Acute respiratory distress syndrome (ARDS) is a clinical condition first described by Ashbaugh et al in 1967 using the term “adult respiratory distress syndrome”. In order to establish a diagnosis of ARDS, radiological findings are necessary and they serve as one of the postulates. According to the latest definition, which was created by a panel of experts in 2011 in Berlin, thus termed the Berlin definition of ARDS, ARDS is a condition starting within 1 week of clinical insult with bilateral infiltrates detectable by chest imaging (either conventional radiography or multidetector computed tomography (MDCT) scan of lungs) and severe hypoxemia in the absence of evidence for cardiogenic pulmonary edema or fluid overload. It is necessary to explain the origin of edema, and to do that we need objective assessment (e.g., echocardiography) in order to exclude cardiogenic factors. Severity of ARDS is based on ratio between partial oxygen pressure in arterial blood and fraction of oxygen in the inspired air (Pa\(_\text{O}_2\)/FIO\(_2\)) on 5 cm of continuous positive airway pressure (CPAP). The 3 categories are mild (Pa\(_\text{O}_2\)/FIO\(_2\) 200-300), moderate (Pa\(_\text{O}_2\)/FIO\(_2\) 100-200) and severe (Pa\(_\text{O}_2\)/FIO\(_2\) =100). The definition itself says that in order to make a diagnosis we must do radiology imaging, although it does not say which one should be performed, the conventional radiography or MDCT. ARDS represents a stereotypic response to many different inciting insults and goes through a number of different phases, from alveolar capillary damage to lung resolution or a fibro-proliferative and fibrotic phase. The pulmonary epithelial and endothelial cellular damage is characterized by inflammation, apoptosis, necrosis and increased alveolar capillary permeability, which lead to development of alveolar edema. Purpose and role of radiographic methods is to assist in the visualization of above mentioned pathomorphological substrate. Because of the fact that sensitivity of conventional radiography is significantly lower than that of MDCT imaging, MDCT could be the primary method of choice in the initial diagnosis, but for the patient with ARDS it is most important that he has the best conditions concerning mechanical ventilation, which is very complicated to provide during the transportation of the patient from intensive care unit to MDCT diagnostic unit. As the disease evolves inside the lung area, some of the complications can be visualized only with MDCT. That is one of the main reasons MDCT is used for that period of disease evolution. Because of everything that is mentioned above, it is hard to decide whether and when MDCT scan should be performed.

Key words: ARDS, diagnostic imaging, MDCT, conventional radiography

INTRODUCTION

Acute respiratory distress syndrome (ARDS) is a clinical condition first described by Ashbaugh et al in 1967 using the term “adult respiratory distress syndrome”. In order to establish a diagnosis of ARDS, radiological findings are necessary and they serve as one of the postulates. According to the latest definition, which was created by a panel of experts in 2011 in Berlin, thus termed the Berlin definition of ARDS, ARDS is a condition starting within 1 week of clinical insult with bilateral infiltrates detectable by chest imaging (either conventional radiography or multidetector computed tomography (MDCT) scan of lungs) and severe hypoxemia in the absence of evidence for cardiogenic pulmonary edema or fluid overload. It is necessary to explain the origin of edema, and to do that we need objective assessment (e.g., echocardiography) in order to exclude cardiogenic factors. Severity of ARDS is based on ratio between partial
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OUR EXPERIENCE

In the intensive care unit of Emergency Center in Clinical Center of Serbia we usually do bed chest radiography in supine position when we believe that the patient is suspicious of developing ARDS in its early phase. For making a diagnosis of ARDS we have two different methods: bed AP radiography of the lungs and heart and MDCT scan of thorax. On the conventional chest radiography of the patient with ARDS these pathomorphological changes can be detected: typically a delay of up to 12-24 hours elapses since the clinical onset of respiratory failure to the appearance of abnormalities of the chest radiograph. The earliest findings consist of patchy, ill-defined bilateral lung opacities. The chest radiograph is characterized by bilateral opacities involving at least 3 quadrants that are not fully explained by pleural effusions, atelectasis and nodules. Characteristically involvement is diffuse and affects all lung zones from the apex to the base and to the extreme periphery of each lung, with air bronchogram frequently visible. The differential of this finding is pulmonary effusion that is characteristically apparent on supine radiographs, and its presence should strongly suggest concomitant hydrostatic pulmonary edema or complicating acute pneumonia or pulmonary infarction. That is the reason why in these situations the MDCT is indicated. After a week the lung remains diffusely abnormal, but the pattern tends to become reticular. The sensitivity of conventional chest radiography with these changes is very small. Findings on CT or HRCT in early disease show diffuse non-gravity dependent patchy consolidation and ground glass opacification. Air bronchograms and small pleural effusions are common. CT is used for defining the severity score, ARDS-SS, which can be used to classify patients in groups that contain patients of high mortality risk. The CT itself has the purpose of rating the presence of the lung damage. Some authors recommended measuring zero end-expiratory pressure (ZEEP) at an early phase of ARDS, but that procedure has not been accepted in our clinical routine.

THE ROLE OF CHEST RADIOGRAPHY AND MDCT

Chest radiography is a useful tool for establishing the diagnosis of ARDS, it is low-cost, practical and fast, able to monitor evolution of disease as well as to detect complications. Furthermore radiographic appearance in large extent correlates with histopathological stages of the condition described in further text.

