RESEARCH ARTICLE

Long-term Efficacy of Microwave Hyperthermia Combined with Chemoradiotherapy in Treatment of Nasopharyngeal Carcinoma with Cervical Lymph Node Metastases

Min Kang, Wen-Qi Liu, Yu-Tao Qin, Zhu-Xin Wei, Ren-Sheng Wang*

Abstract

Objective: The long-term efficacy of microwave hyperthermia combined with chemoradiotherapy in treating nasopharyngeal carcinoma (NPC) with metastatic foci in cervical lymph nodes was evaluated. Methods: A total of 154 cases of N2 or N3 stage NPC were randomized into two groups: hyperthermia group (76 cases) and control group (78 cases). Both received cisplatin chemotherapy and radiotherapy. In addition, the hyperthermia group further received microwave hyperthermia to the metastatic cervical nodes with different patterns (before or after radiotherapy), heating temperatures (T90 < 43°C and T90 ≥ 43°C) and hyperthermia episodes (< 4 times, 4-10 times and > 10 times). Results: The 3-month and 5-year complete response (CR) rates of cervical lymph nodes in the hyperthermia group were significantly higher than those in the control group. The 5-year disease-free survival (DFS) rate and the 3-year / 5-year overall survival rate in the hyperthermia group were also significantly higher. There was no significant difference in 5-year metastatic rates. In the hyperthermia group, the 3-month and 5-year CR rates of T90 < 43°C treatment were significantly lower than with T90 ≥ 43°C treatment. The CR rate was highest when the hyperthermia was performed 4-10 times. There were no significant differences in 3-month and 5-year CR rates between hyperthermia before or after radiotherapy treatment. Conclusion: Microwave hyperthermia combined with chemoradiotherapy can increase local control, DFS and 3, 5-year overall survival rates of patients with N2 ~ N3 stage NPC. The heating temperature should be over 43°C with hyperthermia repeated 4-10 times.

Keywords: Nasopharyngeal carcinoma - metastatic node - chemoradiotherapy - hyperthermia - efficacy

Asian Pac J Cancer Prev, 14 (12), 7395-7400

Introduction

Nasopharyngeal carcinoma (NPC) is a unique type of head and neck cancer in terms of epidemiology, method of treatment and prognosis, and is particularly prevalent in Southeast Asia (Roychowdhury et al., 1996; Erkal et al., 2001; Liu et al., 2003). The incidence of cervical lymph node metastasis in nasopharyngeal cancer (NPC) is high. About 70% ~ 80% of newly diagnosed NPC patients have enlarged cervical lymph nodes (Yin et al., 2008). After radiotherapy and chemotherapy, some enlarged cervical lymph nodes still exist in NPC patients. Increased local radiation dose is likely to lead to severe radiotherapy complications, such as skin ulcers, neck fibrosis and cranial nerve damage (Tate et al., 1999; Teo et al., 2000; Lee et al., 2001; Wolden et al., 2001; Levendag et al., 2002; Lu and Yao, 2008). However, without increased radiation, local recurrence and distant metastasis rate will certainly increase. Microwave hyperthermia combined with radiotherapy and chemotherapy has been used widely and successfully in clinic.

The effects of microwave hyperthermia on tumor cells are as follows. Firstly, hyperthermia has cytotoxic effects on tumor cells. The thermo sensitivity of tumor cells is higher than normal cells. Tumor cells would be killed after treatment at 42°C for 2 h. Due to their high thermo sensitivity, the temperature of tumor cells is 3°C-7°C higher than that of surrounding normal tissues when heating. Therefore, appropriate hyperthermia will directly kill tumor cells without injuring surrounding normal tissues. Secondly, radiation-insensitive tumor cells are mainly S phase cells and hypoxic cells, which are highly sensitive to hyperthermia. Thirdly, hyperthermia can inhibit the damage repair of tumor cells after radiotherapy (Zastrow et al., 2010; Ghahremani et al., 2011; Colombo and Moschini, 2013). Fourthly, because of the sufficient blood supply in tumor surrounding tissues, the cytotoxicity of hyperthermia on surrounding tissues is much less severe than that on tumor center. The hyperthermia treatment failure is mainly due to the peripheral tumor recurrence while radiotherapy failure is mainly due to local recurrence in the tumor center. Therefore, combination of hyperthermia and radiotherapy can have a synergistic sensitizing effect (Perez and Brady,
Table 1. Clinical Data of NPC Patients Used in This Study

