

Analysis of 96 cases of solitary pulmonary nodule diagnosed by MSCT

Zhijun Ma, Guozhi Yang, Jing Wang

Department of Radiology, The People's Central Hospital of Siping City, Siping 136000, China

Received: 25 November 2013 / Revised: 25 December 2013 / Accepted: 20 January 2014
© Huazhong University of Science and Technology 2014

Abstract Objective: The aim of this study was to explore the diagnostic value of multi-slice computer tomography (MSCT) in solitary pulmonary nodule (SPN). **Methods:** Contrastive analysis of the differences of CT signs between benign and malignant SPN. **Results:** The typical sign of pleural indentation was a reliable sign for lung cancers. Vacuole sign suggested lung cancer highly. Blood vessels cluster involving the vein alone had big opportunity to lung cancer. Type I tumor-bronchial relation was the most common relation in lung cancers. Type V tumor-bronchial relation was the most common relation in benign SPN. **Conclusion:** MSCT had a very high diagnostic value in SPN.

Key words multi-slice computer tomography (MSCT); solitary pulmonary nodule (SPN); diagnosis

Solitary pulmonary nodules (SPN) can be seen frequently in daily clinical work, but it is difficult to identify them. A retrospective analysis of 96 cases of SPN with complete CT data confirmed by pathology from May 2005 to June 2012 will be reviewed in this paper to explore the diagnostic value of multi-slice computer tomography (MSCT) in SPN in order to improve comprehension to the signs of SPN.

Patients and methods

SPN could be seen frequently in daily clinical work, but it was difficult to identify them. A retrospective analysis of 96 cases of SPN with complete CT data confirmed by pathology from May 2005 to June 2012 would be reviewed in this paper to explore the diagnostic value of MSCT in SPN.

Patients

The 96 cases of SPN include 57 cases of male patients and 39 of female patients, aged ranging from 22 to 76 years. The median age was 59.3 years. The biggest diameter was from 1.0 to 3.0 cm, with an average of 2.6 cm. These 96 SPN included 34 cases of adenocarcinoma, 21 cases of squamous cell carcinoma, 5 cases of small cell carcinoma, 5 cases of bronchioloalveolar carcinoma, 16 cases of tuberculosis (TB) ball, 11 cases of inflammatory pseudotumor, 1 case of arteriovenous deformation, 2 cases of

hamartoma and 1 case of adenoma. All cases were confirmed by pathology. The main symptoms: cough sputum, blood in phlegm, chest pain, 12 patients have no symptom

Scan machine and parameters

The GE Light speed 16 slice CT, performed volume scan at the end of inspiration with breath holding, scanned sphere from apex pulmonis to adrenal, and 120 KV, 200 MA, pitch 1.375:1, and 5.0 mm thick layer. Reconstruction interval 1.25 mm.

Image post-processing

Reconstruct in multiple direction and multiple angle applying ADW 4.2 software to display all kinds of signs.

Results

The results of 96 cases SPN CT signs and pathological relations were shown in Table 1.

Discussion

Multi-slice CT has further improved time and space resolution with strong post-processing function. It provides more assistance for diagnosis, and has become the first choice in differential SPN diagnosis examination

SPN density change

Glass ground opacity

Table 1 Relation between CT signs of 96 cases SPN and pathological

	n	PI	Vessels	Cluster	Calcify	Sublobe	Sentus	Metabasis	GGO	Vacuolus	Cavitas	Tumorbronchial relationship				
												I	II	III	IV	V
SC	21	9	4	15	2	17	16	1	0	3	3	11	0	0	4	2
AC	34	10	27	6	18	22	5	1	5	6	12	5	3	6	2	0
BAC	5	0	3	1	2	1	4	3	0	1	2	1	1	0	2	0
SCC	5	2	1	2	0	3	2	2	0	2	1	2	1	0	1	0
Tuberculosis	16	3	1	3	6	2	7	0	0	0	6	0	2	0	0	6
IPT	11	2	4	2	2	1	2	0	0	0	0	2	1	0	1	3
Angioma	1	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0
Harmatoma	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Adenoma	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

SC: squamous carcinoma, AC: adeno-carcinoma, BAC: bronchioloalveolar carcinoma, SCC: small cell carcinoma, IPT: inflammatory pseudotumo, PI: pleuralindentation

