CONE BEAM COMPUTED TOMOGRAPHY LIKE A METHOD FOR MEASUREMENT THE ACCURACY OF IMPRESSION MATHERIALS

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Abstract

Introduction: Computer Tomography for dental purposes is used for diagnosis and planning of future treatment. Cone beam computed tomography (CBCT) allows the volumetric perception of a subject, using various instruments to conducting analytical measurements.

Purpose: Demonstration of the ability of cone beam computer tomography as the method of choice for measuring the volume accuracy of different border molding impression materials, theirs radiopacity and density.

Materials and methods: The study was made in the Department of "Imiging diagnostic, dental allergology and physical therapy", FDM - Plovdiv, on Planmeca ProMax 3D Classic device. The objects of the study were impression materials for border molding - silicones (additive type *Detaseal* and condensation type *Sta-seal f*), thermoplastic materials (impression compound Kerr and wax mass GC Iso functional). Each material was scanned three times for lineal and volume changes - immediately after elastification /hardening, after 24 and 48 hours. For the correct positioning of the objects, a new additional attachment by authors design was created, allowing the models to be placed in the area of the X-rays.

Results: The received digital images were distinguished by a very good radiopacity and a difference in a density of the impression material and impression tray, and visualization of the border points. It was found a statistically significant difference in the measured values of condensation silicone and there wasn't a significant difference in the other materials.

Conclusion: CBCT can be used as a method for impression materials measuring due to the presence of the indispensable radiopacity and the functions of the applying software.

Key words: CBCT, impression materials, measurement.

INTRODUCTION: Computer tomography is introduced in dentistry for diagnosis and treatment. Cone-beam computed tomography (CBCT) is a sophisticated method with a more accurate image presentation, lower radiation dose and more data processing capabilities (1, 2). Measuring instruments allow an individual approach by applying different number and position of slices, measuring length, angle, etc. (3, 4, 5).

Huntfield units (HU) are mainly used in the implantology for classifying bone types in four main classes (D1, D2, D3, D4) (6). Measured bone values complement the Misch primary classification with one additional degree (D5) - less than 150 HU, immature non-mineralized bone (7, 8).

Impression materials have different time stability. For elastomers, it is determined by proper storage after impression taking and by the chemical reactions that occur during the polymerization (9). Thermoplastic materials for border molding, although considered classic, find their place. Their main advantage is the possibility of repeated shaping after thermal softening (10).

N. Popov (1970) developed a method for obtaining and examining isometric X-ray images of the contour of the gingivobuccal sulcus and the top of the alveolar ridges by radiographing. It was constructed an additional device for the "Panoramix" X-ray apparatus and by its help was scanned impressions, taken with radiopaque impression materials (11, 12).

PURPOSE: Demonstration of the ability of cone beam computer tomography as the method of choice for measuring the volume accuracy of different border molding impression materials, theirs radiopacity and density.

MATERIALS AND METHODS: The study was made in the Department of “Imiging diagnostic, dental allergology and physical therapy”, FDM - Plovdiv, on **Planmeca ProMax 3D Classic device**. The objects of the study were impression materials for border molding - silicones (additive type ***Detaseal*** and condensation type ***Sta-seal f***), thermoplastic materials (**impression compound Kerr** and synthetic resin **GC Iso functional**).

Fig.1. Tested materials:

1 – Detaseal function
2 – Sta-seal f
3 – GC Iso functional
4 – Impression compound Kerr

For the proper scanning of the objects, it was made a new additional author's design device allows the positioning of the models in the area of the X-rays. This appliance consists of three main parts:

- Vertical cylindrical holders for fixing to the machine's metal holder
- Horizontal playground with trapezoidal shape for placement of the individual impression tray with the shaped impression
- Slanted surface lifting the horizontal platform 20 mm above the level of the supports, Fig. 2 and 3.

