Physical Agents Theory and Practice

Second Edition

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Preface to the Second Edition: For the Student

The Guide to Physical Therapist Practice (2nd edition, APTA 2001) in combination with the increased interest in Evidence-Based Practice have strengthened our quest to provide you, the user of physical agents, with:

- the information you need to know for safe practice,
- the rationale for why it is important to know it,
- guidance on using the information,
- skills to determine if physical agent techniques utilized produced the results that were anticipated, and
- insight into the questions that patients might ask regarding their intervention.

New features include:

- Case study examples, which will facilitate integration of material
- Incorporation of language from *The Guide to Physical Therapist Practice*

We have provided updates on all chapters from our last edition and organized material in a way to enhance learning. Many of the illustrations and photographs are new and enhanced from the last edition. We, the editors, hope to have accomplished our goals and look forward to hearing feedback from you.

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Contents

Chapter

9

Objectives

- Describe the components and care of the electrode interface.
- Outline the process of electrode selection and placement.

Key Terms

Banana tip	Electrode	Monopolar	Quadripolar
Bipolar	Lead wire	Pin tip	

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Electrodes: Material and Care

Outline

"Will I be electrocuted by what you are doing?"

Clinical electrical stimulation involves the passing of current through the skin via electrodes. An electrode is used to either deliver electric current or record electrical activity of muscle, such as in electromyography (EMG). The delivery of current is accomplished through a system of electrically conductive elements.[1] This includes the lead wire, two or more electrodes per circuit, a conductive substance such as referred to as the electrode interface, and the patient. Each of these components will affect the amount of electrical charge delivered to the patient. The influence of each of the components will either facilitate the flow of current, if the resistance is low, or inhibit the flow of current, if the resistance within the system is too high. Refer to Chapter 8 for a review of resistance and current flow.

Electrodes represent the "instrument" for current delivery from an electrical stimulation generator. Leads connect the electrodes to the stimulator. Each lead has both a jack and a pin to interconnect the electrode to the lead and the lead to the stimulator.[1] Each of these components will be discussed in terms of the structures themselves, their possible configurations, and appropriate handling techniques.

Electrodes vary in shape, size, and flexibility, to fit the needs of the therapeutic application of the electrical current to the patient. An electrode is made of an electrically conductive material that is housed in a nonelectrically conductive material. The purpose of the housing material is to inhibit the delivery of electrical energy to either the patient or the clinician if either should touch the back of the electrode.

Types of Electrodes

Metal Plate Electrodes

Early electrodes were composed of metal plates such as tin, steel, aluminum, and zinc, which are good electrical

Patient Perspective

Remember that your patient is curious about what you are doing with electrical stimulation. Some of the terms might be familiar, such as "stereo jack" or lead wire, but he or she will not know what you are going to do with them and why. Another key thing to remember is that you are deliberately moistening the electrodes, yet your patient may be fearful of the combination of water and electricity. It is the responsibility of the clinician to properly inform the patient about the rationale behind the "tasks" that are involved.

PATIENTS' FREQUENTLY ASKED QUESTIONS

1. Do you use tap water or distilled water? Why?
2. Why do you use water?
3. Will I be electrocuted by what you are doing?
4. Where will I feel that, and what will it feel like?
5. Why are you doing that to me?
6. Have you ever had this done to you?

conductors for therapeutic stimulation. The electrode was usually contained within a rubber casing with only one surface exposed to the patient. The interface between the metal electrode and skin was accomplished through a sponge or felt pad moistened with water. This served to reduce the skin—electrode impedance, because water is a good conductor of electricity. Distilled water should not be used; it contains no free ions, which are required for the transmission of electrical current,[1] and therefore would not be electrically conductive (Fig. 9-1).

Disadvantages of metal plate electrode systems include the following:

- Metal plates may not be flexible enough to maintain adequate contact with certain body parts.
- These electrodes may be difficult to secure comfortably to the patient.
- There are few sizes of these electrodes, making specific treatment goals for smaller treatment areas difficult to accomplish.

Carbon-Impregnated Rubber Electrodes

Electrodes composed of rubber, silicon, and polymer have mostly replaced the older metal plate electrodes and are typically used with clinical devices. Carbon-impregnated silicon rubber electrodes are commonly used in many clinics. They are backed with a nonconductive material to prevent unintentional current delivery. These electrodes are available in many shapes and sizes, and they can be trimmed or fitted to different locations of the body (Fig. 9-2).

Carbon-impregnated silicon rubber electrodes should be replaced when necessary. They degrade over time, resulting in nonuniformity of current delivery, or the presence of "hot spots." Hot spots represent those areas of the electrode that

Why Do I Need to Know About...