Glass ground opacity (GGO) nodules performs as focal slightly density increased nodules that looks as glass ground opacity. It can be divided into pure GGO (PGGO) and mixed GGO (MGGO). GGO has various reasons as inflammation, limitations pulmonary fibrosis and lung cancer [1]. It can be seen in non-typical adenomatoid hyperplasia, or in early adenocarcinoma. In Nakata M's [2] report, the majority of 15 cases mixed GGO are lung cancers, only one case is pre-cancerous adenomatoid hyperplasia (AAH), and 28 cases of PGGO, 8 cases are AAH, 17 cases are bronchioloalveolar carcinoma (BAC). Noguchii [3] considers GGO is the early performance of BAC and adenocarcinoma. 5 cases of bronchioloalveolar carcinoma and 1 case of adenocarcinoma have ground glass in this paper were diagnosed lung cancer after anti-inflammatory treatment with density increases, appeared mixed GGO. Postoperative pathology was high differentiated adenocarcinoma and alveolar carcinoma. Accordingly, MGGO has higher chance of malignant. Image workers should pay attention to GGO. As the ground glass shadow can only be showed in lung window even only in the thin layer spiral CT lung window to observe, thin layer of scanning and rebuilding after scanning is necessary. Application of computer isolated nodules analysis software in measuring GGO is necessary (Fig. 1–4). For the error of directly measurement of GGO after dynamic scan is visible. It can greatly reduce interference of human factors. It is helpful for sure tumor doubling time and is worth being generalized, but for the same machine, the same scanning parameters choose the same threshold.

Calcification

Generally the more calcification proportion, in nodule the more benign possibility, more cases of benign cases were seen which have more than 10% calcification, especially in TB ball. Thus data meet the above characteristics. But it is not absolute. Attention need to be paid to tuberculosis scar cancerous which can have large calcification, dynamic observation will help to identify it.

Cavitas

Cavitas can be seen both in tuberculoma and lung cancer, relative cavitas in tuberculoma are generally fissure-like or having regular form. But none of the thin-wall cavitas appeared in the data. Lung cancer are all thick-wall-hollow, irregular form. But it is difficult to identify by cavitas only. Facts such as disease location, satellite, enhancing examination, age and sometimes the pursuit of CT-guided fine needle biopsy should be combined.

Vacuole sign

Vacuole sign appears mainly in adenocarcinomas and bronchioalveolar carcinoma, especially in high differentiated adenocarcinoma [4]. Adenocarcinoma and squamous cell carcinoma all appear vacuole sign in this case material, more cases appear in adenocarcinomas, especially in high-differentiation adenocarcinoma. None appears in benign nodules. Wang JC [5] considered that vacuole sign and GGO highly suggest bronchiogenic carcinoma. Vacuole sign should not be presumed cavitates. Or it could reduce the diagnosis value, and is easy to be misdiagnosed.

Fat density

Hamartoma can be easily diagnosed if fat density appears. In these two cases case have such feature and 1 case have less fat content which looks as soft tissue density, and was misdiagnosed as peripheral lung cancer. Retrospectively analyzed if performed by MRI fat pressure sequence may help to differentiate.

Lung-tumor-border CT manifestations

Sentus f 96 cases SPNs, 74.19% (46/62) of pulmonary carcinoma manifest sentus, which appears as short sentus and radiate align. Sentus appearance rate are 35.29% (6/17) in tuberculoma cases with the performance of long and soft burr, pathology base of Burr is the morphological differences between them, the edge of burr is the result of lung cancer invasive growth. Tuberculosis burr is inflammation and fibrosis around or the spread of tuberculosis.

Sublobe sign

The growth of lung carcinoma is uneven. Anisotropic growth of lung carcinoma is the base of sublobe

