**Ablation Index, a novel marker of ablation lesion quality: prediction of pulmonary vein reconnection at repeat electrophysiology study and regional differences in target values**

**Short title:** Ablation Index and PV reconnection

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**INTRODUCTION:**

Creation of durable ablation lesions during pulmonary vein isolation (PVI) for atrial fibrillation (AF) is of critical importance to prevent late PV reconnection, which is responsible for the great majority of arrhythmia recurrence in patients with paroxysmal AF.1 Despite improvements in technology, the proportion of PVs remaining chronically isolated following radiofrequency ablation has remained disappointingly low.2,3 This has led to much interest in the delivery of effective ablation lesions.

In the absence of real-time assessment of lesion development and transmurality, surrogate measures of lesion quality are commonly utilized. The fall in local impedance during ablation, which has been shown to relate to lesion size,4,5 is commonly used as a marker of the direct effect of ablation on cardiac tissue.6-9 More recently, the minimum Force-Time Integral (FTI), which multiplies contact force by radiofrequency application duration has been shown to be predictive of PVI segment reconnection at repeat electrophysiology study.2 Prospective use of a minimum FTI-target during each ablation application improved rates of enduring PV isolation but nevertheless, over one-third of patients were still found to have at least 1 reconnected PV.3 This may be because FTI does not take into account the important role of power delivery, and is derived from a simple multiplication of contact force by time, whereas it is likely that these factors along with power provide differing contributions to lesion formation.10,11 Furthermore, using a single target FTI value for all segments of the circumferential PVI circle, as has previously been suggested,2 assumes that tissue thickness, and therefore the ablation depth required, is the same for all areas of the left atrium. However, it is known from anatomical studies that tissue thickness varies considerably between different left atrial regions.12

Ablation Index (AI) (CARTO 3 V4, Biosense Webster, Inc., Diamond Bar, CA) is a novel marker of lesion quality that incorporates contact force, time and power in a weighted formula, and has been shown to accurately estimate lesion depth in canine studies.13,14 We hypothesized that a lower minimum AI within a WACA segment would predict PV reconnection at repeat electrophysiology study. We also hypothesized that different AI and FTI targets would be required to prevent late reconnection in different segments of the circumferential PVI circle.

**METHODS:**

**Patient population:**

The study population for this investigation was derived from an on-going randomized controlled trial entitled “Pulmonary vein re-isolation as a routine strategy: a success rate evaluation (PRESSURE)” (ClinicalTrials.gov Identifier: NCT01942408). In brief, this is a randomized study of early reassessment and re-isolation of reconnected PVs 2 months following PVI (“Repeat Study” arm) compared with routine management of a single PVI procedure (“Standard Care” arm) in patients with paroxysmal AF.

This study included the 40 patients enrolled to the PRESSURE trial who were randomized to undergo a protocol-mandated repeat electrophysiology study at 2 months, regardless of symptoms. Study inclusion criteria were as follows: a current pattern of paroxysmal AF (defined as ECG proven episodes of AF which are self-limiting and last less than 7 days on each occasion, or which were cardioverted electrically or pharmacologically less than 48 hours from onset), and aged over 18 years. Exclusion criteria were: previous ablation procedure for AF, prior prosthetic mitral valve replacement, severe structural cardiac abnormality (significant congenital heart disease likely to affect cardiac hemodynamics, including atrial septal defect with a significant shunt), known infiltrative cardiomyopathy, severe left ventricular systolic dysfunction (ejection fraction <35%) and pregnancy. All patients provided written informed consent and the study was approved by the United Kingdom National Research Ethics Service.

**Initial PVI procedure:**

Patients taking amiodarone had this stopped a minimum of 2 months prior to their PVI procedure; where possible, it was replaced with an alternative anti-arrhythmic drug. All other anti-arrhythmic drugs were stopped 5 days prior to the procedure. Patients taking warfarin continued this in the peri-procedural period. An INR level between 2.0 and 3.5 was considered acceptable. Direct thrombin or Factor Xa inhibitor drugs were stopped 24-48 hours pre-procedure.

