Paratracheal air cysts on thoracic multidetector CT: incidence, morphological characteristics and relevance to pulmonary emphysema

H-J BAE, MD, E-Y KANG, MD, H S YONG, MD, Y K KIM, MD, O H WOO, MD, Y-W OH, MD and K W DOO, MD

Department of Radiology, Korea University Guro Hospital, Korea University College of Medicine, Seoul, Republic of Korea

Objective: To determine the incidence, morphological characteristics and relevance of paratracheal air cysts (PTACs) with pulmonary emphysema, as seen on thoracic multidetector CT (MDCT).

Methods: The CT images of 854 consecutive patients who underwent thoracic MDCT during a period of 2 months at our institution were reviewed. 538 of the patients were male and 316 were female. The incidence, size and shape of the PTACs and their relation to pulmonary emphysema were retrospectively analysed.

Results: Among the 854 patients, 69 (8.1%) had PTACs. 37 (6.9%) of the 538 male patients and 32 (10.1%) of the 316 female patients had PTACs. The highest prevalence of PTACs (25 patients, 11.2%) was found in those who were in the sixth decade of life. 48 (69.6%) PTACs measured 3–10 mm at the longest diameter and 33 (47.8%) were elongated on the coronal section images. 12 (17.4%) patients with PTACs had underlying gross morphological emphysema. The relationship between the presence of PTACs and the presence of emphysema and the relationship between the presence of PTACs and the severity of emphysema were not statistically significant. The size of PTACs showed an inverse relation to the severity of emphysema.

Conclusion: The incidence of PTACs was estimated to be much higher than that of previous studies. There was a slight female predilection for PTACs, most commonly found in the sixth decade of life; PTACs mostly measured 3–10 mm and were elongated in shape. The relation of PTACs to gross morphological emphysema was low.

Advances in knowledge: PTACs are not correlated with the presence of emphysema on MDCT.

Received 24 April 2012
Revised 2 October 2012
Accepted 1 November 2012

DOI: 10.1259/bjr.20120218

© 2013 The Authors

Paratracheal air cysts (PTACs) are small air collections in the right paratracheal area at the level of the thoracic inlet. The histopathological diagnosis of PTACs in the reported surgically confirmed cases included tracheal diverticulum, tracheocele, lymphoepithelial cyst and bronchogenic cyst. In all of these cases, the cysts were lined with ciliated columnar epithelia and communicated with the trachea [1–3].

Various causes of PTACs have been suggested [3–12], but only a few reports have mentioned the relationship of PTACs with pulmonary emphysema [8, 13]. Goo et al [8] suggested that there is an association of PTACs with obstructive lung disease and emphysema that is caused by increased expiratory pressures, which results in weakness of the right posterior lateral wall of the trachea at the level of the thoracic inlet. By contrast, a recent study by Buterbaugh and Erly [13] found no association between the presence of emphysematous lung changes and PTACs. The relationship between PTACs and pulmonary emphysema is still a matter of debate.

In daily practice, we occasionally see PTACs on CT scans. However, PTACs have been infrequently described in the radiological literature. Furthermore,

the relationship between PTACs and pulmonary emphysema is still uncertain. The purpose of this study was to determine the incidence and morphological characteristics of PTACs seen on thoracic multidetector CT (MDCT) scans, and the relevance of pulmonary emphysema to PTACs.

Methods and materials

This retrospective study was approved by the institutional review board of Korea University Guro Hospital and the informed consent requirement was waived. Patient confidentiality was guaranteed by using only anonymous data and CT scans.

Patients

This study included a total of 854 consecutive patients who had undergone thoracic MDCT examinations from 1 January 2009 to 28 February 2009; the registered continuous section CT images and 1-mm thin section CT images were available on a picture archiving and communications system (PACS). 538 of the patients were male and 316 were female. 48 patients were aged under 30 years, 50 were aged 30–39 years, 155 were aged

Address correspondence to: Dr Eun-Young Kang. E-mail: keyrad@korea.ac.kr

40–49 years, 223 were aged 50–59 years, 212 were aged 60–69 years and 166 were aged over 70 years (range 18–80 years) (Table 1).

