Electrosurgical Plasma Devices-Some Physics, Chemistry, and Medical Applications

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Electrosurgical devices employing plasmas to ablate, cut and otherwise treat tissues have been in widespread use for decades. Following d'Arsonval's 19th century work on the neuromuscular response from high-frequency excitation of tissue, Doyen treated skin blemishes with a spark-gap generator in 1909. In the late 1920's, physician Harvey Cushing and physicist William Bovie [1] developed an electrosurgical device and power source that eventually became a standard of care for cutting, coagulating, desiccating, or fulgurating tissue. Beginning in the 1990's a new class of electrosurgical devices, employing electrically-conducting fluids were developed by ArthroCare Corp. and other medical device manufacturers. These modern devices are now widely used in many different surgical procedures, including those in arthroscopic surgery, otorhinolayrngology, spine surgery, urology, and gynecological surgery, and others [2].

This talk will include an introductory review of some of the research we have been doing over the last decade to elucidate the physics and chemistry underlying modern electrosurgical devices. I will also show some videos of several procedures employing these devices. Electrical-, thermal-, fluid-, chemical- and plasma-physics all play important roles in these devices and give rise to a rich variety of observations. Experimental techniques employed include optical and mass spectroscopy [3], fast optical imaging [4], and electrical voltage and current measurements. Many of the features occur on fast time scales and small spatial scales, so coupled-physics finite-element-modeling can also be employed to glean more information than has been acquired so far through physical observation [5].

References

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