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SYMPOSIUM

Percutaneous Window Chamber Method for Chronic Intravital Microscopy of Sensor–Tissue Interactions

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Abstract

Background:

A dorsal, two-sided skin-fold window chamber model was employed previously by Gough in glucose sensor research to characterize poorly understood physiological factors affecting sensor performance. We have extended this work by developing a percutaneous one-sided window chamber model for the rodent dorsum that offers both a larger subcutaneous area and a less restrictive tissue space than previous animal models.

Method:

A surgical procedure for implanting a sensor into the subcutis beneath an acrylic window (15 mm diameter) is presented. Methods to quantify changes in the microvascular network and red blood cell perfusion around the sensors using noninvasive intravital microscopy and laser Doppler flowmetry are described. The feasibility of combining interstitial glucose monitoring from an implanted sensor with intravital fluorescence microscopy was explored using a bolus injection of fluorescein and dextrose to observe real-time mass transport of a small molecule at the sensor–tissue interface.

Results:

The percutaneous window chamber provides an excellent model for assessing the influence of different sensor modifications, such as surface morphologies, on neovascularization using real-time monitoring of the microvascular network and tissue perfusion. However, the tissue response to an implanted sensor was variable, and some sensors migrated entirely out of the field of view and could not be observed adequately.

Conclusions:

A percutaneous optical window provides direct, real-time images of the development and dynamics of microvascular networks, microvessel patency, and fibrotic encapsulation at the tissue–sensor interface. Additionally, observing microvessels following combined bolus injections of a fluorescent dye and glucose in the local sensor environment demonstrated a valuable technique to visualize mass transport at the sensor surface.

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Abbreviations: (E-collar) Elizabethan collars, (LDF) laser Doppler flowmetry, (nA) nanoamperes, (NIH) National Institutes of Health, (PLLA) poly-L-lactic acid

Keywords: glucose sensor, microcirculation, PLLA, porous, window chamber

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