Abstract: Hydatid cysts are widespread zoonosis that originate from the larval embodiment of the Echinococcus and can be frequently found in the lung and liver parenchyma, in addition, they emerge in various atypical locations in the thoracic cavity such as the mediastinum, its vascular compounds and the heart, the interlobar fissures, the pleural and pericardial space, as well as the structures of the chest wall and the diaphragm. Computed tomography as one of the most utilized instruments of radiology imaging has a crucial role in the diagnosis of hydatid cysts, depiction of their exact size and location, as well as estimation of impending complications.

The aim of this pictorial review is to offer full scale understanding of the recurrent imaging findings in thoracic hydatid disease as well as to display some rare, extra parenchymal involvement and a summary of the complications and differential diagnosis.

We did an in depth analysis of 55 chest CT scans of patients with thoracic hydatid cysts from North Macedonia and all patients underwent a contrast enhanced chest CT according to appropriate diagnostic protocol on a 16-slice Somatom GO computed tomograph (Siemens Healthineers, USA).

Hydatid cysts in all 55 patients were divided by location and appearance in two by two categories, uncomplicated parenchymal and extra parenchymal, and complicated or ruptured parenchymal and extra parenchymal cysts. Uncomplicated parenchymal hydatid cysts were presented by well circumscribed, low attenuating, homogenous lesions with smooth walls of varying thickness, whereas complicated or ruptured hydatid cysts could be categorized in two forms, contained or complete rupture. The most frequent imaging findings were the air crescent sign, waterlily sign and dry cyst sign. Uncommon extra parenchymal hydatid cysts’ locations were the mediastinum, pericardium and the diaphragm.

Computed tomography plays an important diagnostic role in common thoracic hydatid cysts and aids in the evaluation of rare and complicated cases.

Keywords: hydatid cysts, Echinococcus, lung parenchyma, multidetector computed tomography (MDCT), extra parenchymal
hemoptysis, anaphylactic reactions or expectoration of the membranes or hydatid sand which has been described in almost one third of the cases (13-18). There are several frequent complications that transpire in half of the patients and they are cyst rupture which can be contained or direct communicating, as well as seeding and infection. Complicated hydatid cysts that present with detachment of the outermost layer or pericyst from the inner layer or endocyst, are classified as contained ruptures, and direct or communicating are those in which the cyst content, membranes and hydatid sand, are expectorated into the airways through a draining bronchus (19, 20, 21).

The aim of this pictorial review is to offer full scale understanding of the recurrent imaging findings in thoracic hydatid disease as well as to display some rare, extra parenchymal involvement and a summary of the complications and differential diagnosis.

2. MATERIALS AND METHODS
Non enhanced CT is usually applied for the evaluation of majority of typically located lung parenchymal cysts, whereas contrast enhanced CT plays a major role in the diagnosis of extra thoracic hydatid cysts, especially those who are found in the mediastinal space.

We did an in depth analysis of 55 chest CT scans of patients with thoracic hydatid cysts from North Macedonia and all patients underwent a contrast enhanced chest CT according to appropriate diagnostic protocol on a 16-slice Somatom GO computed tomograph (Siemens Healthineers, USA). Scans were acquired with the patients on the table in a supine position, arms overhead and with a single breath hold during the scan time. A power injector was used for the introduction of the iodinated contrast agent into a cubital vein, and an early arterial and delayed venous phase were performed in a craniocaudal direction from the base of the neck to the upper abdomen. The CT parameters were 100 mAs, 120 kVp, rotation time 0.25s, and collimation of 192 × 0.6mm with a pitch of 2.5. Images were obtained in an axial plane with the possibility of post processing and multi planar reconstruction. All 55 CT scans were thoroughly evaluated by a radiologist with a subspecialty in thoracic and vascular radiology and features such as location, shape, size and signs of complications, as well as the most common differential diagnoses of the hydatid cysts were summarized.

3. RESULTS
After the liver, lungs are considered second most frequent location for hydatid cysts in adults. The most common areas involved are the lower lobes (60% of patients), especially the right lower lobe, and the disease is bilateral in almost 20% of cases (22, 23). Computed tomography is a diagnostic module of choice although the conventional x-ray can offer enough diagnostic information in cases with simple hydatid lung cysts, while the ultrasound can aid to the diagnosis of pleural based lesions as well as evaluation of pleural complications such as pleural seeding or empyema.

Hydatid cysts in all 55 patients were divided by location and appearance in two by two categories, uncomplicated parenchymal and extra parenchymal, and complicated or ruptured parenchymal and extra parenchymal cysts. 35 patients (64%) were diagnosed with either solitary or multiple parenchymal hydatid cysts without signs of complication or impending rupture. 10 patients, all children, had concomitant multiple liver cysts. The remaining 20 patients (36%) had complicated parenchymal and atypically located hydatid cysts.

