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2nd Department of Radiology, Medical University of Lublin
Department of Imaging Diagnostics of the District Specialist Hospital no. 2 in Rzeszów

JANUSZ ZŁOMANIEC, WIESŁAW GUZ,
MAŁGORZATA MATYSIAK, WITOLD KRUPSKI

High resolution computed tomography (HRCT) in diffuse pulmonary intraparenchymatous disorders

HRCT has revolutionized the radiologic picture of diffuse, chronic infiltrative pulmonary diseases visualizing early changes, imperceptible on radiograms, poorly visible, doubtful or ambiguous (4). This technique has shown these changes many times in patients with scanty symptoms with normal results of functional tests (13).

The aim of the paper is to assess the usefulness of HRCT in early imaging of fine parenchymal densities and their character on the lung lobule level.

MATERIAL AND METHODS

The material comprised 62 patients (49 men and 13 women aged 43-74 years). Chest X-rays taken with the hard rays technique in maximal inspiration were preceded by HRCT examinations. They were done with Somaton ART Apparatus by Siemens equipped with the reconstruction matrix 512 x 512 pixels and a special picture reconstruction program referred to a high spatial resolution algorithm sharpening the contours of fine pulmonary lesions. Two 2 mm thickness of sections ensured optimal spatial resolution. Table shift was 10 mm, projection field 35 x 40 cm was, when needed, reduced to 12 x 24 cm. The duration of sections was 3 sec. Routine pulmonary window was used with the width level 1,000–1,600 Hu, the center from –700 to –500 Hu. The supplementary mediastinal window: width 400 Hu, center 35 Hu. Exposition parameters: voltage 130 kV, current intensity 150 mA.

After a screening tomogram in AP projection sections were done in the selected fields of anomalies visible in radiograms. Most frequently 7-8 sections in 10 mm intervals between layers were done, directed to an observed radiographic pathology. In some cases the examination was performed from the apices to the diaphragm. The sections were done with arrested breathing at the end of inspiration. The examination was many times supplemented in the lying on the stomach position. This position precluded condensation which could result from hydrostatic mechanism and pseudo-changes eliminating the so-called gravitational effect.

RESULTS

HRCT detected various abnormalities. Milk-glass fields occurred in about 42% patients forming amorphous parenchymal densities diffuse or focal.

In 4 cases opacities, especially in inferior and posterior parts of the lungs resulted from gravitational effect, which in supine position formed densities simulating pulmonary fibrosis (Fig. 1a). Lying-on-the stomach-position eliminated densities dependent on a decrease of parenchymal volume and compressive changes at the base on the lungs in the so-called dependent pulmonary fields. It let differentiate potentially reversible changes from irreversible fibrosis (Fig. 1b).

