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Accuracy of CBCT for Measurement of the Volume, Area and Bone Density of Periapical Lesions

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Abstract: ***The aim of this study was to evaluate the accuracy of cone beam computed tomography (CBCT) for measurement of the volume, area and bone density of periapical lesions. 50 CBCT-images from patients with endodontic treated teeth with periapical lesions were examined.*** *The software for the images which was used is* ***Planmeca Romexis®. The results showed that the root canal filing quality is extremely important and influences both volume of the lesion and bone density.***

Keywords: cone beam computed tomography, periapical lesions, diagnosis

1. Materials and Methods

A total of 50 CBCT-images from 50 patients from University Medico-dental centre, Faculty of Dental Medicine, University of Varna, Bulgaria were investigated. They were selected randomly. Planmeca ProMax®3D Max unit was used. The software for the images which was used is Planmeca Romexis®.

All the patients were registered by e-card, which includes patient's name and years as well as data from the CBCT in the software imaging Planmeca Romexis®. The subject of retrospective analysis were CBCT-images of 50 patients with endodontic treated teeth with periapical lesions. The criteria used for inclusion in the study were: patients over 18 years old coming for the first time in the Medico-dental centre. The following parameters were registered: 1. The area of a periapical lesion /mm^2/ - fig. 1. 2. The bone density of a periapical lesion - fig. 2. 3. Homogeneity of the root filling according to de Moor et al.(12) /tabl.1/.4. The volume of a periapical lesion in cm^3 - fig.2. 5. The bone density of a healthy bone- fig.3.

The following exclusion criteria were attached: upper and lower third molars (wisdom teeth), patients under 18, patients over 69, the totally toothless patients, teeth after endodontic surgery.

The results are recorded in tables and were subject to statistical analysis with specialized statistical analysis package STATISTICA.

Table 1: Homogeneity of the root filling (de Moor et al.)

Score	1	2
Homogeneity of the root filling	Homogeneous root filling, good condensation, no voids visible (acceptable)	Inhomogeneous root filling, poor condensation, voids visible

