



MINIMALLY INVASIVE SURGERY HAS RAPIDLY GAINED ACCEPTANCE. BECAUSE MANY SURGEONS ARE ACCUSTOMED TO OPEN ELECTROSURGICAL APPLICATIONS, THEY FIND IT DIFFICULT TO APPRECIATE THE SIGNIFICANT DIFFERENCES WHEN USING EXTENDED ELECTRODES THROUGH THE TROCAR SLEEVE. THIS SOMETIMES RESULTS IN TRAUMATIC INJURIES. INSULATING SUCH ELECTRODES IS FALSE SECURITY -- SELECTING THE PROPER WAVEFORM IS EQUALLY OR EVEN MORE IMPORTANT. SURGEONS MUST BE KNOWLEDGEABLE ABOUT THE EFFECTS OF WAVEFORM, WATTAGE AND ELECTRODE SIZE.

A DANGEROUS SITUATION EXISTS IN LAPAROSCOPIC CHOLECYSTECTOMY. OUR REPAIR DEPARTMENT RECEIVES DOZENS OF BURNED ENDOSCOPIC HOOKS, SPATULAS, AND OTHER KINDS OF ELECTRODES OF ALL MAKES, WHICH CLEARLY SHOW THE FOLLOWING:

1. THE WRONG WAVEFORM OR EXCESSIVELY HIGH POWER SETTINGS ARE BEING USED BECAUSE STAINLESS STEEL DOES NOT MELT AT TEMPERATURES WHICH SHOULD PREVAIL DURING ELECTROSURGICAL PROCEDURES. THE RECOMMENDED NON-MODULATED WAVEFORM SHOULD BE AT A POWER SETTING NOT EXCEEDING 40 TO 60 WATTS -- BUT WATTAGE ALONE IS AN INSUFFICIENT CRITERION FOR SAFETY.
2. WHEN SURGEONS DEMANDED THAT HOOK AND SPATULA ELECTRODES BE INSULATED TO THE TIP, THE BURN-UP OF SUCH ELECTRODES, INCLUDING BLISTERING OF THE COATING, SIGNIFICANTLY INCREASED. BECAUSE BLISTERING IS CAUSED BY EXCESSIVE CURRENT DENSITY, EXCESSIVE HIGH POWER, AND THUS OVERHEATING OCCURS.
3. LAPAROSCOPIC CHOLECYSTECTOMY INVOLVES A SIGNIFICANT AMOUNT OF BLEEDING WITHIN THE SURGICAL FIELD. THE BLOOD QUICKLY DEHYDRATES ON AN OVER-HEATED ELECTRODE, MAKING THE ELECTRODE POORLY CONDUCTIVE OR EVEN NON-CONDUCTIVE. TO AVOID THIS PROBLEM, IRRIGATION AND SUCTION ARE MANDATORY.
4. NON-CONDUCTIVE IRRIGATES MUST BE USED IN ALL INSTANCES WHERE ELECTROSURGERY WILL BE PERFORMED. THE PRACTICE OF USING SALINE BASED IRRIGATES INCREASES THE RISK OF INJURY AND ELIMINATES THE PREDICTABILITY OF THE ELECTROSURGICAL CURRENT.

WITH THE GROWING POPULARITY OF ENDOSCOPIC SURGERY USING ELECTROSURGERY, THE RISK AND OCCURRENCE OF INJURIES WILL CONTINUE TO INCREASE UNLESS SURGEONS USE ELECTROSURGERY PROPERLY.

### THE MISLEADING WATT METER

WITH THE INTRODUCTION OF THE WATTAGE METER, A FALSE SECURITY WAS CREATED. A WATT IS ONE VOLT-AMPERE (VA). WATTAGE, THE MEASUREMENT OF POWER, IS VOLTAGE (V) MULTIPLIED BY AMPERAGE (A). BUT 20 WATTS CAN BE:

$20V \times 1A = 20 \text{ WATTS}$   
 $200V \times 0.1A = 20 \text{ WATTS}$   
 $2000V \times 0.01A = 20 \text{ WATTS}$   
 $10,000V \times 0.002A = 20 \text{ WATTS}$

IF A SURGEON IS CONVINCED THAT A GIVEN APPLICATION REQUIRES 20 WATTS, HE COULD BE USING INSUFFICIENT VOLTAGE OR EXCESSIVE VOLTAGE. FOR EXAMPLE, 20 WATTS FROM A LOW-VOLTAGE BIPOLAR GENERATOR COULD MEAN 200 VOLTS OR, IF THE BIPOLAR UNIT IS IMPROPERLY DESIGNED, IT COULD ENERGIZE THE BIPOLAR FORCEPS AT 10,000 VOLTS -- A DANGEROUS SITUATION. SUCH BIPOLAR GENERATORS ARE IN USE IN HOSPITALS TODAY!

