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# Temperature Changes in Cortical Bone during Intraosseous Anesthesia with Anesto And Quicksleeper

Emiliya Simeonova[1],Snezhana Canova[2],Plamen Zagorchev[3],Silviya Dimitrova[1]
[1]*Assistent Professor, Department Of Operative Dentistry And Endodontics, Faculty Of Dental Medicine, Medical University- Plovdiv, Bulgaria*
[2]*Professor, Department Of Operative Dentistry And Endodontics, Faculty Of Dental Medicine, Medical University- Plovdiv, Bulgaria*
[3]*Associate Professor, Department Of Medical Physics, Biophysics And Mathematics, Faculty Of Pharmacy, Medical University- Plovdiv, Bulgaria*

***Abstract***
***Aims:*** *To investigate the temperature changes in the cortical bone during intraosseous anesthesia with Quicksleeper and Anesto.*
***Materials and Methods:*** *12 swine fresh jaws were used for each of the examined intraosseous systems. The target point of anesthesia and the places of fixing of the thermocouples were pre-marked. The process of needle's rotation into the bone was stopped at the moment the felling of sinking, which is an indication for perforating of the cortical bone and entering the cancellous bone. For both systems were measured the dynamic temperature changes generated by needle rotation into the cortical bone.*
***Results:*** *Measured maximum temperatures are higher and statistically distinguishable for Anesto (9,0 ° C ± 2,0 ° C) compared to Quicksleeper (QS): 2,0 ° C ± 0,5 ° C.*
***Conclusion:*** *Despite big differences between measured results for Anesto and Quicksleeper, temperature values are below the critical 47 ° C, which could lead to thermal osteonecrosis.*
***Keywords:*** *Intraosseous anesthesia, thermal osteonecrosis, Anesto, Quicksleeper.*

## I. Introduction

Achieving profound pulpal anesthesia in a mandibular molar diagnosed with irreversible pulpitis can be argued to be the most testing of dental anesthetic challenges[1]. The failure rate of conventional inferior alveolar nerve block is around 44-81% [2,3,4]. Primary or supplementary intraosseous anesthesia in some clinical situations could be a better dicision to achieve an effective pulpal anesthesia of mandibular posterior teeth. The combination of predictability and rapid anesthetic effect, the lack of numbness of mouth or tongue and ease opreration through specially developed systems, such as Anesto( W&H Dentalwerk Bürmoos, Austria) and Quicksleeper( Dental Hi Tec, Cholet Cedex, France), offers the clinician a good alternative especially when it is nessecary to repeat the conventional inferior alveolar nerve block. The most frequently described disadvantage of intraosseous anesthesia is postoperative pain as a result of temperature changes during perforation of cortical bone[5,6,7]. Many studies have shown that the local increase in the temperature of the bone above 47°C might cause thermal osteonecrosis. Futhermore, thermal injury may occur micro-damage (microcracks), which could produce osteocytes apoptosis and that is the signal for ostoclasts activation and bone resorption [8,9,10,11].

## II. Material And Methods

12 swine fresh jaws were used for each of the examined intraosseous systems- Quicksleeper and Anesto, which had been previously placed in a laboratory thermostat UTerm37 (C-optic Ltd, Bulgaria) at a temperature of (32,0 ± 1,0)°C. The target point of anesthesia and the places of fixing of the thermocouples were pre-marked- FR (medially located) and BK (distally located). Perforations holes for fixing the thermocouples were made through the whole thickness of the cortical bone at a distance of about 1 mm from the target point of anesthesia. The process of needle's rotation into the bone was stopped at the moment the felling of sinking, which is an indication for perforating the cortical bone and entering the cancellous bone. Then followed infiltration of anesthetic solution, in order to create the real conditions of anesthesia. For both systems were measured the dynamic temperature changes generated by needle rotation into the cortical bone: heating from the initial temperature (32,0 ± 1,0) ° C to a distinct maximum and subsequent cooling of the bone again to a temperature of 32 ° C ± 1 ° C.

It was used a dual-channel interface system for collecting, recording and processing of laboratory data. 13bit analogue-to-digital converter and parallel communication with a PC provided a tracking both temperatures with accuracy ± 0,050C. Sampling interval is 500ms. To the parallel port on your computer for this interval are fed data from collecting and averaging 800 measurements. The data was processed using the spline interpolation. Controlling the temperature changes were performed before each measurement and was guaranteed by the calibrated thermometer Hart 1522 Handheld Standards Thermometers (Hart Scientific Utah, USA), fixed with semiconductor thermo-sensor Steinhart-Hart thermistor polynomial YSI 400.

