121

Temperature rise during implant site osteotomy. An in vitro/in vivo study

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Topic: Basic research

Abstract

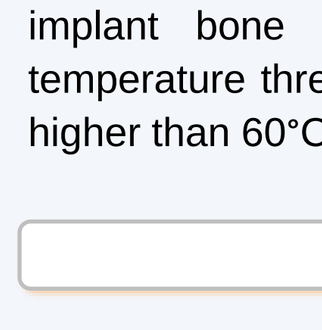
Objectives*:** Drilling procedures during implant osteotomy may induce an increase of the temperature in the surrounding bone. ***Aim*:** To measure, *in vitro,* the effect of different cooling methods on cortical bone temperature during implant site preparation. To evaluate histologically, *in vivo*, the implant osseointegration development when elevated temperature values were reached. ***Material and methods*:** One hundred and twenty implant osteotomic sites were prepared in fresh sheep mandibles using three different twist drill diameters (2 -2,7 and 4 mm). The bone temperature was recorded after using the different burs with different cooling methods plus no irrigation. Fifteen implant sites were prepared in two sheep mandibles *in vivo*. Ten sites were randomly warm up using a customized probe: 5 sites to 50°C for 1 minute (group 1) and 5 sites to 60°C (group 2) before inserting implants (Cortex®, Shlomi, Israel). After 2 months of healing the sheep were sacrificed and the histological analysis of the samples was performed. ***Results: 2mm-twist drill could overheat cortical bone during implant surgery more than other wider burs and internal irrigation was more efficient than other cooling methods. The bone temperature tested seemed to not prevent the osseointegration but implant in group 2 showed bone suffering signs as infrabony pockets of 1,5 mm in depth. ***Conclusions and clinical implications:*** Insufficient bur cooling caused bone temperature rise during implant drilling procedures (Eriksson et al.1984). This bone overheating could induce peri-implant bone resorption (Trisi et al. 2013) although the temperature threshold to prevent the osseointegration should be higher than 60°C.

Background and Aim

It was reported that a bone temperature of 50°C for 1 minute was the threshold value of significant bone resorption (Eriksson et al. 1983, 1984). The aim of the present study was, therefore, to histologically evaluate *in vivo*, in cortical bone, the effects of two different overheating temperatures on the development of osseointegration in the osteotomic sites prior to implant placement.

Methods and Materials

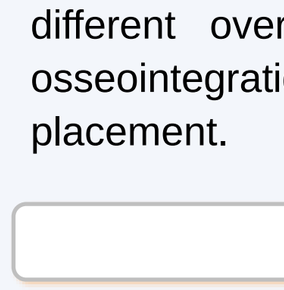
IN VITRO



- 40 osteotomic sites using 2 mm bur
- 40 osteotomic sites using 2 mm and 2,7 mm burs
- 40 ostetomic sites using 2 mm, 2,7 mm and 4 mm

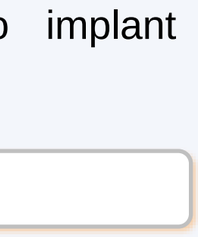
Each bur was tested with different cooling methods and bone temperatures were recorded

IN VIVO



- **8 sites heated up to 50°C 1 min**
- **8 sites heated up 60°C for 1 min**
- **8 sites not heated**

