Received: 4 December 2023 | Revised: 24 December 2023 | Accepted: 8 January 2024

DOI: 10.1002/joa3.12993

Journal of Arrhythmia Open Access WILEY

ORIGINAL ARTICLE

Chemical ablation of the left ventricular endocardium reduces ventricular fibrillation inducibility in acute ischemic canine heart

Takashi Nitta MD, PhD[1] | Tetsuo Asano MD, PhD[1] | Toshimi Yajima MD, PhD[1] | Toshiaki Otsuka MD, PhD[2] | Yosuke Ishii MD, PhD[1]

[1]Cardiovascular Surgery, Nippon Medical School, Tokyo, Japan

[2]Public Health (Statistical Analysis), Nippon Medical School, Tokyo, Japan

Correspondence
Takashi Nitta, MD, PhD, Emeritus Professor, Nippon Medical School, 1-1-5 Sendagi, Bunkyo-ku, Tokyo 113-8602, Japan.
Email: nitta@nms.ac.jp

Abstract

Objective: Ventricular fibrillation remains as the major cause of death in patients with acute myocardial infarction. Effects of trans-atrial chemical ablation of the left ventricular (LV) endocardium with Lugol's solution on ventricular fibrillation inducibility and ventricular conduction were examined in canines with acute myocardial ischemia.

Materials and Methods: Chemical ablation of the LV endocardium with Lugol's solution or normal saline was preformed through a left atrial appendage in 14 canines 30 min after occlusion of the left anterior coronary artery.

Results: Ventricular fibrillation threshold decreased after the coronary artery occlusion and increased after endocardial chemical ablation. There was a significant difference in the ventricular fibrillation threshold after chemical ablation between with Lugol's solution and with normal saline (25.9 ± 9.2 mA vs. 11.3 ± 2.7 mA, $p < .01$). QRS width significantly increased from 88 ± 4 msec to 116 ± 5 msec ($p < .01$) after the chemical ablation with Lugol's solution, and the activation map of the ventricles demonstrated a left bundle branch block ventricular conduction pattern. Histological examination of the LV endocardium showed lymphocyte infiltration for a depth of 1 mm.

Conclusions: Chemical ablation of the LV endocardium with Lugol's solution injures endocardial conduction system and increases ventricular fibrillation threshold in the early phase of myocardial ischemia in canines. The procedure may be useful in suppressing intractable ventricular tachyarrhythmias in patients with acute myocardial ischemia.

KEYWORDS
chemical ablation, left ventricular endocardium, Lugol's solution, ventricular fibrillation

1 | INTRODUCTION

Ventricular fibrillation (VF) remains as the major cause of death in patients with acute myocardial infarction despite with advanced technologies and treatments of current medical care system.[1,2] Patients with VF are defibrillated with external direct-current shocks and subsequently placed on medical therapies to prevent recurrence of VF. Coronary intervention is performed to halt myocardial ischemia that may decrease the incidence of recurrent VF. An implantable cardioverter defibrillator is implanted

to prevent sudden cardiac death due to recurrent VF and other ventricular tachyarrhythmias.[3,4] In the chronic phase of myocardial infarction, reentrant activation conducting through the surviving myocardium in the scar tissue has been shown to be the mechanism of ventricular tachyarrhythmias.[5] However, mechanism of VF that occurs in the early phase of myocardial ischemia has not been fully understood,[6] and effective therapies to prevent VF in the early phase of myocardial ischemia have not been established.

Ventricular endocardium and Purkinje fibers have been shown to play an important role in the development of ventricular arrhythmias that occur in the acute phase of myocardial ischemia.[6] Triggered activities induced by early or delayed afterdepolarizations are demonstrated in experimental myocardial ischemia. Reentrant activations using endocardial Purkinje fibers have been demonstrated in patients with refractory and intractable ventricular tachyarrhythmias that occur in the early period of myocardial ischemia.[7] Radiofrequency catheter ablation applied at the Purkinje fibers has been shown to effectively terminated ventricular tachycardias that occurred in the early period myocardial infaction.[8,9]

Chemical ablation of the left ventricular (LV) endocardium using phenol or Lugol's solution has been shown to ablate Purkinje fibers in normal canine.[10,11] In this experimental study, trans-atrial chemical ablation of the LV endocardium with Lugol's solution was performed in canine acute myocardial infarction model and the effects of the procedure on the VF inducibility and ventricular conduction were examined.

2 | MATERIALS AND METHODS

2.1 | Surgical preparation

All animals received humane care in accordance with standard guidelines as recommended by the Science Council of Japan. (http://www.scj.go.jp/en/animal/index.html) In addition, the study protocol was approved by the Animal Ethics Committee of Nippon Medical School.

Fourteen adult mongrel canines weighing from 20 to 25 Kg were anesthetized with intravenous thiamylal sodium (10 mg/kg), intubated with a cuffed endotracheal tube, and mechanically ventilated with a volume-controlled respirator. An adequate level of anesthesia was maintained by an additional infusion of thiamylal sodium. A limb-lead electrocardiogram and the arterial pressure were continuously monitored. A quadrupolar electrode catheter was inserted from the right carotid artery, and its tip was positioned at the right sinus of the Valsalva to record the His bundle electrogram.[12] Electrolytes, acid–base balance, PaO_2, and other parameters were measured and maintained within normal ranges. After systemic injection of heparin sodium, cardiopulmonary bypass was established with a venous drainage from the right atrium and an arterial return to the right femoral artery.