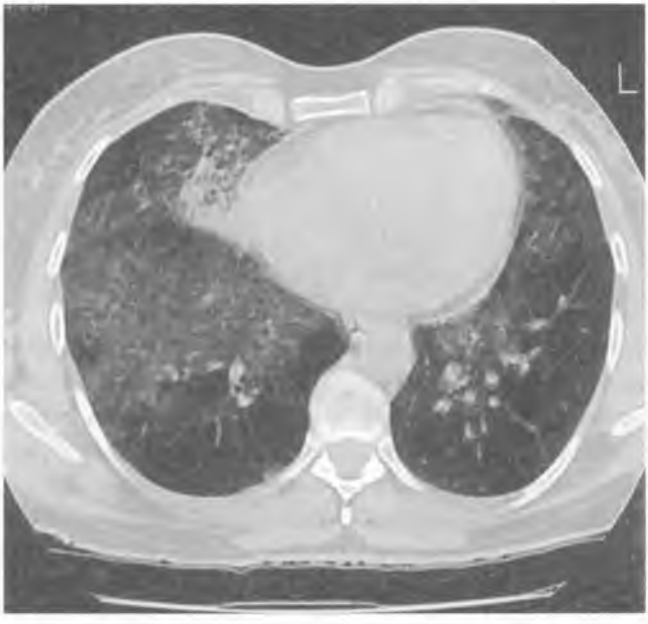

Fig. 1a. Supine position spotted thickening of pulmonary parenchyma

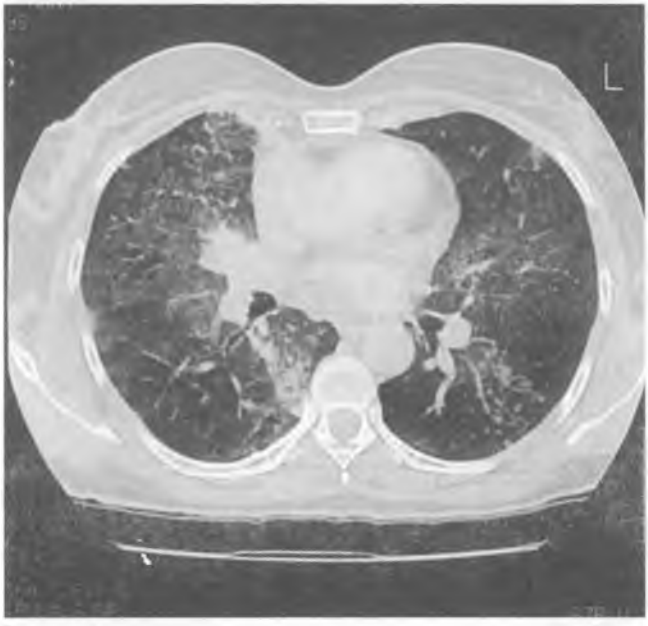

Fig. 1b. Position of the stomach decreases densities dependent on the gravitation effect

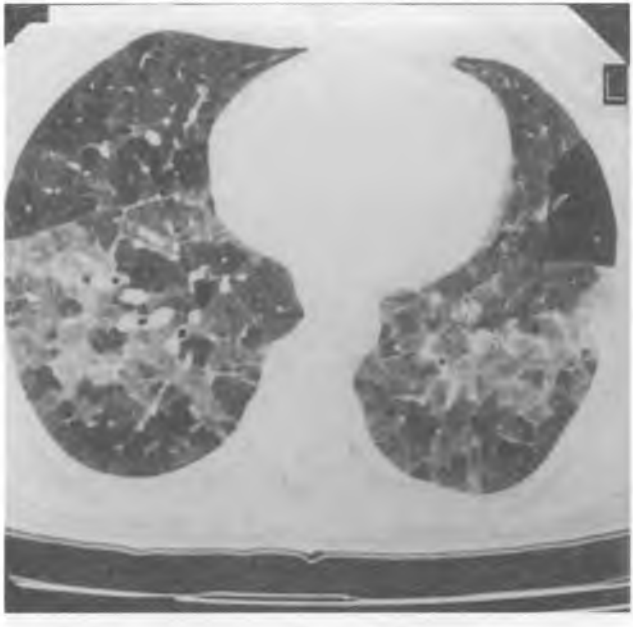

Fig. 2. In expiratory section in the course of alveolitis allergica numerous air traps are visualized

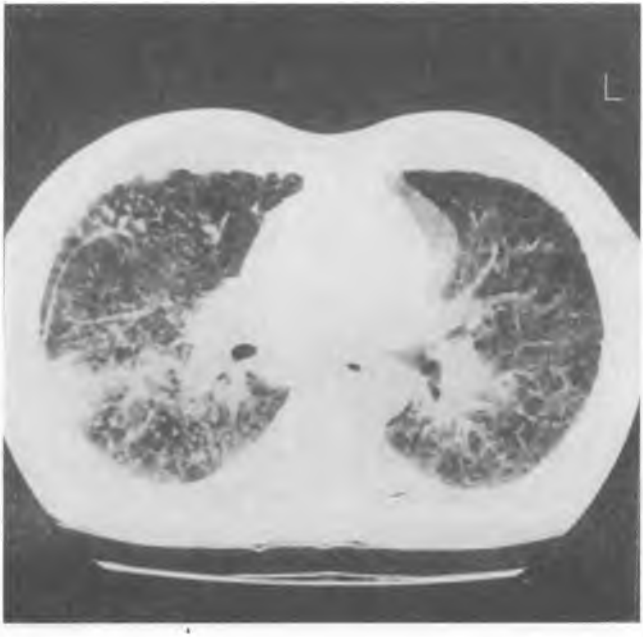

Fig. 3. Blurred heterogenous spotted parenchymal thickenings against the background of inflammatorily intensified bronchial and peri-bronchial outline

