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Conceptual Method of a systems to support the process dental implant

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***Abstract*—In recent years there has been a technological evolution that has provided the integration between different areas of knowledge, an example of this is the integration between Dentistry and Engineering in order to find new solutions to improve the surgical process of dental implants. This work proposes a conceptual method of reasoning to determine the type of dental implant based on the tomographic image where it will support the surgeon in determining the best dental implant options, depending on the characteristics of each patient. This system will analyse tomographic images through the bone structure, density and the load that implant will support, identifying the most appropriate models for the patient. The system creates a three-dimensional model of the dental arch and interacts with the dentist, leaving him free to choose among the selected ones the most appropriate implant. This system is a planning tool that assists the dentist during the preoperative period and in his / her decision making. Main contributions of the article are: i) design and development of a computational reasoning tool that supports the dental implant process; ii) interactivity in the development of surgical planning.**

Keywords: dental implant, image processing, systems, support decision

I. INTRODUCTION

People lose their teeth throughout their lives, whether due to longevity, hygienic difficulties or accidents. To provide means to resume their routines, the surgical procedure for the placement of dental implants becomes necessary [CHELAHI CHIKR]. In order to have a lower chance of rejection, consequently improving the existing alternatives, considering the tomographic images analysis, the size of the failure and the bone structure it was possible to identify the need to develop a decision support method that can evaluate the patient condition and contribute to the surgical planning based on the best choice in the dental implant process. The research is considered of an applied nature, since the knowledge was applied in the solution of a specific and qualitative problem, as it seeks a deep understanding of a specific phenomenonthrough descriptions, comparisons and exploratory interpretations, as it provides greater familiarity with the problem. to make it explicit. The main objective was to propose a conceptual method using digital image processing software to support the decisions of dentists and minimizethe chances of errors. Software developed on the Matlab platform utilizes image processing to provide a more assertive outcome to the dental implant process. The system has an easy to understand interface that will be used by the dentist, he should open the image in DICOM format made available on computed tomography. It can determine whether the tooth failure is single or multiple and which slice of the image will have the best view. By advancing the program will make the pixels become black and white making it easy to identify the region of interest. By selecting and identifying this area, the system will create two straight lines at the base of the existing teeth and then calculate and plot the bisector respecting the angle of the bone, each space of which will be allocated to an implant. To calculate the implant diameter the system will scan the image to identify the white pixels that will be the beginning and the end of the bone, so the implant calculation will be performed following osseointegration concepts, the image will undergo a new process to identify the coloration of the pixels and identify the bone density, which may be denser or more porous bone and directly impacting in the implant fixation method. A slice of the image will be projected to a cross section so that the implant length as well as the location of the lower nerves can be calculated.

I. SISTEMATIC REVIEW

The study had as conceptual base the works developed by[2], [3], [10], [16].

The result of the systematic literature review obtained 13 articles, which are important in the dental implant process and shown in the table I[18].

TABLE I.
SISTEMATIC REVIEW

Authors	Product Model	Computed tomography	Failure dimension	Bone structure	Computational system
Fleischmannova, et al 2009	✓			✓	
Lin, D; et al 2009	✓		✓	✓	✓
Chen, XJ et al 2010.	✓				✓
Ribeiro-Rottaet al 2010.			✓	✓	
Bardyn, T et al 2010	✓			✓	✓
Naitoh et al 2010	✓			✓	✓
Wakimoto, M et al 2011		✓	✓	✓	
Kim, G et al 2012	✓	✓	✓		
Neves, FS et al 2012	✓	✓			
Monaco, C et al 2015	✓				✓
Luangchana, P et al 2015	✓			✓	✓
Romero, L et al 2015	✓				✓
Cheng, Y-C et al 2016	✓				

Source: Adapted from [18]

Analyzing the results of the systematic literature review, as well as the content analysis, it was possible to identify that there are studies aimed at the most different research segments, however these segments are analyzed individually, that is, some authors analyze the image processing, others the dimension of the failure or surgical planning system, however there was no success in the search for a method or model that would evaluate a large number of variables and could provide the unique conditions to support the surgeon's decisions.

A computed tomography is a process that obtains an image of a return section of an analyzed object, differentiating mainly the X-ray, as it allows a depth of depth of objects, a clear definition of elements analyzed and the possibility of using different tissues .