APPLICATION OF ELECTRODES
You will be applying electrodes to patients and need to be familiar with the terminology and the purpose to be successful.

Figure 9-1 Metal plate electrode. The metal surface of the electrode is covered by a sponge that would be soaked in water. The left-hand corner of the sponge is folded back to reveal the metal plate. The electrode is encased in a nonelectrically conductive rubber cover.

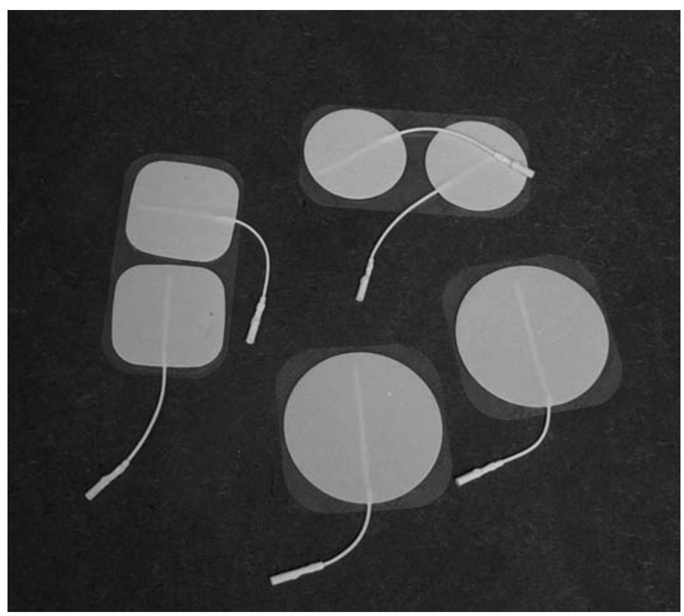

Figure 9-2 Several different sizes of self-adhering electrodes that have a mesh of electrically conductive material woven into them. This photograph depicts other self-adhering electrodes with smaller conductive surface areas and also illustrates the flexibility of the mesh electrodes. The mesh electrodes easily conform to irregular body surfaces.

continue to maintain their conductivity while other areas of the surface no longer conduct electrical energy. The result is analogous to 10 cars trying to merge onto an uncrowded highway versus those same 10 cars trying to merge onto a crowded highway. The 10 cars will get on the crowded highway, but if time was a factor, the amount of resistance that they would face in meeting their goal would be significantly higher when the traffic was heavy, or the window to merge was smaller. Carbon rubber electrodes should be rinsed off and dried after each use. Replace these electrodes every 12 months to ensure good conductivity. Again, if the goal is to have current pass through the electrodes, then they must be taken care of to maintain their conductivity.

Self-Adhering Single-Use or Reusable Electrodes

Self-adhering single-use or reusable electrodes are composed of other flexible conductors such as foil or metal mesh, conductive Karaya, or synthetic gel layered with an adhesive surface (see Fig. 9-2). The advantage of these electrodes is convenience of application. No strapping or taping is necessary to secure the electrodes to the patient.

Clinicians should carefully read the manufacturer's suggestions before utilizing these electrodes. Because of the potential for cross-contamination, use of a package of electrodes for each patient is prudent. The package can be marked with the patient's name and identification number so that they will only be used for a given patient.

Considerations for Electrode Selection

There are advantages and disadvantages with each type of electrode, including self-adhering electrodes. Often, the impedance of these electrodes is significantly higher than that of other electrode systems, resulting in reductions in potential current outputs of the stimulation device. These limitations may make it difficult or impossible to accomplish the desired clinical goal with a given stimulator, if the output of the stimulator is not sufficient to overcome the resistance of the electrodes.

The resistance of the electrode, which is listed in ohms, should be as low as possible when significant motor levels of stimulation are required. If the desired effect is a comfortable nonmotor level of stimulation, the impedance value of the electrodes is not as critical to success. If the impedance value of the electrodes is high, then the stimulator will need to overcome that value before the current is delivered to the patient. This may result in higher output levels of stimulation, which may be uncomfortable to the patient. The package of the electrodes may indicate the ohms of resistance, which will be lower with larger electrodes and higher with smaller electrodes.

Before You Begin

Ask yourself what types of electrodes are available and which ones would be the most economical and appropriate for the patient that you are treating. Not all clinics will have individual single-patient reusable electrodes. The insurance coverage for some patients does not permit this type of expense, so reusable carbon-impregnated rubber electrodes may need to be used.

The method of current delivery into the electrode will also affect the uniformity of the current delivery from the electrode. Some self-adhering electrodes have a metal wire that inserts into the center of a conductive-adhesive or adherent surface. The current delivery at the point of attachment of the wire to the surface will be relatively higher than the current delivery to the periphery of that electrode. This may result in a hot spot where the wire connects to the surface of the electrode. Optimally, the conductive surface of the electrode will have "uniform" conductivity. This potential for uniformity of conductivity is enhanced through foil or mesh surfaces within the electrode to spread out the delivered current.

