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Imaging Diagnosis using Computed Tomography in Three Dogs with Giant Bullous Emphysema

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Abstract : A miniature pinscher and two Maltese dogs were present with dyspnea, and radiography and computed tomography (CT) were performed. All dogs were diagnosed with giant bullous emphysema of the massive, hyperexpanded, and hypoattenuating bulla causing contralateral mediastinal shift. Giant bullous emphysema, the rarest form of bullous lung disease, is defined as a bulla that fills more than 30% of the hemithorax, and multi-detector CT scanning could provide the useful information to confirm a diagnosis of giant bullous emphysema in older dogs. The radiographic and computed tomographic features for giant bullous emphysema were described.

***Key words* :** MDCT, bullous emphysema, dog.

Introduction

Giant bullous emphysema (GBE), originally described by Burke in human medicine in 1937, is an idiopathic, distinct clinical syndrome of severe progressive dyspnea caused by extensive, predominantly asymmetric upper lobe bullous emphysema, which may eventually lead to respiratory failure (2). It was radiographically defined as bullous emphysema of at least one third of hemithorax by Roberts *et al* (14).

In the veterinary literature, although bullous emphysema is common lung pathology as a cause of pneumothorax (4,11, 17,21), few GBE have been described (7,10,17). This report described the radiographic and computed tomographic features for GBE diagnosed by multi-detector computed tomography (MDCT) in three dogs.

Cases

Three dogs diagnosed with GBE were reviewed. 8-year-old castrated male maltese (dog 1), 12-year-old spayed female miniature pinscher (dog 2), and 10-year-old spayed female maltese (dog 3) had dyspnea, and thoracic radiography and MDCT scan were performed (Table 1).

Right lateral and ventrodorsal radiography of the thorax were obtained by direct digital radiography in dog 1 and computed radiography in dog 2 and 3. In dog 1, the sharply demarcated radiolucency area that fills caudally more than 2/3 of the right hemithorax was shown and results in left cardiac shift. In dog 2, bilateral pneumothorax was detected as a cause of dyspnea. In dog 3, there was a well-defined, air-filled large mass of almost left hemithorax and right shift of the heart and cranial mediastinum (Fig 1).

To evaluate the radiolucent lesions, computed tomography (CT) examinations were performed in dorsal (dog 1) or ventral (dog 2, 3) recumbency under general anesthesia. The positive pressure ventilation was given for breath holding during scanning, but breath holding of dog 2 was not controlled by hyperventilation. Pre and postcontrast images were acquired with iodine contrast media (600-850 mgI/kg, intravenously, Omnipaque®, GE healthcare, Ireland).

CT results were summarized at Table 2. Dog 1 had a thin walled, sharply demarcated giant bulla with maximum length of 7 intercostal spaces (Fig 2). The giant bulla was originated from the right middle lung lobe and lobulated with thin septum, and compressed the right cranial and caudal lung lobes and heart displaced to the left. Compressed lung surrounding bulla had the ground glass opacity. CT images of dog 2 had the motion artifact by uncontrolled breathing. Radiographic air-filled area was identified as pneumothorax. Two thin-walled bulla with length of 2 intercostal spaces from the right caudal lobe and 3 intercostal spaces from the left caudal lobe were also detected (Fig 3). Pneumothorax occupied most of left hemithorax and the remained left lung lobes were collapsed. Right hemithorax had lesser pneumothorax and more inflated lung than right, relatively. It was

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Table 1. Signalment and diagnostic imaging modality

Case No.	Species	Breed	Age	Sex	Imaging Modality
1	Canine	Maltese	8 yrs	Castrated male	Digital radiography[§] MDCT[¶]
2	Canine	Miniature Pinscher	12 yrs	Spayed female	Computed radiography[§§] MDCT[¶¶]
3	Canine	Maltese	10 yrs	Spayed female	Computed radiography[§§] MDCT[¶¶]

[§]Vetter DX 16®, Medien International INC, Korea
[§§]Kodak Point-of-Care CR System®, Kodak, Japan
[¶]LightSpeed®, GE healthcare, USA
[¶¶]Asteion®, Toshiba, Japan

