

## MICROWAVE THERMOTHERAPY OF RECURRENT CHEST-WALL CARCINOMA

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### ABSTRACT

During the past four years, 42 patients with chest-wall recurrence of breast carcinoma were treated with microwave thermotherapy and ionizing radiation. Complete or subtotal tumor regression and healing of lesions was achieved in about 70% of the patients.

### INTRODUCTION

Breast cancer is the leading cause of cancer death for women in the United States. At the present rate, one out of every 14 women will develop breast cancer sometime in her lifetime. Primary breast cancers are usually treated by surgery or by radiation therapy, or by a combination of the two. Breast cancer may locally recur months or even many years after the original treatment of the primary cancer. Local recurrence presents a serious problem because it causes pain and frequently infections, but most importantly because the new growth becomes a source of tumor dissemination.

Management of patients with local recurrence of breast cancer is difficult using conventional therapies, particularly if a full tolerance dose of radiation was administered during the treatment of the primary tumor (5000 rad to the chest wall after mastectomy, 5000 rad + 1500 rad boost dose if the breast was preserved). An additional course of radiation is hazardous because it would likely cause excessive radiation damage, surgery is risky because healing is likely to be poor in a previously fully irradiated field; and the effectiveness of chemotherapy is usually low because the vascular system, damaged as the result of the previous radiation, frequently is unable to supply adequate amounts of chemotherapeutic agents to the tumor.

Thermotherapy is well-suited as an adjuvant therapeutic modality in treating recurrent chest-wall carcinoma because (1) chest-wall lesions, since they are on the surface, are easily accessible for heating, (2) thermotherapy can be safely applied to tissues that have been previously irradiated, and (3) thermotherapy enhances the effectiveness of radiation therapy, so that good results can often be obtained with small amounts of radiation combined with thermotherapy.

### CLINICAL EXPERIENCE

During the past four years we have treated 42 patients with chest-wall recurrence of breast cancer with combinations of ionizing radiation and microwave thermotherapy. Usually the patients

have been referred to us when trials of chemotherapy, hormonal therapy or additional radiation have failed to produce regression.

A typical tumor field may present problems which require an individualized approach in delivering the thermotherapy. The lesions may occupy a large area and be widely spaced; scar tissue, a result of previous surgery which often crisscrosses the field, may overheat easily due to a poor vascular supply; nerve endings in the tumor site might have been damaged by surgery or scarring, thus lowering the patient's perception of heat and increasing the possibility of local burns.

Most of the recurrent chest-wall lesions are fairly superficial and a frequency of 2450 MHz is well-suited to induce tumor heating to the hyperthermic range. A variety of 2450 MHz applicators (Figure 1) are used depending on the status, shape, size and location of the lesions.<sup>1</sup>

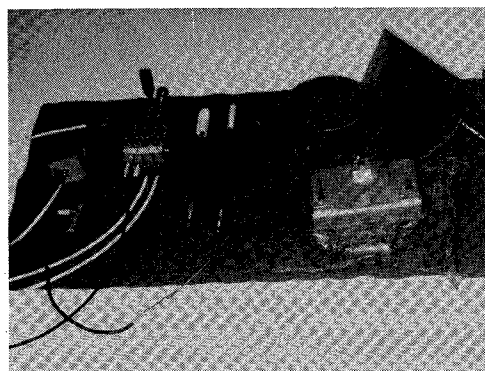


Fig. 1. Waveguide, coaxial, and conformal applicators for microwave thermotherapy.

For ulcerated wet lesions we use the "C"-type Burdick noncontacting antenna initially in order to achieve drying and also because contact applicators cause much pain at this stage. Air-filled waveguide applicators can also be used for this purpose but must be impedance-matched to the tissues with an external tuner.

Small lesions can be treated with dielectrically-loaded waveguide applicators that have a 1-2 cm<sup>2</sup> treatment area, prematched to muscle tissue. These applicators can be used singly or in a multiple array system for small, dispersed lesions.

