Application of Electrosurgery in Scalp Reduction

Experience with an Ultrasharp Tungsten Needle Electrode

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An ultrasharp tungsten electrode was used in several hundred scalp reduction procedures from 1988–1992 at Peterson Medical Institute, Santa Monica, California. This unique instrument has proved to be a useful adjunct in facilitating hair restoration surgery. J Dermatol Surg Oncol 1994;20:209–212.

Electrosurgery is an established and well-accepted medical technique. The term includes electrodessication, electrocoagulation, electrodissection, electrocautery, and electrolysis (Table I).[1] Many important developments followed the first crude experiments in 1875 in which the effects of electricity upon living tissue were evaluated.[2] Electrodes that were used for medical treatments at that time were large, specifically to avoid current concentration, with consequent burning of tissue.

By the turn of the century it was recognized that, despite the increase in current density, beneficial tissue destruction could be achieved through controlled current issuing from smaller electrodes.[2] Pure cutting current (low voltage, high amperage, monopolar, undamped, sine wave form) was first defined in 1907.[2] Electrocoagulation current (low voltage, high amperage, monopolar, damped) was subsequently reported in 1909. In 1911 current for electrodessication (high voltage, low amperage, monopolar) was subsequently described.[2]

Credit is given to William A. Bovie, a Harvard physicist, for making the first practical cutting/coagulation electrosurgical unit in the 1920s, thereby introducing electrosurgery techniques to general practice. Harvey Cushing, pioneer neurosurgeon, was quick to adopt them to his field. By the mid-20th century most electrosurgical units were the so-called sparkgap generators, a few of which are still in use. Such units worked well for coagulation but not for cutting.[3] Tube generators were introduced a few years later. These improved cutting performance at the expense of coagulation. Today's solid-state generators combine the best characteristics of both types.[3]

As with most techniques, electrosurgery has its advantages and disadvantages (Table 2).[2] Extended discussions of various current types and of various applications can be found in standard dermatologic electrosurgical texts.[2,4,5] Despite all the progress that has been made in electrosurgery technology, the biophysics of its operation is still imperfectly understood, even by physicians who apply the method daily. With knowledge gained largely from personal experience, surgeons have learned to apply electrosurgical methods to their specific practice, avoiding complications and optimizing the controllable parameters to achieve optimal clinical results for their own purposes.

The function of an electrosurgery unit for tissue cutting is to generate local heat at an electrode tip placed in close proximity to the tissue surface. As mentioned above, very early in the development of electrosurgical unit devices, consideration was given to electrode tip size and shape relative to current density and to the desired amount of tissue destruction. With the electrosurgical unit as the power source a working electrode having a small area is brought into near contact with the patient's tissue. The electrical current is transferred back to the power source via a "grounding" electrode having a large surface area and which is attached firmly to the patient, usually near the hip. In this arrangement, termed *monopolar,* the patient is a part of the current path where the patient's body acts as a capacitor as well as a conductor.[2] A high current density occurs at the tip of the working electrode, thereby concentrating the heat energy. Delivery of highly localized heat to the tissue occurs by the formation of a minute arc between the fine needle tip and the moist conducting

In private practice.

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Table 1. High Electrosurgical Modalities

Electrode	*Type*	*Current*	*Radio Frequency Generators*
One	Electrodessication	High frequency oscillating, high voltage, low amerage, damped	Spark gap or solid state
Two	Electrocoagulation	High frequency oscillating, low voltage, high amperage, damped	Spark gap or solid state
Two	Electrodissection	High frequency oscillating, low voltage, high amperage, damped	Spark gap or solid state
		undamped	Vacuum tube or solid state
None	Electrocautery	Direct, low voltage, high amerage	Step-down transformer with variable resistance
Two	Electrolysis	Direct, low voltage, low amerage	Battery or step-down transformer with variable resistance

tissue. A rapid increase in tissue temperature near the electrode tip occurs as energy is delivered.

