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The analysis of the prevalence, importance and reporting rates of incidental lung lesions in non-contrast abdominal CTs performing for the evaluation of the urinary system

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ABSTRACT

Objectives: We aim to find the rate of incidentally detected lung lesions in non-contrast abdominal computed tomography (CTs) performed to evaluate the urinary system (urinary CT), to determine their reporting rate, and to draw attention to the importance of evaluating in an appropriate window the visualized parts of the lung.

Materials and Methods: In total, 152 patients [50.99±18.23; 6-89 years (age ± standard deviation; age range)] were included in the study. Lung segments in the cross-section area were evaluated in patients admitted to the hospital with urinary problems without known lung disease. The findings were classified according to gender, age group, and location of pathology.

Results: Three hundred thirty-four reportable lung pathologies and changes were detected. Of these pathologies, 48 (14.4%) were lesions that could be observed in the urinary CT window while 286 (85.6%) were the lesions that could only be detected by evaluation in the lung CT window. The reporting rate of lesions detected in the lung window was statistically significantly lower than the lesions detected in the urinary CT window [Lesions that could be detected in the main evaluation window were reported at a rate of 83.3%, while the reporting rate of lesions evaluated in the lung window was 20.62% (p=0.007)]. The frequency of encountered lesions increased over 50 years of age. In 67.76% of the patients, there was a pathology that required treatment, follow-up or further radiological evaluation.

Conclusion: The rate of lung lesions seen in urinary CTs is quite high, and the reporting rate is low. Urinary CTs should be evaluated in lung window.

Keywords: Computed tomography; urinary system; pelvic CT

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INTRODUCTION

Non-contrast abdominal computed tomography (CTs) performed to evaluate the urinary system (urinary CTs) are one of the examinations that have an important place in daily routine. It is taken without contrast, especially for better visualization of the calculi.[1] In CT scans focused on one region, the evaluation for the preliminary diagnosis is at the forefront. CT examinations are done in various CT windows with different settings of Hounsfield unit (HU). The most commonly used CT windows are abdomen and bone in abdominal examinations, and mediastinum, lung and bone windows examinations in chest.[2,3] While scanning a non-contrast urinary CT, field of view starts from a little bit upper from the diaphragmatic dome. Therefore, the graph also includes images belonging to the lung basales.[1]

Urinary CT scans usually are not evaluated in the lung window unless there is a suspicious lesion in the main windows from our point of view. Therefore, the evaluation of findings related to lung parenchyma remains incomplete. Because of the same reasons, pulmonary findings may be omitted. In our study, we examined urinary CTs in the lung window. We aim to find the rate of incidentally detected lung lesions in urinary CT, to determine their reporting rate, and to draw attention to the importance of evaluating in an appropriate window the visualized parts of the lung. As far as we know, there is no previous study on this subject in the literature.

MATERIALS AND METHODS

Study Design and Patient Population

Our retrospective study was approved by Muğla Sıtkı Koçman University Human Research Ethics Committee with the number of 210185/2021. The design and conduct of the study were in accordance with the general principles outlined in the Declaration of Helsinki.

The patients with previously known pulmonary pathology, CTs with artefacts, and the patient with urinary system pathology that will be reflected the chest images (34 patients had known lung pathology, two patients had a CT with screening artefacts, 8 patients had malignancy, two patients had autoimmune diseases) were excluded from the study. Urinary CT radiographs of the patients between January 2020 and December 2021 were evaluated retrospectively. In total, 152 patients with the mean age of [50.99±18.23; 6-89 years (age ± standard deviation (SD); age range)] were included in our study. Out of these patients, 87 were males and 65 were females. The mean age of the males was 52.78±17.54; 6-89 years while mean age of females was 48.60±18.99; 8-85 years.

A pre-analysis minimal sample size power analysis had been conducted using G-power 3 software, (https://www.psychologie.hhu.de/arbeitsgruppen/allgemeine-psychologie-und-arbeitspsychologie/gpower) indicating that a total analytic sample of 111 would provide the authors with 0.95 1-β power to detect meaningful results. Our sample size was enough for the study.

CT Technique

All urinary CT images were obtained without contrast agent injection in the supine position and performed with a 256-slice multi-detector CT scanner (Somatom, Siemens Healthcare, Erlangen, Germany) or 4 slices of Toshiba-TCT-60 AX (Toshiba Medical system Corporation, Yokohama, Japan) devices.

The following technical parameters were used; tube voltage, 100-120 kV; tube current-exposure time product, 200-300 mAs; pitch, 0.9125-1.375 and; and section thickness after reconstruction, 1-1.25 mm.

