

ORIGINAL ARTICLE

Gold-tip versus contact-sensing catheter for cavotricuspid isthmus ablation: A comparative study

Altın-uçlu kateter ile temas-özellikli kateterin kavotriküspid istmus ablasyonunda karşılaştırılması

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ABSTRACT

Objective: Radiofrequency (RF) ablation is a highly successful procedure for the management of typical atrial flutter (AFL), an abnormal heart rhythm originating within the atria. There is no strong evidence that the use of contact force (CF) has any impact on procedural duration or acute success in the management of cavotricuspid isthmus (CTI)-dependent AFL. The aim of this study was to compare acute procedural parameters using a non-CF, 4-mm, gold-tip, irrigated catheter and a CF-sensing catheter in patients with AFL.

Methods: This was a retrospective cohort study. Consecutive patients who underwent typical AFL catheter ablation with either a gold-tip or CF-sensing catheter were enrolled. The procedural parameters obtained were: time to achieve bidirectional block, time to terminate AFL, total duration of RF application, procedure duration, fluoroscopy time, acute reconnection within 20 minutes following the last RF application, and procedural complications.

Results: Of the 40 patients screened, 37 were included in the study. The procedural endpoint of bidirectional isthmus block was achieved in all patients. The use of gold-tip catheters was associated with a shorter length of time to achieve bidirectional block (median time: 20.0 minutes [interquartile range {IQR}: 12.0–28.0 minutes]) compared with a median time of 36.0 minutes (IQR: 12.0–53.0 minutes; $p=0.048$) in the CF group. Furthermore, there was a trend toward reduced procedural duration in favor of the gold-tip catheter (median gold-tip: 74.0 minutes [IQR: 57.0–84.0 minutes]; median CF: 85.0 minutes [IQR: 57.0–107.0 minutes]; $p=0.171$). A greater requirement for the use of long sheaths was observed in cases where the CF catheter was employed for the procedure (CF: 11, 57.9%; non-CF: 1, 5.6%; $p=0.005$).

Conclusion: The time required to achieve bidirectional block, which is also reflected in the procedural time, was less when using a gold-tip catheter, and there was less need for the use of a long sheath. Further studies may be useful to evaluate this finding.

ÖZET

Amaç: Radyofrekans ablasyonu (RFA) atriyumlardan kaynaklanan anormal kalp ritmi olan tipik atriyal flutterin (AFL) tedavisi için yüksek derecede başarılı bir işlemdir. Kavotriküspit istmusla (KTI) ilişkili AFL'nin tedavisinde temas kuvveti (TK) kullanımının prosedürün süresi veya akut dönemde başarısına herhangi bir etkiye bulunduğu dair güçlü kanıtlar yoktur. Bu çalışmanın amacı AFL hastalarında TK'den yararlanmayan 4 mm'lik altın uçlu irigasyon kateteri ile TK'ye duyarlı kateteri akut dönem parametreleri açısından karşılaştırmaktır.

Yöntemler: Bu bir geriye dönük kohort çalışmasıydı. Altın uçlu veya TK'ye duyarlı kateterle tipik AFL gerçekleştirilmiş arıdışık hastalar çalışmaya alındı. İşleme ilişkin parametreler, iki yönlü blokun oluşmasına, AFL'yi sonlandırmaya kadar geçen zaman, toplam RF uygulama süresi, işlemin, floroskopinin uygulama süreleri, son RF uygulamasından sonraki 20 dakika içinde yeniden uygulama ve işlemim komplikasyonlarından ibaretti.

Bulgular: İncelenen 40 hastanın 37'si çalışmaya alındı. Uygulamada son nokta hastaların tümünde iki yönlü istmus blokunun gerçekleşmiş olmasıydı. Altın uçlu kateterin kullanılmasıyla daha kısa sürede çift yönlü blok gerçekleşti (ortanca süre, 20.0 dakika [çeyrekler arası aralık {IQR}]: 12.0–28.0 dakika; TK grubunda ise ortanca süre, 36.0 dakika (IQR: 12.0–53.0 dakika; $p=0.048$). Ayrıca, altın uçlu kateter lehine işlem süresinde kısalma eğilimi mevcuttu (altın uç grubunda ortanca süre: 74.0 dakika [IQR: 57.0–84.0 dakika] iken TK grubunda ortanca süre: 85.0 dakika [IQR: 57.0–107.0 dakika]; $p=0.171$). Uygulamada daha uzun KF kateterine daha fazla gereksinim duyulmuştur (TK: 11, %57.9; altın uç: 1, %5.6; $p=0.005$).