THE SITUATION CAN BE EQUALLY AS MISLEADING FOR MONOPOLAR GENERATORS. TWENTY WATTS OF NON-MODULATED "CUTTING" CURRENT MAY ENERGIZE THE ELECTRODE AT ANY VOLTAGE FROM 400V TO 1,200V. IF THE OUTPUT IS SWITCHED TO THE MODULATED "BLENDED" OR "COAGULATION" CURRENTS, WITH THE SAME 20WATT SETTING, THE ELECTRODE WILL BEGIN DISCHARGING A HIGH-VOLTAGE ARC OF BETWEEN 1,500 TO 3,000 VOLTS. SUCH HIGH-VOLTAGE ARCING CAN BE BOTH MORE DESTRUCTIVE AND, PARTICULARLY IN THE ENDOSCOPIC ENVIRONMENT, MORE HAZARDOUS.

ANOTHER CONSIDERATION REGARDING WATTAGE INDICATORS IS THAT THEY ONLY SHOW THE POWER DELIVERED TO THE GENERATOR'S OUTPUT SOCKET UNDER A GIVEN IMPEDANCE LOAD, NOT THE CURRENT TO THE LOAD. MANY FACTORS AFFECT THE ELECTROSURGICAL CURRENT LEAVING THE UNIT THROUGH THE ATTACHED RF CONNECTION CABLE, SUCH AS VARYING IMPEDANCE AND/OR CAPACITANCE LEVELS, WHICH MAY BE DETERMINED BY THE LENGTH, DIAMETER AND CONFIGURATION OF THE RF CABLE (COAXIAL STYLE CABLES CREATE MORE CAPACITANCE IN THE CIRCUIT), AND THE ENVIRONMENT OF THE SURGICAL PROCEDURE PERFORMED. THE LONG, INSULATED INSTRUMENTS AND THE ASSOCIATED INSTRUMENT CANNULA USED IN ENDOSCOPIC SURGERY CREATE CAPACITANCE IN THE ELECTROSURGICAL CIRCUIT, MAKING THE HIGHER-VOLTAGE CURRENT HAZARDOUS BOTH TO PATIENT AND PERSONNEL. THIS ALSO RENDERS THE WATTAGE INDICATOR LESS USEFUL.

DIFFERENT GENERATORS ALSO HAVE SUBSTANTIALLY DIFFERENT OUTPUT VOLTAGE CHARACTERISTICS (20%), EVEN WITHIN ONE MANUFACTURER'S LINE. THEREFORE, THE 20-WATT OUTPUT LEVEL INDICATED ON THE DIGITAL METER CAN BE MISLEADING -- THE OUTPUT-VOLTAGE LEVEL MUST ALSO BE KNOWN AND TAKEN INTO ACCOUNT.

THE VOLUNTARY STANDARDS COMMITTEE OF THE AMERICAN ASSOCIATION OF GYNCOLOGICAL LAPAROSCOPISTS MADE ITS RECOMMENDATION TO THE BUREAU OF MEDICAL DEVICES OF THE U.S. FOOD AND DRUG ADMINISTRATION IN 1974 TO USE ONLY UNIPOLAR GENERATORS WITH A MAXIMUM OUTPUT POWER OF 100 WATTS, AND A MAXIMUM PEAK-TO-PEAK VOLTAGE TO 1200 VOLTS. THE PURPOSE OF THIS RECOMMENDATION WAS TO REDUCE THE RISK OF INJURIES, WHICH HAD OCCURRED ON NUMEROUS OCCASIONS, WHERE FOR ONE REASON OR ANOTHER A GENERAL ELECTROSURGICAL UNIT HAD BEEN TURNED UP TO AN EXCESSIVELY HIGH POWER LEVEL, OR WAS UTILIZING A MODULATED, HIGH VOLTAGE CURRENT. WE ALSO SUBSCRIBE TO THIS RECOMMENDATION

### CAPCITANCE

BECAUSE HIGH-VOLTAGE RF CURRENT CANNOT BE FULLY CONTAINED IN A CONDUCTOR BY INSULATION, A CERTAIN AMOUNT OF RF CURRENT WILL "LEAK". SUCH RF LEAKAGE CURRENT, WHEN PICKED UP BY THE METALLIC CANNULA, WILL BE DISSIPATED INTO THE ABDOMINAL TISSUE, RENDERING IT HARMLESS. IF IT SHOULD BUILD-UP, AN INJURIOUS DISCHARGE COULD TAKE PLACE. THEREFORE, METALLIC, REUSABLE SLEEVES ARE NOT ONLY CHEAPER IN OPERATING COST BUT ALSO SAFER.