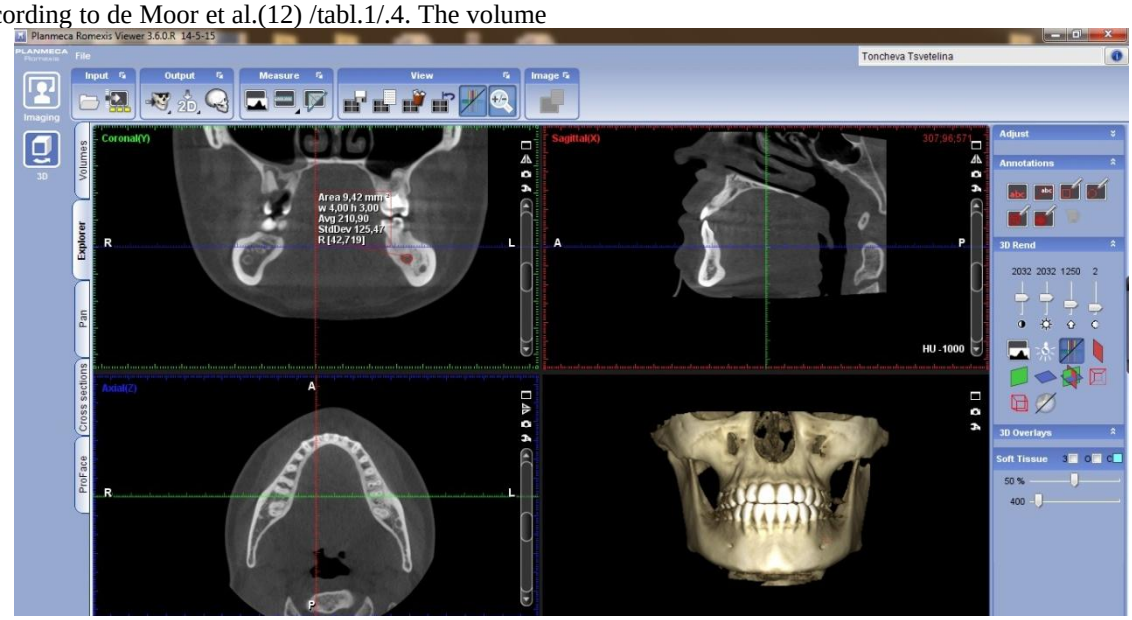

Figure 1: Measurement of the area of a periapical lesion /mm^2/

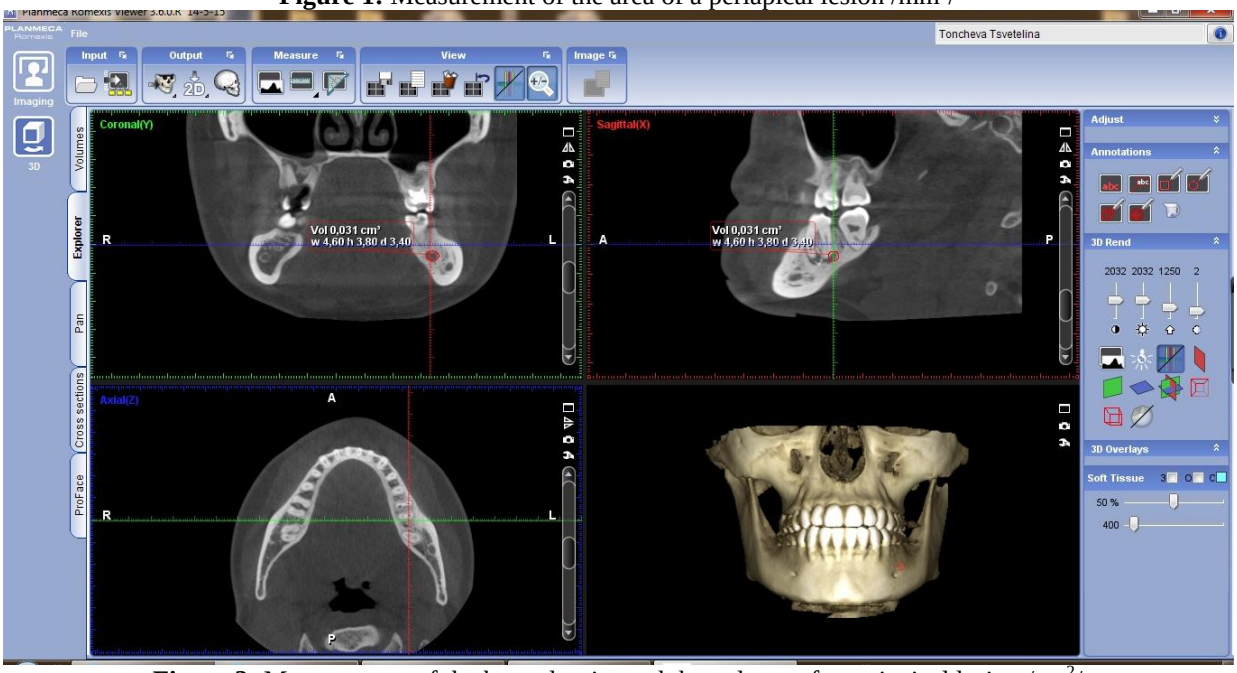

Figure 2: Measurement of the bone density and the volume of a periapical lesion /cm^2/

