

Parasternal intercostal approach as an alternative to subxiphoid approach for epicardial catheter ablation: A case report



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Introduction

The importance of an epicardial substrate for cardiac arrhythmias has been increasingly recognized. Combined endocardial and epicardial mapping and radiofrequency catheter ablation (RFCA) has become the standard strategy for treatment of ventricular tachycardia (VT).^{1,2} The subxiphoid approach is the standard and most frequently used method for percutaneous epicardial access.^{1,2} However, complications of the subxiphoid approach are not uncommon, even in experienced centers, with reported rates of 4% to 7%.^{3,4} In addition, obtaining epicardial access using the subxiphoid approach may be difficult because of extracardiac structures located on the epicardial needle trajectory. Therefore, the epicardial approach to reduce complications and as an alternative to the subxiphoid approach is essential for epicardial RFCA.

We described the case of a patient with successful epicardial access twice and RFCA using a parasternal intercostal approach, which is an alternate solution when the standard subxiphoid approach to obtain epicardial access is difficult.

Case report

A 43-year-old man was diagnosed with dilated cardiomyopathy and sick sinus syndrome in 2009 and underwent pacemaker implantation. He had a history of VT, and his pacemaker was upgraded to implantable cardioverter-defibrillator in 2014. He was treated with amiodarone and carvedilol but since May 2014 had frequent episodes of VTs

requiring DC shock to terminate. Endocardial-only RFCA at the left ventricle (LV) was performed in June 2014, but VT could not be suppressed. He was referred to the National Cerebral and Cardiovascular Center for electrophysiologic study and RFCA. His weight was 86 kg and height was 170 cm. His body mass index was 30, and his abdomen was protuberant. Echocardiography revealed severely dilated and reduced LV wall motion, with diastolic dimension of 73 mm and ejection fraction of 0.15.

Epicardial approach

After obtaining written informed consent, electrophysiologic study and RFCA were performed with the patient under conscious sedation with propofol and dexmedetomidine. Preprocedural computed tomography (CT) revealed the presence of liver and stomach throughout the subdiaphragmatic space in the upper abdomen (Figure 1). Image quality of the heart by echocardiography was poor from the subxiphoid space because of the patient's obesity.

Epicardial access initially was attempted from the subxiphoid. Although aspiration of air in the stomach was performed using a stomach tube, fluoroscopy showed the presence of stomach in the subdiaphragmatic space. The needle was advanced from the entry site between the xiphisternum and the left costal margin. A blunt-tipped Tuohy needle was angled superficially approximately 20 degrees to the horizontal plane and directed toward the left mid-clavicle. However, the needle could not be advanced because the liver and stomach were on the needle trajectory to the heart under fluoroscopic guidance in the left anterior oblique (LAO) view, and the needle had to angled more shallow to the horizontal plane to avoid these structures. However, the adjusted angle was too shallow to approach the heart. Thus, we failed to obtain access to the epicardial space using the subxiphoid approach.

Subsequently, we attempted to access the epicardial space using a parasternal intercostal approach. We selected the entry site at the parasternal 5th intercostal space based on findings of echocardiography and preprocedural CT. The heart was clearly visible by echocardiography. The distance between the chest wall to the anterior wall of the right

KEYWORDS Ventricular tachycardia; Epicardial ablation; Parasternal intercostal approach

ABBREVIATIONS CT = computed tomography; ITA = internal thoracic artery; LAO = left anterior oblique; LV = left ventricle; LVZ = low-voltage zone; RFCA = radiofrequency catheter ablation; RV = right ventricle; VT = ventricular tachycardia

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KEY TEACHING POINTS

- The subxiphoid approach for epicardial ablation is the standard and most frequently used method for percutaneous epicardial access. However, complications of the subxiphoid approach are not uncommon, even in experienced centers.
- The parasternal intercostal approach is feasible and could be alternative to the subxiphoid approach for percutaneous epicardial access for treatment of cardiac arrhythmias.
- The 5th intercostal space usually is used for the parasternal intercostal approach. However, the entry site for the parasternal intercostal approach should be determined for each patient based on the findings of preprocedural CT and echocardiography.

ventricle (RV) was close (~ 2 cm), and there was no lung between them. The absence of the internal thoracic artery (ITA) on the needle trajectory was confirmed by preprocedural contrast-enhanced CT imaging.