The electrical energy that is delivered to the working electrode is always in the form of an oscillating applied voltage, usually at radiofrequency. It is either damped or undamped in modulation. The wave form may range from a simple sine wave (usually used for cutting) to very complex modes which may include a train of repeating packets or bursts of waves separated by a time at zero voltage. If the circuit is designed to produce packets within each of which the wave amplitude decreases, the wave form is said to be damped. This is the delivery form of pure coagulation current where tissue destruction is greatest. Pure cutting current is undamped. Variations of the damped packet mode have been found to be suitable for mixed coagulation and dessication effects. If half of the wave cycle is deliberately blocked (or reversed) by the electrical circuit the wave form is said to rectified. For some clinical applications a combination or blend of two or all three of these modes is found to be most effective.

In cutting soft vascularized tissue, especially where cosmetic considerations are important, the destruction of tissue adjoining the plane of dissection should be minimized. Ideally, simultaneous cautery of severed blood vessels is desired to maintain working visibility. Both of these effects are promoted by keeping the tip of the working electrode as small as possible. Because the electrical energy tends to concentrate where the electrode radius is smallest (like the action of a sharp lightening rod) less applied power is necessary to maintain cutting action without encountering tissue drag. Thus, with lower applied power, heat trauma to the adjoining tissue will be less; consequently, healing is faster, hair loss is less, and there is less scarring than when larger electrodes are used.

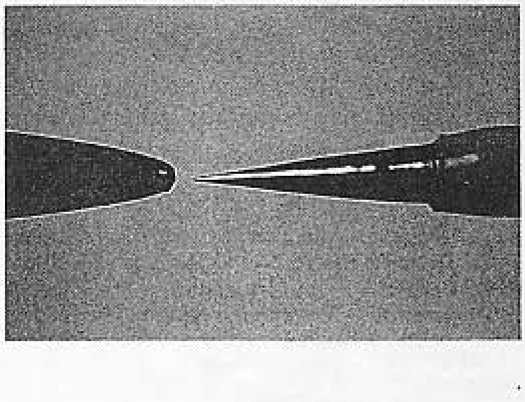
Needle electrodes have been known and used for many years. However, before the development of the ultrasharp MicroDissection needle (Figure 1) (Colorado Biomedical, Evergreen, CO) they have all been made of stainless steel, a class of ironbase alloys that melt around 1600°C, well below the temperature of the cutting arc. Attempts to utilize sharp stainless steel needles for electrosurgery have therefore been frustrated by the melting of the fine tip. To avoid this limitation the MicroDissection needle, produced by a patented electrochemical method, is made of nearly pure tungsten, which will not

*Table 2. Electrosurgery Considerations**

Advantages	*Disadvantages*
Simplicity	Overtreatment
Wide application	Hypertrophic scarring
Speed	Excessive tissue destruction
Cost-effectiveness	Destruction of histology
Safety	Delayed hemorrhage
Controled hemostasis	Slow healing
	Smoke and odor
	Alopecia

* *Adapted from Sebben JE. Cutaneous Electrosurgery.*

Figure 1. Close-up of view of the two electrode tips. Left) Stainless steel, 50 µm radius, Right) tungsten, 1 µm radius.



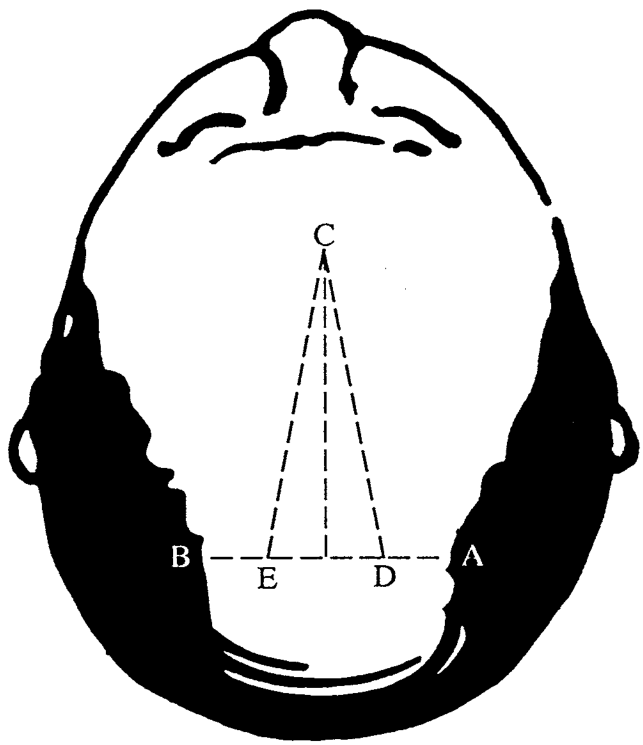


Figure 2. Scalp reduction.

melt at temperatures below 3400°C. The extremely fine tip therefore maintains its sharpness throughout its normal use.

