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Evaluation of 3D Templated Synthetic Vascular Graft Compared with Standard Graft in a Rat Model

Authors : Won-Min Jo, Suk-Hee Park, Tae-Hee Kim

Abstract : Although the number of vascular surgeries using vascular grafts is increasing, they are limited by vascular graft-related complications and size discrepancy. Current efforts to develop the ideal synthetic vascular graft for clinical application using tissue engineering or 3D printing are far from satisfactory. Therefore, we aimed to re-design the vascular graft with modified materials and 3D printing techniques and also demonstrated the improved applications of our vascular graft clinically. We designed the 3D printed polyvinyl alcohol (PVA) templates according to the vessel size and shape, and these were dip-coated with salt-suspended thermoplastic polyurethane (TPU). Next, the core template was removed to obtain a customized porous TPU graft. The mechanical testing and cytotoxicity studies of the synthetic 3D templated vascular grafts (3DT) were more appropriate compared with commercially available polytetrafluoroethylene (PTFE) grafts (ePTFE; standard graft, SG) for clinical use. Finally, we performed implantation of the 3DTs and SGs into the rat abdominal aorta as a patch technique. Four groups of the animal model (SG_7 days, SG_30 days, 3DT_7 days, and 3DT_30 days) were enrolled in this study. The abdominal aorta was surgically opened and sutured with SG or 3DT with 8/0 Prolene. The degree of endothelial cell activation, neovascularization, thrombus formation, calcification, inflammatory infiltrates, and fibrosis were analyzed histopathologically. There was significantly decreased thrombogenesis in the group treated with the 3DT for 30 days compared with the group treated with the SG for 7 and 30 days, and the 3DT for 7 days. In addition, the group treated with the 3DT for 30 days may also have shown increased postoperative endothelialization in the early stages. In conclusion, this study suggests the possibility of using the 3DT as an SG substitute in vascular surgery.

Keywords : 3D templated graft, hrombogenesis, calcification, inflammation
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