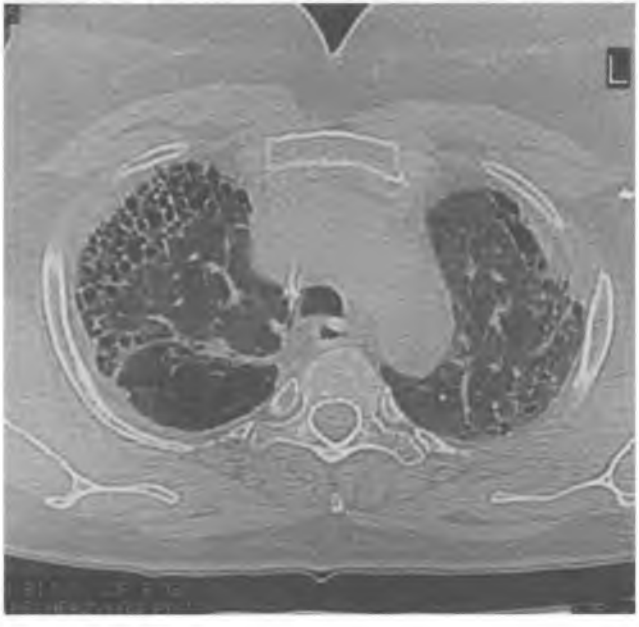

Fig. 4. Honeycomb picture in peripheral parts of the lungs

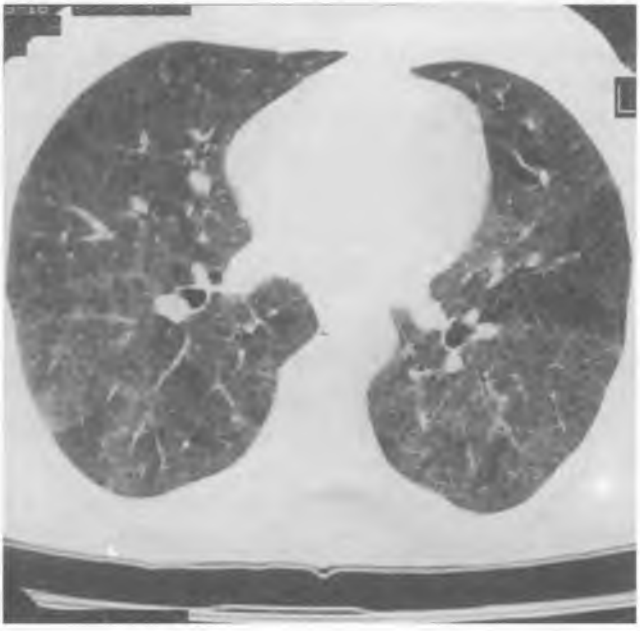

Fig. 5. Milk vailing of pulmonary fields (alveolitis allergica)

