

CT Findings of Bronchioloalveolar Carcinoma: Correlation with Pathology*

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Bronchioloalveolar cell carcinoma is a controversial primary malignant pulmonary neoplasm, with varied growth patterns, mixed histologic features, and various clinical and radiologic presentation. Bronchioloalveolar carcinoma can be defined as a peripheral, well differentiated neoplasm, arising beyond a recognizable bronchus, with a tendency to spread locally in a peripheral air space, using the lung structure as stroma(1-4).

The features of bronchioloalveolar carcinoma on CT scans have not been extensively described in the literature, and there are only a few reports about the role of CT in the differentiation of the solitary from the diffuse type(5). Characteristic CT features are reported in the solitary nodular type(6) and the lobar consolidation type(7,8). The capability of mucin production in bronchioloalveolar carcinoma is known to incur characteristic clinical(9,10) and radiological findings on CT(8). With the review of CT scans of 26 patients with bronchioloalveolar carcinoma, we describe CT findings of various involvement types and intend to correlate those CT findings with the

ability of mucin production by the tumors.

MATERIALS AND METHODS

We reviewed CT scans of 26 patients with pathologically proven bronchioloalveolar cell carcinoma studied from 1984 to 1990. The twenty-two patients consisted of 15 females and 11 males, ranging in age from 36 to 76 years (mean age, 60 years).

The diagnosis was based on lobectomy in 12 patients, transbronchial biopsy in 12, open lung biopsy in one and percutaneous needle aspiration biopsy in one. The pathologic designation of bronchioloalveolar carcinoma was based on the generally accepted criterion of a typical growth of cuboidal or columnar tumor cells along alveolar or fibrovascular septa with preservation of the underlying architecture (1-2,7,11). Of 18 patients that had pathologic slides reviewed, the tumors were classified into two types, mucinous and non-mucinous differentiation.

CT scans were obtained with a CT/T 9800 scanner (General Electric Medical System, Milwaukee) in 17 patients. In the remaining patients, CT scan were

Index Words: Lung, CT 60.1211

Lung neoplasms 60.3216

Lung neoplasms, CT

*본 논문은 한국 방사선 연구재단의 보조를 받은것임

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이 논문은 1991년 5월 28일 접수하여 1991년 9월 18일에 채택되었음

Received May 28, Accepted September 18, 1991

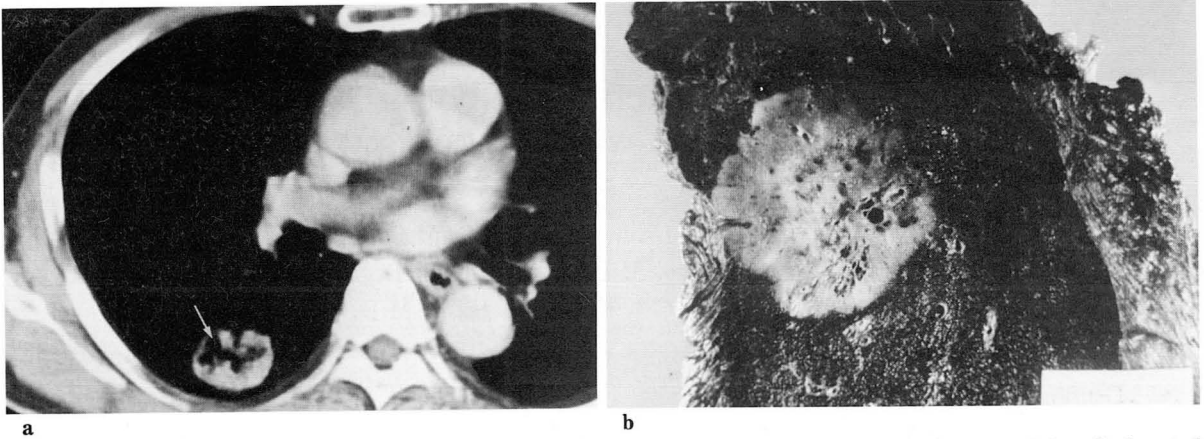


Fig. 1. 64-year-old male with solitary nodular bronchioloalveolar carcinoma. (a) CT scan shows peripherally located tumor mass which contains pseudocavitation: gaseous space showing tubular or septated appearance(arrow). (b) Cutsurface of the resected right lower lobe shows dilated airways within the partly hemorrhagic tumor.

