Impact of tag index and local electrogram for successful first-pass cavotricuspid isthmus ablation

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BACKGROUND The optimal ablation index (AI) value for cavotricuspid isthmus (CTI) ablation is unknow.

OBJECTIVE This study investigated the optimal AI value and whether preassessment of local electrogram voltage of CTI could predict first-pass success of ablation.

METHODS Voltage maps of CTI were created before ablation. In the preliminary group, the procedure was performed in 50 patients targeting an AI ≥450 on the anterior side (two-thirds segment of CTI) and AI ≥400 on the posterior side (one-third segment of CTI). The modified group also included 50 patients, but the target AI for the anterior side was modified to ≥500.

RESULTS In the modified group, the first-pass rate of success was higher (88% vs 62%; $P < .01$) than in the preliminary group, and there were no differences in the average bipolar and unipolar voltages at the CTI line. Multivariate logistic regression analysis revealed that ablation with an AI ≥500 on the anterior side was the only independent predictor (odds ratio 4.17; 95% confidence interval 1.44–12.05; $P < .01$). The bipolar and unipolar voltages were higher at sites without conduction block than at sites with conduction block (both $P < .01$). The cutoff values for predicting conduction gap were ≥1.94 mV and ≥2.33 mV with areas under the curve of 0.655 and 0.679, respectively.

CONCLUSIONS CTI ablation with a target AI >500 on the anterior side was shown to be more effective than an AI >450, and local voltage at a conduction gap was higher than without a conduction gap.

KEYWORDS Cavotricuspid isthmus; Ablation index; First-pass success; Atrial flutter; Ablation

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Introduction

Bidirectional conduction block by cavotricuspid isthmus (CTI) linear ablation is an established treatment for typical atrial flutter (AFL).[1,2] The anatomy of the CTI, which is delineated by the borders of the tricuspid valve and the Eustachian ridge, is not consistent and reportedly influences ablation results.[3–6] Laborious cases without first-pass success reportedly had prolonged procedural times.[7,8] We have previously reported that deep CTIs have lower first-pass success rates than shallow CTIs.[9]

To achieve transmural lesion formation and to avoid serious complications, the ablation index (AI) has become a comprehensive system of evaluation using 3-dimensional mapping (CARTO® 3 System Version 7; Bioscence Webster, Inc, Diamond Bar, CA).[10] Notably, AI-guided pulmonary vein isolation (PVI) has been proven to be an especially effective tool because of its accuracy in estimating the ablation lesion area. Consistent with atrial fibrillation, a multicenter randomized controlled trial has recently demonstrated the safety and efficacy of AI-guided CTI ablation.[11] AI-guided CTI ablation has been reported in several studies, but the optimal AI value is still not established.[12–16]

Atrial wall factors are also important for durable lesion formation.[17] In addition to the thickness of the atrial wall, local electrogram voltage amplitude and its ratio with AI have also been used as predictors for acute pulmonary vein reconnections after PVI.[18] We therefore hypothesized that assessment of electrogram voltage of CTI can also be used to predict successful CTI ablation. In this study, we investigated the optimal ablation index AI value for CTI ablation and whether preassessment of local electrogram voltage of the CTI predicts first-pass success of CTI ablation.

Materials and Methods

Study design

A total of 100 consecutive patients who underwent CTI linear ablation at Wakayama Medical University Hospital between January 2021 and June 2022 were retrospectively included in

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KEY FINDINGS

- Incomplete conduction block sites of cavotricuspid isthmus (CTI) ablation were more frequently observed at the anterior site (two-thirds segment of the CTI) than at the posterior site (one-third segment of the CTI).
- In the preliminary group, the procedure was performed targeting an ablation index (AI) ≥450 on the anterior side and an AI ≥400 on the posterior side. In the modified group, the target AI for the anterior side was modified to ≥500. The first-pass rate of success was improved in modified group without complication.
- There were no differences in the mean bipolar and unipolar voltages at the CTI line between the preliminary and modified groups. The bipolar and unipolar voltages were higher at sites without conduction block than at sites with conduction block.

this study. In all patients, the CARTO3 mapping system was applied, and computed tomography was performed prior to CTI ablation. Excluded from the study were cases of recurrence of AFL after CTI ablation (n = 2) and patients that had CTI-dependent AFL rhythm during the procedure (n = 18). This study was carried out in accordance with the Declaration of Helsinki. This study was approved by the local ethics committee (Research Ethics Committee of Wakayama Medical University, 3557), and the requirement for written informed consent was waived because of the retrospective nature of the study.

