Morphologic Analysis of Water-Cooled Bipolar Radiofrequency lesions on Egg White *in Vitro*

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**Background:**

The aim of this study was to document the optimal spacing of two cannulae to form continuous strip lesions and maximal surface area by using water-cooled bipolar radiofrequency technology.

**Methods:**

Two water-cooled needle probes (15 cm length, 18-gauge probe with 6 mm electrode tip) were placed in a parallel position 10, 20, 24, 26, and 28 mm apart and submerged in egg white. Temperatures of the probes were raised from 35°C to 90°C and the progress of lesion formation was photographed every 1 minute with the increase of the tip temperature. Approximately 30 photographs were taken. The resultant surface areas of the lesions were measured with the digital image program.

**Results:**

Continuous strip lesions were formed when the cannulae were spaced 24 mm or less apart; monopolar lesions around each cannula resulted if they were spaced more than 26 mm apart. Maximal surface areas through the formation of continuous strip lesion were 221 mm², 375 mm², and 476 mm² in 10, 20, and 24 mm, respectively. Summations of maximal surface area of each monopolar lesions were 394 mm² and 103 mm² in 26 and 28 mm, respectively.

**Conclusions:**

Water-cooled bipolar Radiofrequency technology creates continuous “strip” lesions proportional in size to the distance between the probes till the distance between cannulae is 24 mm or less. Spacing the cannulae 24 mm apart and treating about 80°C for 24 minutes maximizes the surface area of the lesion. *(Korean J Pain 2012; 25: 151-154)*

**Key Words:**

bipolar, egg white, radiofrequency.
INTRODUCTION

Radiofrequency (RF) is now widely used in various medical departments for treating a wide variety of conditions including cardiac arrhythmia, benign prostatic hyperplasia, malignant tumors and chronic pain. In comparison with traditional monopolar RF, bipolar RF creates a continuous strip lesion that is proportional in size to distance between the electrodes. From this benefit, bipolar RF is reported to be superior in creating a larger and more predictable lesion over monopolar RF [1-3]. For this purpose, accurate prediction of lesion created by ablation is essential for less morbidity and more satisfying results especially in pain management. Water-cooled electrodes are capable of creating larger lesions than non cooled ones by removing heat from adjacent tissue and deliver power without causing high impedance and tissue charring [4]. By comparing the maximum surface area formed by conventional RF and cooled RF in egg white, these benefits of water-cooled RF could be specified.

This study is aimed to evaluate the maximum surface area formed by two parallel electrodes and the distance between them for creating a largest lesion.

MATERIALS AND METHODS

Two water-cooled needle probes (15 cm length, 18 gauge probe with 6 mm electrode tip) were placed in a transparent bowel filled with egg white and used to create the lesions. The needles were fixed by the sponge above the bowel to be placed in a parallel position spaced 10 mm, 20 mm, 24 mm, 26 mm, and 28 mm apart. The first probe was connected to the RF electrode system (Trans-Discal™ System, Baylis Medical, Montreal Inc., QC, Canada) in the usual manner recommended by the manufacturer, and the second probe was attached, through an adapter provided by the same manufacturer. Energy level was set to maintain electrodes 20 Watt and the following impedance was around 90 Ω. The temperature of the cooled electrodes maintained 35°C while the temperature of the second electrodes raised with the same energy level between 10 to 12 Watt. The transparent bowel was used for a clear vision of the RF lesions. From the initiation of the lesion formation, photographs were taken every 1 minute through 30 minutes. The surface areas of the lesions were measured under the assistance of a computer-imaging program designed to estimate the area of irregularly shaped regions (UTHSCSA Image Tool 3.0, Texas, USA). All of the procedures were repeated twice and the average was calculated.

RESULTS

Double trial was done in procedures of each distance apart and similar results were shown between two trials. Continuous strip lesions were formed when the cannulae were spaced 24 mm or less apart. From further distances apart, even with larger maximum surface area, two separate monopolar lesions were formed (Fig. 1). Time to form initial continuous strip lesion in each group were 11, 10, and 12 minutes in 10, 20, and 24 mm. Maximal surface area through the formation of continuous strip lesion were 221 mm², 375 mm², and 476 mm² in 10, 20, and 24 mm at 23, 22, and 24 minutes, respectively. Summation of maximal surface area of each monopolar lesions were 394 mm² and 103 mm² in 26 and 28 mm at 28 and 27 minutes, respectively (Fig. 2).

DISCUSSION

Recently for more accurate targeting and larger lesion formation, bipolar RF was proposed and has been applied

Fig. 1. Bipolar cooled radiofrequency lesions formed with cannulae spaced 10, 20, 24, 26, and 28 mm apart in egg white when maximal surface area achieved. A continuous “strip” lesion is formed when the cannulae are separated by 24 mm or less and discrete lesions are formed when the cannula are 26 mm or more apart.
Lesion surface area (mm²) according to duration of bipolar cooled radiofrequency treatment (minutes) is shown. The spacing of the 2 cannulae is indicated to the right of each line. Continuous "strip" lesions were made when the cannulae were spaced 24 mm or less apart. This figure was created by spreadsheet program (Microsoft excel® 2007, California, USA).

Continuous strip lesions were formed in three groups of 10, 20, and 24 mm. In group of 26 mm apart, the maximum surface area of two monopolar lesions around both cannulae tips was larger than a single lesion formed by a needle placed 24 mm apart. Two electrodes should be placed between 20 mm to 24 mm apart in clinical practice in order to maximize the surface area and to form a resultant strip lesion. Treatment duration is required about 22 to 24 minutes to achieve maximal surface area.

In conclusion, water-cooled bipolar Radiofrequency technology creates continuous “strip” lesions in size proportional to the distance between the probes when the distance between cannulae is 24 mm or less. Further trials with various medium are required to confirm the promising results by using bipolar RF with a cooled tip in pain management.

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