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TECHNICAL TIPS

Subdermal Needle Electrodes: An Option for Emergency ("Stat") EEGs

Anita L. Schneider, R. EEG/EP T., CNIM

Jordan NeuroScience, Inc.
San Bernardino, California

ABSTRACT. *Emergency or "stat" EEGs are ordered on patients who are suspected to have serious acute brain dysfunction (ABD). Often, these patients are comatose or have some altered level of consciousness (ALOC) from stroke, brain hemorrhage, head trauma, encephalopathy, seizures, or status epilepticus—which may be convulsive (SE) or non-convulsive (NCSE). As the number of stat EEGs increases, consider alternatives to traditional methods and tools, keeping overall patient care and outcome in mind.*

INTRODUCTION

In neurodiagnostic labs around the world, "stat" EEGs are frequently ordered. According to Stedman's Medical Dictionary, stat is the "abbreviation for statim, at once, immediately." Should our EEG procedure methodology be the same for a stat EEG as it is for our healthy outpatient who enters the EEG lab for a 1.5-hour procedure? Is our traditional procedure always the best option for the patient? It is human nature to become stuck in the inertia of doing things the same old way simply because it's the way it has "always been done." I suggest we evaluate each patient and setting and choose the optimal approach for that patient's management.

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"WHAT'S THE HURRY?"

There is abundant published data about the importance of accurate diagnosis and early intervention in acute brain dysfunction (ABD). A study by Young et al. (1996) found that the duration of a seizure and time to diagnosis are both predictors of outcome in patients, independent of etiology. When nonconvulsive status epilepticus (NCSE) was diagnosed within 30 minutes of onset, mortality was 36%, compared to 75% when diagnosis was delayed for over 24 hours.

Vespa et al. (2003) reported that seizures (most of which were nonconvulsive) after intracerebral hemorrhage were associated with a significant increase in mass effect and shift on serial computerized tomography (CT) scans, even after accounting for other factors such as the size of the hemorrhage. There was also a trend toward worse outcome in those patients with seizures.

Pioneering studies by Jordan (1993), utilizing EEG, revealed that seizures were more common in ABD patients than previously recognized. In the neurologic intensive care unit (NICU) 34% of 124 patients undergoing continuous EEG (cEEG) monitoring had nonconvulsive seizures (NCS) and 76% of these cases had NCSE.

In 2004, Columbia University Medical Center conducted a study of 570 consecutive patients, two thirds of whom were in the NICU undergoing cEEG. They found, overall, 19% had seizures of any type, 18% had nonconvulsive seizures, and 10% had NCSE. The majority of the seizures were nonconvulsive and would not have been identified without EEG monitoring (Hirsch and Kull 2004).

When stroke is the diagnosis, the clock starts ticking from the onset of the event. Tissue plasminogen activator (tPA) is the only treatment of proven effectiveness in acute ischemic stroke (AIS) (Burger and Tuhrim 2004) and can only be administered within the first few hours after the event. EEG is the most sensitive neurodiagnostic tool for detecting cerebral ischemia and correlates with its location and degree (Jordan 2004) but needs to be done early to make a difference.

RAWOD (Regional Attenuation WithOut Delta) is a distinctive EEG pattern found in emergency department patients with sporadic AIS. This study of emergency EEG (EmEEG) in 48 patients with AIS (Jordan 1998) revealed a distinctive EEG pattern of regional attenuation of all frequencies without supervening delta. This pattern shares cardinal features with early EEG reports in pathologically proven massive AIS with herniation. The incidence of RAWOD was the same in patients studied before or after three hours from stroke onset, suggesting that RAWOD occurs rapidly after AIS. However, without timely EEG, these changes remain unobserved and undocumented (Schneider and Jordan 2005).

"SHOULD WE CONSIDER USING NEEDLE ELECTRODES?"

In this critical care setting, "time is brain." The best electrode for this application may be the subdermal EEG needle electrode, which can be quickly and easily inserted. There is no need for abrasive skin prep, conductive paste, or adhesive electrode covering in the initial "stat" procedure. This time advantage is crucial for the emergency EEG. In the case of head injury with bleeding and abrasions (or worse), it is often not possible to apply a surface electrode, but you can always find some area to insert the small, sterile needle electrode.

"Don't they hurt?"

Today's needle electrodes are small (12 to 13 mm in length) and are very thin (27 to 28 gauge). They have a beveled edge for easy insertion, causing minimal discomfort to the patient. Most stat EEGs are ordered for patients who are comatose or have an ALOC. Remember too, the EEG is ordered "stat" due some type of emergency and the tiny, subdermal needle electrodes are usually very well tolerated, even in the alert patient.

"Are they accurate?"

The entire needle surface is the recording area, just as the entire disk electrode *plus* surrounding conductive cream is the recording area when using surface disk electrodes. The needles should be placed symmetrically, equidistant from one another. In a study by Tyner and Knott (1976), they emphasize that the direction of insertion of subdermal electrodes is important to avoid voltage asymmetries. Interelectrode distance may vary with regard to the direction of insertion rather than with the point of insertion.