Sonuç: Altın uçlu kateter kullanıldığında işlem süresine de etki eden çift yönlü blok daha kısa sürede gerçekleştiği gibi uzun kateter kullanımına daha az gereksinim duyulmuştur. Bu bulguyu değerlendirmek için daha fazla çalışma gerçekleştirilmelidir.

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Radiofrequency (RF) ablation is the first-line therapy for atrial flutter (AFL), with a greater success rate than antiarrhythmic drugs.^[1] The acute and long-term success rates of catheter ablation of typical flutter remain high. However, optimizing procedural outcomes to achieve success with minimal ablation and fluoroscopy has been the subject of recent studies.^[2] Procedural endpoints such as total RF time, time to achieve bidirectional isthmus block, fluoroscopy time, and procedural duration have been investigated. Previous studies have demonstrated that the efficacy of RF and outcomes for cavotricuspid isthmus (CTI) ablation are influenced by multiple factors, one being the type of ablation catheter employed. (2) Irrigated ablation catheters with a larger tip have been found to be more effective than non-irrigated ablation catheters.^[3]

Contact force (CF) during catheter ablation is safe for treatment and is associated with a positive outcome during RF ablation.^[4] The EFFICAS I and II studies^[4,5] described successful optimum CF parameters and reported their association with a lower incidence of gap formation in patients with atrial fibrillation (AF). A landmark study by Reddy et al.^[6] of pulmonary vein isolation procedures confirmed the importance of CF-guided ablation in meeting safe and effective endpoints. Recently, 2 prospective studies have demonstrated the use of real-time, guided CF assessment in catheter ablation of AFL to be a safe procedure, which allows for a significant reduction in total RF delivery time.^[7,8]

Gold catheters have the theoretical advantage of creating larger lesions than platinum-iridium catheters.^[9] Gold-tip catheters were associated with an 8.5% reduction in the number of RF applications and a 6.4% reduction of the cumulative duration of application.^[9] The randomized AURUM 8 study suggested the use of gold-tip catheters over standard non-irrigated catheters due to greater primary ablation success, and reduced incidence of charring/coagulum formation.^[9] The results of another study have also shown that gold-tip RF ablation catheters enabled faster, more efficient ablation procedures than standard platinum-iridium catheters.^[10] Gold-tip catheters

Abbreviations:

AF	Atrial fibrillation
AFL	Atrial flutter
CF	Contact force
CS	Coronary sinus
CTI	Cavotricuspid isthmus
IQR	Interquartile range
PV	Pulmonary vein
RF	Radiofrequency
SR	Sinus rhythm

have been reported to create similar lesions in terms of size, but in 33.3% less time.^[10] While the use of gold-tip catheters has been widely reported, there remains a need for comparison of gold-tip catheters and CF-enabled catheters in terms of procedural outcomes; therefore, the aim of this investigation was to examine the impact of these 2 types of catheter on procedural duration and acute success in the management of CTI-dependent AFL.

METHODS

Patient demographics

A total of 40 consecutive patients who underwent CTI ablation for AFL with either a non-CF catheter (AICath Flux eXtra Gold; Biotronik, Berlin, Germany) or a CF-sensing catheter (TactiCath Quartz; St Jude Medical, St. Paul, MN, USA) were retrospectively screened. Two patients in the CF group and 1 patient in the gold-tip group were removed from the cohort due to persistent AF at the time of catheter ablation, and AFL was confirmed electrocardiographically in all patients.

Patients were excluded if they had: (i) at least 1 prior ablation procedure for AFL, (ii) any sustained non CTI-dependent and atypical AFL, (iii) or concomitant AF, or (iv) if the patient was unwilling to participate in the study. Data of patient demographic details and medications used at the time of initial ablation were also obtained from medical records.

Anti-arrhythmic medications (except amiodarone, for a minimum of 4 weeks) were discontinued for 5 half-lives prior to the procedure. This study was approved by the ethics committee of Kingston General Hospital, and the Queen's University Institutional Review Board in Ontario, Canada.

Catheter setup and electrophysiology study

Patients were brought to the electrophysiology lab having fasted and in a consciously sedated state. Standard intracardiac catheters were introduced through the right femoral vein and positioned as follows: (1) decapolar catheter (St. Jude Medical, St. Paul, MN, USA), in the coronary sinus, (2) mapping and ablation catheter (TactiCath or AICath) delivered through a 9-F femoral sheath, or (3) an Agilis steerable sheath (St. Jude Medical, St. Paul, MN, USA), which was used in some cases for better stability or longer reach to the

tricuspid valve annulus, and (4) quadripolar catheter (St. Jude Medical, St. Paul, MN, USA) placed at the right ventricular apex in patients who presented with AFL at the time of procedure.

