0.740), which means that the association was not significant.

Concerning the applied questionnaire to the pediatric dentists, the ages and the professional experience time were equivalent among the clinicians who agreed in most of the answers, except in two questions, where the differences were expressive. However, only when it comes to the experience the difference was statistically significant (P= 0.331).

The clinicians included in group 1 presented Taub = 0.183 and P= 0.144 for the classification of the fissures in relation to the tomography, and group 2 demonstrated Taub = 0 and P= 0.991. The statistic values were calculated by using the SPSS v. 10.0.

DISCUSSION

No similar study was found in the literature using CBCT analysis to validate the morphologic evaluation of the occlusal surfaces. Considering this and the fact that studies performed in occlusal diagnosis present distinct methodologies, the discussion and the comparison of the herein results with other studies become quite difficult. However, the general results and conclusions can be compared and applied to the first and second permanent molars due to the occlusal similarity.[2]

The examiners, even experts, presented errors in the classification of the teeth according to the depth of the groove-fossa system, when the clinical and tomographic analyses were compared (Figure 3B). Clinically, it is difficult or almost impossible to visualize the bottom of the deepest fissure, which could be extended until the DEJ, noticed in 7 teeth of this study. When categorized in 3 groups, it was observed that 39 (81.25%) of the 48 teeth were classified within the same scores (ICC = 0.910). Costa et al.10 also found high values of agreement among the examiners (87% to 89%) when they compared the DIAGNOdent to the visual analysis, inter-proximal X-ray and conventional X-ray, for enamel caries diagnosis. However, Fung et al.13 found low agreement among the examiners (K = 0.19 to 0.30), when comparing the accuracy of caries diagnosis. These differences of agreement among the examiners, in different studies, demonstrate that the diagnosis of occlusal surface is still a challenge to dentists and might vary according to the different philosophy of each Institution, time of graduation, individual diagnostic criteria and even to the anatomic complexity of these teeth.

Clinicians with less experience time (G1) presented an additional acceptable clinical analysis (P= 0.144) than the more experienced (G2) (P= 0.991), when compared to the tomographic results. These are similar to Cardoso *et al*.[18] who also found that the background experience of the examiners is not the best indicator for occlusal caries diagnosis and indication for sealant placement. The clinicians with less experience used more complete selection criteria. Similar results were found by Fung *et al*.[13] when comparing the accuracy of the occlusal caries diagnosis of 3 groups of professionals to different experience times, and concluded that the youngest group had presented higher sensitivity values.

The measurements of depth and angle of the fissure (Table 1) were similar to other studies.[5,6] However, Ekstrand *et al*.[19] found values varying from 0.13 to 0.55 mm length and angles from 2° to 170°. The divergent values from this previous study may be due to the employed methodology, which used 2mm cuts, probably decreasing of the accuracy results. In this study, 1mm sections of the images were used, to provide a superior quality of the anatomic details. Furthermore, there was no loss of structure as in the serial cuts. Studies show that this loss is, at minimum, equal to the width of the section.[20]

Calculating the percentage of the fissures depth in relation to the adjacent total enamel allowed good visualization of their penetration inside the enamel (table 1). Symons *et al*.[21] classified the fissures as shallow (with no grooves), intermediate (until 1mm depth) and deep (more than 1mm).

A negative correlation between the angle and the fissure depth was also identified (Figure 3A), indicating that, in general, the smaller the angle the higher the depth of the fissure. The same correlation was not identified by *Ekstrand et al*.[19] as their analysis did not correlate between depth and angle of the groove and fissure depth. These observed differences may appear from methodological differences, as well as, the statistical method of data analysis. The results showed the limitations of visual analysis for correct diagnosis of the occlusal morphology. The morphological evaluation through visual examinations should not be used as the sole criteria for sealant placement or treatment, as it did not adequately estimate the real dental anatomic condition (Figure 3B). It is important for dentists to use different methods to evaluate the groove-fossa-system depth as risk factors for caries to develop. A relevant criterion, not often used in diagnosis, is the observation of the inclination and cusp height that assemble the structure angles. The angle formed showed an inverse relation with the depth of the fissures, whereas there was high correlation between these variables ($r = 0.771$; $P < 0.01$) (Figure 3A). In general, the smaller the angle between these structures, the greater the fissure depth.

The ACCUITOMO 3DX is an evolution of conventional tomography. Its image capture system is through a single conical X-ray beam and allowed complete visualization of the internal anatomy of each tooth, enabling to quantify the real size of the deepest fissure, its opening angle and the real depth (Figure 2). The results showed that, the morphometric analysis, based on a three-dimensional method was appropriated for the understanding of the depth variables in the groove-fossa-system. This technique recommended by *Arai et al*.[17] proved to be a useful tool to evaluate the groove-fossa-system, due to higher image resolution compared to the conventional methods.

CONCLUSION

By visual analysis, clinicians were not able to provide an accurate diagnosis of the groove-fossa-system depth. The Accuitomo 3D computed tomographic examination was efficient in the validation of the clinical analysis, under the methodological conditions of this study.

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