STEREOLITHOGRAPHIC FABRICATION OF CULTIVATION CHAMBERS FOR CONNECTIVE TISSUE

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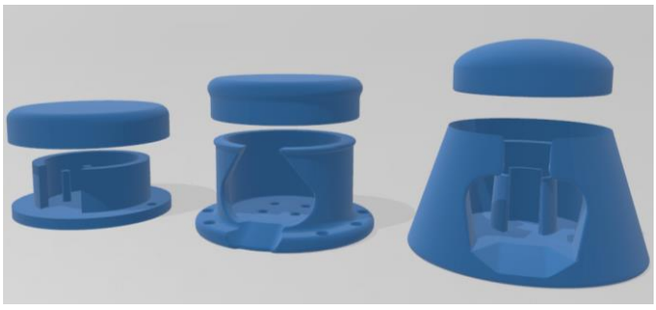
THE AV LOOP TECHNIQUE – CULTIVATION OF PATIENT SPECIFIC TISSUE FLAP

INTRODUCTION

In the field of reconstructive surgery, free flap transplantation is a standard procedure for soft tissue defect reconstruction. If no autologous tissue is available, this technique reaches its limits. One approach to overcome this limitation, may be the cultivation of patient-specific and transplantable axial vascularized tissue flaps based on the arteriovenous loop (AVL) technique. With this technology, perfused tissue flaps can be grown in subcutaneous isolation chambers embedded below. Feasibility has been successfully demonstrated with Teflon® chambers. For the development towards a patient- and defect-specific reconstruction, individualized plastic chambers should be generated via 3D-priting methods.

METHODS

It was possible to develop a combination of material, printing process and post-processing method with which all requirements for mechanical, optical and cell-biological properties were achieved. The material is based on acrylic and methacrylic functionalized monomers with a high polyurethane content. The manufacturing process is based on LCD technology. The original Teflon chamber design was further developed in several iteration cycles. This has resulted in a chamber that closes flush, sews well, and creates minimal friction points with the patient's skin during the implantation period.



Picture 1: Evolution of chamber design; milled Teflon chamber design (l), first iteration design with snap lock and seam holes(m), new friction-reduced design with added loop fixation feature (r).

CULTIVATING OF TISSUE FLAPS IN RAT MODEL

SURGICAL TECHNIQUE

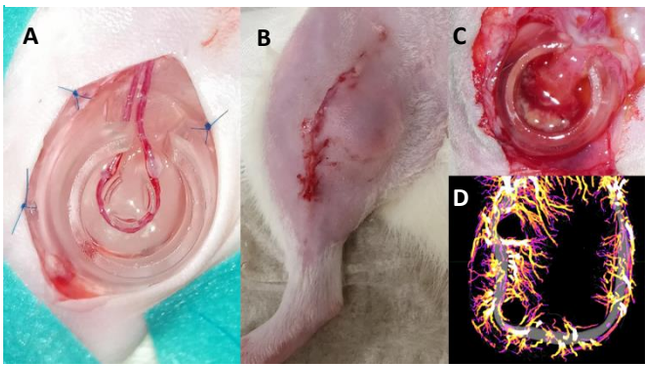
An AVL is generated by means of an interpositional vein graft, which is harvested contralaterally. The AVL is subsequently placed into an isolation chamber and embedded an avascular dermal matrix (ADM). Over the course of a few days a fully functional three-dimensional microvascular network forms and permeates the matrix in a centrifugal fashion. Without the addition of external stimulants, such as growth factors, or other angioinductive substances, the AVL can thus be applied to provoke angiogenesis. Hereby, the pre-vascularization of formerly avascular tissue (ADM) can be achieved, and an axial vascularized soft-connective tissue flap is generated.

RESULTS

13 spraque dawley rats were operated with the stereolithographic fabricated isolation chamber. All animals tolerated the chamber well, no signs of inflammation or wound healing disorders were seen over the course of 28 days. Nano-CT scans and histological cross sections revealed a significant increase of mean vessel number, cell count and proliferating cells increase significantly over time inside the AVL chamber, thus creating a prefabricated axial

CONCLUSION

Sterolithographic fabrication is suitable to produce biocompatible 3D-printed isolation chambers for *in vivo* growth of axial vascularized soft-connective tissue. Future confirmatory studies in large animals are required in order to achieve translation into clinical applications.



Picture 2: The AVL is placed in the subcutaneous isolation chamber and embedded in an ADM (A). The lid is closed, and the skin is sutured (B). After 28 days the formation of soft-connective tissue (C) and new vessels can be observed by 3D nano-CT scans (D).

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