

# Regency Empress March 13, 2000

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### Increased Centrilobular Opacity in Pulmonary Artery Hypertension.

**Hart E** (Northwestern University Medical School,  
Chicago, IL 60611, [ehart@radiology.nwu.edu](mailto:ehart@radiology.nwu.edu))

**Introduction:** Pulmonary vascular disease has been reported but not well characterized as a cause of increased centrilobular opacity on HRCT. This report describes the presence of increased centrilobular opacity on HRCT scans of patients with primary and secondary pulmonary artery hypertension.

**Materials and Methods:** HRCT scans of 25 adult patients with pulmonary artery hypertension were retrospectively evaluated for the presence of increased centrilobular opacity. Included were 15 patients with the Eisenmenger Syndrome (secondary pulmonary artery hypertension), and 10 patients with primary pulmonary hypertension. Increased centrilobular opacity was subjectively characterized as mild, moderate, or severe when present.

**Results:** Increased centrilobular opacity was present in 23 of 25 patients evaluated, including all patients with the Eisenmenger Syndrome and eight of ten patients with primary pulmonary hypertension. Increased centrilobular opacity was judged to be mild in 14 patients, moderate in 9 patients, and severe in 2 patients. There was no correlation between the severity of centrilobular opacification and the etiology of the underlying pulmonary artery hypertension.

**Conclusion:** Increased centrilobular opacity is a common HRCT finding in patients with primary and secondary pulmonary artery hypertension.

**Correlation of Tumor Size and Survival in Patients with Stage IA Non-Small Cell Lung Cancer: Implication for CT Screening.** Edward F. Patz, Jr., Santiago Rossi, Edith M. Marom, David H. Harpole, James E. Herndon, Jr., Philip C. Goodman (Duke University Medical Center, Durham, NC 27710, [marom001@mc.duke.edu](mailto:marom001@mc.duke.edu)).

**Introduction:** New lung cancer screening trials with thoracic computed tomography (CT) have been proposed suggesting that the ability of CT to detect smaller lesions will result in identifying earlier stage disease, and thus lead to improvements in survival. The purpose of this study was to determine the relationship between tumor size and survival in patients with stage IA non-small cell lung cancer (NSCLC) (ie T<3 cm).

**Method:** Five hundred and ten patients with pathologic stage IA (T1N0M0) NSCLC were identified from our tumor registry over an 18 year period. There were 285 men and 225 women with a mean age of 63 years (range 31-90 years). Cox proportional model was used to examine the effect on survival. Tumor size was incorporated into the model as a linear effect and as categorical variables. Kaplan-Meire's product limit estimator was used to graphically display the relationship between the tumor size and survival.

**Results:** Cox proportional hazards model did not show a statistically significant relationship between tumor size and survival ( $p=0.71$ ) as a linear effect. Tumor size was then divided into quartiles, and again, there was no significant difference in survival between groups ( $p=0.597$ ). When tumor size was categorized into deciles, there was no statistical relationship between tumor size and survival ( $p=0.674$ ).

**Conclusions:** These data support stratifying patients with stage IA NSCLC in the same TNM classification given no apparent difference in survival. Unfortunately, these data cautions the notion that earlier detection of a lesion <3 cm may not result in significant improvements in survival with current technology.



FDG-PET Imaging of Pleural Effusions in Patients with Non-Small Cell Lung Cancer (NSCLC). Rossi S, Erasmus JJ, McAdams HP, Goodman PC, Coleman RE, Patz EF (Duke Univ Medical Center, Durham, NC 27710, eras001@mc.duke.edu).

**Purpose:** To determine the ability of FDG-PET imaging to differentiate benign from malignant pleural effusions in patients with NSCLC.

**Methods:** Patients presenting with a primary NSCLC and a pleural effusion on staging CT who had undergone FDG-PET imaging, were reviewed. There were 25 patients, 18 men and seven women. Pleural FDG-PET activity was considered positive if greater than background mediastinal activity and negative if activity was the same or less than mediastinal activity. FDG-PET findings were correlated with pathologic diagnoses.

**Results:** All 25 patients had effusions on the same side as the primary tumor. The pleural effusions were classified as small (n=11), medium (n=6) or large (n=8). The pleura was normal on CT in 14, nodular in four and diffusely thickened in seven patients. Twenty-two patients had a malignant pleural effusion confirmed by thoracentesis (n=19) or biopsy (n=3). FDG-PET was positive in 21 of these patients and negative in one patient. Three patients had no evidence of malignancy in the pleural space documented by cytology (n=2) or biopsy (n=1). FDG-PET uptake was positive in one and negative in two patients. The sensitivity, specificity and accuracy of FDG-PET imaging for detecting pleural metastases was 95%, 67%, and 92%, respectively.