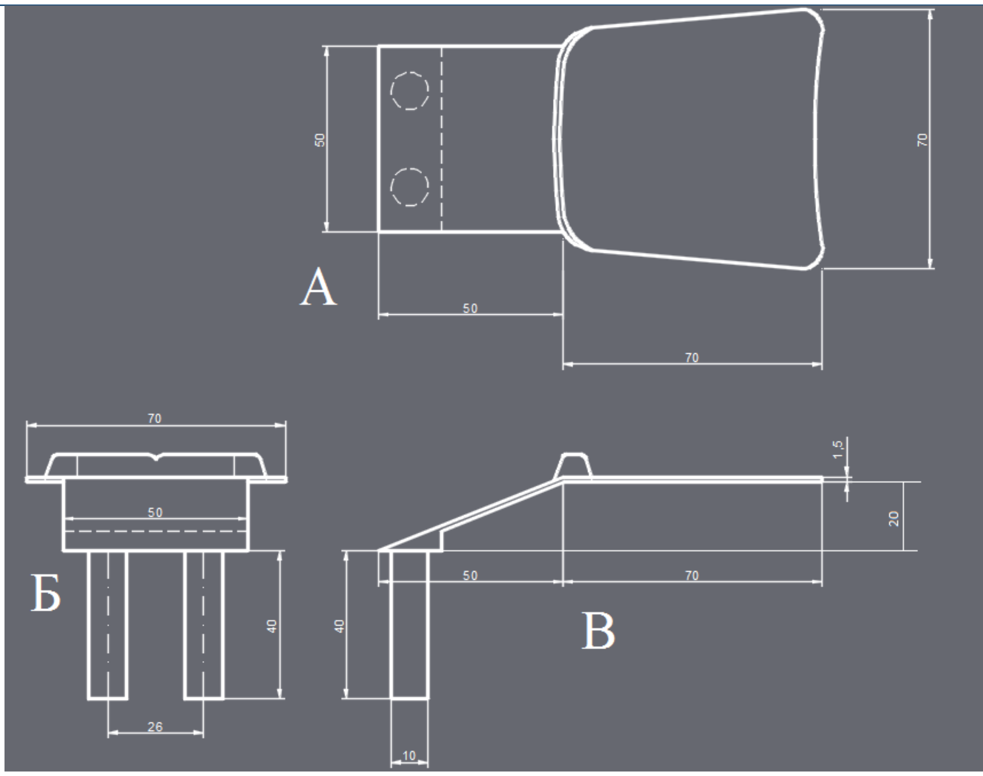

Fig. 2. Scheme of the new appliance for Planmeca Promax 3D classic (A-top view, B- front view, B-side view)

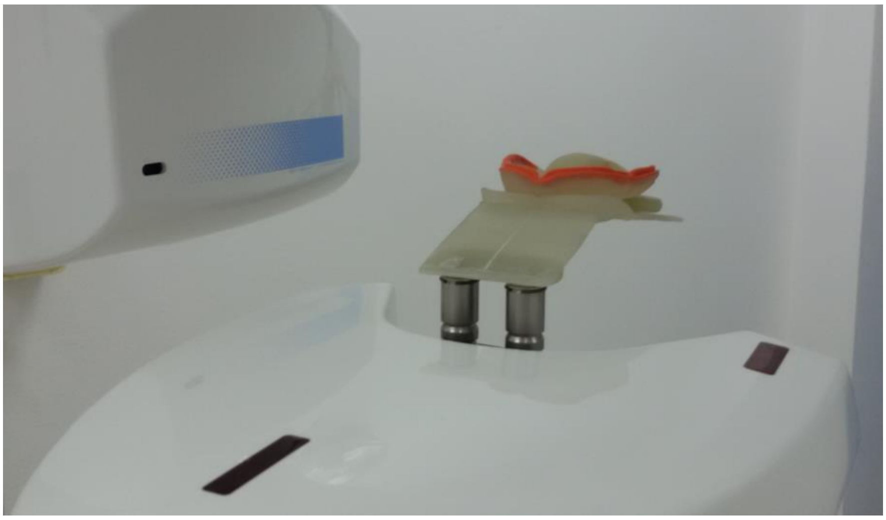

Fig. 3. Position of the appliance and individual impression tray of the Planmeca ProMax 3D Classic

Each material was scanned three times for lineal and volume changes - immediately after elastification /hardening, after 24 and 48 hours. The resulting X-ray images were recorded on an HP DVD + R disc, the data processed and written in tables.