The remainder of this article presents a summary of our experience and our conclusions using this novel tungsten electrode in scalp reduction surgery during hair restoration services at Peterson Medical Institute from 1988–1992.

Materials and Methods

Several hundred scalp reduction procedures have been done using a basically standard procedure, described below. The power to the needle was provided by an electrosurgery unit (Elmed, Inc., Addison, IL) attached to a monopolar handpiece. This unit is capable of delivering distinctly different wave forms intended for cutting, blending and coagulating respectively. The power settings are indicated only in number settings from 0.5 to 10; the wattage at each setting is not indicated on the control panel but, according to the manufacturer, is about 1300V (blended) with a resistance of 500 Ω.

The patient is anesthetized, draped, and connected to the return plate of the electrosurgical unit in the customary manner. The area of alopecia to be removed is first diagrammed with a felt pen (Figure 2). With power on at numbers 4–5, the needle electrode is inserted through the scalp and perpendicular thereto at the right base, and is drawn firmly and at constant depth and speed to the left base. It is then inserted at the apex (C) and is drawn in the same manner to the right base (D) of the diagram via the uncut route. These incisions are made using the side of the needle within 2 mm of the tip. Further trimming is then performed using as low power as possible consistent with no tissue drag at the needle tip. The section to be removed is then dissected from the skull in the galeal plane with further undermining as appropriate, using the extreme tip for cutting. Finally, the needle is again inserted at the apex with power on and drawn to the left base(E). The scalp skin patch to be removed is then lifted off and discarded. Closure of the wound is performed routinely with layered sutures.

Except for large vessels, bleeding is easily controlled. Individually cauterizing the larger vessels using a spatula electrode is quickly done when necessary.

Results

No quantitative measurements of blood loss have been made. However, qualitative assessment during surgery showed a dramatic decrease as compared with cold steel whenever the ultrasharp tungsten needle was used. For every hundred patients there were only 1 or 2 who required special attention to hemostasis. Although the microdissection needle did not always produce complete hemostasis while cutting, hemostasis was complete in about 2 patients out of every 100. Most cases fell somewhere in between.

The heat produced by the needle was sufficient to produce a minor amount of smoke and odor in virtually all patients. However, this was of minimal annoyance to the operator and was rarely (approximately 5%) mentioned by patients.

Cutting with the microdissection needle was smooth and easy although somewhat slower than with a cold steel scalpel. The incision was at least as precise as cold steel with no visible charring of tissue. Occasionally, the needle seemed to catch and skip causing a "jerk" to the otherwise effortless cutting motion. This was probably due to the operator's sudden but slight increase in force. This effect did not present a problem.

The incidence of postoperative infection even with cold steel is extremely low, and there was no problem with postoperative infection with the electrodessication needle. Therefore, no assessment could be given of the killing efficacy on bacteria of the minute arc.

Healing time averaged 6 to 12 days, comparable with our cold steel experience. Also the resulting scars were about the same as when cutting is done with cold steel. There was no problem with wound dehiscence and the

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sutures were removed on the same schedule as that following cold steel.

Summary

Primarily intended for fine aesthetic surgery, this unique electrosurgery needle has proved very useful in several hundred scalp reduction procedures. Especially noticeable characteristics were ease and precision of cutting, and significantly decreased bleeding, with consequent cleaner field and enhanced visualization and reduced operating time as compared with cold steel. The amount of heat-traumatized tissue was minimal, producing small amounts of odor and smoke, and allowing rapid healing with reduced scarring and alopecia. We believe that blood loss may be still further diminished through optimization of electrosurgical unit wave modulation.

Overall, our results using the ultrasharp tungsten needle have been excellent. This new instrument adds a welcome dimension to scalp reduction surgery.

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