

# Improving Quality of Life through Reducing Post-operative Bacterial Infections

CY Yeung<sup>1</sup>, LH Li<sup>2</sup>, KWK Yeung<sup>1</sup>, RYT Kao<sup>3</sup>, D Yang<sup>2</sup>, KDK Luk<sup>1</sup>

Corresponding Author: KMC Cheung<sup>1</sup>

<sup>1</sup>Department of Orthopaedics and Traumatology, The University of Hong Kong, Hong Kong <sup>2</sup>Department of Chemistry, The University of Hong Kong, Hong Kong <sup>3</sup>Department of Microbiology, The University of Hong Kong, Hong Kong

## Introduction

Metallic implants such as titanium alloy have been widely used in orthopaedic surgeries<sup>1</sup>. 2-5% of the patients acquire post-operative bacterial infections at implant site though prescription of antibiotics<sup>2</sup>. Patients may suffer from surgeries like debridement of wound, removal of problematic implant and insertion of new implant.

To reduce bacterial infections and improve quality of life of patients, implant surfaces loaded with antibiotics<sup>3</sup>, TiO<sub>2</sub><sup>4</sup>, Ag or Cu ions<sup>5</sup> were developed. None has been successful due to durability or compatibility of released ions to surrounding tissues. We therefore aim to develop a biocompatible surface with antibacterial functions by incorporating novel peptide onto the Ti alloy surface.

## Materials and Methods

**Materials Fabrication** 5mm diameter medical grade Ti-6Al-4V discs were mirror polished, oxidized to Ti-OH<sup>6</sup>, then converted to Ti-OSi-(CH<sub>2</sub>)<sub>3</sub>-NH<sub>2</sub><sup>7</sup>. Novel peptide (patent pending) was then covalently incorporated onto the Ti surfaces.

**Biocompatibility Evaluation** In the osteoblast adhesion test, 4,000 green fluorescent protein osteoblast from mice were applied on each sample and incubated at 37°C for 10hrs. The adhered cells were examined under fluorescent microscope.

In the MTT assay, 30,000 MC3T3-E1 pre-osteoblast cells were applied on each sample and standard MTT procedures were conducted to evaluate the cytotoxicity at 36hrs. Absorbance values of cells attached on culture wells and medium without cells serve as the positive and negative controls. Independent-samples t test was applied to evaluate the statistical difference.

**Antibacterial Activity Assessment** Samples were incubated with 10<sup>5</sup> *Staphylococcus aureus* cells at 37°C for 30min. The adhered bacteria were fluorescent stained and the density of live bacteria on the treated surfaces were compared with the untreated controls.

## Results

### Osteoblast adhesion test

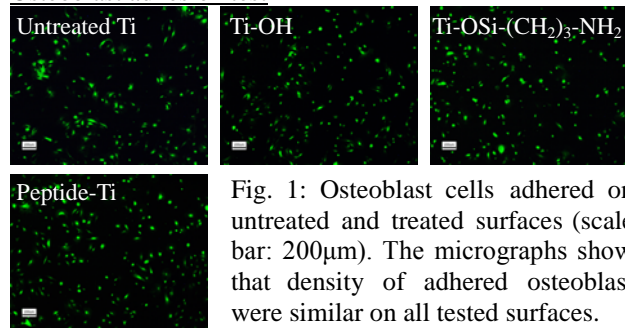


Fig. 1: Osteoblast cells adhered on untreated and treated surfaces (scale bar: 200µm). The micrographs show that density of adhered osteoblast were similar on all tested surfaces.

### MTT assay

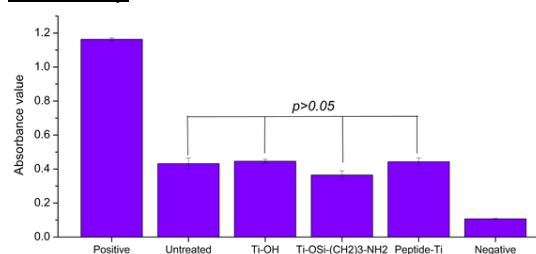


Fig. 2: MTT results of untreated and treated surfaces. No significant difference exists between all treated and untreated surfaces. This indicates a lack of cytotoxicity in the intermediate linker and the final peptide surfaces.

### Antibacterial test

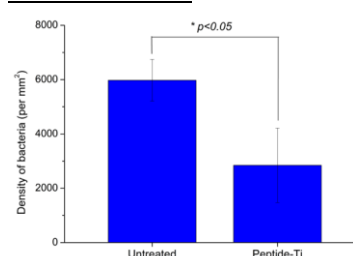


Fig. 3 Density of bacteria attached on untreated and peptide treated surfaces. The density of bacteria on the peptide-Ti surfaces was significantly different from the untreated control. The incorporation of novel peptide reduced bacterial adhesion by 52%.

## Discussion and Conclusions

We successfully improve the antibacterial activity of a biocompatible surface by 52% through incorporating novel peptide. This surface treatment is potentially useful as it reduces bacterial infections and thereby encourages proper functioning of the implants. With fewer chances of getting infected, we improve the quality of life of patients.

## References

- <sup>1</sup>Bruni S, et al. *Acta Biomaterialia* 1, 223, 2005.
- <sup>2</sup>Darouiche RO. *The New England Journal of Medicine* 350, 1422, 2004.
- <sup>3</sup>Radin S, et al. *Biomaterials* 28, 1721, 2007.
- <sup>4</sup>Chung CJ, et al. *Surface and Coatings Technology* 202, 1302, 2007.
- <sup>5</sup>Wan YZ, et al. *Vacuum* 81, 1114, 2007.
- <sup>6</sup>Chu CL, et al. *Materials Science and Engineering: A* 417, 104, 2006.
- <sup>7</sup>Martin HJ, et al. *Langmuir* 23, 6645, 2007.

## Acknowledgments

HKU Seed Funding for Basic Research, HK Research Grants Council General Research Fund #124009, Innovation and Technology Fund ITS#342/09 & AO Foundation Research Fund S-09-75Y

**Disclosures** The corresponding author is past chair of AO Spine Research Commission, board member of Scoliosis Research Society & chair-elect research council of Scoliosis Research Society, receives research support from Synthes & Ellipse Tech. Ltd.