Computed tomography–based measurement of CTI

The CTI anatomy was assessed using multidetector computed tomography, as previously reported.[9] In brief, acquired images were reconstructed in different planes on a workstation (Intuition Thin Client; TeraRecon, Durham, NC). Anatomical information was analyzed in the sagittal plane across both the center of the tricuspid valve and the inferior vena cava (IVC). The following parameters were analyzed: (1) length of the CTI, (2) depth of the CTI, (3) distance from the right coronary artery to the right atrium, (4) height of the Eustachian ridge, and (5) angle between the CTI and IVC (Figure 1). The Eustachian ridge was measured from its base to its distal extremity in the plane passing through the center of the IVC.

Electrophysiologic study

Patients were mildly sedated with hydroxyzine pamoate or dexmedetomidine hydrochloride. After obtaining right internal jugular vein access, a multipolar deflectable catheter was inserted into the coronary sinus. Another multipolar catheter (Snake, Japan Life Line, Tokyo, Japan) was placed close to the tricuspid annulus via the right femoral vein. A deflectable sheath (Agilis; Abbott, St. Paul, MN) was also introduced from the right femoral vein for a multipole, multispine catheter (Pentaray NAV; Biosense Webster). Bipolar and unipolar signals were acquired from the right ventricle to the IVC during continuous pacing at a 600-ms cycle from the proximal coronary sinus (Figure 2). For the unipolar electrogram, the indifferent electrode at the level of the IVC was used as the cathode. The voltages at the 3 sites on or those closest to the first-pass CTI ablation site were retrospectively measured and averaged for analysis. The modified AI was calculated as previously reported[18]: modified AI = AI / bipolar or unipolar voltage.

Ablation method

CTI ablation was performed starting from the tricuspid valve to the IVC. A 3.5-mm open irrigated-tip ablation catheter (Navistar ThermoCool SmartTouch; Biosense Webster) was used with point-by-point application. During CTI ablation, continuous pacing at 500 to 700 ms cycle from the proximal coronary sinus was performed. The radiofrequency (RF) sites of the CTI were divided into 2 parts: the anterior side (two-thirds segment of CTI) and the posterior side (one-third segment of CTI).[12]

Both the VisiTag module (Biosense Webster) and fluoroscopy provided each RF location during the procedures. In the current study of the preliminary group (PG), our setting of the VisiTag was as follows: minimum time of 5 seconds, maximum range of 3 mm, minimum contact force of 5 g, and force over time of 25%. In the 50 patients in the PG, RF energy was 30 to 35 W, with saline irrigation at a flow rate of 17 to 30 mL/min; duration at each RF site was maximum 40 seconds, aiming for an AI ≥450 for the anterior side and an AI ≥400 for posterior side; and the distance between 2 neighboring RF sites did not exceed 6 mm. In the modified group (MG) (n = 50), RF ablation with an AI ≥500 for the anterior side and an AI ≥400 for the posterior side were performed. Ablation was terminated when the target AI value was reached.

The bidirectional conduction block was confirmed using differential pacing from the proximal coronary sinus and inferior lateral wall of the right atrium. The widely spaced double potential was also confirmed. If incomplete conduction block was suspected near the IVC, the ablation catheter would be deflected by more than 90° to ablate the interior of the pouch.[9] Complications were defined as vascular complication (pseudoaneurysm, fistula, and bleeding requiring transfusion), cardiac tamponade, valvular damage, pneumothorax, and hemothorax.

Follow-up

The patients were scheduled for follow-up visits at 3 and 6 months after the procedure, and a 12-lead electrocardiogram was routinely performed. If the patient had an episode of palpitations, further examination, including Holter monitoring, was considered to determine whether AFL was present.

Statistical analysis

Statistical analysis was performed using JMP Pro version 16.0 for Macintosh (SAS Institute, Cary, NC). Results are expressed as median and interquartile range (IQR). Qualitative