2.2 | Myocardial ischemia and chemical ablation

The left anterior descending (LAD) coronary artery was dissected and tied at just distal to the branching of the first diagonal coronary artery. No anti-arrhythmic drugs or catecholamines were used. Thirty minutes after the LAD ligation, the ascending aorta was clamped and the heart was arrested by an infusion of 10 m1/kg of cardioplegic solution into the aortic root. The left atrial appendage was incised, and the LV endocardium was swabbed with Lugol's solution (water solution of 10% KI and 5% I_2) through the left atrium and across the mitral valve ($N = 10$). Approximately 3 mL of Lugol's solution was required to swab the entire endocardium of the LV. After the LV cavity was flushed with normal saline (0.9% NaCl), the incision on the left atrial appendage was closed, and the heart was reperfused. In the control group, the LV endocardium was swabbed with normal saline solution ($N = 4$). Myocardial ischemic time was set in 15 min both in Lugol's solution and saline groups.

2.3 | Ventricular fibrillation threshold

Inducibility of VF was evaluated by the measurement of VF threshold at three time points during the study: before LAD occlusion, 30 min after LAD occlusion, and 15 min after stable heart beats were obtained after coronary reperfusion. VF threshold was determined as the minimum current of rectangular pulses with 3 ms width and 100 Hz frequency that induced into VF (Figure 1), according to the method advocated by Han.[13] The pulses were delivered to the anterior LV epicardium at the ventricular vulnerable period following 8 beats of atrial pacing through bipolar electrodes with an electrode distance of 10 mm that were mounted on a patch. The delivered current was increased in increments of 1 mA until VF was induced. VF was defined as irregular ventricular tachyarrhythmia that sustained for 30 s or more. Induced VF was defibrillated immediately by a direct current shock. The measurement was repeated 10 min after defibrillation, and the average of the minimum current of the rectangular pulses that induced VF was determined as the VF threshold at each time point. Myocardial temperature was kept at 34 degrees Celsius throughout the VF threshold measurement.

2.4 | Epicardial mapping

The effect of chemical ablation of the LV endocardium on the ventricular activations was examined by epicardial mapping. Bipolar electrograms were recorded from 54 epicardial sites of the right and left ventricles during sinus rhythm using hand-held electrodes with an inter-electrode distance of 2 mm. A reference electrogram was recorded simultaneously by bipolar electrodes sutured on the right ventricular outflow. Both the local and reference electrograms were recorded at a time constant