The resulting color in the exam is evaluated according to the Hounsfield scale for determining the tissue and identifying the lower nerves, for example.

TABLE II
Escala de Hounsfield

Tissue	Unity Hounsfield	Shades of gray
Air	-1000	Black
Lung	-500 a -800	Very dark gray
Fat	-20 a -80	Dark gray
Water	0	Dark gray
Muscle	20	Cinza Claro
Cerebral Parenchyma	35	Cinza Claro
Pancreas	50	Cinza Claro
Liver	60	Cinza Claro
Normal Bone	100 a 200	Cinza Claro
Dense Bone	300 a 1000	White

Source: Adapted from **[1].**

II. PROCESS

With the systematic review of the literature it was possible to identify that there are studies that address the decision support process, however these studies address some individual characteristics, the need to develop a conceptual method of decision support in the process of dental implants with multiple failures taking into account considering the size of the failure, the bone structure and the location in the lower nerves through computed tomography image processing, providing the surgeon with a better basis for the performance of his work.

The system assists the dentist with the exchange of information, seeking to concisely determine the problem to be solved. Thus, the dentist loads the tomographic images into the system, selecting variables that will assist the system in processing the image and presenting a more assertive solution to the patient.

The user must upload the patient's image and select it as a single implant that will go to the [2]or multiple to evaluate the process of multiple implants. Selecting the position to be used and clicking on calculate the system will start image processing. In this interface the data related to the patient, initial parameters are presented, defining if it will be unitary or multiple and the process of starting the calculation, selecting the image slice and returning to the user.

When the dentist loads the tomographic image acquired by the patient and stored in the DICOM format, which has the axial cross-section tomographic image and patient control information, a method used worldwide[2], it provides information to start image processing by extracting information such as the failure dimension and density that will be used in the implant selection. Patient control information, such as name, date of birth, sex, width (x), length (y), X-ray intensity during the procedure, pixel spacing, distance between cuts, image color data (black , gray scale, color) and the intensity of the gray levels and are stored in the image header.

In axial sections, information is found that is used to calculate the geometry of the patient's mouth, such as the edges of the bone, the location of the flaws and consequently define the region of interest in the system, it is used directly with a two-dimensional matrix and the colors are according to the Hounsfield scale [1].

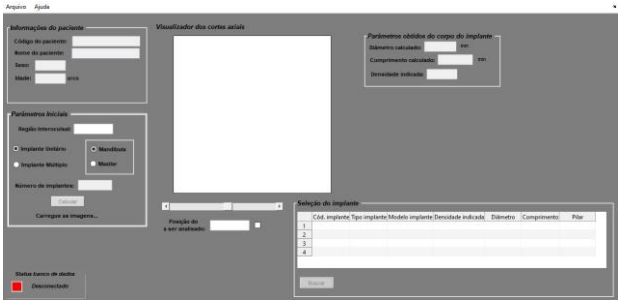

Figure 1. Interface

A. *DIAMETER*

The cross-section is formed by the bisector line between the lines generated by the identification points of the bone edge, with this information it is possible to calculate the implant length and the location of the nerves. The units of measurement of the image are in pixels and will be converted to a metric unit.

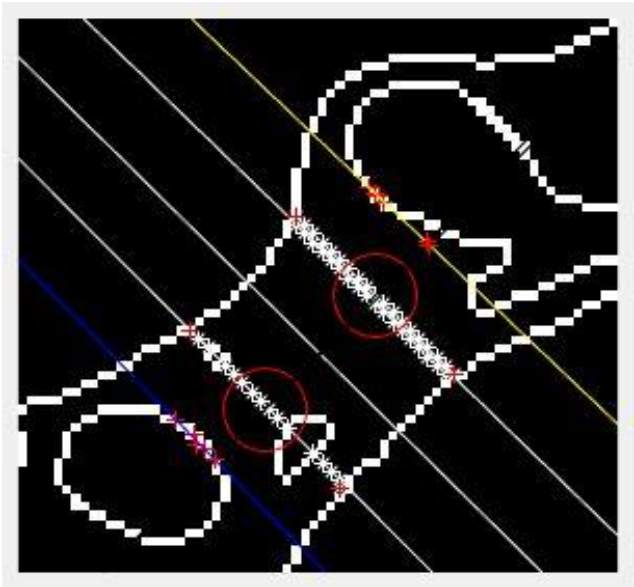

Figure 2. Diameter

B. *DENTAL IMPLANT LENGTH*

The length calculation is the inference mechanism that analyzes and translates the information contained in the cross section through the analysis of the bone depth. This calculation determines the length of the dental implant

body based on the geometry of the bone and the location of the nerves.