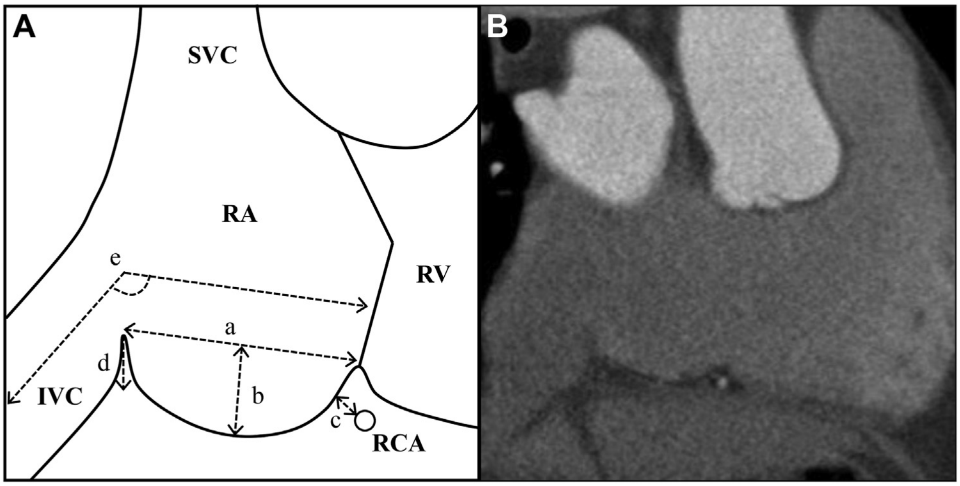

Figure 1 Measurement of the cavotricuspid isthmus (CTI) in computed tomography and representative cases. **A:** Schema of quantitative measurement of the CTI. **B:** Representative computed tomography image of the CTI. IVC = inferior vena cava; RA = right atrium; RV = right ventricle; RCA = right coronary artery; SVC = superior vena cava.

data are presented as number and percentage. The nonparametric Mann-Whitney *U* test was used to test for differences between the 2 groups. Pearson's chi-square test was applied for categorical variables. Univariate and multivariate logistic regression analyses were performed to determine independent predictors of first-pass success of CTI linear ablation. The receiver-operating characteristic (ROC) curve was used to determine the best cutoff value of local voltage parameters for the conduction gap. The best cutoff value was determined according to maximum Youden index. A P value <.05 was considered to be statistically significant.

Results

Preliminary group

A total of 50 patients were enrolled in the PG during the first half of the study period. The bidirectional conduction block at the CTI was achieved in all patients without any complications. First pass was successfully achieved in 32 (64%) patients. The anterior side of CTI was the most common site of the conduction gap, with 16 cases.

Modified group

In the second half of the study, 50 patients were enrolled in the MG. Conduction gaps at the anterior side had been frequently admitted in the PG, so RF ablation with an AI ≥500 for the anterior side was performed in the MG. First-pass success was achieved in 44 (88%) patients. The conduction gap of CTI ablation was admitted in 4 sites on the anterior side and 2 sites on the posterior side.

Comparison between the PG and the MG

Patient characteristics and anatomical data assessed by cardiac echocardiography and computed tomography are summarized in Table 1. There were no significant differences between the 2 groups. In the MG, the rate of first-pass success was higher (88% vs 62%; $P < .01$) and incomplete conduction block at the anterior side was lower (8% vs 34%; $P < .01$) than in the PG, but incomplete conduction block at the posterior side was the same (4% vs 4%; $P = 1.00$) (Table 2). Regarding ablation parameters, average duration of RF per application, contact force, force-time integral, and AI were higher in the MG than in the PG (Table 2). The total ablation time was longer in the PG than in the MG (median 547 [interquartile range (IQR) 367–1064] seconds vs 400 [IQR: 328–626] seconds; $P = .01$). In this study, there were no complications, including audible steam pop. Reconduction of CTI linear ablation was confirmed in 3 PG patients and 2 MG patients during the follow-up period (6% vs 4%; $P = .65$).

Electrical assessment

There were no differences in the mean bipolar and unipolar voltages at CTI line between the PG and MG (bipolar voltage: median 1.26 [IQR 0.68–1.73] mV vs 1.46 [IQR 1.03–1.90] mV; $P = .11$; unipolar voltage: median 1.95 [IQR 1.26–2.84] mV vs 1.93 [IQR 1.50–2.59] mV; $P = .75$) (Table 2). In addition, mean bipolar and unipolar voltage between the anterior and posterior sides were also not different in both groups.