The applied software tools allow linear and angular measurements, displacement and visualization of the three planes (sagittal, coronal and axial). The technology also allows density measurement in Huntfield units (HU), where the air density is taken as -1000 HU, Fig. 4.

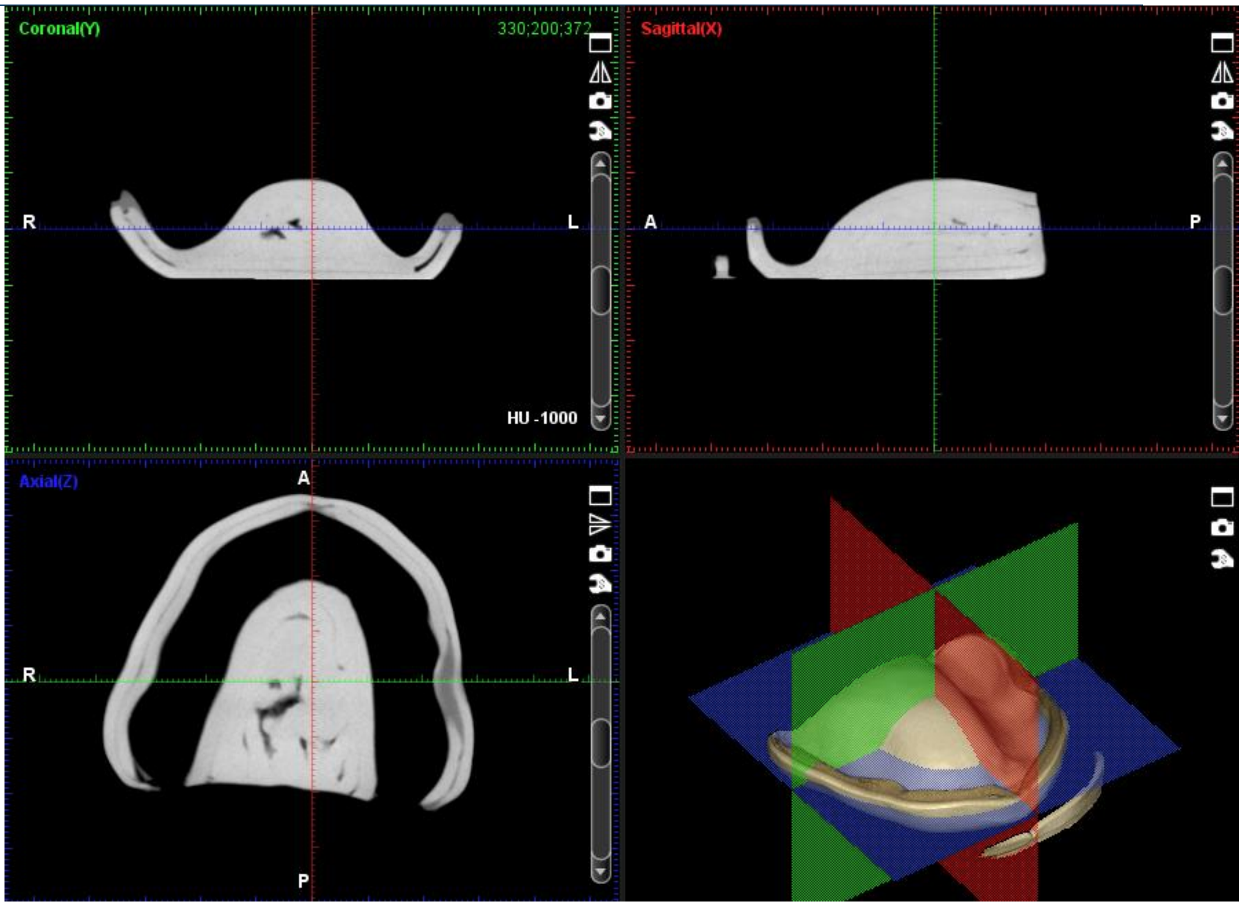

Fig. 4. Digital image obtained by cone-beam computed tomography

Applying the measuring instruments to the sections of the **Explorer** function is parallel to the three main planes (sagittal, coronal and axial), resulting in inaccurate results.

For the purpose of the study, we chose the **Implantology** function of the Planmeca Romexis Viewer, which allows the choice of the number of slices spaced radially and the distance between them. To accommodate most of the print, 10 slits were selected at a distance of 10 mm, Fig. 5.