Thoracic multidetector CT examination and CT image analysis

The CT scans were obtained with 16-channel MDCT (Sensation 16; Siemens, Erlangen, Germany) or 64-channel MDCT (Brilliance64™, Philips Medical Systems, Cleveland, OH). All the CT images were registered on a PACS with a 3- or 5-mm section thickness in continuous sections. The thin section images (1-mm section thickness) and coronal reformatted images were also registered on a PACS. The CT images were reviewed with the lung window setting (window width 1500 HU; window length –700 HU) and the mediastinal window setting (window width 440 HU; window length 45 HU).

Two radiologists retrospectively reviewed all the CT scans. The decisions about the CT findings were reached by consensus. All the CT images were reviewed on a PACS using the continuous axial and coronal reformatted images for detecting PTACs.

The PTACs were evaluated for size and shape and the presence of a visible communication with the trachea. The size of the PTACs was measured by the longest diameter on the axial CT images with the lung window setting. The shape of a PTAC was defined using the coronal CT images. Communication with the trachea was detected using all the CT images with all the CT window settings.

The presence or absence of gross morphological emphysema and its extent were analysed on the thin section CT images. The extent of emphysema was determined based on the method developed by Goddard et al [14]. The analysis was performed using scans at five representative pre-selected anatomical levels of both lungs: the apex, the aortic arch, the pulmonary hilum, the middle and lower lobar bronchial bifurcation, and the middle of the lower lobe. We graded each unilateral lung section on a four-point scale: 1, <25%; 2, 25–50%; 3, 50–75%; 4, >75%. We added all 10 section scores, with the score ranging from 0 to 40. The severity of emphysema was graded as mild to severe depending on the CT-determined emphysema scores: mild, <8; moderate, 9–16; severe, >17.

We randomly selected a control group of 69 patients from the 785 patients who did not have PTACs by matching their age and gender with the PTAC group using automated computer software. We compared the

presence of PTACs with the presence of emphysema, the presence of PTACs with the severity of emphysema and the size of PTACs with the severity of emphysema.

Statistical analysis

We used Pearson's χ^2 method to compare the presence of PTACs with the presence of emphysema. The Mann-Whitney *U*-test was used to compare the presence of PTACs with the severity of emphysema, and Spearman's correlation coefficient was used to compare the relationship between the PTAC size and the severity of emphysema.

Results

A total of 69 (8.1%) of the 854 patients had PTACs. 37 (6.9%) of the 538 male patients and 32 (10.1%) of the 316 female patients had PTACs (Table 1).

All 69 patients had one PTAC located in the right posterolateral aspect of the trachea at the thoracic inlet level. Of the 48 patients aged under 30 years, 1 (2.1%) had a PTAC; of the 50 patients aged 30–39 years, 4 (8.0%) had a PTAC; of the 155 patients aged 40–49 years, 13 (8.4%) had a PTAC; of the 223 patients aged 50–59 years, 25 (11.2%) had a PTAC; of the 212 patients aged 60–69 years, 14 (6.6%) had a PTAC; and of the 166 patients aged over 70 years, 12 (7.2%) had a PTAC (Table 1).

11 (15.9%) PTACs were calculated to measure <3 mm on the axial plane, 21 (30.4%) measured 3–5 mm, 27 (39.1%) measured 5–10 mm, 6 (8.7%) measured 10–15 mm, 2 (2.9%) measured 15–20 mm and 2 (2.9%) measured 20–25 mm. 33 (47.8%) PTACs were elongated on the coronal section images, 16 (23.2%) were round, 5 (7.2%) were irregular shaped, 1 was flat and 11 could not be characterised by shape because they were too small. 26 (37.7%) PTACs had communication with the trachea, while 43 (62.3%) did not. Figure 1 shows PTAC which had no visible communication with the trachea and Figure 2 shows PTAC which had communication.

12 (17.4%) of the 69 patients with PTACs had gross morphological emphysema, while 57 (82.6%) did not. The emphysema scores of the 12 patients ranged from 1 to 20 with a mean score of 5.7. Nine patients had mild emphysema, two had moderate emphysema and one had severe emphysema. The presence of a PTAC was not correlated with the presence of emphysema on the CT images ($p=0.5$), and the presence of PTACs was not correlated with the severity of emphysema ($p=0.8$). The

Table 1. Patient demographics and incidence of paratracheal air cysts (PTACs) on thoracic multidetector CT

Age	Males (n=538)		Females (n=316)		Total PTACs
	PTAC presence	PTAC absence	PTAC presence	PTAC absence	
≤29 (n=48)	1	38	0	9	1 (2.1)
30–39 (n=50)	1	27	3	19	4 (8)
40–49 (n=155)	7	81	6	61	13 (8.4)
50–59 (n=223)	11	120	14	78	25 (11.2)
60–69 (n=212)	9	132	5	66	14 (6.6)
70– (n=166)	8	103	4	51	12 (7.2)
Total (n=854)	37	501	32	284	69 (8.1)

Data are given as number or number (percentage).