<table>
<thead>
<tr>
<th>Clinical features</th>
<th>Hyperthermia group</th>
<th>Control group</th>
<th>X²</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cases</td>
<td>76</td>
<td>78</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>Male</td>
<td>54</td>
<td>62</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>22</td>
<td>16</td>
<td>3.178</td>
</tr>
<tr>
<td>Age (year)</td>
<td>Range</td>
<td>18 ~ 65</td>
<td>19 ~ 68</td>
<td>1.41</td>
</tr>
<tr>
<td>Pathologic type</td>
<td>WHO II</td>
<td>6</td>
<td>7</td>
<td>1.402</td>
</tr>
<tr>
<td></td>
<td>WHO III</td>
<td>70</td>
<td>71</td>
<td></td>
</tr>
<tr>
<td>N staging</td>
<td>N2</td>
<td>41</td>
<td>40</td>
<td>0.533</td>
</tr>
<tr>
<td></td>
<td>N3</td>
<td>35</td>
<td>38</td>
<td></td>
</tr>
<tr>
<td>Clinical staging</td>
<td>III</td>
<td>33</td>
<td>34</td>
<td></td>
</tr>
<tr>
<td>KPS scoring</td>
<td>90</td>
<td>19</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td></td>
<td>80</td>
<td>43</td>
<td>44</td>
<td>0.042</td>
</tr>
<tr>
<td></td>
<td>70</td>
<td>14</td>
<td>21</td>
<td>1.104</td>
</tr>
</tbody>
</table>

KPS, Karnofsky performance status

1987; Li et al., 2004; Nikfarjam et al., 2005). Fifthly, hyperthermia can upregulate expression of pro-apoptotic genes while downregulate expression of apoptosis suppressor genes (Li et al., 2004). Sixthly, hyperthermia enhances cytotoxicity of some chemotherapy drugs, such as cisplatin. In vitro experiments (Zheng et al., 2006) showed that the anti-cancer effect of chemotherapy drugs can be enhanced 10 to 100 times after heating at 42°C for 2 h. Combination of heating and chemotherapy drug can increase the drug concentration within the tumor and increase its anticancer effect. And the toxicity of chemotherapy drugs on unheated normal tissues can be reduced, which will help prevent or delay the drug resistance. Therefore, it is shown by a number of clinical trials that the efficacy of combined treatment including hyperthermia, radiotherapy and chemotherapy were better than the efficacy of each therapy alone (Song et al., 2006; Chen et al., 2009).

Currently, the specific details of hyperthermia treatment such as timing, treatment times and temperature are still controversial. In this study, the long-term effect of hyperthermia in combination with radiotherapy and chemotherapy on NPC patients with cervical lymph node metastasis was investigated. A total of 154 cases of NPC patients at stage N2 ~ N3 were enrolled in this study. The complete response rate, the disease-free-survival rate and the survival rate were analyzed. The number, temperature and timing of hyperthermia were compared.

Materials and Methods

Patient Selection

Patients who fulfilled all of the following criteria were enrolled in this study: (1) NPC confirmed by biopsy and histology; (2) no evidence of distant metastasis; (3) no previous treatment for NPC; (4) T1-4N2-3M0 disease according to the staging system of the 2002 American Joint Committee on Cancer (AJCC) / International Union Against Cancer (UICC) (Fleming et al., 1997); (5) adequate liver function; (6) adequate renal function; (7) adequate bone marrow function; and (8) Karnofsky performance status (KPS) ≥80. The exclusion criteria were as follows: (1) presence of distant metastases; (2) pregnancy or lactation; (3) previous malignancy or other concomitant malignant disease; and (4) without previous radiotherapy, chemotherapy or immunotherapy.

Pretreatment Evaluation

Pretreatment evaluation included a complete history and physical examination with nasopharyngoscopy, chest radiography, ultrasonography of the abdominal region, and hematologic and biochemical profiles. Additional investigations were performed if indicated. Magnetic resonance imaging (MRI) and Contrast-enhanced computed tomography (CT) of the nasopharyngeal region and neck were performed to determine stage. The disease was staged according to the 2002 AJCC/UICC staging classifications.