After administration of local anesthesia with lidocaine, a Tuohy needle was advanced gently until slight negative pressure was felt under fluoroscopic guidance. After the needle reached the heart border, a small amount of contrast medium was injected to assess the location of the needle tip. The needle tip was confirmed to be located in the epicardial space. A soft floppy-tip guidewire (Radifocus, Terumo, Tokyo, Japan) was advanced into the pericardial space through the needle, and we confirmed that the guidewire was wrapped around the left and the right heart borders in the LAO view. An 8Fr long sheath was advanced into the pericardial space over the guidewire to deliver a mapping or ablation catheter into the epicardial space (Figure 2). Intravenous heparin was administered to maintain an activated clotting time > 300 seconds immediately after parasternal intercostal puncture.

RFCA

An 8Fr steerable open-irrigated catheter with 3.5-mm distal electrode was used for mapping and ablation in the epicardial space (Thermocool, Biosense Webster, Johnson & Johnson, Diamond Bar, CA). The catheter moved smoothly over the entire epicardial surface of both the LV and RV, either directly or indirectly by looping the catheter around the heart, allowing for easy mapping and RFCA. There was a widespread low-voltage zone (LVZ) < 1.0 mV in the epicardium (Figure 3). Abnormal electrograms, such as fragmented, double, and/or delayed potentials, were also recorded extensively, especially at the basal lateral wall of the LV epicardium. Epicardial RFCA was performed based on substrate mapping, after which the VTs were no longer inducible by RV pacing. Methylprednisolone 1 mg/kg was administered into the pericardial space at the end of the procedure. No procedural

complications occurred during or after the ablation procedure. A 5Fr pigtail catheter was left indwelling in the epicardial space after the procedure (Figure 1) and was removed the next day after no effusion in the epicardial space was confirmed.

RFCA second session

After the RFCA procedure, the VTs occurred again. RFCA was performed again, 9 days after the previous session. The parasternal intercostal approach was selected. We could successfully obtain access to the epicardial space by the parasternal intercostal approach. The catheter moved smoothly over the entire epicardial surface of the ventricles as well as it did in the previous session. Endocardial and epicardial RFCA was performed based on substrate mapping. After RFCA, the VTs were no longer inducible by RV pacing. No procedural complications occurred during or after the ablation procedure. The patient has been free from any VT recurrences during follow-up of 6 months.

Discussion

Complications related to the subxiphoid approach

Access to the pericardial space requires passage of the needle and sheath through numerous extracardiac structures. Most complications of the subxiphoid approach are due to the needle penetrating the heart and surrounding structures, such as liver, stomach, colon, coronary arteries, diaphragm, pleura, and lungs with its vascular supply.³⁻⁷

The liver, stomach, and transverse colon are present in the subdiaphragmatic space. The left lobe of the liver is near the xiphisternum, and injury risk to the liver may be increased in patients with congestive heart failure and hepatomegaly and/or in those with a relatively small thorax, such as Asian people. Arterial bleeding in coronary arteries, such as the acute marginal branch of the RV, and/or any of the extracardiac structures can occur and may lead to surgical hemostasis.

Parasternal intercostal approach

Because of the complications of subxiphoid approach mentioned, Loukas et al⁷ recommended the parasternal intercostal approach for epicardial access, although they mentioned its use for drainage of pericardial effusions.⁸

We believe that 2 preprocedural images are necessary in preparation for the parasternal intercostal approach. Echocardiography is used to determine the entry site at the intercostal space and to assess the distance between the chest wall and the heart. The ideal entry site is located where the anterior wall of the RV is close to the chest wall and there is no lung between them. Preprocedural contrast-enhanced CT imaging is also used to assess the relative location of the heart and extracardiac structures, including lung, and the distance between the chest wall and the heart. The location of the ITA, which is not effectively shown by echocardiography, should be identified by preprocedural CT so that it can be avoided.

