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The Tissue Effect of Radiofrequency Ablation on Rectal Mucosa

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The aim of this study was to examine the depth of radiofrequency ablation on the rectum. Many elderly people have a rectal mucosal prolapse. The procedure combining radiofrequency ablation and plication of the rectal mucosa was reported as an effective means of treatment. However, no pathologic review of the technique has been reported thus far. This study was conducted from January 2012 to August 2013 at the authors' institution. Thirty rectal specimens obtained from 15 patients who underwent stapled transanal rectal resection were coagulated by radiofrequency ablation using TissueLink at power settings of 30 or 50 W and examined histologically. Mucosal epithelia of all specimens was desquamated after radiofrequency ablation. The distance from the mucosal surface to the lamina muscularis mucosae was significantly shorter in ablated specimens than that of normal mucosa and significantly shorter in proportion to coagulation power settings. This study demonstrated that at least mucosal epithelia disappeared histologically after radiofrequency ablation.

Key words: Rectal mucosal prolapse – Rectal mucosa pathology – Radiofrequency ablation

In colorectal clinics, it is not uncommon for aged patients to show symptoms of advanced rectal mucosal prolapse, which include pain, bleeding, mucus discharge, and pruritus. Gupta[1] reported a procedure combining radiofrequency ablation and plication of the rectal mucosa in 2006 as an innovative treatment for rectal mucosal prolapse with the conventional ligature and excision procedure. However, no pathologic study has been reported thus far about the depth of radiofrequency ablation on the rectum.

The aim of this study was to clarify the depth of rectal thermal injury caused by radiofrequency ablation.

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Table 1 Demographics of 15 patients who received STARR and average weight of specimens

Items	Values
Mean age, years (range)	67.5 (33–87)
Male:female	0:15
Average anterior wall weight, g	5.9 (4.6–6.8)
Average posterior wall weight, g	5.8 (3.1–9.2)

Materials and Methods

Patients and procedure

This study was undertaken at Kameda Medical Center, Japan, between January 2012 and August 2013 after obtaining approval of the institutional ethics committee and written informed consent from each patient. Thirty rectal specimens from 15 patients were evaluated. All patients were diagnosed with internal rectal prolapse or rectocele and underwent stapled transanal rectal resection (STARR)[2] under spinal anesthesia. Thirty specimens were resected; that is, 15 specimens from the anterior rectal wall and 15 from the posterior rectal wall. Patients' age, sex, and weight of specimen are listed in Table 1. As soon as the rectal specimen was resected in the operating room, it was extended and fixed by a pin. Then the specimen was coagulated using a TissueLink DS3.0 Dissecting Sealer (TissueLink Medical Inc, Rochester, New Hampshire [now Medtronic, Inc, Minneapolis, Minnesota]), which is a saline-coupled radiofrequency device that was plugged into an electro-surgical generator in the operating room. The coagulation power was set at 30 or 50 W. One liter of 0.9% sterile saline was connected to the irrigation tubing and adjusted for a drip rate of one drop per second (1.8 mL/min). To ablate mucosa, the electrode tip was moved slowly, avoiding char formation and carbonization, until the mucosa changed dusky white (blanching) in color, as was in line with the techniques reported by Gupta.[1] The mucosa was ablated by setting 2 different coagulation powers, which seemed adequate enough to change mucosal color to dusky white (blanching) as Gupta performed in clinical practice.[1] One side of the mucosa area was ablated at 30 W and the other at 50 W. Control mucosa without coagulation was left between and around them. The specimens were then fixed in 10% buffered formalin. Each specimen was sectioned and stained with hematoxylin/eosin with standard techniques (Fig. 1).

Pathologic procedure

Fixed specimens were sectioned in about 5-mm rectangles. Then 2 central pieces were selected and analyzed histologically under the leadership of an experienced gastrointestinal pathologist (KH).

Three fields of view in which ductal structures in lamina propria were relatively sustained were selected. Depth of injury was characterized by noting whether there was loss of mucosal epithelia or damage to the mucosal layer. The length from the mucosal surface to the lamina muscularis mucosae

Fig. 1 A sample of the specimen after ablation. (A) A resected rectal specimen was extended and fixed by a pin, and then the specimen was coagulated by radiofrequency ablation. One side of mucosa area was ablated at 30 W and the other at 50 W, and control mucosa without coagulation was made between and around them. (B and C) A specimen was fixed in 10% buffered formalin and sectioned in about 5-mm rectangles, and then 2 central pieces of them (*i.e.,* number 3 and 4 pieces) were selected and analyzed histologically.