Clinical data

From January 2007 to September 2008, 154 cases of nasopharyngeal patients at stage N2 ~ N3 were treated in the First Affiliated Hospital of Guangxi Medical University (Table 1), including 116 males and 38 females and with male to female ratio of 3.1:1. They were aging from 18 to 68 years old, with median age of 47 years. All cases were confirmed by histopathological examination. Of them, 13 cases were World Health Organization (WHO) subtype II (8.4%), and 141 cases were WHO subtype III (91.6%). Patients were randomly divided into control group (78 cases, radiotherapy + chemotherapy) and hyperthermia group (76 cases, radiotherapy + chemotherapy + hyperthermia). Of the 78 cases in the control group, 34 cases were in clinical stage III (2002 UICC staging system), and 44 cases were in stage IV. Of the 76 cases in hyperthermia group, 33 cases were in stage III, and 43 cases were in stage IV. Cervical lymph node metastasis (2002 UICC staging system) were all in stage N2 ~ N3. There was no significant difference in KPS score, histological type, clinical stage and N stage between two groups (P > 0.05).

Prior written and informed consent was obtained from every patient and the study was approved by the ethics review board of Guangxi Medical University.

Treatment method

(1) Control group: Control group received radiotherapy combined with chemotherapy. Radiotherapy was performed by weekly exposure of 2Gy per day for 5 days. The primary foci firstly received X ray of 6 MV on face and neck with a dose of DT36 Gy. Afterwards, fields before ear of both sides received radiation of DT34 ~ 40 Gy. The total radiation for nasopharynx was DT70 ~ 78 Gy, 35 to 39 times and 47 to 51 d in total. After the 6 MV perpendicular X ray radiation dose on cervical lymph node metastasis site reached 50 Gy, 9 to 12 MeV electron beam radiation was used as supplement with total vertical radiation amount of DT68 ~ 72 Gy for 34 ~ 36 times in total of 46 ~ 50 d on the neck and with prophylactic dose of DT50 ~ 54 Gy.

Concurrent chemotherapy was performed during radiotherapy, which consisted of cisplatin alone (80 mg/
Microwave Hyperthermia for Control of Nasopharyngeal Cancer

Table 2. Lymph Node Regression Rate and Survival Rate Analysis (n (%))

<table>
<thead>
<tr>
<th>Hyperthermia group (n = 76)</th>
<th>Control group (n = 78)</th>
<th>X²</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>CR rate (%)</td>
<td>62 (81.6)</td>
<td>49 (62.8)</td>
<td>5.537</td>
</tr>
<tr>
<td>PR rate (%)</td>
<td>14 (18.4)</td>
<td>27 (34.6)</td>
<td>4.378</td>
</tr>
<tr>
<td>SD rate (%)</td>
<td>0 (0)</td>
<td>2 (2.6)</td>
<td>1.674</td>
</tr>
<tr>
<td>Efficacy (%)</td>
<td>100</td>
<td>97.4</td>
<td>2.976</td>
</tr>
<tr>
<td>Survival rate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-year survival rate</td>
<td>74 (97.4)</td>
<td>73 (93.6)</td>
<td>0.546</td>
</tr>
<tr>
<td>3-year survival rate</td>
<td>65 (85.5)</td>
<td>48 (61.5)</td>
<td>3.87</td>
</tr>
<tr>
<td>5-year survival rate</td>
<td>52 (68.4)</td>
<td>39 (50.0)</td>
<td>11.338</td>
</tr>
<tr>
<td>5-year local control rate</td>
<td>73 (96.1)</td>
<td>60 (76.9)</td>
<td>11.961</td>
</tr>
<tr>
<td>5-year distant metastasis rate</td>
<td>28 (36.8)</td>
<td>34 (43.6)</td>
<td>0.729</td>
</tr>
<tr>
<td>5-year DFS rate</td>
<td>39 (51.3)</td>
<td>16 (20.5)</td>
<td>15.908</td>
</tr>
</tbody>
</table>

The assessments included blood tests, biochemistry profiles, chest radiography, abdominal ultrasonography, and CT of the nasopharynx and cervical region. Further investigations were arranged as indicated. Management of residual disease and tumor relapse, if detected, was determined on a case-by-case basis. Nasopharynx MRI should be performed every six months. Local or cervical lymph node recurrence was examined by pathologic diagnosis. Suspicious metastasis was analyzed by thoracic and abdominal CT and bone scintigraphy. Acute and late adverse reaction was evaluated by standards of USA Radiation Therapy Oncology Group or European Organization for Research and Treatment of Cancer (Cox et al., 1995). Efficacy evaluation was in accordance with WHO Response Evaluation Criteria in Solid Tumors and classified as complete response (CR), partial response (PR), incomplete response/stable disease (SD) and progressive disease (PD). Neck mass was assessed by CT results. Regression of cervical lymph nodes was assessed 3 months after treatment. Complete regression was recorded as CR, and tumor size regression ≥ 50% was PR.

