Effect of Surface Roughness on Bacterial Adhesion to Different Dental Implant Collar Surfaces

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Introduction

Dental implant collars were historically manufactured with smooth surfaces to facilitate easy cleaning and to minimize plaque formation[1]. More recently, implant collar designs have incorporated textured regions that claim to promote osseointegration or soft tissue attachment, depending upon implant placement. However, this increased roughness may promote bacteria attachment if placed supracrestally, which has the potential to lead to peri-implantitis and marginal bone loss[1,2]. The purpose of this study was to characterize the roughness of different implant collar surfaces and correlate these findings with bacterial adhesion.

Methodology

Four different implant collar surfaces (machined titanium, grit-blasted titanium, acid etched titanium, and laser-microtextured titanium were characterized. Surface roughness (Sa - Absolute Mean Height Deviation) was quantified via an interferometric surface mapping microscope (KLA-Tencor Model MICROXAM-EX100). Bacterial adhesion was quantified by incubating implant collars in tryptic soy broth containing bacteria (Escherichia coli (ATCC 25922) for 24 h (n=6). Following, abutments were washed in PBS to remove non-adhered bacteria and incubated for 2 h in broth containing Microbial Viability Assay Kit (WST, Dojindo). Samples were then collected and the absorbance was analyzed at 490 nm and 650 nm (Synergy HT, Biotek). Bacteria-containing samples were then fixed in 4% PFA, dehydrated, and Au-coated for Scanning Electron Microscope (FESEM) (JEOL Model JSM-7500F, Tokyo, Japan). Statistical analysis used a one way ANOVA and Tukey's test (α=0.05).

Results

Interferometry of the four different surfaces demonstrated differences in surface topography and roughness (**Table 1**).

Table 1. Roughness of Implant Collar Surfaces

	Surface	Sa Value
a –	Machined Titanium	0.15 ± 0.01 μm
b –	Acid-etched Titanium	0.69 ± 0.03 μm
c –	Grit-blasted Titanium	0.92 ± 0.07 μm
d –	Laser-Etched Titanium	3.77 ± 0.21 μm