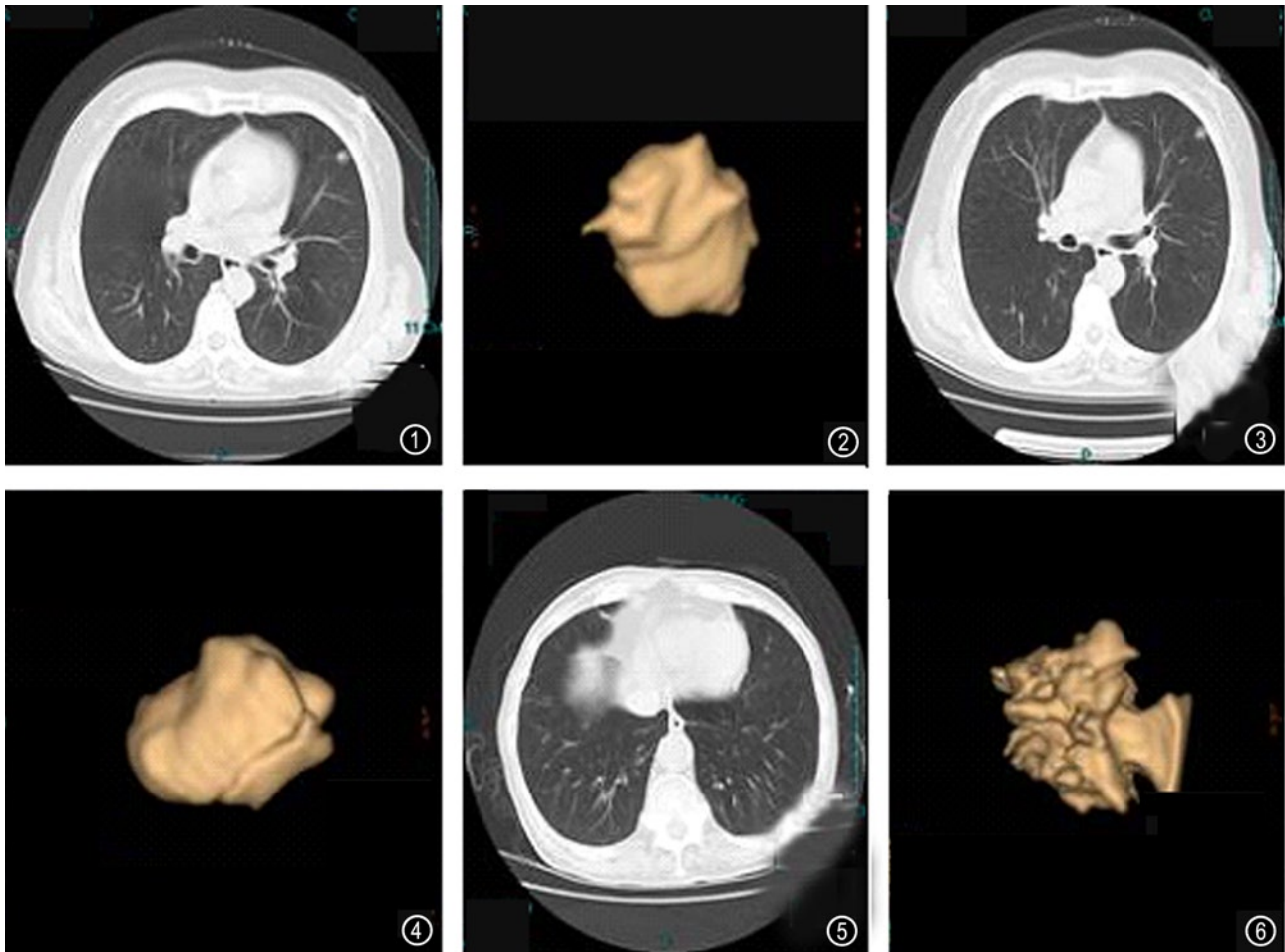


Fig. 1 The left upper lobe ground glass shadow SPN didn't have significant change contrast to Fig. 3 one months later
Fig. 2-4 Application of SPN software confirmed the volume increase from 453 mm³ to 593 mm³ (N1); surgery confirmed for tuberculosis
Fig. 5 Axial scan did not clearly show the NNPI concerns
Fig. 6 SPN analysis software showed irregular surface sign of SPN, not only measured the volume of 1.603 cm³, but also clearly showed NNPI into nodule

sign. Sublobe sign of lung cancer is deep and the typical form is wavy change. The benign nodules are dilatibility growth, that extrude and lapse tissue around, which form isotropic. Therefore shallow sublobe are in the majority. Although benign nodal brim is smooth in the majority, but well-differentiated lung cancer and lung sarcoma also have smooth edge, sometimes it is difficult to identify. Still, it need to take other signs into consideration.

Satellite

Satellites surrounding nodules is the typical performance of tuberculoma, but it is non-specificity. The bronchioloalveolar carcinoma can appear similar satellite. Multi-center lung adenocarcinoma can produce similar satellite change because of nodules nearby accumulation, typical performance of tuberculosis is cable ray and calcification or multiple hard proliferation focus which looks like plum flower. Pay attention not to make cognitive er-

rors, otherwise it is easy to be misdiagnosed.

Pleural indentation sign

Cui Y [6] considered that according to pleural indentation sign only it was difficult to diagnose lung cancer from others nodules through big data meta. And they introduced the conception of nodule notch due to pleural introcession indentation (NNPI). NNPI is defined as the institia or triangle shadow between pleural and nodules. Pleural enter the nodule through indentation. It is considered that NNPI diagnosis have specificity and positive predictive value as high as 96%. According to the criteria in our study, the positive predictive value is 92.31% (12/13). But sensitivity descend to 32.43% (12/37). Pleural introcession of benign nodule does not enter the nodules. Pleural introcession signs have no clear correlation with tumor size. Applications of post-processing function can reveal the pleural introcession more clearly (Fig. 5 and

6).