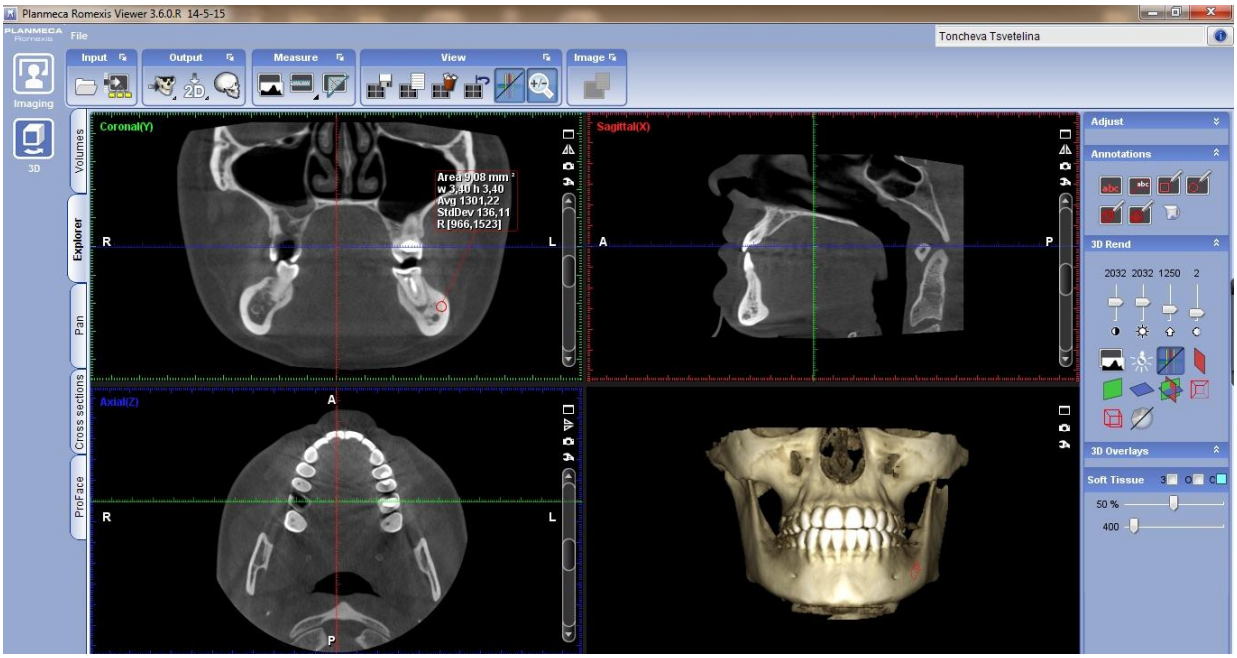

Figure 3: Measurement of the bone density of a healthy bone.

2. Results

The number of analyzed teeth according to the quality of root canal filling are showed in tabl. 2.

Table 2: Number of analyzed teeth according to the quality of root canal filling

Homogeneity of the root filling K-S d=,35956, p<,01				
HF	**Count**	**Cumulative count**	**%**	**Cumulative %**
1	27	27	54,000	540,000
2	23	50	46,000	1,000,000

From these results it is clear that in 27 of the examined teeth, the quality of the root canal filling was 1 according to the criteria of de Moor et al. The remaining 23 studied teeth were with code 2.

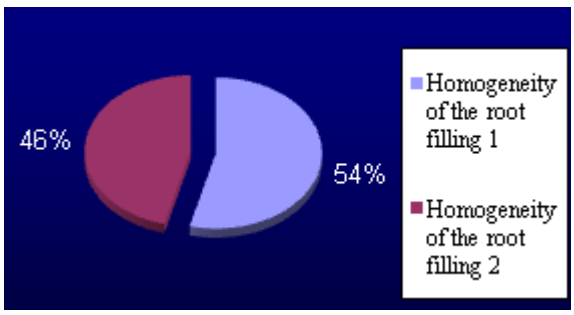

Figure 4: Percentage distribution of the endodontically treated teeth according to the quality of root canal filling

Table 3: Dispersion analysis of the results for the area of a periapical lesion

Test for significance of the lesion area					
	SS	**Degr. of - Freedom**	**MS**	**F**	**p**
Intercept	2,801,416	1	2,801,416	1,084,794	0,000000
Homogeneity of the root filling /Sc. 1-2/	68,480	1	68,480	26,517	0,109984
Error	1,239,572	48	25,824		

From the statistical analysis was clear that p=0,109984 >0,05, so the quality of the root canal filling does not have a statistically significant impact on the area of the periapical lesion.