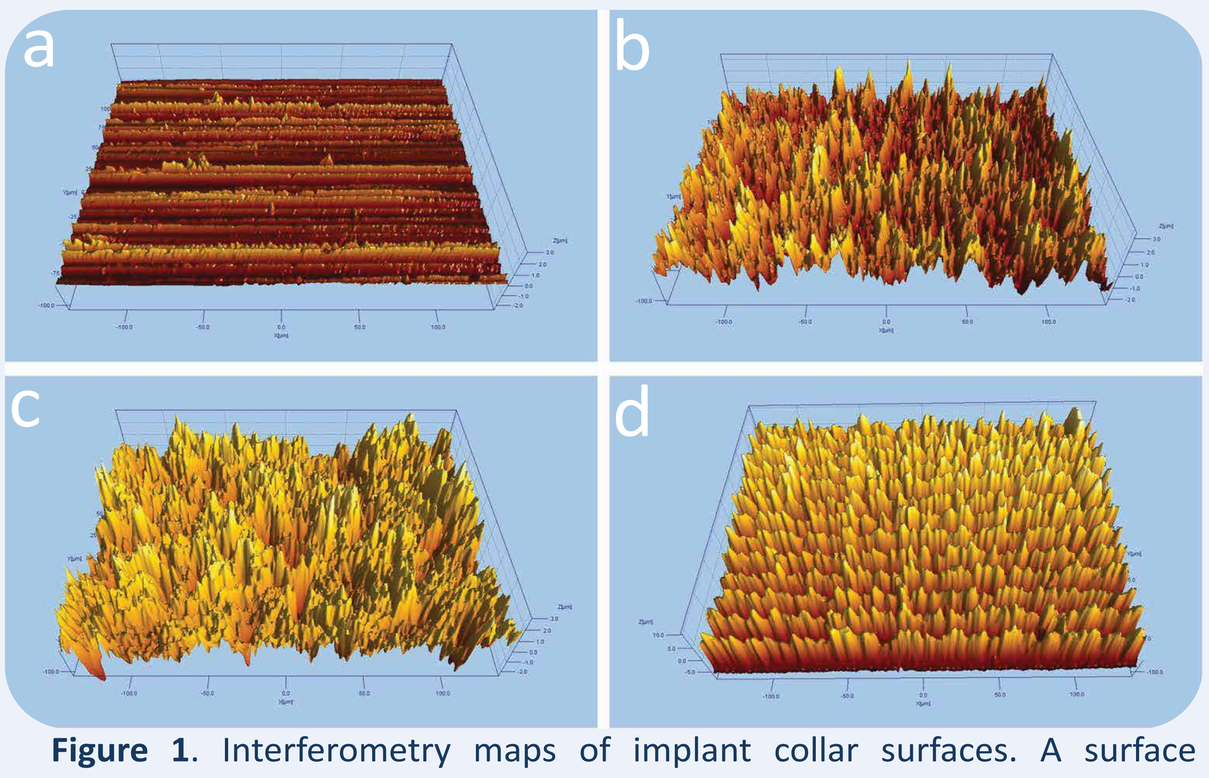


Figure 1. Interferometry maps of implant collar surfaces. A surface mapping microscope was used to quantify the roughness of (**a**) machined, (**b**) acid-etched, (**c**) grit-blasted, and (**d**) laser-etched titanium surfaces.

Quantification of bacteria adhesion demonstrated that there was a significant increase of bacteria on the laser-etched surface compared to the machined and acid-etched surfaces. SEM images confirmed that the bacteria aggregated in the rougher regions in contrast to the smooth surfaces.

