Inducement of Synovial Cartilage around Artificially-Induced Articular by Biomechanical Stimuli

Norio TSUTA

Katsunari NISHIHARA*

Department of Technology, Hiroshima University, Higashi-Hiroshima, Hiroshima 739-0046

*Faculty of Medicine, University of Tokyo, Bunkyo-ku, Tokyo 113-8655

In mammalian body there are seven kinds of articulation. What is the articulation? The answer is that different bone can be joint with movable part of bone with synovial fluid or fibrous tissue with the special skeletal system, i.e., cartilage or fibrous osseous tissue called the cementum. The authors find out through biomechanical investigations that all kinds of the articulation can be induced by biomechanical stimuli which are properly applied. In this paper femoral bones of xenopus are cut and repeated bending are applied on cut site of the femurs. After 2 month the specimens are recovered and observed microscopically. It can be observed morphologically that synovial articular cartilage is induced concomitant with the joint formation.

Key Words: Synovial Cartilage, Biomechanics, Articular, The skeletal System, Femur

INTRODUCTION

The gomphotic mammalian tooth system could be developed by the authors through biomechanical stimuli applied to artificial roots which were newly tailored made of sintered hydroxyapatite or titanium, on which repeated weak occlusal stimuli were applied. Around the artificial roots fibrous osseous tissue, i.e., the cementum as well as fibrous ligament, i.e., periodontal membrane and the alveolar bone proper were clearly induced. Through this developmental research on artificial root, the author recognized that the fibrous articular, i.e., periodontal membrane with cementum and the alveolar bone proper can be steadily induced by applying weak repeated occlusal loading immediately after implantation for 3 months to 10 months.

MATERIALS AND METHODS

Fifty xenopus were prepared for experiments. Twenty-five were operated on femurs. They were cut on middle by scissors. After that the femurs of xenopus were bent on operated site 30 times a day for 2 months. Twenty were raised for control, which are operated on the femurs but have no bending movement for 2 months. Five were raised without operation for complete control.

RESULTS

Five out of twenty-five were dead after operation for 2 weeks. One out of 25 operated control was dead and none out of 5 complete control was dead. Each fives out of 20 operated group as well as 24 operated control were recovered and specimens for histopathological observation. From the aspect of histopathological findings, cartilage formation with joint lumens are observed in experimental group. Bone as well as cartilage formation around the wound are observed without joint lumen formation in control group.

DISCUSSION

Through development of artificial bone marrow chamber made of sintered hydroxyapatite and TCP as well as Ti electrode, the authors verified the cause of morphological and functional evolution to be biomechanical stimuli, which evokes the action of organisms against the gravity force of the earth in terrestrialization, i.e., landing. The morphology of the vertebrates evolves in accordance with the Wolff's Law of functional adaptation of the skeletal organs (cartilage and osseous tissue). The os longum shrinks and hardens under repeated loading, of which the principal stress trajectories run according to longitudinal orientation. If the loading on the skeletons is over the remodeling speed of the skeletal tissues fractures occur on diaphysis. After that the organisms continuously moving around with fractured diaphysis, the fracture site can not fuse without rest of the wounds. Around the fuctrued site chondrocytes and fibrous tissues are derived from undifferentiated mesenchymal cells. In this way the wound of fructured diaphysis is organized accordingly to biomechanical stimuli. This is a genesis of the synovial joint in the evolution. The authors develop the experimental evolutionary research methods, in which causative biomechanical stimuli in evolutionary metamorphosis are applied to organisms at present. Artificial synovial anticulation can be easily induced by repeated biomechanical stimuli in this experimental evolutionary research method.

This research has been supported by a Grant-in-Aid for Scientific Research (A)(1)09309003 from the Ministry of Education, Science and Culture, Japan.