PVI was performed under conscious sedation or general anesthesia in a standard fashion. A 3D navigation system (CARTO 3, Biosense Webster, Inc.) was used in all cases to create an electroanatomical map of the left atrium and, where possible, this was integrated with a computed tomography or magnetic resonance imaging reconstruction of the left atrium (CartoMerge, Biosense Webster, Inc.). PVI was performed in a wide area circumferential ablation (WACA) pattern using a Thermocool SmartTouch irrigated tip contact force-sensing RF ablation catheter (Biosense Webster, Inc.). The default power setting was 30W, with limited ranges of 25-30W for the posterior wall and 30-35W for other regions of the left atrium. A contact force of between 5 and 40g with radiofrequency application duration of 20-40s was targeted at each site, aiming for local signal attenuation of >80%. Automated lesion tagging (VisiTag, Biosense Webster, Inc.) was used to mark the location of each lesion,7 and point-by-point focal ablation was predominantly used, though “drag” lesions (a new lesion location marked based on catheter movement during a continuous burn) were allowed. Contiguous lesions around the WACA circle were aimed for. VisiTag settings were as follows: Catheter Position Stability: Minimum time 10sec, Maximum range 2mm; Force Over Time: Time 30%, Minimum force 5g; Lesion tag size: 2mm. FTI, AI or minimum impedance drop targets were not used prospectively to guide ablation to allow for subsequent blinded analysis of association of these variables with late reconnection. No additional ablation to create left atrial linear lesions or of complex fractionated atrial electrograms was performed, and no attempt was made to look for extra-PV triggers. AF that persisted after PVI was terminated with electrical cardioversion. Acute PVI was confirmed by demonstrating entry and exit block with a 20-pole circular mapping catheter (Lasso NAV Eco, Biosense Webster, Inc.) placed sequentially in each of the PVs. On-going PVI was confirmed a minimum of 20 minutes after isolation of that ipsilateral PV pair, with intravenous adenosine administered to unmask sites of dormant conduction. Further ablation was performed at sites of overt or unmasked reconnection to re-isolate the PVs.

**Post-procedure anti-arrhythmic drug therapy:**

If patients were taking anti-arrhythmic medications pre-procedure, these were restarted post-procedure and were stopped after 4 weeks. Beta-blockers and rate-limiting calcium channel-blockers were also stopped after 4 weeks unless required for another clinical indication. Re-initiation of therapy was permitted in the event of symptomatic documented recurrences of atrial tachyarrhythmia after cessation of anti-arrhythmic medication at 4 weeks.

**AI and FTI analysis:**

Ablation maps from the initial PVI procedures were analyzed offline. For each individual ablation lesion, the AI value, FTI value, maximum impedance drop and maximum percentage impedance drop were recorded. Each WACA circle was divided into 6 segments (Figure 1, upper panel), and within each segment, the number of lesions, minimum AI value, mean AI value, minimum FTI value and mean FTI value were calculated (Figure 1, lower panel). Where >1 lesion tags overlapped significantly (center-to-center distance ≤2mm), the greatest of the values was taken.

**Repeat electrophysiology procedure:**

Repeat electrophysiology study was performed 2 months after the initial PVI procedure in all cases. Any anti-arrhythmic medications restarted for symptomatic documented AT recurrences beyond 4 weeks post-PVI were stopped again 5 days prior to the repeat study. This was performed in the same way as outlined for the initial procedure. Each PV was assessed for reconnection by positioning the 20-pole circular catheter at the PV ostium and recording the presence or absence of PV signals. If PV signals were identified in both ipsilateral PVs within a WACA circle, activation timings (relative to a reference site) were compared to establish which PV was activated earliest. The segment containing the electrode bipole with the earliest activation was taken to be the most likely site of reconnection. Re-ablation on the WACA circle within this segment that resulted in isolation of the PV or a significant change in the activation pattern within the PV was required to confirm that segment as a reconnection site. The operator was blinded to AI/FTI analysis from the initial PVI procedure. All identified sites of reconnection were re-ablated to re-isolate the PV(s).

