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In-Vitro Assessment of Temperature Variations Occurring Through Continuous Drilling and Intermittent Drilling Technique in Preparation of Implant Sites: A Comparative Study

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ABSTRACT

Background: To assess the temperature variations occurring through continuous drilling and intermittent drilling technique in preparation of implant sites.

Materials & methods: Fresh bovine ribs were used and bone samples were obtained from them by simple dissection. Twelve blocks of dimension 50 x 50 x 30 mm were prepared. Drilling was carried out in two different procedures; one method involved continuous drilling, while the other involved drill-stop technique. Saline solutions for irrigation were used into two physiologic variant systems; Saline solution A- one in thermal equilibrium with the external environment (at approximately 24 degree centigrade), while other was Saline solution B- saline system refrigerated at approximately 6 degree centigrade. With 15 implant sites in each group, a total of 4 experimental groups were considered. All the temperature alterations were recorded and were analyzed.

Results: Mean temperature among specimens of group 1, group 2, group 3 and group 4 were 30.12 (SD: ±1.41) ºC, 27.93 (SD: ±0.69) ºC, 30.06 (SD: ±1.40) ºC and 27.97 (SD: ±0.71) ºC respectively. While comparing the temperature in between different implant sites divided on the basis of different site preparation technique and on the basis of different irrigating systems used, non- significant results were obtained.

Conclusion: During of implant site preparation, overheating of bone is unaffected by the technique used. Use of irrigating solutions during implant site preparation is highly recommended.

Keywords: Drilling technique, Implant, Site preparation.

INTRODUCTION

Principle of Osseointegration forms the basis of dental implant supported prostheses. Development of sound and adequate bone to dental implant contact and junction is the primary key to the success of dental implants. At the dental implant site, during the process of implant placement, there a rise in the temperature of the intraosseous area because of drilling procedure. Hyperthermia, along with reduced intraosseous perfusion, further resulting in necrosis is bone is the severe consequences of such rise in local temperature.[1,2]

Continuous and intermittent drilling techniques are two different drilling techniques used in cases where multiple dental implant site preparation has to be done. Authors from the past literature advocate that quantity of heat produced during the implant placement procedure is directly proportional to the exposure time of the frictional forces generated during drilling process. Longer the implant site preparation time, higher is the associated temperature.[3-5]

Hence; we planned the present study to assess the temperature variations occurring through

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continuous drilling and intermittent drilling technique in preparation of implant sites.

MATERIALS & METHODS

The present in-vitro study was commenced in the department of oral implantology and it included assessment and comparison of temperature difference between continuous drilling technique and intermittent drilling technique during preparation of dental implant site. Ethical approval was obtained before the starting of the study from the ethical committee of the institution in written. For reproducing the clinical environment of edentulous jaw bone, fresh bovine ribs were used and bone samples were obtained from them by simple dissection. As advocated by authors from previous literature, the bovine ribs and jaw bones are similar in terms of bone density and thermal conductivity. Also, considerable similarity exists between the two in relation to cortical and cancellous bone component ratio.[6,7]

Dissection of twelve ribs was done using micro motor and handpiece. Twelve blocks of dimension 50 x 50 x 30 mm were prepared. After shaping each bony specimen (block) into edentulous shape, preparation of 5 implant site per block was done. Therefore, in the end, a total of 60 sites were prepared. For the thermal probe, single site/block was set-up. DS18B20 temperature sensor thermal probe was used for carrying out all the measurements. From each implant site, the placement of the thermal probe in a set-up hole was done at a distance of 5 mm. Thermal grease was used in the inner bone wall for thermal coupling of the probe. Two layer coating of epoxy resin was used for providing thermal insulation. Ohms unit was used measurement of electrical resistance by the probe, which represented the temperature. The entire readings were obtained at intervals of 1 second, which therefore, were further converted into degree Celsius. Single experienced operator performed the implant site preparation procedure. Dimension of the sites was 13 mm (length) and 2 mm (diameter). Electronic precision balance was used for continuous monitoring of the pressure exerted during the implant site. Continuous speed of 1200 rpm with a torque of 34 N/cm^2 was maintained in the handpiece. Upper limit for pressure was set up as 30 N.

In a climate controlled room, all the thermal measurement procedures were commenced. In the present study, drilling was carried out in two different procedures; one method involved continuous drilling, while the other involved drill-stop technique. Normal saline solutions were used during the implant site preparation procedure through a constant flow rate of 40 mL/minute during the entire drilling procedure. Saline solutions were used into two physiologic variant systems; Saline solution A- one in thermal equilibrium with the external environment (at approximately 24 degree centigrade), while other was Saline solution B- saline system refrigerated at approximately 6 degree centigrade. With 15 implant sites in each group, a total of 4 experimental groups were considered for the present study as shown in **Table 1**. Compilation of all the results was done in Microsoft excel sheet followed by assessment with SPSS software version 17.0. Mann Whitney U test and chi- square test were used for evaluation of level of significance. P- value of less than 0.05 was taken as significant.

