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THE EFFECTS OF A MICRO-CURRENT ON BACTERIAL ADHESION.

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INTRODUCTION: Infection around implanted biomaterials in humans is a major healthcare issue and current ability to effectively prevent and treat such infections using antibiotics is limited. The hypothesis of the study was that surface charge could be manipulated to a positive state and thus moderate bacterial adhesion to the implant. The surface charge was manipulated by creating a galvanic cell using a zinc strip in a standard suction drain.

METHODS: A reference slime producing *Staphylococcus epidermidis* and *Staphylococcus aureus* were used in this study. Bacteria were freshly grown to a concentration of 1`x 10^8 cfu/ml. 2mm stainless steel and titanium Kirschner wires (Stratec Medical) were cut into 50mm segments and the cut ends mechanically polished to a 1&m finish prior to sterilization.

Metals were inoculated for fifteen minutes in the bacterial solution. Samples were rinsed in phosphate buffered saline (PBS). Metals were then cultured in 50ml of RPMI with l-glutamine for 24hrs. Samples contained a 50 x 3.2 mm segment of surgical drain with or without a 0.5 x 50mm strip of 99.99% purity zinc.

At twenty-four hours the samples were removed and rinsed in PBS. Samples were then placed in 10ml PBS and sonicated for 5min. Quantification was by serial log dilution technique on pre-poured Colombia Blood agar culture plates. Plates were incubated at 37^0 C and examined at twenty-four hours and again at 48 hours.

Adult male Wister rats were used in the *in-vivo* study. Prepared 1mm by 25mm Kirchner wires were inoculated in the method previously described. Retrograde femoral nailing was carried out after sacrifice of the extensor mechanism. A 1cm drain, with or without a 1cm zinc strip, was inserted along the medial border of the femur. Animals were necropsied at 24 hours and the implant retrieved. This was then subjected to the same procedures as the *in vitro* experiments. Results were tabulated on an Excel spreadsheet. As only one variable exists a students t-Test was used for the purpose of statistical analysis.

RESULTS: *In vitro* studies initially looked promising with an 88% reduction in *Staphylococcus aureus* adhesion to stainless steel and a 36% reduction in adhesion to titanium in the *in vitro* studies. The adhesion of *Staphylococcus epidermidis* to stainless steel however demonstrated a log increase of 1.81 ± 1.12 *in vitro*. Similarly. adhesion to titanium was increased by a log factor of 1.80 ± 0.12.

In vivo studies *Staphylococcus aureus* showed a reversal of its' *in vivo* activity. There was a log increase of 1.56± 0.09 in adhesion to titanium. The most striking results were from *Staphylococcus epidermidis*. It was impossible to generate an *in vivo* infection on the control implants. The mean bacterial contamination for the active group was 2.4 x 10^5 ± 2.3 x 10^5 on the stainless steel implant. Only minimal contamination of the titanium implants by epidermidis was possible. The presence of a zinc strip in the surgical drain generated a log increase of 3.97± 0.10 in adherent bacteria in this case.

DISCUSSION & CONCLUSIONS: This study shows a very powerful effect of a micro-current on bacterial adhesion to metallic implants. While not clinically viable, it raises a number of very interesting issues for consideration. Firstly, Barium is a divalent atom with a structure similar to zinc. It is also used widely in surgery as a marker in surgical drains and some types of orthopaedic cement. Work is ongoing to see if any effect can be demonstrated by Barium in proximity to metallic implants. Secondly, it is possible to reverse the electrochemical potential using elements with a more positive Galvanic number. This may have an opposite effect and produce a clinically viable implant.

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