【Grant-in-Aid for Young Scientists(S)】

Science and Engineering (Engineering Ⅱ)

Title of Project : Induction of bone tissue with oriented BAp crystallites by materials scientific approach based on anisotropy

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Research Area : Materials Science and Engineering

Keyword : anisotropy, bone quality, bone regeneration, bone cells, structural materials

【Purpose and Background of the Research】

Bone tissue exhibits anisotropic microstructure depending on the bone portion as shown in Fig.1, but the anisotropic tissue is not recovered even by using the most advanced technique for bone regeneration. In this study, we develop not only the analytical method of biological apatite, BAp, orientation as a bone quality parameter, but also the new technique to recover its anisotropic bone tissue in regenerated or pathological bones. A focusing point is that anisotropic bone microstructure is originally produced by bone cells. Thus, the suitable environment for the BAp arrangement will be finally proposed basically using the interaction among bone tissue, biomaterials and cells.

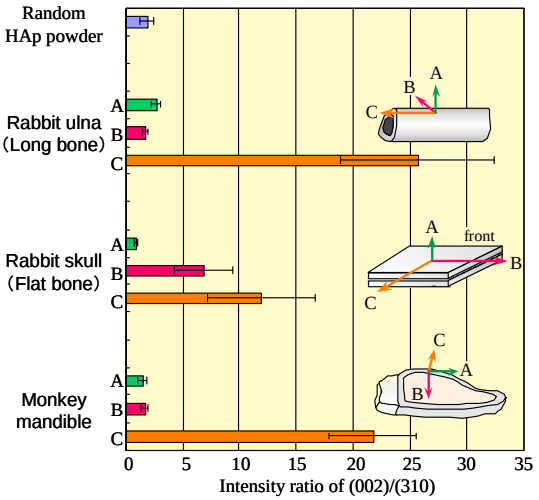

Figure 1 Unique alignment of BAp c-axis depending on the portion of mature cortical bone (T. Nakano et al., Bone, (2002))

【Research Methods】

Two projects will be performed for inducing regenerative bone tissue with oriented BAp.

(A) Development of new substrate materials

(1) Shape Design: control of motion of osteoblast by anisotropic hole and groove

(2) Materials Design: fabrication of zebra-type metallic biomaterials (Figure 2)

(3) Crystallographic Design: growth of single crystals and control of proliferation and differentiation of bone cells on them

(B) Control of preferential alignment of BAp based on Materials Scientific technique

(4) Control of Formation and Growth of BAp Nucleus: effect of small amounts of metallic elements on BAp precipitates in collagen

(5) Control of Applied External Field: control of bone cells under strain field

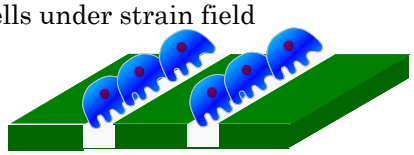

Figure 2 Schematic illustration showing arrangement of cells and BAp crystallites on lamellar alloys.

【Expected Research Achievements and Scientific Significance】

A combination of appropriate biomaterials design and the most advanced Materials Science is expected to control bone anisotropic microstructure. Not to mention the scientific development, this study will also achieve the new strategy of medical care from the viewpoint of bone quality. One of stems for "Materials Science Based on Anisotropy" which I am trying to establish will be finally obtained.

【Publications Relevant to the Project】

・T. Nakano, K. Kaibara, Y. Tabata, N. Nagata, S. Enomoto, E. Marukawa and Y. Umakoshi
Unique alignment and texture of biological apatite crystallites in typical calcified tissues analyzed by micro-beam X-ray diffractometer system, Bone, 31[4] (2002), pp.479-487.

・T. Nakano, T. Ishimoto, J.-W. Lee and Y. Umakoshi
Preferential orientation of biological apatite crystallite in original, regenerated and diseased cortical bones, Journal of the Ceramic Society of Japan, 116 (2008), pp.313-315.

【Term of Project】 FY2009-2013

【Budget Allocation】 81,000 Thousand Yen

【Homepage Address and Other Contact Information】

http://www.mat.eng.osaka-u.ac.jp/msp6/MSP6-HomeJ.htm
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