The surface electrocardiogram and bipolar intracardiac electrocardiograms were monitored and recorded for offline analysis (Prucka Cardiolab; GE Healthcare, Inc. Chicago, IL, USA). Intracardiac bipolar electrocardiograms were filtered from 30 to 500 Hz and measured at a sweep speed of 100 mm/second.

Entrainment was performed in patients who were in AFL at the time of procedure to confirm CTI dependency. For patients in sinus rhythm (SR), coronary sinus (CS) proximal pacing at a rate faster than the sinus rate was performed in order to measure conduction through the CTI.

Catheter ablation procedure

Before mapping, a CF-enabled catheter, the TactiCath Quartz, was calibrated either outside the body, or while freely floating in the mid-right atrium to set the baseline value of CF at 0 g. Point-by-point ablation of the CTI was performed in both groups. RF ablation was performed using a dragging catheter technique, which involved creation of contiguous lesion lines across the isthmus (“pullback” ablation), from the tricuspid valve to the inferior vena cava. This was performed under anatomical (fluoroscopic) and electrocardiogram guidance. Ablation of the CTI was performed either during SR (pacing from the CS ostium) or in typical AFL rhythm. In the control group, a 4-mm, irrigated, non-CF, gold-tip catheter, the AICath Flux eXtra Gold, was used for ablation. In both the gold-tip and CF groups, power delivery for RF was adjusted to 35 W, with catheter irrigation set at 25 mL/minute with 0.9% sodium chloride.

The following criteria were applied in the CF group in order to create a complete lesion: CF >10 g and force-time integral >400 gs. The endpoint of the procedure in both groups was the achievement of bidirectional isthmus block,^[11] which was re-examined and confirmed after 20 minutes. Procedural and fluoroscopy duration, RF time, and length of the waiting period after the last RF lesion were recorded. Definitions of the preceding variables are as follows:

- Procedure time was recorded from sheath placement to its removal.

- RF lesion time was the duration of the RF delivery.
- Time to achieve bidirectional isthmus block was the duration from the beginning of the RF application to the confirmation of bidirectional block.
- AFL cycle length (in milliseconds) was measured for patients who were in AFL at presentation.

Patients were discharged the same day and followed up in a clinical visit 3 months later.

Statistical analysis

Data were collected in an Excel file (Microsoft Corp., Redmond, WA, USA) and imported into IBM SPSS Statistics for Windows, Version 24 (IBM Corp., Armonk, New York, USA). The data were initially analyzed descriptively, including frequencies and percentages for the categorical data, and mean, standard deviation, median and quartiles for the continuous data. The normality of the underlying distributions for the continuous data was tested using the Shapiro-Wilk test. The gold-tip and the CF-sensing catheter groups were then compared using the Pearson chi-square or Fisher’s exact test, as appropriate for the categorical data, and an independent t-test and the Mann-Whitney U test for continuous data. A p-value of 0.05 was used as the level of statistical significance, and no adjustments were made for multiple comparisons.

RESULTS

Baseline characteristics

The baseline patient characteristics are described in Table 1. Thirty-seven patients who underwent ablation of drug-refractory CTI-dependent AFL were enrolled. The majority of the continuous variables were not normally distributed based on the Shapiro-Wilk test, so medians and interquartile ranges (IQR) were used to consistently describe these data. The median age was 68 years, and 29.7% (n=11) of the patients were female. The median left ventricular ejection fraction was 60.7% (IQR: 45.6–64.5%). The median CHA₂DS₂VasC score was 2.0 (IQR: 1–4). Fifteen patients were in AFL at the time of the procedure.

The baseline patient and procedural characteristics of both groups are presented in Table 1. There

were no significant differences in age, sex, presence of comorbidities, or echo parameters. The CHA₂DS₂CVasC score was also comparable between groups (Table 1).

