Tissue growth and its maintains in sterility of recording chambers for primate neurophysiology

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Abstract

A standard technique for collecting neurophysiological data in the monkey entails daily transdermal penetrations with one or more electrodes through a craniotomy encased in a cylindrical chamber. The chamber limits the exposure of the infection-prone tissue to airborne bacteria. Infections of the dura mater endanger the health of experimental animals, delay experiments, and promote the growth of scar tissue; therefore we developed a method to further reduce the exposure of the dura mater to pathogens. The maintenance of the sterility of craniotomies for serial acute neurophysiological recordings is exacting and time consuming yet is vital to the health of valuable experimental animals. We have developed a method to seal the craniotomy with surgical grade silicone elastomer in a hermetically sealed chamber. Under these conditions the tissues in the craniotomy and the inside surface of the chamber remain unpopulated by bacteria. The silicone elastomer sealant retarded the growth of granulation tissue on the Dura and reduced the procedures required to maintain ideal conditions for neurophysiological recordings. When the dura is exposed, a small amount (0.1–0.5ml) of transudate leaks into the craniotomy. Transudate results from capillary permeability and osmotic pressure and contains nutrients such as sugars and amino acids that favour the development of bacteria. Bacteria introduced into this fluid find an ideal milieu for growth and cause a local infection that can spread and cause meningitis. The first sign of this event is the presence of exudate in the recording chamber, a latescent fluid that contains high concentrations of white blood cells and inflammatory mediators. We have filled the craniotomy with sterile silicone elastomer that cures without emanating toxic fumes and forms a precise "plug" of the craniotomy. To prevent the inside of the chamber from being populated with bacteria, we mounted O-rings on either the chamber or chamber lid. The Kwik-Sil silicone elastomer received from the manufacturer is packaged in a dual-syringe applicator. A protective cap is removed from the dual-syringe and a sterilized mixer tip is attached. The two liquid components are ejected simultaneously from the syringe and mixed automatically by baffles inside the tip as they enter the chamber. The components flow easily into the chamber, filling the small spaces. The preparation and administration of the silicone elastomer requires 1 minute. The curing time is 2–3 minutes at room temperature. We gas-sterilize the mixer tips to ensure that the silastic that is ejected into the chamber is free of bacteria. After the silicone elastomer cured, the chamber was hermetically sealed with a lid that fitted over the O-ring. Within one week of the surgery, the animal was sedated and the chamber lid was removed to verify the integrity of the silicone elastomer seal. If no fluid was detected in the chamber, the seal was left untouched for several months until the animal was trained for neurophysiological experiments. In cases where fluid is found in the chamber, the old seal is removed, the chamber is washed and dried, and a seal is applied. The chamber is checked in 24 hours. If fluid is found again, this process is repeated until the chamber is dry indicating a tight seal. If/when no fluid is found, the chamber is checked on a weekly basis. Typically, 1–2 days are required to obtain and verify a secure seal. The occurrence of a new seal leak was rare. Leaks occurred only when insufficient silicone elastomer was applied or when the application omitted a 2–3mm region along the walls of the chamber.