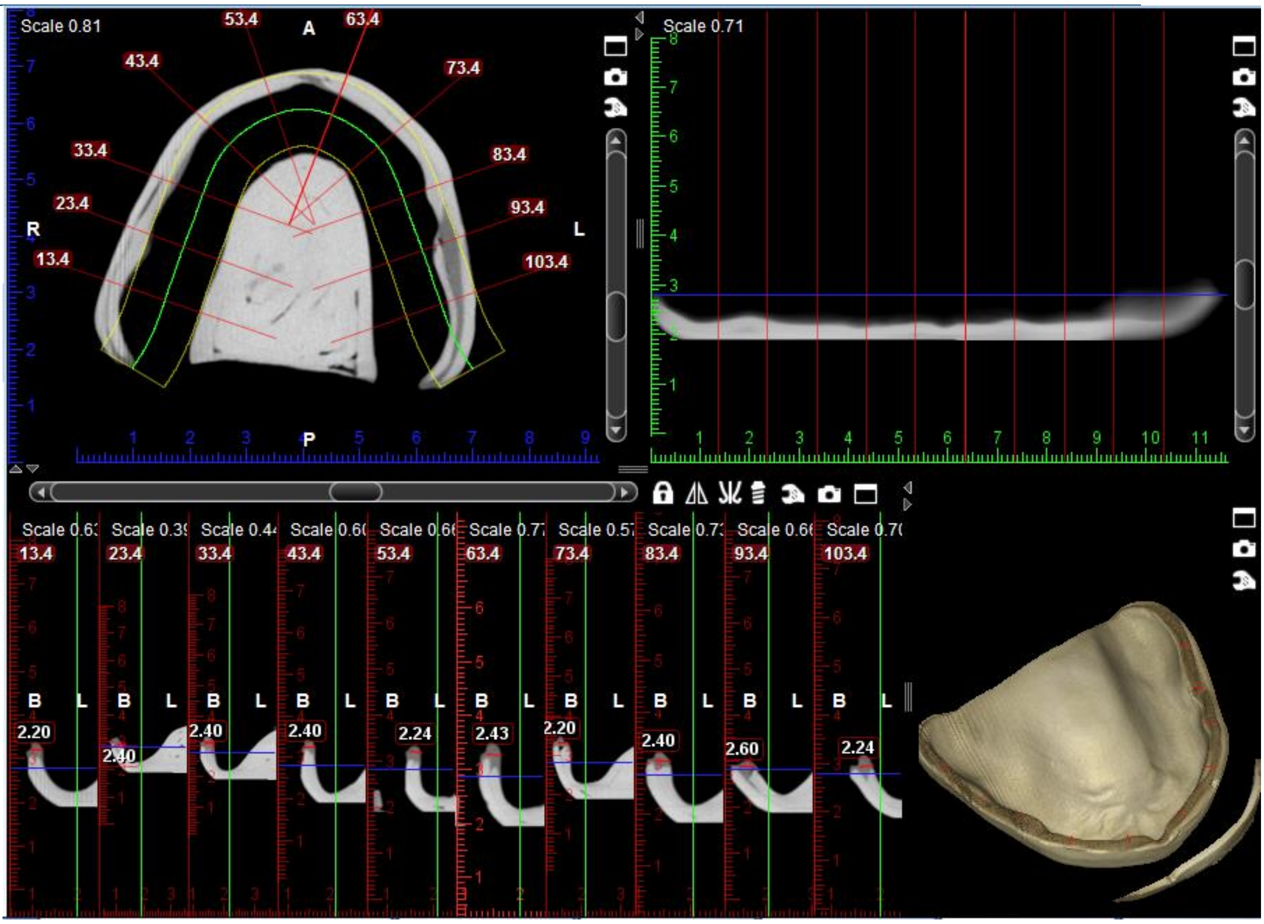

Fig. 5. Location of the radial slides through Planmeca Romexis Viewer Launcher 4.4.2.R – Implant

From each of the materials 3 impressions were taken, which after the X-ray scanning were also measured instrumentally by means of a digital caliper. Full compliance was established, so the required number of units for statistical survey (10 of each material) were supplemented by manual measurement with a digital caliper.

RESULTS: ANOVA repetition analysis, which is specific for comparing more than two average group values, was used to analyze the obtained information. Tests of Tukey, Bonferroni and Duncan were also used to test the results. After statistically processing the data, a significant difference was found only with the silicone condensation type **Sta-seal f** at the intervals between the initial elasticity moment and after 24 hours as well as between the initial moment of elasticity and after 48 hours. The remaining materials did not show a statistically significant difference between different time intervals, table 1.

Table 1. Summarized results after ANOVA repetition analysis

Material / Contrast	Statistical significance			
	Detaseal function	**Sta-seal f**	**GC Iso functional**	**Impression compound**
immediately after elastification /hardening – after 24 hours	No	Yes	No	No
immediately after elastification /hardening - after 48 hours	No	Yes	No	No
after 24 - 48 hours	No	No	No	No

After the density measuring of the impression materials in HU, the following intervals were established, Fig. 6 and 7:

