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Persistence of a bioluminescent *Staphylococcus aureus* strain on and around degradable and non-degradable surgical meshes in a murine model

Seyedmojtaba Daghighi [a], Jelmer Sjollema [a], Valery Jaspers [c], Leonie de Boer [c], Sebastian A.J. Zaat [c], Rene J.B. Dijkstra [a], Gooitzen M. van Dam [b], Henny C. van der Mei [a,*], Henk J. Busscher [a]

[a] Department of Biomedical Engineering, W.J. Kolff Institute, University Medical Center Groningen, University of Groningen, Antonius Deusinglaan 1, 9713 AV Groningen, The Netherlands
[b] Department of Surgery, Division of Vascular Surgery, University Medical Center Groningen, PO Box 30 001, 9700 RB Groningen, The Netherlands
[c] Department of Medical Microbiology, Center for Infection and Immunity Amsterdam (CINIMA), Academic Medical Center, University of Amsterdam, Amsterdam, The Netherlands

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ABSTRACT

Biomaterials are increasingly used for the restoration of human function, but can become infected as a result of peri- or early post-operative bacterial contamination, although biomaterial-associated infections (BAIs) can also initiate at any time from hematogenous spreading of bacteria from an infection elsewhere in the body. Infecting bacteria in BAIs not only seek shelter in their own protective biofilm matrix, but also hide in surrounding tissue. This study compares staphylococcal persistence on and around a degradable and non-degradable surgical mesh through the use of longitudinal bioluminescence imaging in a murine model, including histological evaluation of surrounding tissue after sacrifice. Surgical meshes were first contaminated with bioluminescent *Staphylococcus aureus* Xen29 and subsequently subcutaneously implanted in mice. Bioluminescent staphylococci persisted on and around non-degradable meshes during the 28-day course of the study, whereas bioluminescence returned to control levels and bacteria disappeared from surrounding tissues once a degradable mesh had fully dissolved. Thus the application of degradable biomaterials yields major advantages with respect to the prevention of BAIs, as dissolution of the implant not only is associated with elimination of the protective biofilm mode of growth of the infecting organisms, but also allows the immune system to clear the surrounding tissue from infecting organisms.

1. Introduction

Biomaterials are increasingly used for the restoration of function after trauma, wear or intervention surgery and as a result the number of biomaterial-associated infections (BAIs) is rising [1]. BAI often results from peri- or early post-operative bacterial contamination of the implant or wound site, but BAIs can initiate at any time from hematogenous spreading of bacteria from an infection elsewhere in the body. A BAI involves bacteria adhering in their so-called biofilm mode of growth, a form of community growth through which adhering bacteria envelope themselves in a protective layer of extracellular polymeric substances [2,3]. As a consequence, neither the host immune defence nor standard antibiotic treatments suffice to eradicate biofilms from a biomaterial implant surface, and often an infected implant has to be replaced.

Surgical meshes are used worldwide for the reconstruction of abdominal wall defects. Surgical meshes can be made of non-degradable materials such as polypropylene [4] or degradable materials such as porcine small intestinal submucosa [5]. Recently [6], surgical meshes with different morphologies and made of different non-degradable materials have been compared with respect to their infection resistance in a murine model. Using bio-optical imaging, it was found that the bioluminescence arising from implanted surgical meshes, contaminated with a bioluminescent *Staphylococcus aureus* strain, was higher and persisted longer on multifilament polypropylene and polytetrafluoroethylene meshes than on monofilament polypropylene, polyester and Ti-coated meshes.

Although the presence of a biofilm growing on a biomaterial surface has long been considered the sole cause of BAIs, it has become increasingly apparent that the presence of a biomaterial impairs the host's immune defence [7–10]. In fact, degradable materials for surgical meshes in reconstructive abdominal wall surgery have been developed because of the reported long-term risk of infection and patient morbidity when non-degradable materials are used [5,11]. A rapid restoration of the efficacy of the immune system may be anticipated once the biomaterial has been fully degraded, despite the fact that bacteria may remain

* Corresponding author. Tel.: +31 503633140; fax: +31 503633159.
E-mail address: h.c.van.der.mei@umcg.nl (H.C. van der Mei).

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