**Conclusion:** FDG-PET imaging was useful in the detection of pleural metastases and may have utility in improving staging evaluation in patients presenting with NSCLC and a pleural effusion.

MR Imaging of Pulmonary Perfusion using Arterial Spin Labeling: Preliminary Results.  
Mai VM, Chen Q, Bankier AA, Edelman RR (Beth Israel Deaconess Medical Center, Section of MRI Research, Harvard Medical School, Boston, MA 02215, vmai@froto.bidmc.harvard.edu)

**Purpose:**

To test a newly developed arterial spin labeling MR technique called Alternation of Selective Inversion Pulses (ASI) for imaging pulmonary perfusion.

**Materials and Methods:**

Five healthy volunteers were studied. Imaging was performed on a VISION 1.5 T Magnetom system. Only blood proximal to the imaging plane is labeled. For a 10-mm imaging slice, the saturation and the narrow inversion slabs were 25 mm, and the wide inversion slab was 100 mm - 150 mm. Cardiac triggering was incorporated, and breathholdings on expiration or inspiration were performed. ASI perfusion-weighted images were acquired at times of inversion (TI) of 100-1600 ms. A HASTE sequence was used with a FOV of 400-500 mm and a matrix of 128x256. A time delay of 2-4 s was selected, which is the time period after image acquisition and before the next tagging period.

**Results:**

Perfusion-weighted images acquired during breathhold in expiration showed greater signal enhancement than those in inspiration. ASI showed progressive signal enhancement of the lung parenchyma as TI increased. On all images, large vessels dominate at short TI, and lung parenchyma dominated at long TI.

**Conclusion:**

MR imaging pulmonary perfusion with ASI is feasible. Our preliminary results indicate that given its versatility ASI has the potential to dynamically assess both the proximal and the distal pulmonary vasculature.

**Time Resolved Pulmonary MR Perfusion Angiography in Normal Volunteers.** Carr J, Laub G, Simonetti O, Hart E, Pereles FS, Finn JP (Northwestern University Medical School, Chicago, IL 60611, [ehart@radiology.nwu.edu](mailto:ehart@radiology.nwu.edu))

**Introduction:** A new dynamic, contrast-enhanced, ultra-short TR pulmonary MRA sequence was used to evaluate pulmonary arterial visualization and pulmonary perfusion in normal volunteers.

**Materials and Methods:** Under an IRB approved research protocol, five (5) normal volunteer subjects were examined on 1.5T Magnetom Sonata (Siemens Medical Systems, Iselin, NJ) with a prototype high-performance gradient subsystem (40 mT/m amplitude, 200 mT/m/ms slew rate). Each coronal gradient echo 3D acquisition (TR 1.64 ms, TE 0.6 ms, 15 degree flip angle, 40 partitions) lasted approximately 3 seconds, with an average of 8 sequential acquisitions obtained in a single breath-hold. A 40cc gadopentate dimeglumine bolus was power injected into an antecubital vein at 3-4cc/sec for each examination. Commercially available MIP and volume rendering algorithms were used to reconstruct the 3D data sets for soft-copy display and analysis.

**Results:** Three-second volume acquisition allows for time-resolved contrast bolus tracking throughout the cardiopulmonary cycle. Soft copy display of the pulmonary arteries at peak enhancement demonstrates excellent visualization of the proximal, lobar, segmental, and first sub-segmental pulmonary artery branches in all normal volunteer subjects studied. Additionally, homogeneous pulmonary perfusion was independently demonstrated in all subjects.

**Conclusion:** Dynamic pulmonary MR angiography with this novel sequence results in excellent pulmonary arterial and perfusion visualization in normal volunteers. The combination of angiographic and perfusion imaging possible with this MRA technique may result in improved evaluation of pulmonary vascular disorders. Further validation of this technique in normal volunteers and in patients with known pulmonary vascular disease is underway.

MR Signal Intensity of Lung Parenchyma: Comparison with Spirometrically Monitored Lung Volumes. Bankier AA, O'Donnell C, Mai VM, Ziang M, Edelman RR, Chen Q (Beth Israel Deaconess Medical Center, Section of MRI Research, Harvard Medical School, Boston, MA 02215, [abankier@froto.bidmc.harvard.edu](mailto:abankier@froto.bidmc.harvard.edu))

**Purpose:**

To determine the relation between MR signal intensity of the lung parenchyma and spirometrically measured lung volumes.

