Cooperative Clinical Studies of Hyperthermia Using a Capacitive Type Heating Device
GHT-RF8(Greenytherm)

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Yonsei Cancer Center developed an RF(Radiofrequency) capacitive type heating device, GHT-RF8(Greenytherm)
in cooperation with Green Cross Medical Corp., Korea in 1986 for the first time in Korea. Cooperative clinical
studies of hyperthermia for the treatment of cancer using GHT-RF8 were conducted by Yonsei Cancer Center
in collaboration with the Presbyterian Medical Center, Chonju, Korea. A total of forty patients with various
histologically proven malignant tumors, including superficial (N=13) and deep-seated tumors (N=27), were treated
with this newly developed heating device in conjunction with radiotherapy (N=38) or chemotherapy (N=2) at
two different institutes between October 1986 and September 1987.

These patients were locally far advanced or recurrent cases and considered to be refractory to conventional
cancer treatment modalities. Radiotherapy was given in 200cGy per day, five times a week fractionations
with a total tumor dose of 50-60Gy in 5-6 weeks. Within an hour after radiotherapy, the RF capacitive type
of hyperthermia was given two times a week for a total of 4-10 treatment sessions and an attempt was made
to maintain the tumor temperature at 41-45°C for 30-60 minutes. Of forty patients treated, 14 patients with
deep-seated tumors showed complete response and 20 patients showed partial response. The overall response
rate was 85% (34 out of 40 patients) and only 6 patients showed no response. Complications from this treatment
were mainly burns, superficial first degree burn in 2 cases, second degree in 4 cases and subcutaneous
fat necrosis was observed in 2 cases. These side effects were all self-limited and gradually disappeared within
2-3 months after completion of the treatment. In conclusion, our cooperative clinical studies showed that the
capacitive heating device, GHT-RF8 (Greenytherm) can safely be applied to patients without significant toxicities
and the local tumor control appeared to be excellent in both superficial and deep-seated tumors.

Key Words: Hyperthermia, capacitive heating, deep heating, GHT-RF8 (Greenytherm)

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on Hyperthermic Oncology, Kyoto, Japan, 1988 and at the annual
meeting of the North Radiological Society of North America(RSNA),
Chicago, USA, 1988. GHT-RF8 (Greenytherm) was approved as the
first hyperthermia equipment in treatment of cancer by the Ministry
of Health and Social Affairs of Korea based on the results of this study
in 1987.

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Hyperthermia-elevation of temperature above normal levels has been used for the treatment of various
diseases including cancer for many years.

Hippocrates wrote in his aphorism in 400 BC that "The disease that cannot be cured by medicine,
could be cured by surgery. Those that can not be cured by surgery can be cured by heat, and those heat
does not cure must be considered incurable".

A German physician(Busch 1986) observed that a sarcoma of the face disappeared after a prolonged
ersipelas infection. W.Coley (1893), a New York surgeon, extracted an erysipelas toxin (Coley's toxin) to
induce fever to a number of cancer patients and the results were favorable. Westermark(1927) first in-
troduced the concepts of dose-time response and histopathologic evaluation of thermal effects.

However, wide-spread use of heat has only been
common in recent years, mainly because of better understanding of the biology and physics of hyperthermia and improvement of the technology of heat delivery systems and thermometry in the early 1960's. Cirele (1962) reported cases of local tumor control in dog and human tumor after combining microwave heating with low dose radiotherapy. Cavaliere et al. (1967) announced that tumor cells were apparently selectively thermosensitive compared with normal cells at temperatures from 42°C to 45°C. This report, coupled with the interesting technical means to produce such temperatures, laid the foundation for local hyperthermia as a cancer therapy (Storm et al. 1983).

The rationale for hyperthermia as a cancer therapy is summarized as follows: 1) heat kills cells exponentially as a function of heat at temperature above 42°C (Dewey et al. 1977), 2) heat selectively kills S-phase, hypoxic cells, and also nutritionally deprived acidic cells (Li et al. 1980), 3) heat interacts synergistically with ionizing radiation and certain chemotherapeutic agents (Bichsel et al. 1979, Hahn et al. 1979), and 4) differences in the vasculature in tumors versus normal tissues should lead to a degree of preferential heating and selective biologic effects in tumor tissues (Song et al. 1980, 1986).

