의학석사 학위논문

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# 아르곤 플라즈마 응고술의 적용

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for the treatment of gastric neoplasm?

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이 논문을 의학석사 학위 논문으로 제출함

2023 년 08 월

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# When can we perform argon plasma coagulation for the treatment of gastric neoplasm?


## ABSTRACT

**Background & Ai**ms: Argon plasma coagulation (APC) could be considered a treatment modality for small gastric neoplasms instead of endoscopic resection (ER). Our study investigated the clinical outcomes of APC for treating gastric neoplasms and associated variables with local recurrence.

**Methods:** This study included 1,408 patients who underwent APC for gastric neoplasms at the tertiary hospital from July 2007 to March 2022 with a minimal follow-up of 12 months. Through a retrospective review of medical data, the clinical outcomes and variables associated with the local recurrence were analyzed.

**Results:** A total of 796 patients (median age of 66 years old) were followed up for a median of 30 months and local recurrence has happened in 75 patients (9.42%). Multivariate analysis showed age (hazard ratio [HR] 1.05, 95% confidential interval [CI] 1.02¬–1.08), lesion size (HR 1.04, 95% CI 1.00–1.08), histology of cancer (HR 7.18, 95% CI 4.12–12.52), and scar change (HR 3.85, 95% CI 2.38–6.23) were associated with the local recurrence. Among lesions smaller than 10 mm without scar (n=557), local recurrence was found in 20 cases (3.6%), but local recurrence was in

37 cases (28.5%) with scar change (n=130) and in 18 cases (16.5%) in tumor larger than 10 mm (n=109).

**Conclusions:** In gastric neoplasm smaller than 10 mm without scars, APC is a good treatment modality in place of ER. However, when a lesion is larger or located on the scar, APC should be selected carefully with close monitoring

**Keywords:** gastric neoplasms; argon plasma coagulation; neoplasm recurrence; local

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# Introduction

Gastric cancer is the fifth most common cancer worldwide, accounting for an incidence of 5.6 % in 19.3 million new cases and mortality of 7.7% in 9.9 million deaths in both sexes in 2020.[1] Between 1999 and 2019, 577,502 patients were diagnosed with gastric cancer in Korea with the crude rate increasing from 1999 (44.3 per 100,000 individuals) to 2011 (63.9 per 100,000 individuals), which decreased until 2019 (57.4 per 100,000 individuals).

The five-year relative survival rate of gastric cancer patients in Korea is estimated at over 90% in localized cancer, whereas the rate decreased to 5.5% in distant-stage at diagnosis.[2] Therefore, screening upper endoscopy is recommended for adults aged 40 years or older not only to detect gastric cancers in the early stage but also to find precancerous lesions such as adenoma.[3]

Endoscopic resection (ER) such as endoscopic mucosal resection (EMR) or endoscopic submucosal dissection (ESD) can be applied to remove early gastric cancer (EGC) or gastric adenomas which can progress to malignancy. However, ER cannot be done in patients or lesions with a high risk of complications including bleeding or perforation. An alternative treatment plan for these cases can be argon plasma coagulation (APC), a non-contact electrocoagulation that uses ionized argon gas to apply current to tissues developed in 1994 by Grund et al.[4]. Since APC could induce thermal injury of mucosal and superficial submucosal layers without injuring the proper muscle layer.[5, 6] Also, APC is a relatively easy and less invasive technique compared to ER.

However, pathologic evaluation or predicting invasion depth cannot be done with APC unlike ER, therefore, the risk of local recurrence always exists. Although

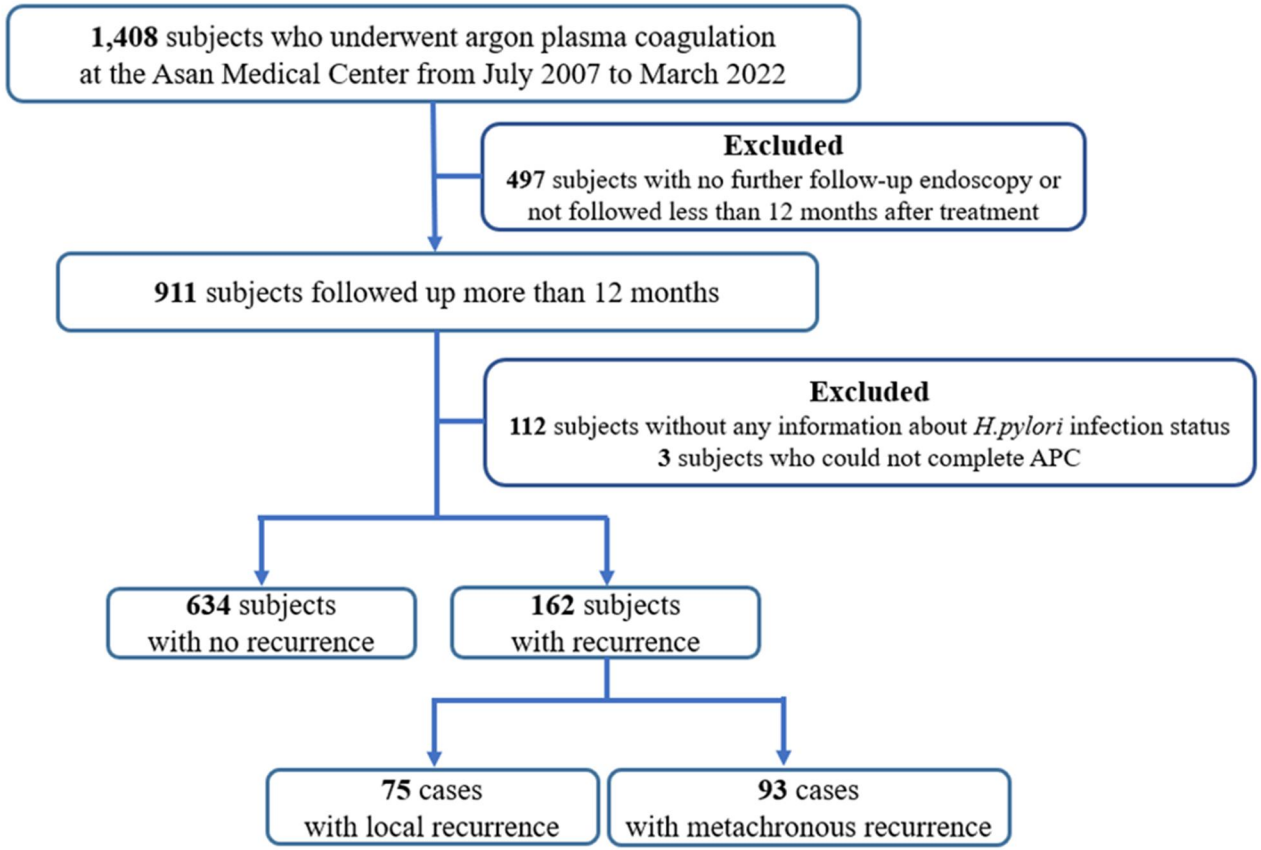
several studies suggested the clinical efficacy of APC for treating gastric neoplasm and risk factors of recurrence after APC, there are no guidelines on treating gastric neoplasm with APC. In this study, we investigated the clinical outcomes using APC for the treatment of gastric neoplasm and associated variables with the risk of local recurrence with long-term follow-up data.

