Advances In Electrosurgery

By Ron Stoker

Although their effects can be devastating, percutaneous injuries from syringes and scalpels have historically been considered as an acceptable occupational hazard by surgical personnel. Everyone has been aware of the potential for injury and yet there have been few attempts to reduce the risk of such injuries.

T he operating room environment is unique among all healthcare settings (1). There is always intense pressure, close working quarters and a high concentration of sharps instruments and potentially infectious blood and body fluids (BBF). Several studies have shown that the skin and mucous membranes of operating room personnel may come in contact with blood or other fluids in as many as 50 percent of surgical procedures (2,3) Other studies have shown that OR personnel are at higher risk for injury as operative time, estimated blood loss, and number of personnel in the operative field increase (4).

The data indicates very little change in the rate of scalpel injuries in the OR in spite of the implementation of Universal Precautions, professional society protocols and new safety-engineered devices have helped decrease the incidence of injury for specific categories of sharps (5). What is causing this lack of change? It most likely reflects a combined failure on the part of healthcare workers to follow surgical safety protocols, the inadequate design of safety devices, and a resistance to using safety-engineered scalpels.

Another possibility for the lack of change in the rate of scalpel injuries may simply be due to the danger inherent to the sharp instrument itself. Sharps injury data collected during a 7 year period by the CDC may help support this conclusion: of 1700 recorded injuries 19 percent occurred during safety device activation, 7 percent because the user improperly activated the safety device, and in 27 percent the user did not activate the safety feature at all (6).

History of Electrosurgery

The scalpel has traditionally used by surgeons for skin incisions and fine dissection because of its precision and favorable healing profile. However, one of the biggest problems is that scalpel incisions result in bleeding that obscures the surgical field.

Effective techniques for bleeding control remained limited until the advent of electricity. The first electrosurgical generator, developed by William T. Bovie in 1914, directed high frequency electrical current through a metal probe to increase temperature in the patient's tissue directly adjacent to the probe. Today, this core technology platform is used in more than 17.5 million electrosurgical procedures in the United States annually .

The fundamental design of the electrosurgical generator and its accompanying handpiece has not changed dramatically through the years : continuous radiofrequency (RF) energy is delivered to the tissue via electrical arcing from a high-temperature, uninsulated metal probe. By adjusting the amplitude and waveform of the RF energy the function of the electrosurgical device may be changed from cutting to coagulation.

Traditional electrosurgery's (i.e. "the Bovie") hemostatic capabilities represents a major technological advance, but its lack of precision and deep thermal injury profile make it impractical for routine use as a primary surgical instrument. This thermal damage produces the functional destruction of adjacent tissues, and may damage nerves and delicate vasculature. This thermal damage increases wound scarring and results in delayed healing, and possibly increased infection rates as thermal debris may act as a "safe harbor" for bacteria. Because of these disadvantages, surgeons stick with traditional scalpels to make skin incisions and then use the electrosurgical device for subcutaneous dissection and bleeding control.

Advances In Electrosurgery

New advances in the electrosurgical arena have eliminated many of the disadvantages inherent to traditional electrosurgery. The use of electrosurgical plasma, induced with pulsed radiofrequency (RF) energy has emerged as a method for precision dissection with simultaneous hemostasis and an improved thermal injury profile. This technology, first described as PEAK® technology, utilizes very short bursts of RF energy to induce a plasma-mediated discharge along the edge of a very thin (12µm), flat, 99.5 percent insulated electrode. This conductive plasma allows RF energy to cross at much lower levels, leading to lower operative temperatures and less thermal damage (7). This technology has been commercially developed as the PEAK PlasmaBlade™ from PEAK Surgical, Inc (Palo Alto, CA), and is currently used in general, plastic, ENT, orthopedic and OB/GYN surgeries.

The use of electrosurgical plasma to effect the incisions and coagulation of blood combines the advantages of the scalpel's cutting precision and conventional electrosurgery's coagulation capability, while minimizing collateral thermal damage. These advantages have been shown to result in stronger healed wound strength, equivalent scarring to a scalpel, reduced serous drainage, and lower inflammatory cell counts in healing incisions.