**Clinical follow-up:**

All patients were provided with a validated portable ECG monitor (Omron HCG-801-E, Omron Healthcare, Kyoto, Japan),15 and were and were instructed to self-record a 30-second ECG every day during follow-up. ECG recordings were downloaded at routine clinic visits at 3, 6 and 12 months and were analyzed by a blinded observer. AF recurrence was defined as any documented atrial tachyarrhythmia (AF, atrial flutter, or atrial tachycardia) lasting ≥30 seconds.

**Statistical analysis:**

Continuous variables are expressed as mean and standard deviation or median and quartiles (25th-75th percentiles) where appropriate. Student's *t* test or the Mann-Whitney U-test was used for unpaired group comparison. Categorical variables are presented as frequency or percentage and were compared by χ2 or Fisher's exact test. Pearson’s r correlation coefficient was used to assess the correlation between variables. Univariable and multivariable logistic regression modeling was used to assess the relationship between lesion quality markers (AI and FTI) and WACA segment reconnection. Univariable predictors with *P*<0.05 were entered into a multivariable model, with logistic ridge regression utilized to account for statistically significant collinearity between variables. Receiver operating characteristic curve analysis was performed for independent predictors of WACA segment reconnection. All tests were 2-sided and a *P<*0.05 was considered statistically significant. All statistical analysis was performed using SPSS (version 22, IBM Corp., Armonk, NY).

**RESULTS:**

Demographic information for the 40 study participants is provided in Table 1. Twenty-four (68%) patients were male, the mean age was 58±12 years and the mean left atrial diameter was 39±5mm. The mean procedure time for initial PVI procedures was 164±34 minutes, with a mean ablation time of 43±9 minutes and a median fluoroscopy time of 11 [8-16] minutes. In 2 patients, the right inferior PV could not be safely isolated at the posterior aspect due to esophageal temperature rise, giving an overall immediate PV isolation rate of 98.8. Acute reconnection was seen after the minimum 20-minute waiting period in 28 (6%) segments (14 spontaneous and 14 adenosine-induced) in 20 (50%) patients, affecting 21 (26%) WACA circles. One major complication (right phrenic nerve palsy) occurred following the initial PVI procedures. There were no complications related to the repeat electrophysiology procedures.

**PV reconnection at repeat electrophysiology study:**

No patients were lost to follow-up or withdrew from the study. The mean interval between the initial PVI procedure and repeat electrophysiology study was 62±6 days. Including the 2 posterior right inferior PV segments that could not be isolated at the initial procedure, PV reconnection was identified in 53 (11%) WACA segments in 25 (62%) patients, affecting 28 (35%) WACA circles. The regional distribution of the 53 reconnected segments was as follows: right posterior 16, left anterior 13, inferior (right and left) 12, left posterior 7, right anterior 4, and roof (left and right) 1. Demographic data for patients with and without PV reconnection are shown in Table 1. All reconnected PVs, including the 2 right inferior PVs not isolated at the initial procedure, were successfully re-ablated to achieve PV isolation. The median ablation time required for these 25 patients was 5.1 [3.6-9.6] minutes.

**Relationships between AI, FTI and maximum impedance drop**

A total of 3239 ablation lesions were performed during the initial PVI procedures (81±16 lesions per patient). Drag lesions, where a second automated lesion tag was created during a single radiofrequency application, were excluded from correlation analysis as the impedance drop may be unreliable for these, but were included for all other analyses. After excluding drag lesions, 2350 (73%) of these lesions (59±21 lesions per patient) were analyzed for AI, FTI and maximum impedance drop values. The relationships between AI, FTI and impedance drop are shown in Figure 2. AI data were normally distributed, whereas FTI and impedance drop data were positively skewed and were therefore logarithmically transformed to base 10 for correlation analysis. AI was found to have a highly significant but weak correlation to logarithmic maximum impedance drop (Pearson r=0.313, *P*<0.0001) and logarithmic maximum percentage impedance drop (r=0.314, *P*<0.0001). Logarithmic FTI also correlated significantly but weakly with impedance drop (r=0.347, *P*<0.0001) and percentage impedance drop (r=0.336, *P*<0.0001). A very strong correlation was seen between AI and logarithmic FTI (r=0.901, *P*<0.0001).