RESULTS

In the present in-vitro investigation, a total of 60 implant sites were assessed. All the implant sites were broadly divided into four study groups, with 15 implant sites in each group, based on the type of drilling technique used and based on the type of saline solution used (**Table 1**). In Group 1 and Group 2, sites for implant placement were prepared with continuous drilling technique, while in Group 3 and Group 4; sites for implant placement were prepared with intermittent drilling technique. Physiologic saline was used in Group 1 and Group 3, while refrigerated saline were used in Group 2 and Group 4. **Table 2** shows temperatures at different implant sites among various study groups. Mean temperature among specimens of group 1 and group 2 were 30.12 (SD: $\pm$1.41) ºC and 27.93 (SD: $\pm$0.69) ºC respectively. Mean temperature among specimens of group 3 and group 4 were 30.06 (SD: $\pm$1.40) ºC and 27.97 (SD: $\pm$0.71) ºC respectively (**Graph 1**). While comparing the temperature in between different implant sites divided on the basis of different site preparation technique, non-significant results were obtained (**P- value > 0.05**) (**Table 3**). Also, when temperature was compared in between different groups, divided on the basis of

Table 1: Distribution of implant sites into various groups.

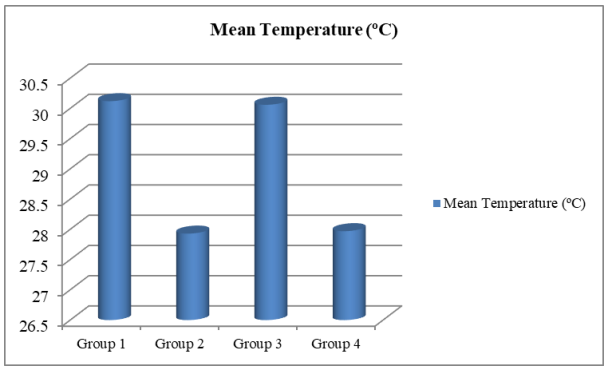
Group	Number of implant sites	Drilling technique	Saline solution
Group 1	15	Continuous	Saline system A
Group 2	15	Continuous	Saline system B
Group 3	15	Intermittent	Saline system A
Group 4	15	Intermittent	Saline system B

Table 2: Temperature with different drilling techniques.

Implant site	Temperature in different Groups at different implant sites (ºC)			
	Group 1	Group 2	Group 3	Group 4
1.	27.85	27.51	27.81	27.49
2.	28.00	27.32	27.85	27.24
3.	28.69	26.92	28.57	27.96
4.	28.91	27.81	28.73	28.50
5.	30.82	28.30	30.84	27.90
6.	31.25	28.52	30.76	27.02
7.	31.86	28.12	31.01	28.96
8.	29.52	28.46	29.87	27.38
9.	31.77	28.66	31.62	28.91
10.	31.28	27.82	31.88	28.35
11.	30.78	27.69	31.05	28.97
12.	29.81	28.69	30.18	28.27
13.	30.75	28.11	30.25	27.23
14.	31.77	28.76	31.81	28.34
15.	28.79	26.33	28.76	27.01

Table 3: Intergroup comparison of temperature

Groups	Temperature (ºC)		P- value
	Mean	SD	
Group 1	30.12	1.41	0.09
Group 2	27.93	0.69	
Group 1	30.12	1.41	0.50
Group 3	30.06	1.40	
Group 1	30.12	1.41	0.08
Group 4	27.97	0.71	
Group 2	27.93	0.69	0.60
Group 3	30.06	1.40	
Group 2	27.93	0.69	0.60
Group 4	27.97	0.71	
Group 3	30.06	1.40	0.08
Group 4	27.97	0.71	



Graph 1: Mean temperature of different study groups.

different type of irrigating systems used, non-significant results were obtained (**P- value > 0.05**) (**Table 3**).

DISCUSSION

Heat generated due to rise in temperature during the dental implant site preparation directly affects the bone. Results from the past studies have demonstrated that amount of necrotic zone produced around the dental implant site is directly proportional to the quantity of heat generated during the implant procedure. Reduction in the efficiency of the drills occurs on repeated use. Along with this, repeated use of drills also lead to subsequent rise in local site temperature.[8,9] Irrigation forms an indispensable component of dental implant placement procedure. Drilling speed depends on numerous parameters, including, dentist's perception, diameter of the drill, type of jaw bone (both quality and quantity), size of dental implant to be placed, and manufacturer's recommendation. Placement of dental implants in routine practice is not performed as a single step procedure. Rather, it is commenced in multiple steps, involving initially drilling followed by gradual widening with larger drills. Past studies have also demonstrated that amount of temperature rise is also significantly proportional to the diameter of the drill.[10-12] Hence; we planned the present study to assess the temperature variations occurring through continuous drilling and intermittent drilling technique in preparation of implant sites.