Yonsei University Hospital and Yonsei Cancer Center have embarked on hyperthermia treatment for cancer patients using microwaves since 1982 and in 1985 installed a capacitive type of hyperthermia using a radiofrequency of 8 MHz (Thermotron RF-8 manufactured by Yamamoto Vinyet Co., Japan) for the first time in Korea. Encouraging clinical results with this equipment have been reported (Loh et al. 1987, 1988). Since foreign hyperthermic equipment is very costly to purchase and maintain, there has been a need for Korean engineers to develop and manufacture a heating device capable of raising temperatures not only for superficial but also for deep-seated tumors to a therapeutic range. The first generation of a capacitive type of an 8 MHz radiofrequency hyperthermia device was developed by the Department of Radiation Oncology at Yonsei University Hospital, Yonsei Cancer Center, the College of Engineering of Yonsei University and Green Cross Medical Corp., and was installed at Yonsei Cancer Center. An experimental study with agar phantom and animal has been successfully done and was reported (Chu et al. 1987). The second generation was then installed at the Department of Radiotherapy, Presbyterian Medical Center, Chonju, Korea. The two institutes collaborated to conduct cooperative clinical studies using the newly developed GHT-RF8 (Greenytherm) on the basis of experimental phantom and animal studies.

These cooperative clinical studies are designed primarily to study safety, toxicity, and effectiveness of the newly developed RF capacitive type of heating device, GHT-RF8 (Greenytherm).

**MATERIALS AND METHODS**

Heating device (GHT-RF8, Greenytherm)

Fig. 1. shows the newly developed 8 MHz capacitive type of hyperthermia equipment, GHT-RF8 (Greenytherm, manufactured by Green Cross Medical Corp., Korea). It basically consists of: 1) an RF generator, 2) a rotational gantry, 3) a treatment table couch, 4) a cooling system provided with 5 different sizes of electrodes; 10, 15, 20, 25 and 30 cm in diameter, and 5) a computer controlled operating console with key board and plotter. A block diagram of the system is shown is Fig. 2.

The principle of RF heating is that as the 8 MHz radiofrequency electric current produced by the RF generator flows between the two paired electrodes, atoms within the medium or body are excited and ionized. These molecular frictions within the tissue generate heat in the medium or body.

A metal plate of electrodes is wrapped with a sheet of flexible vinyl and filled with 0.4% NaCl solution circulating between the electrodes and the heat exchangers. This circulating saline bolus keeps the skin surface cool while the RF energy can be delivered to the deep-seated tumor sites with a relatively homogeneous high temperature. The temperature of the circulating saline is maintained at 5-10°C in most cases unless the tumor is located superficially.

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Fig. 1. Newly developed 8 MHz capacitive type heating device, GHT-RF8 (Greenytherm).
Thermometry system

The appropriate selection of the size of electrodes is dependant on the location and size of the tumor. When using paired electrodes, the high temperature zone can be shifted by employing a different size of electrode, for example, a desired high temperature zone is shifted toward the area of smaller electrodes. Generally, the large size of paired electrodes, i.e. 30cm in diameter, is used for abdominopelvic tumors for the purpose of obtaining a central high temperature zone.

Five Teflon coated sensor probes of copper-constantan micro-thermocouples (Sensortek, Inc., Type IT-18, New Jersey) provided with the GHT-RF8 system can measure the temperature within ±0.2°C accuracy through an automatic temperature power feedback controller and RF filter. These temperature probes were inserted directly into the tumor or adjacent normal tissue either through a 19 or 21 gauge angiocatheter or intraluminally, e.g. through the esophagus, stomach or rectum, by a nasogastric tube in which direct intratumoral temperature measurement was not feasible. These procedures were performed with ultrasound or CT guided aids.