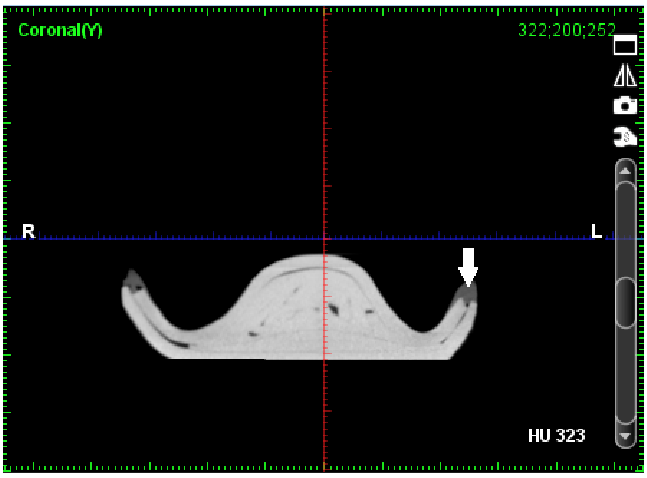

Fig. 6. Synthetic resin GC Iso functional

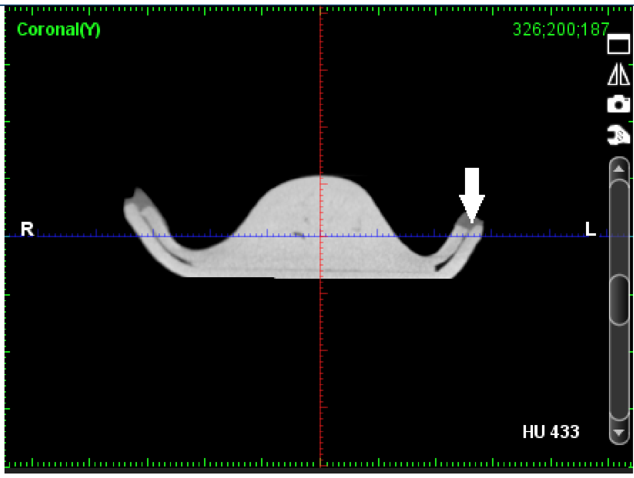

Fig. 7. Condensation type of silicone Sta-seal f

- Detaseal function – 240 – 320 HU
- Sta-seal f – 260 – 350 HU
- GC Iso functional – 350 – 480 HU
- Impression compound Kerr – 450 – 590 HU
- Individual impression tray – 1150 – 1350 HU

DISCUSSION: The statistically significant difference in volume stability of condensation type of silicone (0.1-0.15 mm) is not clinically significant for the purpose of border molding procedure.

Cone-beam computed tomography is a method of choice in determining the approximate density of different impression materials and other X-ray contrast objects.

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REFERENCES:

1. Cassetta, Michele, et al. "How Accurate Is CBCT in Measuring Bone Density? A Comparative CBCT-CT In Vitro Study." *Clinical implant dentistry and related research* 16.4 (2014): 471-478.
2. Veyre-Goulet, Sophie, Thomas Fortin, and Anthony Thierry. "Accuracy of linear measurement provided by cone beam computed tomography to assess bone quantity in the posterior maxilla: a human cadaver study." *Clinical implant dentistry and related research* 10.4 (2008): 226-230.
3. Nowzari, H., S. Molayem, C. Chiu, S. K. Rich. Cone Beam Computed Tomographic Measurement of Maxillary Central Incisors to Determine Prevalence of Facial Alveolar Bone Width ≥2 mm. - Clin Implant Dent., 14(4), 2012, 595–602.