**AI and FTI as a marker of WACA segment reconnection**

For acute reconnection (spontaneous or dormant), the 28 reconnected WACA segments had significantly lower minimum AI values than non-reconnected segments (320 [252–363] vs. 366 [314–418], P = 0.0005). At repeat EP study, the 53 segments exhibiting late reconnection also had significantly lower minimum AI values than non-reconnected segments (308 [252–336] vs. 373 [323–423], P < 0.0001). This difference was also seen for minimum FTI values (137 [92–182] vs. 228 [157–334] gs, P < 0.0001).

The mean AI and mean FTI for reconnected segments were also statistically lower than for non-reconnected segments (mean AI: 395 [350-429] vs. 422 [380-464], *P*=0.002; mean FTI: 311 [225-373] vs. 371 [260-502] gsec, *P*=0.003), but these were not as predictive as minimum values. The number of ablation lesions in segments with and without reconnection was not different (5 [4-6] vs. 5 [4-6], *P*=0.860).

In univariable logistic regression analysis, both minimum AI and minimum FTI were predictive of WACA segment reconnection (both *P*<0.0001), though minimum AI had a smaller *P* value (*P*=9.84e-10 vs. *P*=1.07e-07). In a multivariable model using logistic ridge regression (to account for the highly significant collinearity (r=0.86, *P*<0.0001) between the variables), both minimum AI and minimum FTI remained independently predictive (*P*<0.0001), though again minimum AI had a smaller *P* value (*P*=3.82e-09 vs. *P*=3.24e-06). In receiver operating characteristic analysis, the area-under-the-curve for minimum AI for predicting no reconnection of a segment was 0.77 and for minimum FTI was 0.76.

**Regional differences:**

Median values for the minimum AI and FTI for each of the 12 WACA segments are shown graphically in Figure 4, and minimum AI and FTI values for reconnected and non-reconnected segments in the four regions of the left atrium (roof, anterior, posterior and inferior) are shown in Table 2. As anterior and roof segments were found to have similar values, these were grouped together, as were posterior and inferior segments.

Reconnected anterior/roof segments had significantly lower minimum AI values than those without reconnection (332 [287-385] vs. 409 [350-447], *P*=0.001), with a similar difference seen for posterior/inferior segments (295 [249-322] vs. 344 [302-392], *P*<0.0001, Figure 4 Upper panel). Minimum AI values for non-reconnected anterior/roof segments were significantly higher than those for non-reconnected posterior/inferior segments (409 [350-447] vs. 344 [302-392], *P*<0.0001).

Analysis of minimum FTI values mirrored these findings: reconnected vs. non-reconnected anterior/roof segments - 180 [90-257] vs. 273 [186-372]gsec, *P*=0.001; reconnected vs. non-reconnected posterior/inferior segments - 127 [91-165] vs. 188 [138-284]gsec, *P*<0.0001; non-reconnected anterior/roof segments vs. non-reconnected posterior/inferior segments - 273 [186-372] vs. 188 [138-284]gsec, *P*<0.0001 (Figure 4 Lower panel).

**Discriminatory values for Ablation Index and Force–Time Integral:**

From receiver operating characteristic curve analysis, optimal cut-off points (Youden Index) were calculated. For AI, the optimal cut-off for anterior/roof segments was 376 (sensitivity 63.6%, specificity 77.8%, and positive predictive value 97.2%) and for posterior/inferior segments was 340 (sensitivity 52.9%, specificity 94.3%, and positive predictive value 98.2%). No late reconnection was seen in anterior/roof segments where the minimum AI value was ≥480 or in posterior/inferior segments where the minimum AI value was ≥370. For FTI, the optimal cut-off for anterior/roof segments was 213 gs (sensitivity 67.7%, specificity 72.2%, and positive predictive value 96.8%) and for posterior/inferior segments was 181 gs (sensitivity 52.9%, specificity 88.6%, and positive predictive value 96.4%). No reconnection was seen where the minimum FTI value was ≥420 gs for anterior/roof segments and ≥230 gs for posterior/inferior segments.