performed with various equipment such as Somatom DR or Somatom 2 (Siemens, West Germany) or Technicare Delta scan 2060 scanner (Technicare, ohio). A bolus injection of 100ml of contrast media(Telebrix-30) was given in all patients.

We evaluated the CT findings in reference to the location of the tumor, the presence of pseudocavitation, heterogeneous low attenuation, irregular margins and pleural tag in the nodular form. The presence of the "CT-angiogram sign", homogeneous low attenuation, bronchovascular stretching, undulating border and air-bronchogram were evaluated in the consolidation type. CT patterns were classified into nodular and consolidation types. The two types were correlated with clinical sputum production, pathological evidence of mucin production, CT evidence of visible enhanced pulmonary vessels, and the CT angiogram sign(8).

RESULTS

The most common symptom was cough, followed by sputum production. Six patients had profuse sputum and at bronchoscopy eight patients had excessive frothy secretion within the lobar bronchi. All eight patients with profuse sputum had consolidation type on CT scan. Other clinical symptoms were dyspnea on exertion(5/22), chest pain(4/22), weight loss(2/22), fever and chill(2/22), fatigue and generalized weakness(2/22).

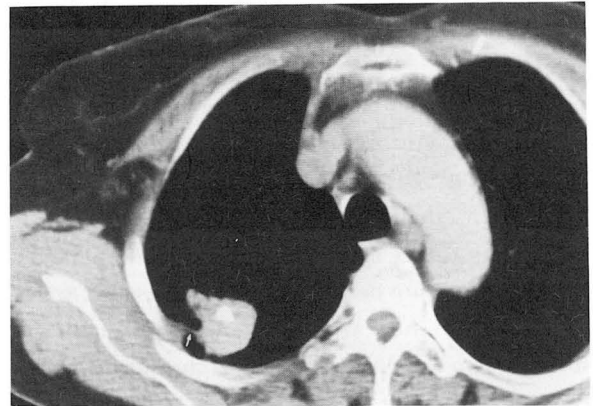


Fig. 2. 68-year-old female patient with purulent sputum and right anterior chest pain. About 3cm sized nodule is seen in the posterior segment of the right upper lobe. Tumor mass shows peripheral location, pleural tag(arrow), irregular margin and calcification. The calcification is thought to be a engulfed calcification.

Presenting CT patterns were localized in 11 patients and diffuse in 15 patients. Localized lesions were mostly of the nodular type(7/11), while diffuse lesions were mostly of the consolidation type(11/15) (Table 1).

CT characteristics of eight patients with the nodular type were peripheral subpleural location(8/8), irregular margin(6/8), pleural tag(5/8), heterogeneous attenuation(4/8) and pseudocavitation(2/8). CT findings of 18 patients with the consolidation type were visible enhancing pulmonary vessels within the low attenuation background(The "CT-angiogram sign") in 15 patients, undulating border in 17, air-bronchogram in 14 and bronchovascular stretching



Fig. 3. 50-year-old female with profuse sputum and dyspnea. Post contrast CT scans shows homogeneous consolidation of the right upper lobe. The consolidative lung shows low attenuation compared with that of the muscle. Segmental bronchi within the lesion is patent and run parallel with the enhanced vessel. The air-bronchogram, "CT-angiogram", and bronchovascular stretching are clearly seen. The margin of the consolidative lung is undulating.

