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HEALING OF EX VIVO SUTURED WOUND MODELS IN HUMAN TISSUES EXPOSED TO SPACEFLIGHT

Abstract

Wound healing (WH) allows the body to survive injuries by restoring its integrity. On Earth, WH dysfunction leads to serious conditions, such as chronic ulcers and fibrosis. The effect of spaceflight on WH is almost completely unknown. The relatively few studies carried out using in vitro and animal models suggest that the healing progression might be impaired and delayed. Therefore, the management of serious injuries that could happen to crew members is a major concern for future interplanetary missions. The only way to develop targeted therapeutic strategies is to learn more about WH in Space. The Suture in Space (SiS) experiment, that was launched with SpX 26 and performed on board the ISS from 28th November to 7th December, 2022, aimed to study for the first time the behavior and healing of ex vivo sutured wound models in human tissues exposed to spaceflight. Sutured wound models were prepared from skin and blood vessel biopsies collected from plastic and cardiovascular surgery, with informed consent and Ethical Committee approval, at Careggi hospital, Florence, Italy. To extend the viability of the explants throughout the experiment, culture media were enriched with serelaxin and (Zn(PipNONO)Cl), and an automated culture chamber reproducing and monitoring the physiological tensile strength in the tissues was developed. Before launch, hardware integration was performed at KSC, Cape Canaveral, U.S.A. After return to Earth, tissue samples were recovered without thawing from the frozen hardware. A ground control experiment was performed applying experimental conditions parallel to the in-flight experiment, except for microgravity. Then, ISS- and control samples were analyzed and compared for structure/ultrastructure, mechanical properties, gene expression, ECM proteins, etc., to understand if and how spaceflight affects WH mechanisms. The results showed that the new ex-vivo tissue culture system devised for the SiS experiment allows human skin and vein specimens to maintain viability for 5 weeks. Events associated with WH were observed in the tissues close to the wound, namely collagen and elastic fibers remodeling, keratinocyte proliferation, changes in expression of genes involved in WH, etc. Significant differences were found between ISS and control samples, in particular in mechanisms involved in the remodeling phase. The results deriving from the SiS experiment help shed light on WH mechanisms in unloading conditions. The authors thank ESA (SiS-ESA-AO-ILSRA-2014 and MAP-WHISPER Project C.N. 4000130928/20/NL/PG/pt) and ASI (SiS C.N. 2018-14-U.0) for their support.