Thoracoscopic Patch Insulation for Phrenic Nerve Stimulation after Permanent Pacemaker Implantation

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One of the complications of permanent pacemaker implantation is unintended phrenic nerve stimulation. A 15-year-old boy with a permanent pacemaker presented with chest discomfort due to synchronous chest wall contraction with pacing beats. Even after reprogramming of the pacemaker, diaphragmatic stimulation persisted. Therefore, we performed thoracoscopic phrenic nerve insulation using a Gore-Tex patch to insulate the phrenic nerve from the wire. A minimally invasive approach using a thoracoscope is a feasible option for retractable phrenic nerve stimulation after pacemaker implantation.

Key words: 1. Minimally invasive surgical procedures 2. Phrenic nerve 3. Thoracoscopy 4. Artificial pacemakers

Case report

A 15-year-old boy presented with recurrent chest discomfort for a week. He had undergone Ebstein anomaly repair, tricuspid valve repair, and permanent pacemaker insertion (DDD type, back-up 60 bpm) 3 years earlier because of Ebstein anomaly (Carpentier type B), severe tricuspid regurgitation, atrial septal defect, and second-degree atrioventricular block. At least 3 to 4 times a day, whenever he breathed, the left side of his chest wall twitched for several hours. The pulsation was severe enough to interrupt sleep. Synchronous contractions of the chest and abdominal wall were also noted.

The patient had visited the emergency department in Seoul National University Children's Hospital 3 years earlier for the same characteristic chest pain. The electrocardiogram demonstrated ventricular pacing rhythm, and the pacemaker function was normal. Noninvasive management to modulate pacing settings was attempted. When ventricular output was greater than 3 V, diaphragmatic pacing was performed. Atrial and ventricular pacing outputs were adjusted from 3.5 to 1.75 V and from 3.5 to 1.25 V, respectively. The symptom was relieved, and the child was discharged from the emergency department. Diaphragmatic contractions rarely occurred during the next 3 years, and thus the child was able to sleep well. However, this symptom recurred, and the pacing setting was adjusted again with an output of 1.25 V, impedance of 703 Ω, pulse width of 2.0 mV, and a threshold of 1 V. However, this attempt to adjust the settings...
failed to relieve the patient’s symptoms. There was no evidence of lead fracture based on the impedance measures taken during regular follow-up. Fig. 1 shows the position of the leads at the time of admission.

As noninvasive options failed to relieve the symptoms, we planned an invasive approach, which involved interposing a pericardial patch between the leads and the nerve. We decided on an approach via video-assisted thoracoscopy as a minimally invasive solution. The approach for the video-assisted thoracoscopic surgery port was via the sixth and eighth intercostal spaces. The window (10 mm) for the thoracoscopic port was placed in the mid-axillary line of the eighth intercostal space, and the instrumental port (5 mm) was placed in the posterior axillary line of the sixth and eighth intercostal spaces (Fig. 2). There was moderate adhesion in the thoracic cavity. During the operation, the proximity of the lead tip to the phrenic nerve and diaphragm twitching were observed directly. A longitudinal opening, parallel to the phrenic nerve, was made on the pericardium. After the pericardium was opened, the space between the ventricular lead and the pericardium was dissected. A Gore-Tex patch was thoracoscopically placed under the pericardium to insulate the phrenic nerve from the lead tip. The patch was fixed with Prolene and the pericardium was closed (Fig. 3). After placement of the patch, no more diaphragmatic twitches were visualized. The anesthesia time and operation time were 220 minutes and 155 minutes, respectively.

On the first postoperative day, the chest tube was removed. The patient was discharged uneventfully on the fourth postoperative day, and no further diaphragmatic contraction was noted during 1 month of postoperative follow-up. The final pacemaker parameters measured at 1 month postoperatively were ac-
Thoracoscopic Patch Insulation for Phrenic Nerve Stimulation

Fig. 3. (A) Photo of the thoracoscopic view. (B) The pericardium was dissected from the fibrous tissue around the ventricle lead (arrow). The opening was 3-4 cm away from the phrenic nerve (dashed arrow). (C) The Gore-Tex patch was inserted into the space between the pericardium and the lead. (D) The pericardium was closed, enclosing the patch. After patch placement, no further diaphragmatic pacing was detected.

Discussion

A permanent pacemaker is a useful technique for management of heart block. However, diaphragmatic stimulation is a possible complication [1]. Because the phrenic nerve is located over the lateral surface of the pericardium, diaphragmatic contractions can occur when the nerve is stimulated. These violent contractions result in severe distress to the patient. Noninvasive management includes setting changes. If stimulation is refractory, invasive management such as electrode repositioning or patch insulation should be considered [2]. Moreover, conversion to another method of pacing, such as transvenous pacing, can be considered; however, this patient had Ebstein anomaly, which limited us to using an epicardial lead. Since this patient had undergone previous cardiac surgery, predisposing him to severe adhesion of cardiac structures, repositioning the catheter could have led to clinical deterioration. Moreover, changing the lead position would not have guaranteed absolute cessation of phrenic nerve stimulation while maintaining appropriate pacing. Moreover, there may not have been any appropriate position to which to change the lead. Fibrotic change around the ventricle would have made it difficult to find another such position. There have been efforts to interpose Teflon felt or a patch between electrodes and the pericardium to stop diaphragmatic stimulation [1,3,4]. Phrenic nerve stimulation could be corrected by interposition of a Gore-Tex patch between the pericardium and electrodes rather than repositioning of the tip itself, the latter of which would pose a risk of perforation or bleeding. Even after repositioning of the lead, phrenic nerve stimulation can recur. Therefore, we planned patch insulation rather than lead repositioning. Adhesion in the mediastinum was anticipated, so we planned a thoracoscopic approach. Previous studies have reported that the thoracoscopic approach may be less traumatic [3-5].

To summarize, we report a successful minimally invasive approach to patch insulation for phrenic nerve stimulation after permanent pacemaker implantation. Use of thoracoscopy for inserting patch insulation is an acceptable and feasible option in cases of intractable phrenic nerve stimulation by pacemaker leads.

Conflict of interest

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