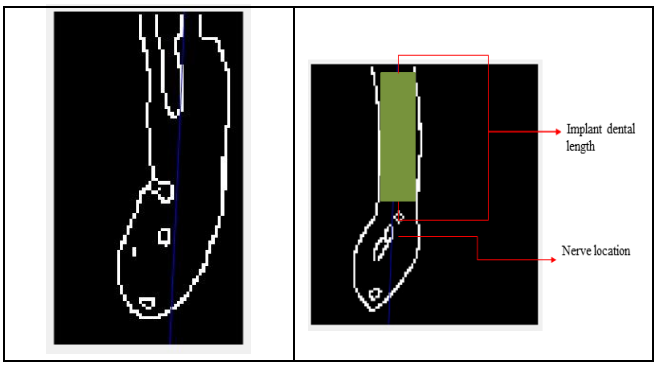

Figure 3. Dental Implant Length

C. *DENSITY*

Bone density is calculated from the bone histogram, identifying the type of implant suitable for each implant body inserted. The use of the Hounsfield scale, for each type of bone, being able to identify bone density from the image.

Misch and Judy established four basic divisions of the bone available in implantology, in the maxilla and in the mandible, which follow the phenomenon of natural resorption represented by Atwood[7][5]. The ability to organize the bone available at the potential implant site, in specific categories and related to common treatment options and conditions is of paramount importance[1].

The 1988 Misch classification was updated in 2000 due to the realization of the importance of bone density in the success of the osseointegrated implant according to table II [6].

TABLE II.
BONE DENSITY CLASSIFICATION ACCORDING TO MISCH

Bone	Density
D1	>1250 UH – Dense cortical bone
D2	= 850 a 1250 UH – Thick cortical bone, dense to porous at the ridge crest and fine trabecular inside
D3	= 350 a 850 UH – Porous and thin cortical bone at the edge involving a thin trabecular bone
D4	=150 a 350 UH – Thin trabecular bone
D5	< 150 UH – Immature non-mineralized bone

Source: Adapted [6]

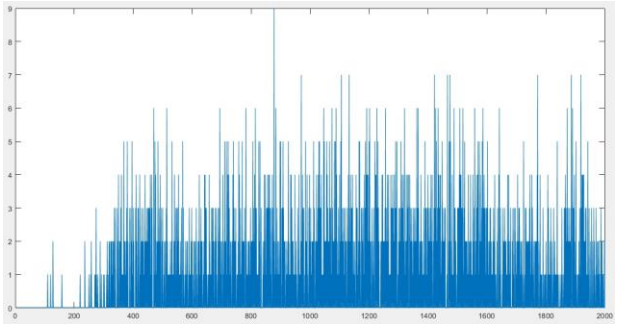

Figure 4. Density

D. *RETURN TO USER*

Finally, the system returns the information to the user, so that it can be compared with the manufacturer's catalog.

```
O valor do diâmetro do primeiro implante é:
    5.1502

O valor do diâmetro do segundo implante é:
    5.0045

O comprimento do implante em mm é:
    2.5000

O osso é do tipo:
     3
```

Figure 5. Return to user

III. DISCUSSION RESULTS

This research presented a proposal for a conceptual method of a system of support for dental surgeons to assist the dental implant planning process and defining the best option that suits the patient. In this way, we sought to present correlated information between engineering, image processing and implantation dental. This conceptual method was presented through a computer system of facilitated interface so that the surgeon can improve the implant process.

Finally, this study characterizes the importance of joint analyzes performed by a professional in the visual analysis of images and in the clinical examination and the correlation by the system that aims to support the dental surgeon, evaluating the density, dimension, length, contributing to the improvement of techniques dental implants, this set of information determines the best choice of dental implant components.

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