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Intratracheal Stenting Under the Aid of Transcutaneous Cardiac Pacing in a Dog with Severe Bradycardic Conduction Defect

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Abstract : A 10-year-old intact female Yorkshire terrier dog (weighing 3 kg) was referred with the primary complaint of severe dyspnea, cyanosis and occasional syncopal episode. Physical examination revealed irregularly irregular bradycardia with persistent pulse deficits. The 12-lead surface ECG showed high grade atrioventricular blocks. Thoracic radiography revealed severe intrathoracic collapse. The dog was successfully treated with an intraluminal self-expanding stent (COOK®) under the aid of transcutaneous cardiac pacing.

Key words **:** Tracheal collapse, intraluminal stenting, transcutaneous cardiac pacing, dog.

Introduction

A pacemaker is a device that delivers battery-supplied electrical impulse through electrodes in contact with the myocardium to produce and artificially triggered depolarization. It is widely used in treating bradycardic heart diseases such as sick sinus syndrome and higher degree heart block (10). Transcutaneous cardiac pacing is a temporary and external type of pacing triggering cardiac conduction through the chest wall using conduction pads attached to the patient chest and connected to a cardiac pacing device (17, 18).

Advantages of transcutaneous pacing are i) it is noninvasive and comparatively easy to perform and requires minimal training, ii) it can be initiated by non-professional staffs (e.g. nurses), iii) it requires very little set-up time, iv) it generally does not include any of the complications associated with invasive techniques, v) it may be used for standby pacing, reducing the need for prophylactic placement of a transvenous catheter, vi) it is especially useful for patients at high risk for infection or bleeding. The major disadvantages of this type of pacing are i) discomfort associated with cutaneous nerve stimulation and skeletal muscle stimulation by electrical current through the chest wall and ii) the substantial cost of pacing device [18].

Tracheal collapse (TC) is characterized by flattened C-shaped cartilaginous tracheal rings and the development of a loose redundant dorsal tracheal membrane, with subsequent tracheal narrowing and obstruction (9). Mild to moderate TC can be managed with weight reduction and medical treatment including bronchodilators and antitussives. However, for the severe or refractory case of TC can be only treated by surgical correction (e.g. plication of the dorsal tracheal membrane, tracheal ring chondrotomy) or non-surgical extraluminal stabilization with polypropylene rings.

Intraluminal prosthetic restoration by using a self-expanding nitinol (nickel-titanium alloy) stent has been used recently to stabilize the collapsed trachea (9, 16). The advantages of this procedure are that it is noninvasive, does not require intensive care after implantation, and takes only 5 to 10 min, depending on the skill of the practitioner, although several complications (e.g. transient coughing, laryngeal spasm, perforation of the tracheal mucosa, stent fracture) due to progressive shortening of the stent have been also reported (11, 16).

Respiratory arrhythmia is the natural cycle of arrhythmia that occurs through the influence of breathing on the flow of sympathetic and vagal impulses to the sinoatrial node. Respiratory arrhythmia can be worsened by severe respiratory diseases (e.g. chronic obstructive pulmonary disease or tracheal collapse). Increased vagal tone by respiratory diseases can cause bradycardic conduction diseases (e.g. atrioventricular heart blocks), which can be worsened by general anesthesia. Therefore careful monitoring including lead II ECG, pulse oximetry, blood pressure and capnography should be accommodated, when the dog with severe respiratory disease are anesthetized. Temporary cardiac pacing is often necessary, if the dog has bradyarrhythmias, to prevent sudden cardiac arrest while the dog is under general anesthesia. This case report described successful placement of intraluminal stent

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for the dog having refractory case of TC under the aid of transcutaneous cardiac pacing.

