



Microwave Treatment of Prostate Cancer and Hyperplasia

Additional uses are found for a relatively inexpensive microwave treatment system.

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Microwave ablation in the form of microwave energy applied to a heart muscle by a coaxial catheter inserted in a vein in the groin area can be used to heat and kill diseased heart cells. A microwave catheter has been developed to provide deep myocardial ablation to treat ventricular tachycardia by restoring appropriate electrical activity within the heart and eliminating irregular heartbeats. The resulting microwave catheter design, which is now being developed for commercial use in treating ventricular tachycardia, can be modified to treat prostate cancer and benign prostatic hyperplasia (BPH). Inasmuch as the occurrence of BPH is increasing — currently 350,000 operations per year are performed in the United States alone to treat this condition — this microwave catheter has significant commercial potential.

The microwave operating frequency affects the heating depth. An electrophysiologist will be able to take advantage of the physics of depth of penetration (in particular, the variations of conductivity and permittivity of tissue with frequency) to focus the microwave beam. The power level and delivery time also affect the balance between the increase in heat (due to the absorption of microwave energy) and the loss of heat (due to conduction away from targeted cells). A computer program that simulates the heating profile has been written to assist in determining the balance needed to necrose targeted cells while saving non-targeted cells.

There are several variations of microwave radiators suitable for treating specific regions of the prostate or the prostate as a whole. The following three configurations are suitable for treating specific conditions and specific locations:

- *Single Antenna Within the Urethra*

A single antenna radiates within the urethra. A urethra catheter can be made to include a phase-change material surrounding the radiation tip to prevent a significant temperature rise without need for a water cooling system. The phase-change material must, of course, be nearly transparent to the microwave radiation. This material provides localized cooling to protect the urethra from damage, but permits microwave heating to occur beyond the urethra, into the prostate. For treatment over the entire prostate, or over large regions of the prostate, it may be necessary to use several throwaway catheters because one may not contain sufficient phase-change material. Calculations have shown the feasibility of this approach, provided that a phase-change material that has the desired characteristics can be found.

- *Multiple Colon Antennas*

Multiple colon catheter antennas can be phased and directed toward the prostate to provide localized temperature gradients in the regions of the prostate located near the colon. Cooling must be provided to protect the colon and the intervening tissue. Prostate cancer often begins in the prostate near the colon and should be treatable with this

technique. Computer simulations show that by adjusting the locations of the microwave radiators and the phases of their microwave signals, the heating centers in the prostate can be adjusted to necrose critical regions only.

- *Single Urethra Antenna and Two Colon Antennas*

Combinations of urethra and colon microwave radiators can be used to provide treatment appropriate to specific problems. Generally, one microwave catheter in the urethra, when working together with one or more catheters in the colon, can provide localized heating to satisfy most requirements. By adjustment of frequency, phase, directionality, and duration of the microwave radiation, one can select from among a wide array of heating profiles in the prostate. Computer simulations indicate that these three antennas can be properly phased together for focusing the heated region.

Laboratory tests of the single urethra antenna and two colon antennas are now underway, using phantom material to represent the prostate gland.

This work was done by G. Dickey Arndt and Phong Ngo of Johnson Space Center, J. R. Carl of Advanced Electromagnetics, and George Raffoul, consultant.

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, Johnson Space Center, (281) 483-0837. Refer to MSC-23049.