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Designing programmable hydrogels for controlled vessel formation within engineered tissues
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INTRODUCTION: Spatiotemporal control on the availability of growth factors is an important factor for controlling the vascularization within an engineered tissue [1]. Therefore, we have designed aptamer-functionalized hydrogel to evaluate their potential for growth factor sequestering, controlled release and study their effect on vessel formation by endothelial cells.

METHODS: The aptamer functionalized hydrogels were prepared via photo-polymerization of gelatin methacryloyl (GelMA) and acrydite functionalized aptamers containing a sequence that is optimized for the binding of vascular endothelial growth factor (VEGF). Irgacure 2959 was used as photoinitiator. The physicochemical properties of these aptamer functionalized hydrogels were evaluated and compared with control samples. To study the programmable release efficiency, the complementary sequences (CSs) were added on the hydrogel system to trigger the growth factor release from the aptamers which was evaluated using ELISA kits. For studying the effect of triggered growth factor release in co-culture system (human umbilical vein endothelial cells (HUVECs) and mesenchymal stem cells (MSCs)), cells were encapsulated within aptamer functionalized hydrogels and the formation of vascular structures was investigated.

RESULTS & DISCUSSION: The results obtained from physicochemical analysis of the aptamer functionalized hydrogels confirmed the aptamer retaining capacity of acrydite functionalized aptamers, in comparison with the control aptamers for as long as 14 days at 37 °C. These results fit well with our hypothesis that the acrydite functionalized aptamers could covalently crosslink within the polymer network whereas control aptamers tend to get just physically entrapped within the hydrogels. The results obtained from the VEGF ELISA experiments showed the triggered release of VEGF from the aptamer functionalized hydrogels in response to CS addition. Without CS addition, these hydrogels could sustain a controlled release for until 10 days. Furthermore, in co-culture experiments, the developed aptamer functionalized programmable hydrogels supported cell viability and the formation of vascular structures by HUVECs and MSCs within the hydrogels for up to 8 days. These results further confirmed the bioactivity of the VEGF molecules after their loading within the aptamer functionalized hydrogels.

CONCLUSIONS: The present study clearly illustrate the beneficial effects of triggered VEGF release on the formation of vascular structures by HUVECs and MSCs in co-culture condition.

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REFERENCES