Case

A 10-year-old intact female Yorkshire terrier dog (weighing 3 kg) was referred with the primary complaint of severe dyspnea, cyanosis and occasional syncopal episode. Before the dog was presented, it was treated with medicines (e.g. aminophylline and hydrocodone) and suffered weight reduction (Hill's w/d) for several months. According to the referring veterinarian, the initial response for this treatment was favorable, but the dog was progressively worse and showed occasional syncopal episode with cyanosis, especially after the excitement. At the presentation, the patient had severe exercise intolerance with cyanosis. In thoracic auscultation, the heart rhythm was irregularly irregular with persistent pulse deficit. However, no murmur was detected in both side of the heart. Complete blood cell count (CBC) and serum chemistry profiles revealed hypoxia (75% SpO_2) and azotemia (urea nitrogen, 50mg/L; creatinine 2.4 mg/L). On the day of presentation, the 12 lead-electrocardiographic (ECG) studies revealed escape beats and severe P and QRS dissociation (atrial rate 120-130 bpm, ventricular rate 40-50 bpm) indicating a third degree atrioventricular (AV) block (Fig 1). On the thoracic radiographs, the trachea was collapsed especially in the thoracic inlet (Fig. 2). There was a mild cardiomegaly (vertebral heart scale = 11), especially in the right atrial area (Fig 2), which was often occurring in the dog with tracheal collapse due to increased pressure in pulmonary arterial vasculature. The collapsed was graded into 4 and 5 depending on the region of the trachea. Based on diagnostic findings, the case was diagnosed as a refractory case of tracheal collapse.

To treat this case, intraluminal stenting using self-expanding nitinol stent was decided after explaining the complications of stenting to the owner. Because the dog was severely bradyarrythmic, the patient heart rhythm was maintained by a temporary transcutaneous cardiac pacing using external pulse generator (Lifepak, Cu-medical system, Korea) to prevent sudden cardiac arrest. The adhesive conduction pads (Cu-medical system, Korea) were attached to the right supracla-

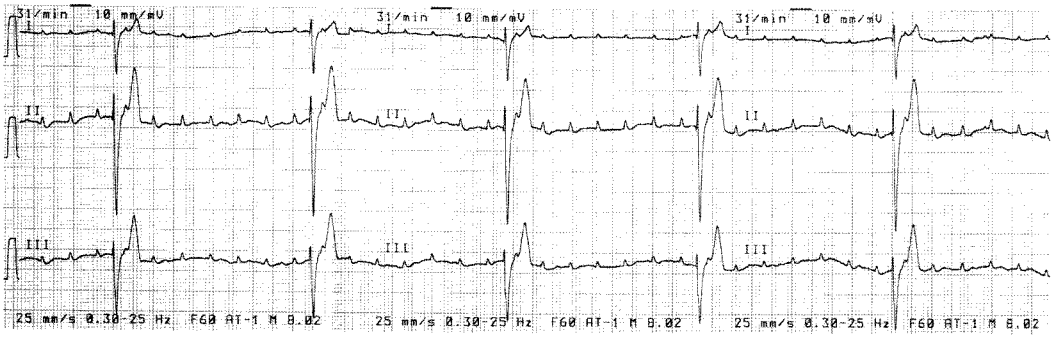

Fig 1. The 12 lead-electrocardiogram (ECG) of this patient recorded at the day of the presentation. The ECG revealed escape beats and severe P and QRS dissociation (atrial rate 135 bpm, ventricular rate 31 bpm) indicating a third degree atrioventricular (AV) block.

