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MORPHOFUNCTIONAL ADAPTATION OF THE MURINE INTESTINE OVER 30 DAYS OF SIMULATED MICROGRAVITY

Abstract

Gastrointestinal tract (GIT) is the only way of nutrients entry into the body. Despite plenty of studies investigate GIT function on Earth, much less is known about GIT adaptation to the conditions of spaceflight. Interpretation of human data is complicated due to heterogeneity of the subjects, diet, the use of countermeasures, thus underscoring the need for animal studies in the standard laboratory settings. This study was aimed to investigate the dynamics of functional and morphological changes of the intestine using the hindlimb unloading model in mice. A total of 120 BALB/c mice were subject to 30 days of hindlimb unloading (HLU) with subsequent 7-day recovery. Data were collected before, over 30 days of unloading, and after the reloading. Total transit time gradually increased peaking (+70 %) on HLU d10. While spontaneous contractions of the isolated jejunum segments were unchanged, the sensitivity to the calcium channel blocker nifedipine was transiently enhanced on d14 and to the inhibiting action of phenylephrine by d30. Colon segments displayed inhibited sensitivity to carbachol starting from HLU d14 and inhibited response to adrenoreceptor agonist phenylephrine as soon as d3 of HLU. The muscle layer thickness gradually increased over 30 days in the medial and, more so, in the distal, but not in the proximal segment of small intestine. Thus, changes in smooth muscle sensitivity to agonists of adreno- and cholinoceptors, along with smooth muscle hypertrophy might underlie the increased transit time. The intestinal wall permeability to FITC-inulin (4 kDa) and Blue1 (0.7 kDa) increased by 30 % by the 14th day of HLU and remained elevated for the next 14 days of exposure till prompt recovery after reloading. The rate of water absorption in the same preparations was unchanged. The villus height, crypt depth, and their ratio in the small intestine did not change over 30 days of HLU. Thus, the increase in intestinal wall permeability during unloading is, presumably, governed by the density of contacts between epitheliocytes, rather than due to an increase in the absorptive surface area. We conclude that murine intestine adapts to the change of gravity direction relative to body axis via altered contractility, permeability, and morphology, disregarding the minute body size and quadruped posture of mice.