Table 2. Relationship between the size of paratracheal air cysts (PTACs) and the extent of emphysema on thoracic multidetector CT

Patient number	Gender	Age (years)	PTAC size (mm)	Emphysema score and severity
1	M	66	2.1	20, severe
2	M	72	2.3	11, moderate
3	M	73	2.9	4, mild
4	M	66	3.1	3, mild
5	M	53	4.6	10, moderate
6	F	43	4.8	1, mild
7	M	50	6.1	2, mild
8	M	52	6.3	8, mild
9	M	54	12.7	3, mild
10	M	80	12.7	2, mild
11	F	73	16.1	2, mild
12	M	74	21.4	2, mild

size of PTACs showed an inverse relationship with the severity of emphysema ($p=0.015$) (Table 2).

All 69 patients with a PTAC had no history of trauma. There was no soft-tissue emphysema, or visible pneumothorax or pneumomediastinum on the thoracic MDCT scans.

Discussion

PTACs are rather frequently detected on thoracic MDCT in daily practice. In previous radiological reports, the incidence of PTACs was 2% according to Goo et al [8] and 3.7% according to Buterbaugh and Erly [13]. However, in our study, the incidence of PTACs was higher: 8.1% in daily practice. The higher incidence in our study was likely to be because of the advanced CT technology we used, resulting in thinner sections and a higher spatial resolution, rather than a true increase in incidence.

The size of the PTACs in our study ranged from 1.5 to 24.0 mm on the axial plane, and 26 (37.7%) PTACs showed communication with the trachea. Goo et al [8]

reported paratracheal cysts measuring 5–20 mm, 8% of which had a tracheal communication, while Buterbaugh and Erly [13] reported paratracheal cysts measuring 1–10 mm, 34.6% of which had a tracheal communication. The difference between our study and that of Goo et al [8] was that detection of smaller cysts and fine communication was possible in our study, owing to our use of advanced CT technology, which resulted in thinner sections and higher spatial resolution.

The causes of PTACs are diverse, and include obstructive lung disease and emphysema from weaknesses in the right posterior lateral wall of the trachea [8], congenital right-sided tracheal diverticula [10, 14], right-sided recurrent laryngeal nerve paralysis [11] and difficult intubation [12].

Buterbaugh and Erly [13] suggested that there was no relationship between trauma and PTACs. None of the patients with PTACs in our study had a history of trauma, subcutaneous emphysema or visible pneumothorax or pneumomediastinum. Therefore, we also suggest that there is no relationship between trauma and PTACs.

The high incidence of PTACs among patients in the sixth decade of life in our study also indicates that a congenital cause of PTACs is unlikely.

The relationship between PTACs and pulmonary emphysema is still a matter of debate. Goo et al [8] suggested that there is an association with obstructive lung disease and emphysema, and that this is caused by increased expiratory pressures resulting in weakness of the right posterior lateral wall of the trachea at the level of the thoracic inlet. By contrast, in the study by Buterbaugh and Erly [13], no association was found between the presence of emphysematous lung changes and PTACs. In our study, the proportion of associated emphysema in the patients with PTACs was 17.4%, which is relatively low, and the mean severity of the emphysema associated with PTACs was estimated to be mild. The size of PTACs showed an inverse relationship with the severity of emphysema in the 12 patients who had both PTACs and emphysema, but the number of these patients was too small for this to be taken as a true

(a)

(b)

Figure 1. A paratracheal air cyst in a 73-year-old female with pulmonary tuberculosis. The axial CT (a) and coronal CT (b) images show a round paratracheal air cyst measuring 16.1 mm in the right posterolateral aspect of the trachea at the level of the thoracic inlet. There is no visible communicating channel (arrow) with the trachea. Minimal emphysema was noted on the additional thin section CT images.

