Bacterial nanocellulose as cooling agent

Judith CJ Holzer[1,3], Katrin Tiffner[2], Sonja Kainz[2], Peter Reisenegger[2], Hanna Luze[1,3], Sebastian P Nischwitz[1,3], Ives Bernardelli de Mattos[4], Martin Funk[5], Thomas Birngruber[2], Lars-Peter Kamolz[1,3]

Background

Cooling of burn injuries is most important, not only to reduce pain but also to reduce the intradermal damage as well as the burn wound conversion. Studies have shown that cooling for about 20 to 30 minutes using only plain tap water at moderate temperature is most efficient resulting in least intradermal damage. However, many burn injuries reach the hospital without any pre-clinical cooling, possibly due to the lack of a cooling agent. After a pilot study, we investigated if a bacterial nanocellulose (BNC)-based wound dressing containing about 95% water can cool a burn injury and if so the effect suffices to reduce the damage in the skin.

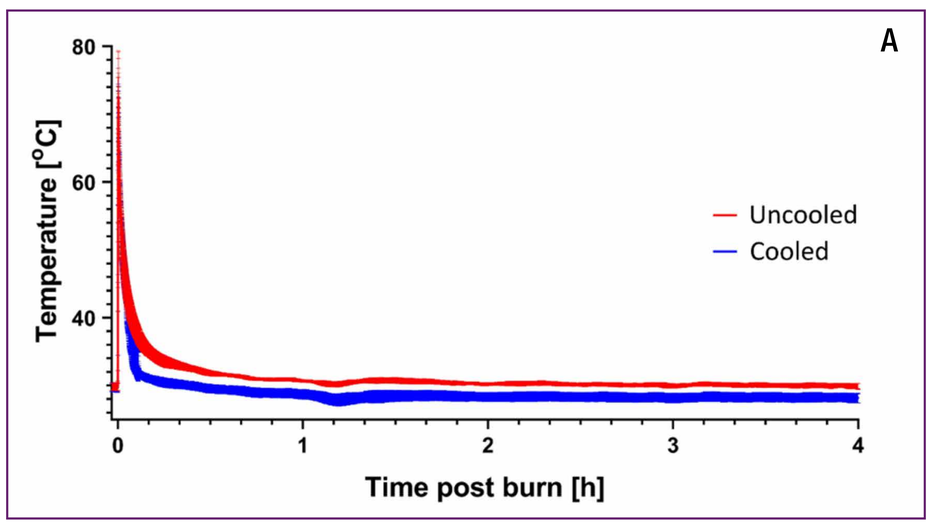
Material and Methods

Skin explants from human donors were burned with inflicted a contact burn injury, of which half were treated with a BNC-based wound dressing and a paraffin gauze dressing. Intradermal temperature sensors measured the temperature changes in the dermis over the course of 24 hours. Biopsies were taken for histological evaluation at different time points.

Results

The intradermal measurements show high temperature spikes at the moment of the burn injuries. After the application of a BNC-based wound dressing the intradermal skin temperature was significantly reduced (Figure 1). The area under the curve in the treated group was significantly less than the untreated (Figure 2). The histological assessment showed according results with less damage in the treated group in comparison to the untreated (Figure 3).

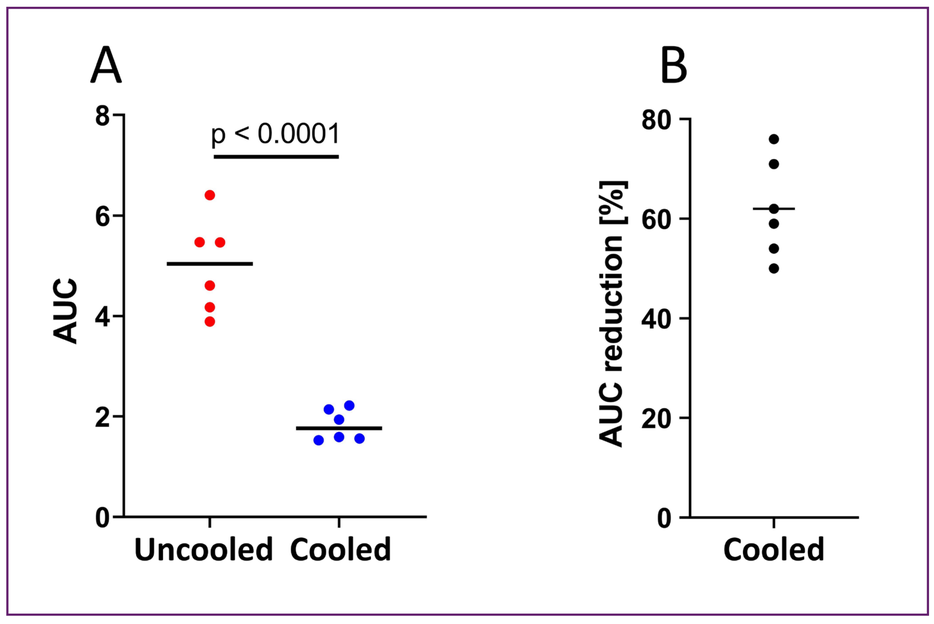
Figure 1: Intradermal temperature measurements. *A: Comparison of the intradermal temperature of the burned uncooled (red) and the cooled (blue) testing sites over the course of 4 hours. B: Difference in the intradermal temperature between the uncooled and the cooled group in the first hour of the experiment. After application of the cooling treatment, the maximum difference was 6.5°C.*