Statistical analysis

SPSS 17.0 software was used for statistical analysis. The Kaplan-Meier (Kaplan and Meier, 1958) method was used to compare the overall survival rate. Pearson Chi-Square test was used for the analysis of distant metastasis rate, disease-free survival rate (DFS) and local control rate. P < 0.05 was considered statistically significant.

Results

Regression rate of cervical lymph nodes in hyperthermia group is higher at 3 months after treatment

At 3 months after treatment, regression rate of cervical lymph nodes was evaluated. As shown in Table 2, the CR rate in hyperthermia treatment group and control group was 81.6% and 62.8%, respectively. And the difference between these two groups was significantly different (P < 0.05). Thus hyperthermia group had higher regression rate of cervical lymph nodes.

The 3-year and 5-year survival rates in hyperthermia group are higher

The follow-up was ended in May 2012, or 5 years after treatment or patient death, with a median follow-up time of 58 months. The follow-up was performed by telephone or letters and with successful rate of 96.1% (148/154). The 1-year, 3-year and 5-year survival rates were calculated. The results were shown in Table 2. The 1-year survival rate in hyperthermia group and control group was 97.4% and 93.6%, respectively. The 3-year survival rate in hyperthermia group and control group was 68.4% and 50.0%, respectively. Statistically, there were significant differences in the 3-year and 5-year survival rate (P < 0.05), but not the 1-year survival rate (P > 0.05), between the hyperthermia group and control group. Therefore, hyperthermia group had higher 3-year and 5-year survival rates.
Table 3. The Lymph Node Regression in Hyperthermia Group Treated with Different Hyperthermia Pattern at 3-month and 5-year after Treatment (n (%))

<table>
<thead>
<tr>
<th>Hyperthermia pattern</th>
<th>n</th>
<th>3-month</th>
<th>5-year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>CR rate (%)</td>
<td>PR rate (%)</td>
</tr>
<tr>
<td>Hyperthermia before radiotherapy treatment</td>
<td>36</td>
<td>28 (77.8)</td>
<td>8 (22.2)</td>
</tr>
<tr>
<td>Hyperthermia after radiotherapy treatment</td>
<td>40</td>
<td>33 (82.5)</td>
<td>7 (17.5)</td>
</tr>
<tr>
<td>X²</td>
<td></td>
<td>0.267</td>
<td>0.267</td>
</tr>
<tr>
<td>P</td>
<td></td>
<td>0.606</td>
<td>0.606</td>
</tr>
</tbody>
</table>

CR, complete response; PR, partial response

Comparison of adverse reactions

Two patients in control group and four patients in hyperthermia group presented skin moist dermatitis on the neck when the radiation dose was 45 to 55 Gy. After short suspension of radiotherapy and corresponding treatment for skin moist dermatitis, the skin healed and the treatment for NPC was continued. The moist dermatitis incidence was 5.7% (4/76) in hyperthermia group, and 2.6% in control group (P < 0.01). While the 5-year distant metastasis rate (36.8% vs. 43.6%) was not statistically significant (P > 0.05).

Table 4. The Lymph Node Regression in Hyperthermia Group Treated with Different Temperature at 3-month and 5-year after Treatment (n (%))

<table>
<thead>
<tr>
<th>T90 (°C)</th>
<th>n</th>
<th>3-month</th>
<th>5-year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>CR rate (%)</td>
<td>PR rate (%)</td>
</tr>
<tr>
<td>&lt; 43</td>
<td>28</td>
<td>18 (64.3)</td>
<td>10 (35.7)</td>
</tr>
<tr>
<td>≥ 43</td>
<td>42</td>
<td>36 (85.7)</td>
<td>6 (14.3)</td>
</tr>
<tr>
<td>X²</td>
<td></td>
<td>4.375</td>
<td>4.375</td>
</tr>
<tr>
<td>P</td>
<td></td>
<td>0.036</td>
<td>0.036</td>
</tr>
</tbody>
</table>