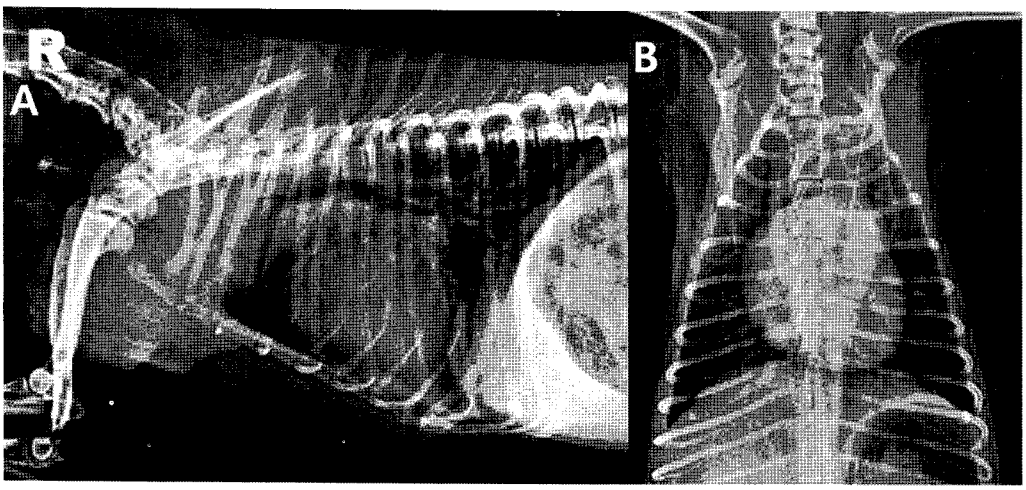

Fig 2. Lateral (A) and dorsoventral (B) thoracic radiography of this case. The trachea was severely collapsed from the caudal aspect of the 3th cervical to the 2nd thoracic vertebra. There was a mild cardiomegaly (vertebral heart scale = 11), especially in the right atrial area, which was often occurring in dog with tracheal collapse due to increased pressure in pulmonary arterial vasculature.

vian and left subclavian area. The mode of cardiac pacing was demand (set starting cardiac pacing when the heart rate of patient is below 100 per minutes) (Fig 4). The electrical current was 2 mA with duration of 1.2 msec and the rate of 135 beats per minutes. After placement of transcutaneous cardiac pacing, the dog was heavily sedated with propofol (5 mg/kg), atropine (0.02 mg/kg) and diazepam (0.2 mg/kg, IV). The dog was intubated with 4.5 Fr intratracheal tube. Using lateral and dorsoventral view of thoracic radiographs with radiographic ruler, the length and diameter of trachea was measured. A 10 mm (diameter) × 80 mm (length) self-expanding intraluminal stent (Zilver® 635 biliary stents, COOK, USA) was selected based on the method described in Moritz *et al* [12] (Fig 3A). The following calculation was used to determine the size of stent: ([Mean tracheal diameter in lateral view + mean tracheal diameter in dorsoventral view] × 2)/ 3.14. The stent was inserted into the intratracheal tube and then released at the 1 cm away from the end of larynx and carina on the fluoroscopy. The trachea was successfully restored and maintained its lumen contour (Fig 3B).

After stent implantation, the cardiac pacing was maintained till the patient became conscious. Although the dog showed mild dry coughing after implantation, the cyanosis was no longer existed even in excitement. However the dry coughing persisted for a month, although the intensity and frequency of coughing were greatly reduced with time. Cough suppressant (methylephedrine, 2 mg/kg BID), prednisolone (0.5 mg/kg BID) and cefazoline (5 mg/kg BID) were administered for 2 weeks, to minimize side effect from metallic stent implantation. The hypoxia was no longer existed after 1 week of implantation (SpO_2: 98%). On the clinical examination at the 4 weeks after implantation, the dog was clinically normal and did not show any clinical signs related to tracheal collapse. However the proximal end of stent was shortened and narrowed while the distal end was not deformed. Tracheoscopy was performed at the 3 month after implantation, the stent except the proximal end appeared to be buried in tracheal stroma. Mild tissue prolifer-