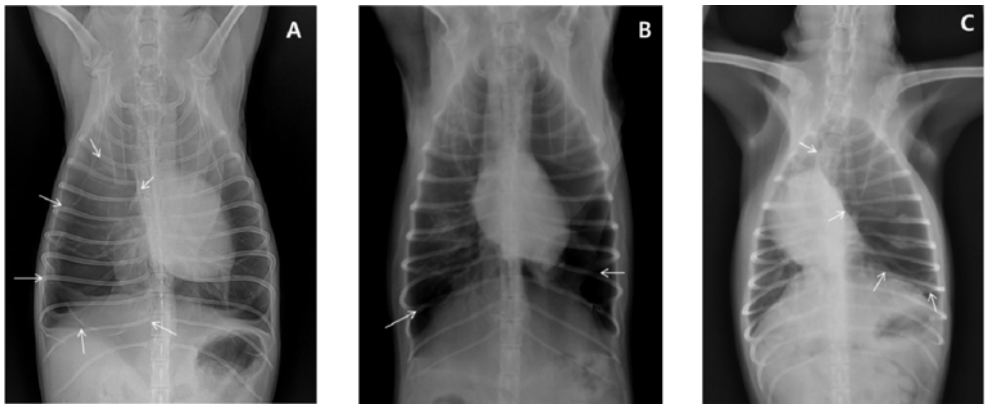

Fig 1. Ventrodorsal thoracic radiography. Thin-walled, sharply demarcated areas of radiolucent mass (arrows) that fills more than 2/3 of the right hemithorax and results in left cardiac shift in dog 1 (A). Air-filled bulla (arrows) on the area of the left caudal lung lobe and pneumothorax were detected in dog 2 (B). There is a large air-filled mass (arrows) of almost left hemithorax and right shift of the heart and cranial mediastinum in dog 3 (C).

Table 2. Computed tomographic features of giant bulla emphysema in three dogs

Case No.	Origin	Maximum Length	Bulla Wall	Cardiac Shift	Compressed Adjacent Lung	Additional Radiolucent Lesion
1	Rt. middle lobe	7 intercostal space	Thin, demarcated, with septum	Left	Increased lung density	None
2	Lt. and Rt. caudal lobe	2 (Rt) and 3 (Lt) intercostal space	Thin, demarcated	No	Collapsed	Pneumothorax
3	Lt. cranial lobe	7 intercostal space	Thin, demarcated	Right	No remarkable change	Bronchiectasis

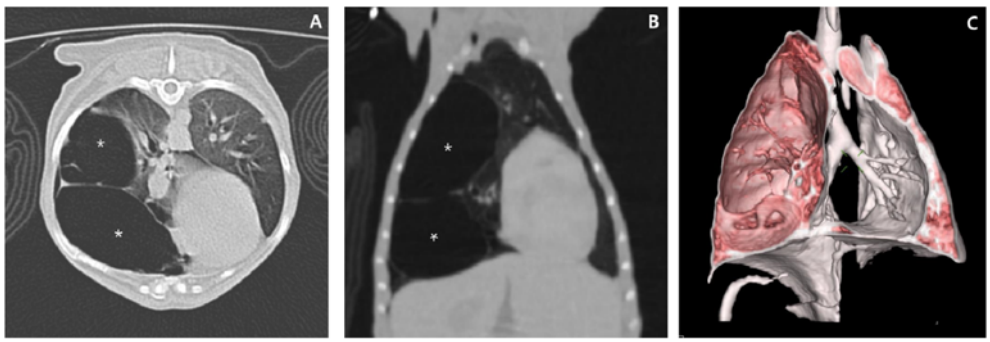

Fig 2. Transverse (A), reformatted dorsal plan images (B) with lung window and 3D reconstruction image (C) by volume rendering technique in dog 1. A lobulated air- filled bullae (*) originated from right middle lung lobe compressing the right cranial and caudal lung lobe and heart.

