Microstructure of Titania Nanorod Arrays and its Cell Attachment

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Statement of Purpose: Titanium have been widely used as orthopedic implants due to their biocompatibility, excellent corrosion resistance and superior mechanical properties [1, 2]. Surface characteristic if the implant greatly influenced their bone-bonding ability. Recent research showed that nanoscale topography was an important factor to improve cellular recognition [3]. In this study TiO_2 Nanorod Arrays were fabricated by anodic oxidation technology on pure titanium in NH4F aqueous solution. The characteristic of the TiO2 Nanorod arrays were investigated by scanning electron microscopy (SEM) and X-ray Diffraction(XRD). the biological performances of TiO_2 Nanorod arrays were studied by Cellular experiments.

Methods: Commercial pure titanium was cut into square pieces of 10 × 10 mm2. Both sides of the specimens were first polished with sandpaper of 200, 600, 1000 grits gradually. After rinsed thoroughly with distilled water, the specimens were ultrasonicated in acetone, ethanol and distilled water, and then dried at room temperature. Then the samples served as the cathode were dipped into 0.5wt.% NH4F aqueous solution at room temperature for 30 minutes. Subsequently, the samples were washed with distilled water in an ultrasonic bath about 10 minutes and dried at 37 °C in air.

Microstructure of the sample was characterized by scanning electron microscope (SEM, Nova Nano SEM 430, Netherlands). The element content in the surface was determined by Energy Dispersive Spectrometer (EDS; INCA, Oxford, England).

Human bone mesenchymal stem cells (h-MSCs) were grown in DMEM (37 °C, 5% CO_2), the culture medium was refreshed every 48 h. All specimens were sterilized by epoxy ethane and put individually into a 24-well plate, and then cells were inoculated onto the 24-well plate (50000cells/10μl droplet culture). The specimens were incubated with cells at 37 °C for 24 h, then rinsed carefully with PBS to eliminate unattached cells and characterized by SEM to study the initial cell attachment.

Results: Figure 1 showed the surface microstructure of anodized titamim plate. The nanorod arrays were observed clearly, which firmly attached to the Ti substrate. The diameter and length of the nanorods are about 50 nm and 700 nm, respectively. The contents of the elements on the titanium were tested by EDS (Fig.2). The elements of Ti and O were present in the surface of titanium after anodization, which indicated that the phase of nanorod was titanium.

To investigate cellular behavioron the surface of nanorod arrays, two kinds of samples, such as nanorod arrays plate and Ti plate for control, were prepared. H-MSCs were simultaneity seeded on the surface of two kinds of samples. cells were observed attaching and spreading on the surface of materials. Only a few cells could be seen on controlled titanium (Fig. 2a) within one microscope field and the cell density on titanium surface was much lower than that on anodized titamim plate. Spindle-shaped cells were anchored tightly on the surface of Titanium nanorod arrays.

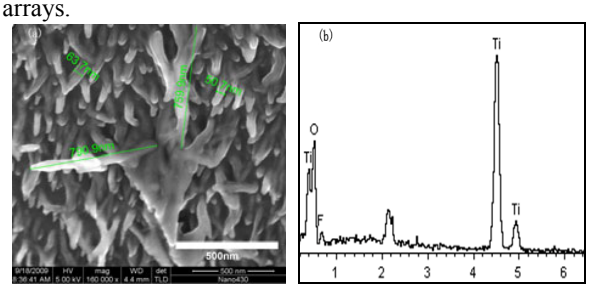

Fig.1. SEM micrographs and EDS spectra of the titanium after anodization

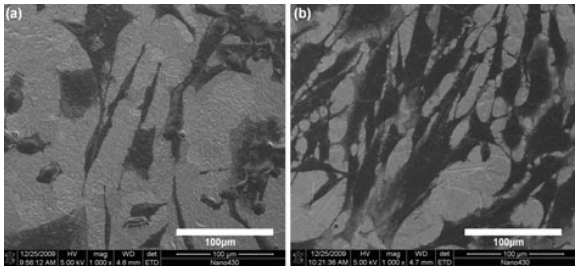

Fig.2. SEM micrographs of h-MSCs cultured on (a) Ti plate and (b) nanorod arrays plate for 24 h.

Conclusions: TiO_2 nanorod arrays were prepared by anodic oxidation technology in 0.5wt.% NH_4F aqueous solution. H-MSCs were tightly anchored on the surface of TiO_2 nanorod arrays, and the cell density on anodized titamim plate was much higher than that on titanium surface.

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