The influence of nano-metric roughness of Ti-6Al-4V on the initial cell adhesion force

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Introduction:

In the application of biomaterials, cell responses play an important role in the tissue-implant interface for long term behavior of implant fixation. Recently, some studies use cell culture to investigate the effect of surface roughness of implants on bone cell response[1-3]. Most of these studies suggest that the roughness of implant surfaces would alter cell proliferation, differentiation and matrix production in vitro at later culture stage. This study aims at investigating the effect of nanometric roughnesss of Ti-6Al-4V alloy on the inital cell adhesion forces.

Methods:

Titanium alloy disks are prepared by wet grinding with grit silicon carbide paper and polishing with Al_2O_3 powder to the surface roughness with Ra values of 2.31, 3.67, 4.65, 9.52, 18.31 and 28.02nm, respectively. After polishing and cleaning, each specimen is passivated by 400℃ air for 45 min. The sterilized disks were placed in 24-well culture plates. Murine NIH-3T3 fibroblasts were cultured on the disk for 3 hours. The cyto-detacher consists of four components as shown in Fig. 1. The system is sealed inside a plastic chamber that maintains 5% CO_2 at 37°C. The maximal deflection at the cantilever's tip was identified by sequenced images. Then, the adhesive force was estimated using Hooke's Law

Results and Discussion:

Measurements of static contact angles are shown in Fig. 2. It is observed that the wettability dscends in the order of surface roughness. The nanometric roughness of Ti-6AV-4V would influence the wettability in this study. Figure 3 shows the correlation between surface roughness and cell adhesion force. The initial cell adhesive force of fibroblasts ranges from 0.055μN to 0.193μN for samples of six different nanometric roughness. The result indicates that the specimens with rougher surface would show the higher cell adhesion force at the nanometric scale. Figure 4 shows the correlation between wettability and cell adhesion force. The result indicates that the specimens with the higher contact angle would show the lower cell adhesion force.

Conclusion:

This study indicates that nanometric roughness affect not only the wetability but also initial cell adhesion forces.

Reference:

1. B. G. Schreiber and R. S. Tuan, J. Cell Sci., 1992;101: 209.
2. Martin JY et al., J Biomed. Mater. Res., 1995;29:389.
3. Schwartz Z et al., J. Biomed. Mater. Res., 1996;30:145.

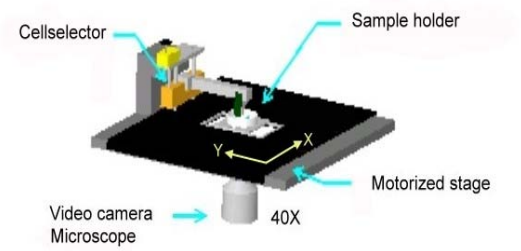

Figure 1. Major components of the cytodetachment apparatus

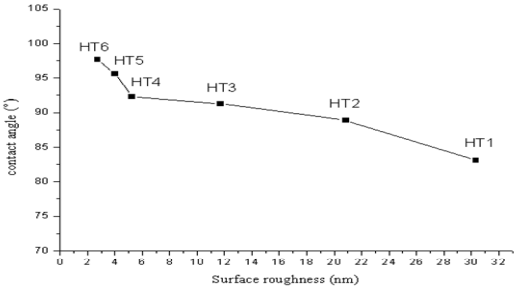

Figure 2. The correlation between surface roughness and wettability.

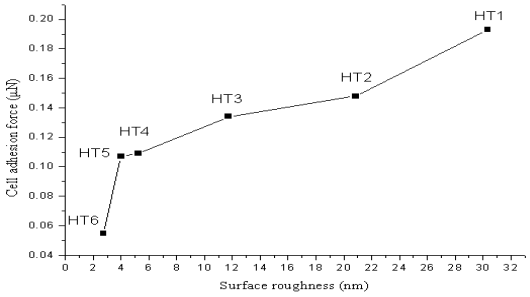

Figure 3. The correlation between surface roughness and cell adhesion force

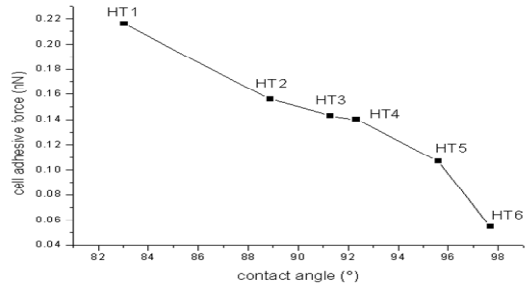

Figure 4. The correlation between wettability and cell adhesion force