A 70-year-old African American female with known history of nonischemic cardiomyopathy (ejection fraction, 15%) was referred for BiVentricular implantable cardioverter-defibrillator (BiV-ICD) implantation for primary prevention. Because of a previous left mastectomy for breast cancer and occlusion of the left subclavian axillary venous system, a right-sided prepectoral implant was chosen for this patient. The procedure included a right-sided prepectoral BiV-ICD implantation, implantation of a right atrial appendage active fixation lead, a single-coil active fixation right ventricular lead, and a left ventricular coronary sinus lead. During the routine testing of the ICD, the defibrillation threshold (DFT) was >35 J, requiring external cardioversion. A second DFT testing performed thereafter with a polarity modification was also >35 J. The patient was subsequently treated with sotalol 80 mg bid for 1 week and the DFT was repeated but was still refractory (>35 J). Hence, alternate options were entertained. Although a left-sided subcutaneous coil array was considered, it was abandoned because the coil extension had to cross the midline of the chest. However, a percutaneous epicardial defibrillation coil implantation was considered (Figure 1A).

A 17-gauge Tuohy needle was introduced at a 45° angle from the subxyphoid region, aiming toward the left scapula under fluoroscopic guidance. A 10-mL syringe of radio-opaque contrast media was attached to the Tuohy needle. The needle was gently advanced until it was close to the cardiac silhouette fluoroscopically. Needle entry into the pericardial space was confirmed when the injection of the contrast medium was seen surrounding the cardiac silhouette (Figure 1B). A soft, floppy-tip guidewire was introduced into the pericardial space through the needle; a 9F sheath was advanced into the pericardial space over the guidewire, and the guidewire was removed. Subsequently, a 6996 Medtronic defibrillation coil was modified using an Ethibond suture traversed through the tip (Figure 2A) and was advanced through the sheath into the posterior epicardial space. The tip of the coil was pulled, using the suture to the entry point, thus forming a halo in the pericardial space in the posterior/lateral orientation. (Figure 1B to 1D). The Ethibond suture, which pulled the loop to close, was then used to anchor the coil tip to the proximal end of the coil, and the entire system is then secured to the tissue around the point of entry. This technique stabilizes the coil halo in the epicardium and avoids dislodgement. The coil lead was then tunneled subcutaneously and connected to the prepectorally implanted right-sided ICD generator. The DFT was tested thereafter with this epicardial coil configuration, and the lowest effective threshold was found to be ≤9 J. A 6-month follow-up reconfirmed the intact position of the epicardial coil system and unchanged DFT (Figure 3).

Unsuccessful DFT testing is encountered more often with the modern transvenous ICD system, given the increased number of tachytherapy device implantations. Clinical characteristics, outcomes, and several solutions for high DFT have been described. Right-sided ICD implantation as in our patient is one of the known causes to increase DFT. In >85% of patients, high DFT can be improved by noninvasive and invasive system modifications. Left-sided subcutaneous coil or array is the commonly used invasive technique. Epicardial patches or coils have been successfully placed to improve the DFT. The use of ICD leads in the pericardial space has been described in the pediatric and congenital heart disease literature but not so much in adult electrophysiology. To our knowledge, our case is the first reported case of a successful percutaneous approach for epicardial coil placement for refractory DFT in an adult patient. The novelty is that this minimally invasive technique can be performed by the electrophysiologist in the electrophysiology laboratory rather than with a more invasive surgical approach by a surgeon.

Although epicardial patches have been used in the past, it is considerably rare now. Epicardial patch effectiveness is based on its location in the pericardium and has a strong inverse correlation of surface area to the DFT. Presently, the epicardial coil is used to achieve improved DFT, but it usually needs surgical intervention. Our technique of percutaneous epicardial placement of a defibrillation coil provides a safe and efficacious approach to ICD therapy in refractory DFT. The coil should ideally be placed in the posterior/lateral pericardial space. This covers the maximal area of the myocardium, allowing current flow from the free wall of the left ventricle to the proximal end of the coil, and the entire system is then secured to the tissue around the point of entry. This technique stabilizes the coil halo in the epicardium and avoids dislodgement. The coil lead was then tunneled subcutaneously and connected to the prepectorally implanted right-sided ICD generator. The DFT was tested thereafter with this epicardial coil configuration, and the lowest effective threshold was found to be ≤9 J. A 6-month follow-up reconfirmed the intact position of the epicardial coil system and unchanged DFT (Figure 3).