## III. Results

Maximum values of measured temperature changes resulting from the friction in rotation of the needle are presented in (Fig. 1) and (Fig. 2):

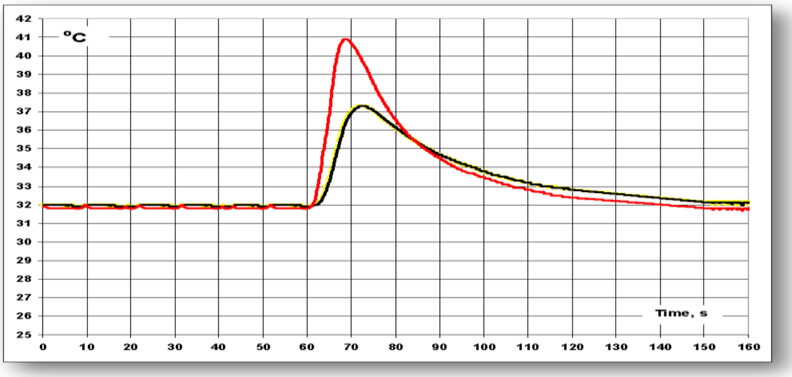


**Figure 1.** Temperature changes during perforating the cortical bone with Anesto

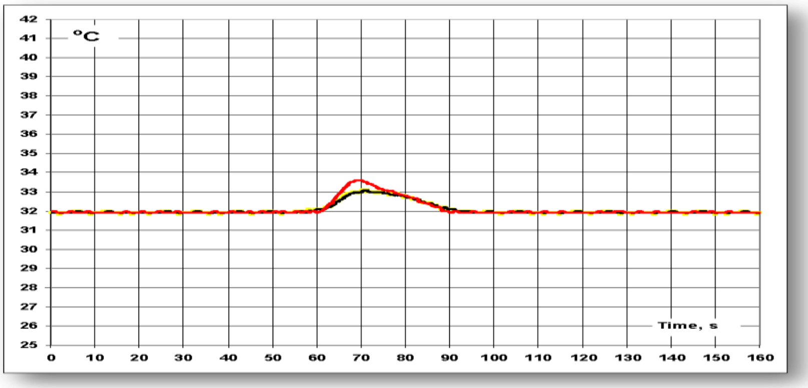


**Figure 2.** Temperature changes during perforating the cortical bone with Quicksleeper

Measured maximum temperatures are higher and statistically distinguishable for Anesto (9,0 ° C ± 2,0 ° C) compared to Quicksleeper (QS): 2,0 ° C ± 0,5 ° C (Anesto-FR VS QS-FR; P <0.05 (‡); Anesto-BK VS QS-BK; P <0.05 (‡); n = 12 in the Paired t-test). We detected different rate of temperature rise for the both examined intraosseous systems (Anesto-FR VS Anesto-BK; P <); n =*0.05 ( 12, Paired t-test) - (Fig. 3). The changes in temperature for Anesto are about 1 ° C, for every second, while for Quicksleeper they are practically insignificant: only about one-tenth of a degree per second. There are statistically distinguishable changes (Anesto-FR VS QS-FR; P <0.05 (‡); Anesto-BK VS QS-BK; P <0.05 (‡); n = 12 in Paired t-test).

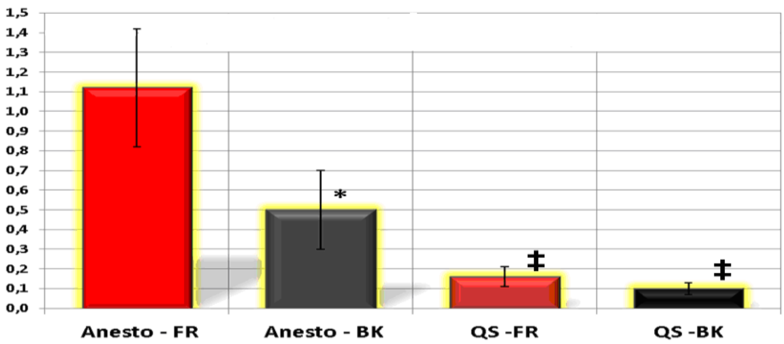


**Figure.3** Rate of temperature increase measured at both thermocouples for Anesto and Quicksleeper

The cooling process of the bone after completing intraosseous anesthesia matter how fast the bone neutralize in real time locally elevated temperature (Fig. 4) and what is the duration of the whole process of local heating and cooling (Fig. 5). There are a statistically difference for both parameters ( Anesto-FR VS QS-FR; $P<0.05$ (‡); Anesto-BK VS QS-BK ; $P<0.05$ (‡); n=12 Paired t-test). When comparing the distribution of temperature field in both directions medial - FR and distal-BK there are no significant differences in the duration of the processes for both intraosseous system $P> 0.05$, n = 12 in Paired t-test - (Fig. 5). But there is a significant difference in cooling rates for Anesto and Quicksleeper (Anesto-FR VS Anesto-BK; P <); QS-FR VS QS-BK; P∗0.05 ( <);∗0.05 ( n = 12) - (Fig. 4).

