

Effect of Hematoma on Early Degradation Behavior of Magnesium After Implantation

Yu YUSA^{*(1)}
Yoshinaka SHIMIZU^{*(2)}
Masanobu HAYASHI^{*(1)}
Takayuki AIZAWA^{*(1)}
Takahiro NAKAHARA^{*(2)}
Takahiro UENO^{*(2)}
Akimitsu SATO^{*(1)}
Chieko MIURA^{*(1)}
Akiko YAMAMOTO^{*(3)}
Yoshimichi IMAI^{*(1)}

Abstract

The corrosion of magnesium (Mg)-based bioabsorbable implanting devices is influenced by implantation environment which dynamically changes by biological response including wound healing. Understanding the corrosion mechanisms along the healing process is essential for the development of Mg-based devices. In this study, a hematoma model was created in a rat femur to analyze Mg corrosion with hematoma in the early stage of implantation. Pure Mg specimen (99.9%, ϕ 1.2×6 mm) was implanted in rat femur under either hematoma or non-hematoma conditions. After a designated period of implantation, the specimens were collected and weighed. The insoluble salts formed on the specimen surfaces were analyzed using scanning electron microscopy, energy-dispersive X-ray spectroscopy, and Raman spectroscopy on days 1, 3, and 7. The results indicate that hematomas promote Mg corrosion and change the insoluble salt precipitation. The weight loss of the hematoma group ($27.31 \pm 5.91 \mu\text{g}/\text{mm}^2$) was significantly larger than that of the non-hematoma group ($14.77 \pm 3.28 \mu\text{g}/\text{mm}^2$) on day 7. In the non-hematoma group, carbonate and phosphate were detected even on day 1, but the only latter was detected on day 7. In the hematoma group, hydroxide was detected on day 1, followed by the formation of carbonate and phosphate on days 3 and 7. The obtained results suggest the hypoxic and acidic microenvironment in hematomas accelerates the Mg corrosion immediately after implantation, and the subsequent hematoma resorption process leads to the formation of phosphate and carbonate with organic molecules. This study revealed the risk of hematomas as an acceleration factor of the corrosion of Mg-based devices leading to the early implant failure. It is important to consider this risk in the design of Mg-based devices and to optimize surgical procedures controlling hemorrhage at implantation and reducing unexpected bleeding after surgery.

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^{*(1)}Department of Plastic and Reconstructive Surgery, Tohoku University Graduate School of Medicine

^{*(2)}Parker Innovation Center, Nihon Parkerizing Co., Ltd

^{*(3)}Research Center for Functional Materials, National Institute for Materials Sciences