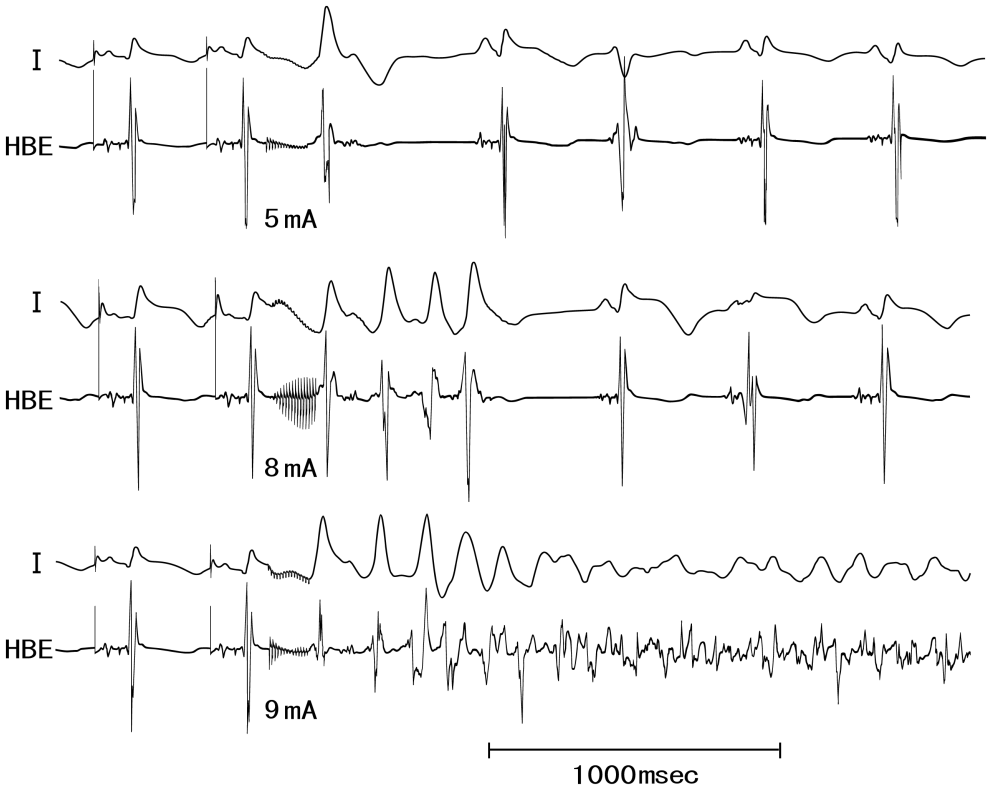

FIGURE 1 Measurement of VF threshold. VF threshold was determined as the minimum current of rectangular pulses that induced VF delivered to the ischemic anterior LV epicardium. See text for detailed explanation. In this example, the rectangular pulses of 5 mA did not provoke any ventricular response and those of 8 mA induced 4 beats of ventricular premature contractions. The current of the rectangular pulses was increased to 9 mA in increments of 1 mA and VF was induced. The measurement was repeated, and the average current that induced VF was determined as the VF threshold. HBE, His bundle electrograms.

of 0.3 msec and with a frequency range of 300–1000 Hz. The electrograms were digitalized and stored in a computer, and activation maps were constructed after an off-line analysis after the experiment. The time of local activation was determined as the onset of electrogram. The time difference between the local activation and the reference activation was calculated at each mapped site, and isochrones were displayed on a geometric net of the ventricular epicardium as an activation map at each time point.

2.5 | Histological examination

After the last measurement of VF threshold was completed, the heart was excised and fixed with 10% solution of formalin. Serial sections cut out from the block of the anterior LV were stained by Hematoxylin–Eosin and Alcian Blue PAS. Sliced specimens were examined by a light microscope.

2.6 | Statistical analyses

Continuous values were expressed as mean ±1 SD. Equality of variance was tested by *F*-test. Paired or unpaired Student's *t*-test was used to compare data between the groups when appropriate. $p < .05$ was defined as statistically significant.

3 | RESULTS

3.1 | VF threshold

VF threshold was measured before and after LAD ligation and after chemical ablation of the LV endocardium with Lugol's solution or normal saline. Equality of variance was confirmed, and there was no significant difference in VF threshold between the Lugol's solution and normal saline groups both before and after the LAD ligation. VF threshold significantly decreased after the LAD ligation both in Lugol's solution group (41.0 ± 11.3 Ma vs. 9.5 ± 1.9 Ma, $p < .01$) and in normal saline group (38.1 ± 9.8 Ma vs. 7.8 ± 2.9 Ma, $p < .05$). Decreased VF threshold after LAD ligation significantly increased after chemical ablation of the LV endocardium either with Lugol's solution (9.5 ± 1.9 Ma vs. 25.9 ± 9.2 Ma, $p < .01$) or with normal saline (7.8 ± 2.9 Ma vs. 11.3 ± 2.7 Ma, $p < .01$) (Figure 2). There was a significant difference in the VF threshold after chemical ablation of the LV endocardium between Lugol's solution and normal saline ($p < .01$), and the percent increase by LV endocardial ablation was 170 ± 65% with Lugol's solution and 50 ± 18% with normal saline ($p < .001$).

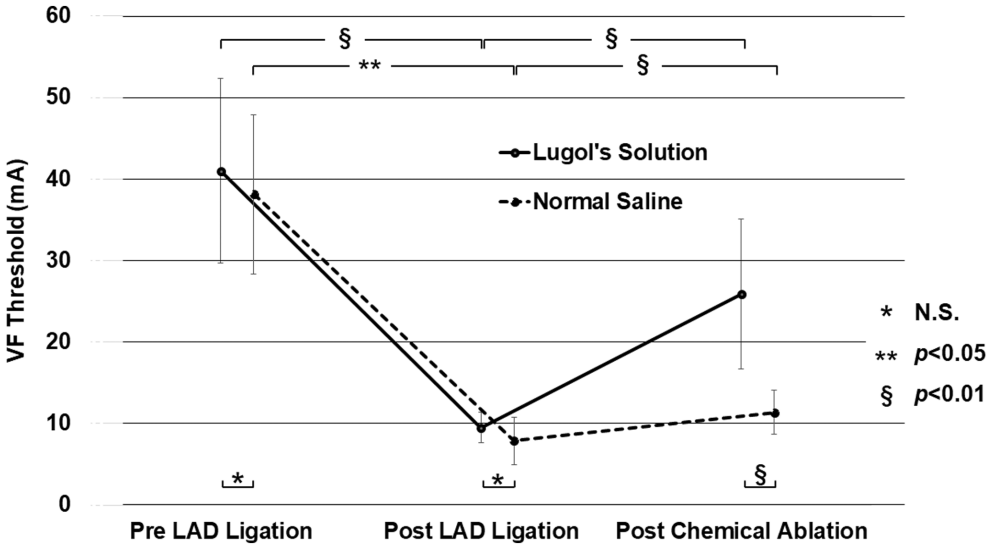

FIGURE 2 Changes in VF threshold. VF thresholds before and after LAD ligation and after chemical ablation of the LV endocardium with Lugol's solution (solid line) or normal saline (dotted line) are shown. Decreased VF threshold after LAD ligation significantly increased after chemical ablation with Lugol's solution than with normal saline ($p < .01$). See text for detailed explanation.