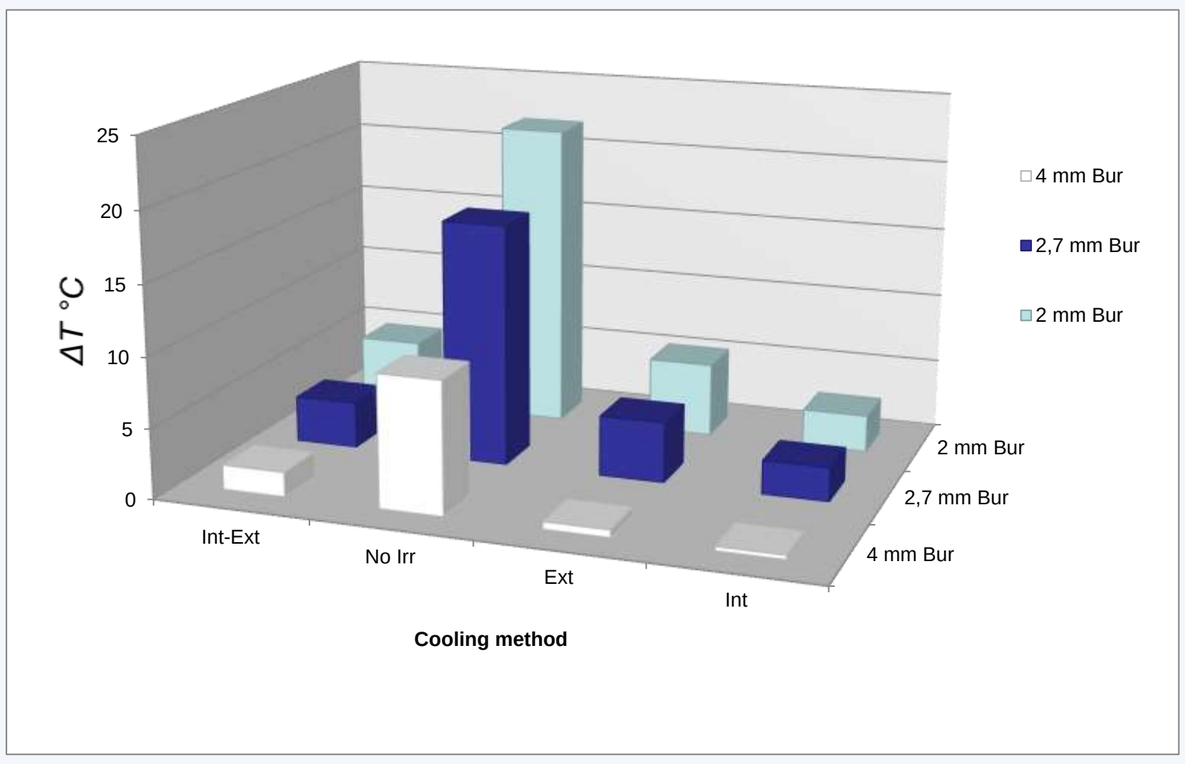
IMPLANTS INSERTION



References

1. Eriksson AR, Albrektsson T. (1983) Temperature threshold levels for heat-induced bone tissue injury: a vital-microscopic study in the rabbit. *Journal of Prosthetic Dentistry* 50: 101-7.
2. Eriksson RA, Albrektsson T (1984) The effect of heat on bone regeneration: an experimental study in the rabbit using the bone growth chamber. *Journal of Oral & Maxillofacial Surgery* 42: 705-11.
3. Eriksson AR, Albrektsson T, Albrektsson B. (1984) Heat caused by drilling cortical bone. Temperature measured in vivo in patients and animals. Acta Orthopaedica Scandinavica 55: 629-31
4. Trisi P, Berardini M, Falco A, Podaliri Vulpiani M, Perfetti G. (2013) Insufficient irrigation induces peri-implant bone resorption: an in vivo histologic analysis in sheep. *Clinical Oral Implants Research* Feb 20 [Epub ahead of print]

Results



Graph - ΔT average values for each bur in relation to each cooling method.