# Materials and Methods

## Study population

Between July 2007 and March 2022, 1,424 patients with gastric neoplasm (1006 men, 418 women; median age, 67 years; interquartile range [IQR] 60–73 years) were treated with APC at the Asan Medical Center, Seoul, Korea. APC treatment was selected by physicians instead of surgical or ER treatment for the following reasons: (1) the patient had a high surgical risk or refused surgery; (2) lesions with a high risk of complications or technical difficulties for ER; (3) lesions small enough to be ablated with APC according to the endoscopist's decision. Among all patients, 497 patients with no further follow-up endoscopy or a follow-up of less than 12 months were excluded. In addition, 112 subjects without any information about Helicobacter pylori (H. pylori) infection status were also excluded. Finally, a total of 796 patients' data were analyzed retrospectively. (Figure 1) This study was approved by the Institutional Review Board (Approval no. 2022-0693).

**Figure 1.** Flowchart of the study




APC, argon plasma coagulation

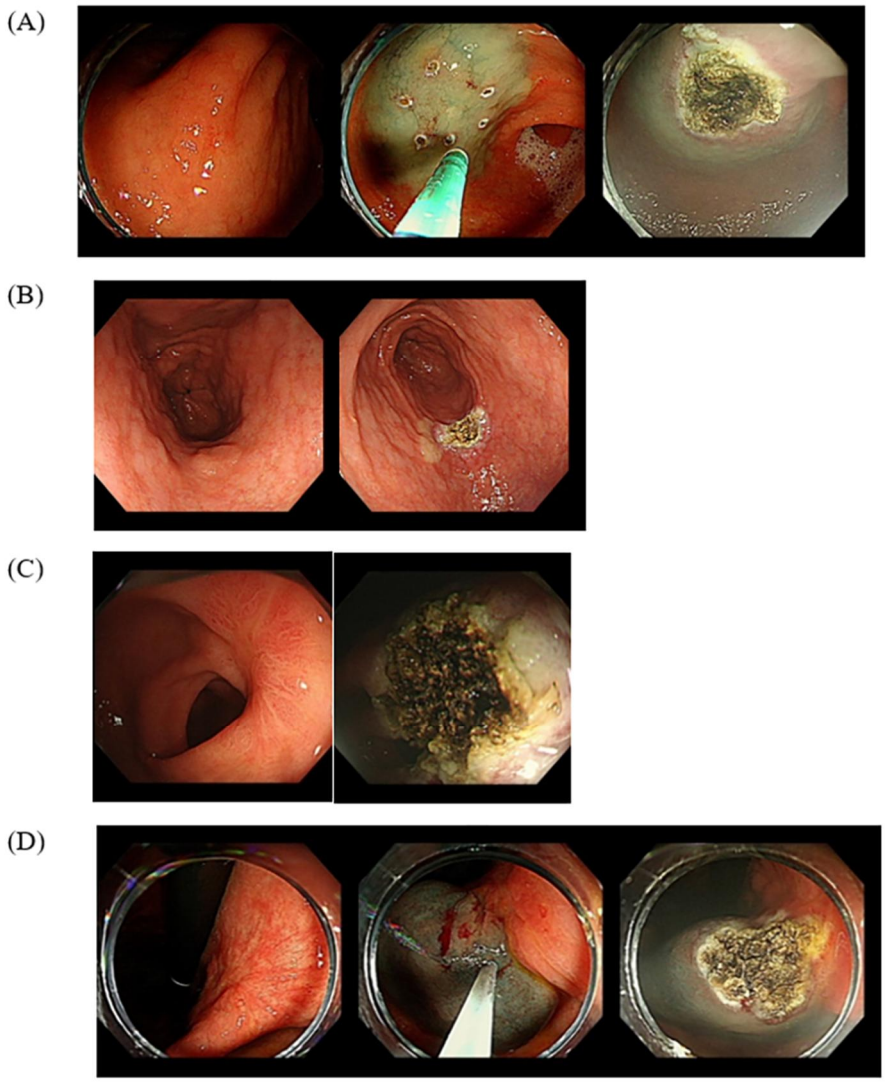
**Endoscopic procedure**

Patients underwent APC under conscious sedation using intravenous midazolam (0.05 mg/kg) and pethidine (25 or 50 mg). Their cardiopulmonary functions including blood pressure, heart rate, respiratory rate, and oxygen saturation were monitored during the procedure. All APC procedures were performed by eight experienced gastrointestinal endoscopists (H.Y.J, J.H.L, H.J.S, K.D.C, D.H.K, J.H.L, J.Y.A, and H.K.N) using a single-channel endoscope (GIF-H260; GIF-HQ290; Olympus Optical Co. Ltd, Tokyo, Japan). After finding the lesion, marking was done with soft coagulation. Submucosal injection was done with saline mixed with epinephrine (0.01 mg/mL) and indigo carmine using a 23-gauge needle. This step was optional which was determined by operators. Lesions were ablated with APC (APC 300; Erbe Elektromedizin, Tu¨ebingen, Germany) with a gas flow rate of 1.8L/min and electrical current set at 40, 60, or 80 W.