3.2 | QRS duration and ventricular activation

QRS width in the electrocardiogram significantly increased from 88 ± 4 msec to 116 ± 5 msec ($p < .01$) after the chemical ablation of the LV endocardium with Lugol's solution (Figure 3). Other parameters of conduction, such as PR interval, AH interval, and HV interval, did not change after the chemical ablation. These data indicate that the chemical ablation of the LV endocardium with Lugol's solution affects the conduction of the ventricles, but not of the In”ra-atria conduction and supraventricular conduction system.

Activation maps of the LV epicardium after the LAD ligation and after the chemical ablation of the LV endocardium with Lugo''s solution are compared (Figure 4). After the LAD ligation, there appeared in the activation map a conduction delay on the anterior LV with myocardial ischemia, while the epicardial breakthrough points of the LV activation remained similar as those seen before the LAD ligation. After the chemical ablation of the LV endocardium with Lugo''s solution, the ventricular activation map showed no earliest activation site on the LV epicardium and the LV epicardial activation spread from anterior and posterior septum with delayed conduction over the anterior and lateral LV epicardium, while the earliest epicardial activation site and the activation pattern of the right ventricle remained the same as the activation map before the chemical ablation. The ventricular activation map after the ablation of the LV endocardium with saline, the LV activation pattern did not change from the activation map before the LV endocardial ablation.

3.3 | Histological examination

Histological examination of the LV endocardium stained with Hematoxylin–Eosin showed lymphocyte infiltration for a depth of 1 mm without any significant changes in the myocardial layer (Figure 5). There were no clear findings of myocardial ischemia, except for thrombosis in the coronary arteries. The LV endocardial conduction system, such as Purkinje fiber network, was stained brown by Alcian Blue PAS.

4 | DISCUSSION

The present study demonstrated that chemical ablation of the LV endocardium with Lugo''s solution increased VF threshold in the early ischemic phase of canine hearts. Epicardial mapping reveled a conduction delay of the LV and the histological examination of the LV endocardium suggested the injured conduction system by the chemical ablation with Lugo''s solution.

Although the mechanism of VF that emerges in the early phase of myocardial ischemia has not been fully understood, the conduction system of the LV endocardium, such as bundle branches and Purkinje fiber, has been shown to play an important role in developing triggered activity or reentrant activations, that leads the ischemic hearts to VF.[6,7] The role of Purkinje fiber in the development and maintenance of VF has been examined in the human Langendorff hearts. A transmural plunge needle mapping demonstrated that no endocardial to epicardial activation frequency gradient was seen, and simultaneous transmural activations were common in short duration of VF, whereas endocardial to epicardial activations were most common in long duration (10 mins) of VF.[15] In the present study, VF was defined as irregular ventricular tachyarrhythmia that sustained for 30 s or more. Continuous recordings of the transmural LV electrogram from early-onset phase to late phase of sustained VF before and after the LV endocardial chemical ablation may provide an additional information of the role of Purkinje fiber on the sustenance of VF.