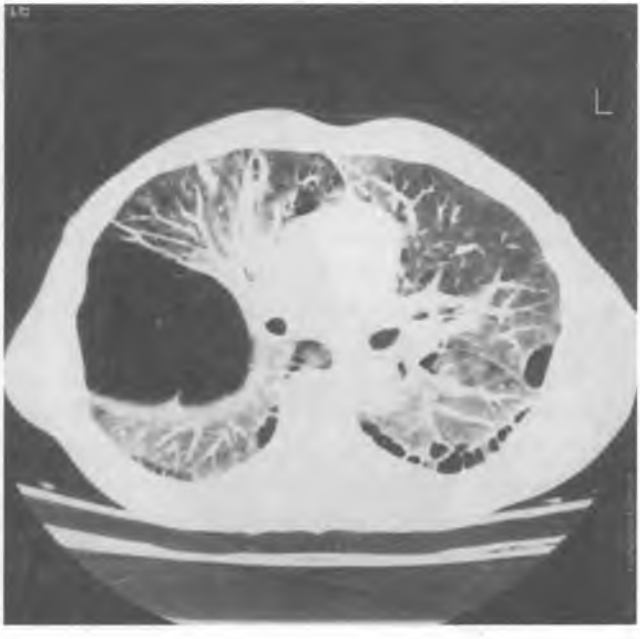

Fig. 6. Alveolar emphysema and compressed pulmonary parenchyma

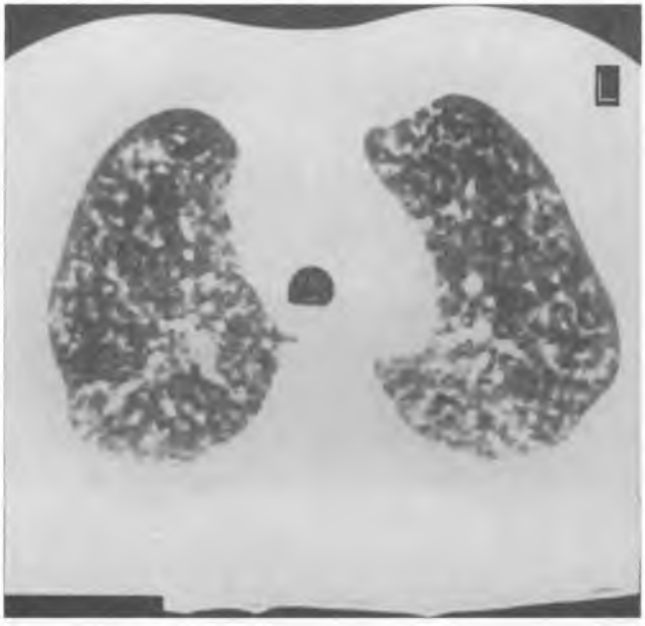

Fig. 7. Blurring nodular changes in the course of sarcoidosis

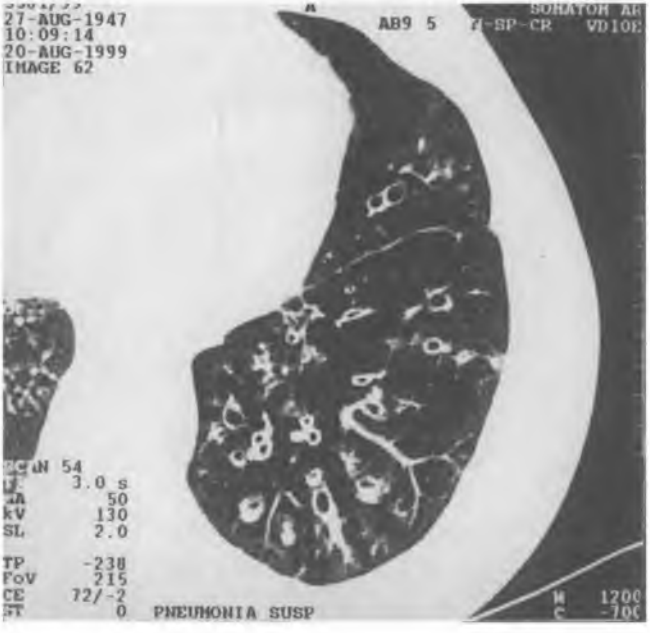

Fig. 8. Cavernous nodules

In 10 cases the areas with a small or visible lack of lung density increase during expiration corresponded to the so-called air traps i.e. focal air arrest (Fig. 2). It was found that density differences in inspiration between condensations of milk-glass and normal parenchyma were similar to those between it and air traps in expiration.

In 2 patients the whole of clinical picture confirmed the diagnoses by HRCT of *bronchiolitis obliterans* organizing pneumonia (Fig. 3).