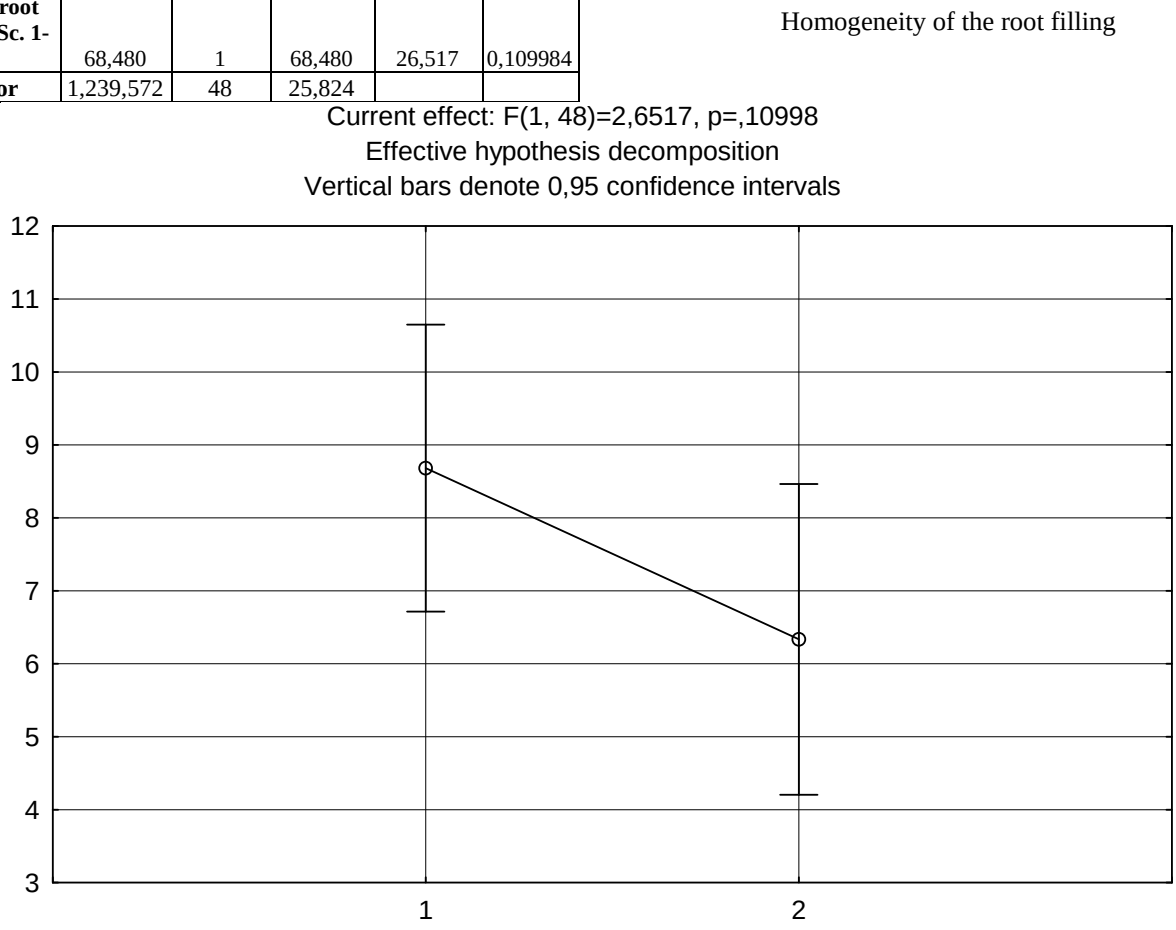

Figure 5: Correlation between the lesion area and the quality of the filling

Regarding the second parameter studied (bone density in periapical lesions) we received the following results:

Table 4: Dispersion analysis of the results of bone density within the endolesion

Test for the significance of bone density within the endolesion					
	SS	Degr. of - Freedom	MS	F	p
Intercept	9085253	1	9085253	6,075,331	0,000000
Homogeneity of the root filling /Sc. 1-2//	179983	1	179983	120,355	0,001113
Error	717808	48	14954		

From the statistical analysis was clear that p=0,001113 <0,05, so the quality of the root canal filling has a statistically significant impact of the bone density within the endolesion.