Electrode Size and Current Density

Current density describes the amount of current concentrated under an electrode. It is a measure of the quantity of charged ions moving through a specific cross-sectional area of body tissue.

Electrode surface area is inversely related to total current flow. The same total current flow passing through large and small electrodes would result in lower current density at the larger electrode. The total current would be distributed over a larger surface area. Conversely, the smaller electrode would be delivering a high-current density because of its smaller surface area. Therapeutic electrical stimulation involves the active or stimulating electrode, the one that exhibits the greater current density, and the dispersive or inactive electrode, which delivers less current density. Electrodes should be appropriately sized for the desired result. If, for example, the treatment goal involved a motor response of one of the forearm muscles, an electrode that was 3 inches in diameter would produce a great amount of "overflow" of current into the surrounding muscles. It would be more appropriate to utilize a small electrode that more closely approximates the size of the target tissue, such as a $1^{1}/_{2}$-inch diameter electrode (Fig. 9-3). The reverse is also true. If the treatment goal involved a tetanic contraction of the rectus femoris, then the electrode size that would afford the greatest comfort would probably be 3 inches in diameter or greater. Smaller electrodes may provide too great a current density, but not enough current flow to elicit a tetanic contraction (see Fig. 9-4).

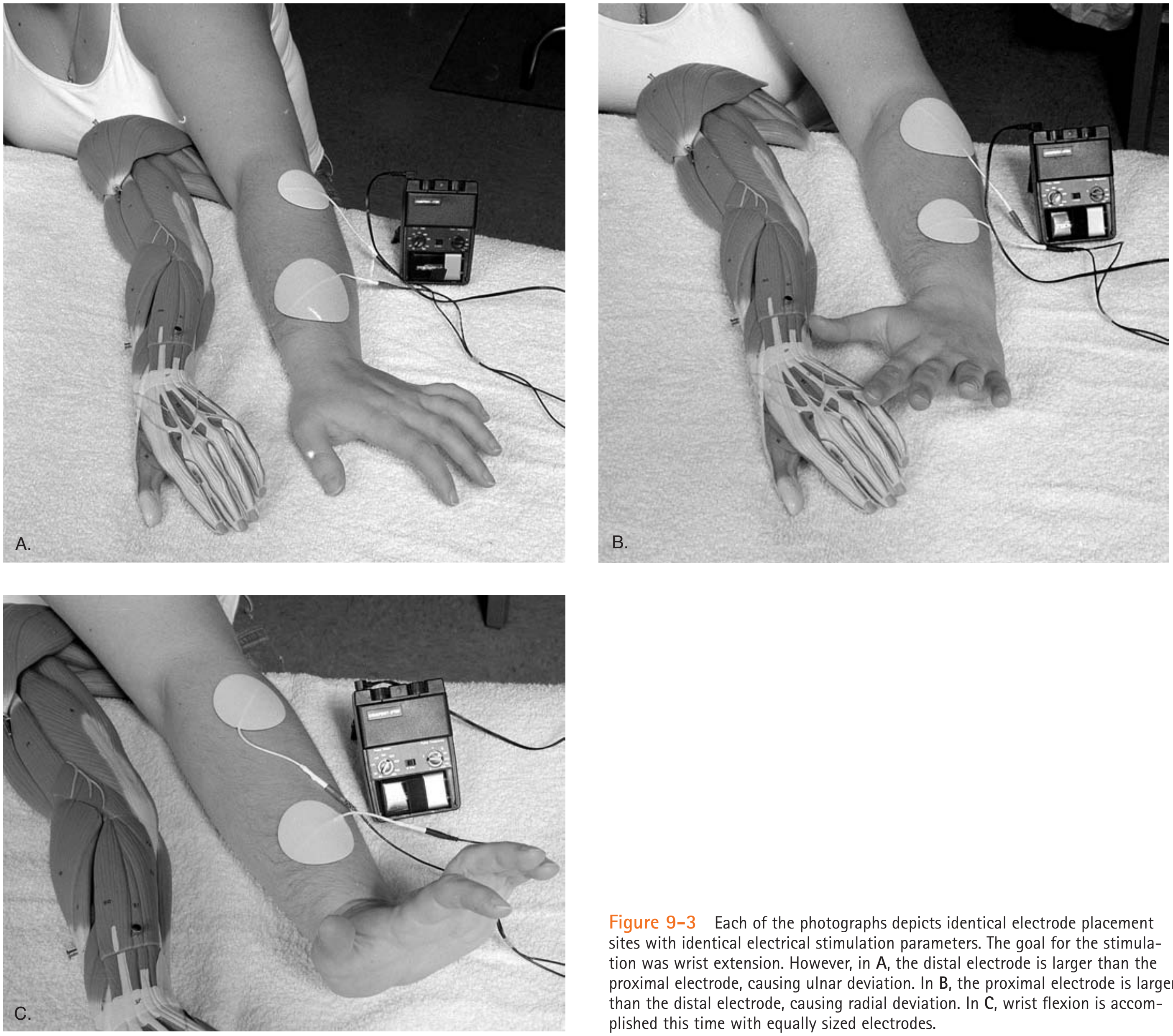

Figure 9-3 Each of the photographs depicts identical electrode placement sites with identical electrical stimulation parameters. The goal for the stimulation was wrist extension. However, in **A**, the distal electrode is larger than the proximal electrode, causing ulnar deviation. In **B**, the proximal electrode is larger than the distal electrode, causing radial deviation. In **C**, wrist flexion is accomplished this time with equally sized electrodes.

Coupling Media and Attachment

Surface-stimulating electrodes require the use of a coupling medium. This medium can be water via soaked sponges, or electrically conductive gel. The coupling medium reduces the impedance at the interface between the electrode and the skin. This results in less current amplitude needed to produce the desired effects of stimulation.[2,3]

Pliability of the electrode to conform to the body part is necessary. Rigid metal electrodes do not conform well to contoured anatomic regions. Poor conformity can also result in hot-spot delivery of the electrical energy. In this case a high concentration of electrical energy over a small area, for example, the "hot spot," is a factor of not having all of the conductive surface of the electrode in contact with the patient's skin. Patient responses indicative of this would be noticeable after several minutes of treatment: the patient moved, he or

