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SHORT COMMUNICATION

A GOLD-PLATED SUCTION ELECTRODE FOR EXTRACELLULAR RECORDING AND DYE INFUSION

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To record extracellular nerve activity, wires or polyethylene suction electrodes are commonly used, which are modified according to particular experimental requirements. For electrophysiological studies in a dissected animal, a length of the nerve under investigation may be lifted on to silver wires (Pearon, Stein & Malhotra, 1972), or a fine wire hook (Wilkens & Wolf, 1974), often under mineral oil. These methods produce good records but the mineral oil and the wires around the nerve and its associate muscle reduce the visibility of the preparation. This may cause difficulties when simultaneous records are required from other parts of a small preparation.

Using drawn polyethylene suction electrodes, successful extracellular recordings can also be obtained from the cut ends of motor and sensory nerves. This is a simple electrode, but its major drawback is that it cannot be used to record from very fine nerves since it is difficult to construct very fine tips using polyethylene tubes. Other suction electrodes have also been used for *en passant* recording attached to the site of an intact nerve by slight negative pressure (Padst & Kennedy, 1967; Larimer & Eggleston, 1971), but it proved difficult to restrict the recording site to only a specific area of the fine nerve branches. Using extremely small diameter tips to localize the recording, new problems of tip clogging and high electrode resistance are encountered. To overcome these problems a gold-plated glass suction electrode has been developed.

To construct this electrode a glass micropipette was pulled from a 1–1·5 mm diameter glass tube and rapidly tapered to reduce the internal resistance of the electrode. The outside surface of the micropipette was coated with a layer of gold about 100 nm thick, by vacuum deposition in a Polaron Sputter Coater. The micropipette was mounted on the end of a stainless steel tube with a small piece of heat shrink sleeving (Fig. 1A). One input of an a.c. differential amplifier was connected to the steel tube. The layer of gold around the pipette was connected to the other input of the amplifier by wrapping silver wire tightly around it and painting it with conductive silver paint.

The main advantages of the gold-plated suction electrode are first, that it can be constructed very easily and, secondly, that it can be used to record from very fine nerves. To achieve this, the tip of the micropipette is broken using a pair of forceps

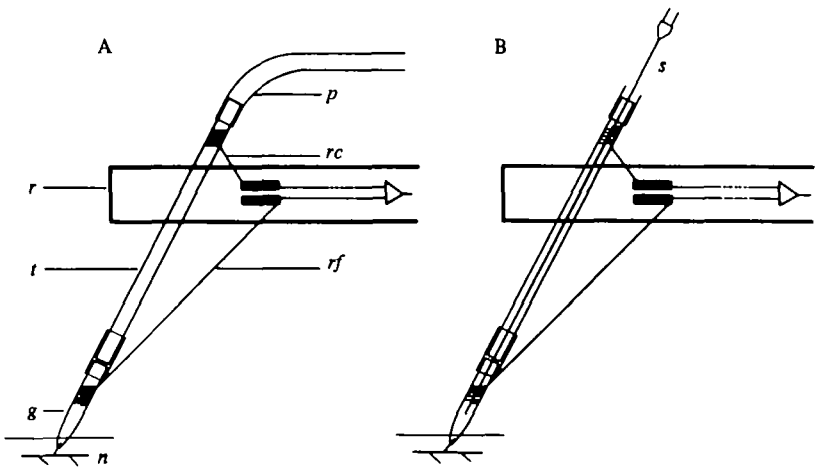

Fig. 1. (A) Diagrammatic representation of the gold-plated suction electrode as it was used to record from fine nerve branches. (B) Modification of the same electrode in order to back-fill the fine nerve branches. *p*, Polyethylene tube; *r*, insulated rod; *rc*, recording wire; *rf*, reference wire; *t*, stainless steel tube; *g*, saline filled gold-plated micropipette; *n*, nerve in saline; *s*, syringe.

under the microscope, giving an internal diameter similar to the outside diameter of the nerve. Then with appropriate micromanipulations the electrode tip is brought very close to the cut end of the nerve which is sucked into the pipette by creating a negative pressure with a 1 ml syringe attached to the steel tube. When the nerve fits well into the tip of the electrode, the negative pressure can be released. The gold film allows the use of a very small electrode tip without degrading recordings, thus it is possible to record after micro-operations from various parts of an intact immobilized animal without large extensive dissections.

Records obtained from the nerve which innervates the metathoracic extensor tibiae muscle of the locust, using this electrode (Fig. 2A), were compared with records taken from the same nerve using a simple hook electrode (B) modified from Wilkens & Wolf (1974). No significant differences were found between the amplitudes of the recorded spikes. However, the duration of the recorded spikes was shortest in the records obtained using the gold-plated suction electrode (Fig. 2). This is mainly due to the fact that the recording site of the electrode (the interior of the micropipette) is very close to the reference site (layer of gold). Spikes having short duration are useful when records are required from motor or sensory neurons firing at high frequencies, and especially when an electronic level detector is to be used to analyse the signals. The layer of gold around the tip also provides a very good screen for the electrode, and so minimizes cross-talk. This type of screen has also been used on intracellular microelectrodes (Sachs & McGarrigle, 1980).

At the end of the electrophysiological experiments, the same gold-plated suction electrode can be used to back-fill the nerves using various stains (usually $CoCl_2$, Pitman *et al.* 1972). For this purpose, the plastic tube to the syringe was cut (Fig. 1B) and the saline inside the micropipette is replaced with distilled water by using a lon

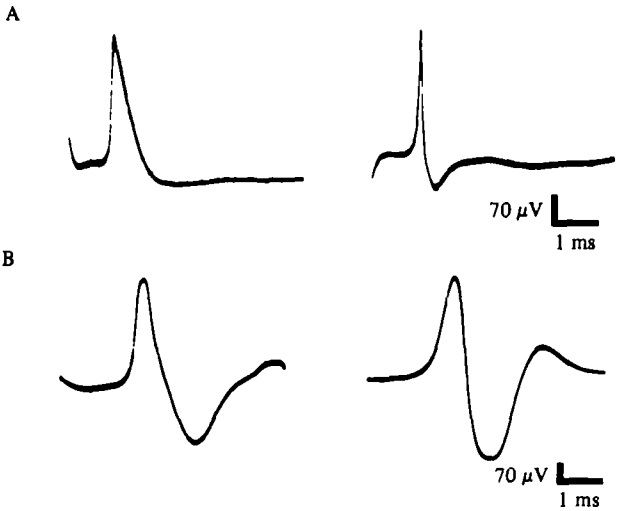

Fig. 2. Extracellular records obtained from the nerve innervating the metathoracic extensor tibiae muscle of the locust (approximate diameter 30 μm) using (A) the gold-plated suction electrode and (B) a hook electrode. Independent stimulation of the axon of the fast extensor motoneurone (FETi) was achieved by stimulating the proximal part of N5.

fine syringe (s). After 3 minutes the distilled water is replaced, with a solution of stain and left for a period of time which usually depends on the distance which the stain has to perfuse. In this case, the interior of the micropipette is used as small pool of stain attached to the end of the nerve and completely isolated from the rest of the animal. Care must be taken to avoid any leak of stain, otherwise the whole preparation will be coloured. The advantages of this method are that motor or sensory nerves can be backfilled without having to remove the nerve from the body cavity and that records can be obtained while the stain (cobaltous chloride, Procion yellow, nickel chloride, horseradish peroxidase) is perfused inside the nerve axons. It is then possible to establish the relationship between the stain concentration and the life-time of the nerve axons during backfilling.

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