

VALUE OF LUNG PERFUSION SCINTIGRAPHY IN PREDICTING UNRESECTABILITY OF PATIENTS WITH LUNG CANCER AND EXPLORATIVE THORACOTOMY

Nina Georgieva¹, George Kalaydjiev², Evelin Obretenov³, Katya Peeva⁴

¹Department of Nuclear Medicine, Medical Faculty, Trakia University Stara Zagora

²Clinic of Thoracic Surgery National Oncology Hospital Sofia, ³Clinic of Thoracic Surgery
University Hospital Stara Zagora

ABSTRACT

PURPOSE: To determine the value of lung perfusion on predicting unresectability of lung carcinoma in patients with exploratory thoracotomy.

MATERIALS AND METHODS: We analyzed retrospectively the value of lung perfusion scintigraphy in 25 cases with primary lung carcinoma who had an exploratory thoracotomy (18 right and 7 left thoracotomy), regarding preoperative suggestion of unresectability. In most of these patients other noninvasive diagnostic methods (X-ray and CT) did not indicate inoperability.

RESULTS: Only the perfusion lung scintigraphy demonstrated defects near the ipsilateral hilum and/or an enlargement of the mediastinum, displacement of mediastinum, displacement (pulling) of the hilum of the affected lung or a part of it to the mediastinum. At thoracotomy we found an involvement of hilar vessels and the mediastinum by the tumor or by “bulky” nodal metastases. Common peripheral concentric decrease of affected lung perfusion image dimensions, lacking or negligible perfusion of the affected lung also suggest inoperability. Perfusion indices at localization of the tumor in the right lung (15 of the patients) were mean=40,8%, SD=11,02%, SE=2,7%, and at localization in the left lung (6 of the patients) mean=36,27%, SD=10,60%, SE=4,01%.

CONCLUSION: These findings show that in some patients with bronchial carcinoma the perfusion scintigraphy image can suggest a potential unresectability and requires a more extensive staging like mediastinoscopy or thoracoscopy.

Key words: lung carcinoma, lung perfusion scintigraphy, explorative thoracotomy, operative contraindications

INTRODUCTION

Surgical resection of non-small cell lung cancer (NSCLC) remains the most effective form of treatment of the disease when feasible. The determination of resectability and operability is the principal problem in evaluating patients with NSCLC for treatment. According to the general view, the data from noninvasive procedures must set indications for invasive staging. Computed tomography (CT) and X-ray imaging are known as the most accurate noninvasive methods. Additional information is provided

Address for correspondence:

Nina Georgieva
Department of Nuclear Medicine
Medical Faculty
11 Armeyska str ,6003 Stara Zagora, Bulgaria
e-mail: ngeorgieva21@yahoo.com

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by fiberoptic bronchoscopy. As for patients with radiologically suspected stage III disease, the differentiation of T3 from T4 and N2 from N3 is required. The possibilities of noninvasive procedures concerning this differentiation are limited and usually the diagnosis involves invasive methods such as mediastinoscopy and thoracoscopy. Some information to predict the inoperability (presence of T4 or N3) is obtained by precise interpretation of lung perfusion scintigraphy performed before the invasive staging. In most cases, the perfusion lung scan demonstrates a picture consistent with the data from other noninvasive imaging procedures.

The role of lung perfusion scintigraphy as determinant of inoperability is discussed in many communications (1,3,5-8). We undertook our study with the assumption that more detailed information about the tumor spread and potential unresectability is of great importance for indicating invasive staging and surgery. In our series of operated lung cancer patients we found a strong correlation between perfusion scan data suggesting unresectability and the number of exploratory thoracotomies.