Vascular cluster

Tissue hyperplasia will drag the blood vessels to the connective nodules or involved in internal nodules. According to Ma DQ's [7] statistics, 15 cases of less than 2 cm SPNs, 93% of which involving pulmonary veins are malignant and benign accounted for only 12.5%. In this material 76.67% (46/60) lung cancer involve pulmonary veins alone, 16.95% involve the pulmonary artery alone. There is certain difference between report in this study and Ma DQ's reports. This has something to do with the diameter size of the selected case. The average is bigger than 2.0 cm by data, there may be more blood vessels cluster opportunity. There are certain effect for involving arterial vein group. Thus the blood vessels cluster may have different diagnostic value for different sizes of nodules. Application of multi-post-processing can better display lung nodules arteriovenous relationship.

It is important to display SPN-bronch-relations clearly. Li SJ recommend [8] 1–2 mm thin layer image observation. We observe all this data in 1 mm slice in three-dimensional to show bronchial relation with tumor clearly. There are 5 types of SPN-bronch-relations [9]. The data shows that Type I is the most common malignant nodules-bronch-relations, Type IV is second to it, and Type V is the most rare; the most common benign nodules are Type V, Type I is second to it. Only one case of inflammatory pseudotumor is Type II. This study shows the same result as other literature.

Transfers out of lung

Transfers will undoubtedly have great help in diagnose, which indicates diseases are advanced stage. 6 patients in the material transferred to other organ, of which 3 cases occurred in the adrenal, 2 cases shift to the brain and 1 case of liver metastasis.

Enhancing check-up

Enhancing check-up is helpful to most tuberculoma differential diagnosis. If typical circular strengthening appeared, tuberculoma should be considered. But if inflammatory granulation is evidently swollen and not manifesting the ring strengthening, then it is difficult to identify lung cancer and early lung abscess. It is also difficult to identify inflammatory pseudotumor, lung abscess and lung cancer, dynamic enhancing form and degree may contribute to the diagnosis, still more experience should be accumulated.

CT guided pathologic biopsy

Check-up in traumatic check-up is sometimes necessary in the differential diagnosis, but there are some false negatives. Negative cases can not completely exclude ma-

lignant tumor. Sometimes it is hard to make qualitative analysis, owing to smaller pathological specimens, and it has certain complications.

Reviewing the CT signs of 96 patients with pulmonary nodules, we can have the following experience and lesson: first, 16-layer spiral CT improved diagnostic level of lung nodules, but pay attention to combining all kinds of other examinations, considering the age of patients, location of disease or dynamic observation, and when necessary, experimental treatment or CT guided pathologic biopsy should be taken into consideration for the definite diagnosis. Second, observe carefully, observe the hidden parts and make a comprehensive analysis rather than make subjective judgment. Pay attention to the sign differences by different CT equipment. Third, it is necessary to perform strengthening examination or CT-guided pathologic biopsy when it is hard to make SPN differential diagnosis. Fourth, scanning range should be wide. Adrenal scanning should be listed as the routine. Fifth, note the tumor younger tendency. Sixth, it is extremely necessary to make a definite diagnosis by choosing appropriate CT post-processing. Last, image doctors should have dialectical view of CT signs and its deficiency. Pay attention to accumulating experience in order to provide better service for patients.

References

1. Nakajima R, Yokose T, Kakinuma R, *et al.* Localized pure ground-glass opacity on high-resolution CT: histologic characteristics. *J Comput Assist Tomogr*, 2002, 26: 323–329.
2. Nakata M, Sacki H, Takata I, *et al.* Focal ground glass opacity detected by low dose helical CT. *Chest*, 2002: 1464–1467.
3. Noguchii M, Morikawa A, Kawasaki M, *et al.* Small adenocarcinoma of the lung: histologic characteristics and prognosis. *Cancer*, 1995, 75: 2844–2852.
4. Hashimoto M, Heianna J, Okane K, *et al.* Small cell carcinoma of the lung: CT finding of parenchymal lesions. *Radiat Med*, 1999, 11: 417–421.
5. Wang JC, Sone S, Feng L, *et al.* Rapidly growing small peripheral lung cancer detected by screening CT: correlation between radiological appearance and pathological features. *Br J Radiol*, 2000, 73: 930–937.
6. Cui Y, Ma DQ, Yang J. The value of pleural indentation in the diagnosis of pulmonary nodule: a Meta-analysis. *J Cap Med Univ (Chinese)*, 2007, 28: 709–712.
7. Ma DQ. CT differential diagnosis of SPN less than 2.0 cm. *Chin J of Radio (Chinese)*, 1997, 31: 497–498.
8. Li SJ, Li CC, Wang X, *et al.* Pulmonary nodules: optimal slice thickness of CT in revealing bronchial imageology. *Chinese-German J Clin Oncol*, 2011, 10: 626–631.
9. Qiang JW, Zhou KR, Jiang YP, *et al.* The value of multislice spiral computed tomography in demonstrating the relation ship between bronchus and peripheral lung cancer. *Chin J Oncol (Chinese)*, 2004, 26: 45–48.