Vaporization and Coagulation Potentials of New Electrovaporization Devices for Transurethral Prostatectomy

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ABSTRACT

Recently, transurethral electrovaporization (EVAP) has been introduced as an alternative for transurethral electroresection as treatment for benign prostatic hyperplasia. This new method combines the use of high electrical power with special developed 'EVAP-elements'.

Four different EVAP-elements were applied to bovine myocard tissue with constant speed (1-4 mm/s) while constant force (20 gm) was applied. Two different electrosurgical generators, the F40 and F300 (both Valleylab) were used. The output power of the F40 decreases rapidly when the tissue impedance, between EVAP-element and return electrode, increases. The F300 has a built-in impedance feedback loop to remain the output power constant in the high impedance region.

When above threshold power all the different EVAP-elements vaporize on average 0.8 ml tissue per track of 5 cm length. Coagulation around the track extended 1-2 mm into the tissue, sufficient for hemostasis. The threshold power for the F300 was lower than with the F40, 175 and 250 W respectively, and depended on translation speed and EVAP-element.

I. INTRODUCTION

As an alternative to transurethral resection of the prostate (TUR-P) for the treatment of benign prostatic hyperplasia (BPH) a new electrosurgical technique has been introduced. This technique, called electrovaporization (EVAP) combines special-developed elements with high electrical power (200-300 Watt). In this study, the tissue effects of five different EVAP-elements were studied. Further two different electrical generators were compared.

II. MATERIAL AND METHODS

A. Electrosurgical elements

Different EVAP-elements for transurethral electrovaporization have been developed in the past year. They mainly consists of a cylinder, either with wide shallow grooves or with long narrow spikes. The devices incorporated in this study are the Single and Double Rollerbar (Prosurg), Large Barrow (Storz) and Vaportrode (Circon). Further the standard tool for coagulating, a ball electrode (Storz), was incorporated as well.

B. Electrosurgical Generators

The generators used for electrosurgery differ regarding frequency, modulation and output power. In most cases the output power is dependent on the impedance between active electrode (EVAP element) and return electrode. In this study we used two different electrosurgical generators: the Force 40 and the Force 300 (both Valleylab). In case of the Force 40 the output power drops rapidly when the impedance increases (which occurs when tissue dehydrates and becomes coagulated). Contrary, the Force 300 uses a feedback loop to correct for this impedance-depending behavior and therefore the power-impedance curve flattens (figure 1).

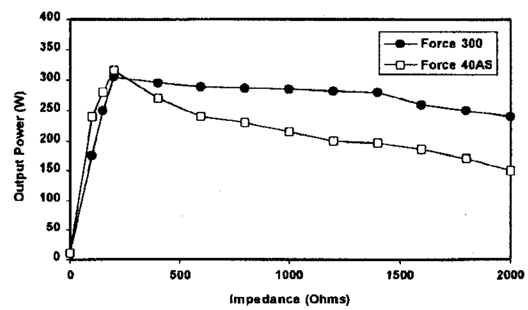

Figure 1. Influence of the impedance between active and return electrode on the output power at a fixed power setting of 300 Watt (monopolar, pure cut mode) for the Force 40 and the Force 300 electrosurgical generators (both Valleylab)[1,2].

Both generators show a decreased power output in the low impedance region (below 200 Ω). This has little impact on the clinical situation as the impedance of fresh tissue is usually over 300 Ω. In the experimental situation it might occur that the impedance is lower, therefore an extra impedance load of 300 Ω has been included in the circuit between generator and active electrode.

C. In-vitro removal of tissue

The EVAP-elements were moved over bovine myocard tissue that was submerged in glycine. A constant force of 20 grams was applied. The translation speed of the elements over the tissue varied between 1 and 4 mm/s. Both electrical generators (Force 40 and Force 300) were used. The power setting on the generators varied between 100 and 300 Watt. After the devices had been moved over the tissue, the macroscopic extent of vaporization and coagulation was measured. Then the total coagulated and vaporized tissue volume was calculated over the length of a 5 cm track.

III. RESULTS

The effect of the different electrosurgery devices on tissue was compared. The electrosurgery devices are usually operated between 200 and 300 Watt. As all devices are being used in a vaporizing mode (i.e., tissue is removed at the time of application), the power for the electrosurgery devices was set at 300 Watt. Figure 2 shows the differences in the vaporizing and coagulating power of all devices incorporated in this study.