Procedure details

CTI ablation was initiated during ongoing AFL in 15 (40.0%) patients. Bidirectional block in the CTI was achieved in all patients, with a median procedure time of 76.0 minutes (IQR: 58–91 minutes), and 16 minutes (IQR: 10–23 minutes) of fluoroscopy. Ablation was performed during AFL in 8 patients (44.0%) of the gold-tip group, and in 7 patients (37.0%) of the CF group (Table 1). During the waiting period, CTI conduction recovered in 3 patients (2 CF group; 1 gold-

tip group). The total RF application time to achieve block was comparable in both groups (Table 2). However, the total time needed to achieve bidirectional block was significantly less in the gold-tip group in comparison with the CF group (median 20.0 vs 36.0 minutes; $p=0.048$) (Fig. 1). Other procedure parameters (baseline and post-CTI conduction, split signal) were comparable in the 2 groups (Table 2). There was a greater requirement for the use of long sheaths in cases in which the CF catheter was employed (CF: 11, 57.9%; non-CF: 1, 5.6%; $p=0.005$) (Table 2). No major complications were observed; however, minor complications included 2 instances of a steam pop in 2 CF group patients. This did not result in pericardial effusion in either case.

Table 1. Demographic and procedural data of patients with typical atrial flutter

	All (n=37)	Contact force-sensing (n=19)	Gold-tip (n=18)	<i>p</i>
Age, years	68 (59, 72)	70 (63, 76)	68 (59, 72)	0.330
Female, n (%)	11 (29.7)	6 (31.6)	5 (27.8)	0.800
Body mass index (kg/m ²)	27 (25, 32)	27 (24, 32)	27 (26, 32)	0.890
Diabetes mellitus, n (%)	10 (27.0)	5 (26.3)	5 (27.7)	0.901
Hypertension, n (%)	25 (67.6)	13 (68.4)	12 (66.7)	1.000
Coronary artery disease, n (%)	7 (18.9)	3 (15.8)	4 (22.2)	0.685
CHA ₂ DS ₂ VasC	2 (1, 4)	2 (2, 4)	2 (1, 3)	0.551
Ejection fraction, %	60 (45, 65)	62 (55, 64)	50 (33, 68)	0.424
Sinus rhythm/atrial flutter, n	22/15	12/7	10/8	0.638

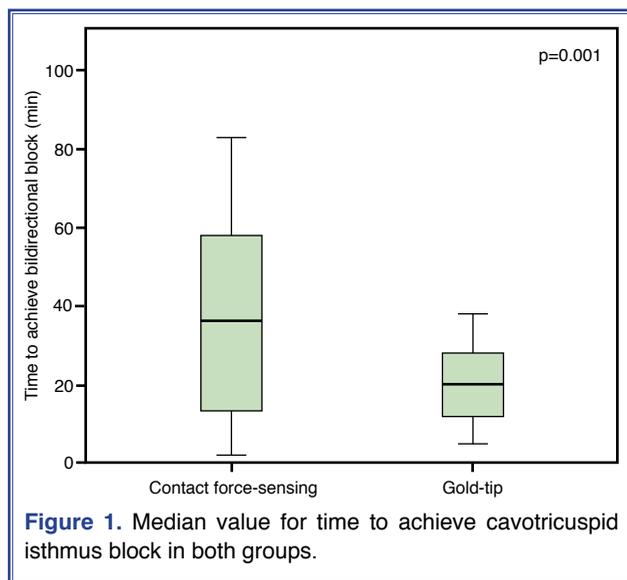
Data were expressed as median and interquartile range (25, 75), or frequency (percentage) unless otherwise stated. Tests of significance were based on the Mann-Whitney U (continuous data) test and the Pearson chi-square test, or Fisher's exact test (2-sided) in the event of cell(s) with fewer than 5 cases.

Table 2. Comparison of acute procedural parameters in gold-tip and CF-sensing groups

	All (n=37)	Contact force-sensing (n=19)	Gold-tip (n=18)	<i>p</i>
Time to achieve block* (min)	23.0 (12, 39)	36.0 (12, 59)	20.0 (12, 28)	0.048
Baseline CTI conduction (ms)	60 (52, 67)	57 (52, 65)	62 (55, 75)	0.274
Post-ablation CTI conduction (ms)	145 (129, 159)	148 (130, 157)	140 (126, 162)	0.419
Split signal time (ms)	98 (83, 112)	99 (83, 115)	97 (81, 110)	0.829
Total radiofrequency time (sec)	594 (315, 910)	522 (209, 1266)	651 (399, 862)	0.362
Procedure duration (min)	76.0 (58, 91)	85.0 (57, 107)	74.0 (57, 84)	0.171
Fluoroscopy time (min)	16 (10, 23)	16 (9, 28)	13 (11, 20)	0.468
Long-sheath, n (%)	12 (32.4)	11 (57.9)	1 (5.6)	0.005

Data were expressed as median and interquartile range (25, 75) or n (%). Tests of significance were based on the Mann-Whitney U test (continuous data) and the Pearson chi-square test, or Fisher's exact test (2-sided) in the event of cell(s) with fewer than 5 cases.