On conventional chest x-ray, uncomplicated hydatid cysts resemble canon ball on the AP projection or rugby ball on the lateral, while on computed tomography they are usually oval shaped, well defined lesions of varying size, with smooth and hyperattenuating walls and a homogenous intracystic fluid attenuation. When in the lung parenchyma, they rarely present with daughter cysts or rim calcification. These unremarkable CT features make it impossible to differentiate them from other lung cysts like the bronchogenic, esophageal duplication cysts, and others (Figure 1, a-c). In comparison liver hydatid cysts may present with rim calcification and daughter cyst formation (Figure 2 a, b).
Figure 1(a-c).

(a) b), c.)
a. Axial computed tomography image of an uncomplicated, oval shaped, well circumscribed hydatid cyst with smooth margins and homogenous fluid attenuation in the posterior segment of the upper right lobe. b.) and c.) Coronary computed tomography images, mediastinal and parenchymal window of a second, complicated hydatid cyst on an atypical location in the upper left lobe attached to the mediastinal pleura at the level of the aortic arch in the same patient.

Figure 2(a, b)

(a), b.)
a.) Coronary computed tomography image of two large hydatid cysts in the right liver lobe with daughter cyst formation and significant mass effect displacing the surrounding upper abdominal structures and the right diaphragm. b.) Axial computed tomography image of multiple hydatid cysts diffusely scattered in the liver parenchyma, and some present with rim calcifications.
On the other hand, complicated or ruptured hydatid cysts could be categorized in two forms, contained or complete rupture.
When the hydatid cyst is large, it causes surrounding lung tissue compression and often bronchial erosion, thus air enters the space between the pericyst and the endocyst and usually resembles an air crescent, or sometimes small blebs of air between the two layers give an air bubble appearance, and both are signs of impending rupture (Figure 1b, c). When air continuously enters the space between the two layers, there is a significant compression to the endocyst and it ruptures with collapse of the membranes thus forming an air fluid level and an onion peel appearance that is known as “cumbo sign”. With a complete collapse of the endocyst, the squashed membranes may float on the surface of the fluid, an appearance known as “water lily sign”. When the fluid is fully expectorated, the membranes fall at the bottom of the cyst and resemble a “mass within a cavity” and when membranes are also being expectorated, “dry cyst sign” (Figure 3 a-c), (Figure 4 a, b).

Figure 3(a-c)

a.) conventional x-ray, posterior- anterior (PA) projection of a complicated hydatid cyst in the lower left lobe with a cumbo or double arch sign; b.) and c.) Axial computed tomography images of a complicated, ruptured hydatid cyst, mediastinal and parenchymal window, demonstrating a classical “water lily sign” with the ruptured membranes floating on the surface of the fluid.
5 patients (9%) had atypically located solitary hydatid cysts without signs of complication and the most common locations we observed were the anterior mediastinum, the pericardium as well as the diaphragm. We also had an atypical case of calcified mediastinal hydatid cyst in an older patient, diagnosed incidentally on a routine chest CT for a different clinical indication (Figure 5,a, b), (Figure 6), (Figure 7, a, b).

a.) and b.) Axial computed tomography images of a complicated, ruptured hydatid cyst, showing fully expectorated fluid and crumpled endocyst at the bottom of the cyst resembling a “mass within a cavity. There can also be noted a surrounding reactive pneumonia and mild bilateral pleural effusion.

Figure 5(a, b)

a.) and b.) Axial and sagittal computed tomography images of a patient with uncomplicated hydatid cysts on an atypical location in the inferior anterior mediastinal space and attached to the pericardium at the level of the right ventricle. b.) there are concomitant liver hydatid cysts with discrete rim calcification in the same patient on the sagittal image.
sagittal computed tomography image of a patient with uncomplicated hydatid cysts on an atypical location attached to the diaphragm on the posterior.

**Figure 7(a, b)**

a.) and b.) axial and coronal computed tomography images of an asymptomatic patient with incidental atypical finding of a completely calcified hydatid cyst in the anterior mediastinum and attached to the pericardium at the level of the right atrium.

### 3. CONCLUSIONS

Computed tomography as one of the most utilized instruments of radiology imaging, has a crucial role and an important contribution in providing accurate diagnosis or a spectrum of most likely differential diagnosis of simple lung hydatid cysts, depiction of their exact size, location and internal structure, assisting in the evaluation of rare, atypically located and complicated cases, and predicting impending complications or rupture by giving a full scale information on the morphology of the cystic hydatid lesions as well as the internal arrangement.

### REFERENCES


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