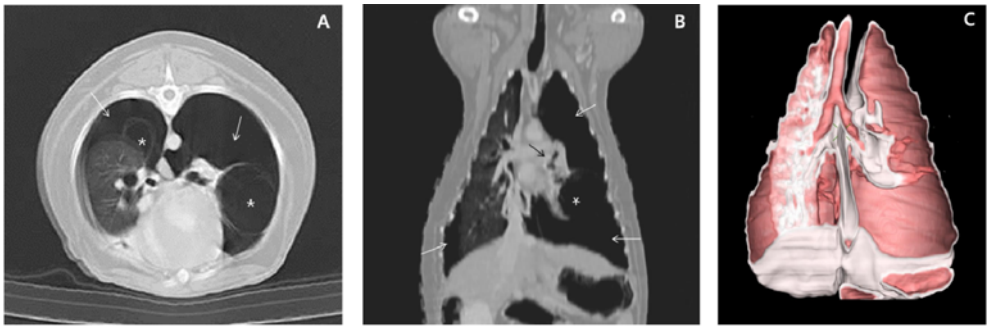

Fig 3. Transverse (A), reformatted dorsal plan images (B) with lung window and 3D image (C) in dog 2. Thin-walled air-filled bullae (*) are located in the left caudal lung lobe and the right caudal lobe, accompanied pneumothorax (white arrows). Left lung lobe is collapsed (B, black arrow).

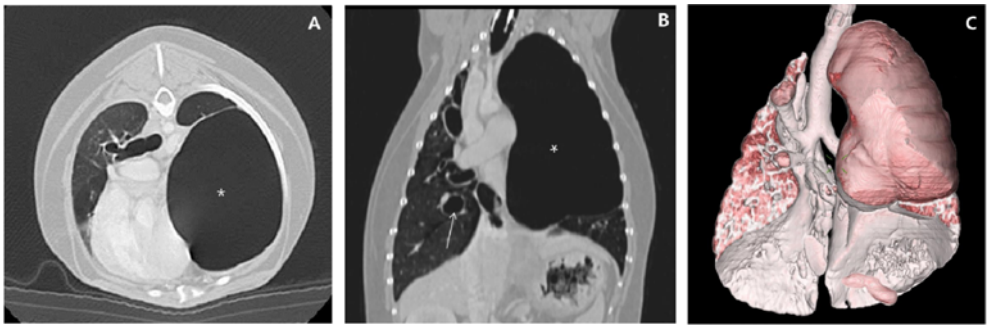

Fig 4. Transverse (A), reformatted dorsal plan images (B) with lung window and 3D image (C) in dog 3. Large air-filled mass (*) compressing the heart is seen in the left cranial lung lobe. Dilated bronchus (arrow) to the right lung lobe is observed.

thought that pneumothorax is induced by the ruptured bulla of left caudal lobe. In dog 3, a large air-filled mass with maximum length of 7 intercostal spaces from the left cranial lung lobe was seen and results in compression of the heart. Dilated bronchus to the right lung lobe was observed (Fig 4).

Dog 2 initially improved after thoracocentesis but the pleural air accumulated repeatedly and the patient died 4 days after diagnosis. Dyspnea in dog 1 partially resolved after oxygenation. Intercostal thoracotomy and lung lobectomy were performed in dog 3. Dog 3 had an uncomplicated recovery and were discharged from the hospital 5 days after surgery. Dog 1 and dog 3 were alive at the time of final follow-up 10 months to 11 months after diagnosis.

Discussion

GBE is a massive, hyperexpanded, and hypoattenuating bulla. In animal, term GBE seldom has been used and just referred as bleb, bulla or bullous emphysema based on size and connection with surrounding lung tissue (6,10). Differences in lesion terminology, lesion description, and histopathological interpretation for bullous emphysema have resulted in conflicting information about pulmonary bleb and bulla lesions (4,5,19,21). In particular, the terms bleb, bulla, and bullous emphysema have been used interchangeably in some reports, making it difficult to determine the specific lesion being described (6). In this study, term GBE defined in human medicine was used by MDCT findings the following large, thin-walled, air-filled structure.