(a)

(b)

Figure 2. A paratracheal air cyst in a 54-year-old male with lung cancer. The axial CT (a) and coronal CT (b) images show an elongated paratracheal air cyst measuring 12.7 mm in the right posterolateral aspect of the trachea at the level of the thoracic inlet. There is a visible communicating channel (arrow) with the trachea. Minimal emphysema was noted on the additional thin section CT images.

inverse relationship; instead, this relationship should be taken as not significant. Therefore, the relationship of PTACs to gross morphological emphysema is of low significance.

There were a few limitations to our study. First, pathological confirmation was not performed in all cases. The pathological results of PTACs could not be obtained in practice because the PTACs were always an incidental finding. Second, there may be doubt as to whether our patient group represents the general population because the patients who underwent thoracic CT may have had some symptoms. However, this study group more obviously reflects routine daily practice. Third, clinical information such as spirometry was not available in this study and the relationship between PTACs and obstructive lung disease was not assessed. We compared only the relationship between PTACs and gross morphological emphysema seen on CT scans. Radiologists and physicians generally detect morphological gross emphysema rather than physiological obstructive lung disease on thoracic MDCT.

In conclusion, PTACs were seen frequently on thoracic MDCT scans in daily practice. They showed a slight female predilection and were most commonly found in patients in the sixth decade of life. The PTACs were always located in the right posterolateral aspect of the trachea at the thoracic inlet level, and were mostly 3–10 mm in size and elongated in shape. The relationship of PTACs with gross morphological emphysema and trauma is of low significance.

References

1. Tanaka H, Igarashi T, Teramoto S, Yoshida Y, Abe S. Lymphoepithelial cysts in the mediastinum with an opening to the trachea. *Respiration* 1995;62:110–13.
2. Tanaka H, Mori Y, Kurokawa K, Abe S. Paratracheal air cysts communicating with the trachea: CT findings. *J Thorac Imaging* 1997;12:38–40.
3. Infante M, Mattavelli F, Valente M, Alloisio M, Preda F, Ravasi G. Tracheal diverticulum: a rare cause and consequence of chronic cough. *Eur J Surg* 1994;160:315–16.
4. Mackinnon D. Tracheal diverticula. *J Pathol Bacteriol* 1953;65:513–17.
5. Collins MM, Wight RG. Posterior tracheal wall diverticula: an unexpected finding. *J Laryngol Otol* 1997;111:663–5.
6. Frenkiel S, Assimes IK, Rosales JK. Congenital tracheal diverticulum. A case report. *Ann Otol Rhinol Laryngol* 1980;89:406–8.
7. Glazer HS, Mauro MA, Aronberg DJ, Lee JK, Johnston DE, Sagel SS. Computed tomography of laryngoceles. *AJR Am J Roentgenol* 1983;140:549–52.
8. Goo JM, Im JG, Ahn JM, Moon WK, Chung JW, Park JH, et al. Right paratracheal air cysts in the thoracic inlet: clinical and radiologic significance. *AJR Am J Roentgenol* 1999;173: 65–70.
9. Restrepo S, Villamil MA, Rojas IC, Lemos DF, Echeverri S, Triana G, et al. Association of two respiratory congenital anomalies: tracheal diverticulum and cystic adenomatoid malformation of the lung. *Pediatr Radiol* 2004;34:263–6.
10. Early EK, Bothwell MR. Congenital tracheal diverticulum. *Otolaryngol Head Neck Surg* 2002;127:119–21.
11. Caversaccio MD, Becker M, Zbaren P. Tracheal diverticulum presenting with recurrent laryngeal nerve paralysis. *Ann Otol Rhinol Laryngol* 1998;107:362–4.
12. Davies R. Difficult tracheal intubation secondary to a tracheal diverticulum and a 90 degree deviation in the trachea. *Anaesthesia* 2000;55:923–5.
13. Buterbaugh JE, Erly WK. Paratracheal air cysts: a common finding on routine CT examinations of the cervical spine and neck that may mimic pneumomediastinum in patients with traumatic injuries. *AJNR Am J Neuroradiol* 2008;29: 1218–21.
14. Goddard PR, Nicholson EM, Laszlo G, Watt I. Computed tomography in pulmonary emphysema. *Clin Radiol* 1982;33:379–387.