Chondrocyte-scaffold Interaction on Four Transplant Types Used for Cartilage Regeneration

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Introduction
The development of new scaffolds for cartilage regeneration is a continuously growing field in material science. However, despite some scaffolds are in clinical application since several years, they have rarely been investigated. The knowledge of the aptitude of the scaffold material under clinical conditions and as carrier of patient’s chondrocytes would though be helpful for the development of new scaffold types. Therefore we investigated the interaction of the chondrocytes of four structurally very different transplant types from patients, which underwent MACT (matrix associated chondrocyte transplantation).

Materials and Methods
Four biodegradable transplant types (Hyalograft®C, Novocart®, Biogide® and CaReS®) were analysed by light, scanning and transmission electron microscopy. The samples were gained from residuals of the implanted transplants directly after MACT-surgery. All surgeries were done in the same hospital by the same surgeons.

Results
Hyalograft®C is the most porous of the four scaffold types and consists of regular hyaluronan-fibers, 10–15µm thick and three-dimensionally arranged. Chondrocytes are regularly distributed throughout the scaffold diameter. Elongated chondrocytes grow along or stretching in between. On those fibers the chondrocytes surround the whole carrier fibers by cell extensions. In behaving like that, the cells remain their shape which is predominantly spherical on this scaffold type. The cell distribution is quite regular.

Biogide® is the densest of the four scaffolds consisting of collagen bundles in parallel orientation to the surface. Cells are almost exclusively present at the surface and have either a spherical or polygonal shape. Apart from some microvilli which penetrate into the scaffold fibers, the cells have no special adaptation to the scaffold morphology.

CaReS® is a collagen gel with individual larger fibers embedded in a fine fibrillar mass. Chondrocytes inside the gel are a mixed population of spherical or polygonal cells. They frequently surround individual collagen fibrils with microvilli. On all three collagen scaffolds few autogen matrix is present and it is not evident that it is involved in cell adhesion.

Fig. 1. SEM images of Hyalograft®C, Novocart®, Biogide® and CaReS® transplants (bar = 20µm).

Discussion and Conclusions
The present study showed the favourable effect of scaffold fibers with a diameter somewhat smaller than the cell-diameter and a distance several times longer than a cell diameter. Those properties cause increased adhesion by the adaptation of the cell shape and prevent the dedifferentiated elongated cell shape. Optimal porosity of the scaffold (between 50 und 100µm) is important for a regular distribution of the cells during seeding and the subsequent migration.

Disclosures
There is no commercial conflict within the study.