Predictors for first-pass success

To evaluate the independent predictor for first-pass success of CTI ablation, univariate and multivariate logistic regression analysis were performed (Table 3). Although univariate logistic regression analysis revealed that depth of the CTI (odds ratio [OR] 0.84; 95% confidence interval [CI] 0.72–0.98; $P = .02$) and distance to the right coronary artery (OR 0.60; 95% CI 0.30–0.91; $P = .01$) were predictors for first-pass success, multivariate logistic regression analysis revealed that ablation with an AI ≥500 for the anterior side was only an independent predictor (OR 4.17; 95% CI 1.44–12.05; $P < .01$). From the ROC curve, an AI ≥500 was a predictor

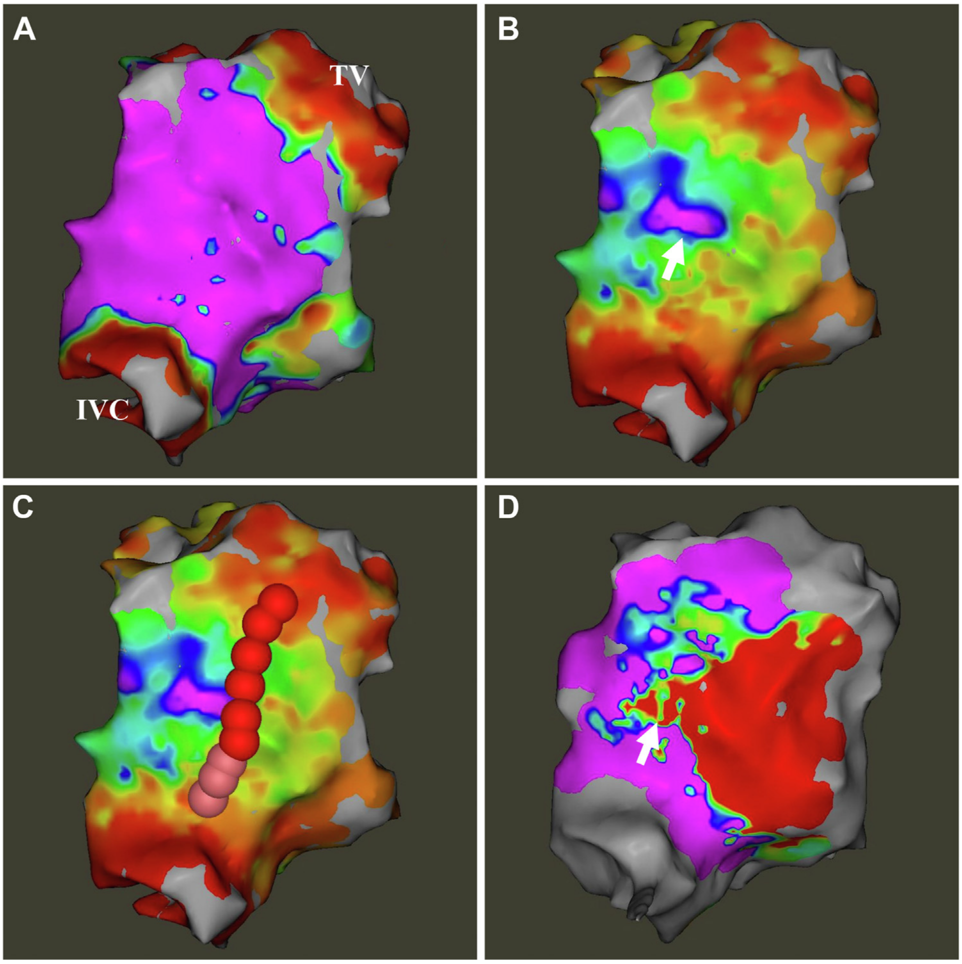

Figure 2 Representative voltage mages of the cavotricuspid isthmus (CTI). **A:** Bipolar voltage map. The bright purple areas are defined as ≥0.5 mV and the rea areas are defined as <0.1 mV. **B:** The unipolar voltage map demonstrated the highest voltage site at the mid portion of the CTI (white arrow). The voltage map threshold is adjusted as follows: for bright purple areas, ≥7.7 mV; and for the rea areas, <0.1 mV. **C:** The CTI ablation tags and unipolar voltage map. Tags turn pink (ablation index ≥400) and then red (ablation index ≥450). **D:** The local activation time isochronal map was created after first-pass CTI ablation and revealed that the highest-voltage site (white arrow) is the conduction gap location. IVC = inferior vena cava; TV = tricuspid valve.