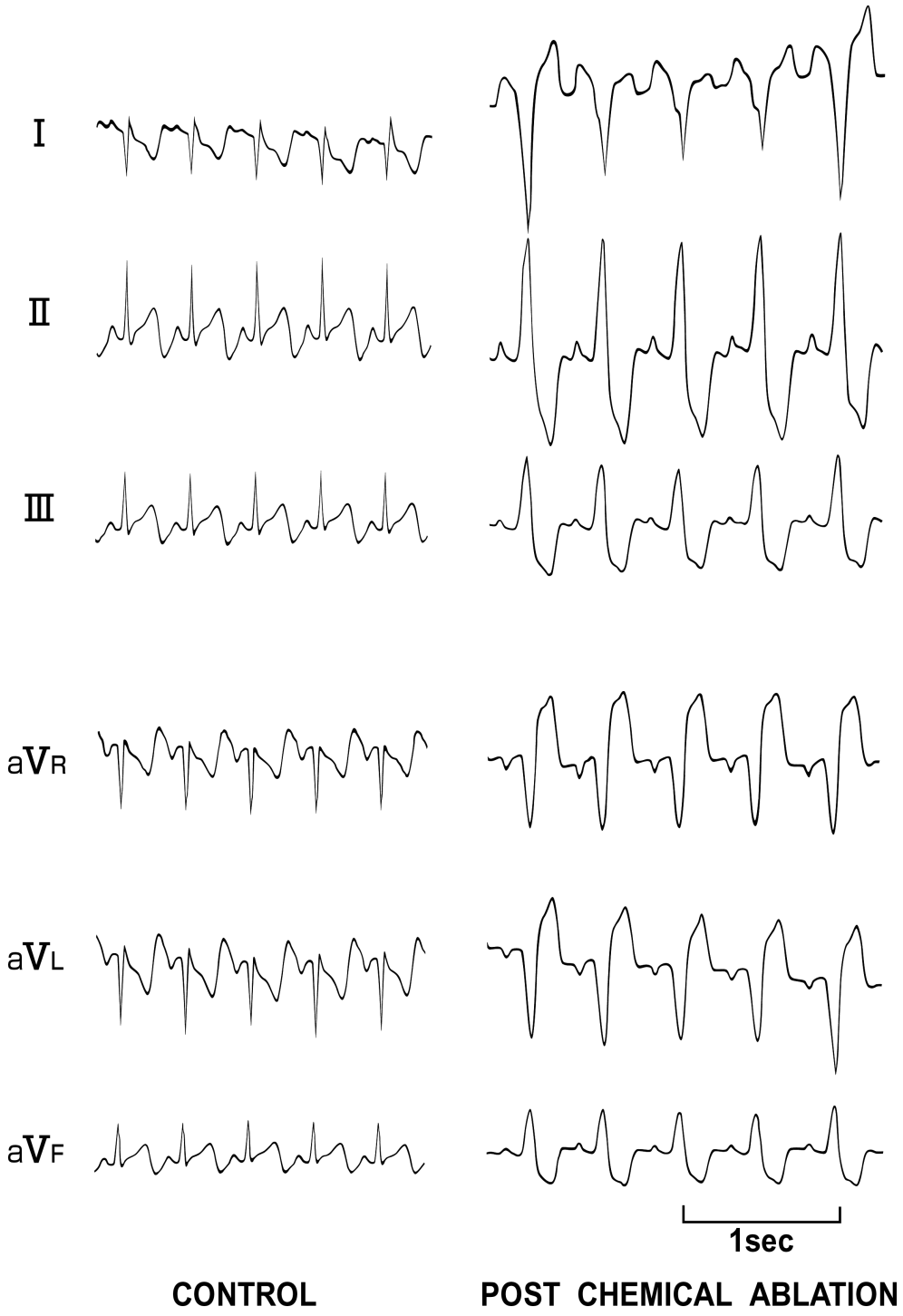

FIGURE 3 Limb leads of the electrocardiogram. Limb leads of electrocardiogram were compared between before (left panel) and after (right panel) chemical ablation of the LV endocardium with Lugol's solution. Note that the QRS duration increased with a left bundle branch block morphology after chemical ablation.

Selective Purkinje fiber ablation with Lugol's solution has been shown to decrease epicardial-endocardial activation rate gradients during early period of VF, suggesting that the Purkinje-muscle junctions determine the activation rate gradients during onset and during early maintenance of VF.[16] Recently, radiofrequency catheter ablation targeting the Purkinje fibers has been shown to effectively terminated ventricular tachycardia in the early period of myocardial infarction.[8,9] Those findings support the role of the LV endocardial conduction system in developing ventricular tachyarrhythmias in acute phase of myocardial ischemia.

Lugol's solution is a product of iodine and has been shown to injure the conduction system,[17] thus may prohibit the development of ventricular tachyarrhythmias in the early phase of myocardial ischemia. The histological examination of the present study