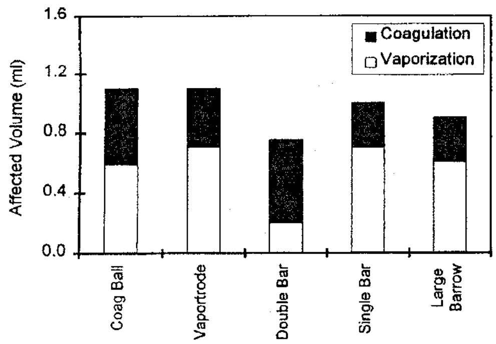

Figure 2. Tissue effects after application of five different EVAP-elements at 300 Watt.

The electrosurgical devices were studied at different power settings and different translation speeds over the tissue. The results of the Prosurg single Rollerbar are taken as an example. Figure 3 shows the calculated vaporized and coagulated volumes after application of the Prosurg single Rollerbar at different translation speeds and at different electrical powers.

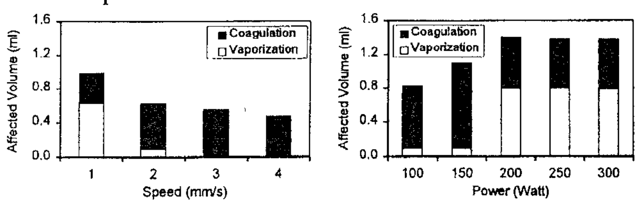

Figure 3. Tissue effects after application of the Prosurg single Rollerbar at 300 Watt, different speeds (left) and at 1 mm/s, different powers (right).

Both electrical generators (Force 40 and Force 300) were used with the Prosurg single Rollerbar. The power varied from 150 to 300 Watt. The results in figure 4 show that with both generators vaporization is possible at 300 Watt, while at 200 Watt similar effects are achieved with the Force 300, but hardly any vaporization occurs using the Force 40.

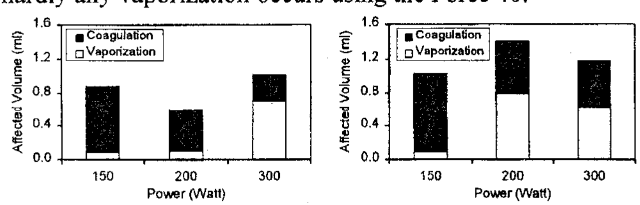

Figure 4 Tissue effects after application of the Prosurg single Rollerbar at 1 mm/s with the Force 40 (left) and the Force 300 (right) at different powers.

IV. DISCUSSION

The different EVAP-elements show similar behavior as to the potential for tissue removal. The extent of coagulation around the vaporized volume is limited and does not exceed 2 mm. Only the Double bar (Prosurg) provides less vaporization, while the coagulation zone is larger then with the other devices.

From the experiments comparing the tissue effects when applying different power settings (the other parameters being kept constant), it can be concluded that a certain threshold power needs to be exceeded before vaporization starts. Below that threshold only coagulation occurs. When the generator is set above threshold power increasing the power to a higher level does not increase the vaporized volume nor the coagulation zone significantly.

The experiments comparing the effect of translation speed, while the power and other parameters were kept constant, supports the theory that a certain threshold power needs to be exceeded before the tissue can be vaporized. Increasing the translation speed will increase the threshold power.

Two different electrical generators, Force 40 and Force 300, were used. The main difference between these devices is the impedance-dependence of the output power. The output power drops more rapidly when the Force 40 is applied then when the Force 300 is applied. The results obtained with the Force 40 are probably comparable to those obtained with the Force 300 at a lower power setting, when corrected for this impedance-output power relation.

Except from the parameters mentioned above, the threshold power above which vaporization occurs, may differ as well, e.g., from tissue type and patient.

V. CONCLUSION

Provided that the set power exceeds a threshold power effective tissue vaporization can be obtained with the studied EVAP-elements. The threshold power depends on generator type, EVAP-element and translation speed. Above threshold power coagulation, necessary for hemostasis, is limited to a depth of 2 mm.

VI. REFERENCES

1. Instruction manual of the Force 30/40, Valleylab, Boulder (CO), 1992.
2. Instruction manual of the Force 300, Valleylab, Boulder (CO), 1992.