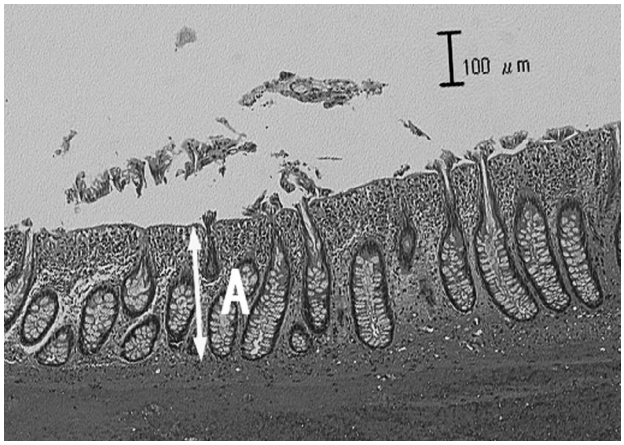

Fig. 2 Histologic view of the specimen. Distance A is the length from the mucosal surface to the lamina muscularis mucosae.

(distance A; Fig. 2) was measured. Distance A was measured 5 times in the same field of view and averaged.

Statistical analysis

The Mann-Whitney *U* test was used to compare the difference in the depth of thermal injury between the groups. $P < 0.05$ was considered a significant value. Data are shown as mean (range). Statmate IV for Windows (ATMS Corporation, Tokyo, Japan) was used for all data analyses. Data are shown as mean (range).

Results

STARR was successfully performed in 15 patients with internal rectal prolapse or rectocele. There was no significant difference in the weight between the specimens resected from the anterior and the posterior rectum. After 12-month follow-up, significant improvements were observed in Constipation Scoring System scores and Fecal Incontinence Severity Index scores and morphology by defecography.[3]

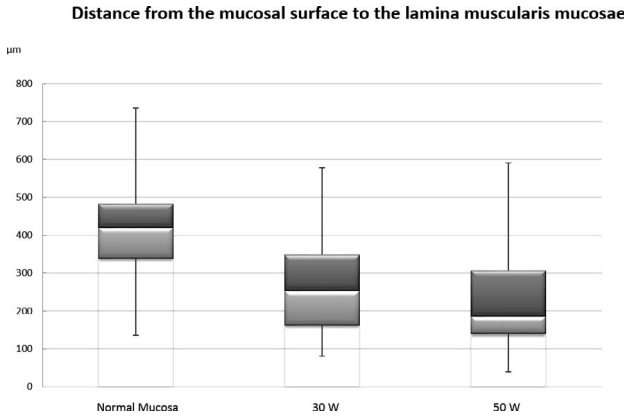

Fig. 4 Distance from the mucosal surface to the lamina muscularis mucosae. The bottom of each box is the 25th percentile, the top of each box is the 75th percentile, and the line in the middle is the 50th percentile. The end of the whisker represents the minimum and the maximum value of all the data. 30 W, specimens ablated at 30 W; 50 W, specimens ablated at 50 W.

Histologically, mucosal epithelia of all specimen was desquamated after radiofrequency ablation at either 30 or 50 W (Fig. 3B), whereas mucosal epithelia and ductal structure in lamina propria were well sustained in normal mucosa (Fig. 3A).

Distance A in the specimens ablated at 30 and 50 W was 267.9 μm (82.6–578.2 μm) and 226.3 μm (100.4–591.0 μm), respectively. Both distances were significantly shorter than that in normal mucosa, which was 428.2 μm (203.0–736.5 μm) ($P < 0.0001$; Fig. 4). Distance A in the specimens ablated at 50 W was significantly shorter than that at 30 W ($P = 0.04$; Fig. 3). Total destruction of mucosa was observed more frequently in the specimens ablated at 50 W than those at 30 W (Fig. 5).

As to the comparison between 30- and 50-W coagulation, distance A in specimens coagulated at

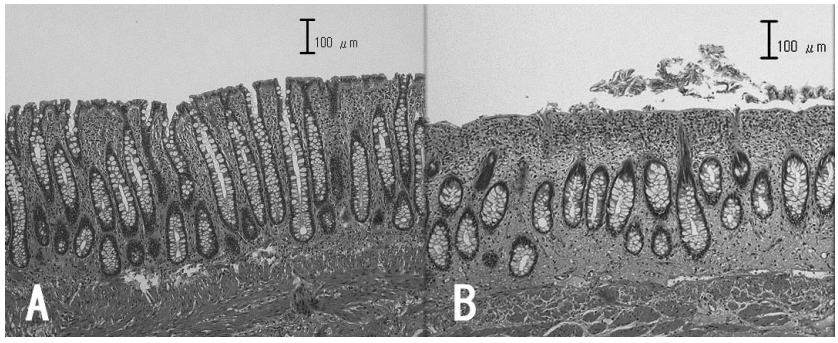

Fig. 3 Control mucosa without coagulation (A) and desquamated mucosal epithelia after radiofrequency ablation (B). (A) Mucosal epithelia and ductal structure in lamina propria were well sustained in normal mucosa. (B) Mucosal epithelia was desquamated after radiofrequency ablation at either 30 or 50 W.