In 9 patients a honey comb picture was observed. It was formed by numerous, thin or thick wall cystic air spaces of different sizes (Fig. 4). In 3 cases of idiopathic pulmonary fibrosis they were surrounded by parenchymal fibroses.

In 7 patients pulmonary parenchyma was considerably deprived of air because of filling alveolar spaces with fluid and tissue masses (Fig. 5). Milk-glass type opacities expressed alveolities with co-existing parenchymal discordance.

In 11 patients alveolar emphysema was recognized, usually associated with intralobular or periseptal one. HRCT revealed the character of emphysymal changes and morphology of compressed pulmonary parenchyma (Fig. 6).

In 22 cases nodular changes were shown (Fig. 7). In 12 patients micronodules were found up to 3 mm in diameter, in 7 – nodules – 3-20 mm, in 3 – over 20 mm in diameter. Identification of micronodules usually localized in the subpleural space absolutely required HRCT sections. Nodules of air spaces had blurred contours and intralobular localization. Three times cavernous nodules were found with thick and more irregular walls than distentions or emphysymal alveoli.

DISCUSSION

Intraparenchymal pulmonary disorders constitute a heterogeneous group with a wide range of histopathologic anomalies. The clinical picture is varied but the common feature is progressing dispnoea and restriction of lung functional tests.

In alveolities the air of alveoli, ducts and bronchioles is replaced by exudates or diverse tissue cells. In fibrosing alveolities alveolar spaces are filled with hyaline membranes. Thickenings of alveolar walls due to parenchymal fibroses with progressing narrowing of the lumen form together milk-glass type opacities.

The area of decreased parenchymal density in expirational air traps side by side with disturbances of blood flow form pictures of mosaic perfusion. *Bronchiolitis* involves fine respiratory ducts i.e. terminal bronchioles and alveolar ducts. *Bronchiolitis constrictiva* or *obliterans* constitutes a concentric narrowing of bronchioles caused by submucous or peribronchial fibrosis (3). The consequence is the occurrence of the syndrome of chronic obstruction of air flow whose intensity depends on the degree of bronchioles narrowing. The impairment of patency may be reversible (inflammation of mucous plugs) and irreversible (stenosis on fibrotic background).

A normal radiogram in HRCT in 20-30% of patients reveals different degrees of excessive pneumotisation, peripheral obliteration of the vascular picture, nodules of air spaces, thickening of bronchial walls of circinate or branch shades character, intensification of the pulmonary picture, the so-called "dirty lung" (1).

Combination of intralobular nodules and branch ramifications forms the "three in bud" symptom. The areas of filling of pulmonary alveoli (milk-glass) are formed by inflammatory exudates occupying septa and alveolar spaces (6). In most diseases pictures with patchy distribution are formed with visible pulmonary vessels within abnormal fields. Thickenings of interlobular septa "crazy pawing" reflect both the swelling of intraparenchymal tissue and filling of alveoli.

Milk-glass symptom in alveolitis of different intraparenchymal inflammatory diseases reflects the activity and reversibility of the inflammatory process. An active disorder was found in over 80% of patients exhibiting this symptom which is not associated with fibrosis (10). When milk-glass opacity occurs in the regions showing the presence of fibroses, it reflects rather the irreversible component than an active process. Active alveolitis and slight fibrosis gives a better prognosis for healing and reversibility of the inflammatory process.

The degree of increased density determines the degree of inflammatory activity. In a later stage fibroses form a honeycomb picture resulting from bronchial distentions. Subpleural densities in gravitation dependent fields were also shown in 17% of patients in control group (5). They resulted from an increased amount of flowing blood and decreased amount of air in posterior, subpleural parts of the lungs.

Intralobular nodules usually occur in the center of secondary lobules showing a definite relation with a bronchiole or intralobular artery (2). They can form an aggregate or rosette of nodules surrounding intralobular vessels. In HRCT the most peripheral nodules are usually localized 5-10 mm from the pleural surface (9). They most frequently occur in various bronchiole diseases. Spiral CT identifies poorly confined micronodules with poor density (13). Isolated nodules also occur in 14% of people without complaints in upper lung zones and in smokers (12). Cavernous nodules develop due to the removal of necrotic material through the respiratory tract in the central part. Big nodular opacities form conglomerates surrounding bronchi and vessels. Bronchi may be compressed, widened because of fibroses and tractions forming distensions.

