

Title: COMPUTER ASSISTED MORPHOLOGICAL ANALYSIS OF OPACITIES ON THE INTERNATIONAL LABOR ORGANIZATION STANDARD RADIOGRAPHS FOR THE PNEUMOCONIOSIS

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Rationale: The International Labor Organization (ILO) standard for scoring chest radiographs requires visual determination of opacity size, shape and perfusion. Inter- and intra-reader variability is one limitation of this method of classifying radiographs. A computer-based technique was developed to accurately and consistently characterize opacities associated with pneumoconiosis. **Methods:** Morphological image processing techniques allow one to use a computer to make quantitative measurements of opacities. The sharp peaks in the morphological pattern spectra were used for assessing opacity size and perfusion. Opacity size corresponds to the location of the peaks, while perfusion is proportional to the heights of the peaks. Opacity shape is assessed through the use of multiple, representative, geometrical elements. The ILO standard chest radiographs were digitized and regions of interest (ROIs) over which there was a known opacity population were selected by two B-readers. Morphological pattern spectra were computed using a circular structural element. **Results and Conclusions:** Sharp peaks in the computed pattern spectra are seen at the expected size and perfusion in the cases of: (i) rounded opacities of q and r in the regions of 1.5-3mm, and 3-10mm respectively; (ii) irregular opacities of u in the region of 3-10mm. The calculated morphological pattern spectra reflect the perfusion, shape, and size as defined by the ILO standard. Concluding, the results show promise for applying morphological pattern spectra as a means for assisting the physician in scoring and screening chest radiographs of workers at risk for pneumoconiosis.

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Relation of Single breath diffusing capacity to radiographic interstitial fibrosis in workers exposed occupationally to asbestos RH Warsaw¹, A Miller², JT Segarra³, WDDS, Claremont, CA, St. Vincent Medical Centre, Brooklyn-Queens, Jamaica, NY², Keesler Medical Center, Biloxi, MS³

OBJECTIVE: Previous investigations have related spirometric function and lung volumes to the ILO perfusion score in asbestos-exposed workers. The purpose of this study is to relate DLCOsb to ILO perfusion category.

METHODS: Asbestos-exposed workers from two southern states (n = 1904) were surveyed for the effects of exposure. All films were read by the same expert reader. Spirometry, DLCOsb and lung volumes were obtained according to current ATS criteria. Predictions were adjusted for duration of smoking¹.

RESULTS: Percent predicted DLCOsb reveals significant (p < 0.0000) decrement with increasing ILO category of irregular opacities (Table 1). Mean percent predicted DLCOsb is 107.1% for category 0/0 (n=526), 106.3% for 0/1 (n=134), 103.2 for 1/0 (n=683), 100.6 for 1/1 (n=461), 91.2 for 1/2 (n=59), 70.8 for 2/1 (n=27), 69.7 for 2/2 (n=9), 62.7 for 2/3 (n=3) and 33.2 for 3/2 (n=2).

CONCLUSION: Percent predicted DLCOsb decreases with increasing ILO prevalence and should be utilized in the evaluation of asbestos-exposed workers. That an independent measure of ILD reflecting gas exchange correlates with radiographic score validates the ILO classification.

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Comparison of duration of exposure, latency and ILO perfusion of irregular opacities in black and white workers from two southern states. JT Segarra¹, RH Warsaw², Keesler Medical Center, Biloxi, MS¹, WDDS, Claremont, CA².

OBJECTIVE: To evaluate differences in exposure, latency and ILO perfusion of irregular opacities in Black and White asbestos-exposed workers from the same population (Mississippi and Louisiana).

METHODS: Black (n = 442) and white (n = 1462) workers with at least 20 years from first exposure to asbestos and at least 5 years total duration of exposure from two southern states who share the same work exposure were compared for duration of exposure and latency from first exposure to asbestos. PA and Lateral chest Radiographs (14 x 17 inches) were read by the same experienced reader according to the ILO Classification. The ILO categories were assigned an ascending number from 1 to 10 (0/0 = 1, 3/2 = 10) and the means for the two groups were compared.

RESULTS: Mean age was 63.8 years for Blacks, 62.4 years for whites (p < 0.006), duration of asbestos exposure was 29.5 years for Whites, 24.8 years for Blacks and latency from first exposure to asbestos was 41.2 for whites vs. 37.7 years for blacks. ILO perfusion was 3.5 for whites and 3.4 for blacks and was not significantly different. Prevalence of asbestos-related pleural changes was 41.2% for whites and 37.7% for blacks (p < .006).