Tyner and Knott's recommendation is to place the three vertex electrodes (Fz, Cz, Pz) inserted toward the nasion *or* toward the inion. No electrodes should ever be angled toward one hemisphere more than the other. If all other electrodes are inserted in the direction *away from* the crown of the head (or *toward* the patient's body), the result will be that all will be placed in nearly parallel planes and all homologous electrodes will be angled in the same direction.

"I have heard the impedances are high when using needles"

Electrode impedance is another area of improvement with modern day needle electrodes. When correctly inserted, impedances usually measure 5 to 8 kilohms and the interelectrode impedances are almost always within 2 kilohms. Such interelectrode impedance matching is often difficult to achieve with surface disk application.

"Can I leave them in place for ICU/cEEG?"

For ICU-cEEG, the inserted needle electrodes can be covered with collodion soaked gauze squares or another EEG electrode adhesive (e.g., Grass Technologies

EC2® electrode cream) and covered with an air-permeable adhesive bandage. This application method works well on comatose or altered patients. Correct needle insertion is important. The needle shaft should be completely inserted just under the skin, parallel to the scalp. When inserted correctly, the low profile hub of today's needle electrode and the electrode wire are positioned nearly flat and can be easily secured without causing upward pressure to the needle. With proper application, the needles stay intact and the impedances remain stable for many days.

EEG disk electrodes, however, require the use of a conductive cream. Within a few days of application, the cream will dry or be absorbed, causing higher impedances. This process requires re-prepping and/or re-application of electrodes.

"What about infection?"

Regardless of electrode choice, cross-contamination should always be a consideration. Guidelines for infection control in the neurophysiology department indicate that all blood and body substances (except perspiration) are potentially infectious for bloodborne pathogens and therefore constitute a risk. Every patient and every staff member, therefore, is a potential risk for cross infection (patient to staff or staff to patient). Any breach of the epidermis, even as slight as that caused by rubbing to lower electrode resistance, predisposes the skin to leakage of tissue fluid that may be contaminated, and thus provide a medium for cross infection (International Organisation of Societies for Electrophysiological Technology 1999). Repeated skin prep or abrading the skin with a blunt tip needle for re-prepping of a disk electrode can clearly cause irritation and abrasion. Disposable needle electrodes are one patient use only, prepackaged and sterile. Once securely in place, there is no need for re-application.

Always follow universal precautions with any electrode application. Wear gloves when inserting and removing needle electrodes and take the necessary time to carefully remove them one at a time. Hold them securely together in one hand close to the needle end. When all are removed, cut the electrode wire near the needle ends and place the needles in the sharps container. The remaining wire can be disposed of in a standard waste container. During electrode application, always inform bedside staff that you have used needle electrodes.

In the past, disposable, sterile EEG needle electrodes were not available. Technologists were often required to sharpen and prepare the used needles for the disinfection process and sterilization. The needles often became dull and bent, were difficult to insert, and painful for the patient. Excessive needle handling put the technologist at greater risk for needle-stick injury as well.

Today's EEG needle electrodes are available in disposable form; there is no need for disinfecting or sterilization. The single use electrodes also eliminate the need for soaking, scrubbing, untangling, or drying electrodes and there is no patient cleanup.

Still, there is the potential risk of a needle stick injury. If a needle stick does occur, report the incident to the appropriate hospital department, according the hospital policy, as you would with any needle stick. One point to be mentioned is that EEG needle electrodes are solid, not hollow bore needles, like syringes, so there is no column for fluid within the needle.

"Can the patient go to CT or MRI with needle electrodes?"

CT scans can be performed with needle electrodes intact. The needle electrodes will be visible on the CT, but produce only minimal dot-like artifacts that do not interfere with interpretation. Disk electrodes usually cause more interference such as large streak artifacts, and need to be removed before and reapplied after the CT scan.

Nonferrous [magnetic resonance imagine (MRI) compatible] electrodes, to my knowledge, are not yet widely available for patient use. The stainless steel needles currently available need to be removed for MRI.

"Are they expensive?"

Single use, sterile, disposable needle electrodes are more expensive than reusable disk electrodes. However, they save tech time and labor cost (20 to 30 minutes/patient—applying, removing, and cleaning the patient and electrodes). For the "stat" emergency EEG, the additional cost may be far outweighed by the advantages.

CONCLUSION

There is increasing recognition of the importance of the "stat" EEG in assessing the electrophysiology of the brain in acute brain dysfunction (ABD). "*The brain is the new heart*"—a phrase I heard recently used by an Emergency Medicine physician group, stresses the emphasis now directed toward diagnosis and treatment of ABD. Similarly, *EEG is the EKG of the brain*, and needs to be as available for monitoring brain function as EKG is for cardiac function. Published data indicates the importance of early diagnosis to initiate available treatment which saves brains and lives. Emergency—"stat"—EEGs are often necessary for optimal patient care. I suggest we pull ourselves out of our inertia and routinely assess each patient's electrode needs, considering options available to facilitate the procedure without compromising accuracy or safety. Disposable, sterile, subdermal EEG needle electrodes may be the best choice for many patients with ABD.

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Address reprint requests to: Anita Schneider, R. EEG/EP T., CNIM, Jordan NeuroScience, Inc., 399 East Highland Avenue, Suite 316, San Bernardino, California, 92404.

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