Anticoagulation and the risk of complications in ventricular tachycardia and premature ventricular complex ablation

Short title: Anticoagulation complications and VT ablation

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Abstract

Background

Many patients undergoing ventricular tachycardia (VT) or premature ventricular complex (PVC) ablation receive anti-thrombotic medications. Their uninterrupted use has the potential to affect complication rates.
We assessed the incidence of complications in a large cohort of patients undergoing these procedures, according to anti-thrombotic medication use.

Methods

From June 2014 to June 2016, 201 VT and PVC ablations were performed at a single center. We allocated patients to three groups: A - anticoagulation group (INR≥1.5 or NOAC or full dose LMW heparin on day of procedure); B - antithrombotic group (antiplatelet therapy and/or prophylactic LMW heparin on day of procedure); C – no anti-thrombotics group. We assessed peri-procedural complication rates in each group. Multivariable analysis was performed.

Results

Group A (47 patients) had an 8.5% procedural complication rate: one stroke, one pseudoaneurysm, one femoral artery occlusion and one access site hematoma.
In this group, 37 patients had femoral arterial and 18 had epicardial access.
In Group B (46 patients) the complication rate was 6.5%: two cardiac tamponades and one pericardial effusion without compromise.
Group C (108 patients) had a 5.6% complication rate: three cardiac tamponades (with one peri-procedural death and one concomitant gastric vessel injury), one

pericardial effusion without compromise, one stomach perforation and two access site hematomas.

Multivariable analysis did not show any significant predictors of complications, though age approached significance.

Conclusions

Complication rates were not significantly different between groups. These findings suggest that VT and PVC ablation can be performed safely in patients with uninterrupted anti-thrombotic medications.

Keywords: ventricular tachycardia; ablation; anticoagulation; PVC; ventricular ectopic; complications

Introduction

An increasing number of patients receiving anticoagulants and antiplatelet agents require ventricular tachycardia (VT) or premature ventricular complex (PVC) ablation. The risks of interrupting anticoagulation must be balanced against potential bleeding risks associated with continuation.

Until recently, patients receiving anticoagulant therapy with either a vitamin K antagonist (VKA), e.g. warfarin, or a non-vitamin K anticoagulant (NOAC) would typically stop these prior to VT or PVC ablation in an attempt to minimize risks of bleeding. The change in practice in relation to anticoagulation for patients undergoing atrial fibrillation (AF) ablation, whereby these agents are continued uninterrupted through the procedure[1–4], has been accompanied by similar changes in the setting of VT and PVC ablation, with increasing numbers of these procedures now also being performed with uninterrupted anticoagulant therapy. In addition, approximately half of VT ablations are performed on patients with ischemic heart disease (IHD), many of whom are receiving single or dual antiplatelet therapy.

Adequate antithrombotic therapy during the procedure is important to minimize the risks of both overt and subclinical thromboemboli[5]. The most recent EHRA position document on antithrombotic management for electrophysiology procedures suggests continuing VKAs uninterrupted for endocardial left ventricular (LV) ablations, but discontinuing 3-5 days prior to anticipated epicardial access, with bridging therapeutic doses of heparin. It advises discontinuation of NOAC therapy ≥ 24 hours prior to LV ablation[6]. However, there is no advice on the safety

of continuing dual antiplatelet therapy.

To investigate the safety of performing VT or PVC ablation without interruption of anticoagulant and/or antiplatelet therapy, we assessed the incidence of complications in a contemporaneous cohort of patients undergoing these procedures.

Methods

This study included 201 consecutive VT and PVC ablations performed at St Bartholomew's Hospital, London between June 2014 and June 2016. We divided patients to three groups: A – anticoagulation group (those taking warfarin with international normalized ratio (INR) ≥1.5 on day of procedure, or patient received NOAC or full dose LMW heparin on day of procedure); B – antithrombotic group (antiplatelet therapy with aspirin and/or an adenosine diphosphate (ADP) receptor antagonist (usually clopidogrel) and/or prophylactic LMWH on day of procedure); and group C – no antithrombotics group (patients not receiving any antithrombotic agents). The INR on the day of procedure was ascertained by either laboratory result, or documented point of care testing. NOAC use on day of procedure was confirmed either by review of the prescription chart, or documentation in the patient's notes or procedure report. Antiplatelet use was determined by review of prescription charts and medical records.