The 5th intercostal space usually is used for the parasternal intercostal approach.^{7,8} However, the entry site

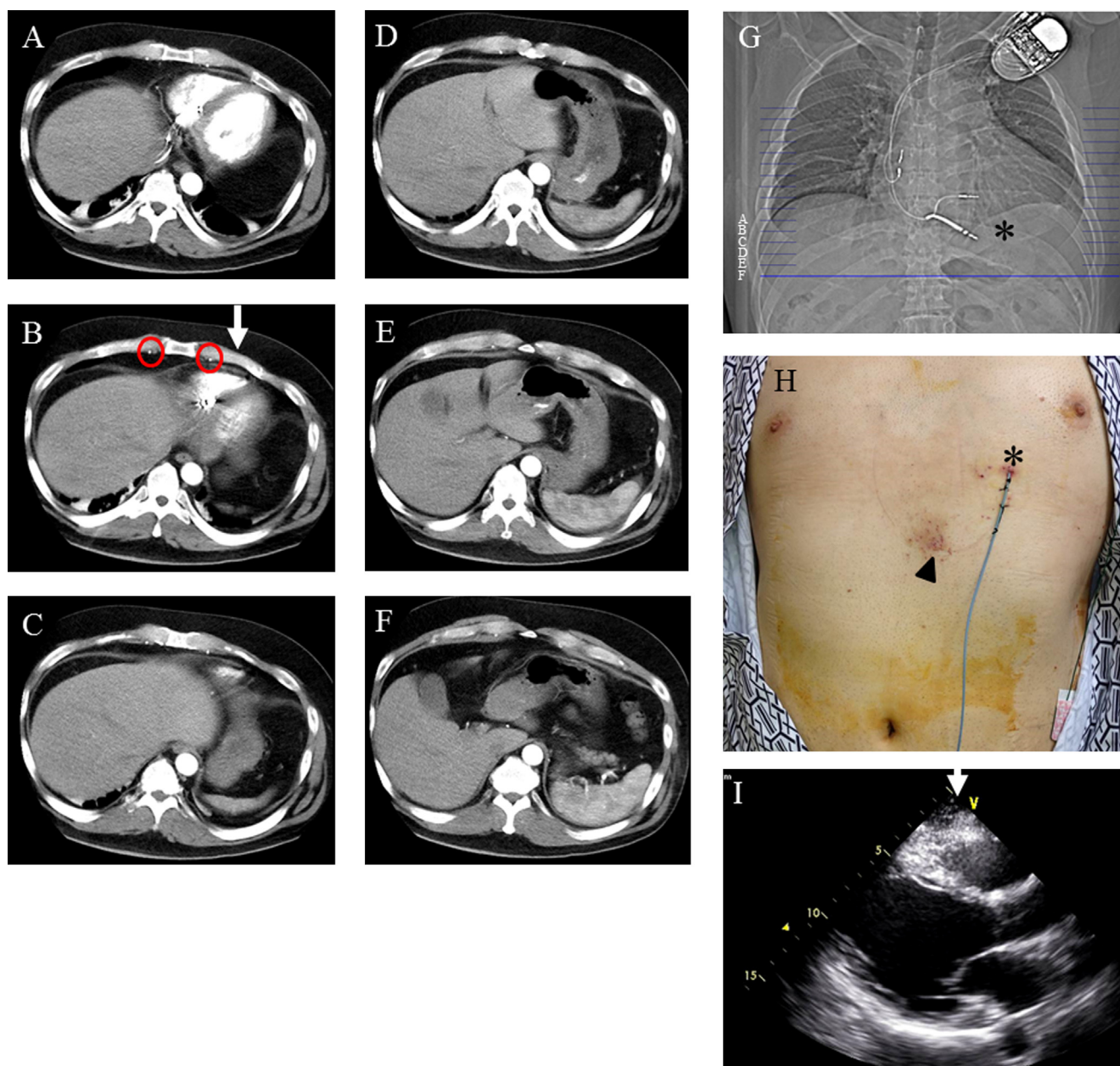


Figure 1 Computed tomographic (CT) image of pericardial access. Transverse views (A–F) corresponding to the anteroposterior view (G) on preprocedural contrast-enhanced CT are shown. Note that the liver and stomach are present throughout the subdiaphragmatic space in the upper abdomen, which are on the trajectory for the subxiphoid epicardial approach. The epicardial needle was inserted at the 5th intercostal space (arrow), where was consistent with plane B. We confirmed by CT that no vital structures, including liver, stomach, transverse colon, and ITAs, were located on the needle trajectory. To avoid the ITAs (red circles), we selected a site 2.5 cm lateral to the parasternal border for needle entry (arrow). **I:** Avoidance of vital structures was also confirmed by echocardiography. Arrow indicates the entry site of the needle. **H:** The pigtail catheter was indwelling in the epicardial space after the procedure. Asterisk indicates location of epicardial needle entry for the parasternal intercostal approach. Arrowhead indicates location of needle entry for the standard subxiphoid approach. ITA = internal thoracic artery.

