Prefabrication of 3D cartilage constructs: towards a tissue engineered auricle—a model tested in rabbits.

The reconstruction of an auricle for congenital deformity or following trauma remains one of the greatest challenges in reconstructive surgery. Tissue-engineered (TE) three-dimensional (3D) cartilage constructs have proven to be a promising option, but problems remain with regard to cell vitality in large cell constructs. The supply of nutrients and oxygen is limited because cultured cartilage is not vascular integrated due to missing perichondrium. The consequence is necrosis and thus a loss of form stability. The micro-surgical implantation of an arteriovenous loop represents a reliable technology for neovascularization, and thus vascular integration, of three-dimensional (3D) cultivated cell constructs. Auricular cartilage biopsies were obtained from 15 rabbits and seeded in 3D scaffolds made from polycaprolactone-based polyurethane in the shape and size of a human auricle. These cartilage cell constructs were implanted subcutaneously into a skin flap (15 × 8 cm) and neovascularized by means of vascular loops implanted micro-surgically. They were then totally enhanced as 3D tissue and freely re-implanted in-situ through microsurgery. Neovascularization in the prefabricated flap and cultured cartilage construct was analyzed by microangiography. After explantation, the specimens were examined by histological and immunohistochemical
methods. Cultivated 3D cartilage cell constructs with implanted vascular pedicle promoted the formation of engineered cartilaginous tissue within the scaffold in vivo. The auricles contained cartilage-specific extracellular matrix (ECM) components, such as GAGs and collagen even in the center of the constructs. In contrast, in cultivated 3D cartilage cell constructs without vascular pedicle, ECM distribution was only detectable on the surface compared to constructs with vascular pedicle. We demonstrated, that the 3D flaps could be freely transplanted. On a microangiographic level it was evident that all the skin flaps and the implanted cultivated constructs were well neovascularized. The presented method is suggested as a promising alternative towards clinical application of engineered cartilaginous tissue for plastic and reconstructive surgery.

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