Peri-procedural major complications in each group were defined as those resulting from the procedure and occurring prior to discharge from hospital, together with one or more of: i. causing long-term harm, ii. delaying discharge, iii. requiring procedural/surgical intervention. These were assessed by review of patients' medical records and procedure reports. Patient information was anonymized.

Antithrombotic therapy

For patients receiving antiplatelet agents (aspirin or clopidogrel), these were continued uninterrupted through the procedure. Warfarin or NOAC therapy was given prior to and following the procedure according to a number of factors, including indication for anticoagulant, procedural urgency, international normalized ratio (INR) stability, and cardiologist preference..

Catheter ablation procedure

Vascular access was guided by ultrasound from late 2015 onwards. For procedures involving catheterization of the left heart, intravenous heparin was administered to achieve an activated clotting time (ACT) of 300-350 seconds.

The majority (89%) of procedures were performed under conscious sedation with midazolam and diamorphine, with the remainder under general anesthesia.

Procedures were performed using fluoroscopic guidance and 3D electroanatomic mapping with CARTO 3 Smart Touch (Biosense Webster, Diamond Bar, USA).

Transesophageal echocardiography was used to exclude left heart thrombus, and to guide trans-septal puncture in cases performed under general anesthesia. In the

vast majority of procedures, ablation was performed with 3.5 mm saline-irrigated tip ablation catheters (Smart Touch or Smart Touch SF catheters, Biosense Webster); non-irrigated 4mm tip ablation catheters were rarely used. Ablation with irrigated tip catheters was performed in power control mode, between 25-45 W dependent on the site of ablation.

Epicardial access was obtained via the subxiphoid approach, in the manner described by Sosa[7]. This was obtained following endocardial LV mapping, and therefore after heparinisation, and in the presence of ACT>250, based on previous work within the unit demonstrating safety of this approach[8].

Coronary angiography was performed in patients in whom epicardial ablation was planned in the basal to mid-ventricular regions, to avoid inadvertent radiofrequency energy damage to epicardial vessels. Proximity of the phrenic nerve was excluded via pacing prior to epicardial ablation of the lateral LV.

Following left ventricular endocardial ablation, if the patient was not already receiving an antiplatelet or anticoagulant agent, aspirin 300mg daily was commenced and continued for at least six weeks.

Statistics

Univariable and multivariable analyses were performed with binary logistic regression using Stata/IC 14.2 (StataCorp, Texas, USA). Predictors with $p<0.1$ in univariable analysis were entered into the multivariable model, as well as antithrombotic groups, given the focus of the study and mechanistic plausibility.

Between-group comparison of procedural complication rates was also assessed with Fisher's exact test. A p-value of less than 0.05 was considered significant.

Results

Patient characteristics and co-morbidities

Demographic and co-morbidity data for each group are shown in Table 1. There were significant differences between groups for all variables, except prevalence of hypertension. Of particular note were the younger average age of Group C, the male preponderance of Groups A and B, the higher prevalence of IHD in Group B, and the lower average LVEF in Groups A and B. These differences to some extent reflect the proportions of patients in each group undergoing VT vs PVC ablation (discussed below).

Table 1

Antithrombotic use

Table 2 shows the use of antithrombotic agents for patients in Groups A and B. For patients in Group A receiving warfarin, the mean INR on the day of procedure was 2.5 (range 1.6 to 4.3). The INR was 1.5-1.9 in 7 patients, 2.0-3.5 in 38 patients, and greater than 3.5 in only two patients.

Table 2

Procedural data

The largest number of procedures were performed for patients in Group C, and interestingly there was a fairly even split in the proportion of VT vs PVC ablations in this group despite the lower prevalence of IHD. Group A had the largest proportion of VT ablations (Table 3).

