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Abstract View

EX VIVO ASSESSMENT OF TISSUE DAMAGE DUE TO NEUROPROSTHETIC DEVICE INSERTION

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Potential benefits of neuroprosthetic devices are currently challenged by biological reactive responses that interfere with the brain-machine interface. Reactive responses begin immediately upon insertion; however, the contributions of insertion parameters (e.g., size, shape and speed) to damage are not known. We have developed an *ex vivo* system that permits collection of time-lapse video images of tissue deformation during device insertion, by labeling the vasculature within live coronal slices. Using this model we compared devices with three tip shapes and three different insertion speeds. Video images revealed several kinds of vascular damage, including displacement of luminal contents, breakage, rupture, and vessel dragging. These may all cause collateral damage to the surrounding nervous tissue. Damage to transcerebral arteries at times occurred over 100 μm from the insertion site, suggesting that initial damage to the neurovasculature may greatly impact the extent of the reactive responses. Surprisingly, cortical surface features were one of the most influential factors affecting insertion damage; attempts to insert devices through pial blood vessels resulted in severe compression. It was not uncommon to see pial vessels being dragged or pushed into the neural parenchyma. Algorithms for automated image analysis were developed to permit tracking of up to 100 interest points within each tissue sample during a single insertion. These measures permitted calculations of tissue deformation and maximum and effective strains achieved during insertion. Tip shape and speed of insertion appeared to have independent effects. Three distinct deformation patterns have been identified based primarily on insertion rate. The results of this study will help guide future design of neural prosthetic devices and provide new insights for establishing safe insertion conditions.

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