Table 1 Patient characteristics and anatomical data

	Preliminary group (n = 50)	Modified group (n = 50)	*P* value
Patient characteristics			
Age, y	71 (65–79)	73 (65–79)	.87
Male	31 (62)	32 (64)	.84
BMI, kg/m^2	24.6 (22.4–26.8)	24.4 (21.8–26.1)	.59
History of atrial fibrillation	44 (88)	48 (96)	.14
Prior cardiac surgery	1 (2)	1 (2)	1.00
Echocardiographic data			
Left ventricular ejection fraction, %	56.8 (53.0–60.2)	58.1 (53.9–60.7)	.35
Left atrial diameter, mm	40 (36–43)	42 (37–46)	.25
Anatomical data collected by CT			
Length of CTI, mm	29.3 (25.8–34.1)	28.8 (24.2–34.7)	.64
Depth of CTI, mm	5.3 (3.1–8.1)	4.4 (2.8–7.5)	.40
CTI-IVC angle, °	96.1 (85.7–103.3)	99.5 (90.4–102.2)	.07
Height of Eustachian ridge, mm	2.6 (0.0–5.0)	2.4 (0.0–4.5)	.57
Distance to right coronary artery, mm	2.5 (1.8–3.2)	2.4 (2.0–2.8)	.94

Values are median (interquartile range) or n (%).

BMI = body mass index; CT = computed tomography; CTI = cavotricuspid isthmus; IVC = inferior vena cava.

Table 2 Ablation-related data

	Preliminary group (n = 50)	Modified group (n = 50)	*P* value
Bidirectional conduction block at the CTI	50 (100)	50 (100)	1.00
First-pass success	32 (62)	44 (88)	<.01
Incomplete block on anterior side	17 (34)	4 (8)	<.01
Incomplete block on posterior side	2 (4)	2 (4)	1.00
Ablation time, s	6 (5–8)	6 (5–7)	.55
Catheter inversion technique	22 (44)	15 (30)	.21
Complication	0 (0)	0 (0)	1.00
Total ablation time, s	547 (367–1064)	400 (328–626)	.01
RF duration per application, s			
Global	23.4 (21.3–25.7)	27.6 (26.0–28.9)	<.01
Anterior	24.7 (22.1–26.9)	29.6 (27.4–31.2)	<.01
Posterior	21.8 (19.2–25.5)	24.0 (20.8–26.0)	.07
Average contact force, g			
Global	11.3 (10.2–12.3)	11.9 (10.9–12.9)	.06
Anterior	11.3 (10.2–12.7)	12.5 (11.5–14.3)	<.01
Posterior	11.2 (9.0–13.0)	10.0 (8.5–12.6)	.42
Average power, W			
Global	33.5 (33.0–33.9)	33.3 (33.0–33.5)	.09
Anterior	35.0 (35.0–35.0)	35.0 (35.0–35.0)	.41
Posterior	30.0 (30.0–30.7)	30.0 (30.0–30.0)	<.01
Average FTI, g			
Global	252 (242–274)	323 (308–337)	<.01
Anterior	264 (249–281)	370 (351–387)	<.01
Posterior	232 (210–258)	235 (221–251)	.45
Average ablation index			
Global	439 (431–443)	469 (463–472)	<.01
Anterior	454(452–455)	503 (502–504)	<.01
Posterior	404 (400–408)	404 (403–405)	.86
Mean bipolar voltage on CTI line, mV			
Global	1.26 (0.68–1.73)	1.46 (1.03–1.90)	.11
Anterior	1.10 (0.69–1.74)	1.52 (0.91–2.00)	.05
Posterior	0.83 (0.60–1.71)	1.47 (0.74–2.35)	.06
Mean unipolar voltage on CTI line, mV			
Global	1.95 (1.26–2.84)	1.93 (1.50–2.59)	.75
Anterior	1.86 (1.28–2.82)	1.95 (1.49–2.80)	.44
Posterior	1.65 (1.21–2.50)	1.87 (1.10–2.72)	.92

Values are n (%) or median (interquartile range).
CTI = cavotricuspid isthmus; FTI = force-time integral; RF = radiofrequency.

of first-pass success of CTI ablation with a sensitivity of 59% and a specificity of 76% ($P < .01$).

Ablation-related parameters at sites with and without conduction gap

Incomplete conduction block sites were more frequently observed at the anterior site than at the posterior site (21% vs 4%; $P < .01$). Comparisons of ablation-related parameters between sites with and without a conduction gap are summarized in Table 4. The bipolar voltage and unipolar voltage were higher at sites without conduction block than with conduction block ($P < .01$). In addition, similar results were observed concerning modified AI (bipolar and unipolar). The ROC curve of bipolar voltage, unipolar voltage, and modified AI (bipolar and unipolar) to predict conduction block are shown in Figure 3, the areas under the curve were 0.655, 0.679, 0.656, and 0.689, respectively. The best cutoff values for predicting a conduction gap were ≥1.94 mV, ≥2.33 mV, ≤313 AU/mV, and ≤236 AU/mV, respectively.