CTI: Cavotricuspid isthmus; CF: Contact force.



DISCUSSION

To the best of our knowledge, this is the first study to compare acute procedural effects of gold-tip and CF-sensed catheters in typical AFL ablation. We demonstrated a significant reduction in the total time to achieve bidirectional block with a non-CF gold-tip irrigated catheter in direct comparison with a CF-sensing catheter. In addition, a long sheath was employed more frequently in cases where a CF catheter was employed for ablation.

Gold can deliver greater power without excessive temperature increases or charring. It can also create broader and deeper ablation lesions, as a result of gold's higher rate of thermal conductivity.^[9,12,13] The gold-tip catheter, when compared with those coated with iridium-platinum and irrigated catheters, has been shown to be an independent predictor of a shorter procedural time and a greater success rate for CTI ablation.^[14] Additionally, non-irrigated, gold-tipped catheters have also been shown to be as effective as non-irrigated platinum and externally irrigated gold-tip catheters in CTI ablation.^[15]

While AFL ablation is a highly successful procedure associated with a low recurrence rate,^[1] focusing and improving on procedural parameters and catheter use may lead to further refinement of this procedure. The degree of tissue contact with the ablation catheter is considered an important factor in creating a deeper and wider lesion.^[16] Low CF during

pulmonary vein (PV) isolation is a predictor of acute and chronic PV reconnections, and is associated with an increased risk of AF recurrence.^[6,17] In addition, ablation procedures under CF guidance improve the lower recurrence rate of PV isolation.^[5] When compared with traditional catheter ablation, CTI ablation can be safely performed using a CF-guided catheter with similar long-term results.^[7] There were no differences in total ablation time in patients with CF compared with those without.^[7] A recent study by Kumar et al.^[18] demonstrated that low CF was implicated in a longer time to achieve bidirectional block, and in an increased risk of acute reconnections. In our study, although the time to achieve bidirectional block was significantly shorter for patients operated on with a gold-tip catheter, the overall duration of the RF application was not significantly different between the 2 catheter types. Recently, the use of a CF catheter with adequate CF parameters has been shown to result in a reduction in the RF delivery time required to achieve bidirectional block in comparison with the blinded use of CF parameters.^[8] That study used different CF catheters with a different curve and a lower requirement for the additional use of a long sheath, hence our results cannot be directly compared. Although the use of a long sheath from the start of the procedure reduces the time to achieve bidirectional block,^[19] switching sheaths during the procedure clearly adds to the overall procedural time; therefore, the former method is preferred.

Our main focus was on procedural outcomes, and we have reported trends in procedural findings. A finding that warrants mention is that RF time did not differ significantly between the 2 groups, which may be explained by the greater need for a long sheath during the period of time needed to achieve block in 12 of the 37 patients.

Nonetheless, the gold-tip catheter performed well without the need for additional sheath support. It also offers greater deflection, and has a shorter shaft than the TactiCath.^[20] This is particularly useful in ablation of CTI-dependent AFL. In addition, the larger number of irrigation ports available in the gold-tip catheter offers an advantage in tissue interface cooling.

Limitations

This is a single-center, retrospective, cohort pilot study with a small sample size; therefore, larger ran-

domized studies with power analyses are warranted to validate our findings. The aim of this study was to examine the acute performance of gold-tipped catheters in a real-world clinical setting. Future studies powered for acute procedural metrics but incorporating medium to long-term follow-up on patients would be valuable. This study employed a particular CF catheter (TactiCath) and the results are not necessarily applicable to other CF catheters due to various catheter shapes and techniques. Finally, data related to CF measurements was not available in the retrospective cohort, which limited our interpretations, however, operators were guided to obtain a minimum of 10 g prior to ablation.

Conclusion

The findings of our study demonstrated that the use of a gold-tip catheter was associated with a shorter length of time to achieve bidirectional block; however, the procedural success was comparable to that of the CF catheter.

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Keywords: Atrial flutter; catheter ablation; contact force; gold-tip catheter.

Anahtar sözcükler: Atriyal flutter; kateter ablasyon; temas-özellikli; altın uçlu kateter.