CONCLUSION: Although blacks of similar age compared to whites from the same asbestos-exposed worker populations have significantly fewer years duration and latency of exposure, there is no difference in ILO perfusion of irregular opacities. Blacks do, however, have a significantly lower prevalence of asbestos-related pleural changes.

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ASBESTOS-RELATED ROUNDED ATELECTASIS IN BRAZIL: A DYNAMIC CONTRAST ENHANCEMENT STUDY. Terra-Filho M, Kawakami J, Nery LE, Rodrigues RT, Capellozi VL, Bagatin E, Interinstitutional Group of Study of Asbestos Related Disorders - Heart Institute (InCor) HCFMUSP, UNIFESP-EPM-HSP, UNICAMP, São Paulo, Brazil

Rounded atelectasis (RA) is a benign and unusual form of subpleural lung collapse that has been described mostly in association with asbestos exposed workers. The objective of this study is to evaluate the contrast enhancement at computed tomography (CT) in asbestos related RA in Brazil. **METHODS:** Between January 1998 and December 2000, high resolution computed tomography (HRCT) were performed in 1658 exposed asbestos workers. The preliminary diagnosis of RA was made on a history of prior asbestos exposure, the presence of characteristic (HRCT) findings and lesions which remained unchanged or slightly reduced in size over 2 years or more (Webb, Muller, Naidich in: HRCT of the Lung 2nd ed. Lippincott-Raven, 137-138, 1996). RA were recognized in 9. In two cases RA was verified by surgery. The dynamic contrast enhancement study, was adapted from Swensen et al. (Radiology 194: 393, 1995) and modified to evaluate nodules and pulmonary masses. **Statistical analysis:** paired t test, significance < 0.05. **RESULTS:** Housefield Unit (HU) initial 62.5±9.7, HU final 125.4±20.7 and median enhancement was 62.8±19.7 HU (range 40 to 89 HU), with a uniform dense opacification. **CONCLUSION:** Using a dynamic contrast study, all the RA showed a contrast enhancement with uniform dense opacification.

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Impairment of diffusing capacity in asbestos exposed workers

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590 smoking workers exposed to asbestos were examined with high resolution computed tomography (HRCT), spirometry and single breath diffusing capacity in order to study the character and reason for lung function impairment. Based on the HRCT finding scored 0-5 for fibrosis (F) and emphysema (E), and 0-3 for adhesions (A), the workers could be divided into five groups of pure diseases, pleural thickenings (N=190)(mean E score=0, F score <1, A score=0), emphysema (mean E score 1.7, F score <1) (N=148), pulmonary fibrosis (mean F score 2.77, E score 0)(N=68), combined emphysema and fibrosis (EF)(mean E score 2.15, mean F score 3.21)(N=74), significant pleural adhesions (N=110). The diffusing capacity was the highest in workers with pleural thickenings (98 ± 14 % of predicted), but the difference was not significant compared with workers with fibrosis (93 ± 15 % of predicted). The diffusing capacity was lowest in workers with EF (72 ± 21 % of pred.), which is significantly lower than in F (p<0.01). The results indicate that the impairment of diffusing capacity in asbestos exposed workers is mostly determined by the presence of emphysema.

OBSTRUCTIVE AIRWAY DISEASES IN ASBESTOS WORKERS

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Introduction: Several studies showed obstructive ventilation patterns among workers exposed to asbestos dust. The aim of our study was to find out whether the frequency of obstructive airway diseases even without simultaneously existing restriction is increased in a group with high asbestos exposure. **Methods:** Clinical findings, lung function data (measured acc. to ATS recommendations; reference values by Maltys et al., 1995, Brändli et al., 1996, 2000) and radiological diagnoses (HR-CT) of 109 randomly selected employees previously highly exposed to asbestos dust were analyzed (mean exposure duration 24.9 years). The subjects had been registered by statutory accident insurance institutions under the issue "Central registration of asbestos dust-endangered employees". Only subjects with a high risk of contracting bronchial carcinoma or mesothelioma due to high exposure and long latency periods according to the model by Coenen and Schenk (1990) were included. 14 people showing anamnestic indications of lung diseases independent of asbestos exposure were excluded. **Results:** 24.1% of non-smokers (n=29) demonstrated an elevation of the specific airway resistance (sRt) whereas none of the subjects had a reduced FEV₁%VC. One non-smoker showed a FVC reduction. sRt was in 28.8% of smokers/ex-smokers (n=86) above normal, and 13% revealed an additional FVC reduction. FEV₁%VC as well as FVC reductions were found in 9.1 of smokers and in 3% of ex-smokers. **Discussion:** Our investigation shows that high asbestos exposure is associated with increases in airway resistance without concomitant restriction. Body plethysmography mainly registers central airways. From the outcome it is assumed that asbestos initiates an inflammatory process within the bronchi resulting in obstructive airway diseases.