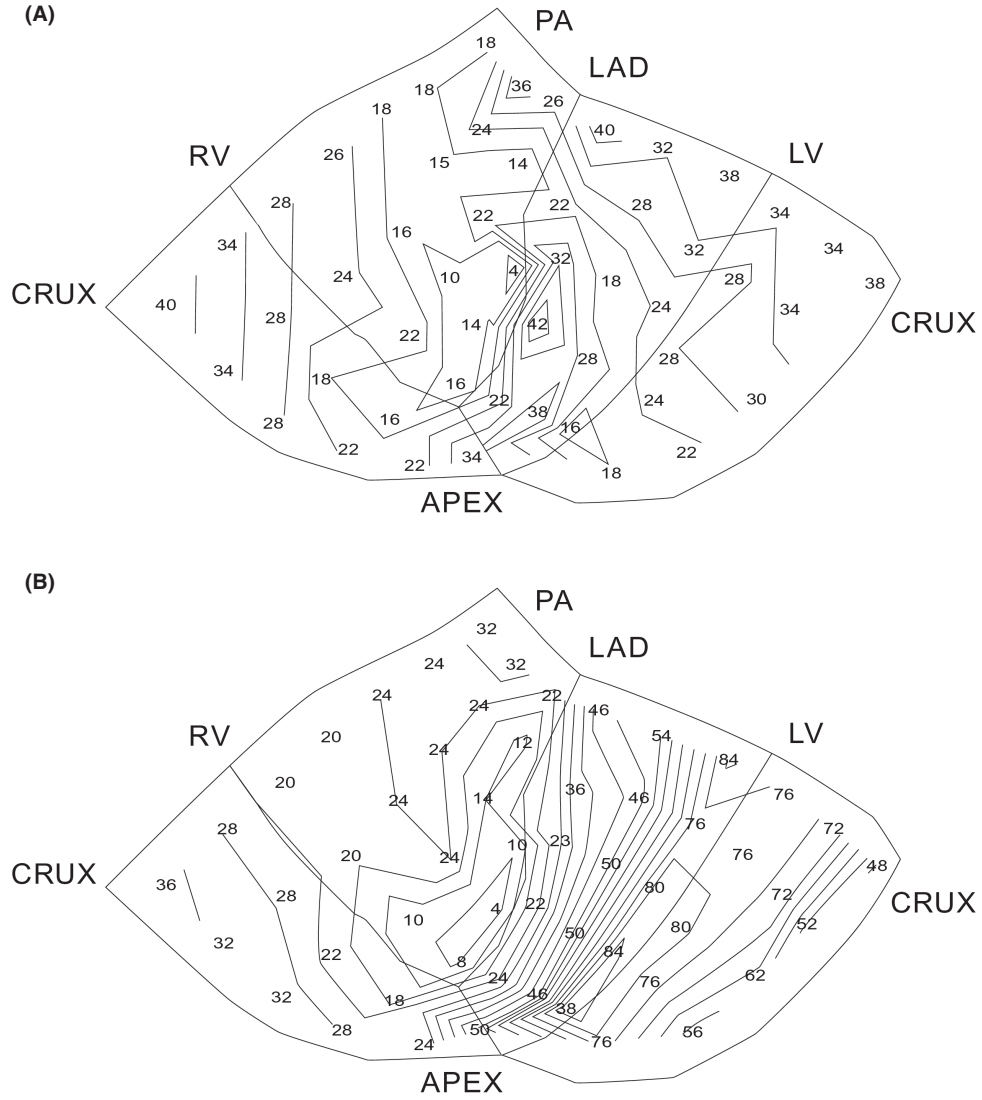

FIGURE 4 Epicardial activation maps before (A) and after (B) LV endocardial chemical ablation. Left panel (a) shows the epicardial activation map of the LV after the LAD ligation and the right panel (b) shows the map after the chemical ablation of the LV endocardium with Lugol's solution. Delayed conduction over the anterior and lateral LV epicardium is noted. See text for detailed explanation. PA, pulmonary artery; LAD, left anterior descending coronary artery; RV, right ventricle; LV, left ventricle; CRUX, crux of the heart, the area on the lower back side of the heart where the coronary sulcus and the posterior interventricular sulcus meet.[14] APEX, apex of heart.

demonstrated lymphocyte infiltration of the LV endocardium and the conduction system was stained brown with Alcian Blue PAS, indicating injured conduction system. Therefore, the increased VF threshold and delayed conduction after chemical ablation of the LV endocardium might be the results of the injured conduction system of the LV endocardium by Lugol's solution.

Intractable ventricular tachyarrhythmias have been the leading cause of death in patients with acute myocardial infarction.[18] Coronary intervention, advanced medical therapies, and other treatments have been conducted to prevent the emergence of ventricular tachyarrhythmias and improve survival.[19] However, there are still patients who are not suppressed of ventricular tachyarrhythmias.[20] Some patients suffer incessant episode of tachyarrhythmias and receive frequent direct current shocks and a cardiopulmonary resuscitation.[18]

Chemical ablation of the LV endocardium may halt the incessant episodes of ventricular tachyarrhythmias and prevent arrhythmic deaths from incessant and uncontrollable VF. In the present study, the procedure has been designed to minimize the surgical invasiveness, because most patients with acute myocardial infarction already have impaired ventricular function. Damiano et al. examined the effect of chemical ablation of ventricular endocardium by painting Lugol's solution on both the right and LV endocardium through the ventricular incisions on the right and left ventricles in normal canines.[11] Bilateral ventriculotomies may provide a wider view of the ventricular endocardium and enable an elaborative painting of the solution throughout the ventricular endocardium, or a localized ablation targeting the limited endocardial surface directed by preoperative or intraoperative electrophysiologic study. In the present study, the effect of chemical ablation of

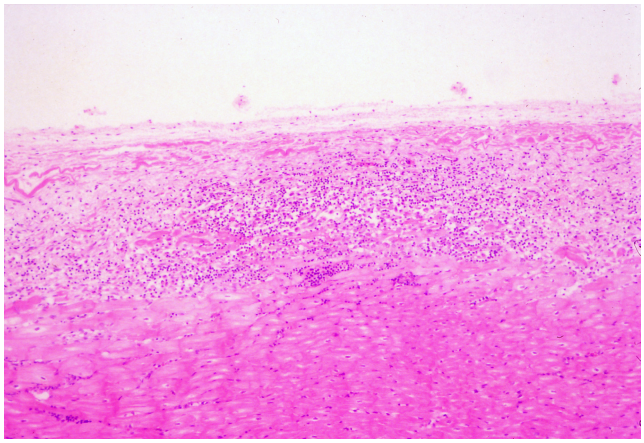

FIGURE 5 Hematoxylin–Eosin stain of chemically ablated endocardium. Lymphocyte infiltration for a depth of 1 mm without any significant changes in the myocardial layer was revealed. There were no clear findings of myocardial ischemia, except for thrombosis in the coronary arteries.

the LV endocardium on the ventricular vulnerability was examined in acute ischemic canine hearts and the LV endocardial chemical ablation was performed through a left atrial appendage in order to avoid a ventriculotomy. Painting the LV endocardium under non-direct vision of the LV endocardial surface might result in patchy or incomplete ablation of the endocardium, such as at the posterior LV behind the mitral valve leaflets. However, the epicardial activation showed a left bundle branch block pattern, and the VF threshold was significantly elevated after the chemical ablation of the LV endocardium, suggesting chemical ablation of the LV endocardium through a left atrial appendage may be effective in preventing VF, avoiding a ventriculotomy to preserve ventricular function.