MATERIALS AND METHODS

We analyzed retrospectively 25 consecutive cases with primary lung carcinoma treated in our departments. Every patient was subjected to a standard postero-anterior and lateral chest X-ray, fiberoptic bronchoscopy and chest CT. There were 24 men and 1 woman. The age range was from 47 to 66 years. The tumor was located in the right lung in 18 patients and in the left lung in the remaining 7 cases. Lung perfusion scintigraphy was performed in all patients with ^{99m}Tc - human albumin microspheres with a particle size of 23-45 μm (kit Sferotec – Sorin Biomedica-Italy). The injection was applied in supine position, intravenously in bolus, 1ml at an activity of 55-74MBq. The period of examination was between the 15th min and the 2nd hour after injection, at anterior, posterior, lateral and 45° detection, perfusion indices from 6 fields in front and posterior projection were calculated (Picker Dyna Camera 4 Scintillation Camera System – Picker Corporation Nuclear and Ultrasound, USA).

We considered 4 pathological criteria for interpretation of lung perfusion scintigraphy:

1. Absent or minimal perfusion of the affected lung or a perfusion defect less than 1/3 of the affected lung.
2. Perfusion defect and enlargement of the hilum of the affected lung.
3. Enlargement and displacement of the mediastinum in anterior and/or posterior detection.
4. Perfusion defect in the contralateral hilum.

Exploratory thoracotomy was performed at 23 patients, at 1 patient was performed only VATS and at 1 patient - VATS/exploratory thoracotomy. An invasive staging with mediastinoscopy before thoracotomy was not performed. The patients were staged in accordance with TNM classification (9).

RESULTS

All patients with exploratory thoracotomy were staged pre-operatively by noninvasive procedures at stages II-III A. The presence of NSCLC histology and performance status (Karnofsky index = 70-80). The lung perfusion scintigraphy demonstrated an enlarged mediastinum in front, posterior or in both projections at 14 of the patients. Impaired perfusion in a zone with polycyclic outlines or perfusion defect in homolateral hilum was present in 24 of the patients. Impaired perfusion in the contralateral hilum was found in 16 of the patients. In one patient lung perfusion scintigraphy of the hilum and mediastinum was normal. Changes in affected lung perfusion varied from impaired in different rate to perfusion defect in at least 3 lung segments (presented in 7 of the patients), or defect affecting whole segments or parts of segments (Fig. 1). In two of the cases affected lung perfusion image was with common concentric decrease of dimensions and with different rate of impaired perfusion. No patient with perfusion defect involving less than 1/3 of the affected lung, a sign indicating unresectability was found (10,11). Perfusion indices at localization of the tumor in the right lung (15 of the patients) were mean= 40,8% , SD = 11,02% , SE=2,7%, and at localization in the left lung (6 of the patients) were mean=36,27%, SD=10,60%, SE=4,01%. All 24 patients were operated on, the most frequent finding on thoracotomy was invasion of the mediastinum by the tumor (T4) or a tumor with “bulky” nodal metastases in hilar and mediastinal lymph nodes. There were 2 patients with invasion of the vena cava superior (without clinically dem-

