Piggy-back pacing: implantation of pacemaker and defibrillator on top of each other

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Following the publication of several landmark trials, there has been a significant increase in the cardiac device implantation. Within this population there are a number of patients who have pre-existing cardiac devices that have been placed for a number of different conditions. While the usual approach is to remove the existing unit and replace it with a new device with the removal or capping of existing lead systems, this practice often sacrifices an existing unit that still possesses good battery longevity. We explored the possibility of separating the pacing and defibrillating functions by implanting a new device on the top of the old device in a ‘piggy-back’ fashion. We report a series of four cases (with various indications) with differing combinations of devices. The procedure was performed safely in every one of them, and no device–device interaction was noted. Combining the new with existing units in a ‘piggy-back’ manner may be a safe and cost-effective technique in the selected cases.

KEYWORDS
Pacemaker; Defibrillator; Device to device interaction

Introduction

The past decade has witnessed a dramatic increase in the implantation of cardiac devices, in particular, implantable cardioverter defibrillators (ICDs). Increasingly, however, patients may present with pre-existing devices that have been implanted for a variety of reasons. While the usual procedure has been to remove the existing unit and remove or cap the existing leads, this practice often sacrifices a functional existing unit with a good existing battery life. We explored the possibility of placing two different devices together in the same pocket in a ‘piggy-back’ fashion. This procedure was found to be both safe and potentially cost-effective in selected patients. No adverse device–device interaction was observed in any patient. (Device–device interactions were evaluated by a method previously described).1

Methods

Case 1

A 68-year-old white male with a history of coronary artery bypass surgery in 1994 subsequently developed sick sinus syndrome, for which a dual-chamber pacemaker was implanted in 1999. He was pacing from his right ventricle most of the time. He was found to have a low ejection fraction and underwent electrophysiologic study for non-sustained ventricular tachycardia. The study demonstrated inducibility for monomorphic sustained ventricular tachycardia and he received an upgrade to a defibrillator in 2002. At that time his right ventricular pacing lead was capped.

After 3 years he developed progressive congestive heart failure with NYHA class III symptoms. He also had iatrogenic LBBB because of constant right ventricular pacing and we decided to upgrade his dual-chamber ICD to a biventricular ICD.

We implanted a heart failure pacing device and attached it to the existing right atrial, previously capped right ventricular and to a newly implanted coronary sinus lead. The pre-existing ICD was converted to single-chamber backup ICD, which still had excellent battery longevity.

Case 2

A 70-year-old white male, with a history of coronary bypass surgery and atrial fibrillation underwent AV node ablation with a single-chamber pacemaker implant. He underwent multiple admissions for congestive heart failure for which he was considered for resynchronization defibrillator implant as per CARE-HF2 criteria. He declined the procedure and was discharged. Patient was readmitted within the next few months with monomorphic ventricular tachycardia, which required an external shock. He subsequently...
underwent an uneventful single-chamber defibrillator implant. A bipolar coronary sinus lead was implanted without complication. The old right ventricular and new coronary sinus leads were attached to the existing single-chamber pacemaker with the help of a Y-adapter. Thus, by utilizing this method we were able to separate the pacing function from the defibrillation function. The pacemaker had almost full remaining longevity and would be utilized only for pacing. This method would help prevent premature depletion of defibrillator battery as well. After 4 years of follow-up the patient required replacement of pacemaker alone thereby preventing the replacement of more expensive defibrillator because of the fact that we had separated the two device functions. He still has 75% of battery life left in his defibrillator.

Case 3
A 75-year-old African American male with a pre-existing dual-chamber pacemaker for sick sinus syndrome presented with NYHA class III congestive heart failure secondary to severe triple vessel coronary artery disease not amenable to revascularization. He was pacing 100% of the time from his right ventricle. His pacemaker was upgraded to a biventricular defibrillator with insertion of a left ventricular lead and defibrillation coil. The old right ventricular lead was capped. On subsequent follow-up the left ventricular lead was found to have high pacing threshold and a diagnosis of microsloidgment was made. Over the next 2 years, rapid depletion of the ICD battery was noted.