As expected, most patients in each group had femoral venous access. The proportion of femoral artery and trans-septal access was lower in Group C than Groups A and B, likely reflecting the greater proportion of PVC ablations in Group C. The highest proportion of epicardial access was in Group A, in keeping with the percentage of VT ablations for this group.

Thirty-seven patients in group A had femoral arterial access, i.e. whilst therapeutically-anticoagulated. Of these, 24/37 were on warfarin (mean INR 2.5 at time of procedure), 12/37 received a NOAC, and 1/37 received LMW heparin on the day of the procedure.

Eighteen patients in Group A had epicardial access. Of these, 16/18 were on warfarin (mean INR 2.5), and 2/18 received a NOAC on the day of the procedure.

The proportion of procedures in each group in which LV ablation was performed was as follows: Group A - 81%; Group B – 79%; Group C – 48%.

Table 3

Complications

There were 47 patients in Group A, with four suffering complications, giving a procedural complication rate of 8.5% (Figure 1). Femoral artery pseudoaneurysm occurred in a 62 year old male undergoing VT ablation; this required surgical repair. An 80 year old female undergoing PVC ablation suffered femoral artery occlusion which was managed medically. She had received rivaroxaban on the day of the procedure. A 69 year old female undergoing VT ablation suffered a vascular access site hematoma which was managed conservatively. She was taking warfarin, with INR 2.9 on the day of the procedure. A 72 year old male undergoing VT ablation suffered an ischemic stroke 10 hours after the procedure. This was confirmed on a computed tomography (CT) scan. A transesophageal echocardiogram prior to the procedure had excluded intracardiac thrombus. He had been receiving warfarin, though as the INR was 1.4 he received full dose enoxaparin both the day before and on the day of the procedure.

Figure 1

Of the 46 patients in Group B, three suffered complications, with a procedural complication rate of 6.5%. All were receiving aspirin monotherapy. Two of the patients suffered pericardial effusion with tamponade: the first was a 79 year old male undergoing VT ablation who required surgical closure of the perforation. The second patient was a 71 year old male who developed tamponade on the ward

following PVC ablation; this was drained percutaneously. The third patient was an 80 year old male undergoing VT ablation who developed an effusion during the procedure without hemodynamic compromise. An attempt to drain the effusion was unsuccessful, and he remained in hospital for observation for 5 days.

There were 108 patients in Group C. Six suffered complications, giving rise to a procedural complication rate of 5.6%.

A 49 year old male undergoing VT ablation with an epicardial approach suffered cardiac tamponade which was drained percutaneously. He also developed a hematoma lateral to the stomach, with moderate hemoperitoneum.

A 93 year old male undergoing VT ablation suffered cardiac tamponade requiring drainage, as well as a left groin hematoma related to femoral artery access.

A 79 year old male suffered cardiac tamponade during VT ablation, and was transferred to the intensive treatment unit, where he died the following day.

A 39 year old male undergoing VT ablation suffered a probable gastric puncture during attempted epicardial access. The patient remained nil by mouth for 3 days and there were no sequelae.

A 32 year old male undergoing VT ablation suffered a groin hematoma which was managed conservatively but which delayed discharge.

And finally, a 58 year old male undergoing VT ablation via epicardial approach suffered a respiratory arrest with hypotension. An echocardiogram demonstrated a small amount of pericardial fluid but no features of tamponade, and the patient

improved with reversal of sedation. The effusion was subsequently drained and delayed discharge home.

In summary, with regard to complications attributable to bleeding, the incidence of vascular access-related hematoma in Groups A, B, and C was 2.1%, 0%, and 1.9%, respectively. And while there were no pericardial effusions, tamponades or abdominal visceral injuries in Group A, the respective rates in Group B, were 2.2%, 4.3% and 0%, and in Group C, 0.9%, 2.8% and 1.9% (Figure 1).

Survival to discharge

Overall, 97% of patients survived to hospital discharge. Of the seven patients who did not survive, two were in Group A, one was in Group B, and four were in Group C. There was one procedure-related death (see above).