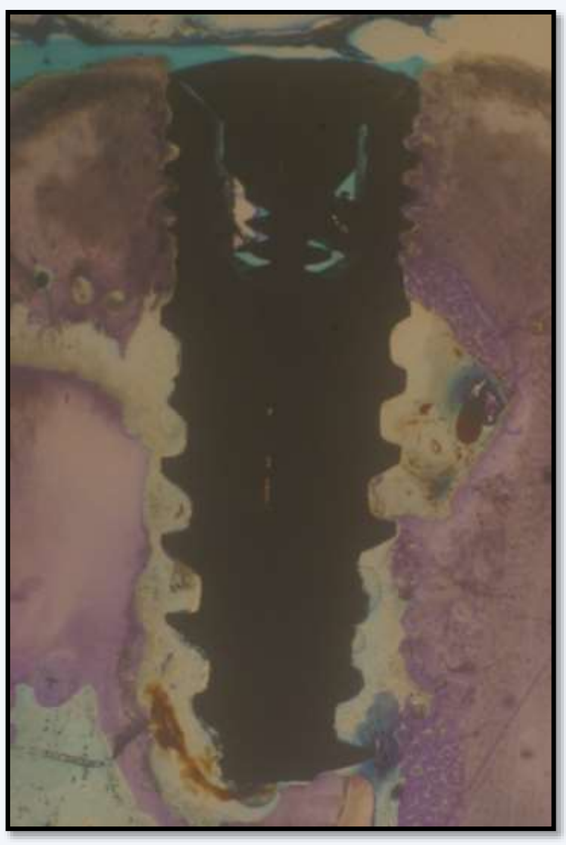


Figure 1: Imlants in control group

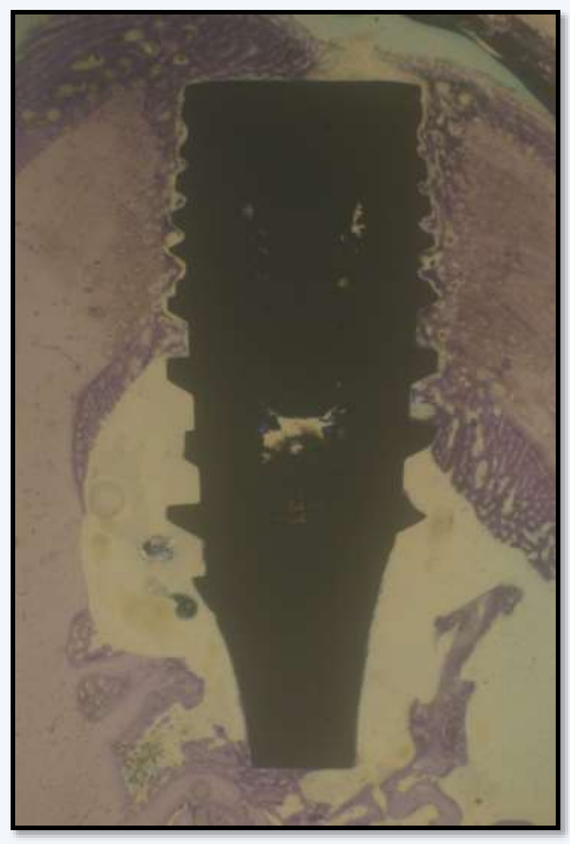
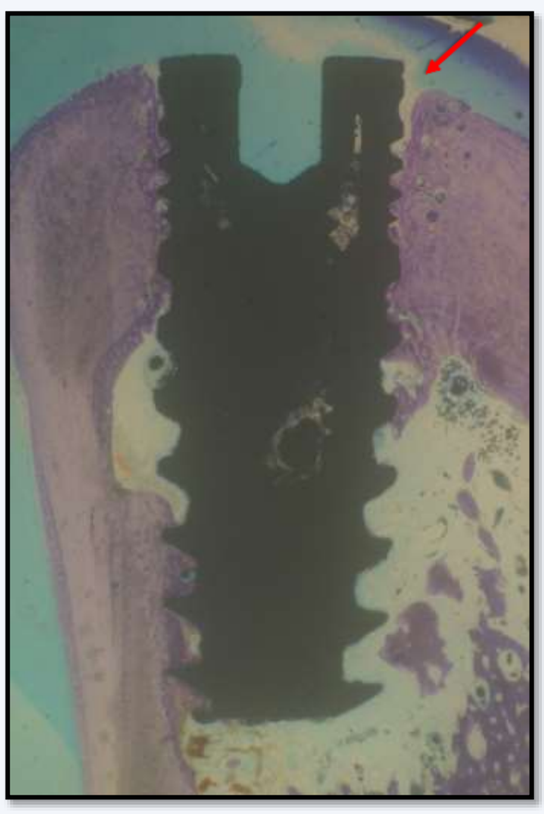


Figure 2: No sign of hard tissue damage (Group 2)



Figures 3 – 4: Infrabony pockets were evident (red arrow) in implants in group 2.

The statistical comparison of %BIC value using unpaired T-test revealed no statistical significant differences between the groups. Implants in group 1 (50°C for 1 minute) didn't show any signs of hard tissue damage nor bone marrow suffering. Implants in group 2(60°C for 1 minute) showed diffused infrabony pockets of average depth of 1,5 mm.

Conclusions

Osteotomic site temperature of 50°C or 60°C for 1 minutes seems not to prevent significantly implant osseointegration although signs of implants suffering as infrabony pockets of 1,5 mm in depth were evident in group of 60°C.
Implant drilling procedures on hard bone need an adequate cooling supply in order to avoid bone matrix overheating and peri-implant infra-bony pockets formation.

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