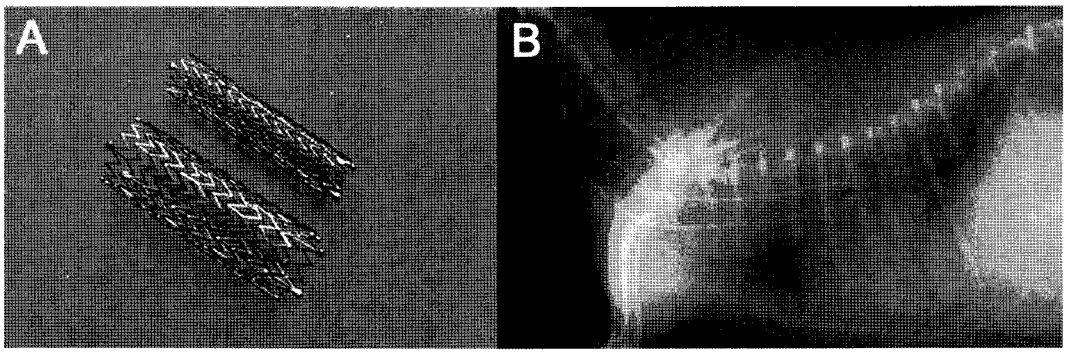

Fig 3. The stent implantation of this case. A: The self-expanding intraluminal stent used for treating tracheal collapse of this case. B: Lateral thoracic radiography showing the successful restoration of the tracheal lumen contour.

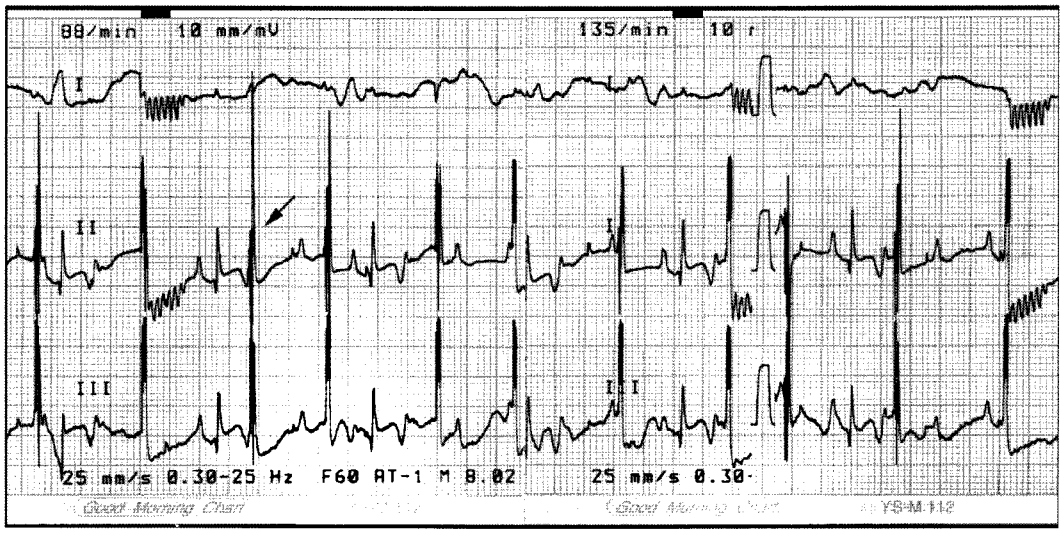

Fig 4. Successful cardiac pacing by transcutaneous pulse generator. The arrow indicates the pacemaker spike from the pulse generator. When the patient's innate heart rate was decreased to 88 beats per minutes, the pulse generate started to pace the heart rhythm at 135 beats per minutes.

ation was observed at the end of stent, although no collapse of fracture of the stent was observed. According to the phone interview with the owner, the dog is still clinically normal and maintains good respiration without coughing or dyspnea.

Discussion

Tracheal collapse is a structural, obstructive airway disease with a dynamic component that can affect the intra- and extrathoracic trachea and mainstem bronchi (7). Many surgical techniques have been described for the refractory case of tracheal collapse (1, 6, 13), although the procedure of extraluminal stabilization is difficult and invasive (12). Unlike extraluminal prosthesis, intraluminal stents can feasibly be used to treat regions of collapse throughout the length of the trachea and mainstem bronchi (7). The implantation of stents is atraumatic, comparatively quick, and technically easy to perform (12). With experience, the implantation of the stent could be performed within 5-15 minutes (4). Intraluminal stabilization of the trachea could be performed along the entire length of the trachea (4, 15). However, implantation of certain intraluminal tracheal stents can be associated with complications and therefore may best be regarded as a salvage procedure for dogs with end-stage disease that are refractory to appropriate medical management, have extensive collapse of the intrathoracic portion of the trachea, or are poor candidates for surgery (9, 11). The reported complications and problems associated with intraluminal stenting are the substantial cost of stent, shortening of stent, transient coughing, laryngeal spasm and perforation of tracheal mucosa (9, 11), which are mostly occurred from the stent migration due to inappropriate selection of intraluminal stent and inaccurate measurement of collapsed tracheal lumen (11). Although most critical problem associated with intraluminal stenting is a laryngeal spasm, it can be prevented if the stent is placed longer than 1 cm away from the larynx (9, 11). Transient dry cough due to stent implantation is a usual complication but can be managed by short-term medication of cough suppressant (9).