**Definitions**

Macroscopic appearances of gastric neoplasms were classified in agreement with the Japanese Gastric Cancer Association.[7] Their histologic differentiations were classified in accordance with WHO Classification.[8] Local recurrence was defined as recurred adenoma or cancer at the site of APC, whereas metachronous recurrence was defined as a lesion found at other sites than a primary lesion during follow-up endoscopy after at least 12 months of the follow-up period. Significant bleeding was characterized as bleeding with clinical symptoms in which hemostasis or transfusion was required. Scar change is defined as lesions showing the fibrotic change. Submucosal injection, which was done optionally by the operator's judgment, was defined as "done" when submucosal lifting was enough and "not done" when the operator did not undergo submucosal injection. Submucosal injection was considered "incomplete" when lifting was not enough due to fibrosis after attempting submucosal injection on lesions with scar change. (Figure 5)

**Figure 5.** Examples of definitions about scar change and submucosal lifting




(A) Submucosal injection “done” when submucosal injection is enough; (B) Submucosal injection “not done” operator did not undergo submucosal injection; (C) Submucosal injection “incomplete” when lesions show non-lifting sign when submucosal injection tried on lesions with scar change

**Follow-up schedule**

All patients were examined using conventional endoscopy at 6 and 12 months after APC. Abdominal computed tomography (CT) scans were performed optionally in some cases to detect extragastric recurrences.

**Statistical analysis**

Continuous variables were reported as medians with IQRs and categorical variables were presented as relative frequencies. Cox proportional hazards regression analysis was used to find out significant variables associated with time to local recurrence. Both univariate and multivariate analyses were done. A p-value smaller than 0.05 was considered significant. All statistical analyses were performed by using IBM SPSS Statistics 28.

# Result

Among 796 enrolled patients (median age 66 [IQR 59-72]; 578 males [72.6%]) the total recurrence was found in 162 patients. Out of 162 cases, the local recurrence was found in 75 cases (46.3%) and metachronous recurrence was in 93 cases (57.4%). (Figure 1)

**Baseline Characteristics of enrolled patients**

Table 1 shows the baseline characteristics of with and without the local recurrence groups. Local recurrence group included older (70 vs 65 years, $p < 0.001$), a higher proportion of male patients (88.0 vs 71.0%, $p = 0.003$), and larger size tumors (10 vs 5 mm, $p = 0.010$) compared to the group without local recurrence. More lesions with histology of cancer were found in the local recurrence group (24.0 vs 1.2%, <0.001). Among 769 adenomas, 754 cases (98.0%) were low-grade dysplasia (LGD) and 15 cases (2.0%) were high-grade dysplasia (HGD). Local recurrence was found in 53 cases (7.0%) of 754 LGD and 4 cases (26.7%) of 15 HGD. Of the total, 417 patients were negative for *H. pylori*, 351 patients underwent *H. pylori* eradication and 28 subjects failed or did not undergo *H. pylori* eradication. Metachronous recurrence happened in 54 cases (12.9%) of the 417 *H. pylori*-negative group, 37 cases (10.5%) of 351 *H. pylori* eradication success group, and two cases (7.1%) of 28 patients who failed or did not undergo *H. pylori* eradication.

**Table 1.** Baseline characteristics

| | Total (N=796) | Local recurrence (N=75) | Without local recurrence (N=721) | p-value |
|---|---|---|---|---|
| Median age, years, (IQR) | 66 (59–72) | 70 (63–76) | 65 (59–72) | <0.001 |
| Sex | | | | 0.003 |
| Male | 578 (72.6) | 66 (88.0) | 512 (71.0) | |
| Female | 218 (27.4) | 9 (12.0) | 209 (29.0) | |
| Median tumor size, mm, (IQR) | 10 (5–10) | 10 (6–10) | 5 (5–10) | 0.010 |
| Location | | | | 0.091 |
| Lower third | 577 (72.5) | 47 (62.7) | 530 (73.5) | |
| Middle third | 101 (12.7) | 11 (14.7) | 90 (12.5) | |
| Upper third | 118 (14.8) | 17 (22.7) | 101 (14.0) | |
| Gross morphology | | | | 0.711 |
| Elevated | 33 (4.1) | 2 (2.7) | 31 (4.3) | |
| Flat or depressed | 763 (95.9) | 73 (97.3) | 690 (95.7) | |
| Histology of lesion | | | | <0.001 |
| Adenoma | 769 (96.6) | 57 (76.0) | 712 (98.8) | |
| Cancer | 27 (3.4) | 18 (24.0) | 9 (1.2) | |
| *H. pylori* infection status | | | | 0.062 |
| Negative | 417 (52.4) | 49 (65.3) | 368 (51.0) | |
| Eradication succeeded | 351 (44.1) | 24 (32.0) | 327 (45.4) | |
| Eradication failed or not done | 28 (3.5) | 2 (2.7) | 26 (3.6) | |

Values are provided as median (interquartile range) and n (%). IQR, interquartile range

