The effects of extracellular magnesium ion on smooth muscle cells

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Introduction: Magnesium alloys have been widely explored in cardiovascular stent application due to biodegradability and good biocompatibility. However, the main drawbacks of magnesium alloys are low corrosion resistance and insufficient mechanical strength. Magnesium-based implants degrade fast and magnesium ion accumulates, which may affect the local cells and tissues, including endothelial cells and vascular smooth muscle cells (SMC). However, the knowledge on the effects of Mg on SMC is still largely missing. In this study, we investigated cellular responses of SMC to Mg, namely, cell adhesion, mobility, cell viability, proliferation, cell morphology, cytoskeleton reorganization and gene expression profile.

Materials and Methods: Human aortic smooth muscle cells (HASMC) were used in this study. The magnesium chloride solution was prepared by dissolving $MgCl_2$ into deionized water and diluted with SMC into solutions with different concentrations. The cell viability was detected by MTT test and Brdu cell proliferation test was used to evaluate smooth muscle cell proliferation. The cell adhesion was characterized by cell adhesion ratio, cell adhesion strength. The cell morphology was quantified by cell length, width, shape index and surface area. The cytoskeleton was stained by immunofluorescence staining kit. The cell migration was detected by cell scratch test. Also LDH test was used to evaluate the cytotoxicity of magnesium ion.

Results: The cellular responses of smooth muscle cell to magnesium ion are in a concentration-dependent manner. Low magnesium ion concentration ion enhanced the cell adhesion, cell viability and cell proliferation and high magnesium concentration opposited them. Variations in magnesium ion concentration also can affect cell migration, LDH cytotoxicity, cell morphology and cytoskeleton. Gene expression profile was also associated with magnesium ion concentrations.

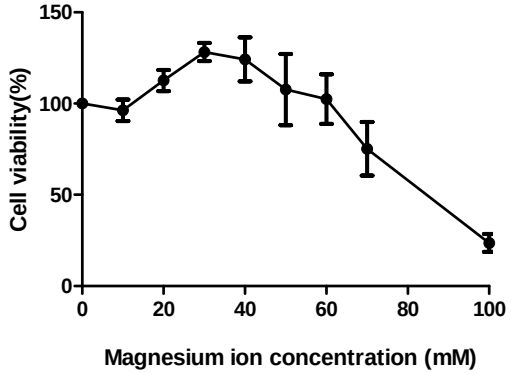

Fig 1. Smooth muscle cell viability at different magnesium ion concentrations.

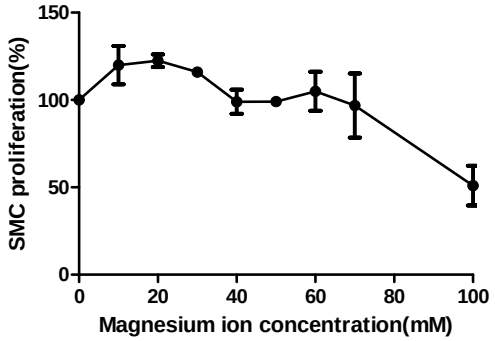

Fig 2. Smooth muscle cell proliferation at different magnesium ion concentrations.

Conclusions: The SMC cellular responses to magnesium ion were concentration-dependent. Low concentrations of Mg are beneficial to SMC growth and movement while high concentrations have an opposite effect. Results indicate that controlling the local Mg concentration by controlling the Mg alloy degradation rate is pivotal to the health of vascular cells.