### INSULATING THE ELECTRODES

INITIALLY, MOST OF THE ENDOSCOPIC ELECTRODES WERE INSULATED BY HEAT-SHRINK TUBING OR KYNAR. THIS INSULATING MATERIAL CAN WITHSTAND ALL THE HEAT USED DURING PROPER SURGERY OR AUTOCLAVING. AS POINTED OUT BEFORE, WHEN SURGEONS USE THE HIGH-VOLTAGE "COAGULATION" CURRENT, OVERHEATING AND DESTRUCTION OF THE ELECTRODE TAKES PLACE.

### BIPOLAR INSTRUMENTATION

BIPOLAR TECHNOLOGY HAS PROVIDED USEFUL INSTRUMENTATION FOR LAPAROSCOPIC SURGERY (E.G., SUCTION COAGULATORS). A NEW INSTRUMENT, THE BI-POL CUTTER (ELMED INCORPORATED) WILL ENHANCE ENDOSCOPIC CUTTING.

HOWEVER, BEWARE OF THE RISK OF IMPROPER WAVEFORM SELECTION FROM MANY POPULAR GENERATORS. FOR EXAMPLE, THE VALLEYLAB FORCE 4B, A POPULAR UNIT IN HOSPITALS, HAS TWO DIFFERENT BIPOLAR MODES. ONE IS DESIGNATED AS "STANDARD", AND FEATURES A MODULATED CURRENT WITH A PEAK-TO-PEAK VOLTAGE OF 1,800V. THIS WAVEFORM DOES NOT PROVIDE AN EQUAL AMOUNT OF CURRENT ON BOTH PRONGS OF THE BIPOLAR FORCEPS, WHICH MEANS ONE PRONG MAY GET TWICE THE CURRENT THAN THE OTHER, NEGATING THE TRUE PURPOSE OF BIPOLAR FORCEPS. IT ALSO RISKS INSTRUMENT DESTRUCTION, AND POSSIBLE UNDESIRABLE CLINICAL RESULTS.

THE SECOND MODE IS DESIGNATED AS "PRECISE", WHICH FEATURES A CLIPPED SINE WAVE WITH A PEAK-TO-PEAK VOLTAGE OF 600V. THIS WAVEFORM WOULD BE SAFER -- BUT IT ALSO DOES NOT PROVIDE EQUAL POWER TO THE ELECTRODES.

### ARGON ELECTROSURGERY

A NEW MODALITY, COMBINING ELECTROSURGERY WITH ARGON GAS, HAS BEEN INTRODUCED. ARGON GAS ENHANCES THE ARCING ENVIRONMENT. WHY DO WE WANT HIGH-VOLTAGE ARCING IN ENDOSCOPIC SURGERY? IN OPEN-AIR SURGERY, OFTEN SPRAY COAGULATION OFFERS PRACTICAL ADVANTAGES VERSUS CONTACT COAGULATION, BECAUSE THE SURGEON MAY CONTINUE UTILIZING THE CUTTING ELECTRODE AND COAGULATE BY MEANS OF ARCING SMALL BLEEDERS OR CAPILLARY BLEEDING.

ARGON GAS ENHANCES THE ELECTRICAL ARE, SO THAT THE PROCESS IS SOMEWHAT LIKE A FLAME THROWER. IN ENDOSCOPIC SURGERY WE WANT PINPOINT ACTION AND THUS, MY INITIAL QUESTION. WILL ARGON ELECTROSURGERY ENHANCE SURGERY OR CREATE NEW PROBLEMS?

### CONCLUSION

ELECTROSURGERY HAS SURVIVED A CENTURY AND WILL CONTINUE TO BE AN IMPORTANT SURGICAL MODALITY. ELECTROSURGICAL CURRENT OBEYS THE RULES AND LAWS OF PHYSICS -- AND SURGEONS MUST UNDERSTAND THESE RULES AND PRINCIPLES FOR SAFE USE. BIOMEDICAL ENGINEERS IN HOSPITALS SHOULD CONDUCT BASIC TRAINING COURSES FOR OPERATING ROOM NURSES AND SURGEONS, EXPLAINING WAVEFORM, PEAK-TO-PEAK VOLTAGE, WATTAGE, CAPACITANCE, AND THE ROLE OF ELECTRODE SIZE. ELMED OFFERS A FREE TRAINING BOOKLET ENTITLED "INTRODUCTION TO ELECTROSURGERY".

### WE DESIGN, MANUFACTURE, & SELL THE TOOLS THE SURGEONS USE

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