> **Why Do I Need to Know About...**
>
> ELECTRODE SIZE
>
> Remember that Ohm's law states that the delivered energy is directly related to the amount of resistance encountered. If you use small electrodes, the resistance will be higher and the sensation potentially more uncomfortable, making it impossible to accomplish a treatment goal.

Figure 9-4 Contraction of the rectus femoris with the use of electrical stimulation delivered through two 3-inch-round electrodes placed on the muscle.

she now feels a prickling sensation ("hot spot") and is afraid to move back to the original position. To remedy this, the concentration of the energy will diminish if the patient returns to the original position, because the uniformity of the contact between the electrode and the patient will have been restored. It is often difficult to convince a patient that if he or she leans back on the electrode that is causing the prickling sensation, that the degree of prickling will subside. Explanations for the phenomenon can reduce the patient's anxiety regarding the electrical stimulation and potentially offset increased muscle guarding as a result of that fear.

Caution should be exercised to make sure that the electrode interface has not dried out during the treatment. If so, repositioning the patient will not remedy his or her complaint, but rehydration of the electrode may do so. This is yet another reason to check on a patient after treatment with electrical stimulation has been initiated.

The electrode should conform to the anatomic region to obtain optimal stimulation. Electrode attachment methods to maximize surface contact include the use of straps, tape, and self-adhering electrodes.

Straps or Tape for the Attachment of Electrodes

Straps have been commercially manufactured to be easy to use, inexpensive, and versatile. Many of the commercially available straps have rubber-backed stretch "eyed" surfaces, with one end of the reversed side of the strap covered with "hooks." These straps should be used to secure either the carbon-impregnated rubber electrodes or the metal-plate electrodes. Proper utilization involves strapping circumferentially around the limb with sufficient pressure to maintain good uniform contact between the electrode and the patient's skin. The pressure should be centered so that the electrode remains flat against the surface of the skin. Once the strap is secured, it should be checked for positioning that may have changed slightly once the strap has been stretched. Straps come in a variety of lengths for different areas of the body and different strapping configurations (Fig. 9-5).

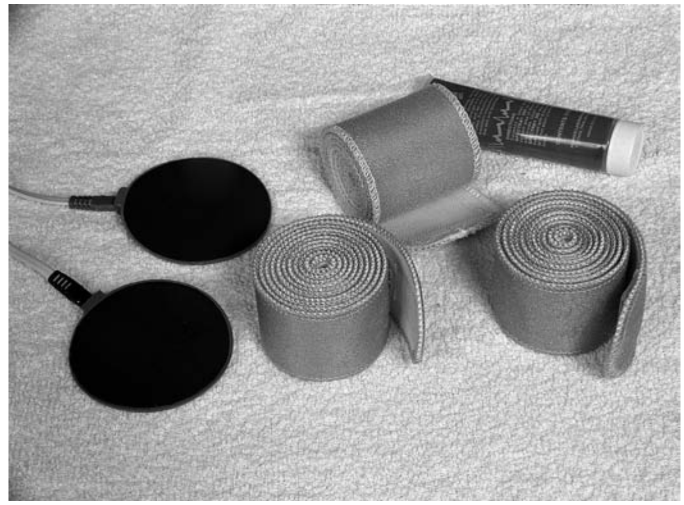

Figure 9-5 Straps used to hold carbon rubber electrodes with sponges or gel, in place during treatment.