**Clinical follow-up:**

After the 2 procedures and a median of 12.5 [12.2-13.1] months of follow-up from the index procedure (including a 3 month blanking period) with daily ECG monitoring, 33 (82.5%) patients remained completely free from atrial tachyarrhythmia off anti-arrhythmic drugs.

**DISCUSSION:**

**Main findings:**

The main findings of this study are that AI, a novel ablation quality marker incorporating contact force, power and time in a weighted formula, correlates with impedance drop, and the minimum AI value within a WACA segment is predictive of reconnection of that segment at repeat electrophysiology study. In a multivariable model incorporating minimum AI and minimum FTI, both remained independently predictive of WACA segment reconnection but minimum AI had the smaller *P* value. Furthermore, higher AI and FTI values are required to prevent reconnection in anterior and roof segments of the WACA circle compared to posterior and inferior segments.

**FTI as a marker of ablation lesion quality:**

FTI has increasingly been used to guide point-by-point radiofrequency ablation for PVI. A correlation between FTI and impedance drop has been demonstrated, though the strength of this correlation has varied between studies.16,17 The minimum FTI value within a WACA segment has been shown to be predictive of PV reconnection at repeat electrophysiology study in EFFICAS I,2 and a FTI target derived from this investigation was used prospectively to guide ablation in the subsequent EFFICAS II study.3 Though this resulted in a reduction in the rate of PV reconnection compared to EFFICAS I, 15% of PVs affecting 37.5% of patients were found to have reconnected at follow-up electrophysiology study. There therefore remains further scope for improvement.

 FTI as a marker of lesion quality suffers from 2 significant limitations. Firstly, it ignores the important role of power delivery in lesion creation.10,18 Indeed, in EFFICAS I, power settings used by operators varied between 10 and 40W.2 This makes interpretation of the derived FTI target very difficult, as a 400gsecs radiofrequency application using 40W creates a much larger lesion compared to one produced with the same FTI value using 10W. In a study by Guerra et al, lesions with a FTI value of 300gsecs (a contact force of 10g for a duration of 30secs) were created with 20W and 35W, with the latter having a volume more than 3 times that of the former.10 Secondly, calculation of FTI relies on simple multiplication of contact force by application time, whereas it is known that the relationship between these parameters is dynamic, with both making differing contributions to lesion formation.11 For instance, it has previously been demonstrated in an animal model that application duration contributes little to lesion size beyond 20secs,19 and therefore doubling the duration is likely to have a lesser impact than doubling the contact force despite an equivalent FTI value.

It also may not be appropriate to extrapolate FTI data derived from the EFFICAS studies, which used the TactiCath contact force-sensing catheter, to the SmartTouch catheter.2,3 The mechanism of contact force-sensing is intrinsically different between these two catheters, and there are data to suggest differences in lesion creation for the same apparent contact force applied.8 To our knowledge, our study is the first to derive FTI threshold values applicable to the SmartTouch catheter from repeat electrophysiology studies.

**Clinical utility of AI:**

In this study, we examined a novel ablation lesion quality marker, AI, which overcomes the main deficiencies of FTI by both incorporating power delivery and combining this with contact force and time in a weighted equation. We have shown a significant correlation of AI with acute impedance drop and also demonstrated the independent predictive value of this marker for reconnection at repeat electrophysiology study. As in the EFFICAS I study, the minimum value within a WACA segment was more predictive than the mean,2 in keeping with the concept that the chain of ablation lesions is only as strong as its weakest link. While minimum FTI was also independently predictive, minimum AI had the smaller *P* value. This finding was despite the very narrow range of power settings (25-35W, predominantly 30W) used in this study, which would be expected to largely offset one of the key advantages of AI over FTI. It is conceivable that had a wider range of power settings been used, as was the case in EFFICAS I (10-40W),2 an even greater difference may have been seen.