NIOSH Extramural Award Final Report Summary

Title: Computer-Assisted Chest Radiograph Reader
Investigator: Peter Soliz, Ph.D.
Affiliation: Kestrel Corporation
City & State: Albuquerque, NM
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Abstract:

To reduce inter- and intra-reader variability in diagnosing chest radiographs, a neural network-based computer-aided diagnostic system was developed and tested. The results of an experiment with 124 digitized chest radiographs, demonstrated high degrees of sensitivity and specificity in classifying chest radiographs. The use of a computer-assisted chest radiograph reader eliminated the inconsistencies in the human readers. The Computer-assisted Chest Radiograph Reader System (CARRS) applies recognized principles in the psychophysics of human vision, incorporates neural network-based image analysis and integrates these with a graphical user interface. Advances in digital image processing, and classification techniques have made CARRS feasible for meeting screening, research and development, and clinical requirements.

Through the adoption of the International Labor Organization (ILO) classification procedures, it had been hoped that reader variation in the classification of parenchymal abnormalities could be minimized. The ILO classification of the pneumoconioses is based on a structured procedure for detecting and characterizing patterns on chest radiographs. Numerous studies have shown, however, that inter- and intra-observer variability of radiograph readings by trained medical personnel has persisted.

The methodology was implemented through the following tasks: 1) From a data base of several thousand patients, a set of 205 chest radiographs were manually graded by two pulmonologists; 124 of the films were then digitized at 12-bit high spatial resolution. 2) Textural features were calculated using high order statistical techniques. The features were classified by the pulmonologists to "train a neural network to extract classification rules chest radiographs based on the ILO methodology. 3) The neural network classification from the graded system was tested using 65 chest radiographs.

For 5-10 areas selected by the pulmonologist on the chest radiograph, a feature vector composed of image characteristics such as density distribution, entropy, fractal dimension, opacity counts, shape, etc. was calculated. This feature vector characterized numerically the areas used by the pulmonologist to grade the radiograph. The neural network trained on the same regions used by the pulmonologist, and through a quantitative feature vector, "learned" the characteristics of each ILO classification.

The laterally-primed adaptive resonance theory (LAPART) neural network was selected. LAPART presents the results of the training in human interpretable "rules." LAPART trains in a single pass ("fast") making it attractive for a clinical setting. To demonstrate that calculated characteristics of chest radiographs could be used to train the LAPART to classify the radiographs using objective and quantitative parameters, a pilot study was conducted. 32 statistical features from 124 digitized chest radiographs were calculated. Statistical parameters were selected based on their contribution to the separation of classes. The parameters included entropy, contrast, fractal dimension, and co-occurrence statistics. The computational efficiency of LAPART was demonstrated in this experiment. LAPART was trained on a Pentium 200. Training time for 10 experiments, where the training and testing radiographs were randomly selected, averaged 15 seconds per experiment.

In conclusion these experiments showed that LAPART is a worthy candidate for basing a semi-automatic chest radiograph classification system. The experiments demonstrated that CARRS has low classification variability and has a significantly high accuracy. The results of each of the 10 experiments showed that the LAPART neural network algorithm could be trained to "learn" the extent of the "hypercubes" which represented each of the six classifications in 32-dimensional space. LAPART classification accuracy averaged 98 %. "Truth" was determined by the two radiologists.

Publications

No publications to date.

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ABSTRACTS

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This special supplement of the *American Journal of Respiratory and Critical Care Medicine* contains abstracts of the scientific papers to be presented at the 2002 International Conference. The abstracts appear in order of presentation, from Sunday, May 19 through Wednesday, May 22 and are identified by session code numbers. To assist in planning a personal schedule at the Conference, the time and place of each presentation is also provided.