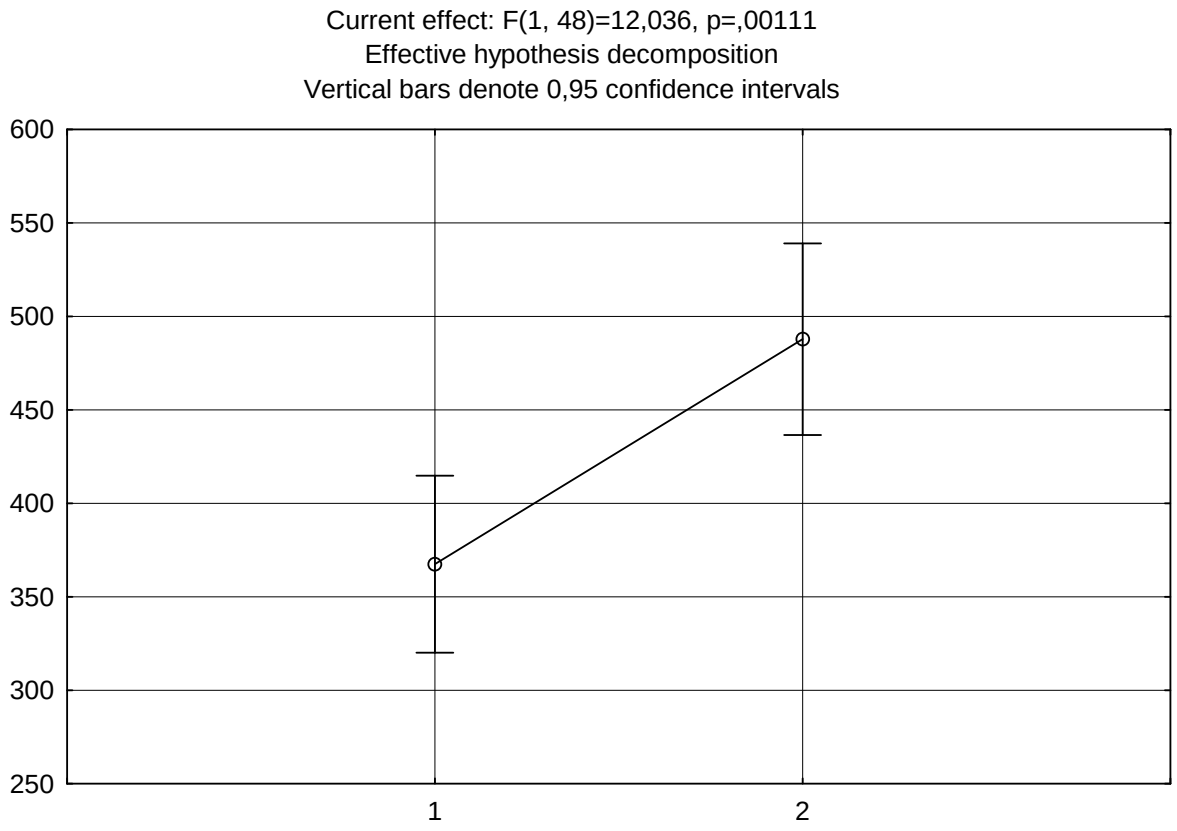

Figure 6: Correlation between the bone density within the endolesion and the quality of the root canal filling.

Regarding the third studied parameter (volume in the area of the periapical inflammatory lesion of endodontic origin) we received the following results:

Table 5: Dispersion analysis of the results obtained for the volume of the lesion

Test for significance of the lesion volume					
	SS	Degr. of – Freedom	MS	F	p
Intercept	0,008020	1	0,008020	2,131,642	0,000029
Homogeneity of the root filling /Sc. 1-2/	0,001335	1	0,001335	354,815	0,045677
Error	0,018058	48	0,000376		

From the statistical analysis was clear that p=0,045677<0,05, so the quality of the root canal filling has a statistically significant impact of the lesion volume.