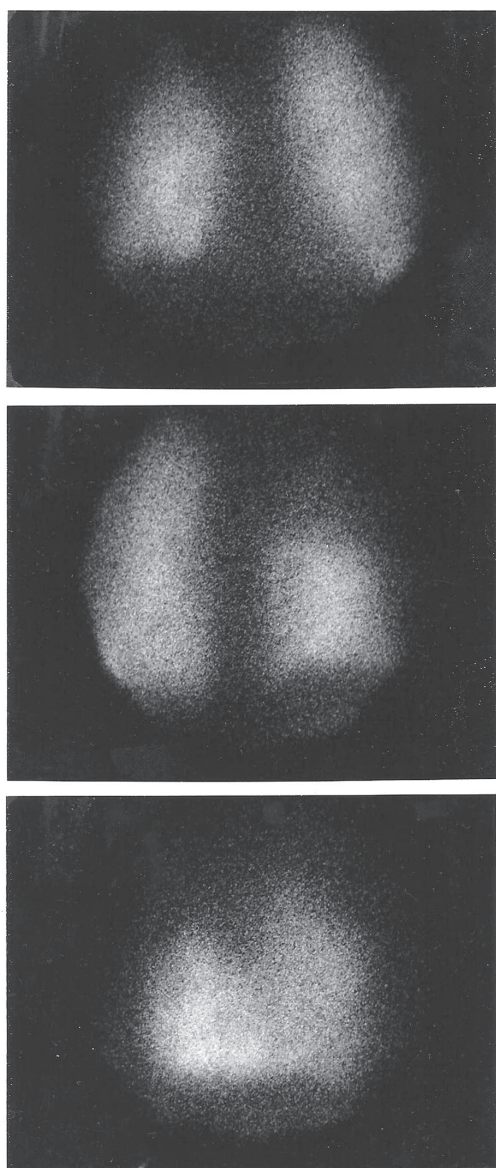


Fig.1. M.52. Carcinoma pulmonis dextra T4N2M0 – IIIB clinical stage. Status post thoracotomia explorativa. Histology: non-differentiated spinocelular carcinoma. Ro gr.: Tu pulm. dex. in upper lung field, unclear outlines and high density. FBS tumor in upper-posterior segment bronchus on the right. Perfusion scintigraphy: perfusion defect in 1,2 and partially in segment 6 of the right lung. Impaired perfusion in zone with polycyclic outlines in both hili. Enlarged mediastinum predominantly in front projection. Perfusion indices: right lung 45,5%, left lung 54,5%. From surgery protocol: Tumor 10-12 cm, with solid consistency, expanded to chest wall and upper-posterior mediastinum, pathologic fracture of IV rib subscapular. Lung hilum is encompassed by conglomerate of lymph nodes with infiltration ahead to v.cava sup.

onstrated VCS-syndrome). All patients were staged as III B stage and operation consisted of exploration only.

DISCUSSION

Lung perfusion scintigraphy was defined as a sensitive determinant of inoperability by several authors.

Lipscomb D.J (6) et al. found in study of 21 patients that the image in lung perfusion scintigraphy before thoracotomy coincides with bronchoscopy and radiologic signs. They have found large perfusion defects in 3 of the patients with tumor expansion over the mediastinum at thoracotomy, while 11 patients presented with mediastinum expansion of the tumor which was not detected by scintigraphy. Authors conclude that scintigraphy is not a sensitive indicator for tumor expansion to the mediastinum.

Buyuklyan A.N. (1) et al. performing inhalation and perfusion scintigraphy in central carcinoma found decreased or lacking accumulation of radiopharmaceuticals in the region of the tumor or at inhalation scintigraphy increased accumulation at the place of the tumor and decreased or missing in the distal part from the tumor. This suggests partial or complete obstruction, while in cases with peripheral tumor changes are only at the place of the tumor. According to Lovyagin (6) et al. influence on the scintigraphy image have level of distribution of the tumor, and in some of the patients the involvement of bronchopulmonary and tracheobronchial lymph nodes.

Levcheva V. (5) et al. in examination of patients with central bronchial carcinoma found defects in perfusion adequate to hypo-ventilated zones, which gives the opportunity to predict the size of the planned pulmonary resection. They consider that diagnostic potential of perfusion lung scintigraphy exclude or indicate additional invasive methods to diagnose pulmonary diseases.

Mluchkov Hr (8) et al. think that perfusion scintigraphy is a method of pre-operative evaluation of the partial pulmonary function in regards to operability of the patients.

Katsarov T (3) et al. establish that isolated focal changes in perfusion in the area of one lung segment correspond to the tumor lesion, often without data for infiltration of regional lymph nodes, while

lack of perfusion corresponds to significant tumor infiltration.

