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Study on 256-slice spiral CT bronchial artery imaging of common pathological types of central-type lung cancer

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Abstract. – OBJECTIVE: In this study, we analyzed features of 256-slice spiral CT bronchial artery imaging in common pathological types of central-type lung cancer to provide a reference for clinical diagnosis.

PATIENTS AND METHODS: 74 patients diagnosed as central-type lung cancer were selected. They included 34 cases of squamous carcinoma and 40 cases of non-squamous carcinoma. 256-slice spiral CT bronchial artery imaging examination was performed for patients in the two groups. The 3D reconstruction technique was used in a stand-alone workstation, using different rotation axis to observe space anatomical details of the bronchial artery and to compare development ratio of the bronchial artery, artery diameter, diameter of tumor and developing condition of the pulmonary artery.

RESULTS: It was found that left side, right side and both sides developing ratios of a bronchial artery in the squamous carcinoma group were higher than the other group. Moreover, the average diameter of the artery and diameter of the tumor was significantly higher than non-squamous carcinoma group. The occurrence rates of compression and narrowing on the pulmonary arterial branch at tumor side were significantly increased ($p<0.05$).

CONCLUSIONS: There were different 256-slice spiral CT bronchial artery imaging results for different pathological types of central-type lung cancer, which has a certain reference value for clinical diagnosis.

Key Words:
256-slice spiral CT, Bronchial artery imaging, Central-type lung cancer.

Introduction

Lung cancer has the highest incidence and death rate in the respiratory system, which is more prevalent in males than females[1]. Central-type lung cancer refers to bronchiolar carcinoma in the lobar bronchus, bronchus and segmental bronchi and most of them are squamous carcinoma and undifferentiated carcinoma. Previously, a bronchoscopic biopsy was used clinically to confirm the disease pathology, with a positive rate about 70-85% with a certain rate of missed diagnosis, which cannot provide complete references for further treatment[2]. With the development of imaging, digital subtraction angiography has become the "gold standard" in angiography. However, it has several drawbacks which hinder its popularity, e.g. invasive, limited examination range, high technical requirements, long examination time, and exposure risk for users[3]. Multi-slice spiral CT has a large range of plain scan and angiography can be enhanced under contrast medium, especially 256-slice CT, which has shorter scanning time, more slices and clearer imaging. It helps the origin, running and compression of the pulmonary artery and bronchial artery, which can be shown directly in 3D through post processing technique. Also, it has good reproducibility and is able to evaluate tumor conditions in the quantitative and objective way[4].

It has been pointed out in some studies that bronchial artery imaging of lung cancer patients

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is different from healthy people[5], which may relate to biological characteristics of the tumor. In this work, we investigated the differences by comparing and analyzing features of 256-slice spiral CT bronchial artery imaging in different pathological types, to provide valuable references for clinical diagnosis.

Patients and Methods

Patients

74 cases diagnosed as central-type lung cancer in this hospital from Oct. 2014 to Oct. 2015 were selected. The diagnosis was confirmed based on puncture pathological biopsy and fiber bronchoscope with full imaging materials. Main clinical symptoms were expectoration, blood-stained sputum, chest pain and cough. Exclusion criteria were lung cancer metastasis, lung cancer with operation and chemoradiotherapy, trauma history on lung and allergy to contrast medium. This study has been approved by patients and their family members through Ethics Committee in this hospital.

Squamous carcinoma group and non-squamous carcinoma group were divided according to their pathological types. For squamous carcinoma group, there were 34 cases with 22 males and 12 females, of ages between 36-74 years old with an average age of (56.7±10.3) years. The course of disease was from 1 month to 3 months, with an average value of 1.8±0.4 months. There were 15 cases of tumor on the left side and 19 cases on the right side; they were all solitary nodule. For non-squamous carcinoma, there are 40 cases with 25 males and 15 females, of ages between 35-72 years and the average age of 55.9±12.4 years. The course of disease was from 1.3 months to 2.6 months; the average value was 1.4±0.5 months. There were 18 cases of tumor on the left side and 22 cases on the right side; they were all solitary nodule. Differences between the two groups in terms of general materials are not evident (p>0.05).

