The effect of modulated electro-hyperthermia on temperature and blood-flow in human cervical carcinoma

Sun-Young Lee¹², Jong-Hun Kim³², Yeon-Hee Han⁴², Dong-Hyu Cho

¹Department of Radiation Oncology, Chonbuk National University Hospital-Chonbuk National University Medical School, Jeonju, Jeonbuk, Republic of Korea
²Research Institute of Clinical Medicine of Chonbuk National University-Biomedical Research Institute of Chonbuk National University Hospital, Jeonju, Republic of Korea
³Division of Cardiovascular-Thoracic Surgery Chonbuk National University Hospital-Chonbuk National University Medical School, Jeonju, Republic of Korea
⁴Department of Nuclear Medicine, Chonbuk National University Hospital-Chonbuk National University Medical School, Jeonju, Republic of Korea
⁵Department of Obstetrics and Gynecology, Chonbuk National University Hospital-Chonbuk National University Medical School, Jeonju, Republic of Korea

Presented at 36th ICHS, Budapest, 2018

Cite this article as:
The effect of modulated electro-hyperthermia on temperature and blood-flow in human cervical carcinoma

Sun-Young Lee1,2*, Jong-Hun Kim3,2*, Yeon-Hee Han4,2, Dong-Hyu Cho5
1Department of Radiation Oncology, Chonbuk National University Hospital-Chonbuk National University Medical School, Jeonju, Jeonbuk, Republic of Korea
2Research Institute of Clinical Medicine of Chonbuk National University-Biomedical Research Institute of Chonbuk National University Hospital, Jeonju, Republic of Korea
3Division of Cardiovascular-Thoracic Surgery Chonbuk National University Hospital-Chonbuk National University Medical School, Jeonju, Republic of Korea
4Department of Nuclear Medicine, Chonbuk National University Hospital-Chonbuk National University Medical School, Jeonju, Republic of Korea
5Department of Obstetrics and Gynecology, Chonbuk National University Hospital-Chonbuk National University Medical School, Jeonju, Republic of Korea

Introduction
Mild hyperthermia has been known to enhance the response of tumors to radiotherapy or chemotherapy by increasing tumor blood flow, thereby increasing tumor oxygenation or drug delivery. The purpose of this study was to assess the changes in temperature and blood flow in human cervical cancer in response to regional heating with modulated electro-hyperthermia (mEHT).

Methods
The pelvic area of 20 patients with cervical carcinoma was heated with mEHT. The peri-tumor temperature was measured using an internal organ temperature probe. The tumor blood flow was measured using 3D color Doppler ultrasound by determining the peak systolic velocity/end-diastolic velocity ratio (S/D ratio) and the resistance index (RI) within blood vessels.

Results
The mean peri-tumor temperature was 36.7 ± 0.2°C before heating and increased to 38.5 ± 0.8°C at the end of heating for 60 min. upon heating for 30 and 60 min, respectively, and was 37.1 ± 0.3°C at 30 min after heating. The S/D ratio was 1.65 ± 0.20 at baseline, 1.40 ± 0.13 and 1.22 ± 0.09 upon heating for 30 and 60 min, respectively, and 1.40 ± 0.16 at 30 min after heating. The RI was 0.40 ± 0.12 before heating, 0.29 ± 0.11 and 0.19 ± 0.06 upon heating for 30 and 60 min, respectively, and 0.30 ± 0.10 at 30 min after heating. The marked declines in RI and S/D values strongly demonstrated that heating significantly increased tumor blood perfusion.

Conclusion
Regional heating of the pelvic area with mEHT significantly increased the peri-tumor temperature and improved the blood flow in cervical cancer. This is the first demonstration that the blood flow in cervical cancer is increased by regional hyperthermia. Such increases in temperature and blood flow may account for the clinical observations that hyperthermia improves the response of cervical cancer to radiotherapy or chemotherapy.

Keywords: intra-tumor blood flow, peri-tumor temperature, electro modulated-hyperthermia
The effect of modulated electro-hyperthermia on temperature and blood-flow in human cervical carcinoma

Sun-Young Lee1,2, Jong-Hun Kim1,2, Yeon-Hee Han1,2, Dong-Hyung Cho1,3

1Department of Radiation Oncology, Chonbuk National University Hospital-Chonbuk National University Medical School, Jeonju, Jeonbuk, Republic of Korea
2Research Institute of Chonbuk National University-Biomedical Research Institute of Chonbuk National University Hospital, Jeonju, Republic of Korea
3Division of Cardiobiotherapy-Thoracic Surgery Chonbuk National University Hospital-Chonbuk National University Medical School, Jeonju, Republic of Korea

INTRODUCTION

Mild hyperthermia has been known to enhance the response of tumors to radiotherapy or chemotherapy by increasing tumor blood-flow, thereby increasing tumor oxygenation or drug delivery. The purpose of this study was to assess the changes in temperature and blood-flow in human cervical cancer in response to regional heating with modulated electro-hyperthermia (mERT).

METHOD

The pelvic area of 20 patients with cervical carcinoma was treated with mERT. The tumor temperature was measured using an internal organ temperature probe. The tumor blood-flow was measured using sono-polarized 2D color Doppler ultrasound by determining the peak systolic velocity (PSV) and pulse wave velocity (PWV) of the tumor-feeding vessels and the resistance index (RI) within blood vessels.

Regional hyperthermia was performed using an mERT device (EHS-100, Chonbuk Center, Tresendorf, Germany). We have previously used this device to stimulate the effect of regional heating on the pharmacokinetics of an orally administered drug. Patients were placed in a supine position on a couch, and a 30cm diameter circular electrode was tightly coupled to the pelvic area. All patients underwent three-dimensional simulation to measure the size of the tumor and its feeding vessels. The pelvis area was treated at 40.8 °C for the first 10 min, 42.8 °C for the next 10 min, and 39 °C for the remaining treatment time (40 min).

RESULTS

The mean perianal temperature was 36.7 ± 0.2 °C before heating and increased to 39.5 ± 0.6 °C at the end of heating for 30 and 60 min, respectively, and was 37 ± 0.7 °C at 30 min after heating. The PSV ratio was 1.6 ± 0.32 at baseline, 1.56 ± 0.53 and 1.65 ± 0.29 upon heating for 30 and 60 min, respectively, and 1.7 ± 0.48 at 30 min after heating. The RI was 0.6 ± 0.11 before heating, 0.29 ± 0.11 and 0.19 ± 0.08 upon heating for 30 and 60 min, respectively, and 0.3 ± 0.16 at 30 min after heating. The marked declines in PSV and RI values strongly demonstrated that heating significantly increased tumor blood flow.

The mean changes in temperature and blood flow are shown in the following graphs.

Conclusion

Regional heating of the pelvic area with mERT significantly increased the perianal tumor temperature and improved the tumor blood-flow in cervical cancer. This is the first demonstration that the blood-flow in cervical cancer is increased by regional hyperthermia. Such increases in temperature and blood flow might account for the clinical observations that hyperthermia improves the response of cervical cancer to radiotherapy or chemotherapy.