**Clinical outcomes of argon plasma coagulation**

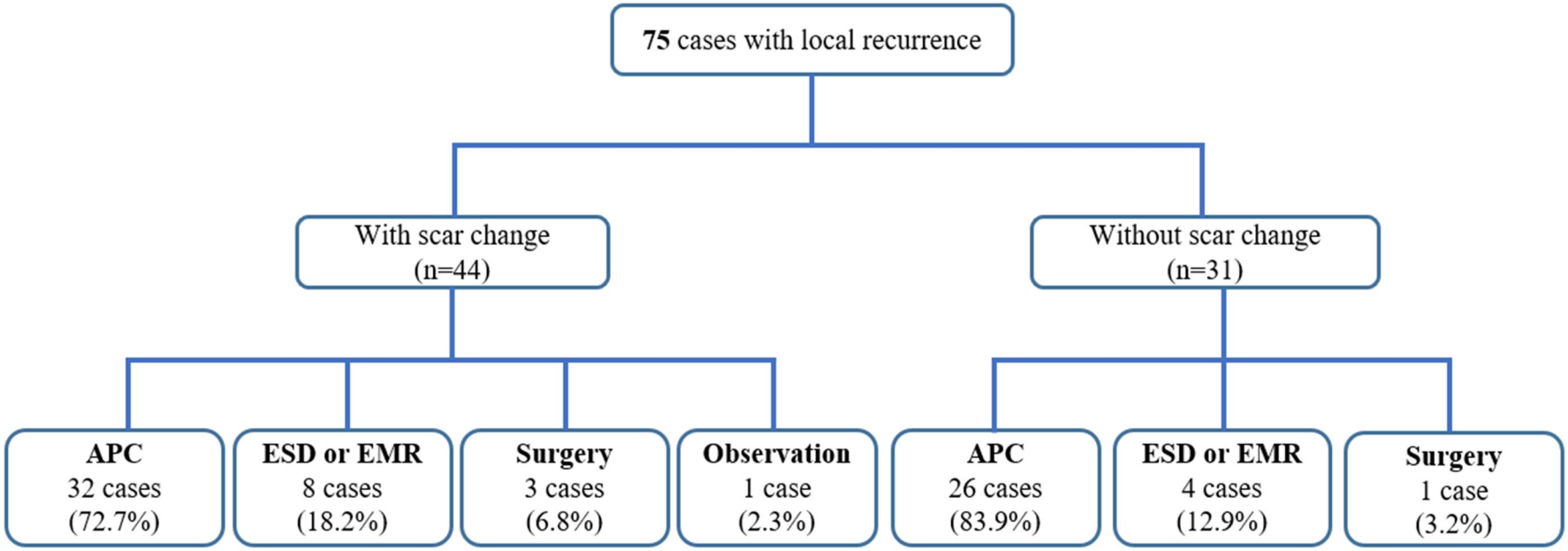
Table 2 shows endoscopic findings and clinical outcomes of patients with a median follow-up interval of 30 months (IQR 18-48 months). Local recurrence happened more frequently in cases with scar change compared to those without scar change (27.5% vs 4.9%, $p < 0.001$) and lower power settings (40 W 25.9%, 60 W 23.5%, 80 W 8.5%, respectively, $p = 0.001$). Bleeding was found in 12 cases (1.5%) of the total cases and there was no procedure-related perforation or death. Among 44 cases of local recurrence with scar change, 32 cases (72.7%) were treated with additional APC, and ER was done in eight cases (18.2%). Surgical resection was done in three cases (6.8%) in which local recurrence of cancer was found after APC. In one observation case, an 81-year-old patient who underwent APC due to massive bleeding during ESD did not undergo any further treatment after local recurrence due to old age. Among 31 cases without a scar, APC was done in 26 cases (83.9%), ER was done in four cases (12.9%) and surgical resection was done in one case (3.2%) in recurrence of cancer. (Figure 6)

**Table 2.** Endoscopic findings and clinical outcomes

| | Total (N=796) | Local recurrence (N=75) | Without local recurrence (N=721) | p-value |
|---|---|---|---|---|
| Scar change | | | | <0.001 |
| No | 636 | 31 (4.9) | 605 (95.1) | |
| Yes | 160 | 44 (27.5) | 116 (72.5) | |
| Power setting, watt | | | | 0.001 |
| 40 | 27 | 7 (25.9) | 20 (74.1) | |
| 60 | 17 | 4 (23.5) | 13 (76.5) | |
| 80 | 752 | 64 (8.5) | 688 (91.5) | |
| Bleeding | | | | 0.713 |
| No | 784 | 73 (9.3) | 711 (90.7) | |
| Yes | 12 | 2 (16.7) | 10 (83.3) | |
| Median follow up period, months (IQR) | 30 (18–48) | 44 (30–63.5) | 27 (18–46) | <0.001 |
| Median time to recurrence, months (IQR) | | 12 (6–32.5) | | |

Values are provided as median (interquartile range) and n (%). IQR, interquartile range

**Figure 6.** Additional treatment after local recurrence




APC, argon plasma coagulation, ESD, endoscopic submucosal dissection, EMR, endoscopic mucosal resection

**Univariate and multivariate analysis of the risk factors for local recurrence after APC**

Univariate analysis showed that age (hazard ratio [HR] 1.06, 95% confidence interval [CI] 1.04–1.10, $p < 0.001$), female sex (HR 0.37, 95% CI 0.19–0.75, $p = 0.005$), high power setting with 80W (HR 0.38, 95% CI 0.17–0.85, $p = 0.018$), *H. pylori* eradication (HR 0.56, 95% CI 0.34–0.91, $p = 0.019$), lesion size (HR 1.04, 95% CI 1.01–1.07, $p = 0.009$), histology of cancer (HR 11.67, 95% CI 6.85–19.88, $p < 0.001$), and scar change (HR 5.52, 95% CI 3.48–8.76, $p < 0.001$) were associated with increased risk of local recurrence. (Table 3) The positive relationship between age (HR 1.05, 95% CI 1.02–1.08, $p < 0.001$), tumor size (HR 1.04, 95% CI 1.00–1.08, $p = 0.028$), histology of cancer (HR 7.18, 95% CI 4.12–12.52, $p <0.001$), and scar change (HR 3.85, 95% CI 2.38–6.23, $p <0.001$) were associated with local recurrence in multivariate analysis. (Table 3)

**Table 3.** Univariate and multivariate analysis of the risk factors for local recurrence

| | Univariate analysis | | Multivariate analysis | |
|---|---|---|---|---|
| | HR (95% CI) | p-value | HR (95% CI) | p-value |
| Age, years | 1.06 (1.04–1.10) | <0.001 | 1.05 (1.02–1.08) | <0.001 |
| Sex | | | | |
| Male | 1 | | 1 | |
| Female | 0.37 (0.19–0.75) | 0.005 | 0.55 (0.26–1.14) | 0.106 |
| Size, mm | 1.04 (1.01–1.07) | 0.009 | 1.04 (1.00–1.08) | 0.028 |
| Histology of lesion | | | | |
| Adenoma | 1 | | 1 | |
| Cancer | 11.67 (6.85–19.88) | <0.001 | 7.18 (4.12–12.52) | <0.001 |
| Power setting, watt | | | | |
| 40 | 1 | | 1 | |
| 60 | 1.01 (0.30–3.48) | 0.983 | 0.92 (0.26–3.26) | 0.893 |
| 80 | 0.38 (0.17–0.85) | 0.018 | 0.64 (0.28–1.43) | 0.273 |
| Scar change | | | | |
| No | 1 | | 1 | |
| Yes | 5.52 (3.48–8.76) | <0.001 | 3.85 (2.38–6.23) | <0.001 |
| *H. pylori* infection status | | | | |
| Negative | 1 | | 1 | |
| Eradication succeeded | 0.56 (0.34–0.91) | 0.019 | 0.76 (0.46–1.24) | 0.266 |
| Eradication failed or not done | 0.53 (1.13–2.19) | 0.383 | 0.86 (0.18–4.09) | 0.849 |