4. Ghassemian, M., H. Nowzari, C. Lajolo, F. Verdugo, T. Pirronti. The Thickness of Facial Alveolar Bone Overlying Healthy Maxillary Anterior Teeth. - J Periodontol., 83(2), 2012, 187–97.
5. Ozdemir, Fulya, Murat Tozlu, and Derya Germec-Cakan. "Cortical bone thickness of the alveolar process measured with cone-beam computed tomography in patients with different facial types." *American journal of orthodontics and dentofacial orthopedics* 143.2 (2013): 190-196.

6. Park, H. S., Y. J. Leeb, S. H. Jeongc, T. G. Kwond. Density of the alveolar and basal bones of the maxilla and the mandible. - Am J Orthod Dentofac Orthop., 133(1), 2008, 30–7.
7. Misch CE. Contemporaly Implant Dentistry, ed.2, St Louis, Mosby Inc. 1999:113- 114.
8. Lindhe, J., E. Bressan, D. Cecchinato, E. Corrá, M. Toia, B. Liljenberg. Bone tissue in different parts of the edentulous maxilla and mandible. - Clin Oral Implants Res., 24(4), 2013, 372–7.
9. Кисов Х. Отпечатъчни материали и отпечатъчни методи в неподвижното зъбопротезиране, София, Индекс, 1998: 31-50.
10. Иванов С. Материалознание за стоматолози, Пловдив, Полиграф, 1997: 178-197.
11. Попов Н. Върху някои филогенетични особености и клиничното значение на устното преддверие в ортопедичната стоматология, канд. дис., С. СФ, 1970 – 223 с.
12. Киселова-Янева А, Недева А, Константинова Б. и кол. Лабораторни изследвания в стоматологията, София, Медицина и физкултура, 1989: 382-383.