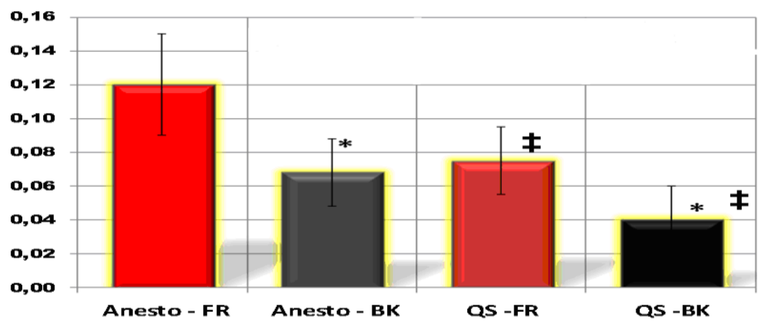


**Figure 4**. Speed of lowering the temperature measured by the thermocouples for both intraosseos systems

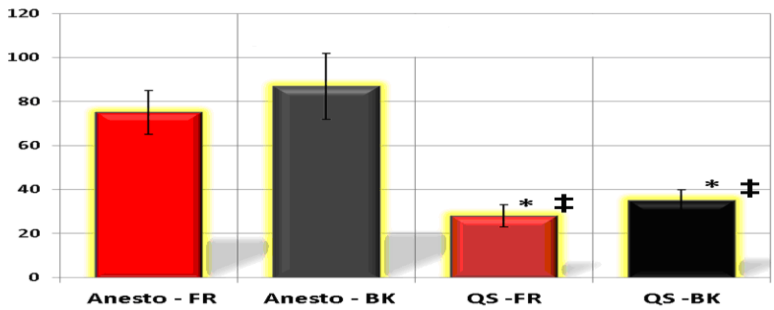


**Figure 5.** Duration of the process of raising and lowering the temperature during intraosseous anesthesia with Anesto and Quicksleeper

## IV. Descussion

The process of perforating the cortical bone with intraosseous systems of anesthesia is accompanied by the possible increase in the temperature due to the occurring friction between the rotating needle and the bone. Registered values of temperature increase in cortical bone are 9,0 ° C ± 2,0 ° C for Anesto and 2,0 ° C ± 0,5 ° C for Quicksleeper, which are lower than reported in the literature critical values (47 ° C) of thermal osteonecrosis. The exposure time of these temperature changes on bone is too short to occur irreversible changes in it. The manufacturers of intraosseous systems recommend perforating the cortical bone can not last more than 4-5 seconds. Thermal osteonecrosis might occur after exposure to the bone at a temperature of 47 ° C at least 1 min[9,]. There are differences in the measured temperature values for the both thermocouples (FR and BK). The higher values of medial thermocouple result from lesser density and thickness of the cortical bone in this area of the jaw.

Statistically significant differences in measured temperatures for Anesto and Quicksleeper could be explained by differences in the diameter of the perforating needle (Anesto- 0,55mm and Quicksleeper- 0,30mm), at the rotation speed (Anesto- min: 15,000 rpm ÷ max: 25,000 rpm and Quicksleeper- 11,000rpm) and in the process of needle rotation. The needle rotation for Anesto is a continuous process until the feeling of sinking, which is a sign of entry into the cancellous bone. Quicksleeper is computer-assisted system with programmed mode of needle rotation- for a little more than a second the needle makes a rotation cycle and cycle to rest and meanwhile infiltrates minimal amount of anesthetic, which has a certain cooling effect.

Factors that could affect the results is that in the experiments were used specimens, without circulation. The generated heat might be partially dispersed by the presence of blood and tissue fluid. It was found that the circulation of cortical bone is too low (2-3mL / 100g of 1min) and during the perforation quickly occur coagulation and occlusion of small blood vessels[12,13]. Interstitial fluid, especially in cancellous bone, might have a cooling effect. In the experimental conditions, it can be imitated by wet bone samples.

## V. Conclusion

Our goal was to determine whether the generated temperature by the needle rotation can reach values that have harmful effects on the bone. We compared conventional intraosseous system Anesto with computer-assisted Quicksleeper. Despite big differences between measured results for both systems, temperature values are below the critical 47 ° C, which could lead to thermal osteonecrosis.

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