CR, complete response; PR, partial response

Table 5. The Lymph Node Regression in Hyperthermia Group with Different Hyperthermia Treatment Times at 3-month and 5-year after Treatment (n (%))

<table>
<thead>
<tr>
<th>Times of hyperthermia</th>
<th>n</th>
<th>3-month</th>
<th>5-year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>CR rate (%)</td>
<td>PR rate (%)</td>
</tr>
<tr>
<td>&lt; 4</td>
<td>15</td>
<td>10 (66.7)</td>
<td>5 (33.3)</td>
</tr>
<tr>
<td>4-10</td>
<td>38</td>
<td>31 (81.6)</td>
<td>7 (18.4)</td>
</tr>
<tr>
<td>&gt; 10</td>
<td>23</td>
<td>16 (69.6)</td>
<td>7 (30.4)</td>
</tr>
<tr>
<td>X²</td>
<td></td>
<td>3.906</td>
<td>0.035</td>
</tr>
<tr>
<td>P</td>
<td></td>
<td>0.046*</td>
<td>0.851</td>
</tr>
</tbody>
</table>

Compared with hyperthermia times of 4-10 times, *P < 0.05. CR, complete response. PR, partial response

Hyperthermia pattern dose not affect regression of cervical lymph nodes

In order to evaluate the effect of hyperthermia pattern on regression of cervical lymph nodes, 76 patients in hyperthermia group were treated differently, with 36 patients received hyperthermia before radiotherapy and 40 patients received hyperthermia after radiotherapy. There was no significant difference in gender, age, KPS score, histological type, clinical stage and N stage between these patients with different hyperthermia pattern (P > 0.05). The regression of cervical lymph nodes at 3 months and 5 years after treatment were evaluated, as shown in Table 3. The differences between hyperthermia before radiotherapy treatment and hyperthermia after radiotherapy treatment in CR rate were not significant (77.8% vs. 82.5%, 91.7% vs. 95.0%) (P > 0.05).

Heating temperature of T90 ≥ 43°C has higher cervical lymph node regression rate

Seventy cases of patients from hyperthermia group with well temperature curve were further analyzed for heat dosage. They were divided into patients with T90 < 43°C treatment (28 cases) and patients with T90 ≥ 43°C treatment (42 cases). There was no significant difference in gender, age, KPS score, histological type, clinical stage and N stage between these patients with different heating temperature (P > 0.05). At 3 months after treatment, the CR rate in patients with T90 < 43°C treatment and T90 ≥ 43°C treatment were 64.3% and 85.7% while the PR rate were 35.7% and 14.3%, respectively. And at 5 years after treatment, the CR rate in patients with T90 < 43°C treatment and T90 ≥ 43°C treatment were 85.7% and 97.6%, respectively. Statistically, the differences between T90 < 43°C treatment and T90 ≥ 43°C treatment were significant (P < 0.05). Therefore, the efficacy of cervical...
such as its timing, treatment times and temperature is still
with NPC staging in III and IVa without increasing
Deng et al. (2002) found that hyperthermia combined
between the hyperthermia group and the control group.
There was no significant difference of adverse reactions
observed in all patients during the five years follow-up.
( data not shown). The most common late toxicities
improved. Moreover, we observed some late toxicities
of nasopharyngeal lesions, which needs to be further
control between the two groups. This might be associated
significant difference in the efficacy of distant metastasis
showed that local control rate of cervical lymph nodes,
respectively in hyperthermia group and control group.
The 5-year distant metastasis rate was 36.8% and 43.6%
higher in hyperthermia group than that in control group.
62.8% at 3 months after treatment ( P < 0.05).