Discussion

In current study, the probability of complete conduction block regarding the first-pass CTI ablation was significantly higher in the MG than in the PG, especially on the anterior side. In addition, the bipolar voltage and unipolar local voltage were higher at the sites without conduction block than at the sites with conduction block.

Factors associated with first-pass failure

The frequency of incomplete conduction block after first-pass CTI ablation was higher at the anterior side than at the posterior side. Although the thickness of CTI was not evaluated in this study because of the lack of noncontrast computed tomography examination in some patients, a previous study reported that the CTI is thicker at the anterior side than at the posterior side.[19] The unipolar and bipolar pulmonary vein–left atrium voltages also reportedly correlated with the wall thicknesses.[20] Although there were no significant differences in mean local unipolar and bipolar voltages between first-pass successful and unsuccessful cases, the higher

Table 3 Univariate and multivariate logistic regression analyses for first-pass success

	Univariate		Multivariate	
	Odds ratio (95% CI)	*P* value	Odds ratio (95% CI)	*P* value
Age	1.02 (0.97–1.08)	.32	—	—
Male	1.48 (0.59–3.72)	.41	—	—
BMI	0.94 (0.83–1.07)	.38	—	—
History of atrial fibrillation	3.38 (0.78–14.69)	.11	—	—
Left atrial diameter	1.02 (0.95–1.10)	.59	—	—
Length of CTI	1.00 (0.93–1.07)	1.00	—	—
Depth of CTI	0.84 (0.72–0.98)	.02	0.88 (0.75–1.04)	.12
CTI-IVC angle	1.01 (0.98–1.04)	.51	—	—
Height of Eustachian ridge	0.88 (0.76–1.03)	.12	—	—
Distance to right coronary artery	0.60 (0.39–0.91)	.01	0.65 (0.40–1.04)	.06
Modified group	4.49 (1.61–12.55)	<.01	4.17 (1.44–12.05)	<.01
Mean unipolar voltage on ablation line	1.30 (0.75–2.29)	.34	—	—
Mean bipolar voltage on ablation line	1.04 (0.57–1.88)	.90	—	—

BMI = body mass index; CI = confidence interval; CT = computed tomography; CTI = cavotricuspid isthmus; IVC = inferior vena cava; OR = odds ratio.

local voltage was related to the conduction gap of CTI ablation, suggesting that the myocardium might be thicker at the incomplete conduction block site that at other sites. In univariate analysis, the depth of the CTI and the distance to the coronary artery were related to first-pass success rate. A deeper CTI requires complicated catheter manipulation, such as the inversion technique, so there may be catheter instability.[9] In addition, a pouch might exit in cases of deep CTI. The right coronary artery and the small cardiac vein travel on the epicardial aspect of the CTI, so a “heat sink” effect could lead to insufficient ablation, especially in cases in which the right coronary artery and CTI are close in distance.[21]

Optimal AI value for CTI ablation

In our previous study, the best cutoff values for first-pass successful CTI ablation were an AI >420 at the anterior side and an AI >376 at the posterior side.[9] In the PG of the current study, CTI ablation was performed with an AI ≥450 at the anterior side and an AI ≥400 at the posterior side. Frequency of incomplete conduction block was higher at the anterior side, so the target AI was raised from AI 450 to AI 500 only at the anterior side. As a result, first-pass success on the anterior side was improved.

As summarized in Table 5, Zhang and colleagues[12] first reported the superiority of AI-guided CTI from a single center. The target AI was 500 on the anterior side and 400 on the posterior side. The first-pass success was 93%, which was similar to our MG results. In a previous report in which CTI ablation was done with an AI of 450 at both the anterior and posterior sides, the first-pass rate was 80%, which was higher than in our PG but lower than in our MG.[16] A more reliable report is a multicenter trial that included 412 consecutive patients from 31 centers; the target AI was ≥500, interlesion distance measurement was <6 mm, and RF power was between 35 and 40 W.[11] The first-pass success rate was 90% and was consistent with our results, with that exception that there were 3 audible pops. When CTI ablation was attempted aiming for local potential decrease and with the operators blinded to AI values, the required AI values for bidirectional block formation were related to the atrium thickness of the CTI evaluated by intracardiac echocardiography.[15] Especially on the anterior side of the CTI, an AI value of around 480 was required, while the posterior side was below 450. Summarizing these results, an AI value of ≥450 may be inadequate for the anterior side, while ≥450 may not be necessary for the posterior side to achieve first-pass success of CTI