CT Image Analysis

A radiologists who have thoracic imaging experience more than 10 years retrospectively evaluated CT images. Every CT were evaluated in lung window settings as width, 1000 to 1600 HU; level, 700 to -550 HU. Detected elementary lesions were stored in excel files.

Clinical Data Analysis

The clinical significance of the lesions and necessity of follow-up and treatment were evaluated by a pulmonologist who have 11 years of experience.

Statistical Analysis

All continuous variables were expressed as medians, intervals, counts and percentages. The data were recorded (Excel 2010, Microsoft) and analysed using statistical software (SPSS, version 22.0, IBM). Continuous variables were expressed as mean ± SD values. CT findings were analysed with chi-square (χ^2) t and Student's t-tests. $P<0.05$ values were considered statistically significant.

RESULTS

Out of 152 patients, 78 of them were requested from the urology outpatient clinic, 62 were requested by the emergency service whereas only 12 examinations were requested by a department except for these two departments.

Twenty-one patients had completely normal lung appearance. Out of these patients, 12 were males and 9 were females. Out of other 131 patients with reportable pathologies and changes,

56 patients were males whereas 75 were females. There was no statistically significant difference between pathological and non-pathological groups according to genders (p=0.71). The mean age of the normal patients was 28.00±14.08 (8-71) while the mean age of the pathological group was 53.39±16.91 (6-89). There was statistically significant difference between normal reported and abnormal groups in terms of the age distribution (p=0.04) (Figure 1).

In total, 61 patients were <50 years old (younger group) while 91 patients were >50 years old (older group). The number of reportable pathologies and changes was significantly higher in older group than younger group (p=0.032). Thirty-nine different pathology and changes were found in the CT images of lung sections.

Three hundred thirty-four different pathology and changes were detected. Most frequent findings in lung images were paracardial fibrotic changes (PFC) with the rate of 40.13%, hiatal hernia with the rate of 21.71% and the pleural thickening with the rate of 19.74%. Fourty-eight of them were the pathologies can be seen in standard CT windows. 40/48 of them were reported (83.3%). Out of the all pathologies, 286 of them can be seen only lung windows. Only 59/286 of them were reported (20.62%). There was statistically significant difference between two groups (p=0.007) (Table 1).

In 103/152 (67.76%) patients, there was a pathology that required treatment, follow-up or further radiological examination.

DISCUSSION

Non-contrast thin section abdominal CT is the standard CT method used for urinary system evaluation. In the literature, this technique is called in different names, especially like non-contrast abdominal CT. However, this name is general and does not completely equal the technique that we mentioned. For this reason, this method will be called urinary system CT or urinary CT throughout our article.[4,5]

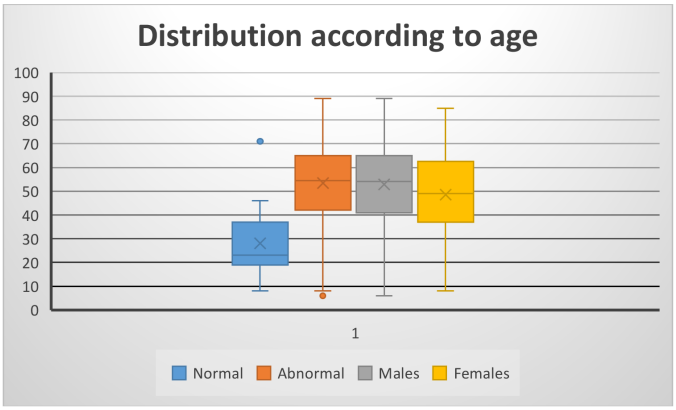

Figure 1. The figure shows the age distribution of normal reported and abnormal groups as well as male and female gender groups. There was significant difference between normal and abnormal groups.

We detected 334 pathologies as 39 different subheadings in 152 patients. In other words, there was an average of 2.2 reportable findings per patient. One hundred twenty-six different appearances related to were detected. Out of them, 61 were PFC, 16 were inferior lingular fibrosis, 23 were basal fibroatelectatic changes, 18 were focal pulmonary intertitial fibrosis (FPIF). There were some solid evidences of ILD compatible with usual interstitial pneumonia (UIP) in two patients. The ground glass opacity (GGO) was detected in the dependent lung region in six patients. In the presence of these findings, there are many reasons that require further examination of the patient in terms of lung findings. Patients with PFC, inferior lingular fibrosis, and basal fibro atelectatic changes should be questioned in terms of infection history, asbestosis, previous diseases and drug use. After anamnesis, an advanced radiological examination should be applied, if necessary, in order to examine the presence of fibrosis in other regions.[6] FPIF occurs especially around osteophytes and a tortoise aorta. It is a very common pathology that manifests itself in a spectrum ranging from GGO and reticulation to coarse fibrosis. Does not require further examination.[7] Six patients had GGO in the dependent lung areas. This finding is usually due to gravity and is innocent. However, in case of the presence of this finding, the patient should be clinically evaluated by a pulmonologist and it should be confirmed by prone position. If it remains fixed in the prone position, it is suspicious for ILD.[8] An UIP pattern was present in two of our patients. In patients with ILD findings, drug history, rheumatological diseases, asbestosis and rare etiological factors should be questioned and idiopathic pulmonary fibrosis (IPF) should be considered in case of exclusion. As it is known, IPF is a serious pathology with a poor five-years survey compared to most of the malignancies.[9-11]

