Porous polyurethane scaffold for facilitating healing in critical sized bone defect

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INTRODUCTION:

Bone graft substitute is a continuously developing field in orthopedics. When compared to tradition biomaterial such as PLA or PCL, elastomer like polyurethane offers advantages in its high elasticity and flexibility, which can establish an intimate contact with surrounding bones. This tight contact can provide a stable bone-material interface for cell proliferation and ingrowth of bone. The aim of this study is to evaluate the osteogenesis capabilities of a porous polyurethane scaffold in a critical size bone defect.

METHODS:

In this study, a porous scaffold synthesized from segmented polyurethane is put under in vitro and in vivo testes to evaluate its potential in acting as a bone graft substitute for critical size bone defects. The scaffold is fabricated by an inverse phase salt leaching methods. Cell morphology and cellular response including proliferation profile and osteogenic properties was elevated. To elevate in vivo tissue response of polyurethane in bone, the same polyurethane scaffold is implanted into the artificial created bone defect of 3 months old NZW rabbits without any anchoring devices. The rabbits are sacrificed after 16 weeks from the operation.

RESULTS:

In vitro results indicate osteoblast-like cells are proliferating on the polyurethane scaffold during the 21-days experiment. Cells express their normal morphology when seeded on polyurethane under fluorescent staining. Although cells show a relatively lower cell activity then that seeded on culture plate, they share a similar alkaline phosphatase activity profile with the controls during the experiment period.

In the in vivo animal model, reconstructed images from micro CT scanning indicates there are bone ingrowth inside the scaffold. No dislocation of implantation has been observed and histology indicates there is a close contact between bone and the implant with the present of osteogenic cells on the surface.

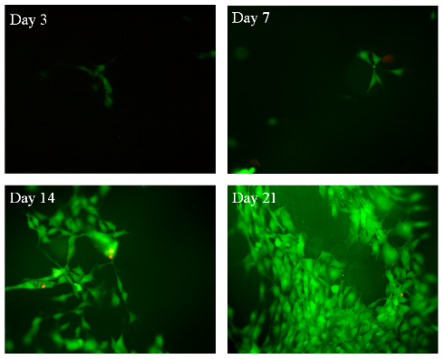

Fig. 1: Proliferation of MC3T3 pre-osteoblast on polyurethane coated on culture plates imaged under fluorescent LIVE/DEAD staining. A sudden boost of cell number was observed at Day 21 from cell seeding. This result was also confirmed under a MTT cell proliferation assay

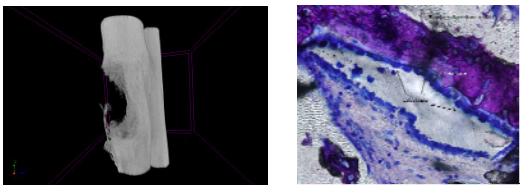

Fig. 2: Reconstructed images from micro CT scanning indicates there is bone ingrowth inside the scaffold after 16 weeks of the operation. Osteogenic cells with newly deposited bone can be found on the surface of scaffold.

DISCUSSION & CONCLUSIONS:

Experimental results indicate osteogenic cells are able to attach and proliferate on segmental polyurethane. In vivo animal model also indicates there are no dislocation of implants and the existence of calcified tissue inside the scaffold. We can conclude that Polyurethane scaffold carries the ability in acting as a bone graft substitute in critical size bone defect.

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