Although the effect of additional ablation of the right bundle branch by the right ventricular endocardial ablation on the VF threshold is not clear, VF threshold was sufficiently elevated only by the LV endocardial ablation in the present study. Moreover, endocardial ablation of the right ventricle may risk an unwanted injury to the atrio-ventricular node that locates at the junction of the right atrium and ventricle. The present study demonstrated normal AH interval after the LV endocardial chemical ablation, suggesting a preserved atrio-ventricular conduction.

4.1 | Limitations

In the present study, ventricular vulnerability was examined by VF threshold, a measuring method that was advocated by Han.[13] Several factors have been shown to participate in the initiation and sustenance of ventricular tachyarrhythmias,[21] and quantification of ventricular vulnerability to VF has not been established.[22,23] Effects of LV endocardial chemical ablation on prevention of VF should be examined by a demonstrative method whether VF spontaneously occurs in a chronic animal model.

A limited injury to the myocardium was demonstrated by a histological examination of the LV endocardium in the early period after the coronary artery occlusion and endocardial chemical ablation. The histological examination was performed on the specimens only from the anterior LV, and serial change after the chemical ablation was not examined in the present study. Progressive change can occur in the longer period after the endocardial chemical ablation. This should also be examined in a chronic animal model.

4.2 | Clinical implications

The procedure, chemical ablation of the LV endocardium with Lugol's solution through a left atrial appendage, may be indicated in patients with intractable ventricular tachyarrhythmias during the early phase of myocardial ischemia. Those patients usually have received cardio-pulmonary resuscitations with multiple direct current shocks despite of maximum medical therapies, including catheter-based endocardial ablation,[8,9] and are frequently associated with progressive myocardial ischemia. The procedure may be combined with coronary artery bypass grafting targeting culprit coronary arteries. The procedure time may not exceed 15 min or more to complete, including a closure of the left atrial appendage.

Before applying the procedure to patients, long-term effects of the endocardial ablation by Lugol's solution should be examined. In addition to the potential injury to the myocardium by chemical ablation as described above, deleterious effects on the cardiac systolic and diastolic functions by left bundle branch block caused by endocardial ablation should also be examined.[24]

5 | CONCLUSIONS

Chemical ablation of the LV endocardium with Lugol's solution injures endocardial conduction system and increases VF threshold in early phase of myocardial ischemia in canines. The procedure may be useful in suppressing intractable ventricular tachyarrhythmias in patients with acute myocardial ischemia.

ACKNOWLEDGMENTS

We are deeply grateful to Prof. Tasuku Shoji and Dr. Masatoshi Ikeshita who have deceased at the time of submission for their invaluable supports.

FUNDING INFORMATION

This work was supported by JSPS KAKENHI Grant Number JP60480322. https://kaken.nii.ac.jp/report/KAKENHI-PROJECT-60480322/604803221986kenkyu_seika_hokoku_gaiyo_jpn/.

CONFLICT OF INTEREST STATEMENT

The authors have no funding or financial supports to disclose. The authors have declared that no competing interest exists.

ETHICAL APPROVAL STATEMENT

All animals received humane care in accordance with standard guidelines as recommended by the Science Council of Japan. (http://www.scj.go.jp/en/animal/index.html) In addition, the study protocol was approved by the Animal Ethics Committee of Nippon Medical School.

PATIENT CONSENT STATEMENT

N/A (because it is an animal study).

CLINICAL TRIAL REGISTRATION

N/A (because it is an animal study).

SECONDARY PUBLICATION

This article is based on a study first reported in Japanese in the following article: Nitta T. The effect of transatrial chemical ablation with Lugol's solution on ventricular vulnerability. *Nihon Kyobu Geka Gakkai Zasshi*. 1988;36:2581-9. The data and the interpretations of the data presented in the secondary version are identical to those of the primary version with a minor abbreviation to meet a different group of readers.

