

Biofilm Affecting the Mechanical Integrity of Implant-Abutment Joints

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Purpose: This in vitro study evaluated the effect of biofilms on abutment torque loss and wear of implant internal connection surfaces. **Materials and Methods:** Morse taper abutments were torqued to corresponding implants and then the implant-abutment assemblies were immersed in a biofilm medium for 72 hours. After detorque evaluation, the abutments were removed and the inner implant surfaces were observed via scanning electron microscopy and profilometry. **Results:** The removal torque values and the implant damaged areas decreased after contact with biofilms. **Conclusion:** The lubricating effect of biofilms decreased the friction between contacting surfaces, negatively affecting the mechanical integrity of the implant-abutment connection. *Int J Prosthodont* 2016;29:381–383. doi: 10.11607/ijp.4759

Dental implant-abutment connections are established on torque application resulting in high friction of the contacting surfaces. Plastic deformation and wear occur on the abutment screw threads and inner implant surfaces during tightening or occlusal loading. Abutment removal may be indicated during treatment, depending on clinical and esthetic needs. Wear and fatigue can significantly modify the inner implant surfaces, leading to microgap size changes and mechanical integrity loss.¹

Acidic substances from biofilm metabolism promote a decrease in pH that can induce corrosion of the structural materials.² Contrariwise, biofilms composed of glycoproteins, microorganisms, and extracellular components act as lubricants and decrease the friction between contacting surfaces, negatively affecting

the mechanical integrity of implant-abutment connections. The aim of this in vitro study was to evaluate the effect of biofilm on abutment torque loss and morphologic wear of implant internal connection surfaces.

Materials and Methods

Ten Morse taper implant systems were assessed in this study (Table 1). The implants were placed in a metallic holding device. Morse taper abutments were tightened to the dental implants by torque application at 15 Ncm, according to the manufacturer's recommendations, using a digital handheld torque meter (TQ-8800, Lutron). The torque meter was attached to a holder device to avoid oblique loads during the measurements.³

The implant-abutment assemblies were placed in 24 well plates containing 2 ml brain heart infusion BHI medium and 5 µl diluted human saliva that was incubated at 37°C under microaerophilic conditions (5% CO₂) for 72 hours. The human saliva was collected from four participants ranging from 20 to 31 years of age. The participants were in good dental and oral health, with no antibiotic treatment history during the previous 6 months.

After removal torque evaluation, the abutments were removed to evaluate the morphologic aspects of the implant internal connection surfaces. The samples were then analyzed by scanning electron microscopy (SEM). After SEM analyses, the Morse taper implants were cross-sectioned to assess the implant inner surfaces by optical profilometry (DektakXT, Bruker). The arithmetic roughness (Ra) and the maximum distance from peak to valley (Rt) were measured at

