Metal Guarder Could Prevent the Spread of Tissue Desiccation: A Preliminary in Vitro Double Blinded Study.

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ABSTRACT

Nowadays the bipolar electro-coagulator is widely used in gynecologic surgery. A major problem with using this instrument was the uncontrolled extension of tissue desiccation, causing organ injuries. This experiment was designed to study the effect of metal guarder on the spread of tissue desiccation compared with the non guarding side. The experiment was divided into two parts according to method of measurement. The first was use of fresh raw meats and measurement by visual inspection which mimicked the real practice. The ten specimens were desiccated by 5-mm bipolar electro-coagulator (40 W). The mean spread of uncontrolled tissue desiccation in the metal guarding side was 1.4 mm. (range 1-3 mm) and non metal guarding side was 4.9 mm. (range 2-7 mm.) which the difference was statistically significant by Wilcoxon Signed-Rank test. The second part was made in the same way as the previous except for the animal specimens and measuring method. Ten pieces of very fresh rat meat, 3 mm thick, were prepared and desiccated. The spread of tissue desiccation was measured on histological section. The mean spread of uncontrolled tissue desiccation in the metal guarding side was 1.1 mm. (range 0.6-1.5 mm.) and non metal guarding side was 4.1 mm. (range 2.5-9.1 mm.). The differences was statistically significant by Wilcoxon Signed-Rank test. We believe that this result can lead the surgeon's technique for the thermal safe electrosurgery or can be a new concept for innovation of a safety bipolar electro- coagulator.

Keywords: bipolar coagulation, thermal damage, electro-surgery.

1. INTRODUCTION

Recently, bipolar electro-coagulator has been introduced as an electrosurgical vessel sealing device. Nowadays, it has been widely used in abdominal, vaginal and laparoscopic hysterectomies with the advantages of reducing surgical blood loss and operating period [1, 2]. The newly bipolar electro-coagulator with audible tone indicating complete of the process is able to seal vessels up to 7 mm. in diameter [3-6]. However, the risk of uncontrolled thermal injury from high temperatures at the instrument tip has been the major problems in iatrogenic thermal injury.

The living tissue is slowly heated when the temperature above 50°C. If the tissue is heated to 90°C, irreversible cellular water completely evaporates (desiccation). The cell walls are ruptured at 100°C (vaporization) and tissue begins to carbonize and char at 250°C.[7,8]. In the operative field, the uncontrolled tissue desiccation could spread (above 60°C) up to 10 mm. from the tip of the instrument [9, 10].

However we have found atraumatic grasping forceps adjacent to bipolar forceps can minimize thermal injury during electrosurgery. To investigate this effect, we designed a study by using fresh animal tissue and measurement by visual inspection and histological analysis.

2. MATERIALS AND METHODS

2.1 Experimental design

The experiment was divided into two parts according to the measurement methods. Each animal tissue was grasped by Kleppinger bipolar electro-coagulator and the laparoscopic grasping forceps, which grasped laterally as experimental side while the other was left as control side. The data was then subjected to statistical analysis.

2.2 Procedures

In the first experimental part, the fresh raw meat with 3 mm. thickness was grasped by Kleppinger bipolar forceps while laparoscopic grasping forceps was being grasped laterally. The tissue desiccation started when 40 W electric power of bipolar electrocoagulator was turned on. The electricity was run until no air bubble on the tissue surface (tissue desiccation). Then, the extension of tissue desiccation was evaluated by visual inspection using measuring ruler which mimicked the real tissue inspection in the operative field. (Figure 1 and 2)

The second part was made in the same way as the previous except for the animal specimens and measuring method. Since the visual measurement alone

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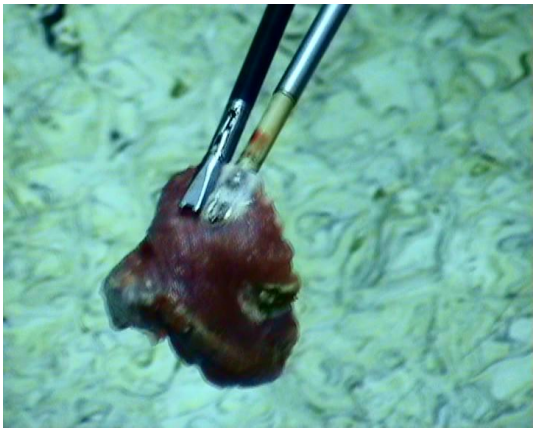

Fig.1: *A piece of meat was desiccated by bipolar electro-coagulator (40 W) while grasping forceps were grasping at the side of the bipolar electro-coagulator as a metal guarder.*