Patients’ characteristics

A total of forty patients with various malignant tumors were treated with hyperthermia using the GHT-RF8 in conjunction with radiotherapy or chemotherapy at the Department of Radiation Oncology from the previously mentioned two institutes between October 1986 and September 1987 (Table 1). The age of the patients ranged from 13 to 69 years with a mean age of 48 years. There were 13 men and 27 women. Squamous carcinoma was the most common histology (N=27) followed by adenocarcinoma (N=6). According to the location of the tumors, there were 13 superficial tumors, mainly from head and neck cancers, and 27 cases of deep-seated tumors. All patients were locally far advanced (N=23) or recurrent (N=17) after surgery or radiotherapy and they were all thought to be refractory to conventional cancer treatment modalities.

Treatment methods

Radiation Therapy: Radiotherapy was given with
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Table 1. Patients' characteristics

<table>
<thead>
<tr>
<th>Number of Patients</th>
<th>40</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>Male:Female=13:27</td>
</tr>
<tr>
<td>Age Distribution</td>
<td>From 13 to 69 years</td>
</tr>
<tr>
<td></td>
<td>Mean 43 years</td>
</tr>
<tr>
<td>Histologic Distribution</td>
<td></td>
</tr>
<tr>
<td>Squamous cell</td>
<td></td>
</tr>
<tr>
<td>Carcinoma</td>
<td>27</td>
</tr>
<tr>
<td>Adenocarcinoma</td>
<td>6</td>
</tr>
<tr>
<td>Undifferentiated ca.</td>
<td>2</td>
</tr>
<tr>
<td>Adenosquamous cell ca.</td>
<td>1</td>
</tr>
<tr>
<td>Transitional cell ca.</td>
<td>1</td>
</tr>
<tr>
<td>Leiomyosarcoma</td>
<td>1</td>
</tr>
<tr>
<td>Intraductal cell ca.</td>
<td>1</td>
</tr>
<tr>
<td>Malignant melanoma</td>
<td>1</td>
</tr>
<tr>
<td>Location of Tumors</td>
<td></td>
</tr>
<tr>
<td>Superficial</td>
<td>13</td>
</tr>
<tr>
<td>Head &amp; Neck</td>
<td>10</td>
</tr>
<tr>
<td>Others</td>
<td>3</td>
</tr>
<tr>
<td>Deep-seated</td>
<td>27</td>
</tr>
<tr>
<td>Pelvis</td>
<td>22</td>
</tr>
<tr>
<td>Abdomen</td>
<td>4</td>
</tr>
<tr>
<td>Chest</td>
<td>1</td>
</tr>
<tr>
<td>Disease Status</td>
<td></td>
</tr>
<tr>
<td>Locally advanced</td>
<td>23</td>
</tr>
<tr>
<td>Recurrent</td>
<td>17</td>
</tr>
</tbody>
</table>

Oct. 1986-Sep. 1987

200 cGy per day, five times a week fractionations employing telecobalt 60 or Linear Accelerators with a total tumor dose of 50-60 Gy in 5-6 weeks, depending on the histology and disease status. Remote controlled intracavitary radiation was added in some cases of cervical cancer.

Hyperthermia: Hyperthermia using a capacitive type of radiofrequency at 8 MHz, GHT-RF8(Greenytherm), was induced twice a week for a total of 4-10 sessions, usually 30-60 minutes after radiotherapy or 60-90 minutes after chemotherapy.

An attempt to maintain 40-45°C for 30-60 minutes was made throughout the entire sessions of hyperthermia. Radiation therapy was combined with hyperthermia in 37 cases, chemotherapy was combined in 2 cases, and 1 case was treated with hyperthermia only (Table 2). Intratumoral temperature was measured via direct insertion of a 19 or 21 angiocatheter through which a thermal sensor probe was placed in 26 patients, and the temperature of the adjacent normal tissue or intraluminal temperature was measured in 14 patients (Table 3).