A decision was made to separate the pacing function from defibrillation function by implanting a separate pacemaker on the top of the previous device which was left in place as a back up for defibrillation only. This defibrillator had not yet reached elective replacement index. The right atrial lead, the retained right ventricular lead and the left ventricular lead were connected to the new device, which was used for pacing function only. No device–device interaction was observed on testing. He has done well over a 2-year follow-up.

Case 4
A 57-year-old white male with a history of congestive heart failure secondary to dilated cardiomyopathy, with class III symptoms and LBBB, was admitted with atrial fibrillation with symptomatic pauses. He was implanted a biventricular pacemaker. He was not a candidate for a defibrillator as per the CMS/Medicare guidelines at that time. Subsequently after the publication of SCD-HeFT and according to the recent CMS guidelines, he qualified for an upgrade to a defibrillator. This would have amounted to the removal of recently implanted biventricular pacer and capping of right ventricular lead. We simply decided to place a single-chamber defibrillator on the top of the existing pacemaker for back up defibrillation only. The procedure was performed without any complications and the patient had no problems on follow-up.

Discussion
The number of patients qualifying for either defibrillator or cardiac resynchronization therapy has gone up significantly after the publication of some of the recent landmark trials like SCD-HeFT, DEFINITE, MADIT II, and CARE-HF. These trials have shown significant morbidity and mortality benefits.

A good number of patients who qualify for such devices already have pre-existing pacemakers or defibrillators with significant remaining battery longevity. Instead of replacing an older device with a whole new expensive device, we decided to retain the older device and place a separate device on the top of it (Figure 1) in the same pocket in a ‘piggy-back’ fashion. The aim was to simply separate the pacing from the defibrillation function. The inherent problem with this procedure is the device–device interaction as well as the problem of cosmetic appearance of the device pocket site. Neither of these problems was encountered in this small series of patients.

Device–device interaction was checked both at nominal settings and by presenting the worst case scenario to the defibrillator. The pacemaker was programmed to DOO and a unipolar mode, with a maximum pulse width and output. Ventricular fibrillation was induced which was appropriately sensed and successfully terminated by intracardiac shocks delivered by the defibrillator. Continuous monitoring during and after defibrillation failed to show any device–device interaction. In case of a biventricular pacemaker both the right and left ventricular leads were programmed to a unipolar mode, and a similar protocol was used for defibrillation and once again no interaction was observed. In the case of biventricular defibrillators ‘double counting’ was not observed even in the case in which Y-adapter leads were used. We recommend that bipolar leads be used as in our cases to avoid the potential for device–device interaction with unipolar leads.

Although there is a risk of damaging the leads while replacing either of the devices, no such complications were encountered in two of our patients who underwent successful generator replacements. In some of our cases the defibrillator was placed above and in others below the pacemaker depending upon the patients’ pre-existing device.

The number of patients requiring device replacements in the United States is unknown, but it is presumed that with the expanding implant indications for these devices, more and more patients will qualify for device upgrades. Although an accurate cost-saving assessment cannot be made from this small study, however, on an average, we were able to achieve a cost saving of almost $15 000–20 000 per patient. It is well known that as compared with pacemakers, defibrillator batteries when utilized for pacing as well as
defibrillator function tend to have shorter battery life. By separating these two functions one can achieve a significant longevity of defibrillators thereby saving the trouble of recurrent replacement of these expensive devices.

The only limitation encountered with this procedure is the requirement of two devices from two different device-manufacturing companies. In case the implanted devices are from the same company, only the front one will be recognized by the programmer. This difficulty is encountered on follow-up when two programmers will be required to interrogate these separate devices. This problem will certainly be circumvented with the advent of radio-frequency technology present in the latest devices.

**Conclusion**

We conclude that in some patients who undergo cardiac defibrillator implant with or without cardiac resynchronization therapy and in those who have a preexisting device, the pacing and defibrillation functions can be safely achieved by placing separate device (either a pacemaker or defibrillator) on the top of the existing device. This procedure may not apply to a majority of device-implanted patients; however, it can safely be performed in a selected group of patients and that too without compromising the cosmetic appearance of the device pocket (Figure 2). This procedure may prove to be cost effective both in the short and long term.

**Conflict of interest:** none declared.

**References**