

PROGRESS ON CONFORMAL MICROWAVE ARRAY APPLICATORS FOR HEATING LARGE AREA CHEST WALL DISEASE

Stauffer P.¹, Maccarini P.¹, Juang T.², Jacobsen S.³,
Gaeta C.⁴, Schlorff J.⁵, Milligan A.⁵

¹ Radiation Oncology Dept., Duke University Medical Center, Durham NC USA

² Radiation Oncology Dept., University of California San Francisco, CA USA

³ Department of Physics and Technology, University of Tromso, Norway.

⁴ IPITEK Corp, 2330 Faraday Avenue Carlsbad, CA USA

⁵ Bionix Development Corp. Station Square Two, Suite 107, Paoli, PA USA

Purpose: Previous studies have reported the computer modeling and theoretical performance of single and multiple antenna arrays of Dual Concentric Conductor (DCC) square slot radiators driven at 915 and 433 MHz. Practical CAD designs of microstrip antenna arrays constructed on thin and flexible printed circuit board (PCB) material were reported which evolved into large Conformal Microwave Array (CMA) sheets that can wrap around the human torso for delivering microwave energy to large areas of superficial tissue. Although uniform and adjustable heating patterns have been demonstrated from CMA applicators in simple homogeneous phantom loads, this effort describes additional design efforts required to achieve good coupling and efficient heating from large conformal array applicators treating chestwall recurrent breast cancer patients with an irregular tissue surface overlying contoured anatomy.

Methods: Recent work has extended the theoretical optimization of DCC antennas to improve radiation efficiency of each individual aperture and reduce mismatch reflections, radiation losses, noise, and cross coupling of the feedline distribution network of large array configurations. Design improvements have also been incorporated into the supporting bolus structure to maintain effective coupling of DCC antennas into contoured anatomy and to monitor and control surface temperatures under the entire array. New approaches for non-invasive monitoring of surface and sub-surface tissue temperatures under each independent heat source are described that make use of microwave radiometry and flexible sheet grid arrays of fiberoptic thermal sensors.

Results: Efforts to further improve the CMA applicator radiation pattern and clinical patient interface and move from simple planar rectangular shapes to contoured vest shaped applicators that accommodate entire disease in a larger number of patients are summarized. This includes results in the following areas:

- Changed flexible printed circuit board (PCB) feedline network from open microstrip to buried coplanar waveguide structure to increase efficiency and improve noise immunity of antennas
- Designed and tested new triangular and pentagon shaped DCC antennas that provide smooth SAR contour around the perimeter of vest shape applicators with curving sides
- Integrated non-invasive surface tissue thermometry for more comprehensive monitoring and control using radiometry and fiberoptic array thermal monitoring sheet (TMS) technologies
- Improved bolus design to ensure tight comfortable fit of CMA on convex and concave anatomy
- Measured conformity of CMA to realistic contoured patient anatomy
- Quantified flow balance and temperature uniformity across large coupling bolus surface

Conclusion: By applying heat more uniformly to large areas of contoured anatomy, the CMA applicator resulting from the above enhancements should improve the quality of heat treatment and expand the number of patients that can benefit from effective heating of superficial disease in combination with radiation or chemotherapy.

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