Low hydroxyl group surface density as an explanation of lower bacterial adhesion on porous alumina

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INTRODUCTION: Bacterial adhesion depends on surface materials[1]. Recently it was suggested that ceramic-on-ceramic bearings could be less prone to infection than other bearings[2]. We examined the possibility that porous alumina ceramic could be less susceptible to bacterial adhesion. As hydroxyl groups (OH) on material surface are a major factor governing the surface properties (for example: adsorption, first non-specific step of bacterial adhesion), we hypothesized that alumina had lower OH group density than other material. Thus, we asked i) if bacterial adhesion was lower on alumina than on titanium alloy, stainless steel and polyethylene and ii) if OH group density was also lower on alumina.

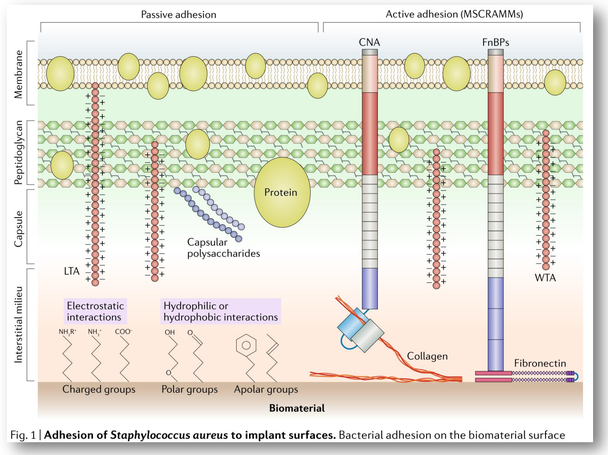
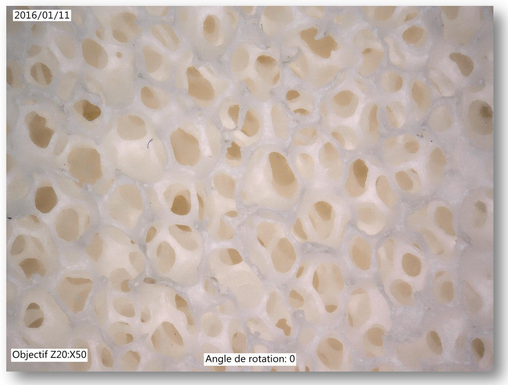


Fig. 1 | **Adhesion of *Staphylococcus aureus* to implant surfaces.** Bacterial adhesion on the biomaterial surface

METHODS: we performed

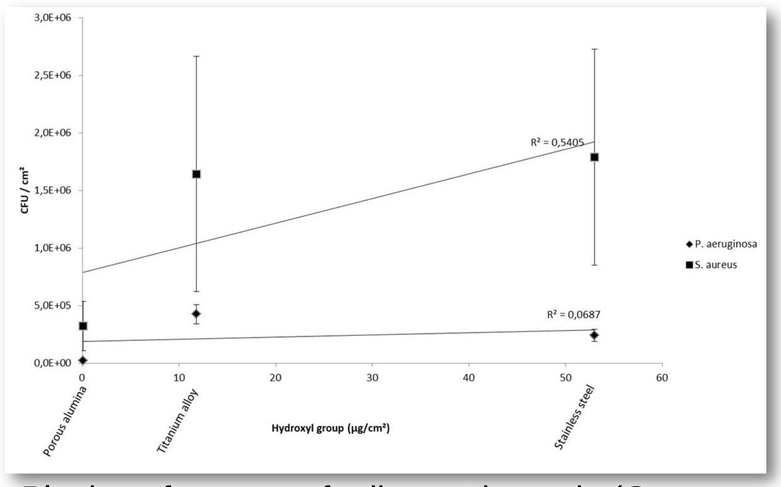
i) *in vitro* bacterial cultures on porous alumina, titanium, stainless steel and polyethylene using *Staphylococcus aureus* and *Pseudomonas aeruginosa*, known to adhere to surfaces. Bacterial cultures were done 3 times in duplicate for each material and each strain. Colony Forming Units (CFU) per cm² were measured.

ii) Neutral red reagent helped obtaining OH density estimates using spacer arms. UV visible spectrophotometry method with Neutral red test, reproduced twice for each surface, provided µg/cm² measurements of OH density.



RESULTS:

- There was significantly less *P. aeruginosa* adherent on porous alumina (2.25x104 CFU/cm²) than on titanium (4.27x105 CFU/cm², p=0.01), on stainless steel (2.44x105 CFU/cm², p=0.02) and on polyethylene (7.29x105 CFU/cm², p<0.001). *S. aureus* was significantly less adherent on porous alumina (3.22x105 CFU/cm²) than on polyethylene (5.23x106 CFU/cm², p=0.01), but there was no difference with titanium (1.64x106 CFU/cm², p=0.08) and stainless steel (1.79x106 CFU/cm², p=0.1).
- There was significantly lower Neutral red grafted on porous alumina (0.09 µg/cm²) than on titanium (8.88 µg/cm², p<0.0001), on stainless steel (39.8 µg/cm², p=0.002) and on polyethylene (4.5 µg/cm², p<0.01).
- However, no correlation was found between bacterial adherence and OH group density.



Plotting of amount of adherent bacteria (*S. aureus* and *P. aeruginosa*) according to hydroxyl group density

Pseudomonas aeruginosa adhesion

Staphylococcus aureus adhesion

DISCUSSION & CONCLUSIONS: Bacterial adherence on porous alumina was lower than on other bearings. Although there were less surface OH groups on porous alumina, we failed establishing a statistical correlation between bacterial adherence and OH group density.

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