A Modified Coaxial Electrode for Electromyography

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● A modification of the standard coaxial electrode is presented along with investigation of its electrical parameters. This type of probe has been in use for two years and has been found to offer advantages such as reproducibility of results; complete coaxial shielding throughout; durability and handling ease; cold sterilization is easily accomplished and efficient, as well as ease of manufacture. The design produces an exceptionally convenient and durable electrode and eliminates the variables produced by frequent replacement of the standard type.

The concentric or coaxial needle electrode as first described in 1929 by Adrian and Bronk[1] has remained essentially unchanged until the present.[2] This type of electrode has been found to be superior to the unipolar and the surface types in selectivity, frequency response and noise level[2, 3] (fig. 1). The usual method of construction (commercial and otherwise) involves the cementing of the amplifier lead in wires directly to the central conductor and the needle itself. This produces a bulky, difficult to handle unit with the further disadvantage that the maximum strain and flexure occurs at the base of the needle. We have found that breakage of the leads at this point will produce irregularity of results and intermittent short circuits. The average life of a probe of this type is a few months under clinical usage. We have further noted that results obtained with one coaxial electrode are not directly comparable to those obtained with another due to unavoidable variation in manufacture; i.e.: area of central conductor exposed, degree of bevel, and variations in inherent capacity. It therefore became desirable to produce a rugged, durable type of electrode, retaining the coaxial feature, that could be used clinically for long periods of time. With such an electrode, results from one patient to the next or in multiple determinations within the same patient would be directly comparable. The variables encountered by using several electrodes or having to discard unserviceable electrodes would be obviated. The authors feel that with the increasing clinical usage of electromyography, standardization of procedures, technics and equipment is required to produce precision in determinations. A modification of the standard coaxial electrode is presented (fig. 2 and 3) along with an investigation of its electrical parameters. This type

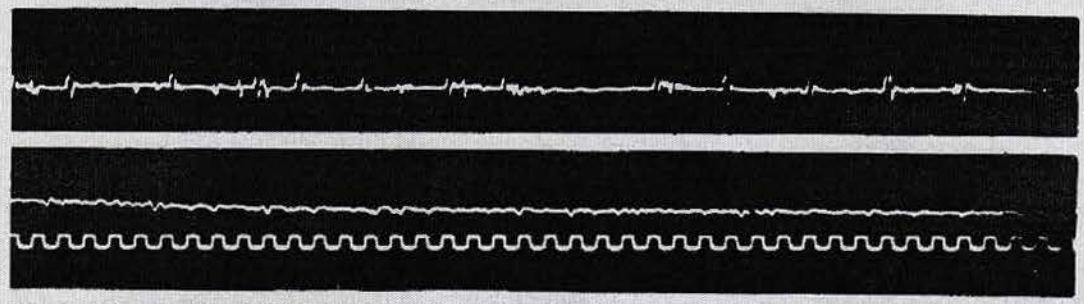

Fig. 1 — Comparative electromyograms obtained simultaneously from the vastus lateralis muscle. Upper trace was obtained with the modified coaxial electrode; the lower trace with a bipolar, silver electrode with 6" spacing. Note the small area of "read out" from the coaxial type and the failure of the surface electrode to pass the high frequency components of the wave forms. Calibration signal 60 cps and 100 micro volts amplitude.

of probe has been in use in this laboratory for two years and has been found to offer the following advantages:

1. Reproducibility of results. The same probe may be utilized for multiple

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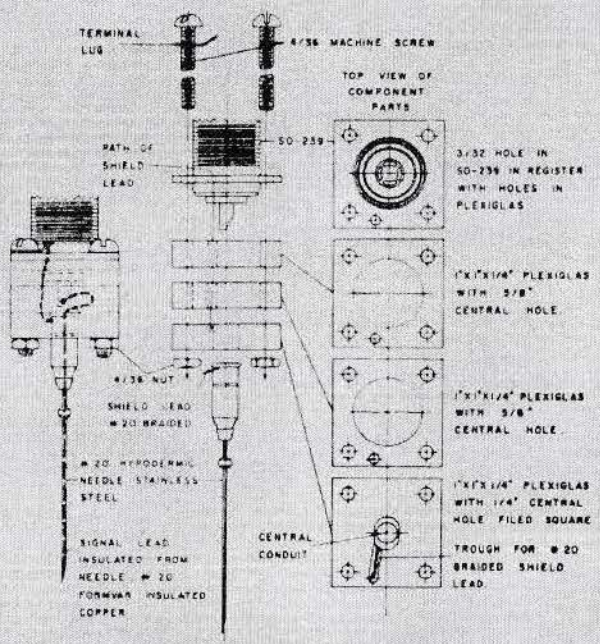

Fig. 2 — Diagram of the modified coaxial electrode illustrating constructional details and dimensions.

