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Journal
Journal of Visualized Experiments, 2020(160)

ISSN
1940-087X

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Publication Date
2023

DOI
10.3791/60560

Peer reviewed

J Vis Exp
2020 Jun 23;(160).
doi: 10.3791/60560.

In vivo Mouse Model of Spinal Implant Infection

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- PMID: 32658180
- DOI: 10.3791/60560

Abstract

Spine implant infections portend poor outcomes as diagnosis is challenging and surgical eradication is at odds with mechanical spinal stability. The purpose of this method is to describe a novel mouse model of spinal implant infection (SII) that was created to provide an inexpensive, rapid, and accurate in vivo tool to test potential therapeutics and treatment strategies for spinal implant infections. In this method, we present a model of posterior-approach spinal surgery in which a stainless-steel k-wire is transfixed into the L4 spinous process of 12-week old C57BL/6J wild-type mice and inoculated with 1 x 10^3 CFU of a bioluminescent strain of Staphylococcus aureus Xen36 bacteria. Mice are then longitudinally imaged for bioluminescence in vivo on post-operative days 0, 1, 3, 5, 7, 10, 14, 18, 21, 25, 28, and 35. Bioluminescence imaging (BLI) signals from a standardized field of view are quantified to measure in vivo bacterial burden. To quantify bacteria adhering to implants and peri-implant tissue, mice are euthanized and the implant and surrounding soft tissue are harvested. Bacteria are detached from the implant by sonication, cultured overnight and then colony forming units (CFUs) are counted. The results acquired from this method include longitudinal bacterial counts as measured by in vivo S. aureus bioluminescence (mean maximum flux) and CFU counts following euthanasia. While prior animal models of instrumented spine infection have involved invasive, ex vivo tissue analysis, the mouse model of SII presented in this paper leverages noninvasive, real time in vivo optical imaging of bioluminescent bacteria to replace static tissue study. Applications of the model are broad and may include utilizing alternative bioluminescent bacterial strains, incorporating other types of genetically engineered mice to contemporaneously study host immune response, and evaluating current or investigating new diagnostic and therapeutic modalities such as antibiotics or implant coatings.