Examination Method

256-slice spiral CT provided by GE Company (Hartford, CT, USA) was used to perform plain scanning and enhancement scanning and the range was from the superior aperture of the thorax until the lower part of the lung. Parameters were vascular voltage 119Kv, vascular current 47-59 mAs, slice thickness 5 mm, slice spacing 1.2 mm, spiral spacing 1mm, rotating time 0.5s and matrix 512×512. After plain scanning, iohexol 350 (GE Healthcare, Belfast, Ireland) was injected into the antecubital vein based on patient's weight; the total dose was 50 ml and the injection rate was 3 ml/s of 4s duration. Meanwhile, enhancement scanning at lungs was performed, which lasted for 22s, while for old people or patients with a poor cardiac function it was 27s. Bronchial artery scanning was finished under single-breath hold condition. After scanning, thin slice reconstruction was performed to original imaging in the first period, the slice thickness was 0.75 mm, slice spacing was about 0.7 mm and filtration function was 10. Thin reconstruction imaging was processed in background processing workstation and analysis software was in Alatoview 1.21 and GE ADW3.1 version. First of all, both ends and running of the bronchial artery were confirmed on surrounding images; then, multiplanar reconstruction was performed and the images were further reconstructed through volume rendering and maximum intensity projection techniques to closely observe the location and form of the lung cancer lesions.

Two doctors with more than 10 years of chest radiograph experience evaluated the radiographs. Subsequently, the two doctors consulted a third doctor for his opinion to arrive at a common agreement. The required lung bandwidth was 1400 HU and window level was -450 HU, bandwidth of the mediastinal window was 400 HU and window level was 60 Hu. Sharp degrees of pulmonary vascular, aorta, chest wall bone and muscle edges and comparison of structures inside mediastinum such as trachea and esophagus with adjacent tissues were used to evaluate imaging of mediastinal window. Alongside, imaging of lung window was evaluated based on sharp degrees of pulmonary vascular, bronchus, trachea and costophrenic angle. Based on the comprehensive evaluation on lung window and mediastinal window, the imaging quality was good with less noise, which was qualified for diagnosis.

Observation Indexes

Developing ratio, artery diameter, tumor diameter and developing conditions of the bronchial artery at tumor side in two groups were compared. Nodular or tubulose strengthening structure from the aorta or its main branch through the root of hilus pulmonis and finally reaching bronchial lung was considered as a bronchial

Table I. Comparison of bronchial artery conditions [case (%)].

Group	Case	Left side	Right side	Both sides
Squamous carcinoma group	34	30 (88.2)	31 (91.2)	28 (82.4)
Non-squamous carcinoma group	40	27 (67.5)	29 (72.5)	24 (60.0)
χ^2		4.465	4.179	4.396
p-value		0.035	0.041	0.036

Table II. Comparison of BA diameter and lump diameter at lung cancer side (cm).

Group	BA	Lump
Squamous carcinoma group	0.18±0.04	4.27±0.91
Non-squamous carcinoma group	0.15±0.03	3.86±0.85
t	4.738	4.625
p-value	0.033	0.034

artery. The focus was locating bronchial artery related to the tumor, to determine its origin and running situation, measuring diameter and incision, which were mainly performed on axial view and multiplanar reconstruction imaging with 350 HU bandwidth and 50 HU window level. Maximum diameters of tumor on X, Y and Z3 axis based on 3D imaging were measured and the average value was taken. Pulmonary artery imaging at tumor side was recorded if there were narrowing, compression, expansion and thickening cases.

Statistical Analysis

SPSS 19.0 statistical software (SPSS Inc., Chicago, IL, USA) was used for data analysis and processing. The measured data was represented by mean value ± standard deviation and through *t*-testing. The qualitative data was shown in cases or percentages; χ^2-testing was used for enumeration data and $p<0.05$ was taken as statistically significant.

Results

Comparison of Bronchial Artery Conditions

Ratios of the left side, right side and both sides of bronchial artery displayed in squamous carcinoma group were significantly higher than those in non-squamous carcinoma group ($p<0.05$) as shown in Table I, Figure 1.