Predictors of complications

In univariable analysis using logistic regression, only age was significant with $\alpha=0.1$ (Table 4). In multivariable logistic regression analysis, age and Group were included given the latter's clinical significance and relevance to the study. Age reached near significance (odds ratio 1.04, 95% confidence interval 1.00-1.09, p0.054). Comparing complication rates between groups, with Group C as the reference group, there were no significant differences (A vs C p=0.822, B vs C p= 0.573). Between-group comparison of complication rates with Fisher's Exact test also found no significant difference (p=0.804).

Table 4

Discussion

Focus of the study

This study has compared procedural complication rates according to antithrombotic drug regimens for patients undergoing VT and PVC ablations. It is the first study to provide detailed data on the use of contemporary antithrombotic agents, including NOACs and antiplatelets in the setting of VT/PVC ablation. The paucity of data in this setting, together with the increase in these procedures and recognition of subclinical adverse effects[5] makes it important to have evidence to guide decision-making in this high-risk group of patients.

We chose to analyze VT and PVC ablation procedure data together due to the frequent use of arterial, and to a lesser extent, trans-septal access in both settings. For example, femoral arterial access was used in almost 50% of PVC ablation cases (data not shown).

Use of anticoagulants and antiplatelet agents

The majority of patients in Group A received anticoagulant monotherapy, and in Group B received antiplatelet monotherapy. Following the publication of trials

comparing strategies of uninterrupted anticoagulation and a 'bridging' strategy with LMW heparin, trans-septal puncture for atrial fibrillation ablation is now routinely performed without interruption of warfarin[4], and more recently the same approach with NOACs has also been reported[3]. In addition, femoral arterial access is often obtained in patients receiving single or dual antiplatelet therapy who are undergoing percutaneous coronary intervention (PCI). And the most recent ESC/EACTS guidelines advocate performing PCI without interruption of anticoagulation, though preferably via the radial route[9].

In our study, 37/130 (28%) patients who had femoral arterial access were in Group A, i.e. in the presence of an INR>1.5 or NOAC therapy. Reassuringly, only 1 of the complications in Group A could be associated with the propensity to bleeding induced by anticoagulant therapy, with 2 complications related to thrombosis despite therapeutic anticoagulation. Thus, the incidence of hematomas was similar between Groups A, B and C. There were no retroperitoneal bleeds seen. The use of vascular ultrasound became routine at our center towards the end of 2015, i.e. over half-way through our study timeframe, so further reductions in vascular complications may be possible[10].

In our center, for patients who required an LV endo- and epicardial approach, we performed the latter in the presence of heparin anticoagulation, i.e. without reversal[8]. Of the 43 procedures requiring epicardial access in our study, 18 (42%) were performed in Group A, i.e. in the presence of oral/subcutaneous, and heparin anticoagulation. Reassuringly, there were no pericardial effusions, tamponades or abdominal visceral injuries in Group A. In Group B, three patients who suffered

pericardial effusions or tamponades did not have epicardial access. In Group C, of the 18 patients undergoing epicardial access, bleeding and/or abdominal vascular complications occurred in three; heparin anticoagulation was present in two of these. This small excess is noteworthy, and without obvious explanation. Procedure-related mortality was very low, and almost all patients survived to hospital discharge.

Overall complication rates

Previous trials and studies of VT ablation have reported complication rates between 4% and 11%, with the most common being cardiac perforation and tamponade, major bleeding, stroke, stroke/transient ischemic attack, and lower limb vascular problems[11–16]. The complication rates for each group in our study were similar to these. Other than the study by Peichl et al who utilized LMW heparin bridging at the time of procedure[14], the other studies did not report their approach to antithrombotic therapy.