Tape can also be used to attach electrodes to the patient, and it has several distinct disadvantages. For example, it can be costly and patients may be allergic to the adhesive. If the electrodes are not properly cleaned after use, the adhesive may migrate to and collect on the conductive surface of the electrode. This decreases both the conductive surface area and increases the potential for skin irritation.

Leads

Leads provide a conductive path for current flow. Electrical stimulators will always have a pair of leads emerging from them. They are the intermediary between the generator and electrodes. The electrodes are connected to the electrical stimulation generator by lead wires. A lead wire has several parts: the point of exit from the stimulator, the wire itself, and the point of attachment to the electrode, known as the tip. The point of exit is referred to as the "jack," which, if it contains two leads, is referred to as a "stereo jack."

The jack plugs into the stimulator and is typically encased in hard plastic. The jack is the portion of the lead that is meant to be handled, and it is constructed to maintain its

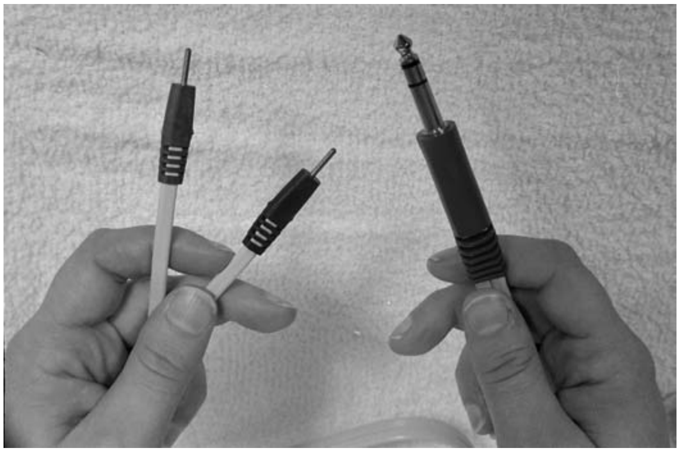

Figure 9–6 The lead wire to an electrical stimulation device connects to the device via a "stereo jack" and is divided into two leads, which are usually pin leads as pictured.

integrity even with multiple plugging and unplugging of the lead into the stimulator. In order for the lead to be able to deliver electrical energy, the jack must be securely plugged into the stimulator so that there is no metal showing between the jack and its plug or receptacle. Each lead wire will usually have two electrodes attached to it by a metal tip that inserts into the electrode (Fig. 9-6). There are different types of electrode/lead wire configurations, such as the pin tip lead and the banana tip lead, which are attempts to standardize the lead–electrode interface and ease the attachment of the electrode to the lead for the clinician (Fig. 9-7). Regardless of the type of tip, it is prone to corrosion and should be cleaned regularly. Scheduled maintenance of the tips should prevent potential problems with current delivery. Steel wool can be used to clean a tip. Gentle rubbing with the steel wool should

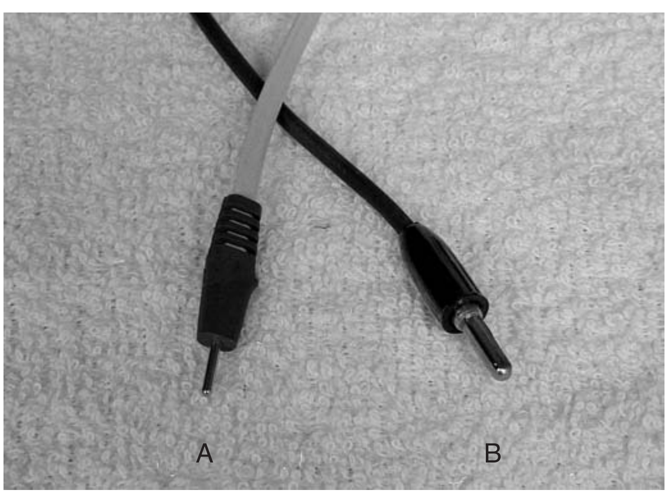

Figure 9–7 (A) "Pin" tip. (B) "Banana" tip. Banana tips are adjustable. If the tip no longer fits tightly in an electrode, then the sides of the tip may be spread apart slightly.