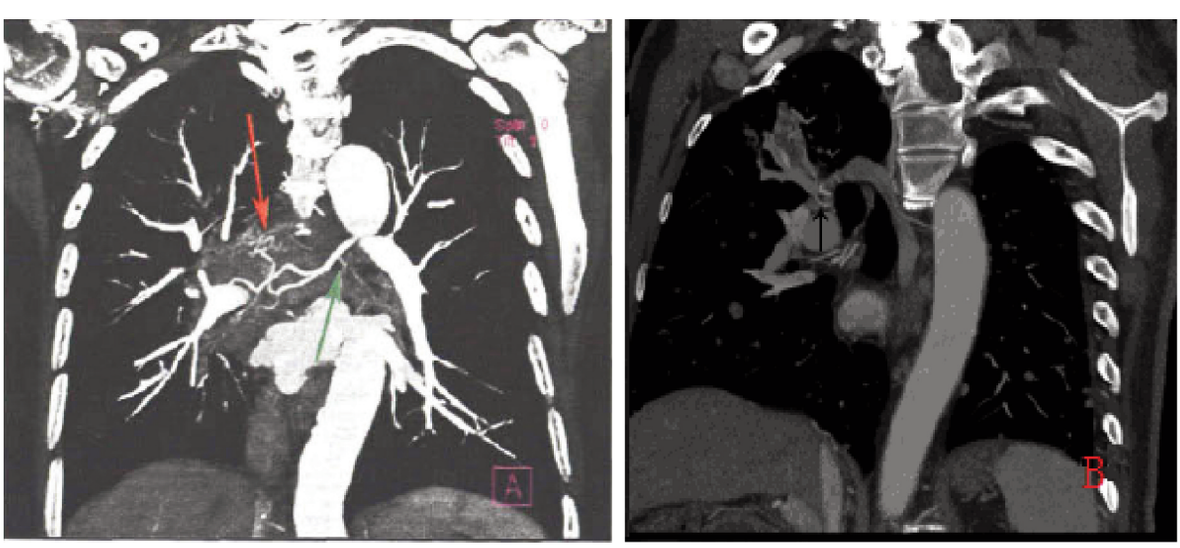

Figure 1. ***A)*** Central-type squamous carcinoma in inferior lobe of right lung; bronchial artery at right side is directly from anterior aortic wall and runs downwards to the right and develops into many branches inside the lump, some are clustering (red arrow) and the other is from bronchial artery at left side *(green arrow)*; BA diameter is 0.19cm while the diameter of tumor is 4.12cm. ***B)*** Central-type lung adenocarcinoma in inferior lobe of right lung; there is only a small segment of bronchial artery at the edge of tumor *(black arrow)*, BA diameter is 0.14cm and diameter of tumor is 3.89cm.

Comparison of BA Diameter and Lump Diameter at Lung cancer Side

Average BA diameter and lump diameter in squamous carcinoma group was significantly larger than those in non-squamous carcinoma group ($p<0.05$), as shown in Table II and Figure 1.

Comparison of Pulmonary Artery Developing

There are more compression and narrowing cases and less expansion and thickening cases for the pulmonary arterial branch in squamous carcinoma group, while the occurrence rates for compression and narrowing were significantly higher than those in non-squamous carcinoma group ($p<0.05$), as shown in Table III and Figure 2.

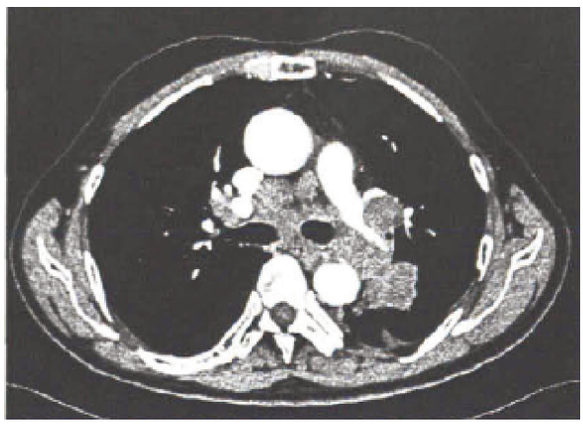

Figure 2. Compression and narrowing of left pulmonary artery.

Discussion

Normal pulmonary blood circulation includes pulmonary vein, pulmonary artery and bronchial artery and vein of the systemic circulation. The main function of pulmonary artery and vein is the gas exchange, main function of bronchial artery and vein is providing nutrition for lymph gland, bronchus and pleura. Once the tumor is grown to a certain stage, it builds its own blood supply to ensure nutrition required for growth[6]. Angiogenesis is a necessary condition for the development and metastasis of a tumor and most malignant cells were able to enter into the blood through immature blood capillary[7]. When tumor vessels are formed, vascular growth factor secreted from tumor stroma cell and tumor cell will function on the surface receptor in endothelial cells of vascular bed and join in development, metastasis and invasion of the tumor[8]. A large amount of nutrition is required for growth of tumor cell; therefore, blood flow of bronchial artery is increased and the vascular diameter is thickened and enlarged[9]. It is found after arteriography on lung cancer patients that bronchial artery is in charge of blood supply in lung cancer. Some scholars[10] also believe that both bronchial artery and pulmonary artery join in blood supply in lung cancer.