HR, hazard ration, CI, confidence interval

**Subgroup analysis according to the size, scar change, and submucosal injection**

Local recurrence rates of subgroups of lesion sizes, scar changes, and submucosal injections were presented in Table 4. In groups with lesions smaller than 10 mm without scar change, local recurrence was found in 9 of 253 cases (3.6%) when submucosal lifting was not done and in 11 of 304 cases (3.6%) when submucosal lifting was done. In groups with lesions smaller than 5 mm without scar change, local recurrence was found in 0 of 87 cases (0.0%) when submucosal lifting was not done and in 2 of 129 cases (1.5%) when submucosal lifting was done. Local recurrence rate was found to be 5.4% (9 of 166 cases) and 5.1% (9 of 175 cases) according to submucosal injection status in a group with lesion size between 5 mm and 10 mm. Local recurrence was found in 18 of 109 cases (16.5%) in a group with a lesion size larger than 10 mm. The local recurrence rate was 16.0% (16 of 100 cases) in lesions sized larger than 10 mm and smaller than 20 mm and 22.2% (2 of 9 cases) with lesions larger than 20 mm.

**Table 4.** Local recurrence rate after APC according to lesion size, scar change, and submucosal saline injection

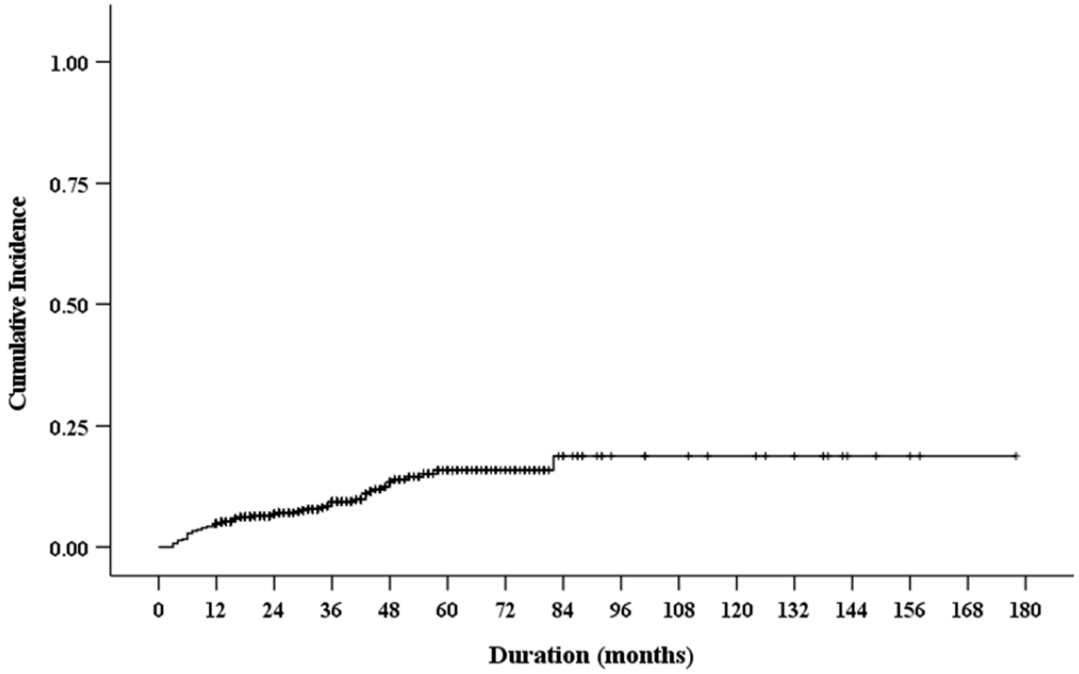
| Lesion size / Submucosal injection | | Smaller than 10 mm (n=687) | | < 5 mm (n=262) | | 5 - 10 mm (n=425) | | Larger than 10 mm (n=109) | |
|---|---|---|---|---|---|---|---|---|---|
| | | n | Local recurrence | n | Local recurrence | n | Local recurrence | n | Local recurrence |
| Total | | 687 | 57 (8.3) | 262 | 18 (6.9) | 425 | 39 (9.2) | 109 | 18 (16.5) |
| Without scar change | Total | 557 | 20 (3.6) | 216 | 2 (0.9) | 341 | 18 (5.3) | 79 | 11 (13.9) |
| | Lifting not done | 253 | 9 (3.6) | 87 | 0 (0.0) | 166 | 9 (5.4) | 43 | 2 (4.7) |
| | Lifting done | 304 | 11 (3.6) | 129 | 2 (1.5) | 175 | 9 (5.1) | 36 | 9 (25.0% |
| Scar change | Total | 130 | 37 (28.5) | 46 | 16 (34.8) | 84 | 21 (25.0) | 30 | 7 (23.3) |
| | Lifting not done | 39 | 13 (33.3) | 13 | 7 (53.8) | 26 | 6 (23.1) | 12 | 3 (25.0) |
| | Lifting incomplete | 91 | 24 (26.4) | 33 | 9 (27.3) | 58 | 15 (25.9) | 18 | 4 (22.2) |

Values are provided as n (%).