Bronchiectasis was detected in eleven of our patients. In one patient, bronchiectasis is in plugged form. Although bronchiectasis is most commonly idiopathic, it may be secondary to primary ciliary dyskinesia, cystic fibrosis, post-infective pathologies, central obstructions and many rare factors.[12,13] It can be seen in tubular, varicose and cystic forms. Radiologically, the signet ring sign is diagnostic. It can be mutually the result or cause of infective processes. It is associated with numerous pathologies. In the diagnosis of diseases associated with bronchiectasis, it is necessary to evaluate the lung as a whole.[14] Since this pathology is detected only at baseline in urinary CT, the diagnosis cannot be made from a small part of the lung. It requires further radiological examination and clinical evaluation to rule out the above-mentioned pathologies.[15]

Table 1. Lung lesion and reportable changes can be seen in urinary CT, their percentage and reporting rates

Pathology or reportable changes	Males	Females	Age <50	Age >50	Total	Per	Reporting rate	Per
PFC	36	25	12	49	61	40.13%	11	18.03%
Inferior lingular fibrosis	9	7	4	12	16	10.52%	4	25%
Basal fibro atelectatic changes	12	11	6	17	23	15.13%	4	17.39%
FPIF	13	5	1	17	18	11.84%	1	5.56%
Dependant GGO	3	3	2	4	6	3.95%	1	16.67%
ILD-honey comb changes	2		-	2	2	1.32%	1	50%
Bronchiectasis	7	3	3	7	10	6.58%	3	30%
Plugged bronchiectasis	1		1	-	1	0.66%	-	0%
Nodule <6 mm single	6	8	7	7	14	9.21%	2	14.29%
Nodules <6 mm multiple	8	9	5	12	17	11.18%	4	23.5%
Nodule >6 mm single	6	6	2	10	12	7.89%	3	25%
Nodules >6 mm multiple	2	2	2	2	4	2.63%	2	50%
Subsolid GGO nodule multiple >6 mm	1	-	-	1	1	0.66%	-	0%
Subsolid single nodule >6 mm	-	1	-	1	1	0.66%	-	0%
Infection (COVID-19)	2	2	1	3	4	2.63%	1	25%
Air cyst	11	3	4	10	14	9.21%	1	7.14%
Mosaic attenuation	5	1	4	1	6	3.95%	-	0%
Hiatal hernia	19	14	9	24	33	21.71%	27	81.82%
Lymph node	2	-	1	1	2	1.32%	2	100%
Curvilinear bant unilateral	4	1	1	4	5	3.39%	1	20%
Curvilinear bant bilateral	1	-	-	1	1	0.66%	-	0%
Atelectasis	-	1	-	1	1	0.66%	1	100%
Tree-in-bud	-	2	1	1	2	1.32%	-	0%
Eventration	8	6	6	8	14	9.21%	4	28.57%
Bochdalek hernia	4	6	2	8	10	6.57%	3	30%
Multicystic disease	1	-	1	-	1	0.66%	-	0%
Focal pleural thickening	17	13	11	19	30	19.74%	11	36.67%
Mitral calcification	-	1	-	1	1	0.66%	1	100%
Cardiomegaly	-	1	1	-	1	0.66%	1	100%
Rib fracture	1	-	1	-	1	0.66%	1	100%
Aorta aneurism	1	-	-	1	1	0.66%	1	100%
Emphysema	5	-	2	3	5	3.39%	1	20%
Focal GGO	-	2	2	-	2	1.32%	-	0%
Pericardial fluid	-	3	1	2	3	1.97%	2	66.67%
Dependant atelectasis	3	1	2	1	4	2.63%	1	25%
Pleural plaques and calcifications	2	2	-	2	4	2.63%	3	75%
Interlobular septal thickenings	1	-	-	1	1	0.66%	-	0%
Vascular malformation	-	1	-	1	1	0.66%	-	0%
Paracardial fat hypertrophy	-	1	1	-	1	0.66%	1	100%

Per: percentage; PFC: paracardial fibrotic changes; GGO: ground glass opacity; FPIF: focal pulmonary interstitial fibrosis; ILD: interstitial lung disease; COVID-19: coronavirus disease-2019; CT: computed tomography