Deformation of the architecture of pulmonary parenchyma is characterized by dislocations and damages to bronchi, lung vessels and interlobular partitions with a decrease of pulmonary volume.

Intralobular parenchymal thickenings occur in the center of secondary lung lobules surrounding the intralobular artery and bronchioles (2). They can be the dominant symptom in disorders of intralobular bronchioles. Interlobular septa form regular thickenings with linear or polygonal structure communicating with intralobular pulmonary artery. Septal thickenings are best visible in the subpleural region.

Consolidations form heterogeneous increase in lung density with obliteration of the vascular outline. Diffuse speckled or lobar ones get localized around terminal bronchioles. The air filling bronchi gets visualized due to increased density of surrounding parenchyma forming the so-called air bronchogram.

Bronchial distensions are divided into cylindrical varicose and cystic-balloon-like (11). They form circinate shadows which are poorly separated, thin wall and may contain fluid levels.

In an advanced form honeycomb pictures are formed, which may be the final stage of fibroses with different etiology and parenchyma distraction (7).

HRCT is a technique of choice replacing bronchography. HRCT symptoms depend on the morphologic type of distensions and orientation of the bronchus to the section plane. It is essential to classify emphysemal HRCT into intralobular, the whole of the lobule, periseptal, irregular. Different types of emphysema can be associated with bigger alveoli HRCT is the most sensitive technique in detecting emphysema, determining its form and extent (8). The technique reveals its presence before the occurrence of anomalies in pulmonary tests.

Intralobular emphysema in the most common upper-lobe localization shows numerous, fine spheric fields of small density. Emphysemal spaces grouping in the center of secondary lobules surround intralobular arterial branches. The areas of emphysema do not usually show the walls in contrast to cysts.

Damages to pulmonary vessels include the reduction of arterial branches, increase in the caliber and number of peripheral vessels, lack of vessels or dislocations caused by cysts, widenings and deformations of vessel division angles with the loss of lateral branches.

In more intense intralobular emphysema destruction fields can fuse, intralobular structure is not perceptible in HRCT and forms emphysema involving the whole of the lobules.

CONCLUSIONS

1. 2 mm thick HRCT sections in high resolution algorithm optimalise spatial resolution, sharpen fine parenchymal structures and give a possibility for interpreting changes on the lung lobule level.

2. They let detect early and slight changes imperceptible radiographically, let confirm or exclude doubtful ones. When clinical, radiographic and functional symptoms are not fully developed, revelation of covered changes allows to assess their structure and character.

3. They make possible differentiation of active changes from irreversible (fibrous) ones showing at the same time specific fields for biopsy.

4. Expirational HRCT sections facilitate the discovery of air traps.

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SUMMARY

The value of high resolution computed tomography (HRCT) was presented in the material of 62 diffuse pulmonary intraparenchymatous disorders. Visualisation of milk-glass type opacities, honeycomb picture, nodular changes, alveolar emphysema, usually associated with intralobular or periseptal, was analyzed. Expirational HRCT section facilitate the discovery of air traps. HRCT make possible differentiation of active changes from irreversibles (fibrous).

Tomografia komputerowa wysokiej rozdzielczości (TKWR) w rozlanych schorzeniach śródmiąższowych płuc

Wartość tomografii komputerowej wysokiej rozdzielczości (TKWR) przedstawiono w materiale 62 rozlanych schorzeń śródmiąższowych płuc. Analizowano uwidocznienie zacienień typu szkła mlecznego, plastra miodu, zmian guzkowych, rozedmy pęcherzykowej zwykle skojarzonej ze śródpłacikową lub przyprzegrodową. Wydechowe przekroje TKWR ułatwiały odkrycie pułapek powietrznych. W TKWR było możliwe zróżnicowanie zmian aktywnych i nieodwracalnych (zwłóknień).