**Cumulative incidence of local and metachronous recurrence**

Figures 2 and 3 show the cumulative incidence of local and metachronous recurrence estimated utilizing the Kaplan-Meier analysis. During a median follow-up period of 44 months (IQR 30–63.5), the 1- and 5-year cumulative incidence of local recurrence was 5.0% and 16.0%, respectively. (Figure 2) Figure 3 shows the cumulative incidence of local recurrence according to scar change. Both 1- and 5-year cumulative incidence was significantly higher in a group with scar change (2.0 vs 16.9% at 1-year, 9.9 vs 35.5 % at 5-year, $p < 0.001$) The 1- and 5-year cumulative incidence of metachronous recurrence was 3.9% and 19.4%, respectively during a median follow-up period of 47 months (IQR 30–73). (Figure 4)

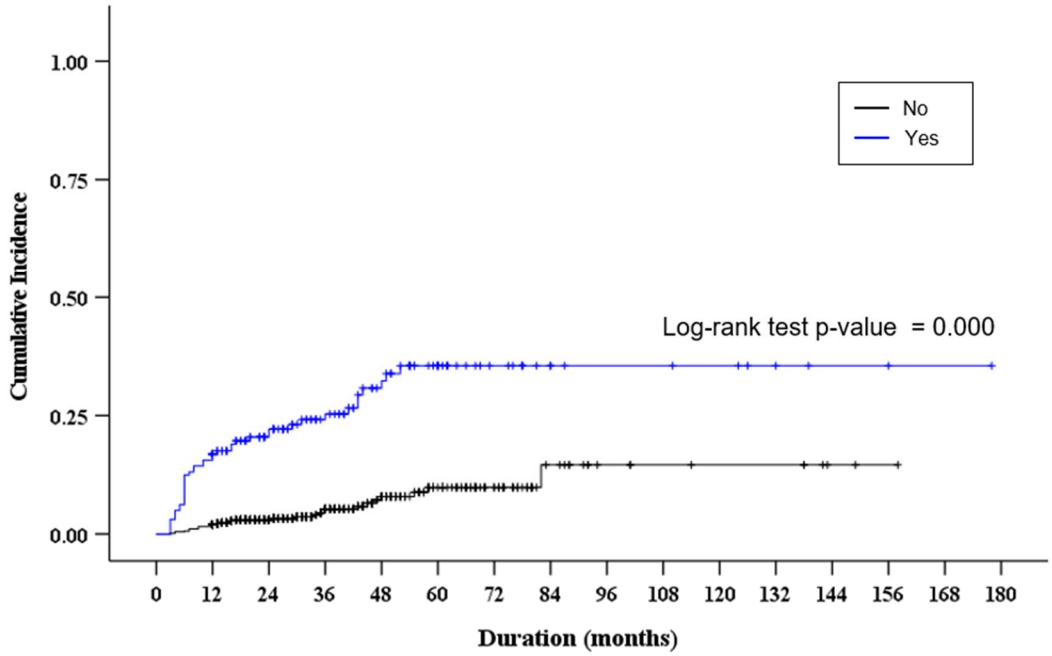
**Figure 2.** Cumulative incidence of local recurrence after APC for gastric neoplasm




| Duration (Months) | 0 | 12 | 24 | 36 | 48 | 60 | 72 | 84 | 96 | 108 | 120 | 132 | 144 | 156 | 168 | 180 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number at risk | 796 | 683 | 426 | 273 | 167 | 104 | 58 | 25 | 16 | 14 | 12 | 9 | 4 | 2 | 1 | 0 |
| Cumulative incidence (%) | 0.00 | 5.00 | 7.00 | 9.50 | 13.50 | 16.00 | 16.00 | 18.90 | 18.90 | 18.90 | 18.90 | 18.90 | 18.90 | 18.90 | 18.90 | 18.90 |

APC, argon plasma coagulation

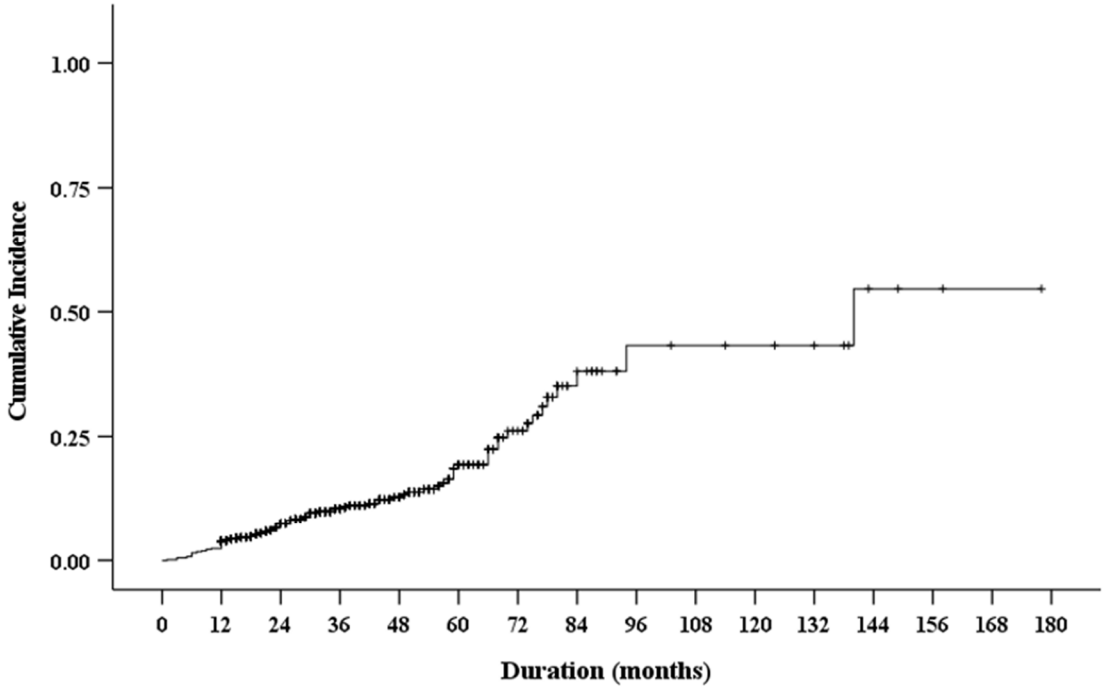
**Figure 3.** Cumulative incidence of local recurrence after APC for gastric neoplasm according to scar change




| | Duration (Months) | 0 | 12 | 24 | 36 | 48 | 60 | 72 | 84 | 96 | 108 | 120 | 132 | 144 | 156 | 168 | 180 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scar "No" | Number at risk | 636 | 560 | 334 | 209 | 123 | 79 | 42 | 17 | 9 | 7 | 6 | 6 | 2 | 1 | 0 | 0 |
| | Cumulative incidence (%) | 0.00 | 2.00 | 3.00 | 5.30 | 7.90 | 9.90 | 9.90 | 14.60 | 14.60 | 14.60 | 14.60 | 14.60 | 14.60 | 14.60 | 14.60 | 14.60 |
| Scar "Yes" | Number at risk | 160 | 123 | 92 | 64 | 44 | 25 | 16 | 8 | 7 | 7 | 6 | 3 | 2 | 1 | 1 | 0 |
| | Cumulative incidence (%) | 0.00 | 16.90 | 22.20 | 25.30 | 32.30 | 35.50 | 35.50 | 35.50 | 35.50 | 35.50 | 35.50 | 35.50 | 35.50 | 35.50 | 35.50 | 35.50 |