It is worth noting that although the procedural complication rates for Groups A, B, and C were 8.5%, 6.5%, and 5.6% respectively, two of the six patients in Group C had more than one complication, such that the complication rate per patient was slightly higher in this group. Interestingly, the cardiac tamponade rate in Group C was higher than Group A, and the only death in the study occurred in this group. Although overall Groups A and B had a higher proportion of VT ablations and co-morbidities than Group C (and Group A had more epicardial procedures), the complications in Group C all occurred in patients undergoing VT ablations (and two

382 complications occurred in a 93 year old patient), such that within Group C, they
383 could be considered to be some of the higher risk procedures.
384
385
386 *Multivariable analysis*
387 Multivariable analysis showed that age was the only near-significant variable
388 (p=0.054), with odds of 1.04, equivalent to a 24% increase in odds for each 5 year
389 increment. This is both plausible, and in keeping with the findings of Peichl et al[14].
390 They also found a higher complication rate in patients with structural heart disease
391 compared to idiopathic VT, though did not specify whether the latter included PVC
392 ablation, i.e. for non-sustained VT.
393 Interestingly, we found no significant differences in the risk of complications
394 between the different groups, with both univariable and multivariable analyses,
395 supporting the notion that therapeutic anticoagulation at the time of procedure is
396 safe within the studied INR range (1.6 to 4.3). Thus, although Group A's
397 complication rate was 8.5% compared to 5.6% in Group C, patients in Group A were
398 older, had more co-morbidities, and a lower average LVEF than Group C. In
399 addition, Group A had more VT ablations, and greater use of femoral arterial and
400 epicardial access.
401
402 *Study limitations*
403 This was a retrospective observational study from a single center with associated
404 selection biases. Despite a reasonably-sized cohort, there were limited data on the

use of dual or triple antithrombotic therapy. Finally, there was relative heterogeneity between groups limiting the generalizability of the findings.

Conclusion

This is the first study to compare complication rates in patients undergoing VT and PVC ablation, according to whether they received anticoagulation, antiplatelet agents or neither. Our cohort included 201 patients undergoing these procedures in a contemporary setting. Complication rates were similar to those previously published, and small differences in these rates between groups were not significant. Interestingly, there were no trends to bleeding-related complications in the anticoagulation group. These results therefore support a strategy of continuing anticoagulation uninterrupted for VT and PVC ablation, with the caveat that prudence be practiced for patients receiving two or three antithrombotic agents, and for those with INRs > 3.5.

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Author contributions

Concept/design: MD and JDL; Data collection, analysis and interpretation: DC, EV and JDL; Drafting article: JDL; Critical revision of article: MD, DC, EV, AG, AC, MJE, RJH, FK, PDL, RJS, SS; Approval of article: JDL, MD, DC, EV, AG, AC, MJE, RJH, FK, PDL, RJS, SS; Statistics: JDL.

References

1. Di Biase L, Burkhardt D, Santangeli P, Mohanty P, Sanchez JE, Horton R, Gallinghouse J, et al. Periprocedural Stroke and Bleeding Complications in Patients Undergoing Catheter Ablation of Atrial Fibrillation With Different Anticoagulation Management. *Circulation*. 2014;129:2638-2644. doi:10.1161/CIRCULATIONAHA.113.006426.
2. Kirchhof P, Benussi S, Kotecha D, Ahlsson A, Atar D, Casadei B, Diener H, et al. 2016 ESC Guidelines for the management of atrial fibrillation developed in collaboration with EACTS The Task Force for the management of atrial fibrillation of the European Society of Cardiology (ESC) Developed with the special contribution of the Europ. *Eur Heart J*. 2016;37:2893-2962. doi:10.1093/eurheartj/ehw210.
3. Cappato R, Marchlinski FE, Hohnloser SH, Naccarelli GV, Xiang J, Wilber DJ, Ma C-S, et al. Uninterrupted rivaroxaban vs. uninterrupted vitamin K antagonists for catheter ablation in non-valvular atrial fibrillation. *Eur Heart J*. 2015;36:1805-1811. doi:10.1093/eurheartj/ehv177.
4. Calkins H, Hindricks G, Cappato R, Kim Y-H, Saad EB, Aguinaga L, Akar JG, et al. 2017 HRS/EHRA/ECAS/APHRS/SOLAECE expert consensus statement on catheter and surgical ablation of atrial fibrillation: Executive summary. *Europace*. 2018;20(1):157-208. doi:10.1093/europace/eux275.
5. Whitman IR, Gladstone RA, Badhwar N, Hsia HH, Lee BK, Josephson A, Meisel KM, et al. Brain Emboli After Left Ventricular Endocardial Ablation. *Circulation*. 2017;135:867-877. doi:10.1161/CIRCULATIONAHA.116.025546.