The results of different authors show on MDCT scan that in contrast to lower lobes, which are essentially non aerated, the upper lobes are normally aerated in 36% of patients with ARDS, partly aerated in 41%, and non aer-
ated in the remaining 23%. Radiologically these morphological differences in the distribution of air within the upper lobes give the visual impression either on CT or chest radiography - that hyperattenuated areas are lobar, diffuse or patchy. As soon as these differences in lung morphology become obvious to us, we make the logical hypothesis that they are associated with differences in clinical characteristics, outcome, pulmonary hemodynamics, ventilation-perfusion mismatch and respiratory mechanics.

Imaging is an essential part of establishing the diagnosis of ARDS and it can also provide clues which can point out etiology and chronicity of the condition, as well as to monitor ARDS and identify clinical complications. It is also increasingly being shown to provide prognostic information.

Three histopathological stages of ARDS can be identified:

1. Exudative or Acute Phase (1–7 Days) - during which, after initial radiographically silent 24 hour period, we observe increased capillary permeability and the influx of protein-rich fluid into the alveolar space and interstitium due to endothelial injury. This is usually manifested as predominantly bilateral and symmetrical air space and interstitial opacities on the chest radiography. Using chest radiography alone it can be hard to differentiate ARDS from cardiogenic pulmonary edema, which is more often associated with cardiomegaly, septal lines or pleural fluid and perihilar alveolar opacities.

2. Proliferative or Intermediate Phase (8–14 Days) - during which the radiographic appearances usually stabilize and remain static in form of diffuse coarse reticular opacities, although this does not imply irreversible fibrosis, as the opacities may resolve.

3. Fibrotic or Late Phase (>15 Days) - during which most radiographic abnormalities begin to resolve if the acute phase is survived and the findings on chest radiography in this phase range from completely normal to widespread coarse reticular opacities.

**Computed Tomography in ARDS**

The benefits of CT imaging have to outweigh the risks associated with transporting a patient from the intensive care unit (ICU) to the radiology department and also the practicality of bedside radiography in ICU.

There are two phases of ARDS that can be recognised on MDCT exam:

1. The early phase - with the opacifications that follow an antero-posterior density gradient within the lung, from dense consolidation in the most dependent regions to normal or hyperexpanded lung in the non-dependent regions. Another characteristic in acute ARDS is dilatation of bronchi within the ground-glass opacification areas that may be a sign of the development of early fibrosis (traction bronchiectasis), but this is not a conclusive proof of fibrosis because the reversal of bronchial dilatation in the later stages of ARDS.

2. The late phase - where complete resolution of abnormalities may occur, but also the more typical later stage CT appearances are that of a coarse reticular pattern and ground-glass opacification (both being the signs of fibrosis, probably due to barotrauma during mechanical ventilation) in the nondependent part of the lungs. Dependent part of lungs seems to be spared from barotrauma by consolidation or atelectasis, especially in patients with the nonpulmonary cause of ARDS due to better alveolar recruitment (thus lesser barotrauma) dur-
In the clinical setting CT is a recognized and effective means of confirming the diagnosis of ARDS, it is perhaps most often used for identifying complications, but also has the potential to determine different ventilation strategies as well as prognosis (presence of fibrosis indicated by ground glass opacification, traction bronchiectasis, and honeycombing was a strong independent predictor of mortality).5,9,10

SUMMARY

MDCT KOD ARDS-α: NAŠE ISKUSTVO

Akutni respiratorni distres sindrom (ARDS) je kliničko stanje koje je prvi opisao Ashbaugh 1967, upotrebivši termin “adultski respiratorni distres sindrom”. Za postavljanje dijagnoze ARDS-α, radiološki nalazi su neophodni i predstavljaju postulat. Prema najnovijoj definiciji sa panela eksperta 2011, Berlinska definicija ARDS-α, ARDS5 je stanje nastalo tokom jedne nedelje od početka kliničkog nalaza, sa obostranim infiltrativnim promenama u plućnom parenhimu koje su otkrivene radiografskim metodama udružene sa teškom hipoksiom, bez znakova kardiogenog plućnog edema ili hipervolemije. Procena težine ARDS-α se zasniva na određivanju odnosa između parcialnog pritiska kiseonika u arterijskoj krvi i frakcije kiseonika u inspirisanoj vazduhu (PaO2/FIO2) na 5 cm pozitivnog vazdušnog pritiska (CPAP). U definiciji je navedeno da je za postavljanje dijagnoze neophodno uraditi imaging dijagnostiku, ali nije precizno definisano koji imaging modalitet se mora upotrebiti (konvencionalna radiografija ili MDCT). Plućna epitelna i endotelna oštećenja kod ARDS-α se karakterišu inflamacijom, apoptozom, nekrozom i povećanjem permeabilnosti alveolo-kapilarne membrane, usled čega dolazi do nastanka alveolarnog edema. Svrvha i uloga dijagnostičkih metod je da pomogne u vizualizaciji pato-morfološkog substrata. Zbog činjenice da je senzitivnost konvencionalne radiografije signifikantno niža od MDCT pregleda grudnog koša u detekciji promena, MDCT pregled bi trebao da bude primarni metod izbora u dijagnostici, ali je za pacijente sa ARDS-om najbitnije obezbediti idealne uslove mehaničke ventilacije, što je veoma teško sprovedi u toku transporta pacijenta od jedinica za intenzivno lečenje do MDCT dijagnostike. U toku evolucije bolesti, pojedine komplikacije je moguće vizualizovati samo MDCT pregledom, tako da je to jedan od glavnih razloga za pregled. Obzirom na sve navedene činjenice jako je teško odlučiti se da li, kome i kada treba uraditi MDCT pregled.

Ključne reči: ARDS, dijagnostički imidžing, MDCT, konvencionalna dijagnostika

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