Table 4 Parameters at ablation sites with and without conduction gap

	Conduction gap (n = 25)	No conduction gap (n = 556)	*P* value
RF duration, s	25.2 (22.5–30.0)	25.8 (22.5–29.0)	.94
Contact force, g	11.0 (9.0–13.0)	11.0 (9.0–14.0)	.55
RF power, W	35.0 (32.5–35.0)	35.0 (30.0–35.0)	.29
FTI, g	275 (231–322)	274 (238–361)	.64
Ablation index	453 (446–473)	454 (405–503)	.83
Bipolar voltage, mV	2.01 (0.89–3.02)	1.08 (0.58–2.00)	<.01
Unipolar voltage, mV	2.67 (1.64–4.24)	1.77 (1.08–2.80)	<.01
Ablation index/bipolar voltage	226 (152–559)	418 (222–765)	<.01
Ablation index/unipolar voltage	175 (113–236)	258 (162–413)	<.01

Values are median (interquartile range).

FTI = force-time integral; RF = radiofrequency.

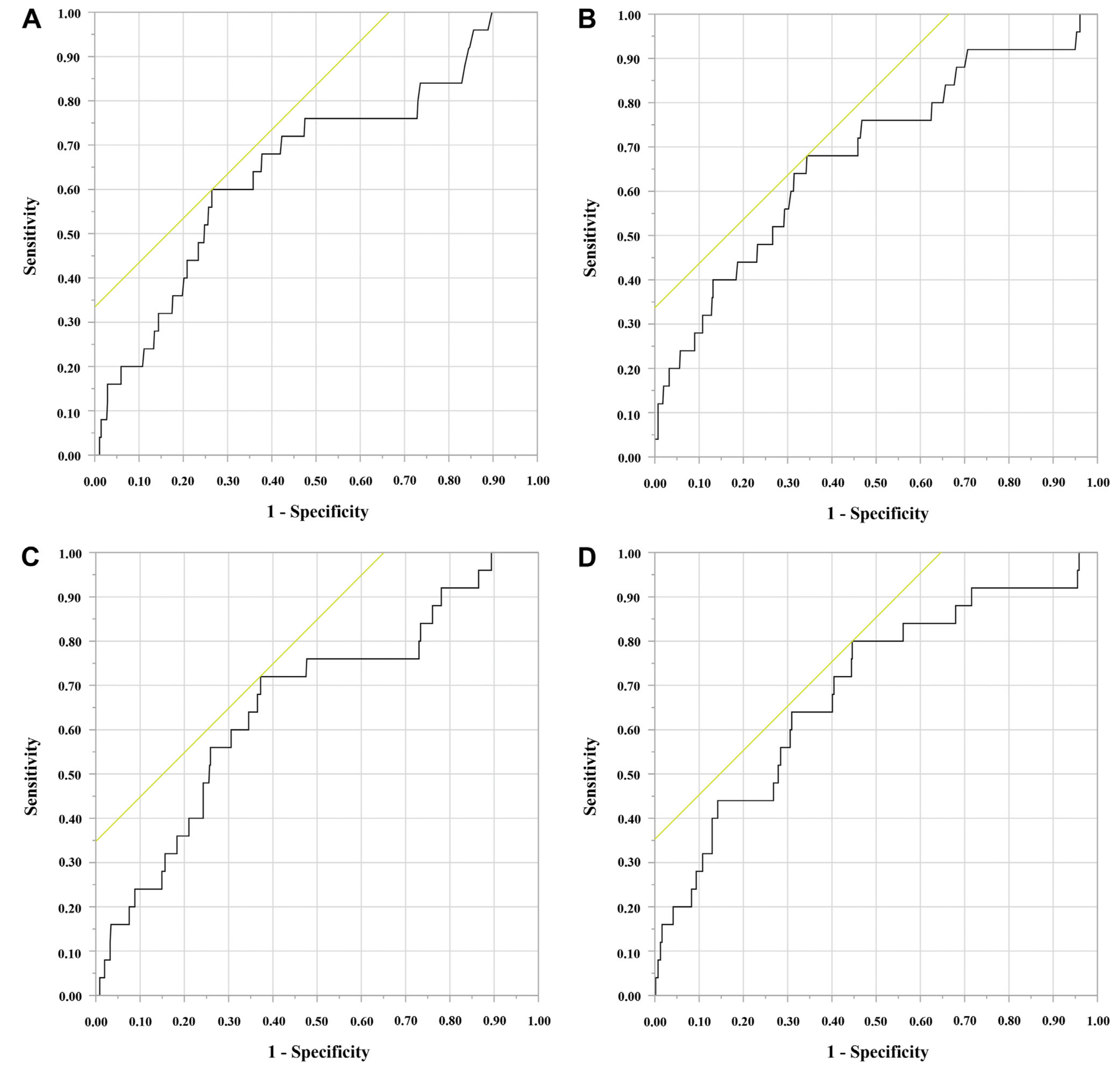

Figure 3 Receiver-operating characteristic curve to predict first-pass success of cavotricuspid isthmus linear ablation according to the local voltages and modified ablation indices (Ais). **A:** Bipolar voltage. **B:** Unipolar voltage. **C:** Modified AI (bipolar voltage). **D:** Modified AI (unipolar voltage). Areas under the curve were 0.66, 0.68, 0.66, and 0.69, with cutoff values of ≥1.94 mV, ≥2.33 mV, ≤313 AU/mV, and ≤236 AU/mV, respectively.

ablation. The IVC side is thinner than the tricuspid side on intracardiac echocardiography, so it may be appropriate to set the target AI lower than on the anterior side. However, whether 450 or 400 is the best target AI value at the posterior side requires further study.

In a recent report of AI-guided CTI ablation using high power (50a W) with a target AI of 550,[13] the first-pass success rate was 80%, which was slightly lower than in our report and in Zhang and colleagues' study.[12] The reason for the lower success rate despite the higher AI value may be that the ablation depth is shallower due to high power and short duration, which may lead to a conduction gap, especially at the anterior side. In another study, CTI ablation with higher power (45 W) has been reported as a faster method and provided a higher probability of first-pass conduction block, but stem pops occurred in 2 cases.[22] There were no audible stem pops in this study, so it may be safer to use conventional ablation power.

Relationship with local voltage

Unlike previous AI-guided CTI ablation studies, evaluation of local potential prior to ablation was performed in all patients in the current study. The preoperative local voltages

Table 5 First-pass success rate of AI-guided CTI ablation

Study	Target AI (anterior/posterior)	Power (W)	ILD (mm)	Multicenter	n	First-pass success	Steam pops
Zhang et al (2019)[12]	500/400	35	6	No	43	93%	0
Tscholl et al (2020)[13]	550	50	6	No	52	80%	1