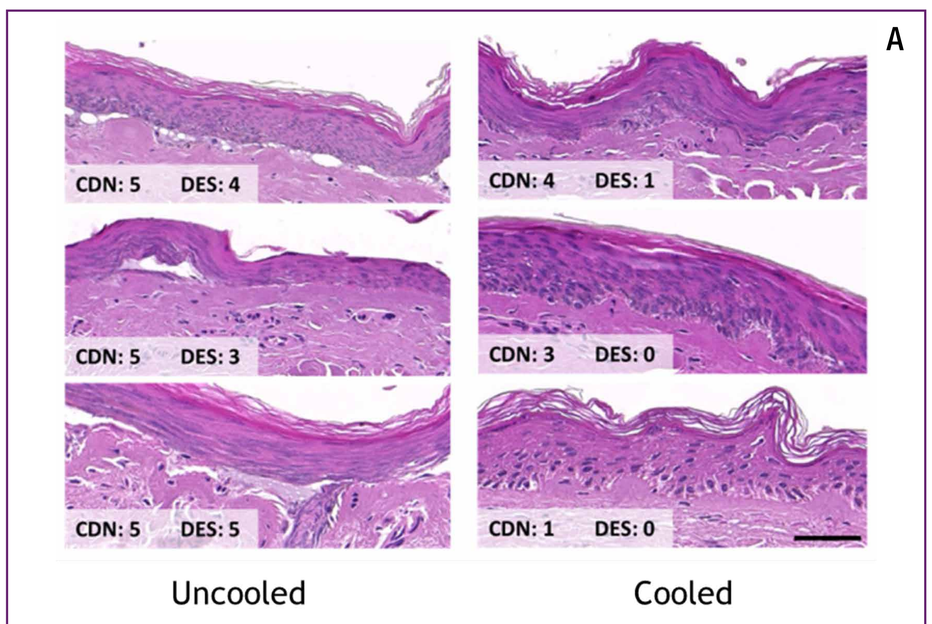


Conclusion

Bacterial nanocellulose-based wound dressings with high water content significantly lower the intradermal temperature after a contact burn and reduce the thermal damage inflicted to the skin. A secondary dressing that permits the water to evaporate slower additionally prolongs the cooling effect. The use of such a wound dressing could find use in a preclinical setting where other cooling options are not available.

Figure 2: Comparison of the Area-under-the-curve (AUC) of the experimental groups in 4h post-burn. *A: Difference in the AUC of the uncooled and the cooled group when measured from the baseline of 29.8°C, the mean intradermal pre-burn temperature. B: The reduction of the AUC in the treated group was 62% (mean).*





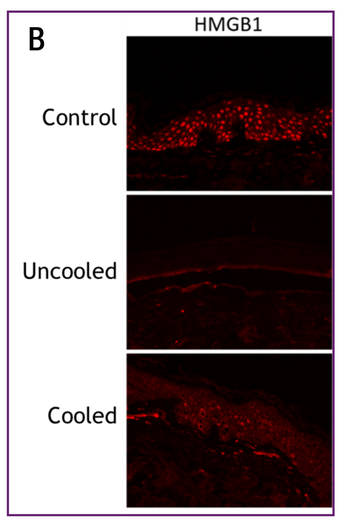


Figure 3: Histology and immunofluorescence. *A: 1 hour after the burn injury the cooled burns show less necrosis (CDN) as well as dermal epidermal separation (DES) in comparison to the uncooled burns. B: Immunofluorescence shows more viable cells in the burned and cooled skin than in the burned and uncooled skin. HMGB1 is located in the cell nuclei of healthy cells and is released into the intracellular plasma when the cell is stressed, reaching the extracellular space when the cell is destroyed.*

CONTACT

JOANNEUM RESEARCH
Forschungsgesellschaft mbH

[1] COREMED
Cooperative Centre for
Regenerative Medicine
Neue Stiftingtalstraße 2
8010 Graz
Phone +43 316 876-60 00
Fax +43 316 876-60 10
coremed@joanneum.at
www.joanneum.at/coremed

[2] HEALTH
Institute for Biomedicine
and Health Sciences
Neue Stiftingtalstraße 2
8010 Graz
Phone +43 316 876-40 00
Fax +43 316 876 9-40 00
health@joanneum.at
www.joanneum.at/health

[3] Medical University of Graz,
Austria
Division of Plastic, Aesthetic and
Reconstructive Surgery,
Department of Surgery

[4] Fraunhofer Institute
for Silicate Research ISC, Translational
Center Regenerative Therapies,
Wurzburg, Germany

[5] QRSKIN GmbH
Wurzburg, Germany

Disclosure

Martin Funk is an employee of QRSkin GmbH whose product epicitehydro was used for the experiments. All other authors state no conflict of interest.

This study was approved by the ethical committee of the Medical University of Graz (EK: 28-151 ex 15/16).