APC, argon plasma coagulation

**Figure 4.** Cumulative incidence of metachronous recurrence after APC for gastric neoplasm




| Duration (Months) | 0 | 12 | 24 | 36 | 48 | 60 | 72 | 84 | 96 | 108 | 120 | 132 | 144 | 156 | 168 | 180 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number at risk | 796 | 693 | 426 | 280 | 176 | 100 | 51 | 20 | 11 | 10 | 9 | 7 | 3 | 2 | 1 | 0 |
| Cumulative incidence (%) | 0.00 | 3.90 | 7.50 | 10.50 | 12.90 | 19.40 | 26.20 | 38.10 | 43.30 | 43.30 | 43.30 | 43.30 | 54.60 | 54.60 | 54.60 | 54.60 |

APC, argon plasma coagulation

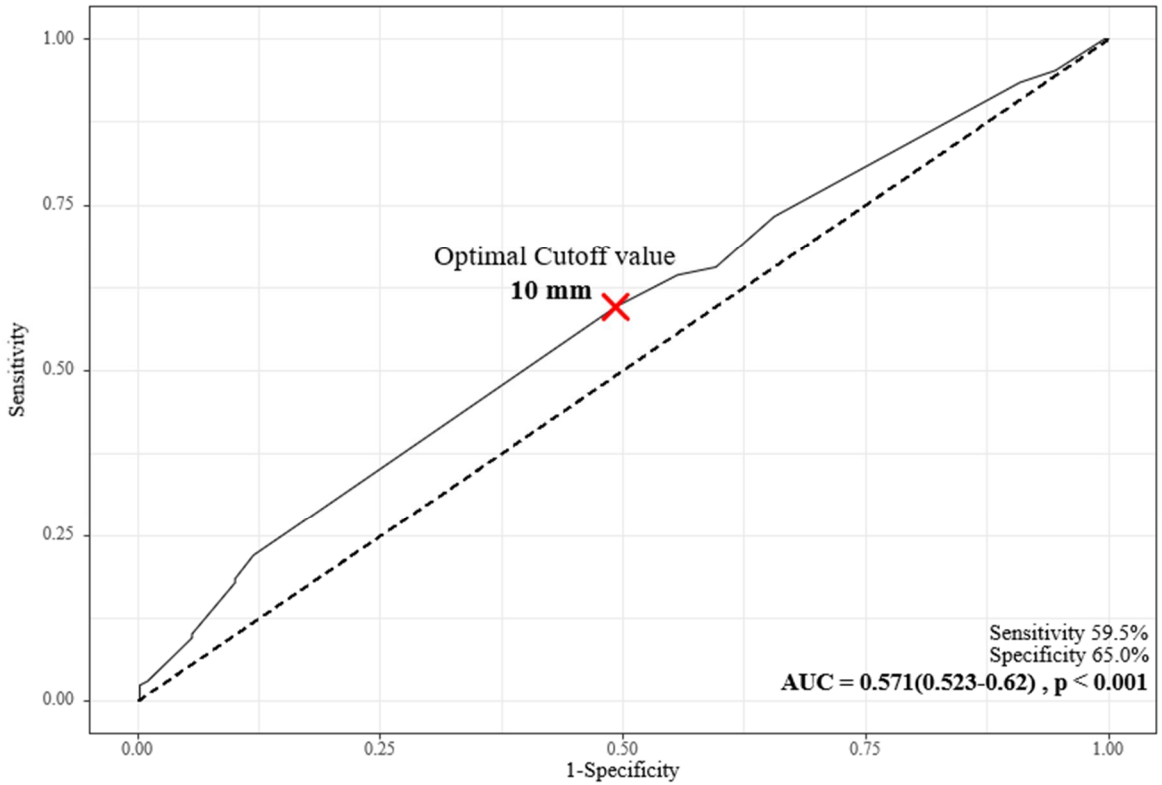
## Discussion

Traditionally, APC has been used to treat gastrointestinal bleeding caused by peptic ulcer[9] vascular ectasia[10], and varices[11]. APC has been suggested as an alternative treatment modality to treat gastric neoplasm which cannot be treated with ER or surgery because of multiple comorbidities or high risk of complications. In our study, we found age, tumor size, histology of cancer, and scar change were associated with an increased risk of local recurrence. Treating tumors smaller than 10 mm without scar change with APC showed the local recurrence rate of 3.6%. Therefore, in this case, APC can be recommended as a first-line treatment in place of ER.

Previously, a study on clinical outcomes of APC suggested that APC was useful in treating early gastric neoplasm including 24 well-differentiated EGC, one signet ring cell carcinoma, and 23 gastric adenomas smaller than 20 mm with an annual recurrence rate of 1.8%.[12] Another study showed APC could be a useful treatment for LGD under 20 mm in contrast to ESD because of shorter procedure time and hospital stay and low complication rate.[13] All target lesions included in these studies were smaller than 20 mm within the indications of ER. However, an additional analysis drawing the receiver operation characteristic (ROC) curve with tumor size and local recurrence indicated that the optimal cut-point value of tumor size was 10 mm with an annual recurrence rate of 5.00%. (Supplementary Figure 1) This discrepancy could be due to the inclusion of smaller lesions detected early and lesions that did not meet the indications of ER like poor histologic differentiation. The range of local recurrence rates after ER for EGC was found to be from 0.0% to 3.1% according to previous studies.[14-17] The local recurrence rate was 3.6% when

APC was done at lesions smaller than 10 mm, and the rate was especially lower (0.9%) with lesions smaller than 5 mm. However, it would be appropriate to use ER than APC for gastric neoplasm larger than 10 mm considering the local recurrence rate.

