May 2007

Concentric and Monopolar electromyographic (EMG) needles

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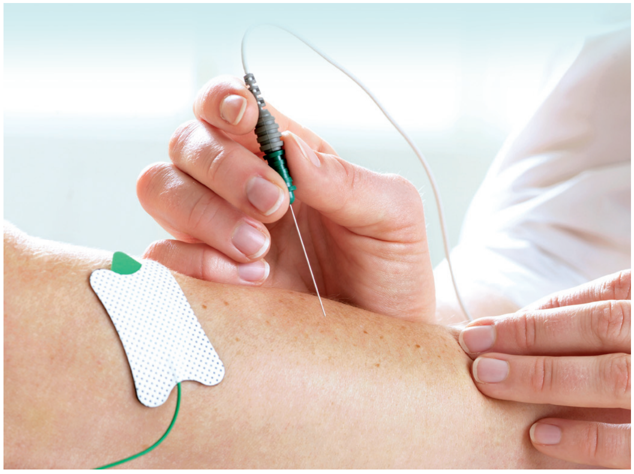
THE CHOICE IS JUST A MATTER OF TRAINING AND PREFERENCE

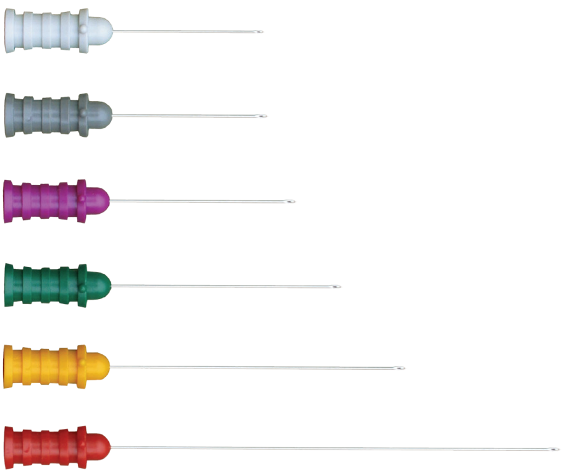
The measurement of the body's electrical signals involves a sensor, an amplification system, and a display. Within the last decades, the development of electronics and specially amplifiers made it possible to record signals of very small amplitude (micro Volts). However, the sensor element, which is a needle in the case of electromyography (EMG), became the critical component of the recording process. In fact, the design of the two most popular types of EMG needle electrodes, the concentric and monopolar needles, remains almost unchanged since they were introduced in the forties[1].

Concentric (or coaxial) and monopolar needles present different characteristics, the recording demands a slightly different set-up, and therefore, the EMG signal acquired also presents specific characteristics. However, there is little advice in the literature regarding whether to choose a concentric or a monopolar needle in the specific clinical tests. Both types of needles present advantages and disadvantages, and the final decision seems to be guided by training and personal preference

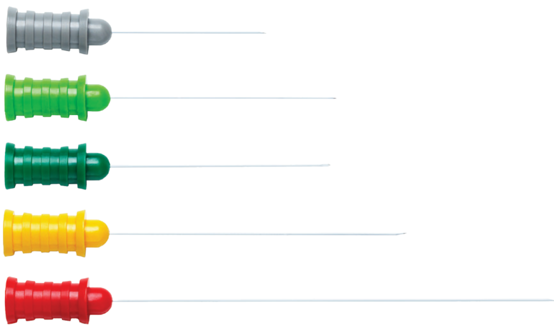


of the physician that performs the studies. These habits, once developed, are difficult to change[1,2,3].

The present manuscript presents a brief summary of the technical specifications and recording characteristics of monopolar and concentric needles, and discusses the main advantages and disadvantages of both needle types.



Ambu Concentric



Ambu Monopolar

THE MONOPOLAR NEEDLES

The use of a monopolar needle to measure both normal and denervated muscle activity was first introduced by Jasper and Ballem in 1949, and the design has not changed much since that first prototype. Nowadays, most monopolar needles are made of stainless steel with a gauge ranging from 26 to 31 (AMBU has sizes 25 to 28). The needle is covered with an insulating material layer. This insulation covers the whole needle except for the tip, which is the conductive (measuring) area of the needle. The tip is traditionally sharpened to a conical shape*), and the length of the electrical conductive tip varies among manufacturers. The area of the conductive tip is one of the most critical factors in the recording, as it is directly related to the pick up field and the amplitude of the recorded activity.