ORCID

Takashi Nitta https://orcid.org/0009-0004-3068-0550

REFERENCES

1. Zipes DP, Camm AJ, Borggrefe M, Buxton AE, Chaitman B, Fromer M, et al. ACC/AHA/ESC 2006 guidelines for Management of Patients with Ventricular Arrhythmias and the prevention of sudden cardiac death: a report of the American College of Cardiology/American Heart Association task force and the European Society of Cardiology Committee for practice guidelines (writing committee to develop guidelines for Management of Patients with Ventricular Arrhythmias and the prevention of sudden cardiac death): developed in collaboration with the European heart rhythm association and the Heart Rhythm Society. Circulation. 2006;114:e385–484.
2. Prystowsky EN. Primary prevention of sudden cardiac death: the time of your life. Circulation. 2004;109:1073–5.
3. Ellis SG, Tendera M, de Belder MA, van Boven AJ, Widimsky P, Janssens L, et al. Facilitated PCI in patients with ST-elevation myocardial infarction. N Engl J Med. 2008;358:2205–17.
4. Sesselberg HW, Moss AJ, McNitt S, Zareba W, Daubert JP, Andrews ML, et al. Ventricular arrhythmia storms in postinfarction patients with implantable defibrillators for primary prevention indications: a MADIT-II substudy. Heart Rhythm. 2007;4:1395–402.
5. de Bakker JM, van Capelle FJ, Janse MJ, Wilde AA, Coronel R, Becker AE, et al. Reentry as a cause of ventricular tachycardia in patients with chronic ischemic heart disease: electrophysiologic and anatomic correlation. Circulation. 1988;77:589–606.
6. Di Diego JM, Antzelevitch C. Ischemic ventricular arrhythmias: experimental models and their clinical relevance. Heart Rhythm. 2011;8:1963–8.
7. Bogun F, Good E, Reich S, Elmouchi D, Igic P, Tschopp D, et al. Role of Purkinje fibers in post-infarction ventricular tachycardia. J Am Coll Cardiol. 2006;48:2500–7.
8. Bänsch D, Oyang F, Antz M, Arentz T, Weber R, Val-Mejias JE, et al. Successful catheter ablation of electrical storm after myocardial infarction. Circulation. 2003;108:3011–6.
9. Hayashi M, Kobayashi Y, Iwasaki YK, Morita N, Miyauchi Y, Kato T, et al. Novel mechanism of postinfarction ventricular tachycardia originating in surviving left posterior Purkinje fibers. Heart Rhythm. 2006;3:908–18.
10. Chilson DA, Peigh PS, Mahomed Y, Waller BF, Zipes DP. Chemical ablation of ventricular tachycardia in the dog. Am Heart J. 1986;111:1113–8.
11. Damiano RJ Jr, Smith PK, Tripp HF Jr, Asano T, Small KW, Lowe JE, et al. The effect of chemical ablation of the endocardium on ventricular fibrillation threshold. Circulation. 1986;74:645–52.
12. Ikeshita M, Yamauchi S, Nitta T, Shoji T. Continuous and stable recording of the His bundle electrogram during open heart operations. Ann Thorac Surg. 1995;59:535–7.
13. Han J. Ventricular vulnerability during acute coronary occlusion. Am J Cardiol. 1969;24:857–64.
14. Magherini A, Azzolina G, Careri J. Anatomy of the echocardiographic crux cordis in the evaluation of the spectrum of atrioventricular valve atresia. Int J Cardiol. 1984;5:163–74.
15. Jackson N, Massé S, Zamiri N, Azam MA, Lai PFH, Kusha M, et al. Mechanisms of long-duration ventricular fibrillation in human hearts and experimental validation in canine Purkinje fibers. JACC Clin Electrophysiol. 2015;1:187–97.
16. Anderson RD, Massé S, Asta J, Lai PFH, Chakraborty P, Azam MA, et al. Role of Purkinje-muscle junction in early ventricular fibrillation in a porcine model: beyond the trigger concept. Pacing Clin Electrophysiol. 2022;45:742–51.
17. Wennemark JR, Benvenuto P, Lewis JF. Destruction of the specialized conduction tissue in the live canine heart with iodine. J Thorac Cardiovasc Surg. 1960;39:137–43.
18. Bhar-Amato J, Davies W, Agarwal S. Ventricular arrhythmia after acute myocardial infarction: 'The perfect storm'. Arrhythmia Electrophysiol Rev. 2017;6:134–9.
19. Mehta RH, Starr AZ, Lopes RD, Piccini JP, Patel MR, Pieper KS, et al. Relationship of sustained ventricular tachyarrhythmias to outcomes in patients undergoing primary percutaneous coronary intervention with varying underlying baseline risk. Am Heart J. 2011;161:782–9.
20. Behnes M, Mashayekhi K, Weiß C, Nienaber C, Lang S, Reiser L, et al. Prognostic impact of acute myocardial infarction in patients presenting with ventricular tachyarrhythmias and aborted cardiac arrest. J Am Heart Assoc. 2018;7:e010004. https://doi.org/10.1161/JAHA.118.010004
21. Jalife J. Ventricular fibrillation: mechanisms of initiation and maintenance. Annu Rev Physiol. 2000;62:25–50.
22. Nearing BD, Oesterle SN, Verrier RL. Quantification of ischaemia induced vulnerability by precordial T wave alternans analysis in dog and human. Cardiovasc Res. 1994;28:1440–9.
23. Orini M, Graham AJ, Srinivasan NT, Campos FO, Hanson BM, Chow A, et al. Evaluation of the reentry vulnerability index to predict ventricular tachycardia circuits using high-density contact mapping. Heart Rhythm. 2020;17:576–83.
24. Yajima T, Ikeshita M, Shoji T. The effect of chemical ablation with Lugol solution for ventricular tachyarrhythmia on cardiac function. Nihon Kyobu Geka Gakkai Zasshi. 1990;38:2409.(Japanese)–15.

How to cite this article: Nitta T, Asano T, Yajima T, Otsuka T, Ishii Y. Chemical ablation of the left ventricular endocardium reduces ventricular fibrillation inducibility in acute ischemic canine heart. J Arrhythmia. 2024;40:325–332. https://doi.org/10.1002/joa3.12993