Discussion
In this study, complete lymph node regression rate in
hyperthermia group and control group was 81.6% and
62.8% at 3 months after treatment ( P < 0.05), and local
control rate of cervical lymph node was significantly
higher in hyperthermia group than that in control group
at 5 years after treatment ( P < 0.01). The 3-year and 5-year
survival rate was statistically significant ( P < 0.05). The
5-year DFS rate was statistically significant ( P < 0.01).
The 5-year distant metastasis rate was 36.8% and 43.6%
respectively in hyperthermia group and control group,
without significant difference ( P > 0.05). Our results
showed that local control rate of cervical lymph nodes,
3-year and 5-year survival rate and 5-year DFS rate was
significantly higher in hyperthermia group, indicating
that local hyperthermia can increase local control rate
of cervical lymph nodes. In this study, there was no
significant difference in the efficacy of distant metastasis
control between the two groups. This might be associated
with inadequate number of cases, or with the status of
nasopharyngeal lesions, which needs to be further
improved. Moreover, we observed some late toxicities
data not shown). The most common late toxicities
were of grades 1 and 2 among patients with 5 years of
follow-up. The skin reaction was severe in hyperthermia
group but without statistically significant difference
( P > 0.05). No severe sequela, or complication was
observed in all patients during the five years follow-up.
There was no significant difference of adverse reactions
between the hyperthermia group and the control group.
Deng et al. (2002) found that hyperthermia combined
with radiotherapy and chemotherapy treatment could
significantly improve the local control rate for patients
with NPC staging in III and IVa without increasing
toxicity, which was in accordance with this study.

Although hyperthermia with radiotherapy has been
used for many years, the implement of hyperthermia
such as its timing, treatment times and temperature is still
controversial. Liu et al. (2005) showed that there was no
significant difference in different procedure (hyperthermia
before radiotherapy or radiotherapy after hyperthermia)
on the inhibition rate of HeLa cells ( P > 0.05). With same
procedure but different time intervals (30 min, 2 h, 24
h), there was also no significant difference of inhibition
rate on HeLa cells ( P > 0.05). In this study, the cervical
lymph nodes regression rate in patients with hyperthermia
before radiotherapy treatment and those with hyperthermia
after radiotherapy treatment was not statistically
significant ( P > 0.05). This data suggest that there was no
significant difference in lymph node metastasis regression
between hyperthermia before radiotherapy treatment
and hyperthermia after radiotherapy treatment. And this
data was consistent with findings of He et al. (2002) in
esophageal cancer.

For the comprehensive treatment of superficial
tumor with hyperthermia and radiotherapy, different
hyperthermia times (such as 3-14 times) had different
efficacies (Li and Hu, 1995; Liu et al., 1997). It is indicated
that the number of hyperthermia is associated with clinical
efficacy. In this study, we showed that CR rate were 66.7%
(3-month CR rate) and 73.3% (5-year CR rate) in patients
with hyperthermia < 4 times, 81.6% (3-month CR rate)
and 97.4% (5-year CR rate) in patients treated with hyperthermia
4 - 10 times, and 69.6% (3-month CR rate) and 82.6%
(5-year CR rate) in patients with hyperthermia > 10 times.
Thus this result indicates that less than 4 times or more than
10 times of hyperthermia could not increase CR rate in tumor of relatively larger
volume. Increasing the number of hyperthermia will not
only increase the financial burden on patients, but also
increase the incidence of heat injury.

It is reported that cell damage from temperature below
43°C is different from that over 43°C. The cytotoxicity
target is different with temperature above 43°C and below
42.5°C. Thermal resistance can be changed in the heating
process with temperature below 43°C. However, when
temperature is above 43°C, thermal resistance cannot
be further developed. Kapp and Cox (Kapp and Cox,
1995) analyzed the efficacy of 332 times of hyperthermia
combined with radiotherapy in 83 cases of recurrent or
metastatic breast cancer patients using the “heat map”
or multi-point temperature measurement technology.
They found that cumulative Eq min T90 at 43°C was
significantly related with CR rate ( P < 0.01) and with
local control rate ( P < 0.01). In this study, we showed that
at 3 months after treatment, regression rate of cervical
lymph node was 85.7% and 64.3% in patients with T90
≥ 43°C treatment and those with T90 < 43°C treatment,
and 97.6% and 85.7% at 5 years after treatment. The
difference between patients with T90 ≥ 43°C treatment
and those with T90 < 43°C treatment was statistically
significant ( P < 0.05).

In conclusion, microwave hyperthermia is easy
to implement without significant side effects. For
example, radiation skin reactions will not be increased
by hyperthermia with carefully operating. Therefore,
combination of hyperthermia with radiotherapy and
chemotherapy for the treatment of cervical lymph node
metastasis of NPC is an effective therapy that worth
further study.
Acknowledgements

This work is supported by Key Research Projects of Guangxi Health Department (Grant No. 200626). The author(s) declare that they have no competing interests.

References


