

A Novel Mounting Device For Attaching Intracranial Probes To The Skull For Use In Experimental Research Models

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Abstract

A simple mount capable of securely holding a variety of intracranial probes to the skull was constructed from commonly available clinical consumables. Using this device the cerebral cortical blood flow of preterm lambs was measured using a laser Doppler flow probe, and cerebral pH and cortical electrical impedance were measured in newborn piglets using pH electrodes and Ag/AgCl wire electrodes. In both studies, the mount held the various probes for periods up to 6 h with no dislodgement or probe failure. The simple mount presented here can be adapted to a wide variety of intracranial probes and will hold them securely to the skull.

Keywords: intracranial probe; laser Doppler flow; skull; brain; electrode; animal disease models

1. Background

Physiological research frequently requires mounting intracranial probes rigidly to the skull. While some probes come with specially designed mounts, many do not. Additionally many of these probes are not designed for use in small animals and a large percentage of the probe must remain, unsupported, above the skull. This added weight makes stabilizing the probe difficult. We present a simple universal mount that is easily constructed from readily available clinical consumables.

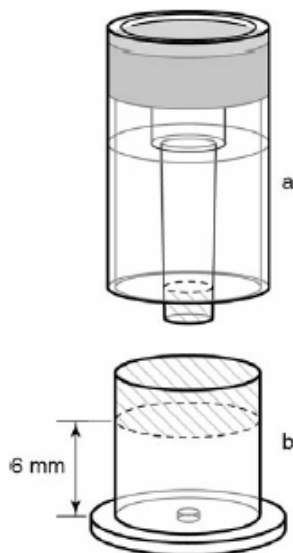


Figure 1. Removal of the luer tip from the injection site (a) and trimming of the luer-loc adapter (b).

2. Methods

2.1. Intracranial probe mount

The mount was constructed from the normally discarded component packed with a universal luer-loc adapter (figure 1(b), Tufflink, Becton

Dickinson, Sandy, UT, USA) and an injection site (figure 1(a), Maersk Medical, Sydney, NSW, Australia). A hole with a diameter suitable for the introducer needle (see below) was drilled centrally in the face of the luer-loc adapter. Using a sharp hobby knife the luer tip was removed from the injection site (figure 1(a)) and approximately 2 mm of plastic was removed from the luer-loc adapter, leaving 6 mm (figure 1(b)). Both components were then de-burred and glued together using silicone sealant (e.g., Selleys roof & gutter sealant, Padstow, NSW, Australia).

Use of the completed mount is shown in figure 2. A hypodermic needle with a bore sufficient to accommodate the probe is introduced through the hole in the bottom of the mount (a) and brought out through the centre of the injection site bung. The probe is placed down the bore of the needle (b) and the needle is carefully withdrawn (c) leaving the probe held snugly by the injection site bung and protruding just beyond the mount. The completed assembly is placed on the exposed skull bone with the probe tip going through a predrilled hole in the skull. The assembly is then cemented in place with bone cement or dental acrylic. Once the cement is dry, the probe can be advanced the desired distance into the brain.

2.2. Experimental use

We used the skull mount in two unrelated experiments. Both of these animal studies were approved by The University of Queensland Animal Ethics Committee.

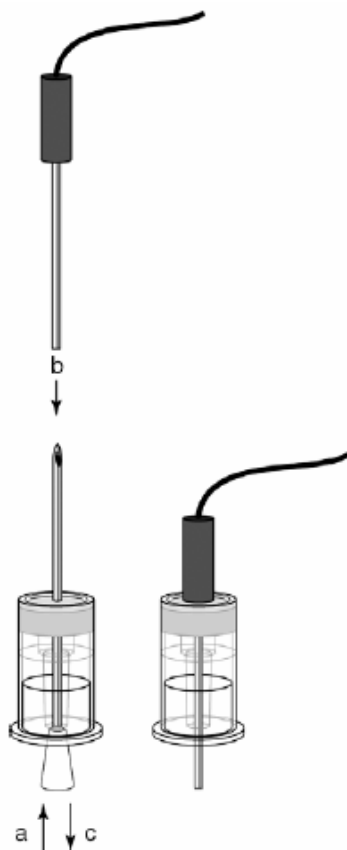


Figure 2. A needle is introduced through the hole in the bottom of the mount (a). The probe is placed down the bore of the needle (b) and the needle is carefully withdrawn (c).

In the first study, laser Doppler probes of diameters 0.5 mm and 1.0 mm (Oxford Array, Oxford Optronix, Oxford, UK) were used to measure laser Doppler flow in the cerebral cortex of preterm lambs. The study was to assess changes in cortical cerebral blood flow with different modes of mechanical ventilation. In the second study, 21G pH electrodes (Microelectrodes Inc., Bedford, NH, USA) and Ag/AgCl wire electrodes (1 mm diameter) were used to measure cerebral pH and cortical electrical impedance in newborn piglets. The study was to investigate responses to cerebral hypoxia.

3. Results

Fifty laser Doppler probes were mounted on the skulls of 50 preterm lambs. The probes were *in situ* for a mean of 3 h (range 0.7–4.1 h), with 74% of probes in place for over 3 h. In none of the 50 was the probe dislodged and there were no occurrences of poor signal quality. In each of ten newborn piglets one pH electrode and two impedance electrodes were

held in place—the probes remained *in situ* for at least 6 h. In none of the ten piglets was the probe dislodged and there were no occurrences of poor signal quality.

4. Discussion

We have developed a simple mounting device to attach intracranial probes to the skull for use in experimental studies. We have demonstrated its usefulness in attaching laser Doppler flow probes, pH electrodes and Ag/AgCl wire electrodes. In addition to these probes the mount could also be used with a variety of microdialysis, sampling catheters, intracranial pressure monitors and other probes. The flange on the luer-lok adapter allows reliable cementing of the assembly to the skull. With any set-up for a given probe, the probe can be inserted at a uniform distance from the skull surface, thus allowing reproducibility of probe placement.

The mount is cheap, easy to construct and provides a high degree of protection to fragile probes. By using different brands and sizes of injection sites the overall length of the device can be varied to accommodate probes of differing lengths and allowing differing penetration into the brain.

The maximum outside diameter of the hypodermic needle used for the introduction of the probe is determined by the internal diameter of the luer fitting and this is approximately 3 mm. Therefore, the maximum outside diameter of a probe able to be used with this set-up will be approximately 2.5 mm. We propose that the technique may be modified for even larger probes by replacing the luer fitting with a rubber septum and replacing the luer-lok adapter with a section cut from the matching plastic vial. These septa and vials are used in blood auto-samplers and are readily available at low cost (examples are the Greiner Bio-One VACUETTE plastic blood collection tubes, Greiner Bio-One Ltd, Gloucestershire, UK; and the BD Vacutainer plastic blood collection tubes, Becton, Dickinson & Company, Franklin Lakes, NJ, USA).

Using the mount with fragile probes requiring introducers would be more difficult, but may be accomplished if 'peel-away' needles and introducers were used. These components are available in a number of catheter insertion kits (such as the PN-05014 Peel-Away Sheath over Needle Sheath (accepts 5 Fr., 1.65 mm diameter or smaller device), Arrow International Inc., Reading, PA, USA; and the V-PPC series of 3, 4 & 5 French polyurethane catheters with Peel-Away^R sheath needles, Global Veterinary Products Inc., New Buffalo, MI, USA).