It should be noted that accurate calculation of both AI and FTI is dependent on accurate calculation of contact force. A recent study by Bourier et al. has shown a high level of accuracy of contact force-sensing with the SmartTouch Surround Flow catheter (Biosense Webster, Inc.) when the catheter tip is perpendicular or at 30° or 60° angulation to the tissue. However, accuracy is reduced when there is parallel contact and this could lead to underestimation of contact force and consequently AI or FTI calculation in certain areas of the left atrium, such as the left superior pulmonary vein/appendage ridge.

**Regional differences in ablation target values:**

It is well-recognized that tissue thickness varies in different regions of the left atrium.12 An extremely important finding from this study is that there is a significant difference in AI and FTI values required to avoid reconnection in the anterior and roof segments of the WACA circle compared to the posterior and inferior segments, suggestive of thicker atrial tissue in anterior and roof regions. Following identification of a single FTI target of 400gs in EFFICAS I,2 application of this target value throughout the left atrium has been widely adopted. However, this may lead to unnecessary ablation on the thin posterior wall, with an associated risk of esophageal fistula formation, a major complication with an extremely high fatality rate. In our study, although a FTI threshold of 420gs was identified for anterior/roof segments, a FTI value of only 230gs was required to avoid reconnection in posterior/inferior segments. The equivalent AI target values were 480 and 370 respectively. Application of these regional target values therefore provides a more tailored approach to left atrial ablation by avoiding excessive ablation in higher-risk thin-walled areas such as the posterior wall, without compromising on efficacy at areas of thicker tissue such as the PV/appendage ridge.

**LIMITATIONS:**

Due to the invasive nature of the assessment for PV reconnection, sample size of this study was small, which limits the strength of the observations. The chosen analysis methodology did not take clustering of effects by patients into account. In the WACA segments reconnection, the statistical tests that were undertaken assumed that each clinical test was independent, which is not actually the case. Therefore, a hierarchical analysis could have potentially been performed to account for this. However, this is a highly complex analysis which was not feasible in this situation due to the relatively small sample size described above and the small number of clusters (segments). Therefore, the standard errors of the results could be underestimated, which would result in narrower confidence intervals and over-optimistic *P* values. Depending on the extent of the correlation, the *P* values should potentially be larger than they are. However, in most cases, they are at least <0.003, so even a fairly large increase in standard error would have a minimum impact on the significance of the results.

We re-isolated all PV reconnection identified at repeat electrophysiology study as we felt it in the patients' best interests to do so given the strong association between PV reconnection and AF recurrence in paroxysmal AF. The relationship between AI and AF recurrence is, therefore, not interpretable; however, our focus for this work was purely to study associations between acute markers of lesion quality with late recovery in conduction.

**CONCLUSIONS:**

AI, a novel ablation quality marker incorporating contact force, time and power in a weighted formula, correlates with impedance drop. The minimum AI and FTI in a WACA segment are independently predictive of conduction recovery of that segment at repeat electrophysiology study, but minimum AI has the smaller *P* value. Higher AI and FTI values are required to prevent reconnection of anterior/roof segments than posterior/inferior segments. AI target-guided ablation warrants prospective evaluation for a reduction in PV reconnection.

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**CONFLICTS OF INTEREST:**

DMT has received speaker fees from Boston Scientific and Medtronic; MCSH has received speaker fees from Medtronic, speaker fees and Fellowship support from Boston Scientific, and educational event support from Biosense Webster, Inc.; DG has received speaker fees, research grants and Fellowship support from Biosense Webster, Inc. No other relationships to declare.

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**Figure legends:**

*Figure 1:* (Upper panel) Diagram showing the 12-segment WACA model used.

(Lower panel) Screenshots showing VisiTags color-coded by Ablation Index value. The lesion with the minimum Ablation Index value within the inferior segment of the right WACA circle is marked with an arrow

*Figure 2:* Scatter plots showing the relationships between Force-Time Integral and maximum impedance drop (top left panel), Ablation Index and maximum impedance drop (top right panel), and Ablation Index and Force-Time Integral (lower panel).