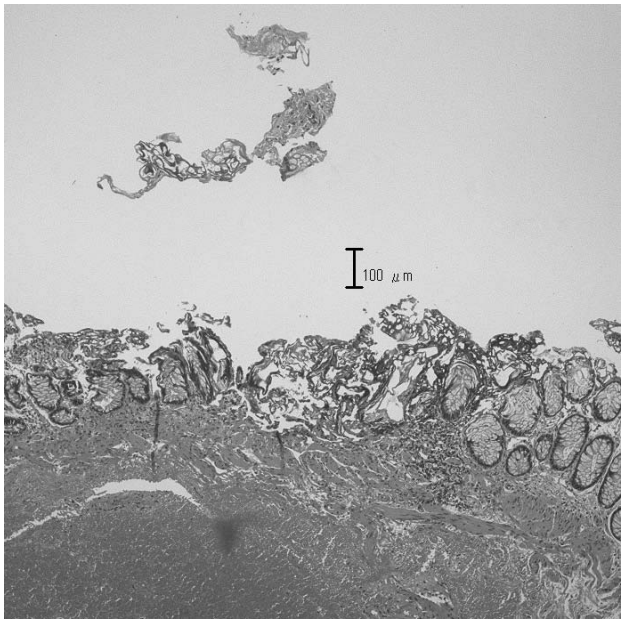

Fig. 5 Histologic view of the specimen coagulated by radiofrequency ablation at power of 50 W, which shows total destruction of mucosa.

30 W was 260.5 μm (500.0–58.6 μm). The effect of coagulation partially reached muscularis propria beyond the submucosa, and the mucosal layer was completely destroyed in all specimens coagulated at 50 W (Fig. 6).

Discussion

This is the first study to examine the depth of thermal injury to the rectum in response to radiofrequency ablation. The results of the histologic study demonstrated that at least lamia propria disappeared after radiofrequency ablation at the coagulation power setting at 30 or 50 W and suggested that the depth of thermal injury after ablation became deeper in proportion to its wattage.

The power setting of radiofrequency ablation at 30 or 50 W seemed adequate because gradual change of mucosal surface to dusky white color, as Gupta[1] regarded as satisfactory ablation, was obtained at these power settings in our preliminary experiments. In our view, 30 W seemed better for "satisfactory ablation" because locations on the specimen that were burnt black (overdone) became more frequent when the power was set at 50 W.

This study had certain limitations. Because the specimens were fixed soon after ablation in this study, tissues without destruction seemed to be

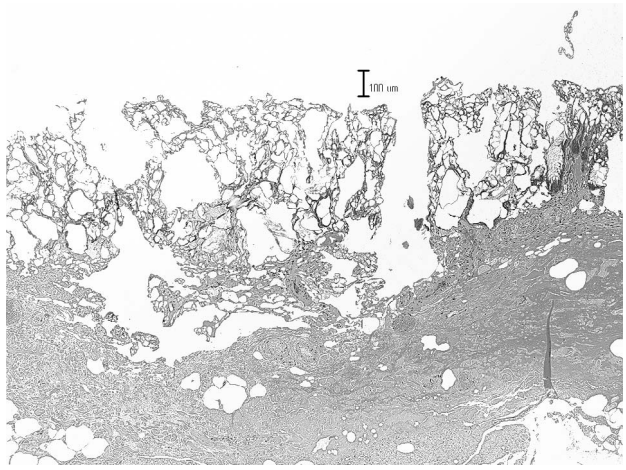

Fig. 6 The effect of coagulation partially reached muscularis propria beyond submucosa, and the mucosal layer was completely destroyed in all specimens coagulated at 50 W.

intact histologically, and the exact depth of thermal damage in the specimens may not be determined. Actual thermal damage may reach through the lamia propria to the lamina muscularis mucosa. On the other hand, in vivo, the changes in ablated mucosa may not be permanent, and the lamina propria may have viability and proliferate with time.

Although there are few data from comparative trials of radiofrequency ablation versus other modalities, such as monopolar electrosurgical, neodymium:yttrium aluminum garnet (Nd:YAG) laser coagulation, and argon plasma coagulation, it is believed that the depth of injury with radio frequency ablation is less than that of these other techniques and that this technique is therefore less likely to result in postcoagulation syndrome or perforation. Several studies of the depth of injury in the colon associated with monopolar electrosurgical and laser coagulation have demonstrated significant damage to muscularis propria and serosa.[4,5] The results were supported by our results using normal electrosurgical knife, where muscularis propria was partially destroyed in all specimens coagulated at 50 W (Fig. 3). Argon plasma coagulation also showed significant injury to the muscularis propria.[6]

In conclusion, this study demonstrated that at least the mucosal epithelia disappeared histologically after radiofrequency ablation. However, the viability of the lamina propria after ablation was not determined. Further study is required to confirm the results.

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