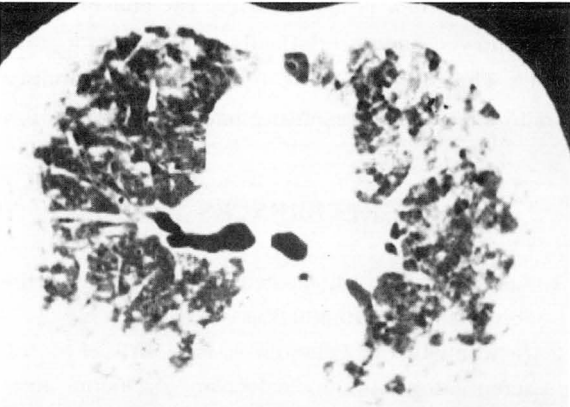


Fig. 4. 67-year-old male patient with diffuse bronchioloalveolar carcinoma. CT scan shows multiple nodular lesions mixed with consolidative lesion.

Table 1. Presenting CT Patterns of 26 Patients with Bronchioloalveolar Carcinoma

Patterns	No. of patients	Total
Localized		11
Nodular type	7	
Lobar consolidation type	4	
Diffuse		15
Nodular type	1	
Lobar consolidation type	11	
Mixed	3	
Total		26

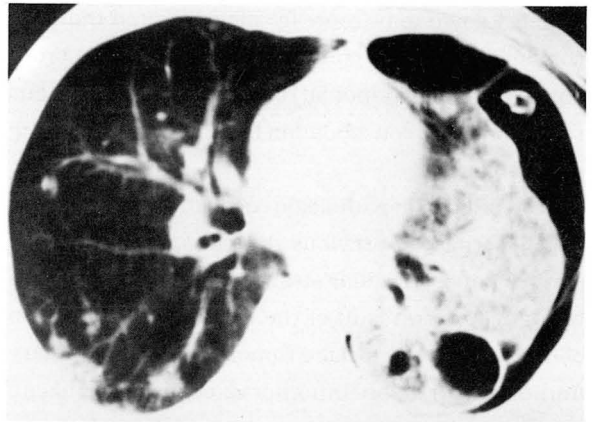


Fig. 5. 50-year-old male patient with diffuse bronchioloalveolar carcinoma. CT scan shows spontaneous pneumothorax in left side, and also shows consolidative lesion.

Table 2. CT Findings of Lobar Bronchioloalveolar Carcinoma

(N = 18)

Findings	No. of cases (%)
Low attenuation	15 (83%)
CT-angiogram sign	15 (83%)
Undulating border	17 (94%)
Air-bronchogram	14 (77%)
Bronchovascular stretching	10 (56%)
Calcification	2 (11%)
Accompanied other findings	
pleural effusion	2 (11%)
pneumothorax	1 (5%)

in 10 patients (Table 2).

On microscopic examination, 8 patients showed mucinous differentiation, all of whom showed lobar consolidation on CT scan. of the 10 patients with non-mucinous differentiation 8 showed nodular lesions on CT scan.

DISCUSSION

Bronchioloalveolar carcinoma represents an estimated 6%-9% of primary lung cancers (5,9,12) and this tumor may present as a solitary nodule, patchy or diffuse pneumonic infiltration, diffuse consolidation or multinodular lesions (12-16). We categorized our cases as localized and diffuse lesions, nodular and consolidative lesions. The localized mass

type is known to be more frequently found than the consolidation type, comprising 43-79% of all bronchioloalveolar carcinoma(15,17,18). However, in our cases the lobar consolidation form outnumbered the nodular form.

The radiologic-pathologic correlation of the tumor was described in previous reports(4,13,14,19). The pleural tag or irregular strands from the tumor was thought to be a result of the desmoplastic reaction of the peripherally located tumor. And the secondary findings such as pneumothorax or pleural effusion also seems to appear due to the peripheral location of this tumor(12,13). Pseudocavitation in the lesion was thought to be the result of the propensity of the tumor to proliferate along the walls of alveolus without destruction of lung architecture and represents alveolar spaces which are not involved by tumor(1,6,11,13-15).

