Osteosynthesis of partial rib osteotomy in a miniature pig model using human standard-sized magnesium plate/screw systems: Effect of cyclic deformation on implant integrity and bone healing.


Abstract
Magnesium alloys are candidates for resorbable material in bone fixation. However, the degradation and performance of osteosynthesis plate/screw systems in vivo, under cyclic deformation, is unknown. We evaluated the outcomes of human standard-sized magnesium plate/screw systems with or without plasma-electrolytic surface modifications in a miniature pig rib model. Of a total of 14 minipigs, six were implanted with coated magnesium WE43 six-hole plates/screws, six received magnesium uncoated plates/screws, and two received titanium osteosynthesis systems. The performance of the plate/screw fixation system on partially osteotomized 7th ribs was compared with that on intact 9th ribs. Radiological examinations were performed in vivo at 1, 4 and 8 weeks and after euthanasia at 12 and 24 weeks. After euthanasia the bone blocks were analyzed by computed tomography (CT), microfocus computed tomography (micro-CT), histology and histomorphometry. Follow-up post-surgery showed no trouble with wound healing. In vivo radiological examinations showed higher amounts of gas formation above the uncoated magnesium plates fixed on the partially osteotomized and intact ribs. CT scans showed no broken plates or implant displacement. The micro-CT examination demonstrated better surrounding bone properties around the coated than the uncoated magnesium implants 12 weeks after surgery. No negative influence of magnesium degradation on bone healing was observed with histological examinations. Plastic deformation during surgery and cyclic deformation did not affect the integrity of the used magnesium plates. This study showed promising results for the further development of coated magnesium plate/screw systems for bone fixation.

KEYWORDS: Biomaterial; Degradation; Implant; Magnesium alloy; Osteosynthesis

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