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Cardiac Resynchronization Therapy Defibrillator Treatment in a Child with Heart Failure and Ventricular Arrhythmia

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Cardiac resynchronization therapy (CRT) is a new treatment for refractory heart failure. However, most patients with heart failure treated with CRT are adults, middle-aged or older with idiopathic or ischemic dilated cardiomyopathy. We treated a 12-year-old boy, who was transferred after cardiac arrest, with dilated cardiomyopathy, left bundle-branch block, and ventricular tachycardia. We performed cardiac resynchronization therapy with a defibrillator (CRT-D). After CRT-D, left ventricular ejection fraction improved from 22% to 44% assessed by echocardiogram 1 year postoperatively. On electrocardiogram, QRS duration was shortened from 206 to 144 ms. The patient's clinical symptoms also improved. For pediatric patients with refractory heart failure and ventricular arrhythmia, CRT-D could be indicated as an effective therapeutic option.

Key words: 1. Arrhythmia
2. Heart failure
3. Cardiomyopathy
4. Cardiac resynchronization therapy
5. Defibrillator

Case report

A 12-year-old boy was referred after cardiac arrest. He was previously diagnosed with dilated cardiomyopathy with left bundle-branch block (LBBB) and had a history of cardioversion due to ventricular tachycardia. He was presented to another hospital with cyanosis, altered mental state, pulselessness, and was found to have ventricular fibrillation. Cardiopulmonary resuscitation was initiated and his rhythm was restored. After return of spontaneous circulation, he was transferred to our hospital for further management. He underwent induced hypothermia therapy and recovered consciousness.

Cardiomegaly was found on a posteroanterior chest radiograph (Fig. 1A), and a LBBB pattern and prolonged QRS interval (206 ms) were identified on an electrocardiogram (ECG). Echocardiography revealed an enlarged left ventricle (LV) with an LV end systolic internal dimension of 59.3 mm and severe LV dysfunction with a left ventricular ejection fraction (LVEF) of 22% by Simpson's method. An LV dyssynchrony with septal-to-lateral delay of 220 ms was also found on tissue Doppler imaging (Fig. 2A). The pro-B-type natriuretic peptide was 248 pg/mL.

We performed an elective operation for cardiac resynchronization therapy with a defibrillator (CRT-D) implantation. The patient was too small (body weight of 30 kg) to approach transvenously; thus all procedures were done via median sternotomy under gen-

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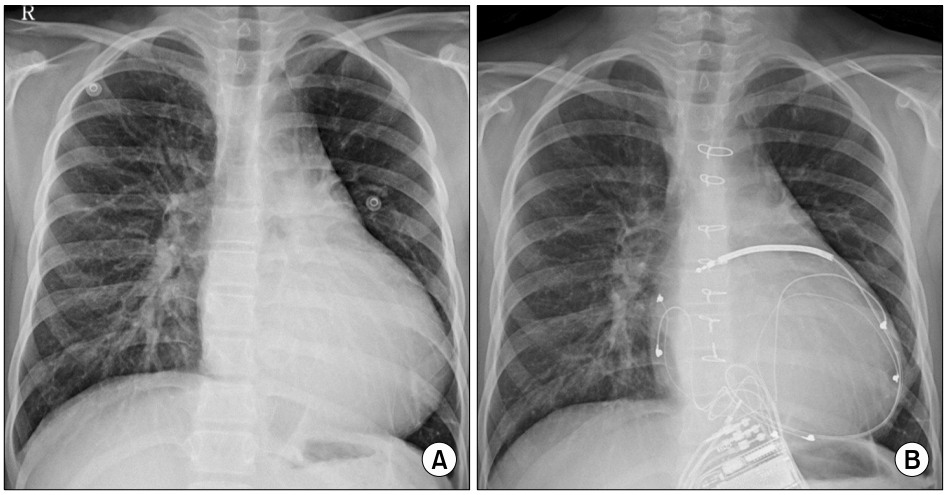

Fig. 1. CR finding of the patient. (A) Preoperative CR showing cardiomegaly due to dilated cardiomyopathy. (B) Postoperative CR showing slightly improved cardiomegaly and an implanted implantable cardioverter-defibrillator lead with a CRT with a defibrillator generator. CR, chest radiography.