In the present study, four study groups were assessed based on the type of drilling method used and based on the type of irrigating solution system employed. Mean temperature at the site of implant preparation in the areas prepared with continuous and intermittent drilling technique was found to be 30.12 and 27.93 Degree C. No significant results were obtained while comparing the mean temperature in between sites prepared with continuous and intermittent drilling technique (**P-value > 0.05**). Results obtained in the present study were in concordance with the results obtained by previous who also reported similar findings in their studies.[7-9,13] In one of the previous studies conducted by Scarano A, authors evaluated and compared the alterations occurring in local temperature of the bone, along with drill's apical end during dental implant placement procedure with a cylindrical implant drill and a conical implant drill. Using a bovine femoral cortical bone, they used two dental implant drill systems; cylindrical drill with triple twist drills and a conical drill with quadruple twist drills. Infrared thermography was used by them for assessing the temperature of both the bone site and the apical portion of the drill. During dental implant preparation procedure, in the cortical bone, the mean temperature produced in their study was 31.2 °C and 29.1 °C for cylindrical and conical drill respectively. In the apical portion of the drill, the mean temperature produced during dental implant site preparation, in their study was 32.1 °C and 29.6 °C for cylindrical and conical drill respectively. While comparing the results in between the two study groups, statistically significant results were obtained by the authors. From their results, the authors concluded that amount of heat generated during dental implant site preparation is dependent upon the geometry of the drill.[8]

The temperature alterations occurring during dental implant osteotomies with combined and commonly used irrigation systems was compared by Strbac GD et al, on one of the past studies. In VII bovine ribs, they performed the drilling procedures with the help of a computer-aided surgical system. They used this particular surgical system with the aim of simulating the clinical conditions, as this system ensures an automated intermittent drilling cycles. With twist and conical dental implant drills, a combined total of 320 drilling osteotomies were performed, at varying drilling depths, and with various irrigation protocols. Using two custom built thermoprobes of fourteen different temperature sensors, they recorded in alterations in the

temperature in real time at defined measuring depths. In the group with any coolant irritant, they observed the highest elevation in temperature during the osteotomy procedures. Next to follow were external saline irrigants, combined irrigants and internal saline irrigants, in which median temperature increase of 2.60°C, 1.51°C and 1.48°C were observed. The results of temperature alteration comparison with different drill diameter were statistically significant. Significant results were also obtained by the authors while comparing the drill depth, time of drilling as influencing factors of heat generation in between the different groups. Under the light of their results, conclusion was withdrawn by the authors that during dental implant drilling process, combined irrigation delivers significant reduction in temperature alteration.[13]

In the present study, while comparing the mean temperature during the implant preparation site in between different study groups based on the type of irrigating solution system used, non- significant results were obtained (**P- value > 0.05**). Temperature alterations occurring at the dental implant site by various drilling methods was assessed in-vitro by Lucchiari N et al using infrared (IR) thermometer. From the bovine rib, they obtained 40 samples and randomly divided them into two study groups with 20 samples in each group. In group A and group B, they performed osteotomies using standard method of four drills and single drill respectively. They further divided these each group into two subgroups; subgroup 1 and subgroup 2. A1 and B1 referred to the subgroups in which drilling was commenced with irrigation, while A2 and B2 referred to the subgroup in which drilling was commenced without irrigation. Measurement of the baseline temperature (T0) and maximum temperature (Tmax) was done. Difference in the temperature (ΔT) was done drawn in between subgroups A1 and B1 and in between subgroup A2 and B2. 0.3150 degree centigrade was the average difference of temperature between the traditional technique and single drill technique in subgroups in which irrigation as used. However; the results were not statistically significant. However; they observed statistically significant results which comparing the mean difference in between the two techniques when the irrigation was not used. From their results, the authors concluded that significantly larger variation in the temperature in produced by single drill method in comparison to the traditional method.[14] In one of the previous study conducted by Calvo-Guirado JL et al, authors assessed the thermal changes occurring in hybrid drilling protocol in dental implant site preparation, and concluded that for preparing the dental implant bed without using irrigation, the hybrid protocol elevates the temperature approximately in a similar manner in comparison to the incremental conventional protocol.[15]

CONCLUSION

Under the light of obtained results, it can be concluded that overheating of bone is unaffected by the technique of implant site preparation used. Both continuous and intermittent drilling techniques are equally effective in terms of temperature alteration produced. Also it is recommended to use the irritating solution. Although seems to be equally effective, refrigerated irrigating solutions should be preferred over physiologic irrigating solutions. However; further studies are recommended for better exploration of this field of implantology.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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