Figure 9–8 The tip must be fully inserted into the electrode so that the metal pin tip touches the conductive surface of the electrode. Failure to insert the pin into the electrode fully will result in poor current delivery to the electrode.

restore the shiny metal surface of the tip, which will maintain its conductivity.

The tip can assist in the delivery of electrical energy only if it is in contact with the conductive surface of the electrode. There is a small housing that surrounds the tip opening within every electrode. The tip must be pushed as far as possible into the opening so that it does come in contact with the conductive surface of the electrode. There should be no metal showing between the plastic-coated pin housing and the electrode. Failure to insert the electrode properly will result in poor clinical results because current cannot be delivered to the patient (Fig. 9-8).

Many electrical stimulation devices have multiple lead wires that have one stereo jack with two leads and pins for two electrodes. If the intended result is to cover a larger area and there are not any additional channels of electrodes available, then each lead may be "split" through the use of a bifurcator. A bifurcator is an attachment that fits on the pin of the lead wire and has two smaller leads coming off of it. Use of a bifurcator will split the output from that lead into the two electrodes attached to it, thereby decreasing the total amount of current flow through each independent electrode. (Current density is reduced or dispersed). If a patient perceives too much sensation underneath one of the electrodes from a channel, then either the size of the electrode can be in-

Why Do I Need to Know About...

TIP MAINTENANCE

Sometimes the reason that the current is not being perceived is as simple as the point of attachment to the electrode. BEFORE checking to see if this is a problem, make sure that the intensity is at ZERO.

TABLE 9-1 Channel Setups and Lead Management

TREATMENT GOAL	NO. OF LEADS AND ELECTRODES	MONOPOLAR	BIPOLAR	QUADRIPOLAR
Muscle (motor) stimulation	One lead per muscle with both electrodes on the same muscle, two leads if it is a larger muscle or if the device has more than one head		X	
Sensory stimulation	One or two leads depending upon the size of the area; use as many electrodes as possible for sensory stimulation			X
	One lead if only one lead and two electrodes fit into the treatment area		X	
	One lead with one electrode at the spinal nerve root and the other in the sensory area	X		
Delivery of medication	One lead and one electrode in the treatment area and the other more proximally placed on soft tissue	X		

creased or a bifurcator can be used, which would then split the output delivered to that electrode.

Neither lead should be considered a "ground" but rather part of the electrical circuit. If there are not at least two points of contact between the electrical stimulation device and the patient, the patient will not have any electrical stimulation. A circuit has not been completed. Some older sources for electrical stimulation may use the term "ground" for the dispersive electrode but this is a misnomer. Each electrical stimulation device will have its own set of peculiarities with respect to the management of leads. Examples of the channel setups and lead management can be found in Table 9-1. Potential causes and remedies for patient complaints of prickling or itching sensations underneath the electrodes are listed in Table 9-2.

TABLE 9-2 Potential Causes and Remedies for Patient Complaints of Prickling or Itching Sensations Underneath the Electrodes

COMPLAINT	POTENTIAL CAUSE	REMEDY
Prickling or itching underneath the electrodes during treatment	The patient is moved off of one of the electrodes during treatment.	Restoring contact with the electrode will restore the sensation; however; you may need to decrease the intensity of the unit first before a patient will let you do this.
	One of the electrodes is not making good contact.	Restoring contact with the electrode will restore the sensation; however, you may need to decrease the intensity of the unit first before a patient will let you do this.
	One of the electrodes has dried out.	Restoring the moisture necessary for good conduction can be as easy as re-wetting the electrode.
	The patient has dry skin.	Restoring the moisture necessary for good conduction can be as easy as re-wetting the electrode. If the patient has dry skin, his or her skin may absorb the moisture rapidly. Sponges may work better for these patients.
	The patient's skin is oily.	This patient may not be receiving the appropriate current density due to his or her own skin condition. Cleansing the skin with alcohol can remove the oil from the surface of the skin.
	The patient's skin is soiled under the surface of the electrode.	This patient may not be receiving the appropriate current density due to his or her own skin condition. Cleaning the skin with alcohol can remove the oil from the surface of the skin.
	The electrode is losing its conductivity.	The electrode may need to be replaced. The patient is NOT always the problem.
	A strap has come undone.	Restoring contact with the electrode will restore the sensation. You may need to resecure the straps. However, you may need to decrease the intensity of the unit first before a patient will let you do this.
	Water dripped out from the sponge when the straps were applied.	Restoring the moisture necessary for good conduction can be as easy as re-wetting the electrode. Restoring contact with the electrode will restore the sensation; however, you may need to decrease the intensity of the unit first before a patient will let you do this.

