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Life and Physical Sciences under reduced Gravity (7)

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MANIPULATION OF BLOOD CIRCULATION BY EXTERNAL MAGNETIC FIELDS AND
MAGNETIC NANOPARTICLES UNDER ZERO GRAVITY CONDITIONS

Abstract

Our blood circulatory system, evolved to operate in a 1-g environment, will alter to adjust to the 0-g condition by decreasing cardiac output of the heart – the amount of blood pumped out of the heart each minute, and by redistributing the blood flow– more blood will stay in the legs and less blood will return to the heart. Additionally, under no gravity, more blood goes to the chest and head, causing astronauts to have puffy faces and bulging blood vessels in their necks. Fluid congestion at the head also triggers a lowering of the blood pressure and increased elimination of fluid from body by urination. All these changes in the circulation will affect wound healing in space. We propose a novel method to control and manipulate the blood circulation by pumping magnetic nanoparticles (MNP) into the wound area. Under external permanent magnetic fields the movement of the MNPs can be adjusted to the heart rate by cyclic shifting of the magnet position along the main blood vessel at the wound site. The resulting forced movement of the MNPs, coupled with the ambient blood, will increase the circulation of the latter and help to deliver vital nutrients for the healing area. The application of ac magnetic field on top of the permanent field will trigger the magnetic hyperthermia effect through the relaxation and hysteresis losses of the MNPs. Such heating will also contribute to the increase of the blood circulation. The proposed manipulation of the blood circulation will be tested in our laboratory of magnetic levitation for small animals (frogs, rodents) with the aim to understand whether the application of permanent and high levitation fields have their own effect on the circulation. Obtained results will represent crucial knowledge for the wound healing in space.