should be determined for each patient based on the findings of preprocedural CT and echocardiography. The checkpoints of CT images used to select the entry site are as follows: (1) the contact area between the chest wall and the anterior wall of the RV. The larger contact area between them is highly preferred to avoid injury to the lung. If there is the lung on the needle trajectory, it should be avoided by necessity; (2) the distance between the chest wall to the anterior wall of the RV; and (3) the absence of the left ITA and lung along the needle trajectory.

Echocardiography should be used to reconfirm the contact area and distance between the chest wall and the anterior wall of the RV, and the absence of lung between them.⁷ In this case, the contact area between the structures was large at the 4th and 5th intercostal spaces on CT images; however, the image quality at the 4th intercostal space was not good. The distance between the structures was short (~2 cm) at the 5th intercostal space. In addition, it was easy to avoid the left ITA and lung at the 5th intercostal space based on findings of preprocedural CT and echocardiography. Therefore, in this

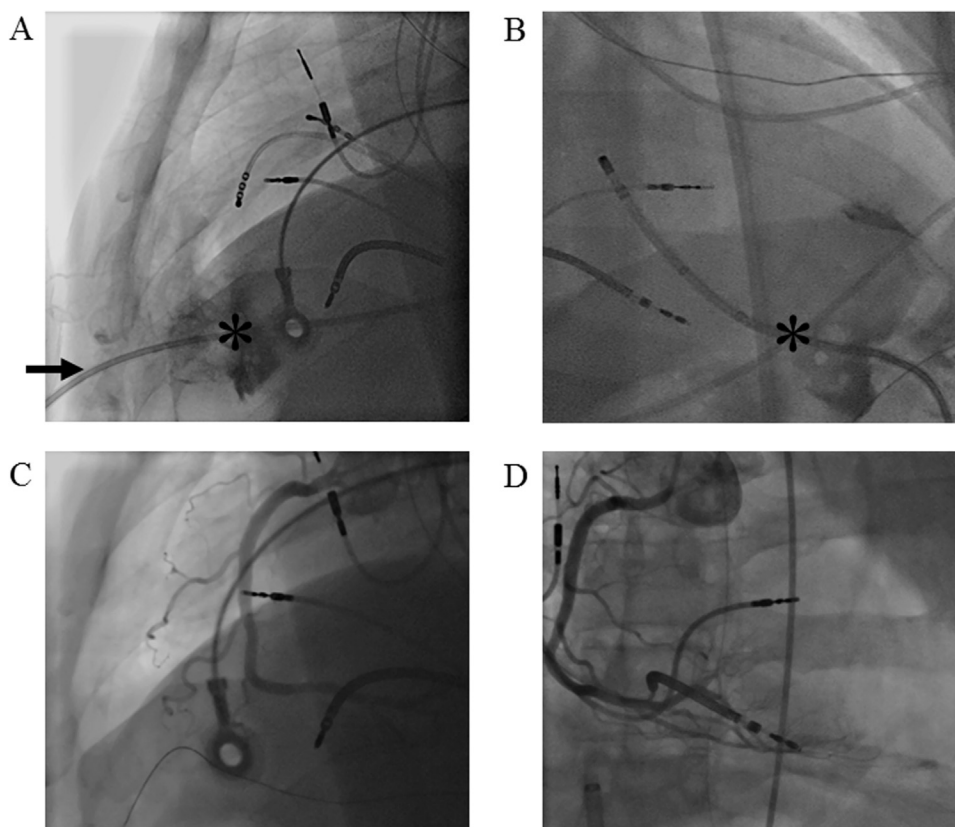


Figure 2 Fluoroscopic images of epicardial access by the parasternal intercostal approach (**A, B**) and right coronary angiography (**C, D**). Panels **A** and **C** are left anterior oblique views; panels **B** and **D** are anteroposterior views. *Arrow* indicates the 5th intercostal space. There are no coronary arteries, including the right ventricular marginal artery, on the trajectory of the epicardial access from the entry site at the parasternal 5th intercostal space to the heart. *Asterisk* indicates location of epicardial needle entry to the heart.

case we selected the 5th intercostal space for the parasternal intercostal approach.