We found the most versatile units for the treatment to be the conformal ("bean-bag") applicators (Figure 2), which have been built in different sizes.

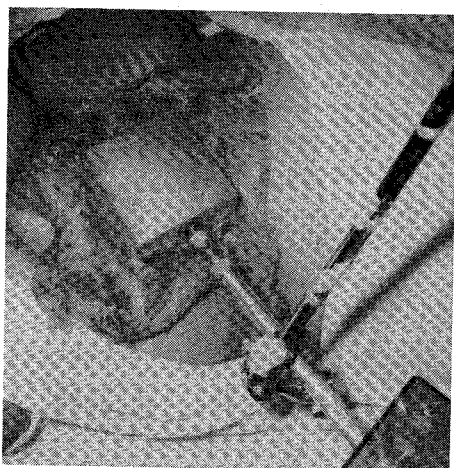


Fig. 2. "Bean-bag" conformal applicator shown in a typical application.

These applicators can conform to irregular surface masses and are particularly suitable for the types of tumors encountered on the chest wall and are the applicators that are most frequently used. Interstitial arrangements<sup>2</sup> can also be used to advantage, in some instances, particularly for bulky chest-wall tumors.

A "cross-fire" applicator arrangement, in which two conformal applicators are placed on opposite sides of the tumor site, has been utilized for treating primary breast tumors, recurrent tumors in the preserved breast, and large protruding tumors. Protruding tumors that are up to 5 cm wide can be uniformly heated using this technique. Tumors which are embedded in the fatty tissues of the breast can also be heated using this technique even though the distance between the two applicators is greater than 5 cm. This is possible because the fatty tissues have a lower water content than the tumor and therefore the energy can penetrate deeper into these tissues and selectively heat the tumor.

Our treatment protocol is based on our clinical experience and biological data. In order to insure a maximum therapeutic response and to take advantage of the synergistic effects of heat and x-radiation, we use the two modalities conjunctively whenever possible. Patients who have exhausted their tolerance dose of radiation are treated with hyperthermia alone.

Thermotherapy is administered as soon as possible after radiotherapy and is scheduled twice weekly 48-72 hours apart in order to overcome the expected period of thermal tolerance. The ionizing radiation treatments are given three times a week, but fractions are kept at the lowest effective level so that the treatment period can be extended to at least five weeks and at least ten thermotherapy sessions can be delivered.

A typical thermotherapy session lasts 45-60 minutes. Intratumor temperature is targeted at 42-43°C. Temperature is monitored by means of several copper-constantan thermocouples placed on the surface of the tumor. We believe that limited invasive intratumor temperature measurements do not provide adequate information regarding heat distribution patterns within an irregular, widely spread tumor

mass with an uneven vascular network, but they do add greatly to the patient's discomfort. We have therefore been using mostly non-invasive temperature measurements during our clinical trials. A surface temperature of 42-43°C represents in our experience, based on animal and phantom experiments, sufficient assurance that the temperature within superficial tumors has reached the therapeutic range.

In summary, patients with chest-wall lesions secondary to breast carcinoma are usually treated as follows: ionizing radiation therapy - total dose between 1500 rad to 3000 rad depending on previous radiation -- is given in three fractions weekly, usually between 150 rad to 200 rad per fraction. Twice-a-week radiotherapy is immediately followed by one hour of hyperthermia delivered with an appropriate 2450 MHz applicator. Surface temperature is maintained at 42-43°C. Ten to 16 treatments are administered in most cases.

The patients tolerate the treatment very well. If discomfort due to an inadvertent hot spot is experienced, the patients are instructed to signal, thus enabling us to adjust the applicator to assure proper heat distribution. The occasional burns or blisters heal without significant complications. We have not observed any other serious adverse effects.

The response to the combined treatment has been encouraging with either complete or subtotal tumor regression and healing of lesions observed in about 70% of patients.

