Nanostructure at Bone Cell/Material Interface

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The ultimate goal of the project is to develop biomimetic materials that possess the surface properties of normal tissue based on the hypothesis that these surfaces will induce a more normal biological response from cells that are grown on them.
Aim I. Determine if the micron scale, submicron scale and nanoscale structural features of bone surfaces following osteoclastic resorption are different in normal and osteoporotic bone.

Aim II. Develop a new Ti or collagen/HA biomimetic substrates exhibiting micron and submicron scale topography typical of normal and osteoporotic bone.

Aim III. Examine the nonstructural features at the interface of osteoblasts and biomimetic substrates exhibiting micron and submicron scale topography typical of normal and osteoporotic bone.
Aim I

GT has experienced more difficulty than anticipated in obtaining osteoclast-resorbed bone substrates and has only recently initiated the collaboration with MTF to resolve this problem.

Dr. Boyan has established a collaboration with Dr. MoonHae Sunwoo at the Musculoskeletal Transplant Foundation to provide us with human bone wafers that have been partially demineralized as a model of the bone surface following osteoclastic resorption. We are assessing bone cell response to these surfaces in addition to examining their surface structure features. The bone wafers are from normal adult bone, but future studies will use wafers from osteoporotic bone.
Decalcified rats cortical bone
Collagen and mineralized collagen
Aim II
We are developing scaffolds that possess the surface properties of bone tissue. We have prepared several scaffolds with electrospun nanofibers to mimic the collagen fiber structure of bone matrix.
Electrospinning

• Electrospinning is a simple and versatile method to produce fibrous structure with nanoscale to microscale dimensions from synthetic and natural polymers.
Alginate fiber SEM image of the alginate-hydroxyapatite composite and FTIR of mineral confirming it is hydroxyapatite
PLGA/HA
• Dr. Boyan prepared Ti disks using acid etching and electrochemical matching to form the submicron-scale surface structure. Then applied MG63 osteoblast-like cells on the Ti substrate to study the cell response. They finally found out that submicron-scale structures did modulate osteoblastic phenotype.

PMMA and TiP are dissolved in THF/DMF solvent

Fabricate the fibrous scaffolds by electrospinning

Calcine the samples to remove the organic compounds.
• Diameter: about 300nm
• Diameter: about 20 μm
Aim II

Dr. Boyan has assessed cell response to collagen/hydroxyapatite scaffold prepared using two different techniques (deposition of HA on the surface and integration of HA crystals into the collagen fibrils) and in two different formats (film and sponge). Our cell culture studies indicate that osteoblasts can discriminate between collagen films and sponges and the form in which mineral is presented to them. Fig 4 shows the results from an experiment assessing alkaline phosphatase activity in osteoblasts cultured on tissue culture polystyrene (insert), a type I collagen sponge (CS), a CS with hydroxyapatite precipitated onto the surface (CSHA), and a collagen sponge in which HA has been incorporated into the fibrillar structure (CSPILP). We are presently repeating these experiments with a second batch of scaffolds to validate our initial observations.
Alkaline phosphatase specific activity in cultures of MG63 osteoblast like cells grown on collagen substrates. Data are means ± SEM, N=6.
Aim III to be done

Problems

Facilities

Olympic Games

Communication
Thank You