[Online Supplemental Figure 1](#) shows the preprocedural CT image of a 46-year-old man with successful epicardial ablation by the subxiphoid approach. The heart is almost absent in the CT image at the 5th intercostal space ([Online Supplemental Figure 1C](#)). Therefore, if we attempted the parasternal intercostal approach in this case the 5th intercostal space would not be selected for the entry site. Instead, the 4th intercostal space ([Online Supplemental Figure 1A](#)) might be selected. However, the contact area between the chest wall and the anterior wall of the RV is relatively small at the 4th intercostal space. Therefore, the needle angle should be advanced caudally in this case. [Online Supplemental Figure 2](#) shows the preprocedural CT image of a 60-year-old man who underwent RFCA for atrial fibrillation. In this case, all the contact areas between the chest wall and the anterior wall of the RV at the 4th, 5th, and 6th intercostal spaces are relatively small. In a case like this, epicardial access by the parasternal intercostal approach might be difficult to obtain.

The entry sites should be the superior border of the costa to avoid the vascular bundle at the inferior border of each costa. After local anesthetic is administered at the determined entry site, the needle is advanced toward the heart. Fluoroscopy in the LAO view is useful for

assessing the depth of the needle as well as when we performed the subxiphoid approach.

Advantages and disadvantages of the parasternal intercostal approach

When using the epicardial approach, it is impossible to avoid completely the extracardiac structures and their vascular supply. The strategy to minimize risk of injury to the extracardiac structures is to decrease the number of thoracic and abdominal structures on the needle trajectory and to reduce the distance between the entry site and the heart. In the parasternal intercostal approach, some structures can be avoided, including the liver, stomach, transverse colon, and diaphragm, which are at risk for injury with the subxiphoid approach.³⁻⁷

Using the subxiphoid approach in an obese patient may increase the risk of complications due to the steeper needle angle required on entry because of the patient's protuberant abdomen, the longer distance to the epicardium, the greater forward pressure required, and the impaired image quality of preprocedural echocardiography. In contrast, we assume that there is no increased risk of complications using the parasternal intercostal approach, even in obese patients, because the distance between the entry site and the heart does not increase so much with this approach.