6. Sticherling C, Marin F, Birnie D, Boriani G, Calkins H, Dan GA, Gulizia M, et al. Antithrombotic management in patients undergoing electrophysiological procedures: A European Heart Rhythm Association (EHRA) position document endorsed by the ESC Working Group Thrombosis, Heart Rhythm Society (HRS), and Asia Pacific Heart Rhythm Society . *Europace*. 2015;17(8):1197-1214. doi:10.1093/europace/euv190.

7. Sosa E, Scanavacca M, D'Avila A, Pilleggi E. A new technique to perform epicardial mapping in the electrophysiology laboratory. *J Cardiovasc Electrophysiol*. 1996;7:531-536.

8. Page SP, Duncan ER, Thomas G, Ginks MR, Earley MJ, Sporton SC, Dhinoja M, et al. Epicardial catheter ablation for ventricular tachycardia in heparinized patients. *Europace*. 2013;15(2):284-289. doi:10.1093/europace/eus258.

9. Windecker S, Kolh P, Alfonso F, Collet JP, Cremer J, Falk V, Filippatos G, et al. 2014 ESC/EACTS Guidelines on myocardial revascularization. *Eur Heart J*. 2014;35(37):2541-2619. doi:10.1093/eurheartj/ehu278.

10. Sharma PS, Padala SK, Gunda S, Koneru JN, Ellenbogen KA. Vascular Complications During Catheter Ablation of Cardiac Arrhythmias: A Comparison Between Vascular Ultrasound Guided Access and Conventional Vascular Access. *J Cardiovasc Electrophysiol*. 2016;27:1160-1166. doi:10.1111/jce.13042.

11. Sapp JL, Wells GA, Parkash R, Stevenson WG, Blier L, Sarrazin J-F, Thibault B, et al. Ventricular Tachycardia Ablation versus Escalation of Antiarrhythmic Drugs. *N Engl J Med*. 2016:NEJMoa1513614.

485 doi:10.1056/NEJMoa1513614.
486 12. Reddy V, Reynolds M, Neuzil P, Richardson A, Taborsky M, Jongnarangsin
487 K, Kralovec S, et al. Prophylactic Catheter Ablation For The Prevention Of
488 Defibrillator Therapy. *N Engl J Med*. 2007;357(26):2657-2665.
489 13. Kuck K-H, Schaumann A, Eckardt L, Willems S, Ventura R, Delacrétaz E,
490 Pitschner H-F, et al. Catheter ablation of stable ventricular tachycardia
491 before defibrillator implantation in patients with coronary heart disease
492 (VTACH): a multicentre randomised controlled trial. *Lancet*.
493 2010;375(9708):31-40. doi:10.1016/S0140-6736(09)61755-4.
494 14. Peichl P, Wichterle D, Pavlu L, Cihak R, Aldhoon B, Kautzner J.
495 Complications of catheter ablation of ventricular tachycardia a single-
496 center experience. *Circ Arrhythmia Electrophysiol*. 2014;7(4):684-690.
497 doi:10.1161/CIRCEP.114.001530.
498 15. Della Bella P, Brugada J, Zeppenfeld K, Merino J, Neuzil P, Maury P,
499 Maccabelli G, et al. Epicardial ablation for ventricular tachycardia: a
500 European multicenter study. *Circ Arrhythm Electrophysiol*. 2011;4(5):653-
501 659. doi:10.1161/CIRCEP.111.962217.
502 16. Tanawuttiwat T, Nazarian S, Calkins H. The role of catheter ablation in the
503 management of ventricular tachycardia. *Eur Heart J*. 2016;37(7):594-609.
504 doi:10.1093/eurheartj/ehv421.
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Figure 1 Procedural complications in each group. Complications for Groups A, B, and C, with subtypes for pericardial and vascular complications. Pseudoan. – pseudoaneurysm, Art. occlusion – femoral arterial occlusion.