Electrosurgery and Thermocoagulation at Operative Endoscopy

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Introduction

The ability to achieve hemostasis is integral to any laparoscopic procedure and is probably the single most important factor that delayed the evolution and widespread applicability of operative endoscopy. The modalities to achieve hemostasis essentially mirror those of laparotomy surgery. Today there are many hemostatic techniques available including lasers, suturing, clips and staples, and thermocoagulation. Nonetheless, the most widely used and least expensive method of maintaining hemostasis within the pelvis are the electrosurgical modalities. This chapter discusses electrosurgery and briefly reviews the use of thermocoagulation. The use of lasers is discussed in Chapter 6, and sutures, clips, and staples are examined in Chapter 9.

Electrosurgery

American gynecologic laparoscopists use unipolar and bipolar instruments with cutting (undampened) or coagulation (dampened) waveforms more extensively than any other modality to achieve hemostasis. Nonetheless, a thorough understanding of the basic physics of this modality is often lacking. In Fig. 5.1 we see a schematic representation of the various measures of electrical energy.

Tissue Effects

Electric current has the ability to fulgurate, desiccate, coagulate, or cut tissue.

a. **Fulguration** refers to the heating of tissue by sparks of electrical current when the electrode is close to, but not in direct contact with, the tissue. This technique requires relatively high voltages and achieves superficial hemostasis with minimal tissue penetration. It can be used to stop diffuse bleeding such as that occurring after myomectomy.

b. **Coagulation** occurs when the tissue is heated, and protein loses its conformation, subsequently solidifying. Coagulation usually results in tissue blanching and occurs at temperatures of 45° to 60°C.¹

c. **Desiccation** refers to the evaporation of all liquid until the tissue is completely dry,
which occurs at higher temperatures than coagulation, 45° to 100°C. The term desiccation, however, is rarely used and coagulation (or electrocoagulation) is used to describe both effects.

d. Vaporization occurs at temperatures above 100°C when the intracellular liquid boils, leading to cellular disruption.

During electrosurgery a combination of these tissue effects is usually seen, although generally one type is predominant. Depending on the predominant tissue effect, electrosurgery results in tissue cutting or ablation. The different tissue effects can be achieved by varying the type of current waveform, the power output of the generator, the electric circuit, and the type of electrosurgical instrument tip used.

Electrosurgical Generators and Power Density

Electrosurgery requires generating units that are able to transform the available low-voltage (110 V), low-frequency (60 Hz) alternating electrical current into a high-voltage, high-frequency current. Spark gap circuits and triode vacuum tubes have now been replaced by solid-state units, which are widely employed at laparotomy and laparoscopy.1,2

A significant variable determining the type of tissue damage is the waveform of the alternating electrical current. The sine wave may be pure, with continuous regular oscillations (undamped or unmodulated) (Fig. 5.2), or may be released in short bursts (dampened or modulated) (Fig. 5.3). The former is usually referred to as "cutting" and the latter as "coagulation" current. The two may be blended to produce a combination that cuts and coagulates (Fig. 5.4). The undampened waveform vaporizes tissue and is ideal for cutting when applied with an instrument of small surface area such as a needle electrode. If an instrument with a large surface area is used, tissue coagulation is the effect principally seen. Dampened current, on the other hand, has a widespread coagulating effect on the surrounding tissue, including blood vessels, and therefore is useful for hemostasis. Nonetheless, the use of dampened current, by virtue of its extensive coagulation, can produce widespread tissue damage and necrosis.

Additional variations in tissue effects can be achieved with changes in power density, electrosurgical instrument tip, and electric circuit used. Generally, higher power densities