Electrochemical Behavior and Biocompatibility of Co-Cr Dental Alloys

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Abstract: In order to investigate electrochemical behavior and biocompatibility of Co-Cr dental alloy by electrochemical corrosion test and MTT assay, the xCo-25Cr-yW-zNi alloys were used in this study. Samples of Co-Cr-W-Ni alloys were manufactured using arc melting furnace. The microstructure of the alloys was examined by optical microscopy (OM), Field emission scanning electron microscopy (FE-SEM), energy dispersive X-ray spectroscopy (EDS), X-ray diffraction (XRD), MTT assay, and corrosion test. Corrosion resistance increased slightly as cobalt (Co) content increased. And bioactivity was concerned with nickel (Ni) and tungsten (W). Biocompatibility of Co-Cr alloy depended on Ni and W contents.

1. Introduction

Cast Co-Cr dental alloys are in use for many years for dental devices manufacturing and their bio-compatibility is well documented. Besides it has specific strength, and corrosion resistance as well as matching thermal expansion coefficient with the ceramics of metal-ceramic restorations. Co-Cr alloy possesses high strength due to tungsten (W) as powerful strengthening agents for these alloy while nickel (Ni) is concerned with ductility. Recently, demand of domestic removal partial denture (RPD) is increased by national health insurance coverage of RPD.

In this study, electrochemical behavior and biocompatibility of Co-Cr dental alloy by electrochemical corrosion test and MTT assay were investigated using various experimental instruments in order to compare with commercial Co-Cr alloy and xCo-25Cr-yW-zNi alloy on properties.

2. Experimental

Samples of Co-Cr-W-Ni alloys were manufactured using arc melting furnace. Each sample having 4 mm thickness was cut from the wire using a diamond cutting, and followed by polishing the Co-Cr disks with up 3μm Al_2O_3 slurry after all samples cleaning. The electrochemical potentiodynamic polarization studies for corrosion behaviors were carried out in 0.9% NaCl solution at 36.5 ± 1 °C using a potentiostat. A conventional three-electrode system with high-density graphite as counter electrode and saturated calomel electrode (SCE) as reference was used. The electrolyte was deaerated using high-purity Ar gas for 30 min before starting the experiment. Deaeration was continued at a uniform rate during the experiment. The potentiodynamic polarization test with a scan rate of 1.67 mV s^{-1} was carried out from −1500 mV to 2000 mV. The crystallinity and morphology of surface were examined by OM, FE-SEM, EDS, and XRD. Briefly, cells (1 x 10^5 per well) were seeded into 24-well plates. After drug treatment, 3-(4,5-dimethylthiazol-2-yl)-2, 5-diphenyl-tetrazolium bromide (MTT) solution (5 mg/mL in PBS) was added, and cells were incubated at 370C for 3h. The culture medium was then aspirated, and acid isopropanol (0.04 mol/L hydrogen chloride (HCl) in isopropanol) was added to dissolve the dark blue crystals. The optical density value of the dissolved solute was then measured using a Microplate Autoreader (Bio-Tek Instruments Inc., Winooski, VT) at a wavelength of 540 nm.

3. Conclusion

Corrosion resistance increased slightly as cobalt (Co) content increased. And bioactivity was concerned with nickel (Ni) and tungsten (W). Biocompatibility of Co-Cr alloy depended on Ni and W contents.

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