Secker-Walker R.H. (10,11) et al. in their series of examinations establish in bronchial carcinoma that when perfusion in affected lung is less than one third of the whole, the tumor is inoperable. All the patients with successful resection presented with perfusion of the affected lung more than 33%. Patients evaluated by bronchoscopy as inoperable, and in 3 of 4 patients found as unresectable at thoracotomy had relative share of perfusion less than 33%. They find perfusion defects in 48% in the contralateral lung and ventilation defects in 78%. Ventilation and perfusion scintigraphies could complete the routine spirometry test, as they give evaluation of regional function of the lungs, indicate operability and sometimes could detect occult (in situ) bronchial carcinoma. Large tumors present with defect in perfusion, varying in size from X-ray changes to lack of perfusion in the whole lung. The extent of the perfusion defect is closely connected with the involvement of the pulmonary vessels in the hilum through distortion, compression or invasion of the tumor. Bronchial obstruction has lower influence on defect formation. The larger the defect in perfusion, the greater the extent of involvement of hilar and mediastinal structures, implicating higher than surgically expected injury. The median value of relative perfusion for inoperable patients is $28,5\% \pm 4$.

Ellis D. A. (2) et al. conducted ventilation and perfusion scintigraphy at 58 patients with bronchial carcinoma preoperatively to determine in which patients scintigraphy detects the tumor expansion in the mediastinum and tumor resectability. Change in the perfusion of the affected lung is lower and encompasses greater area in central tumors. Perfusion is also lower in left localization of the tumor compared to right but this is explained with the normal difference between left and right. Scintigraphy could not predict resectability in peripheral tumors but in central tumors if the perfusion of the affected lung is less than 25% from total perfusion, the lesion is most probably unresectable, because there is expansion in the mediastinum. Always obstruction is presented in 67% of the patients but it does not influence the interpretation of the scans.

Von S.A. Beyer-Enke (12) et al. compares CT, bronchoscopy and lung ventilation and perfusion scintigraphy in 87 patients with histologically evidenced bronchial carcinomas to evaluate the tumor related bronchial obstructions and pulmonary function. The established by bronchoscopy high-extent stenosis of bronchi are interpreted by CT in 85% properly. The two methods coincide in 57%. With an increasing number of CT- diagnosed atelectatic or infiltrated segments an almost linear decrease in ventilation and perfusion values is observed. In comparison, bronchoscopy-diagnosed tumor stenosis result in decreased ventilation and perfusion data only if the lesion is centrally located. Reduction of perfusion is better expressed than reduction of ventilation and to high extent in lobar and bi-lobar cases, while in segment infiltration both values are in the normal range. Parenchymal infiltration has more importance than bronchial obstruction for the reduction of pulmonary perfusion and ventilation.

In our series detecting inoperability we established lower than cited by other authors ($28,5\% \pm 4$) perfusion in only 2 patients with affected right lung - 17,2% and 32% respectively, and in another 2 with affected left lung - 21,8% and 27,2% respectively. When the process is in the left lung the total mean perfusion is lower because of the ratio right-left. Additionally, in our series four of the inoperable patients with affected right lung presented with preserved perfusion percentages as well as two of the patients with affected left lung. The changes in the perfusion percentage vary in big range and could have relation to determination of functional operability. The area of perfusion changes is larger in central carcinoma or tumor situated in the hilum.

CONCLUSION

Impaired perfusion or perfusion defect in homolateral hilum, displacement towards the mediastinum, accompanied by enlarged in some of the projections mediastinum demand additional diagnostic assessment, as they could be a sign of expansion of the tumor process over the mediastinum structures. Impaired perfusion in the contralateral hilum, as well as the enlarged in some of the projections mediastinum suggest to be suspected T4 and are sign of possible inoperability. Our findings are that inoperability could not be determined only by perfusion

percentage of the affected lung. Perfusion percentages could serve for evaluating the functional operability in preoperative preparation of patients with lung cancer. Each patient with indicated pathologic signs of perfusion scintigraphy should be staged precisely with new non-invasive methods - PET/CT⁴ or invasive like VATS or mediastinoscopy. We hope to obtain more adequate staging of lung cancer and to reduce the number of exploratory thoracotomies.

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