Unsuccessful DFT testing is encountered more often with the modern transvenous ICD system, given the increased number of tachytherapy device implantations. Clinical characteristics, outcomes, and several solutions for high DFT have been described. Right-sided ICD implantation as in our patient is one of the known causes to increase DFT. In >85% of patients, high DFT can be improved by noninvasive and invasive system modifications. Left-sided subcutaneous coil or array is the commonly used invasive technique. Epicardial patches or coils have been successfully placed to improve the DFT. The use of ICD leads in the pericardial space has been described in the pediatric and congenital heart disease literature but not so much in adult electrophysiology. To our knowledge, our case is the first reported case of a successful percutaneous approach for epicardial coil placement for refractory DFT in an adult patient. The novelty is that this minimally invasive technique can be performed by the electrophysiologist in the electrophysiology laboratory rather than with a more invasive surgical approach by a surgeon.

Although epicardial patches have been used in the past, it is considerably rare now. Epicardial patch effectiveness is based on its location in the pericardium and has a strong inverse correlation of surface area to the DFT. Presently, the epicardial coil is used to achieve improved DFT, but it usually needs surgical intervention. Our technique of percutaneous epicardial placement of a defibrillation coil provides a safe and efficacious approach to ICD therapy in refractory DFT. The coil should ideally be placed in the posterior/lateral pericardial space. This covers the maximal area of the myocardium, allowing current flow from the free wall of the left ventricle to the proximal end of the coil, and the entire system is then secured to the tissue around the point of entry. This technique stabilizes the coil halo in the epicardium and avoids dislodgement. The coil lead was then tunneled subcutaneously and connected to the prepectorally implanted right-sided ICD generator. The DFT was tested thereafter with this epicardial coil configuration, and the lowest effective threshold was found to be ≤9 J. A 6-month follow-up reconfirmed the intact position of the epicardial coil system and unchanged DFT (Figure 3).

Unsuccessful DFT testing is encountered more often with the modern transvenous ICD system, given the increased number of tachytherapy device implantations. Clinical characteristics, outcomes, and several solutions for high DFT have been described. Right-sided ICD implantation as in our patient is one of the known causes to increase DFT. In >85% of patients, high DFT can be improved by noninvasive and invasive system modifications. Left-sided subcutaneous coil or array is the commonly used invasive technique. Epicardial patches or coils have been successfully placed to improve the DFT. The use of ICD leads in the pericardial space has been described in the pediatric and congenital heart disease literature but not so much in adult electrophysiology. To our knowledge, our case is the first reported case of a successful percutaneous approach for epicardial coil placement for refractory DFT in an adult patient. The novelty is that this minimally invasive technique can be performed by the electrophysiologist in the electrophysiology laboratory rather than with a more invasive surgical approach by a surgeon.

Although epicardial patches have been used in the past, it is considerably rare now. Epicardial patch effectiveness is based on its location in the pericardium and has a strong inverse correlation of surface area to the DFT. Presently, the epicardial coil is used to achieve improved DFT, but it usually needs surgical intervention. Our technique of percutaneous epicardial placement of a defibrillation coil provides a safe and efficacious approach to ICD therapy in refractory DFT. The coil should ideally be placed in the posterior/lateral pericardial space. This covers the maximal area of the myocardium, allowing current flow from the free wall of the left ventricle to the proximal end of the coil, and the entire system is then secured to the tissue around the point of entry. This technique stabilizes the coil halo in the epicardium and avoids dislodgement. The coil lead was then tunneled subcutaneously and connected to the prepectorally implanted right-sided ICD generator. The DFT was tested thereafter with this epicardial coil configuration, and the lowest effective threshold was found to be ≤9 J. A 6-month follow-up reconfirmed the intact position of the epicardial coil system and unchanged DFT (Figure 3).