Our previous study(8) documented visible enhanced pulmonary vessels within the low density consolidation, the "CT-angiogram sign", as a specific sign for lobar bronchioloalveolar carcinoma. Nine and ten of the 11 cases of bronchioloalveolar carcinoma showed angiogram sign on CT, while 23 and 25 of the 26 cases of the consolidative lesion without bronchioloalveolar carcinoma did not show the sign. We suggested that the ability for the tumor cells to produce mucin as a main reason for the angiogram sign. The result of our current study suggests that the ability to produce mucin not only affects the "CT-angiogram sign" but also affects the presenting pattern of the tumor. All 8 patients with mucinous differentiation had the consolidation pattern, while 8 of 10 patients with nonmucinous differentiation had the nodular pattern on CT. These results explains in part why the "CT-angiogram sign" is visible only in the lobar consolidation type.

Since Liebow(1) coined the term bronchioloalveolar cell carcinoma, this entity has remained the subject of considerable controversy and interest to the clinician, pathologist and radiologist. He suggested this term because two cell types— one cuboidal, resembling alveolar type II pneumocytes and the other columnar, similar to bronchial walls— could be found growing along the overall lung ar-

chitecture. Several authors have observed two patterns of differentiation: a mucinous type, several cases of which have been shown to correspond to metaplastic bronchiolar goblet cell differentiation by electron microscope, and a non-mucinous type which in several reports appeared to correspond ultrastructurally to the type II pneumocyte or the Clara cell differentiation(1-2,12,14,18-20). In the study with 135 cases by Elson et al., mucinous differentiation was defined as the presence of tall columnar tumor cells with basally located nuclei and obvious intracellular mucin. Non-mucinous differentiation was defined as the presence of cuboidal to low columnar tumor cells lacking the above cytoplasmic features and the cells in this group showed a hobnail pattern(20).

Conclusively, typical CT appearances of the nodular form of bronchioloalveolar carcinoma were peripheral mass, pleural tag, heterogeneous attenuation and pseudocavitation, while the consolidation form showed characteristically the "CT-angiogram sign". The ability for the tumor cells to produce mucin affects the presenting pattern of the tumor.

REFERENCES

1. Liebow AA. Bronchiolo-alveolar carcinoma. *Adv Intern Med* 1960;10:329-358
2. Schraufnagel D, Peloquin A, Pare JAP, et al. Differentiating bronchioloalveolar carcinoma from adenocarcinoma. *Am Rev Respir Dis* 1982;125: 74-79
3. Ludington LG, Verska JJ, Howard T, et al. Bronchiolar carcinoma(alveolar cell), another greater imitator; a review of 41 cases. *Chest* 1972;61:622-628
4. Edward CW. Alveolar carcinoma: a review. *Thorax* 1984;39:166-174
5. Metzger RA, Muhern CB, Arger PH, et al. CT differentiation of solitary from diffuse bronchioloalveolar carcinoma. *J Comput Assist Tomogr* 1981;5:830-833
6. Kuhlman JE, Fishman EK, Kuhajda FP, et al. Solitary bronchioloalveolar carcinoma: CT criteria. *Radiology* 1988;167:379-382
7. Im JG, Choi BI, Park JH, et al. CT findings of lobar bronchioloalveolar carcinoma. *J Comput Assist Tomogr* 1986;10:320-322