Viola et al (2021)[11]	500	35/40	6	Yes	412	93%	3
Sakama et al (2022)[16]	450	35	4	No	151	80%	3
Schillaci et al (2022)[15]	500	35/40	6	No	30	93%	0
Chikata et al (2023)[22]	500/450	45 or 35	4	No	65/65	94/77%	2/0

AI = ablation index; CTI = cavotricuspid isthmus; ILD = interlesion distance.

and modified AI (unipolar and bipolar) at incomplete conduction block sites were significantly different from those of complete block sites. However, all the areas under the ROC curve were 0.65 to 0.70, which is not a sufficient index due to its accuracy.[18,20] Although there was no significant difference in the mean local potential between successful and unsuccessful first-pass cases, it is noteworthy that the local voltage at the gap area was higher than that in other areas. Consideration of the local potential to predict a conduction gap for each patient, rather than an absolute potential index in comparison with other patients, may be useful. Preoperative evaluation of local voltages at CTI lines could facilitate the identification of the gap when an attempt of first-pass CTI ablation failed. Assessment of CTI anatomy by voltage map before ablation is also useful for individual operators. However, the cost effect should be part of the consideration in requirement of a multipolar mapping catheter. Irrespective of after PVI or other procedures, the merit of perioperative mapping may be limited by the time requirement.

Limitations

There are some limitations to this study. Patients were continuously enrolled but were not randomized, and they were derived from a single center, so there may be a selection bias. The sample volume was also relatively small. In addition, the CTI lines between actual ablation lesions and computed tomography imaging might be different. This study focused only on the first-pass success rate of CTI ablation, so its long-term efficacy remains uncertain. The thickness of the CTI was not analyzed due to the limitation of noncontrast computed tomography image, which could influence the success rate. In this study, we divided the CTI into anterior and posterior sides. The MG followed sequentially on from PG. Therefore, improvements in ablation techniques might affect results. Finally, we evaluated RF location based on VisiTag, so the site might differ from anatomical assessment.

Conclusion

CTI ablation with a target AI >500 on the anterior side was shown to be effective, and local voltage at the conduction gap was higher than at other sites. Further investigation including target AI, especially for the posterior side, and distance interval of RF sites is required.

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