The design of the PlasmaJet® thermal plasma system and its application in surgery

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The majority of recent papers in the field of plasma medicine have described the potential clinical applications of low-temperature or so-called "cold" plasmas, usually generated by a dielectric barrier discharge. These applications include disinfection and wound healing, but these non-thermal plasmas have low power density and have insufficient power to produce a surgical effect.

By contrast, to create thermal plasma that has a surgical effect requires an arc discharge in a device designed to deliver a much higher power density of 1 – 5 kW/mm^3. In the PlasmaJet® system a multiple electrode array is used to generate a thermal plasma with high power density that can deliver an output power of 20 – 300W using a very low flow of argon gas of typically 0.2- 0.6 l/min. The resulting plasma has the ability to cut and coagulate all tissues including bone.

The PlasmaJet system comprises a console providing an initial ignition pulse of up to 3kV followed by a DC voltage in the 30 – 50V range to maintain the plasma flow. The console also provides control electronics for the user interface and a circulating coolant to maintain the handpiece tip at a low temperature. A range of sterile single-use handpieces for open and laparoscopic surgery complete the system. The PlasmaJet system is both CE marked and FDA cleared for use in surgery, and extensive clinical experience including over 1,300 fully documented cases has confirmed its ability to cut with the precision of the surgical laser but with greater coagulation capability and enhanced safety.

As an electrically neutral energy source, the PlasmaJet handpiece provides a safer alternative to conventional electrosurgery. The thermal plasma can achieve temperatures in the region of 10 – 20,000 degrees Kelvin, but it is short-lived and at the low gas flow employed, the amount of damage to underlying and adjacent tissue is minimal – typically less than 0.2 – 0.5mm, which his less than that found with any other surgical technology.

The ability to cut tissue precisely and with simultaneous coagulation of the cut surfaces and minimal damage to underlying structures makes the PlasmaJet a valuable new energy source for use in surgery. The first papers have now appeared in peer reviewed journals confirming its abilities in a range of surgical applications.

This presentation will describe the PlasmaJet system, discuss the effects of this thermal plasma energy at the tissue level, and illustrate some of its applications in surgery.