Unsuccessful DFT testing is encountered more often with the modern transvenous ICD system, given the increased number of tachytherapy device implantations. Clinical characteristics, outcomes, and several solutions for high DFT have been described. Right-sided ICD implantation as in our patient is one of the known causes to increase DFT. In >85% of patients, high DFT can be improved by noninvasive and invasive system modifications. Left-sided subcutaneous coil or array is the commonly used invasive technique. Epicardial patches or coils have been successfully placed to improve the DFT. The use of ICD leads in the pericardial space has been described in the pediatric and congenital heart disease literature but not so much in adult electrophysiology. To our knowledge, our case is the first reported case of a successful percutaneous approach for epicardial coil placement for refractory DFT in an adult patient. The novelty is that this minimally invasive technique can be performed by the electrophysiologist in the electrophysiology laboratory rather than with a more invasive surgical approach by a surgeon.

Although epicardial patches have been used in the past, it is considerably rare now. Epicardial patch effectiveness is based on its location in the pericardium and has a strong inverse correlation of surface area to the DFT. Presently, the epicardial coil is used to achieve improved DFT, but it usually needs surgical intervention. Our technique of percutaneous epicardial placement of a defibrillation coil provides a safe and efficacious approach to ICD therapy in refractory DFT. The coil should ideally be placed in the posterior/lateral pericardial space. This covers the maximal area of the myocardium, allowing current flow from the free wall of the left ventricle to the proximal end of the coil, and the entire system is then secured to the tissue around the point of entry. This technique stabilizes the coil halo in the epicardium and avoids dislodgement. The coil lead was then tunneled subcutaneously and connected to the prepectorally implanted right-sided ICD generator. The DFT was tested thereafter with this epicardial coil configuration, and the lowest effective threshold was found to be ≤9 J. A 6-month follow-up reconfirmed the intact position of the epicardial coil system and unchanged DFT (Figure 3).
interventricular septum to the free wall of the right ventricle. We achieved this by maintaining the coil loop in the epicardial space in a posterior orientation by stabilizing the tip and the body of the coil in a halo shape (Figure 2B) and securing the lead to the surrounding tissue.

This technique has some limitations. Although defibrillation coil lead dislodgment from the pericardium is a concern, the securing suture used in our technique should stabilize the lead in the pericardium. Moreover, placing the coil in the pericardial space may lead to pericarditis, adhesions, infection, fibrosis, or epicardial thickening. Additionally, proximity of the ICD coil to the epicardium may lead to irritation of diseased myocardium and thus may have a risk of inducing ventricular arrhythmias; however, no such cases are reported. This percutaneous approach to implant an epicardial defibrillation coil will be more feasible for electrophysiologists who perform epicardial arrhythmia ablations and will be a viable nonsurgical technique to improve DFT. However, operator experience is crucial in this technique, and the long-term stability and reliability of this method must be proven.

Disclosures

None.
References


**Figure 2.** A, 0-Ethibond suture is driven through the tip of the Medtronic defibrillation coil lead 6996 and the lead and the suture is inserted through the sheath. B, Technique by which the suture is pulled to create a loop, tied around the lead, and anchored to the surrounding tissue. This technique stabilizes the halo-shaped loop in the pericardium and prevents dislodgment.
Figure 3. Lateral chest radiograph of the patient taken at 6-month follow-up with the epicardial coil stable in the pericardial space.
Percutaneous Epicardial Defibrillation Coil Implantation: A Viable Technique to Manage Refractory Defibrillation Threshold
Sony Jacob and Randy A. Lieberman

Circ Arrhythm Electrophysiol. 2010;3:214-217
doi: 10.1161/CIRCEP.109.930552

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://circep.ahajournals.org/content/3/2/214