Transcutaneous and Percutaneous Electrodes

Electrodes that are applied to the surface of the skin are termed transcutaneous electrodes. Transcutaneous refers to the delivery of electrical energy or recording of electrical energy across the skin. Percutaneous electrodes are inserted into the skin. Percutaneous electrodes are commonly used for invasive EMG procedures, or they may be used for the application of electrical stimulation for patients with quadriplegia or paraplegia. Of the two types of electrodes, transcutaneous electrodes are more common in therapeutic delivery of electrical stimulation.

Terminology for Configurations of Electrode Setups

Electrodes can be oriented in monopolar, bipolar, and quadripolar manner, meaning one, two, or four electrodes in the treatment area, respectively. Placement across body tissues can be longitudinal and parallel, such as when stimulating quadriceps muscles of the thigh to facilitate a stronger contraction, or they may be criss-crossed, as when administering electrical stimulation treatment for pain management.

Monopolar Application of Electrodes

The monopolar technique involves a single electrode from a channel, usually smaller in size, placed over the target area called the active electrode. The greatest stimulation perception will be in the target tissue area. The larger dispersive electrode or second electrode is placed at a distance from the target electrode to complete the circuit. Its placement is usually over the nerve root supplying the target treatment area. The size differential between the electrodes ensures a greater current concentration in the treatment area (Fig. 9-9A).

Bipolar Electrode Setup

The bipolar electrode technique requires two electrodes from one channel within the target treatment area. They are usually of equal dimension and shape. Current flow through tissue is usually confined to the problem area. When using the bipolar placement, the patient will experience an excitatory response and/or sensation under both electrodes. One can be smaller if the intention is a more effective activation of excitable tissues. This would be an appropriate electrode setup for eliciting a motor response.[4] One of the electrodes will be placed over the motor point, and the other electrode, which may be slightly larger, will be placed somewhere else over the muscle belly (Fig. 9-9B). Occasionally, a clinician may bifurcate the leads when a situation requires a larger target area, such as with a combination of back and lower ex-

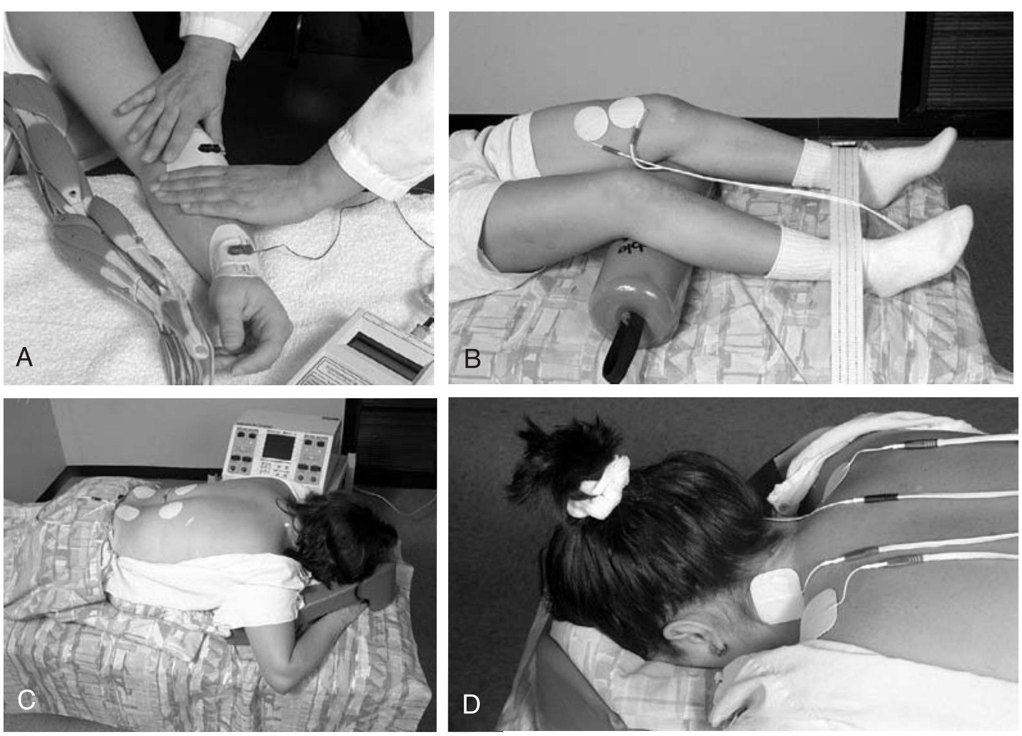

Figure 9-9 Various electrode setups. **(A)** Monopolor electrode placement setups with only one electrode from the channel in the target of treatment area. **(B)** A bipolar electrode setup, with both electrodes from the same channel in the target or treatment area. **(C)** A quadripolar treatment setup in the low back and **(D)** a dual bipolar setup for the cervical musculature.

