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学位論文名　Effect of implant surface roughness on bone fixation: the differences between bone and metal pegs

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# 論文内容の要旨

## INTRODUCTION

Bone pegs made from cortical bone are used to fix osteochondral fractures and osteochondritis dissecans. This technique has many advantages compared to nonbiological devices. However, bone pegs require long-term immobilization. Therefore, ways to accelerate the fusion between cortical bone pegs and cancellous bone are sought for early postoperative rehabilitation.

The surface roughness of metal implants improves the bone response and implant fixation, and the appropriate roughness has been determined empirically. Therefore, the surface roughness of cortical bone might affect biological fixation. This study examined the effect of surface roughness on fixation with bone and metal pegs.

## MATERIAL AND METHODS

Pegs with either rough or smooth surfaces were made of a cortical bone from Japanese black cattle or stainless steel (SUS316L). The arithmetic mean roughness of the rough surface was 15.0 μm, while that of the smooth surface was less than 0.6 μm. Pegs were inserted into holes made in the distal femurs of 34 rabbits. At the time of surgery and 14 days later, the stability of the implanted peg was measured using a tensiometer. The maximum value was defined as when the force reached a peak. Two-factor analysis of variance was used to investigate the variation in surface roughness and individual animals. In addition, micro-computed tomography and histological observations were performed to analyze the interface between the bone pegs and recipient bone.

## RESULTS AND DISCUSSION

At the time of surgery, although the push-out forces were less than 0.3N, the rough surface had a higher value than the smooth surface ($P$=0.0002). No difference was observed according to the material ($P$=0.54). 14 days after surgery, no significant difference was detected in the push-out forces between bone pegs with rough and smooth surfaces (489.0 ± 149.6 vs 478.3 ± 134.4 N (mean ± SD), $P$ = 0.52), while a marked difference was seen with the metal pegs (235.7 ± 115.7 vs 2.2 ± 1.6 N, $P$ =

0.0005). The bone pegs with rough surfaces made contact with the recipient bone at the high points on the abraded surfaces. After the mechanical tests, the fusion was broken within the new bone for bone pegs with rough or smooth surfaces, while no breakage occurred at the junction of bone peg and new bone.

We found no positive effect of bone peg surface roughness on accelerated bone fusion at 14 days after surgery, while the surface roughness of the metal pegs improved the push-out force dramatically. Morphologically, the bone pegs with rough surfaces made contact with the recipient bone through new bone at the high-points on the abraded surface, and regardless of surface geometry, the breakage between the bone peg and recipient bone after measuring the push-out force 14 days after surgery occurred within the new bone. Therefore, the stability at day 14 might be determined by biological influences, rather than the physical properties of the bone surface.

## CONCLUSION

The surface roughness of bone pegs has little effect on bone-to-bone fusion 2 weeks postoperatively, unlike the effect with metal pegs.