**Material and Methods:**

We studied 6 healthy volunteers (mean age, 41±8.3 years). Lung volume was spirometrically monitored during the MR studies. Data were acquired in 10 incremental steps from vital capacity (VC) to 10% of VC. Each experiment was performed twice in two independent sessions, resulting in 20 measurements per volunteer, and in a total of 120 measurements. Imaging was performed on an 1.5 T Magnetom Vision with a 4 element body-array coil and cardiac triggering. Coronal 2.5 mm thick slices were obtained over the entire lung volume using a multiple inversion recovery HASTE sequence (echo spacing time, 4.5 ms; TI<sub>1</sub>, 800 ms; TI<sub>2</sub>, 150 ms). Signal intensity of the lung parenchyma was measured using a MATLAB macro, and correlated to the spirometrically determined lung volumes.

**Results:**

Correlation coefficients for the comparison between signal intensity of the lung parenchyma and spirometrically monitored inspiratory volumes ranged from 0.88 to 0.97. For the comparison of the two independent measurements, correlation coefficients ranged from 0.88 to 0.99. All correlations were statistically significant ( $P \leq 0.05$ ). In all but one incremental step (between 70% and 80% of VC), 10% increments of TLC resulted in statistically significant ( $P \leq 0.05$ ) changes of lung parenchymal signal intensity.

**Conclusion:**

MR signal intensity of the lung parenchyma is closely related to the amount of inspired air. MR signal intensity of the lung parenchyma accurately and reproducibly reflects change in lung volume.



The Evaluation of Regional Pulmonary Perfusion using Ultrafast Magnetic Resonance Imaging. Levin DL, Chen Q, Zhang M, Edelman RR, Hatabu H (University of California, San Diego, San Diego, CA 92130, dlevin@ucsd.edu)

An ultrafast MR sequence was used to measure changes in signal intensity during the first pass of intravascular contrast through the pulmonary circulation. From this, mean transit time, relative blood volume, and relative blood flow were calculated. In six healthy subjects, data were collected in an isogravitational plane. A slight, but significant, gradient in transit time was present, with faster times at the lung apex. A significant decrease in blood volume was also seen in the apex compared with the lung base. Significant decreases in blood volume and blood flow were seen in the lung periphery compared with central portions of the lung. Six additional subjects were imaged along a gravitational plane. A significant gradient in transit time was seen, with faster transit in dependent regions of the lung. Two patients with severe emphysema were also imaged and these patients demonstrated marked heterogeneity in perfusion. MR imaging is able to evaluate regional differences in pulmonary perfusion with high spatial and temporal resolution.

Solitary Pulmonary Nodule: Evaluation of Blood Flow Patterns with MR Perfusion Study. Ohno Y, Takenaka D, Kojima Y, Motoyama A, Adachi S, Sugimura K (Univ of Kobe, Kobe, 650-0017, yosirad@kobe-u.ac.jp.)

**Introduction:** The purpose of this study was to evaluate the efficiency of MR perfusion study for differentiating malignant from benign solitary pulmonary nodule (SPN).

**Methods/Materials:** 65 patients with pathologically diagnosed SPNs (diameter, less than 30 mm; 7 non-invasive adenocarcinoma (localized bronchioalveolar carcinomas; BACs), 30 invasive adenocarcinoma, 8 pulmonary metastasis, 10 tuberculomas, 4 organizing pneumonias and 6 inflammatory SPNs) underwent pulmonary MR perfusion study. MR perfusion study was assessed by using a 3D spoiled gradient echo sequence (TR 3.0 msec/ TE 0.6 msec/ 20 degree flip angle) following intravenous administration of contrast media. The acquisition time of each phase of MR perfusion study was 1.1 seconds. Start-up times of enhancement and relative enhancement ratios of SPNs were measured and statistically evaluated.

**Results:** Concerning the start-up time of enhancement, pulmonary metastasis and invasive adenocarcinoma were significantly different from all kinds of benign SPN ( $p < .05$ ). BAC was also significantly different from almost all kinds of benign SPN except inflammatory SPN ( $p < .05$ ). Pulmonary metastasis (5.0 sec), BAC (6.2 sec), inflammatory SPN (6.8 sec), organizing pneumonia (8.8 sec) were during pulmonary arterial and parenchymal phase. Invasive adenocarcinoma (13.6 sec) and tuberculoma (18.7 sec) were during aortic phase. Concerning the relative enhancement ratio, tuberculoma (18 %) was significantly lower than any other kinds of SPN ( $p < .0001$ ). Inflammatory SPN (214.7 %) was significantly higher than pulmonary metastasis and invasive adenocarcinoma ( $p < .05$ ).

**Conclusions:** Pulmonary MR perfusion study is an applicable diagnostic method for differentiating SPNs and characterization of small SPNs.

# Notes