AMBU has previously used PTFE as insulating material; however, the new version of the monopolar needle is insulated with an acrylic coating. Moreover, the needle is covered with a second layer of medical silicone aiming to decrease the friction between the needle and the biological tissue, facilitating the penetration and decreasing the discomfort of the patient.
The EMG measurement is performed by inserting the monopolar needle (active electrode) as close as possible to the potential of interest. The reference electrode, generally a surface electrode, is placed close to the active electrode but not on the active tissue. Finally, a ground electrode is placed relatively away from these two electrodes.

THE CONCENTRIC NEEDLES

Adrian and Bronk first introduced the concentric needle electrode in 1929. The concentric needle consists of a cannula (reference electrode) and a core (active electrode) generally made of different materials. The outer diameter of the cannula is generally 0.45 to 0.7 mm diameter (AMBU has sizes 0.3 to 0.65 mm), and the core approximately 0.1 mm diameter. The core is embedded in an insulating material, so that the two metal parts (electrodes) are electrically insulated. The tip of the needle has a flat elliptical shape and is generally ground to an angle of approximately 15 degrees.
The AMBU concentric needle has a core of silver and a cannula of stainless steel. Some manufacturers use platinum as the material of the core.

The measurement is performed by inserting the concentric needle, which contains both the active (core) and the reference (cannula) electrodes as close as possible to the potential of interest. Finally, a ground electrode is placed relatively away from the needle.

ARGUMENTS FOR MONOPOLAR NEEDLES

- The exposure area: As it was explained, the recording area of monopolar needles is the whole tip, however, for concentric needles the recording area is only a flat elliptical face of the core wire. One of the arguments for monopolar needles is that the measuring area of monopolar needles (average area of 0.10 to 0.50 mm²) is approximately three times larger than the total area of exposure of the concentric needles (approximately 0.02 to 0.1 mm²), and the impedance is also lower by a factor of several times. Thus monopolar needles recruit activity from a larger amount of muscle fibres (larger pickup field) than do concentric needles[2]. As a result, the amplitude of potentials recorded with monopolar needles is larger than those recorded with concentric needles.

- Recording characteristics 1:
  The monopolar needles record activity from all directions, however, concentric needles record mainly signals in the direction of the elliptical surface (bevel) and must be rotated to pickup activity from fibers in other directions. Monopolar needles then record more electrical activity than do concentric needles.

- Recording characteristics 2:
  In the concentric needle, the active electrode (core) and reference electrode (cannula) are located so close to each other that both may be recording the information of interest at the same time. Theoretically, if the cannula has a potential equally to the mean potential of the tissue in contact with the cannula surface, the potentials will average out and the cannula will end up being electrically indifferent. However, if the cannula does not reach the zero potential, there will be some loss of the active signal due to cancellation between the core and cannula potentials[2].

ARGUMENTS FOR CONCENTRIC NEEDLES

- Recording characteristics: In the concentric needles the active (core) and reference (cannula) electrodes are located very close to each other. This produces an excellent common mode rejection and a more stable signal. However, in monopolar needles, it may take some time to find a good location for the reference electrode in order to get a stable signal[3]. Moreover, the measurement with concentric needles is more specific.
- Reproducibility: Studies have shown that the repro-

ducibility of recordings performed with concentric needles is higher than those performed with monopolar needles[3]. As a consequence, there is a larger amount of reference data (normal values) available of different muscles and age classes, for concentric measurements than for monopolar measurements.
- The recording process is simpler as only one needle and one ground electrode are used.

Regarding patient discomfort, there is not clear evidence showing differences between the two needle types[3].

Discomfort depends primarily on the sharpness and diameter of the needle, and as the diameters of concentric and monopolar the needles are very close, and single-use needles always have a sharp tip, there is not clear evidence on this matter. Some studies however, indicate that the pain perception is different for concentric and monopolar needles depending on the insertion technique and the size of the needle movement [4]. Results indicate that when small repositioning movements are used, the concentric needle cause less discomfort than do monopolar needles, but the opposite has been reported when large repositioning movements are performed[4].

CONCLUSION

Although monopolar and concentric needles present different characteristics, the choice for clinical use seems to depend on the training of the physicians performing the studies, and their personal preference.

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