External cardiac pacing is indicated in patients who have high risks of cardiopulmonary arrest, especially in emergency situation where medical service from any trained cardiologist is not available, where invasive cardiac pacings are not suitable because of high risk of infections, where the patient is infant or young child, and where the standby use is more appropriate (18). Although the usefulness of transcutaneous cardiac pacing in veterinary field, it has not been well studied, especially the optimal capture threshold which is the minimum amount of electricity that the box has to emit to pace the heart. Recent studies found external pacing in dogs requires 30-100 times greater than internal transvenous pacing (5, 14). Based on human studies, the average current necessary for external pacing is about 65-100 mA in unstable bradycardias and about 50-70 mA in hemodynamically stable patients (8). Furthermore, animal studies have found that stimulation up to 10-20% over the threshold stimulates only the ventricles, while higher amounts are needed to stimulate the atria (5). Although higher energy can increase the efficacy to pace the heart rhythm, it may also increase discomfort for the patient by triggering a muscular twitching or peripheral neuronal sense for pain (3). Unfortunately no study has yet found the optimal capture threshold for dog. In our case, we initially started from 1 mA and found that 2 mA was enough to pace the heart. Because the dig was under general anesthesia, we could not evaluate whether the dog had painful sensation from external electrical stimulation, although the dog was tolerable while in awaking period.

To date, no enzymatic, electrocardiographic, or microscopic evidence of myocardial damage has been found after pacing (dogs and humans) for as long as 60 minutes (2). In addition, one study found that stimulation of the anoxic dog heart during the vulnerable period did not produce ventricular fibrillation (VF) or ventricular tachycardia (VT) unless one was using current that was 10 times higher than pacing threshold (18).

Several suggestions have been recommended to minimize the discomfort by the use of transcutaneous cardiac pacing (18). For instance, placing electrodes over areas of least skeletal muscle can minimize discomfort. Therefore placement is generally best in the midline chest and just below the left scapula (because this is the bony area). The lowest effective current should be used to minimize the discomfort. The echocardiography may be helpful to determine the lowest rate of capture energy. In our case, we used the lowest capture energy and attached conduction pads to the bony area of the chest. Since we mostly used the cardiac pacing for the patient undergoing surgery or intervention with deep sedation or general anesthesia, the discomfort from transcutaneous cardiac pacing was not problematic.

In conclusion, the case report described successful treatment of dog with refractory case of tracheal collapse and bradycardic rhythm disturbances using self-expanding intraluminal stent under the aid of transcutaneous cardiac pacemaker.

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중증 서맥성 전도장애 개에서 피부경유 심박 조절 하에 기관내 스텐트 장착

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10살된 암컷 요오크셔테리어(체중 3 kg)가 심한 호흡곤란, 청색증, 간헐성 발작 증상으로 진료가 의뢰되었다. 신체검사 결과 지속성 맥박결손을 동반한 불규칙 서맥이 부정기적으로 관찰되었다. 심전도 검사에서 고도의 방실차단이, 방사선 검사에서 중증 기관허탈이 진단되었다. 피부경유 심박조절 하에 자동확장 기관내 스텐트를 성공적으로 장착할 수 있었다.

주요어 : 기관허탈, 기관내 스텐트, 피부경유심박조절기, 개