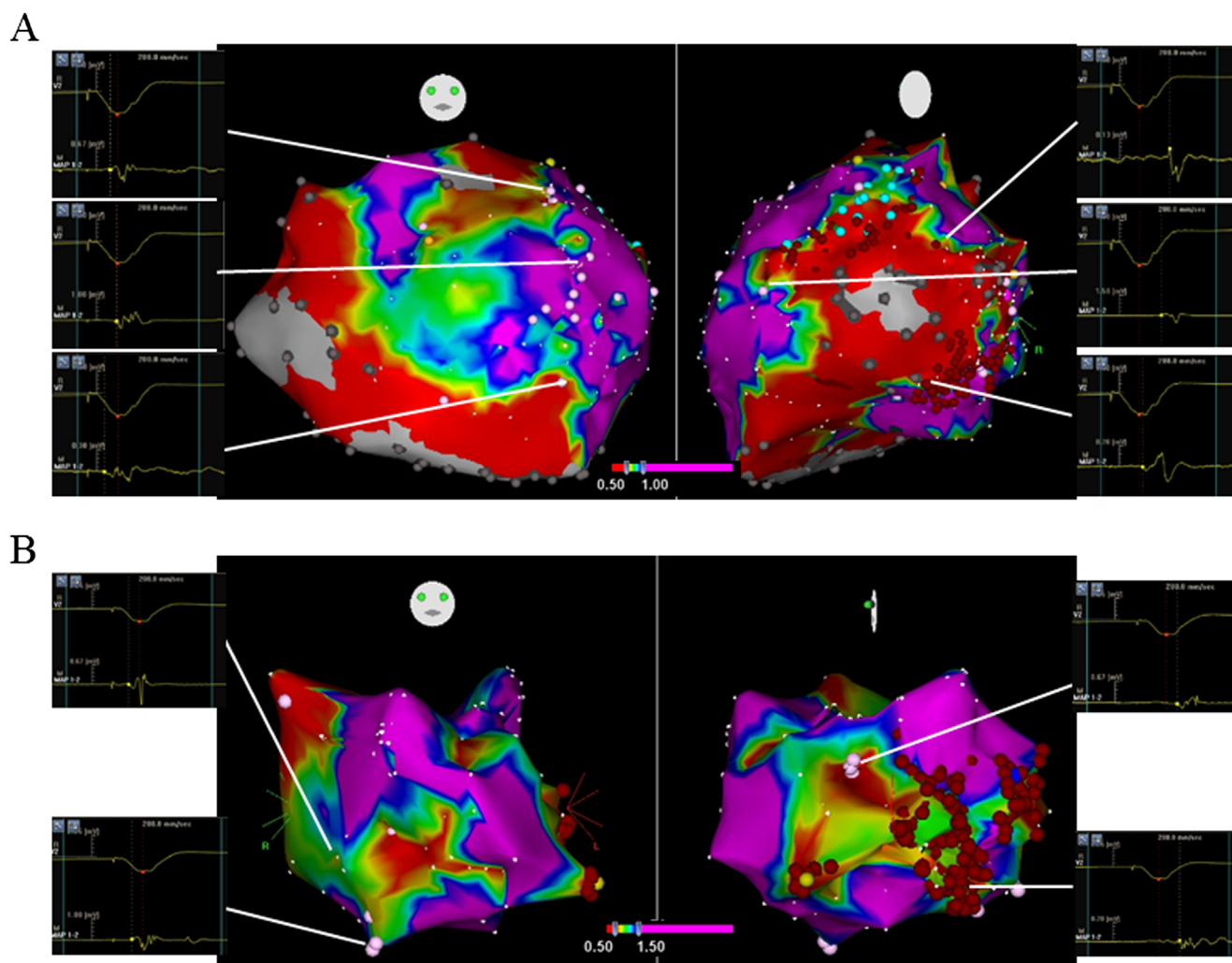


Figure 3 Bipolar voltage maps of the epicardium (A) and endocardium (B) of the left ventricle. The low-voltage zone (LVZ) was defined as <1.0 mV in the epicardium and 1.5 mV in the endocardium. Representative electrograms at the LVZ are also shown. **A:** Epicardial voltage mapping. Left panel is anteroposterior (AP) view and right panel is left posterior oblique view. **B:** Endocardial voltage mapping. Left panel is AP view and right panel is left lateral view.

The structures that may be encountered and should be avoided in the parasternal intercostal approach are the ITA and the lung. The ITAs lie at the margins of the sternum, typically 1 cm to the parasternal border.^{7,9} Loukas et al⁷ reported that the parasternal approach is often performed immediately adjacent to the sternum to avoid the ITAs. However, recognition (palpation) of the parasternal border sometimes is difficult. Therefore, we selected an entry site more lateral (~ 2.5 cm) to the parasternal border to avoid the ITA based on CT imaging. We believe that injury to the ITA can be avoided with use of preprocedural CT imaging.

The risk of pneumothorax caused by pleural injury may be higher with the parasternal intercostal approach.¹⁰ However, this complication could be avoided by determining the relative location of the entry site and the lung on preprocedural CT and echocardiography.

Loukas et al⁹ recommended the parasternal intercostal approach for drainage of pericardial effusions. The safety of the parasternal intercostal approach was confirmed in a cadaver study.¹⁰ Ebrille et al⁹ reported a CT-guided parasternal intercostal approach for VT ablation for the first time

in patients with post-partial colectomy with colostomy, in whom bowel was present throughout the subdiaphragmatic space. Theirs is an excellent case report, but the strategy requires specific preparation, such as CT with an “external lead grid.” In contrast, our strategy requires only standard preprocedural preparation, such as echocardiography and contrast-enhanced CT. Therefore, this strategy can also be used as an alternative in patients in whom the epicardial approach was initially attempted by the subxiphoid approach but failed.

In conclusion, this report demonstrated successful epicardial access twice and RFCA using the parasternal intercostal approach. The parasternal intercostal approach is feasible and could be an alternative to the subxiphoid approach for epicardial access for treatment of cardiac arrhythmias.

Appendix Supplementary data

Supplementary material cited in this article is available online at <http://dx.doi.org/10.1016/j.hrcr.2014.12.014>.

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