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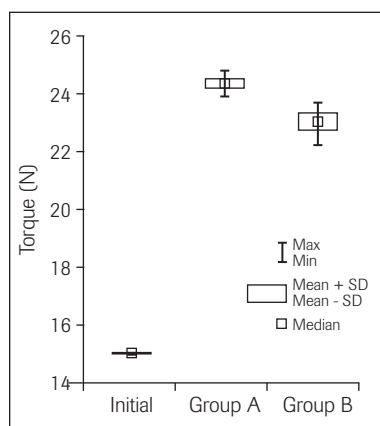
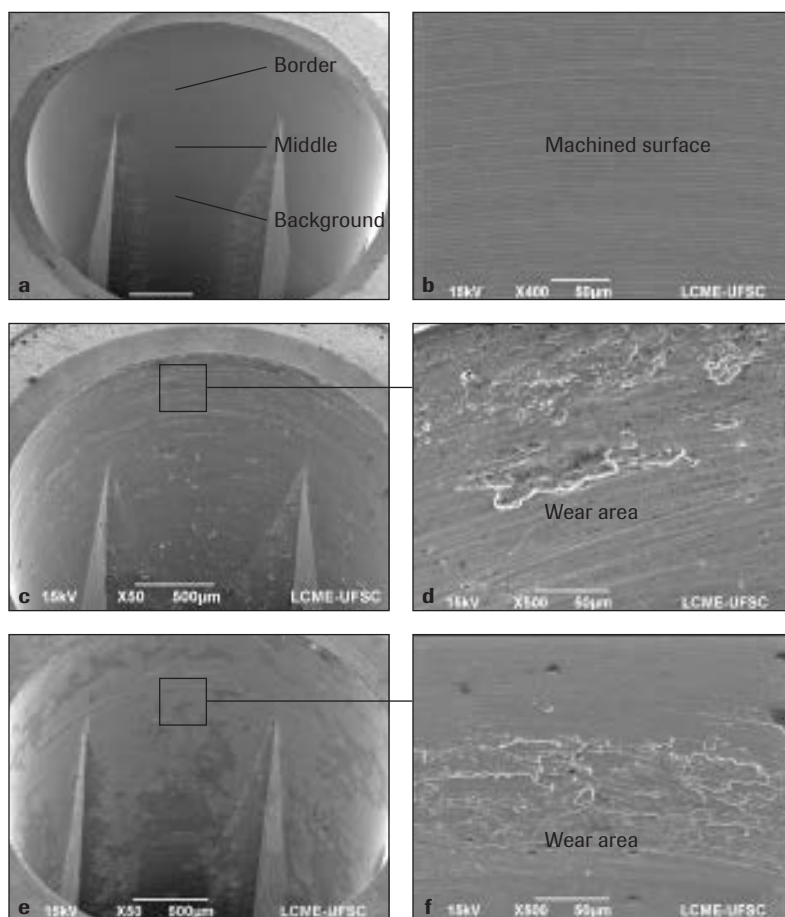
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Table 1 Specifications of the Dental Implant Systems Used in this Study (n = 10) and Test Environment

Group	Implant	Dimensions (mm)	Environment effect
A	Titamax CM (Neodent)	Abutment: $4.5 \times 4 \times 1.5$	At room environment
B		Implant: 4.0×1.3	After immersion in biofilm medium

**Fig 1** (left) Mean and SD for detorque values of Morse taper abutments without and after contact with biofilms grown for 72 hours.**Fig 2** SEM micrographs of the Morse taper implant obtained by secondary electrons (SE) mode at 15 kV. **(a)** Before connection at $\times 40$ magnification. **(b)** Before connection at $\times 400$ magnification. **(c)** After connection with no contact with biofilm at $\times 50$ magnification. **(d)** After connection with no contact with biofilm at $\times 500$ magnification. **(e)** After contact with biofilms grown for 72 hours at $\times 50$ magnification. **(f)** After contact with biofilms grown for 72 hours at $\times 500$ magnification.

three Morse taper regions (border, middle, and apical background). The results were statistically analyzed by Kruskal-Wallis and Mann Whitney test, with a significance level of $P < .05$.

Results

Mean removal torque values were statistically lower among the implant-abutment assemblies that had had contact with biofilms (group B) than those that were free from biofilms (group A) (Fig 1).

Plastic deformation and abrasion marks on the inner implant surface were detected by SEM analyses, as seen in Fig 2.

The mean roughness values recorded on the implant Morse taper connection surfaces (border and apical areas) after contact with the biofilm in group B were higher than those in group A (Fig 3).

Discussion

The present study reported the abutment torque loss and the damage to implant internal connection surfaces after immersion in a biofilm medium. The tightening and removal of the titanium alloy abutments resulted in abrasion, plastic deformation, and increased roughness of the corresponding implants based on commercially pure titanium. Such wear in the implant connections occurs because the titanium alloy structures possess higher mechanical strength, elastic modulus, and hardness than that on commercially pure titanium.

Nevertheless, microgaps between abutment and implant or between abutment and crown are susceptible to biofilm accumulation.⁴ The biofilm can decrease the friction of implant-abutment contact surfaces due to the presence of biologic macromolecules such as proteins, lipids, polysaccharides, and microbial cells.⁵ Furthermore, corrosive substances from biofilms

