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An activable adhesive for patch closure of cardiovascular defects

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Background: Tissue adhesives have many advantages over sutures, namely in the reduction of operative times and procedural simplification. However, FDA approved tissue adhesives are associated with low adhesive strength, especially in the presence of blood and under dynamic conditions. Thus, we developed a light-activated adhesive, poly(glycerol-co-sebacate) acrylate (PGSA) that works efficiently on the beating heart in an in vivo model. The aims of this study were to evaluate in vitro adhesion in the presence of blood, obtain a quantitative evaluation of the long term adhesion on the epicardium, and the potential use for vascular anastomosis.
Methods: Adhesion strength was evaluated in pull-off tests using fresh epicardial tissue in the presence of saline or blood. Cyanoacrylate was used as control. A biocompatible patch was attached with PGSA or cyanoacrylate on the epicardium in a chronic in vivo rat model (n=30). Hearts were explanted after 2, 7 and 14 days for histology and adhesion testing performed. A longitudinal incision (2 mm) of a porcine carotid artery was closed with a patch and PGSA in vitro (n=4). Burst testing was performed after closure.
Results: In vitro adhesive strength was 1.2±0.8 N/cm2 for PGSA in the presence of saline. Attachment of a biocompatible patch with PGSA and cyanoacrylate was shown to be feasible on the epicardium of a beating rat heart. The patches were well attached upon sacrifice 14 days after implant in the majority of the cases. Adhesive strength after 2 days was 0.34±0.44 N/cm2 for PGSA. Histology revealed favorable biocompatibility of PGSA. The adhesive strength for PGSA did not decrease in the presence of blood (1.1±0.7 N/cm2;p=0.7). In contrast, cyanoacrylate was associated with a pronounced inflammatory reaction and the adhesive strength significantly decreased by 50% in the presence of blood. The PGSA patch on the carotid artery could withstand pressures of 300 mmHg before leaking.
Conclusions: PGSA is biocompatible and exhibits sufficient adhesive strength for attachment of patches or devices on dynamic tissues over the longterm and does not lose its adhesive strength in the presence of blood. Furthermore, it provides excellent anastomotic bursting strength in a model of vascular anastomosis.