Table 2. Treatment methods

| Heating Machine: GHT-RF8 (Green Cross Medical Corp., Korea) |
| Hyperthermia: Each session: 40°C-45°C for 30-60 min. Interval: 72-96 hours Total No. of session: 4-10 |
| Radiotherapy: 200 cGy/day, 5 times a week Total 5000-6000 cGy |
| * RT+HT: 37 cases |
| * CT+HT: 2 cases |
| * HT alone: 1 case |
| Sequence: RT/CT given 30-60 min. prior to HT. |

Table 3. Temperature measurement

<table>
<thead>
<tr>
<th>Superficial Tumor</th>
<th>Deep-seated Tumor</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intratumoral</td>
<td>12</td>
<td>14</td>
</tr>
<tr>
<td>Adjacent</td>
<td>1</td>
<td>13</td>
</tr>
<tr>
<td>Vaginal fornix</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Stomach</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Esophagus</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Rectum</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

Table 4. Response evaluation

| Evaluation time: 1-3 months after the completion of treatment |
| Evaluation criteria: |
| Complete response (CR): Complete disappearance of all objective evidence of disease. |
| Partial response (PR): Decrease of 50% or more in the sum of the products or the two greatest perpendicular diameters of all measurable lesions with no new lesions. |
| No response (NR): Decrease of less than 50% in the sum of these measurements, or evidence of disease progression. |
Evaluation criteria of tumor response

Criteria for evaluation of tumor response were established according to the three categories of CR (Complete response), PR (Partial response), and NR (No response) as shown in Table 4. Evaluation was done by physical examination and radiographs, including CT scan, within 1-3 months after completion of the treatment.

<table>
<thead>
<tr>
<th></th>
<th>Superficial Tumor</th>
<th>Deep-seated Tumor</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CR</td>
<td>14</td>
<td>14 (35)</td>
<td>85%</td>
</tr>
<tr>
<td>PR</td>
<td>12</td>
<td>8</td>
<td>20 (50)</td>
</tr>
<tr>
<td>NR</td>
<td>1</td>
<td>5</td>
<td>6 (15)</td>
</tr>
</tbody>
</table>

Table 5. Tumor response

Fig. 3. Pretreatment (A) and Post-treatment (B) CT scan of a patient (Lee, M/60 yrs) with colon cancer and liver metastasis. Radiotherapy (RT) was given by a 10 MeV Linear Accelerator at a dose of 180 cGy 5 times a week for a total of 3060 cGy over a 4 week period. Hyperthermia (HT) was given twice a week for a total of 7 sessions. HT started 30 minutes after RT. On the post-treatment CT scan (B), the previously noted huge metastatic tumor shows marked necrosis.

Fig. 4. Pretreatment (A) and post-treatment (B) CT scan are shown of a patient (Koh, F/50 yrs) with cervix cancer stage IVa with bladder invasion. Radiotherapy (RT) was administrated by a 10 MeV Linear Accelerator at a dose of 180 cGy, 5 times per week. A total of 4500 cGy was applied to the whole pelvis over a 5 week period and a 1500 cGy boost was applied to the pelvic side wall. Hyperthermia (HT) treatments were conducted twice a week for a total of 10 sessions. The HT treatment commenced 30 minutes after RT. The post-treatment CT scan (B) shows nearly complete response of the tumor mass.
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Fig. 5. Pre-treatment (A) and post-treatment (B) CT scan are shown of a patient (Ji M, 51 yrs) with stomach cancer with paraaortic lymph node metastasis. The patient was treated with radiotherapy (RT) by a 10 MeV Linear Accelerator at a dose of 180 cGy, 5 times a week, for a total of 5040 cGy over 6 weeks. Hyperthermia (HT) was induced twice a week for a total of 8 sessions. The HT started 30 minutes after the RT. The post-treatment CT scan (B) reveals marked tumolysis of the bulky paraaortic mass.

Table 6. Complications of hyperthermia

<table>
<thead>
<tr>
<th></th>
<th>Superficial Tumor</th>
<th>Deep-seated Tumor</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1° burn</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>2° burn</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Fat necrosis</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

RESULTS

Tumor response

As shown in Table 5, CR was achieved in 14 patients with deep-seated tumors (35%) and PR was achieved in 20 patients (50%). 12 with superficial and 8 with deep-seated tumors. The overall response rate was 85%. Only 6 patients (15%) showed NR. Some of the cases are illustrated in Fig 3, 4 and 5.

Complications

The most common complaint during the heat treatment was the hot sensation or pain particularly the edge of the electrode. This discomfort could be minimized by using a large electrode, i.e. 30cm in diameter, which allows the patient to tolerate the heat relatively well. As shown in Table 6, a superficial first degree burn was observed in 2 patients, and second degree burn in 4 patients. Subcutaneous fat necrosis was observed in 2 patients. These painful, tender masses gradually disappeared within 2-3 months after completion of the treatment. There were no significant toxicities requiring hospitalization or intensive medical care.

