The application of a bioresorbable scaffold composed of hydroxyapatite and polylactide

Abstract of Doctoral Thesis

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In case of large bone defects, allografts are preferentially selected for reconstructive surgery because of their good mechanical strength and high osteoinductive potency. In this study, we used the frozen cortical allografts(FCAs) for the reconstructive surgery of patients with femoral nonunion. FCAs were successfully united to the host bone, resulted in excellent recovery of the locomotive function of the affected hindlimb. However, specific facilities are required to conduct FCAs, with a long period of time required for the FCAs to be completely substituted. To resolve the problem, we focused on using a bioresorbable material composed of hydroxyapatite (HA) and poly-L-lactide (PLLA). There has been much debate about potential acute aseptic swelling caused by PLLA during the extended follow-up period. However, aseptic swelling from using the HA/PLLA combination has not been documented. In this study, we inserted HA/PLLA screws and PLLA screws in the femur and observed the subject for 84 months. Subsequently, we evaluated the inflammatory reaction and substitution process of the screw hole. The results indicated that the PLLA screw caused severe histiocyte infiltration and did not facilitate substitution of the host cortical bone. In comparison, the HA/PLLA screw caused mild histiocyte infiltration. The material was united with the host bone, then, the screw hole was substituted to the host cortical bone. These results were considered to suggest that the bioresorbable material composed of HA and PLLA could act as an effective bioresorbable scaffold in reconstructive surgery.

However, HA/PLLA requires a long period to be completely absorbed. To enhance absorption, HA mixed with poly-D/L-lactide (PDLLA), which is the stereocomplex of PLLA and poly-D-lactide, has developed as a new bioresorbable material. The HA/PDLLA scaffold has a characteristics which can be transformed by heating and treated easily with a pair of scissors or a scalpel. We conducted a comparative study of the substitution process of the HA/PDLLA and β-TCP scaffolds in the unloading site. In addition, we compared the bonding strength between the HA/PDLLA and β-TCP scaffolds and the effect of heat-transforming treatment. We found that the substitution process of the HA/PDLLA scaffold was slower compared to that of the β-TCP scaffold; however, both scaffolds had similar bonding strength. At the bonding interface, both scaffolds directly united with the host bone. The heat-transforming treatment of the HA/PDLLA scaffold did not influence this process. Then, we conducted a comparative study of the substitution process between the HA/PDLLA and β-TCP scaffolds at the loading site. The HA/PDLLA scaffold showed similar bone formation and superior scaffold absorption and tissue infiltration compared to the β-TCP scaffold. Therefore, the performance of the HA/PDLLA and β-TCP scaffolds was similar. However, neither scaffold achieved complete substitution; therefore, it is necessary to continue the follow-up study to confirm complete substitution.