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ABSTRACTS

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NUMERICAL MODEL OF THERMAL NECROSIS DUE A DENTAL DRILLING PROCESS

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Introduction

The main goal of this paper is to present a numerical model for studying the thermal necrosis due a dental drilling process. When cutting tools, as drills, are used to cut a material, heat is produced and temperature increases of both the tool and material. The drilling parameters (drill speed, drill depth, drill diameter, applied load and feed rate) are important to determine the effect on thermal necrosis. When the irrigation is possible, the effect is decreasing the temperature rise in bone [1]. Bone is a poor conductor of heat, and heat generation is a common problem during any drilling [2]. The value of threshold temperature above which cell necrosis occurs have been presented for different researchers. The literature shows that if the temperature rises above 55ºC for a period of longer than 30*s*, serious bone damage will be done [2].

Materials and methods

In order to model the thermal necrosis due a dental drilling process, a finite element method was used with Ansys program. This analysis was conducted with transient heat conduction by modelling the heat flow from the drill process, during a time equal to 10*s*. A surgical drill with straight shank and diameter equal to 4.1mm and a rotational speed equal to 750rpm was selected. The finite element mesh constituted by cortical and trabecular bone has a hole with diameter equal to the cylindrical part of the drill, as represented in figure 1.

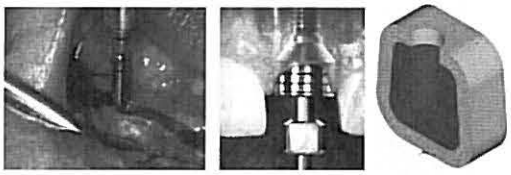

Figure 1: Surgical drill (***3i – Brasil***) and idealized mesh.

An initial-boundary condition with a temperature T_0=37ºC was considered in all dental bone model. The modelling of heat propagation from drill process was described by a heat flux density q received in the bone surface. The heat flux density is according the following equation:

$$q=P_c/S \quad (W/m^2) \qquad (1)$$

P_c is the total cutting power and S the surface area. The total cutting power is a combination between the power derived from the feed component (P_f) and the power derived from the cutting torque (P_M).

Results and discussion

Figure 2 shows a typical mesh used in all simulations. The ash zone represents the bone tissue damage at the end of drilling process. The results show the influence of the drill diameter and the value of rotational speed in the thermal necrosis phenomena.

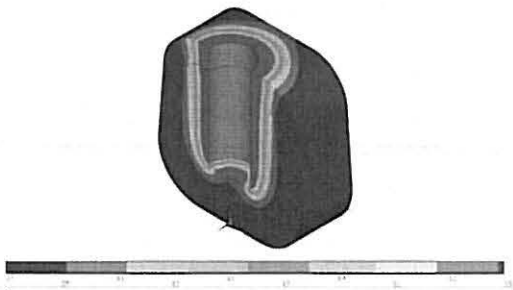

Figure 2: Numerical model due a dental drilling process.

Conclusions

The numerical analyse presents a methodology for determining the bone tissue damage according a dental drilling process. The parameters selection is important to increase a surgical planning definition. The numerical model could be a technique to lead better prediction of results and complement the surgical diagnosis.

References

[1] Davidson, *Applied Science Master Degree*, University of Toronto, Canada, 1999.
[2] Hillery *et al*, *Materials Processing Technology J*, **92-93**:302-308, 1999.