Discouraging cellular and bacterial adhesion on surfaces for bone temporary devices through ZrO_2-Ag coatings

Andrea Cochis[1,*], Sara Ferraris[2], Alessandro C. Scalia[1], Silvia Spriano[2] and Lia Rimondini[1]

[1]*Department of Health Sciences, Center for Translational Research and Autoimmune and Allergic Diseases (CAAD), University of Piemonte Orientale, Novara, Italy*
[2]*Applied Science and Technology Department, Polytechnics of Turin, Torino, Italy*

Keywords: Silver; bone; temporary device; cytocompatibility; transcriptomics; proteomics

Hem. Ind. **78(1S)** 53 (2024)

Available on-line at the Journal web address: http://www.ache.org.rs/HI/

INTRODUCTION: ideally bone temporary fixation devices must support the healing process but at the same time being surgically removed without hindering the newly formed tissue [1]. Moreover, they should prevent bacterial infection preserving the healing site. Accordingly, here we propose a surface coating of biomedical Ti6Al4V surface with inorganic zirconia matrix embedding silver nanoclusters (ZrO_2-Ag) where the Ag amount has been designed in order to prevent cells and bacteria adhesion avoiding cytotoxic side effect.

EXPERIMENTAL: ZrO_2-Ag coated specimens were produced introducing high (AH) or low (AL) amount of silver. Specimens were characterized for physical-chemical properties and then the biological assessment was performed by directly seeding human mesenchymal stem cells (hMSC) and the pathogen *Staphylococcus aureus* (*S. aureus*) to test the different surfaces in term of preventing adhesion. Finally, transcriptomics (RNAseq) and proteomics were applied to unravel the hMSC pathways regulated by the AH/AL-tuning.

RESULTS AND DISCUSSION: AL and AH specimens reported a different release of silver over time (Fig. 1a). The biological characterization suggested AH being toxic for both hMSC and *S. aureus* that were unable to colonize the specimens due to a contact-killing effect. On the opposite, AL specimens reported very promising results: cells and bacteria were unable to colonize AL surfaces too, but they were viable thus suggesting for a non-toxic anti-adhesion effect. In fact, both transcriptomics (Fig. 1b) and proteomics (Fig. 1c) studies of non-adherent hMSC revealed a strong down-regulation of genes and proteins related with pro-adhesion processes, whereas pro-apoptotic pathways were not up-regulated.

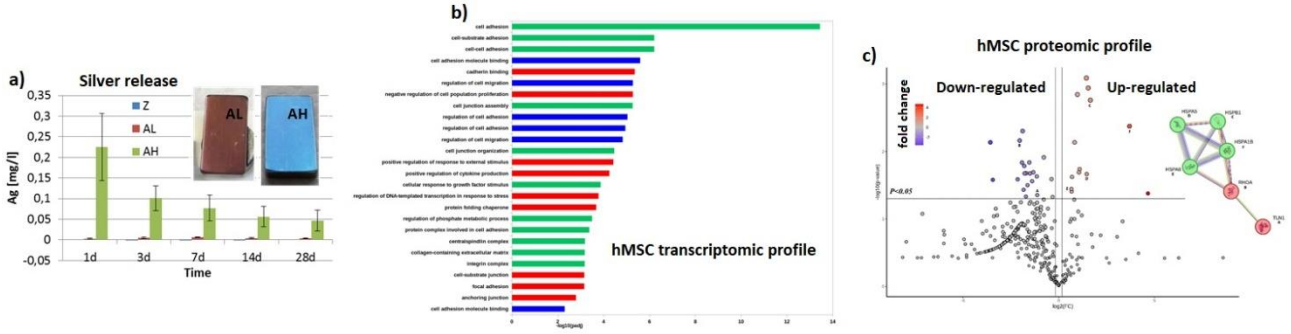

Figure 1. *a) silver release profile in function of time of AL and HL ZrO_2-Ag specimens; b) transcriptomics (RNAseq) studies of non-adhered hMSC cells onto AL specimens and c) their proteomics profile.*

CONCLUSIONS: the AL ZrO_2-Ag specimens reported a very promising solution for temporary fixation devices being able to prevent the surface colonization of both bacteria and cells by down-regulating the gene and proteins expression of several hMCS pro-adhesion pathways without cytotoxic effect.

Acknowledgements: Easy-Fix project, MANUNET call 2017 is acknowledged for founding (European Commission Through Local Agency Finpiemonte). INTRAUMA S.p.a. for collaboration and helpful discussion.

REFERENCES

[1] Ferraris, S., Perero, S., Costa, P., et al. Antibacterial inorganic coatings on metallic surfaces for temporary fixation devices. *Appl. Surf. Sci.* (2020); 508:144707. https://doi.org/10.1016/j.apsusc.2019.144707

*Corresponding author E-mail: andrea.cochis@med.uniupo.it