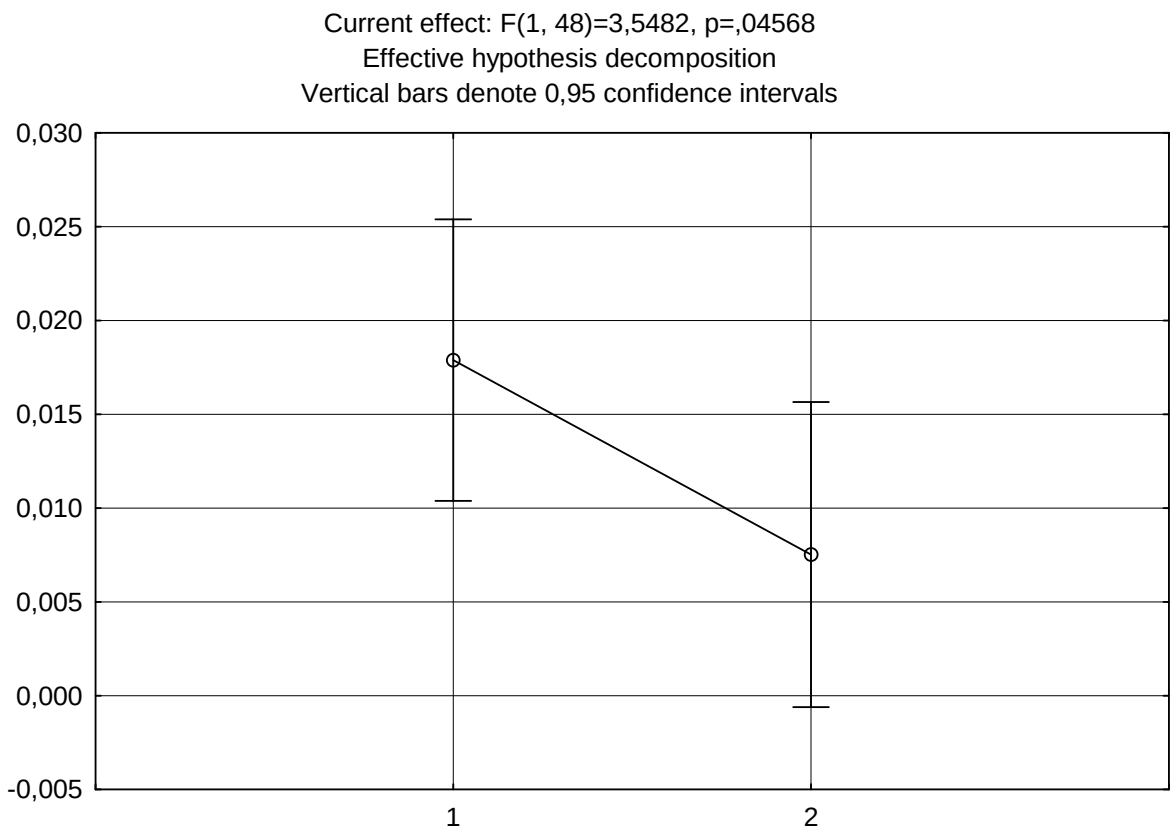

Figure 7: Correlation between the volume of the lesion and the quality of the root canal filling

3. Discussion

Cone beam computed tomography is an accurate means of measuring the volume, the bone density and the area of periapical lesions. Currently, there are few studies confirming the accuracy of CBCT to measure lesions in bone volumetrically (Agbaje et al. 2007). Some studies have employed methods using calibration cubes (Marmulla et al.2005, Eggers et al.2008), spherical phantoms ofknown size (Obenauer et al.2007) or calculating volume using either automated segmentation or from manual linear readings (Pinsky et al.2006).

Sedentex CT (2011) produced evidence-based guidelines for use of CBCT in oral and maxillofacial imaging and concluded that currently a high-level evidence base for diagnostic efficacy of CBCT was lacking, most notably that of patient outcome efficacy (Horner 2011).

CBCT is more reliable at diagnosing apical periodontitis than two-dimensional radiography (Patel et al. 2009, Paula-Silva et al. 2009).

The CBCT of the periapical lesions of endodontic origin enables the reproduction of a three-dimensional image of teeth and the surrounding tissues. This is achieved with much lower radiation dose compared with the conventional computed tomography and the two-dimensional radiographs. Periapical lesions can be diagnosed at a very early stage and the volume, surface area and bone density in the periapical inflammatory changes to be determined. The endodontic surgery in the molar region can be planed more accurately using CBCT. This is almost impossible with the two-dimensional image, because it does not provide information on thickness of the bone and the location of anatomic structures such as maxillary sinus and inferior alveolar nerve, whatever gives three-dimensional image. There are not superposed tissue on the CBCT, which is one of the main problems of the two-dimensional X-ray examinations.

4. Conclusion

The retrospective study confirms that the root canal filing quality is extremely important and influences both lesion volume and bone density. The entry of such new technologies in the diagnosis and treatment of endodontic lesions will enable the improvement of methods and increasing of the criteria for qualitative endodontic treatment, and prevention of the occurrence of periapical inflammatory changes of endodontic origin.

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