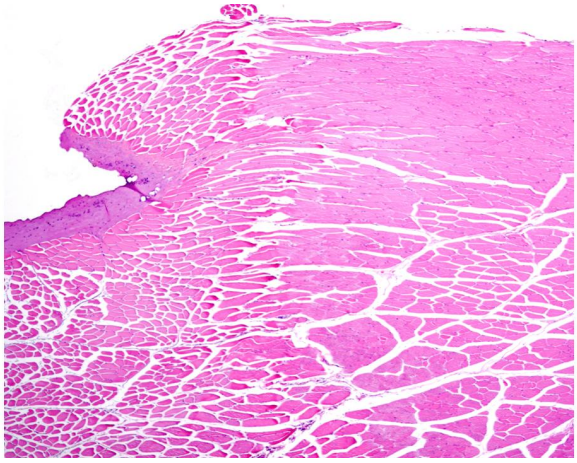

Fig.3: *Normal muscle tissue is shown on the right side of the picture. On the left side, the desiccated area is obviously eosinophilic with glassy appearance.*

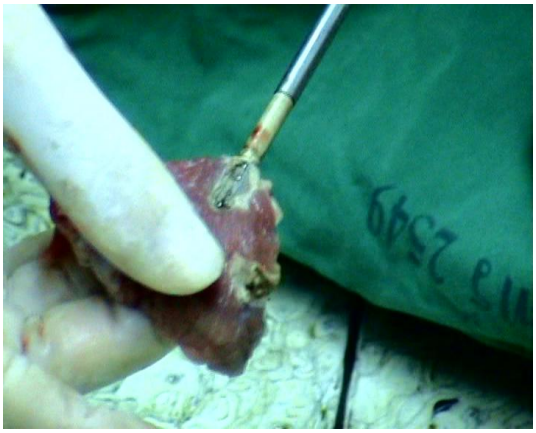

Fig.2: *The spread of uncontrolled tissue desiccation in the metal guarding side (arrow) was lesser than non metal guarding side.*

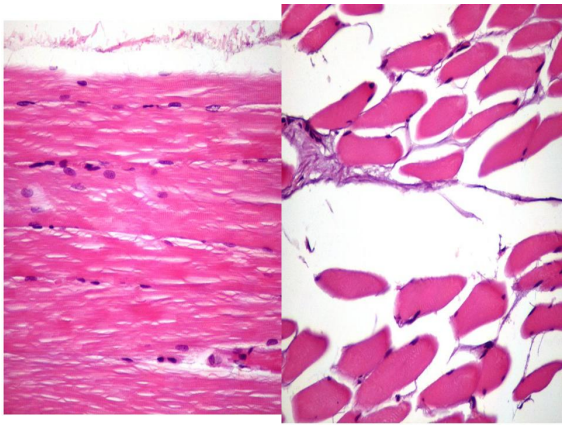

Fig.4: *The cytoplasm of desiccated muscle cells (Right Pict.)is glassy and eosinophilia with partial loss of striation. The nuclei are condensed and deep basophilic. The normal muscle cells (Left Pict.), on the contrary, retain striation and detailed nuclei.*

was not sufficient to fully represent the histological differences, then we decided to measure on microscopically histological section and used fresh rat meat as the experimental specimens. After ending of each one, the tissue was immediately placed into a 10% formalin-buffered solution. After 24 hours, the samples were embedded in paraffin, sectioned and stained with hematoxylin/eosin. Then, the section was evaluated microscopically for the whole area where thermal effects were evident-was measured, in mm, using a built-in stage micrometer calibrated.

The experiment was performed at the Srinagarind Hospital and the study was approved from the Animal Care and Use Committee of Khon Kaen university, Thailand.

2.3 Statistical analysis

On the study design, each specimen was measured for both control and experiment sides, then it could prevent intervariable influences that might have induced a confounding bias. To abolish of personal bias, we use double blinded technique for our pathologist. Finally, the spread of uncontrolled tissue desiccation in the metal guarding side and the non metal guarding side of each experimental part was statistical analyzed by Wilcoxon Signed Rank test.

3. RESULTS

Ten pieces of fresh raw meat were desiccated by Kleppinger bipolar electro-coagulator (40 W) while the grasping forceps were grasping beside the bipolar electro-coagulator as a metal guarder. The length of laterally uncontrolled tissue desiccation was measured in both sides.

The results of first part were showed in the Table 1. The mean length of uncontrolled tissue desiccation in

the metal guarding side (group 1) 1.4 mm. (range 1-3 mm) and non metal guarding side was 4.9 mm. (range 2-7 mm.). There was significant difference between the two groups according to Wilcoxon Signed Rank test.

