USING POLYMERS: UTOPIA OR REALITY?

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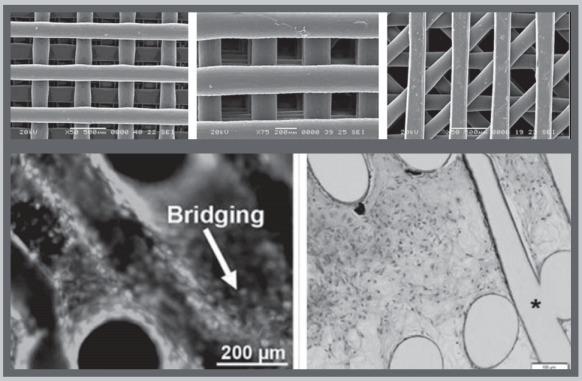
Introduction

Medicine has witnessed several revolutions in the last decade. New therapies as well as new drugs have been implemented in the medical practice at a high pace. One revolution witnessed includes the application of patient specific implants. The concept is straightforward. When a certain organ or part of it is malfunctioning, a medical imaging technique is applied to map the defect and its extent. Using an automated CAD CAM approach (Computer Aided Design - Computer Aided Manufacturing), a perfect copy of the original defect can be produced. In our laboratories, we have applied FDA approved poly-ε-caprolactone (PCL) as starting material for the production of 3D porous materials using the Bioplotter™ as rapid prototyping technique.

Materials and methods

From previous research on 2D PCL (M_w=80KDa, biomedical grade) spincoated on glass slides, it was evident that native PCL did not possess cell-interactive properties (towards osteosarcoma cells) while being non-toxic to cells. [1] To overcome this key limitation, a multi-step modification strategy compatible with 3D porous materials was elaborated on in the present work. The procedure was comprised of (1) a plasma treatment to introduce surface (hydro)peroxides, (2) the radical grafting of 2-aminoethylmethacrylate to introduce functional anchoring groups, (3) the bioconjugation of gelatin as biopolymer prime layer and (4) the application of a top layer (fibronectin, …) to fine-tune the biological properties. [1-3] The method was applied on 3D scaffolds fabricated with different lay-down patterns : 0/90°, 0/45° and 0/90° shifted pattern (0/90° S). To visualize cell adhesion and colonization on the scaffolds by MC3T3-E1 cells (mouse calvaria preosteoblast cells, ATCC), cell/scaffold constructs were evaluated using inverted contrast light and fluorescence microscopy (calcein AM stained cells) at various time points after cell seeding (750 000 cells/40 µl/47.71 mm^3 scaffold). The following parameters were quantified for the different scaffolds developed: cell seeding efficiency, cell adhesion, - proliferation, - colonization and - differentiation.



Results and discussion

The in vitro cell culture tests on the 3D scaffolds developed (see top figure aside) revealed a good cell adhesion on and infiltration throughout the entire 3D structure (see bottom figure aside for representative fluore-scence and optical microscopy images). Very interestingly, we were able to show that at least for the developed double protein coated PCL scaffolds, the scaffold coating overrules the scaffold design in terms of its osteogenic potential. During the presentation, quantitative data for various cell related phenomena (adhesion, colonization, differentiation) will be presented as well as the mechanisms and/or reasons underlying the observed findings.

Conclusions

In conclusion, we have applied PCL as an exemplifying case to proof the feasibility of seamlessly merging three key technologies with the aim to increase the human quality of life: (1) polymer (processing) technology, (2) polymer surface technology and (3) cell technology.

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References

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POROUS PLURONIC-BASED