Surgical site infections (SSI's) are serious operative complications that occur in approximately 2 percent of surgical procedures and account for some 20 percentof healthcare associated infections. A recent study utilizing the 2005 Healthcare Cost and Utilization Project National Inpatient Sample (HCUP NIS) examined the impact of SSI's on length of stay and cost. On a national average, the average SSI extended length of inpatient stay by 9.7 days and increased cost by $20,842 per admission (9).

The incidence of surgical Site infections may be reduced by a cooler operating temperature and improved thermal injury profile in electrosurgical plasma products. Specifically, reducing the amount of necrotic surgical debris and inflammatory response, in conjunction with the reduced narcotic use and faster return to normal activity, may present a distinct advantage over traditional electrosurgical devices in decreasing SSI incidence.

The cost to a hospital from operating room scalpel injuries is astronomical. Recent data on the cost of occupational BBF exposure from sharps injuries date to 2007 when the CDC published an analysis of four US healthcare facilities. Examining the direct and indirect costs to manage exposure, with an average frequency of 9.4 scalpel injuries per year for a 700 bed hospital results in a minimum cost of $3,534 per year, assuming all patients were of unknown infection status and there was no resulting mechanical injury (11, 12).

It is reasonable to conclude that the actual cost of scalpel injuries may be much higher. For example, a prominent hospital in Milwaukee recently shared that their estimated cost to manage scalpel-related injuries is nearly $10,000 per incident (13).

The introduction of safer alternatives in the OR is very important, particularly given the risks of injury, infection exposure and the costs associated with the traditional scalpel. It is only feasible, however, if those alternatives offer surgeons funcationality and handling equivalent or superior to the traditional surgical instruments they use now.

1 *Recommendations for Prevention of HIV Transmission in Healthcare Settings; MMWR Morb Mortal Wkly Rep 36 Sup pp21S-18S.*

2 Gerberding, JL, et al; Risk of exposure of surgical personnel to patients' blood during surgery at San Francisco General Hospital. N England J Med 1990: 322

3 Quebbeman, EJ; et al; Risk of blood contamination and injury to operating room personnel; Ann Surg. 1991:214

4 Jagger, JM et al; A study of patterns and prevention of blood exposures in OR personnel. AORN J 1998; 67:979-981

5 Jagger J, Perry J, Gomaa A, Phillips EK. The impact of US policies to protect healthcare workers from blood borne pathogens: The critical role. Journal of Infection and Public Health. 2008: 1: 62 – 71

6 Centers for Disease Control workbook for designing, implementing, and evaluating a sharps injury prevention program. Center for Disease Control and Prevention, Atlanta, GA USA. Available at: http://www.cdc.gov/sharpssafety/part2TEXTONLY.html [1]. 2008. Accessed April 13, 2009.
7 Stalder et al Applied Physics Letters 2001; Stalder et al J. Physics D: Applied Physics 2005
8 Palanker et al, Bioelectromagnetics 2007

9 De Lissovoy G, Fraeman K, Hutchins V, Murphy D, Song D, Vaughn BB. Surgical site infection: incidence on hospital utilization and treatment costs. Am J Infect Control. 2009 Jun;37(5):387-97.

10 Alp et al, J. Hosp. Infection 2006; Barrett Surg. Endosc. 2003; Bigony, AORN Journal 2007
11 Fuentes H, Collier J, Sinnott M, Whitby M. "Scalpel safety": Modeling the effectiveness of different safety devices' ability to reduce scalpel blade injuries. International Journal of Risk and Safety in Medicine.2008:20:83-89
12 O'Malley EM, Scott RDn, Gayle J et al. Costs of management of occupational exposures to blood and body fluids. Infect Control Hosp Epidemiol. 2007:28:774-782.
13 *PEAK Surgical Sales Force, personal communication. April 2009.*

Links:
[1] http://www.cdc.gov/sharpssafety/part2TEXTONLY.html