Ten pieces of fresh rat meat were desiccated in the same way as the previous The results of laterally uncontrolled desiccated length were showed in the Table 2. The mean length of uncontrolled tissue desiccation in the metal guarding side (group 1) was 1.1 mm. (0.6-1.5 mm.) and non metal guarding side (group 2) was 4.1 mm. (2.5-9.1 mm.). There was also significant difference according to Wilcoxon Signed Rank test.

Table 1: *The results of first experimental part, group 1 was the spread of uncontrolled tissue desiccation data of the metal guarding side and group was the data of non metal guarding side, using visual inspection (measuring ruler).*

Number of Experiments	Group 1(mm.)	Group 2(mm.)
1	1	4
2	2	5
3	1	2
4	1	6
5	1	7
6	1	5
7	3	5
8	1	5
9	2	5
10	1	5

Statistical significance P< .001.

Table 2: *The result of second experimental part, group 1 was the spread of uncontrolled tissue desiccation data of the metal guarding side and group 2 was the data of non metal guarding side, using microscopically histological measurement.*

Number of Experiments	Group 1(mm.)	Group 2(mm.)
1	1.5	3.5
2	0.8	2.5
3	1.2	3.2
4	0.6	2.5
5	1.1	6.1
6	1.2	4.2
7	0.9	9.1
8	1.5	3.5
9	1.2	3.2
10	1	3.1

Statistical significance P< .001.

4. DISCUSSION

The development of laparoscopic surgery has stimulated substantive research and development in the medical devices industry for the progression in the technologies of energized dissection. With the advantages of reducing surgical blood loss and operating period, nowadays, electro-coagulator has been widely used in all routes of surgery, including laparoscopic hysterectomies. [1, 2] ,[11]

The incidence of iatrogenic complications caused by laparoscopic electro-surgery is 2 to 5 per 1,000 [12,13]. Most are thermal injuries result from electro-coagulator. Major of these are caused by the stray current injuring adjacent structures, such as the bowel, bladder, and ureter. Bipolar electro-coagulator can better control this unwanted stray current [14,15].

The mechanism of bipolar electro-coagulator is to form vapor pockets coalesce and then become the vaporized zones at the areas of highest power density along with a proximal thrombus, causing hemostasis.[16] However, thermal damage may occur well beyond their confines. The unabated application of current can propagate a thermal bloom that disruptively bubbles steam through the surrounding parenchyma, damaging tissue at some distance from the target site.[17] (Figure 5)

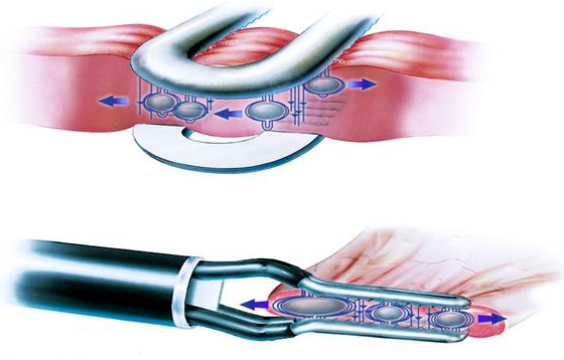

Fig.5: *The mechanism of bipolar electro-coagulator was to form vapor pockets coalesce and then become the vaporized zones at the areas of highest power density. The desiccation caused thermal effect spreading through the adjacent tissue*

A recent study conducted by the Dundee group on detection of the spread of thermal energy in bipolar electro-coagulator by using an infrared imaging system, suggested that a maximum temperature of 150°C was detected at the instrument tip and a thermal spread (above 60°C) was extended up to 10 mm. from the tip. [7-10]

Remorgida V [18] report that tissue thermal damage caused by bipolar forceps can be reduced with

outer plastic shield. However, in practice, plastic shield can concentrate the heat inside the jaws, but cannot neutralize the electrical current causing a thermal bloom from the bubbles steam.

So that we designed this study under the hypothesis that metal guarder could both neutralize the spread of electromotive energy and absorb the spread of thermal energy. Then, it could better reduce the spread of uncontrolled tissue desiccation which this experiment showed a better effect of metal guarder compared to the control part.

Finally, we recommend conducting the experiment on alive animals to gain data on the effect of this technique in living tissue.

5. CONCLUSION

Metal guarder could prevent uncontrolled tissue desiccation from bipolar electro-coagulator. We believe that this procedure could modified to the thermal safe surgical technique and lead the inventor to modify the newly safety bipolar electro-coagulator.

6. ACKNOWLEDGMENT

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