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Development of porous nano-zirconia scaffold for oral maxillofacial bone repair by the method of template replication

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Background: Searching for a qualified scaffold in bone tissue engineering for oral maxillofacial bone repair is still under research. A new kind of porous scaffold was prepared in our laboratory and this study was to determine whether the scaffold could offer a microenvironment for bone marrow stromal cells to grow.

Methods: Zirconia ceramic (ZrO_2) powders (3% Y_2O_3-97% ZrO_2, Tosoh, Japan) with nano-grain size were chose as the starting material and prepared to porous scaffold by the method of template replication method. Macro- and micro-structures of the scaffold were observed by SEM and micro-CT. X-ray diffraction analysis (XRD) was carried out to identify the phase composition of sintered nano-ZrO_2 scaffold under several basic temperatures from 1100 °C to 1350 °C. Hemolysis test was taken to evaluate the scaffold's biological safety. Canine bone marrow stromal cells (BMSCs) were isolated from the iliac crest of 1-year-old male beagle (purchased from Animal Experiment Center of Jingling Hospital of Nanjing military, China, license number: 0029943). Cells early adhesion and subsequent activity on nano-ZrO_2 scaffold was tested.

Results: Nano-ZrO_2 scaffold made by template replication method in our study presented complex porous structure with a well connected inner. It had a high porosity of about 92. 667±0. 324%. Its mean pore size was about 500-800μm, which was demonstrated to be beneficial for osteogenesis reported in other studies. The XRD spectrum exhibited that ZrO_2 scaffold remained a tetragonal phase in the temperature range from 1100 °C to 1350 °C. Value of the hemolysis test was 2. 19% (<5%), which meant that the scaffold was safe for biological experiment.

Cnanine bone marrow stromal cells (BMSCs) in our study were demonstrated to be successfully isolated and induced to osteoblasts, functioning osteogenesis. Cells could colonize the surface of the nano-ZrO_2 scaffold, bridge macro-porosity and proliferate on the scaffold. OD values taken by the method of MTT on day 1, 3, 6, 9, 12 were 0. 261, 0. 604, 1. 215, 1. 385, and 1. 506.

Conclusion: The three-dimensional nano-ZrO_2 porous scaffold made by the method of template replication in our study presented satisfactory physical structure and biocompatibility. It could offer a microenvironment for osteoblasts growth.

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