Original Contribution

Importance of Patient Positioning in Hyperthermia for Deep-seated Intrathoracic Tumors Using an 8 MHz RF Capacitive Heating Device

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Abstract : We evaluated the influence of a patient's position on the effectiveness of hyperthermia of deep-seated tumors using an 8 MHz radiofrequency (RF) capacitive heating device for 26 cases of intrathoracic tumors without chest wall invasion.

We found that the degree of thermoesthesia (pain caused by heating) was significantly smaller in the prone position when compared to the supine position ($p < 0.0001$). Average maximum RF outputs for supine and prone positions were 813 ± 141 W and 1281 ± 166 W (mean $\pm$ SD), respectively ($p < 0.001$).

We recommend treatment in the prone position for hyperthermia on deep-seated, intrathoracic tumors.

Key word : treatment position, deep hyperthermia, intrathoracic tumor, thermoesthesia

Introduction

Few studies have examined the technique of heating deep-seated regions using a radiofrequency (RF) capacitive heating device¹⁾⁻⁴⁾. We found that the quality of heating can be additionally improved by refinement of overlay bolus circulation route⁵⁾, increased degree of cooling⁶⁾, refinement of circulating liquid⁷⁾, and body earthing⁸⁾. In addition, we found that the patient's position is important in terms of optimization of treatment conditions in case of intrathoracic tumors.

Materials and methods

A prospective view was performed on 26 cases of intrathoracic tumors (21 cases of lung cancer and five cases of esophageal cancer) treated by hyperthermia at the hospital of the University of Occupational and Environmental Health of Radiology between 1995 and 1996 (Table I).

Thermotron RF-8, an 8 MHz RF capacitive heating device (Yamamoto VINITA Co., Osaka, Japan) was used. Heating was performed with two disc electrodes (diameter = 30 cm) and overlay bolus placed

between the electrodes and the patient's body. Tap water cooled to 5°C was circulated in the bolus during treatment.

Each patient was treated in both the supine and prone positions at least two times. The maximum RF output as well as degree of thermoesthesia was compared between both positions. The maximum RF output was defined as the output at which the patient was able to continue heating without thermoesthesia at least 10 minutes. The thermoesthesia score was defined as follows: score 1, none / minor; score 2, mild; score 3, moderate, treatment could be continued; score 4, severe, temporary interruption of treatment due to pain; score 5, prominent, treatment could not be continued. Level of significant difference was calculated with the *t*-test and sign test.

Table I. Patients' characteristics.

Lung ca.	21
Esophageal ca.	5
Male	26
Female	0
Age(mean $\pm$ SD)	62.9 $\pm$ 9.8

Results

The maximum RF outputs in the supine or prone positions are shown in Fig. 1. The average of the maximum RF output in every patient treated in the prone position was significantly higher than that in the supine position ($p < 0.001$), 1281 ± 166 W vs. 812 ± 141 W, respectively. The scores showing the degree of thermoesthesia during hyperthermia are shown in Fig. 2. The thermoesthesia score was significantly smaller in the prone position when compared to the supine position ($p < 0.0001$). Twenty of 26 patients (77%) with score 4 or 5, who were treated in the supine position, did not finish their scheduled hyperthermia. However, in patients with a marked increase of power in the prone position, the scores were equal to, or less than 3 for all cases. The maximum RF outputs and corresponding degree of thermoesthesia for the prone and supine positions in relation to the thickness of the subcutaneous fatty layer of the chest wall are summarized in Table II. Regardless of the thickness of the subcutaneous fatty layer, the maximum RF output was higher and the thermoesthesia score was smaller in the prone position compared to the supine position.

Discussion

Since the anterior chest wall is usually uneven, it is difficult to uniformly fit electrodes with bolus to the surface. In regions where the electrodes with bolus do not fit tightly, magnetic waves do not entirely penetrate

Fig. 1. Maximum RF output in the supine and prone positions.

Fig. 2. Score of thermoesthesia in the supine and prone positions.

Table II. Maximum RF output and thermoesthesia score in the supine and prone positions in relation to the thickness of the subcutaneous fatty layer of the chest wall.

Thickness of subcutaneous fatty layer of the chest wall	No. of cases	Supine position					Prone position			
		Maximum RF output (W)	Score of thermoesthesia			Maximum RF output (W)	Score of thermoesthesia			
		(mean±SD)	1,2	3	4,5	(mean±SD)	1,2	3	4,5	
1 cm>	8	925±183	0/8	3/8	5/8	1381±160	7/8	1/8	0/8	
1~1.5cm	9	811± 65	0/9	3/9	6/9	1306±101	7/9	2/9	0/9	
>1.5cm	9	711± 65	0/9	1/9	8/9	1167±166	1/9	8/9	0/9	

inside of the patient's body, resulting in hot spot formation. Therefore, patients complain of various degrees of thermoesthesia. In particular, hot spot induction in the treatment of the mammary region must be avoided. In the prone position, the anterior chest wall securely attaches to the bolus surface due to the body weight, and results in increased heating uniformity. Consequently, the degree of thermoesthesia was diminished.

The superiority of the prone position in hyperthermia of deep-seated intrathoracic tumors became evident by analyzing RF output values together with corresponding scores of the degree of thermoesthesia (Table II and Fig. 1 and 2). Since the maximum RF output is determined by the patient's ability to tolerate heat, increased RF output in the prone position is considered to be due to marked reduction of thermoesthesia. This difference may not be observed in patients treated using power at about 800 W. To our knowledge, many institutions rarely use power over 1000 W which is needed for effective heating of deep regions⁹⁾. The position change in such cases may markedly improve the effectiveness of treatment.

During hyperthermia by Thermotron RF-8, patients in the prone position are fixed between electrodes and their positions become very tight in many cases. In aged patients, shoulder aches may become a problem in the prone position. Thus, it is important to set the optimal position of each patient. In addition, the design of the Thermotron RF-8 device must be improved to make the prone position more comfortable.

When hyperthermia is performed for intrathoracic tumors that contact the anterior chest wall, a relatively low output power is sufficient, and thermoesthesia is not usually severe¹⁰⁾. In such cases, the supine position is recommended.

Conclusion

In hyperthermia for intrathoracic tumors using an 8 MHz RF capacitive heating device, heating in the prone position allows a higher RF output elevation and diminishes the degree of thermoesthesia

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8 MHz誘電加温装置による胸腔内深在性腫瘍の温熱療法における 治療体位の重要性

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要 旨：深在性の胸腔内腫瘍26例において、8 MHz誘電加温装置での深部加温における体位の影響を検討した。腹臥位は背臥位に比べて、熱感・疼痛が有意に減少した ($p<0.0001$)。平均最高出力は、背臥位で 813 ± 141 W、腹臥位で 1281 ± 166 W (mean $\pm$ SD) と有意に上昇した ($p<0.001$)。胸部の深部加温においては、腹臥位での治療が勧められる。