1. Title
FY2006 Ground-based Research Program for Space Utilization Research Report

2. Research Term
FY2006〜2008

3. Research Fields
Life Science

4. Research Categories
Exploratory Research for Space Utilization

5. Research Theme
Application of the new bioresorbable bone substitutes for prevention and therapeutics of excessive bone loss of the astronaut

6. Investigators
Tohru Ikeda*, Koji Ioku**, Kazuo Toda*, Yasuhiro Kumei***

7. Organization
*Nagasaki University, 1-7-1 Sakamoto, Nagasaki 852-8588, Japan
**Tohoku University, 6-6-20 Aramaki, Aoba-ku, Sendai 980-8579, Japan
***Tokyo Medical and Dental University, 1-5-45 Yushima, Bukyo-ku, Tokyo 113-8549, Japan

8. Summary of Research
We have developed β-tricalcium phosphate (β-TCP) and hydroxyapatite (HA), each of which composed of rod-shaped particles using applied hydrothermal methods. Recently, we also developed spherical β-TCP and HA granules composed of rod-shaped particles using a unique dropping slurry method. Eight-week-old female Wistar rats were anesthetized, a bone defect 2 mm in diameter and 3 mm in depth was created in distal end of the right femur of each animal, 30 mg of spherical β-TCP or HA granules composed of rod-shaped particles were implanted and the wound portion was sutured. Operated animals without implantation of spherical granules were used as a control. The right sciatic neurectomy was performed 2 weeks before euthanization. Four, 8, 12 and 24 weeks after implantation, animals were euthanized and operated bones were resected. Undecalcified bone tissue sections were made from the resected bones and analyzed histologically. In the animals without implantation, the amount of regenerated bone was smaller than the surrounding bone tissue. In the animals implanted with spherical granules, osteoconductivity of the spherical granules were very high and mosaic tissue composed of rod-shaped particles were implanted and the wound portion was sutured. Operated animals without implantation of spherical granules were used as a control. The right sciatic neurectomy was performed 2 weeks before euthanization. Four, 8, 12 and 24 weeks after implantation, animals were euthanized and operated bones were resected. Undecalcified bone tissue sections were made from the resected bones and analyzed histologically. In the animals without implantation, the amount of regenerated bone was smaller than the surrounding bone tissue. In the animals implanted with spherical granules, osteoconductivity of the spherical granules were very high and mosaic tissue composed of ceramic granules and newly formed bone were formed. Histological structures of mosaic hard tissue were not ruined even after 2 weeks unloading. Total amount of mosaic hard tissue was much larger than the surrounding bone tissue. Net bone volume in mosaic hard tissue tended to be larger than volume of newly formed bone in the control animals, but it was significant only in the animals implanted with spherical HA. However, in some portions of the implanted ceramic granules, composites composed
of bone tissue with ceramic particles were formed, and total amount of bone tissue in the animals implanted with spherical β-TCP was also thought to be larger than that of the control animals. Physical strength of mosaic hard tissue and composite was thought to be much higher than the original ceramics. Mosaic hard tissue with composite was thought to work as the bone especially in astronauts under low or microgravity because of the high osteoconductivity, probably high physical strength and biodegradability. Physical strength of mosaic hard tissue will be analyzed in the future.

Implanted with β-TCP granules Implanted with HA granules Without implantation
(a, c, e: 4 weeks after implantation; b, d, f: 24 weeks after implantation with 2 weeks of unloading)
*: the site of a bone defect

9. Publication List

10. URL