EPSRC supported PhD with Integrated Studies:

Tax free bursary £16,800 p.a. plus fees

Project title: Enhancing bone integration through the formulation of a new cell delivery device

Company title(s): ImplantCast

Location(s): Birmingham (UK)/Buxtehude (Germany)

Academic supervisor(s): Prof. Liam Grover and Prof. Martyn Snow *(University of Birmingham),* Prof. Lee Jeys (*Royal Orthopaedic Hospital)*

Company:

ImplantCast is an orthopaedics company with a turnover of 80m Euros per year, who focus on the development of orthopaedic devices to replace bone removed for the treatment of bone tumours. They also develop novel designs for more routine joint replacements, such as hips and knees.

Problem:

The treatment of many bone cancers in young adults and children require the removal of very large quantities of bone. In order to treat these defects, large bespoke implants are made, which restore the physical function of the original bone. Although this approach is widely used, the size of the implant means that failure can occur because of the large forces at the bone implant interface. One of the major reasons for failure is poor integration of the metallic prosthetic into the patient's skeleton. In order to avoid the use or reduce the size of these custom implants, frozen allograft (taken from cadavers) is often utilized. Due to the absence of a blood supply, these grafts are substituted only slowly with new bone and reossification occurs only a few centimeters into the graft. The areas of bone, which do not revascularise, develop microfractures due to mechanical strain and subsequently can fail with catastrophic fracture, which often will not heal, necessitating further major surgery. The formulation challenges that will be addressed include: *the development of a material with appropriate handling properties for use by surgeons; the development of a sterilization and packaging method for the device; and the collection of data to demonstrate the biological efficacy of the harvested cell fraction.*

Objective:

This project will develop a technology that will encourage bone growth over large surface areas of bone or metal. If better integration or biological covering of either bone or metal were possible, it would lead to reduced rates of infection, increased survivorship of the prosthesis and reduced fracture rates in allografts, which are major complications of these procedures. Enhanced bone growth will be facilitated using populations of mesenchymal stem cells that may be harvested from patients from adipose fat or bone marrow and concentrated in theatre. They are known to promote new bone formation, vascularity and fibrous ingrowth. This project will focus on the development of a technology that will allow for the isolation and subsequent delivery of osteogenic (bone forming cells) at the patient's bedside. The sorting process will be facilitated through the use of a material modified to facilitate the extraction of the these cells from the patient's bone and subsequently allow for the localized delivery of the resulting cell/material construct into the body.

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Training and opportunities:

We have previously demonstrated proof of concept using these materials for the delivery of populations of cells. In order to move this project to the next stage, it will be important to systematically formulate and characterize a fluid gel material such that it handles appropriately, maintains cell viability and may be packaged and sterilised without a deleterious influence on the properties of the cell delivery device.

Broadly, this project will focus on:

- The development of a material to allow for cell selection and delivery
- The development of packaging and sterilization methods
- Biological efficacy characterisation

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