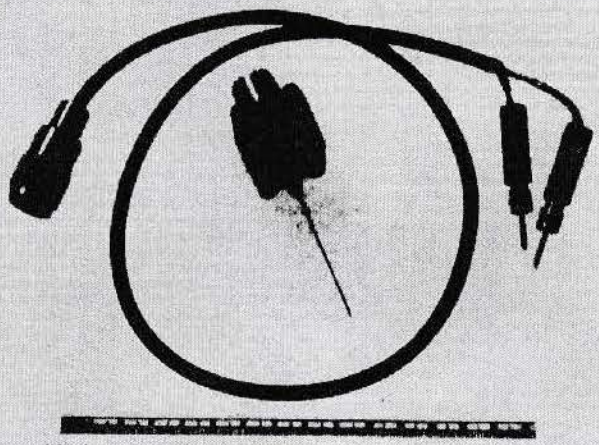

Fig. 3 — View of the modified coaxial electrode and the coaxial cable and fitting for connection to the amplifier first stage.

determinations on the same or different patients with the assurance that probe parameters will remain constant.

2. Complete coaxial shielding throughout. This allows the use of high gain amplifiers in an unshielded area.

3. Durability and handling ease. The original model made two years ago is still in use.

4. Cold sterilization is easily accomplished and efficient. No infections have occurred in more than 300 determinations.

5. Ease of manufacture. Construction is simple and easily accomplished by the average investigator.

In the manufacture of this probe, we have routinely used liquid Plexiglas® to cement the central conductor in place. In regrinding the bevel a fine oil stone is used and care must be exercised to prevent shorting between the needle barrel and central conductor at the tip. Formvar® insulated platinum wire of 26-gauge may be used for the central conductor.

A short length (less than two feet) of RG 62/U coaxial cable with a PL 256 coaxial fitting is used to connect the probe to the cathode follower input of the amplifier. The probe may be supported at any level or angle within the

muscle with a few blocks of ½" thick sponge rubber. The needle barrel acts as the primary ground connection to the patient and further grounding is undesirable. The probe is remarkably well tolerated and pain is noted only when a sensory nerve is impinged upon.

The area of signal pick-up of this electrode has been found to be less than 5 mm. and precise determinations can be made from various muscle groups in close proximity without "cross talk." The frequency response is flat from 10 cycles per second to 2 megacycles per second. Actually the electrode provides adequate passband characteristics up to 8 megacycles, which should allow unaltered reproduction and amplification of pulses with fast rise times. Muscle action potentials with rise time in the order of 0.1 millisecond have been observed using this electrode and the electrode is capable of unaltered wave forms of much higher rise times. The inherent capacity of the electrode was calculated to be +6 micro micro farads and RG 62/U coaxial cable was selected for connection to the cathode follower because of its low capacitance per foot, small size, light weight and flexibility.

A modification of the coaxial needle electrode for electromyography has been presented. The design produces an exceptionally convenient and durable electrode and eliminates the variables produced by the frequent replacement of the standard type.

N.B. Since this paper was written we have applied the same principles to the construction of an electrode using subminiature components. (Amphenol type 27-1 plugs, type 27-3 receptacles, and type 21-598 coaxial cable). This results in a great increase in ease of handling due to a 10 fold reduction in weight and increased cable flexibility. The electrical characteristics are identical with those of the electrode described.

References

1. Adrian, E. D., and Bronk, D. W.: Discharge of Impulses in Motor Nerve Fibers. J. Physiol. 67:119, 1929.
2. Basmajian, J. V.: IRE Transactions on Medical Electronics, No. 11, July, 1958.
3. Weddell, G.; Feinstein, B., and Pattle, R. E.: Electrical Activity of Voluntary Muscle in Man Under Normal and Pathological Conditions. Brain 67:178, 1944.

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