In normal cases, the pulmonary artery is not directly connected with the bronchial artery. During the development process of malignant tumor, it causes invasion and damage to the pulmonary artery and then fibroplasia is developed; therefore, the pulmonary artery is obstructed[11]. There are many small and straight vessels formed in the bronchial artery and they will proliferate from edges of lung toward the center part, gradually forming lumps of vessels surrounding tumor[12]. When the time for obstruction of pulmonary circulation gets longer, bronchial artery circulation needs to be increased to maintain the normal running of pulmonary blood circulation[13]. Some scholars concluded based on hemodynamic changes experiments by contrast medium injection that iopromide injection after pulmonary artery clipping can effectively lower vascular resistance of bronchus. It is reminded that under the circumstances of obstructed pulmonary circu-

Table III. Comparison of pulmonary artery developing [case (%)].

Group	Case	Compression and narrowing	Expansion and thickening	No changes
Squamous carcinoma group	34	13 (38.2)	2 (5.9)	19 (55.9)
Non-squamous carcinoma group	40	6 (15.0)	1 (2.5)	33 (82.5)
χ^2			6.310	
p-value			0.043	

lation, blood flow in bronchial artery is clearly increased. When blood flow of pulmonary artery is obstructed, CT imaging will show regurgitation of contrast medium into bronchial artery. It is reminded that the growth of tumor will cause open connection between the bronchial artery and pulmonary artery[14]. Therefore, the vessel diameter expansion and the increased blood flow phenomena of the bronchial artery will be shown in the lung cancer.

256-slice spiral CT was able to perform continual observation on inside of lung cancer lump based on cross-sectional imaging and avoid influences of cardiac artifacts on imaging and, therefore, improve the imaging quality of the bronchial artery[15]. Basically, the imaging quality is qualified. The profound observation was performed for supplying blood to the bronchial artery for lung cancer in a large scale, which is good for intervening in chemoembolization and reaching target site and evaluating the effects. It will effectively reduce vascular damage and missing, which will lower treatment time greatly and will reduce the radial exposure for the patients[16]. For 256-slice spiral CT bronchial artery imaging, sizes and running of bronchial artery, operation skills, scanning technique and patients' cardiac function status will influence the display results of the bronchial artery. Among which, operation skills and scanning technique can be controlled[17]. High quality imaging can be obtained by selecting reasonable parameters and suitable delaying time when collecting original data. Multi planar reconstruction was able to obtain a two-dimensional image of any slice in the original cross-sectional imaging. Running of the bronchial artery was complicated because of a thin slice, it is really hard to show the whole imaging during scanning. However, when the slice is thickened and more structures can be shown, the comparability of imaging is not satisfying. Multiplanar reconstruction technique can be used to confirm the configurational relationship of location, incision and surrounding structure of bronchial artery and obtain reliable and faithful data[18].

There are few reports on bronchial artery imaging features of different pathological types of central-type lung cancer. It can be concluded through studies that the left side, right side and both sides developing ratios of the bronchial artery in squamous carcinoma group were significantly higher than the other group. Moreover, the average diameter of artery and diameter of tumor were significantly higher than non-squamous carcinoma group. Also, the occurrence rates of compression and narrowing on the pulmonary arterial branch at tumor side were significantly increased.

Squamous carcinoma is formed through metaplasia of bigger bronchiolar epithelium, which has a rich blood supply, slow growth speed and local growth, it may form lump inside bronchial lumen and be late for distant metastasis and, therefore, it may be good for the growth of its bronchial artery[19]. Adenocarcinoma is mainly originated from small epithelial cells on bronchi mucosa; it grows slowly but distant metastasis may also occur in an early stage; undifferentiated small cell cancer grows fast and has strong invasiveness, which requires a lower local blood supply. After embolotherapy of bronchial artery chemotherapeutics on central-type lung cancer, effects on squamous carcinoma were greatly improved. It showed that bronchial artery might provide required substances in growth process of squamous carcinoma. It was found in an animal model[20] that cytokines related to vessel growth of squamous carcinoma have a high expression level such as vascular endothelial growth factor. It was reminded that angiogenesis of squamous carcinoma may be getting more. Imaging features of the bronchial artery of peripheral lung cancer were not included, and further exploration was required for related mechanisms.

Conclusions

Above all, 256-slice spiral CT bronchial artery imaging had different results in central-type lung cancer. It requires more studies on a large sample and prospective studies to verify the identification of different pathological types in an early stage.

Conflict of Interest

The Authors declare that they have no conflict of interests.

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