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Abstract

Digital-Light-Processing technologies to manufacture biocompatible bone scaffolds

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In today's trauma surgery the treatment of critical sized bone defects can cause different problems, such as stability issues and impaired healing processes. The defects often have an irregular shape and result from inflammation, tumor resection or trauma.

Additive manufacturing technologies can support the filling and healing process of such critical sized bone defects. With that in mind the aim of our project is, to build a biocompatible scaffold with a spongiosa like structure using Digital-Light-Processing (DLP) technology. This printing approach has a lot of advantages compared to other printing technologies. DLP with the printer used (Lumen X, Cellink) enables to print up to a resolution of 50 micrometer allowing to build scaffolds with high and biomimetic details. Further, this technology is useful to integrate cells directly into the printing process, because of the low cytotoxicity of the applied wavelength (405nm) in combination with biocompatible BioInk´s.

In our study we established a biocompatible BioInk composed of Gelatine-Methacryloyl (GelMa) a photoinitiator and a photoabsorber. We were able to show the increased biocompatibility compared to commercially available alternatives by analyzing the cellular proliferation and differentiation of mesenchymal stem cells (MSC´s) and MG63 (osteosarcoma cell line) encapsulated into the BioInk.

The scaffolds printed by the established BioInk had more than four times higher DNA content after 7 days compared to the commercial GelMa BioInk alternative, indicating cellular proliferation. Confocal laser scanning imaging of the different scaffolds underlined these results. Cells in the commercial alternative BioInk stayed round in their shape while cells in self-made BioInk showed an elongated morphology after staining with Hoechst and Phalloidin TRITC and survived up to over 2 weeks.

In further studies we will analyze how bioactive substances integrated into the BioInk support cell proliferation and differentiation towards an osteogenic phenotype.

AUTHOR'S STATEMENT

Authors state no conflict of interest. Informed consent: Informed consent has been obtained from all individuals included in this study. Ethical approval: The research related to human use complies with all the relevant national regulations, institutional policies and was performed in accordance with the tenets of the Helsinki Declaration, and has been approved by the authors' institutional review board or equivalent committee. Acknowledgments: We thank the medical faculty of Christian-Albrechts-University for financial support in form of the fellowship of Sven Malte Krümpelmann. Also we thank Lennard Arp for the excellent technical assistance.

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