European Cells and Materials Vol. 7. Suppl. 1, 2004 (page 3) ISSN 1473-2262

Clinical applications of surfaces: Keep it simple

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INTRODUCTION: Studying cell behaviour, morphology and adhesion on potential implant surfaces describes the surface cytocompatibility and gives a first indication as to the suitability for fracture repair applications. With long term or permanent orthopaedic implants osseointegration is vital to their success. Early soft tissue integration without liquid filled capsule formation is also important for internal fixation plates. Good vascularisation is imperative at the implant / tissue interface, especially for prevention of infection. In certain cases such as distal radius fractures where tendons have to glide over internal fixation plates, or in the cranio-maxillofacial area in orbital fractures tissue adhesion is undesirable. Bacterial adhesion to internal fixation implants is always undesirable. Microtopography is one of the fundamental factors controlling cell and bacterial adhesion and can be used simply to control this.

In this conference the participant will see a wide range of methods to improve cell reactions to surfaces *in vitro*, with some of the surfaces being tested *in vivo*. The participant will also see ways of reducing bacterial adhesion at biomaterial surfaces *in vitro*. There are several beautiful developments within this area that function well in static, non-loaded *in vitro* conditions. Not all will survive the severe test of *in vivo* situations where mechanical abrasion occurs during implantation and the time of use of the implant and the materials lie within the highly corrosive milieu within the body.

The first aim of this talk will be to show some simple examples of controlling tissue adhesion to surfaces which work both *in vitro* and are able to withstand the harsh *in vivo* conditions. Another aim of the talk will be to introduce the laboratory scientist to real examples of what happens to internal fracture fixation devices during surgical implantation.

The basic applied problem, still in 2004 eludes numerous scientists (as observed at the 7th World Biomaterials Congress in Sydney). Biomaterials are developed to help solve clinical problems. Without knowing the clinical problem how can one test a biomaterial for it's biocompatibility? One should look at the clinical problem first (the actual medical problem, repair or restoration method including surgical technique). One should then look at what material is available that may be able to be used to help this situation both biologically and mechanically, or possibly develop such a material. The material should be tested both *in vitro* (biologically and mechanically modelling the situation in which it will be used) considering it's strength for what it is to be used, and surface design. After *in vitro* biological and mechanical tests the implant design for the *in vivo* model should be considered and *in vivo* tests carried out. Many scientists are separated from the clinical problem and have a favourite material that they test *in vitro* and sometimes *in vivo* with no real idea what the clinical problem is and after several random tests that fit the current trend, look for a use it for 'their' material.

One must remember that in for example the case of orthopaedics a surface must be able to withstand the following:

- Sterilisation
- Storage time within the sterile packing material.
- Abrasion from the handling within the sterile packing material during transport etc.
- The surgeon's hands, most internal fracture fixation devices require large amounts of manipulation to the patient's anatomy.
- The highly corrosive milieu within the patient's body.
- Abrasive muscle, tendon or ligament movements upon the implant surface. Fretting particles produced should not be inflammatory.
- Time within the body to achieve the desired regeneration / repair.
- If the surface is a coating it should not delaminate from the bulk material and should not cause corrosion to the bulk material if it is to resorb.

There are many points to consider when designing a surface to help solve a clinical problem, but simple ideas usually are the most robust to the various stages of surgery and the healing process.