DISCUSSION

Of the many heating methods, the most promising modes for inducing local hyperthermia are those involving the use of electromagnetic waves, e.g. radiofrequency waves of 100KHz-100MHz, microwaves of 100MHz-3000MHz, and ultrasound waves of 0.5-10MHz(U et al. 1982)

Ultrasound at frequencies between 0.3 to 6.0 MHz gives effective heating of superficial lesions when used in stationary modes. For deeper targets, focusing scanning or the use of multiple transducers is essential. Furthermore, ultrasound cannot be used for tumors located beyond air containing organs or bone (Stewart et al. 1984)

Electromagnetic frequencies suitable for human cancer therapy are 13.56, 27.12, 40.46, 915 and 2450 MHz(U et al, 1983). For commonly used high frequencies at 930-2450 MHz, applicators can be small, coupling is effective and relatively localized energy
depositions are easily attained. However, the depth of effective heating is limited to 1-3 cm in most circumstances (Stewart et al. 1984). Diathermy at a frequency of 434 MHz by a commercially available European device has been used clinically, however, the physics of the device indicate that it is unlikely that deep heating can be achieved (Paliwal et al. 1980).

Hyperthermia by using ultrasound or microwave has been clinically used extensively for superficial tumors and very encouraging clinical results have been reported (Marmor et al. 1980, Perez et al. 1983). However, clinical applications for deep seated tumors have been virtually absent mainly because of inadequate development of heating devices (Hiraoka et al. 1987, Stewart et al. 1984).

To achieve deeper heating, frequencies below 100 MHz are employed, either as propagative waves or in an induction mode. Applicators must be large due to the long wave length at low frequency. Selective heating of deep tumors is possible, particularly if they are hypoperfused relative to adjacent normal tissues (Stewart et al. 1984).

Leveen et al. (1980) reported clinical application of RF capacitive hyperthermia using 3 pairs of electrodes but his results were disappointing and the description of thermometry was very limited. Two RF capacitive heating devices using a frequency of 13.56 or 8 MHz (Thermotron RF-8) were developed in Japan in 1979 and 60 deep-seated tumors in 59 patients were treated with this equipment. It was possible to raise the intratumoral temperature to the therapeutic level without significant toxicities, except for preferential excessive heating of subcutaneous fat tissue resulting in fat necrosis, which is the major disadvantage of the capacitive type of heating (Abe et al. 1986, Hiraoka et al. 1987). Preferential fat heating is due to low electric conductivities and lack of blood flow of the fat tissue. Elliot (1982) reported that when the combined thickness of the skin and fat layer in man was below 1 cm, the temperature of the skin and fat layer could be maintained below a physiologically tolerable level. Kato (1985, 1986) calculated the one dimensional bioheat equation and showed that when the thickness of the fat layer is below 1.6 cm, the muscle in the deep portion could be heated without excessive heating of fat tissue.

Hiraoka et al. (1987) presented a paper based on clinical data that 80% of tumors could be heated to at least 42°C when the thickness of the subcutaneous fat layer was below 2 cm. Careful selection of the patient is therefore necessary to avoid this problem. RF current also interferes with bone, gas and metal within the body causing hot and cold spots beyond these areas.

GHT-RF8 (Greenytherm) is a capacitive type of hyperthermia using an 8 MHz radio-frequency developed by the Yonsei Cancer Center in cooperation with Green Cross Medical Corp., Korea. This system includes: 1) an 8 MHz RF producing generator with maximum variable power of 2000 w, 2) a gantry capable of 0-180° rotation, 3) a treatment table with capability of up-down and forward-backward movement, 4) a cooling system provided with 5 different sizes of electrodes; 10, 20, 25 and 30 cm in diameter, wrapped with a 0.4% NaCl solution circulating water bolus, and 5) computer controlled operating console with key board and plotter. This system is provided with 5 copper-constantan temperature sensors (microthermocouple, Sensortek, Inc., Type IT-18, New Jersey), which have the capability of measuring temperature through a 19 or 21 gauge angiocatheter within ±0.2°C accuracy. Selective and homogeneous heating, depending on the location of the tumor, is possible by using an appropriate combination of the 5 different sizes of electrodes. Surface skin can be well protected from excessive heating with the saline circulating water bolus covered by flexible vinyl which can fit any anatomical sites to be treated, including irregular body contours such as the head and neck and thorax.