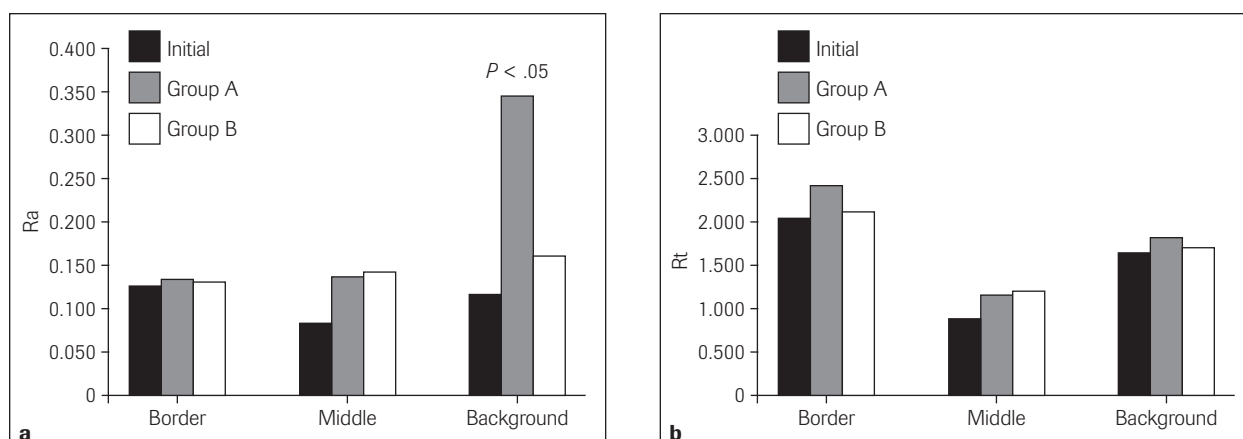


Fig 3 Mean values of the arithmetic roughness **(a)** and the maximum distance from peak to valley **(b)** for each region of the inner implant connection surfaces.

can accumulate in the microgaps, causing corrosion of the metallic surfaces. Corrosion degradation in a biologic system, by itself, may amplify the material loss leading to loosening of the mechanical integrity of the implant-abutment connection.

Conclusions

The main outcome of this in vitro study was the noticeable decrease in torque mean values on implant-abutment connections after immersion in a biofilm medium. However, the damage to the internal connection of the implants was reduced after contact with the biofilms. These results suggest that biofilms have a lubricating effect that decrease friction between contacting surfaces. This can lead to the loosening of the mechanical integrity of the implant internal connections.

Acknowledgments

The authors reported no conflicts of interest related to this study.

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Literature Abstract

A Prospective Cohort Study on Poor Oral Hygiene and Pancreatic Cancer Risk

This prospective study examined the role of oral health in pancreatic cancer development in Uppsala County in central Sweden. A total of 19,924 patients from a population-based prevalence study of oral diseases performed between 1973 and 1974 were followed up through links with the Swedish Cancer and Total Population registers. Number of teeth, dental plaque, and presence of oral lesions were recorded at baseline. Hazard ratios (HRs) and 95% confidence intervals (CIs) for pancreatic cancers were estimated using Cox proportional hazard regression models after adjusting for tobacco use. A total of 126 pancreatic cancer cases were identified during an average 28.7-year follow-up. Subjects with fewer teeth at baseline appeared to have an increased risk for pancreatic cancer, though this finding was not statistically significant (HR 1.4, 95% CI: 0.8, 2.5). Subjects with high plaque scores had twice the risk for pancreatic cancer (HR = 2.1, 95% CI: 1.0, 4.6). Individuals with Candida-related or denture-related oral mucosal lesions or tongue lesions had a 70%, 30%, or 80% higher risk for pancreatic cancer, respectively. Furthermore, individuals with all three oral mucosal lesions had three times the risk of pancreatic cancer. In conclusion, poor oral hygiene seems to be a moderately strong risk factor for pancreatic cancer. However, further studies are required to investigate potential underlying mechanisms and to identify pathogens and other factors related to dental plaque and oral mucosal lesions.

Huang J, Roosaar A, Axéll T, Ye W. *Int J Cancer* 2016;138:340–347. **References:** 52. **Reprints:** Jiaqi Huang, MSc, Department of Medical Epidemiology and Biostatistics, Karolinska Institutet; Box 281, 17177 Stockholm, Sweden. Fax: +46 8 31 4975. Email: Jiaqi.huang@ki.se —Teo Juin Wei, Singapore