Patient L.H. illustrates a typical case history and one of our more rewarding results.

Case History: L.H., a 75 year old woman, underwent a left radical mastectomy in 1978 for breast cancer. Her first local recurrence one year later was treated with surgical excision; the second recurrence in 1980 responded temporarily to tamoxifen (hormonal treatment) but in 1981 multiple nodules appeared on the chest wall and continued to grow rapidly in spite of stillbesterol, (another hormone). In March 1982, when the tumors were hard and fixed measuring 6x6, 6x3 and 2x2 cm, the patient was started on radiotherapy with Cobalt beam. After 2500 rad there was no response. At this point, the patient was referred to us for thermotherapy. Radiation continued at the same schedule and microwave hyperthermia was administered twice a week using the bean-bag applicator. The tumors began to decrease rapidly. After 4400 rad and ten hyperthermia treatments there was complete tumor regression (Figures 3 and 4). There has been no recurrence during the subsequent 12-month observation period.

#### SUMMARY OF RESULTS

The results of treatment of our patients are summarized in Table 1. These results nearly correspond to those of other workers in the field.<sup>3</sup> When interpreting these results it should be kept in mind that the majority of patients treated by us arrived in very poor physical condition. These patients, who are often debilitated, whose immune system has been substantially suppressed, and who may suffer from general spread of malignancy, would respond poorly to any type of treatment. Thus even temporary or partial tumor regression or relief of pain are in a way therapeutic victories.

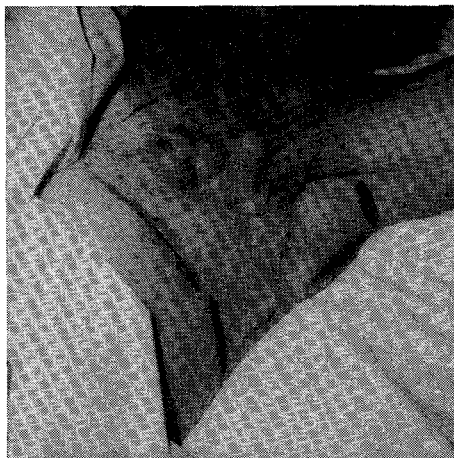


Fig. 3. Patient L.H. after 2500 rad of Cobalt beam and prior to thermotherapy.

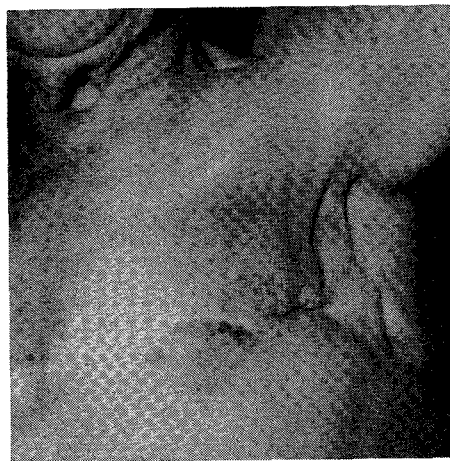


Fig. 4. Patient L.H. after 4400 rad and ten hyperthermia treatments.

Table I

Summary of Responses to Thermotherapy Combined with Radiation Therapy in Chest-Wall Recurrences of Breast Carcinoma.

<u>Response</u>	<u>No.</u>	<u>%</u>	<u>Duration</u>
Complete Response	17	40%	2 months to 2 years no tumor regrowth
Partial Response	13	30%	1 month to 18 months no progression of tumor
No Response	8	19%	
Not Evaluable	4	11%	

#### CONCLUSION

Microwave thermotherapy is a safe and effective adjuvant to conventional modalities in the treatment of locally recurrent carcinoma of the breast. A variety of microwave applicators are required to treat the different types of chest-wall lesions that are encountered.

#### ACKNOWLEDGMENTS

This work was partially supported by a grant from the Cancer Research Institute, New York, NY

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