As mentioned earlier, preferential heating of fat tissue is the major problem with this capacitive type of device. We experienced 2 cases of fat necrosis which is usually painful and causes tender mass but these symptoms were gradually diminished and disappeared within 2-3 months after the treatment. This side effect can be minimized by the use of a precooling method and overlay bolus and can be avoided by choosing a patient with less than a 2 cm thick fat layer.

Another problem is the generation of excessive heat near the edge of the electrodes and most patients complained of a hot sensation beyond the area of the rim of the electrode. This edge effect can be minimized by using the large bolus, i.e. 30 cm in diameter, provided with the GHT-RF8. Inadequate contact of bolus and body surface leaving a small air gap also produces a hot sensation and uniform application of electrically-conductive jelly over the contact surface is one of the important initial steps.

There were several problems in measuring the temperature and the thermometry system. In all 40 cases, temperatures were measured invasively by inserting an angiocatheter through the tumor and normal tissue directly or indirectly by a nasogastric tube through the adjacent lumen i.e. esophagus, rectum,
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or stomach. Twenty-six of 40 patients could be heated to over 42°C which is the maximum temperature within the tumors and 14 patients were measured from the adjacent normal tissue or indirectly through an intraluminal method. The incidence of thermal damage to normal tissue has been related to maximum tumor temperature.

Measurement of minimum or average temperature has been shown to have significant correlation with the prognosis when assessing the efficacy of the heating (Dewhirst et al. 1984). However, measurement of the minimum or average temperature above 42°C was not possible because although the RF capacitive heating device can sufficiently raise the temperature of the center of the tumor to the therapeutic range, it cannot heat all areas of the tumor mass to the therapeutic range. This difficulty in achieving a whole tumor temperature greater than 42°C seems to be a common problem for regional deep heating and it is well known that intratumor temperatures during hyperthermia are very nonuniform. (Hiraoka et al. 1987, Dewhirst et al. 1984).

The temperature nonuniformity that develops during hyperthermia is the result of multiple factors, including nonuniform power deposition and nonuniform tumor perfusion rates, which vary spatially through the tumor volume (Dewhirst et al. 1984). Currently, no temperature monitoring system is commercially available to document the minimal tumor temperature within the tumor mass. The recent development of thermal mapping techniques has begun to reveal the full extent of the problem. For those patients in whom temperature measurement is not possible because of various reasons including general condition, hyperthermia can be induced at the maximum RF power that patients can tolerate.

Considering that all of our patients group were locally far advanced or recurrent and no effective cancer treatment modalities were available, our clinical results of an 85% response rate with the GHT-RF8 could be considered to be excellent. When evaluating these clinical results, hyperthermia using GHT-RF8 has a definite therapeutic role in deep-seated tumors and we were able to raise the temperature with this heating device.

Systemic manifestations including changes in pulse rate and blood pressure were not observed in our study and these are not limiting factors for power evaluation. These findings are in striking contrast to those by regional deep heating with an annular array system in which systemic symptoms and signs are the predominant power limiting factors (Sapozink et al. 1984).

Although the RF capacitive type heating includes several unsolved problems as mentioned above, its clinical effectiveness proves advantageous in application to cancer patients, and further technical improvement and development are expected to resolve these problems.

In conclusion 1) The GHT-RF8 heating machine can be used safely in patients with various cancers. 2) Tumor response appeared to be excellent even in far advanced diseases. 3) Intratumoral temperature to the therapeutic range can possibly be achieved with this device while the skin surface can be protected from excessive heating. 4) There were no significant complications during and after hyperthermic treatment. 5) The Ministry of Health and Social Affairs of Korea approved GHT-RF8 hyperthermia equipment for cancer treatment for the first time in Korea on the basis of the results of this cooperative clinical study.

REFERENCES