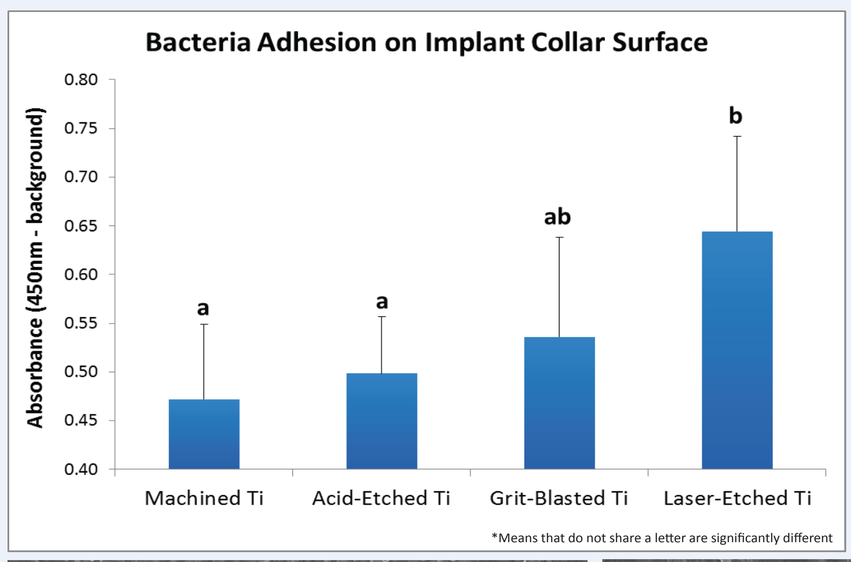
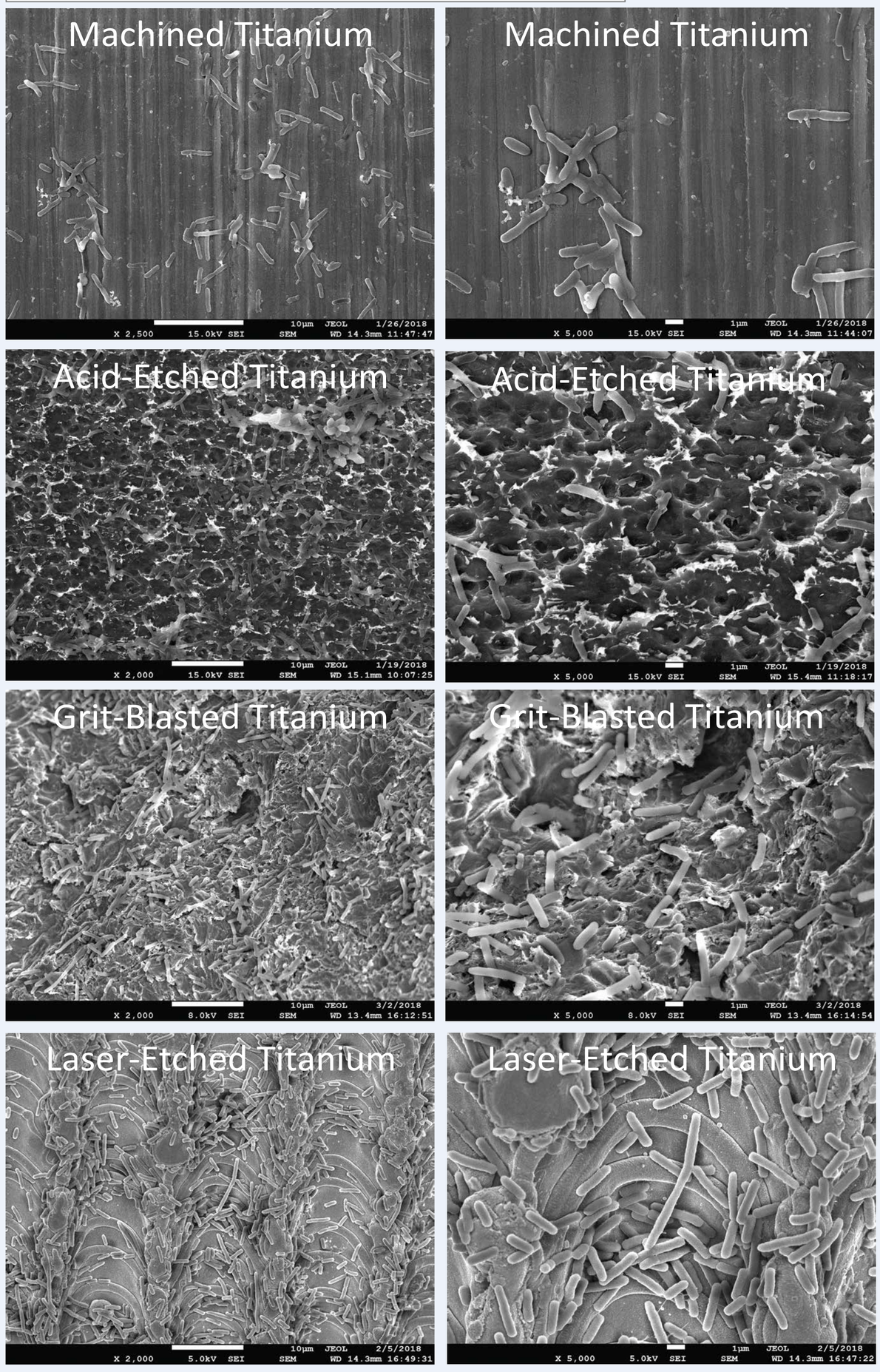


Figure 2. Bacteria adhesion on implant collar surfaces. Implant collars were incubated in bacteria-containing broth for 24 h. Following, the total amount of bacteria that adhered to each surface was quantified.



Conclusion

While previous work has largely focused on the surface properties of the implant body for increased osseointegration, the aim of this study was to evaluate the implant collar. Significant variability in surface roughness was observed across the different implant collar surfaces due to the different manufacturing processes. Significant differences in bacterial adhesion were observed on the different implants. There was an observed correlation between the roughness of a surface and the amount of bacteria that adhered.

References

1. Albrektsson T, Wennerberg A, **Oral implant surfaces: Part 1: review focusing on topographic and chemical properties of different surfaces and in vivo responses to them**, Int J Prosthodont. 2004 Sep-Oct;17(5):536-43.
2. Koldsland OC, Scheie AA, Aass AM. **Prevalence of Peri-Implantitis Related to Severity of the Disease With Different Degrees of Bone Loss**. *J Periodontology*. 2009, 81, 231-238.