**Supplementary Figure 1.** Receiver operating characteristic analysis of lesion size according to local recurrence




Receiver operation characteristic (ROC) curve with tumor size and local recurrence showed that the optimal cut-point value of tumor size was 10 mm, with sensitivity 59.5%, specificity 65.0%, area under the curve (AUC) 0.571 with *p*-value < 0.001

Submucosal injection lifts the mucosal layer during ER to prevent proper muscle damage from coagulation. It can also help to predict whether or not the lesion invaded the submucosal layer or underwent fibrosis.[18] With the submucosal fluid cushion, APC could be done on an outpatient basis, because it can prevent the risk of perforation.[19, 20] Scar change was associated with a higher risk of local recurrence. We assume APC cannot be done enough to ablate deep lesions with submucosal invasion or fibrosis because there will be an increased risk of proper muscle injury or perforation without a submucosal saline cushion. In Korea, the needle used for submucosal injection is not covered by national health insurance during APC in the treatment of early gastric neoplasm. Therefore, submucosal injection was not done in 296 lesions without scar change in this study, however, a low rate of local recurrence was detected among gastric neoplasms smaller than 10 mm without submucosal injection. With these results, we can infer that submucosal injection is not mandatory when applying APC for lesions smaller than 10 mm.

In a study that investigated the local recurrence after APC at different power settings, a high-power setting of 60 or 80 W at APC decreased the risk of local recurrence compared to that at 40 W.[21] However, in another study, coagulation depth in the submucosal level reached a plateau after fifteen seconds regardless of the power setting.[18] In this study, power setting was not significantly associated with local recurrence after APC. Although we could not quantify the exact time of ablation, it could be due to the coagulation depth reaching the plateau after ablating over fifteen seconds.

Gastric adenoma occurs and recurs in chronic atrophic gastritis, intestinal metaplasia, and H. pylori infection.[22, 23] The Asia-Pacific regions including Korea,

Japan, and China show a high incidence of gastric cancer with a high prevalence of H. pylori infection as well. The seroprevalence of H. pylori remains over 50% in Korea.[24] Therefore, recent evidence-based guideline for the treatment of H. pylori in Korea recommends H. pylori eradication after ER for H. pylori-positive gastric adenoma to prevent a metachronous recurrence.[25] Our study demonstrated that H. pylori infection status did not show any statistically significant correlation to recurrence. We believe that it was difficult to analyze the actual recurrence rate according to H. pylori infection status because we could not differentiate H. pylori naive patients and those with past infections.

Our study has several limitations. First, the study is designed as a retrospective study, so we could not figure out the exact infection status of H. pylori. Second, whether to use APC for treatment of gastric neoplasm or attempt submucosal injection before APC was decided by the operator, because there are no definite indications to follow. Third, although we analyzed the risk factors related to recurrence, we could not verify the exact ablation time or depth to prevent recurrence. Fourth, there was no control group to find out the clinical course of gastric neoplasm without treatment. Despite these limitations, this study analyzed the local recurrence rate after APC treatment for gastric neoplasms of different lesion sizes in a large number of patients. Therefore, our results can be helpful for carrying out subsequent research and issuing guidelines about indications of APC for gastric neoplasm thereafter.

# Conclusion

In conclusion, we discerned that APC can be used instead of ER for the treatment of early gastric cancer or adenoma smaller than 10 mm with lower rates of local recurrence and complications. However, more frequent follow-up examinations should be considered in patients with larger size gastric neoplasm or scar change to find local recurrence after APC in early gastric neoplasm. In addition, submucosal injection before performing APC might not be necessary for lesions smaller than 10 mm without scar change, especially for lesions smaller than 5 mm.

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# 국문초록

**서론** : 아르곤 플라즈마 응고술은 병변의 크기가 작은 위 신생물의 치료에 있어 내시경적 절제술을 대체할 수 있는 수단이다. 하지만, 위 신생물의 치료에 아르곤 플라즈마 응고술의 적용에 대한 가이드라인은 정립되어 있지 않은 실정이다. 이에 본 연구는 위 신생물의 치료에 있어 아르곤 플라즈마 응고술을 적용하였을 때의 임상 경과와 국소 재발과 연관된 인자들을 분석하고자 하였다.

**방법** : 2007년 7월부터 2022년 3월까지 아르곤 플라즈마 응고술로 위 신생물을 치료하고, 치료 후 최소 12개월의 추적 관찰이 이루어진 1,408명의 환자 기록을 후향적으로 검토하여 임상 경과와 국소 재발에 연관된 인자들을 분석하였다.

**결과** : 총 796명의 환자(나이 중앙값 66세)를 위 신생물에 대해 아르곤 플라즈마 응고술 시행 이후 중앙값 30개월 간 추적 관찰하였을 때 국소 재발은 75명(9.42%)에서 발생하였다. 국소 재발과 관련된 인자에 대해 다변량 분석을 시행하였을 때, 나이(HR 1.05, 95% CI 1.02-1.08), 병변의 크기(HR 1.04, 95% CI 1.00-1.08), 악성 병변인 경우(HR 7.18, 95% CI 4.12-12.52) 그리고 병변에 반흔성 변화가 있는 경우(HR 3.85, 95% CI 2.38-6.23)가 국소 재발과 연관이 있었다. 반흔성 변화가 없고, 크기가 10 ㎜ 이하인 557건의 병변 중 국소 재발은 20건(3.6%)에서 관찰되었다. 반면, 반흔성 변화가 있는 130건의 병변 중 국소 재발은 37건(28.5%)에서 관찰되었고, 크기가 10 ㎜ 초과하는 109건의 병변 중 국소 재발은 18건(16.5%)에서 관찰되었다.

**결론** : 병변의 크기가 10 ㎜ 이하이고 반흔성 변화가 관찰되지 않는 위 신생물의 치료에 있어 내시경적 절제술 대신 아르곤 플라즈마 응고술을 적용해 볼 수 있겠다. 하지만, 병변의 크기가 크거나 반흔성 변화를 동반한 경우에는 국소 재발 가능성을 고려하여 아르곤 플라즈마 응고술의 적용 및 추적 관찰에 있어 신중을 기해야 할 것으로 생각된다.

**중심단어** : 위 신생물, 아르곤 플라즈마 응고술, 국소 재발