*Figure 3:* Box plots showing minimum Ablation Index values (left panel) and minimum Force-Time Integral values (right panel) for reconnected and non-reconnected segments. The thick line indicates the median, the box represents the interquartile range and the whiskers represent the inner and outer fences.

*Figure 4:* Box plots showing minimum Ablation Index values (upper panel) and minimum Force-Time Integral values (lower panel) for reconnected and non-reconnected segments by left atrial region. The thick line indicates the median, the box represents the interquartile range and the whiskers represent the inner and outer fences.

Table 1:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Total cohort (n=40) | PV reconnection(n=25) | No PV reconnection (n=15) | *P* |
| Age, years | 58±12 | 57±12 | 60±11 | 0.408 |
| Male (n, %) | 24 (60%) | 15 (60%) | 9 (60%) | >0.999 |
| LA diameter, mm | 39±5 | 39±5 | 38±6 | 0.414 |
| Ejection fraction >55% | 40 (100%) | 25 (100%) | 15 (100%) |  |
| Hypertension (n, %) | 14 (35%) | 7 (28%) | 7 (47%) | 0.310 |
| IHD (n, %) | 2 (5%) | 0 (0%) | 2 (13%) | 0.135 |
| OSA (n, %) | 3 (8%) | 3 (12%) | 0 (0%) | 0.279 |
| CVA (n, %) | 1 (2%) | 1 (4%) | 0 (0%) | >0.999 |
| DM (n, %) | 0 (0%) | 0 (0%) | 0 (0%) |  |
| Anti-arrhythmic drugsFlecainideSotalolDronedarone | 22 (55%)18 (45%)3 (8%)1 (2%) | 15 (60%)13 (52%)2 (8%)0 (0%) | 7 (47%)5 (33%)1 (7%)1 (7%) | 0.518 |
| Beta-blockers | 28 (70%) | 17 (68%) | 11 (73%) | >0.999 |
| Calcium channel blockers | 2 (5%) | 1 (4%) | 1 (7%) | >0.999 |
| ACE-I/ARB | 11 (28%) | 5 (20%) | 6 (40%) | 0.273 |
| AnticoagulationWarfarinNOAC | 22 (55%)13 (32%)9 (22%) | 12 (48%)5 (20%)7 (28%) | 10 (67%)8 (53%)2 (13%) | 0.332 |
| Procedure time, minutes | 164±34 | 169±36 | 156±30 | 0.219 |
| Ablation time, minutes | 43±9 | 44±10 | 42±8 | 0.438 |
| Fluoroscopy time, minutes | 11 [8-16] | 12 [8-19] | 11 [8-14] | 0.494 |
| General anesthesia (n, %) | 31 (78%) | 22 (88%) | 9 (60%) | 0.057 |
| Interval between procedures, days | 62±6 | 61±6 | 62±5 | 0.749 |

*Table 1*: Patient demographics for the total cohort of subjects, and for those with and without PV reconnection at repeat electrophysiology study. LA - left atrial; IHD - ischemic heart disease; OSA - obstructive sleep apnea; CVA - cerebrovascular accident; DM - diabetes mellitus; ACE-I - angiotensin converting enzyme inhibitor; ARB - angiotensin receptor blocker; NOAC - non-vitamin K antagonist oral anticoagulant.

Table 2:

|  |  |  |
| --- | --- | --- |
| **Region** | **Ablation Index value** | **Force-Time Integral value (gsec)** |
| Non-reconnected | Reconnected | Non-reconnected | Reconnected |
| Roof | 402 (346-441) | 294\* | 298 (197-363) | 92\* |
| Anterior | 410 (358-452) | 342 (290-395) | 268 (181-375) | 185 (92-271) |
| Posterior | 344 (303-394) | 295 (250-330) | 203 (140-286) | 127 (91-169) |
| Inferior | 349 (296-384) | 301 (236-322) | 179 (126-263) | 126 (80-162) |

\*n=1

*Table 2*: Minimum Ablation Index and Force-Time Integral values for non-reconnected and reconnected segments by left atrial region.