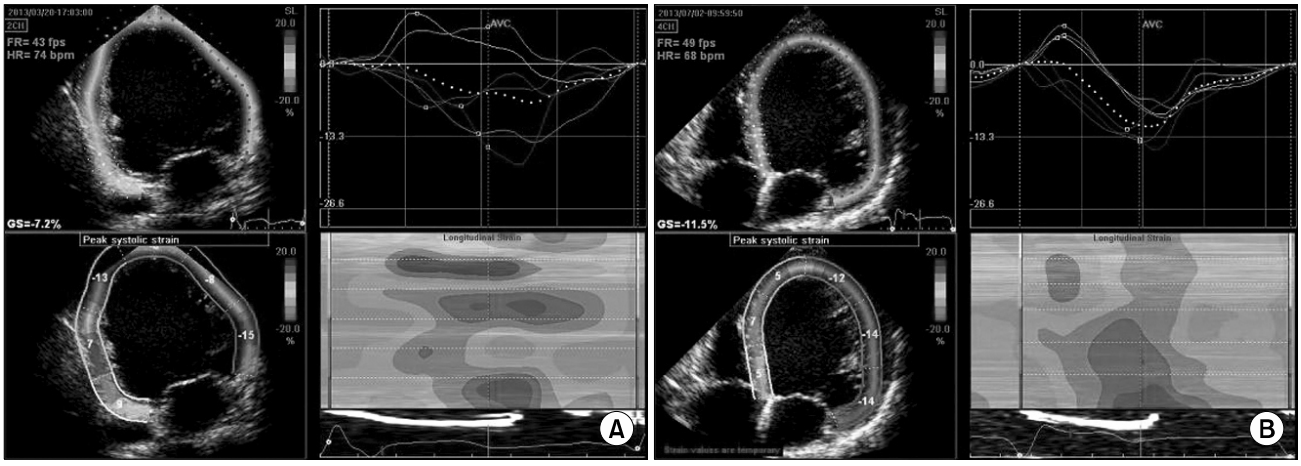

Fig. 2. Tissue strain imaging on echocardiograph. (A) Preoperative imaging showing LV dyssynchrony with significant septal-to-lateral delay. (B) Postoperative imaging showing improved LV synchrony compared with preoperative findings. LV, left ventricle; AVC, aortic valve closure; FR, fractional shortening; HR, heart rate; GS, global strain.

eral anesthesia. We fixed 3 epicardial steroid-eluting bipolar leads as follows: the LV lead to the LV lateral wall near the apex, right ventricular lead to the diaphragmatic surface near the apex, and right atrial lead to the right atrial free wall near the sinoatrial node. An implantable cardioverter-defibrillator (ICD) lead was fixed to the left atrial roof and diaphragmatic pericardium. A CRT-D generator (D354TRG; Medtronic, Dublin, Ireland) was inserted in the left subchondral space above the peritoneum and below the fascia. In cooperation with pediatric cardiologists, the surgeon verified intraoperatively that the lead and ICD were functioning normally using intraoperative transesophageal echocardiography.

Immediate postoperative vital signs were stable. The chest radiograph showed slightly improved cardiomegaly (Fig. 1B). Echocardiography demonstrated LVEF of 30% by Simpson's method and improved LV synchrony with a septal-to-lateral delay of 80–110 ms (Fig. 2B). The LVEF improved up to 44% on postoperative 1-year follow-up echocardiography, and the QRS duration was shortened to 144 ms on ECG. The patient has continued to do well (New York Heart Association [NYHA] class I) without any arrhythmia events so far.

Discussion

CRT is an effective treatment for adult patients with left ventricular failure [1]. Although some benefits were reported in selected patients such as those with pacemaker-induced cardiomyopathy [2], idiopathic dilated cardiomyopathy, or certain forms of congenital heart disease accompanied with systemic ventricular failure, the role of CRT in pediatric patients has not been investigated thoroughly. Currently, CRT is indicated (class I) for patients with NYHA functional class III or IV despite optimized pharmacological therapy, LVEF $<$35%, and QRS duration $>$120 ms. However, it is in question whether these inclusion criteria in adult populations can be applied to pediatric patients [3].

With a lack of studies to support the use of CRT-D in this heterogeneous population with congenital heart disease, the application of CRT alone or CRT-D should be decided case by case. The risk of sudden death associated with arrhythmias must be weighed carefully against the known risk of inappropriate ICD shocks, which was reported to be up to 21% in a large retrospective, multicenter study of ICDs in pediatric and congenital heart disease patients [1].

In this case study, the patient presented with severe LV dysfunction with poor LVEF (22%) and prolonged QRS interval (206 ms). These conditions all met the abovementioned criteria and showed obvious improvement on postoperative 1-year follow-up. The patient was free from arrhythmia requiring cardioversion after CRT-D implantation. The patient had a high risk of sudden death associated with arrhythmia due to his previous history, and thus CRT-D seemed to definitely be indicated for this patient.

In regard to the appropriate placement of CRT leads, a previous study suggested the LV lateral wall to be a 'preferred target area' in patients with wide QRS and LBBB for the best acute hemodynamic results [4]. We followed that approach in this case study.

There have been previous case reports about CRT in pediatric patients [1-3], but as far as we are aware this is the first case report of a successful surgical application of CRT-D in a pediatric patient in Korea. In conclusion, we suggest that CRT-D could be indicated as an effective therapeutic option for pediatric patients with refractory heart failure and ventricular arrhythmia.

Conflict of interest

No potential conflict of interest relevant to this article was reported.

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