The pathogenesis of pulmonary bleb and bulla lesions as well as GBE in both dogs and humans is not completely understood. Influx of inflammatory cells has been associated with bronchiolitis, bronchiolar wall fibrosis, and destruction of pulmonary parenchyma leading to the formation of emphysematous changes (1). The majority reports of GBE in human have been in association with chronic inhalation of tobacco smoke, with Marfan syndrome or with lung cancer (1,16,18,20).

Pulmonary blebs, bullae or bullous emphysema are found most often in middle to old-aged and middle to large-breed dogs (6,11,12). Three dogs with GBE in this study were old age and small breed. Similarly, GBE tends to be found in older dogs, and the breed distribution could be resulted from geographic population.

On radiography, GBE is represented with large, thin-walled radiolucent structure, but definitive diagnosis occasionally is difficult since air-filled massive lesion could be uncertain. Air-filled mass should be differentiate from pneumothorax by positional radiography, and differential diagnoses for an enlarged, hyperlucent lung lobe on radiography include congenital lobar emphysema, bullous emphysema, and bronchial obstruction due to intraluminal foreign body, extraluminal

compression, or a partial torsion (15). Bullous emphysema is differentiated from congenital lobar emphysema by pulmonary vascular structure (8). Congenital lobar emphysema has been reported in young dogs of the various breeds and most congenital lobar emphysema present with acute dyspnea in the first 6 months of life (15). In 3 geriatric dogs of this study, radiographic findings of GBE were similar with that of congenital lobar emphysema including lobar hyperinflation extending to the lobe margin, contralateral mediastinal shift, and caudal displacement of the diaphragm (8).

Radiographic detection of pulmonary bullae is considered unreliable, but serial radiography may increase the possibility that pulmonary bullae will be detected (21). If the diagnosis on thoracic radiography is uncertain, thoracic CT is recommended. In comparison with radiography, CT has been used in preoperative assessment of patients with bullous emphysema to show the extent and distribution of bullous disease, and also allows assessment of associated diseases such as bronchiectasis, infected cyst, pleural disease, pulmonary artery enlargement, and pneumothorax in human medicine (3,9). In this study, CT showed more details and more accuracy about the distribution, number, size, bulla wall, and surrounding lung tissue of GBE than radiography.

In dog 1, the adjacent lung had ground glass opacity. Differential diagnoses for ground glass opacification include fibrosis, interstitial pneumonia, interstitial inflammation, pulmonary edema, and hemorrhage (13). It was suspected to results from compression and incomplete inflation.

Term GBE has been used little in veterinary literatures, although it is similar with bullous emphysema. In this report, large bullous lesion detected by MDCT was diagnosed with GBE. MDCT could provide the useful information to confirm a diagnosis of GBE in older dogs.

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컴퓨터단층촬영을 이용한 거대 낭포성 폐기종의 진단 3례

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요 약 : 12년령의 미니어쳐 핀셔 1 마리와 각각 8년령, 10년령의 말티즈 2 마리가 호흡곤란을 주증으로 내원하여 흉부 방사선 촬영과 다중검출기 컴퓨터단층촬영을 실시하였다. 컴퓨터단층촬영 시, 호흡의 고정을 위하여 양압환기를 실시하여 무호흡을 유발하였다. 3 증례의 컴퓨터단층영상에서 폐의 과확장된 거대한 낭포성 가스 종괴가 확인되었으며, 종괴에 의한 전종격동 및 심장의 변위가 확인되어, 거대 낭포성 폐기종으로 진단하였다. 거대 낭포성 폐기종은 낭포성 가스 종괴가 동측 흉강의 1/3 이상을 차지하는 것으로 정의되며, 다중검출기 컴퓨터단층촬영을 통한 진단으로 유용한 정보를 획득할 수 있다.

주요어 : 다중검출기 컴퓨터단층촬영, 거대 낭포성 폐기종, 개