Figure 9–10 A quadripolar electrode setup in the cervical region to help provide analgesia and relieve muscle guarding as a secondary response to pain reduction.

tremity radicular pain. Bipolar techniques are well suited for stimulation of a large muscle.[5–9] Monopolar techniques are better suited for stimulation over a motor point or a wound.[10–13]

Quadripolar Electrode Placement

The quadripolar method of electrode application involves electrodes from two or more channels, each lead with two electrodes. The electrodes can be positioned in a variety of configurations. Quadripolar electrode placement occurs with an interferential device; however, it also occurs when there are four electrodes within the treatment area, regardless of the type of stimulator utilized to deliver the current.

Quadripolar electrode setups are often used to deliver the electrical stimulation to a larger area, such as in pain management techniques that rely on sensory stimulation of larger fibers for analgesia[14,15] (Figs. 9-9C,D and 9-10).

Application Guidelines

- Make sure that all connections are tight.
  Stereo jack into the stimulator
  Pin or banana into the electrode
  Electrode interface onto the skin
- Make sure that electrode interfaces are moist.
  Self adhering
  Sponges
- Gel must be electrically conductive.
- Water must NOT be distilled water as there are NO ions present for the conduction of electrical current.
- Make sure that your patient does not move the electrodes once they are positioned.
- Make sure that your patient knows how to contact you if he or she needs to during treatment.

> **Why Do I Need to Know About…**
>
> PROPER TERMINOLOGY
> The terminology for electrode setups is verbally communicated between clinicians. Knowing what is meant by the terms helps you to understand what other clinicians are referring to and decreases the confusion in an already terminology-laden intervention.

Care of Electrodes

Because electrodes represent the point of delivery of therapeutic electrical stimulation, the proper care for and cleaning of electrodes are essential. The impedance of carbon-impregnated silicon rubber electrodes can be significantly altered if the surface is allowed to dry or cake with gel. Carbon-impregnated silicon rubber electrodes can easily be cleaned in mild soap and warm water to remove gels. Cracking or "polished" appearance of the electrode surface may indicate that the surface is no longer uniformly conductive. This may result in the formation of spots of high current density on the electrode and poor current delivery. Harsh disinfectants can damage both carbon rubber and metal electrodes. Excessive alcohol use can cause carbon rubber electrodes to lose conductivity. An early sign of electrode wear is a stinging sensation under the electrodes. If there are cracks or uneven surfaces, the electrodes may need to be replaced.

"Hot spots" represent an increase in current concentration or current density within the electrode area, which could result in skin irritation. Patients who complain that they feel a biting or stinging sensation when receiving therapeutic current are probably describing an electrode with uneven conductivity. It is time to replace the electrode, or at least have it checked with an ohmmeter for resistance to determine whether use of the electrode should be continued.

If they are not cleaned on a regular basis, sponges soaked with water may be a source of potential cross-contamination from patient to patient. Germicidal soaps can be used to rinse through the electrodes before their application on a patient. Soap residue must be removed because soap acts as an insulator to the passage of electrical energy. It is usually easier, though, to replace the sponge electrodes with new ones.

Summary

Proper care and selection of electrodes could represent the success or failure of a treatment intervention with electrical

Case Study

Susan is an athletic trainer for the local community college women's field hockey team. She spends a great deal of time kneeling while taping the ankles of the team members. She fell down on her knees and has now been diagnosed with chondromalacia of the patella in both knees. There is marked weakness of the vastus medialis, edema superior to the patella, and a palpable painful crepitus in both knees when descending stairs.

The treatment goals include pain relief, edema reduction, and muscle strengthening.

Electrical stimulation was applied in a quadripolar setup for each of Susan's knees, which initially felt "very comfortable." Susan is now complaining that it feels as if "ants are crawling around" on her knees.

- What probably happened, and what could be done to improve the situation?

stimulation. The electrodes, leads, and electrode interface must be appropriate for a treatment intervention to have a chance of being effective. If a patient is not feeling electrical stimulation where he or she is supposed to be feeling it, due to an unpleasant sensation, clinicians must understand enough to know what to do to remedy the problem. This chapter provided a sampling of what to look for and what to do when problems arise. Familiarity with the equipment that is being used must include all of the peripherals, such as the leads and electrodes.

Discussion Questions

1. Of what significance is the choice of electrodes for a given patient?
2. If the patient complained of a prickling sensation underneath one of the electrodes, what would be the potential causes and potential remedies?
3. If a patient stated that he or she was not feeling the sensation underneath all of the electrodes, what might be the cause for this and what could you do?
4. Using terminology that a patient would understand, how would you explain electrical stimulation to him or her?
5. Your patient decides to lift up the corner of one of the electrodes; what would happen and why?

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