8. Im JG, Han MC, Yu EJ, et al. Lobar bronchioloalveolar carcinoma: "angiogram sign" on CT scans. Radiology 1990;176:749-753
9. Epstein DM, Geftter WB, Miller WT. Lobar bronchioloalveolar cell carcinoma. AJR 1982;139:463-468
10. Marcq M, Galy P. Bronchioloalveolar carcinoma: clinicopathologic relationships, natural history, and prognosis in 29 cases. Am Rev Resp Dis 1973;107:621-629
11. Belgrad RB, Good CA, Woolner LB. Alveolar-cell carcinoma (Terminal bronchiolar carcinoma): a study of surgically excised tumors with special emphasis on localised lesions. Radiology 1962;79:789-798
12. Watson WL, Farpour A. Terminal bronchiolar or "alveolar cell" cancer of the lung. Cancer 1966;19:776-780
13. Shapiro R, Wilson GL, Yenser R, et al. A useful roentgen sign in the diagnosis of localised bronchioloalveolar carcinoma. AJR 1972;114:516-524
14. Hill CA. Bronchioloalveolar carcinoma: a review. Radiology 1984;150:15-20
15. Tao LC, Weisbrod GL, Pearson FG, et al. Cytologic diagnosis of bronchioloalveolar carcinoma by fine-needle aspiration biopsy. Cancer 1986;57:1565-1570
16. McNamara JJ, Kingsley WB, Paulson DL, et al. Alveolar cell(bronchiolar) carcinoma of the lung. J Thorac Cardiovasc Surg 1969;57:648-656
17. Manning JT, Spijut HJ, Tschen JA. Bronchioloalveolar carcinoma: the significance of two histologic types. Cancer 1984;54:523-534
18. Berkmen YM. The many faces of bronchioloalveolar carcinoma. Semin in Roentgenol 1977;12:207-21
19. Elson CE, Moore SR, Johnson WW. Morphologic and immunocytochemical studies of bronchioloalveolar carcinoma at Duke University Medical Center, 1968-1986. Analytical and quantitative cytology and histology. 1989;11(4):261-274
20. Clayton F. Bronchioloalveolar carcinomas; cell types, patterns of growth and prognostic correlates. Cancer 1986;57:1555-1564
21. 정종구, 박규일, 윤엽 등. 세기관지세포암의 방사선학적 소견. 대한방사선의학협회지 1986;22:469-473

<국문 요약>

미세기관지폐포암의 전산화 단층촬영 소견 : 병리조직학적 유형과의 상관관계*

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유은주 · 임정기 · 한춘환 · 윤혜경 · 안인옥** · 이경환 · 이 구 · 한만청 · 박인애*** · 함의근***

세기관지폐포암은 다양한 병리조직학적, 방사선학적 소견을 보이는 원발성 종양이다. 세기관지폐포암으로 진단된 26명의 전산화단층촬영(CT) 소견을 분석하여 CT소견과 종양의 병리조직학적 특징과의 상관관계를 알아보고자 하였다. 남자가 11명, 여자가 15명이었으며 36세부터 76세까지의 연령분포를 보였다. 진단방법은 폐절제술 12예, 경기관지 생검 12예, 그리고 개흉폐생검과 경피세침흡인생검 각각 1예였다. CT상 먼저 결절형과 경결형으로 구분하였으며, 다시 각각을 국소형과 미만형으로 구분하였다. 18예에서 병리조직학적 점액생성형 분화 여부를 재분석하였다.

CT상 11예에서는 국소형, 15예에서는 미만형을 보였으며 국소형은 대부분 결절형이었고(7/11) 미만형은 대부분 경결형이었다. 아주 많은 객담을 보인 8명은 모두 경결형이었다. 8예의 결절형 세기관지폐포암은 CT상 변연부 늑막하 위치(8/8), 불규칙한 경계(6/8), pleural tag(5/8), 비균질적 농도(4/8), 위공동화(2/8)를 보였으며, 18예의 경결형에서는 "CT-angiogram sign"(15/18), 파상의 경계(17/18), 공기기관지음영(14/18), 기관지와 혈관의 압박(10/18)이 보였다. 점액생성형 분화를 보인 8예는 CT상 모두 엷성 경결을 보였으며 점액비생성형 분화를 보인 10예중 8예가 결절형을 보였다.

결론적으로 세기관지폐포암은 병리조직학적 유형별로 비교적 특징적인 전산화단층촬영 소견을 나타내며 점액을 생성하는 종양세포의 경우 종양의 발현시 방사선학적 소견에 영향을 미침을 알 수 있다.