Nodules were detected in 49 patients in different forms. Nodules were smaller than 6 mm in 31 of these patients. According to Fleischner staging, if the nodule is smaller than 6 mm and carries risk factors (genetic malignancy history, smoking, etc.), albeit nodule is single, a 12-month follow-up is necessary. In the case of multiple nodules, short-term follow-up CT examinations of up to 3 months may be required. In nodules larger than 8 mm, (PET-CT) is required in the high-risk group, even if there is only one nodule. Since a part of the lung is seen on urinary CT, it cannot be determined whether the nodule is single or multiple. Perhaps larger nodules and additional findings will be detected in the remaining part of the lung. Therefore, chest CT is required as further examination. Multiple nodules larger than 6 mm were detected in 4 of our patients. According to Fleischner staging, these patients should be followed. In addition, it was detected in a single subsolid nodule larger than 6 mm in our patient. In this patient, even if the nodule is seen alone in the chest CT scan, followed up for at least five years is recommended (Figure 2).[16,17]

The time-period in which we conducted our study overlapped with the Coronavirus disease-2019 (COVID-19) pandemics. Bilateral peripheral GGO and consolidation areas being solid evidence of the diagnosis of COVID-19 that requires the isolation of the patient and the treatment process (azithromycin, doxycycline, favipiravir, prednisolone, etc.) were detected incidentally in 4 patients.[18] In the retrospective inquiry, these patients stated that they did not apply to the hospital due to COVID-19 and that they had not been diagnosed with COVID-19 before. In 75% of these patients, the lesions were not noticed in proper time because only the urinary system was evaluated.

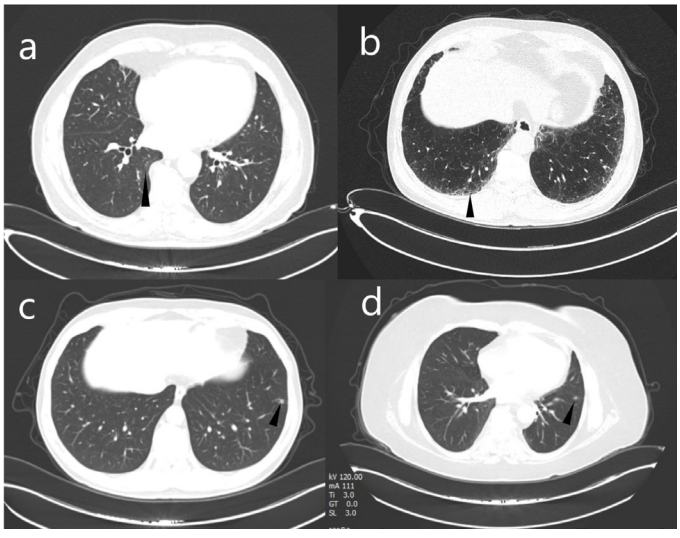

Figure 2. a) FPIF (arrowhead), b) UIP pattern with peripheral reticulations and millimetric honey comb appearances (arrowhead), c) Nodule located in antero-basal segment, d) Nodule with peripheric halo in the same location.

FPIF: focal pulmonary interstitial fibrosis; UIP: usual interstitial pneumonia

In addition, two of our patients had tree-in-bud findings that can be associated with infection. This finding is the reflection of plugged bronchioles on the radiological image. It is primarily associated with bronchiolitis or tuberculosis and need treatment according to primary diagnosis.[19,20]

Fourteen patients had air cysts. The air cyst is distinguished from emphysema by the presence of a wall.[21] These cysts were multiple in four of our patients. Two of them were female in the reproductive age group. As it is known, although the incidence of idiopathic cysts is a high rate, multiple cystic lung diseases should be excluded.[22] Lymphangiomyomatosis should be ruled out in women of reproductive age.[23] Langerhans cell histiocytosis is considered in cysts with irregular borders.[24] Requires further investigation. Our patient has findings evidence of the multicystic disease (Figure 3).[25]

Mosaic attenuation findings were detected in 6 of our patients. It is a pattern that can be seen in small airway diseases, especially in hypersensitivity pneumonia and obstructive vascular diseases. Requires further investigation if the appearance is evident.[25,26] Prominence in the expiration CT is valuable in radiological diagnosis.[27]

Curvilinear parenchymal band alone is not a diagnostic finding but it is valuable along with other findings. Pleural thickening with plaque or calcifications suggests ILD when accompanied by asbestosis, honeycomb or reticulation. More often, it may be due to parenchymal compression or compressive atelectasis.[28] In our study, there were unilateral curvilinear bands in five patients and

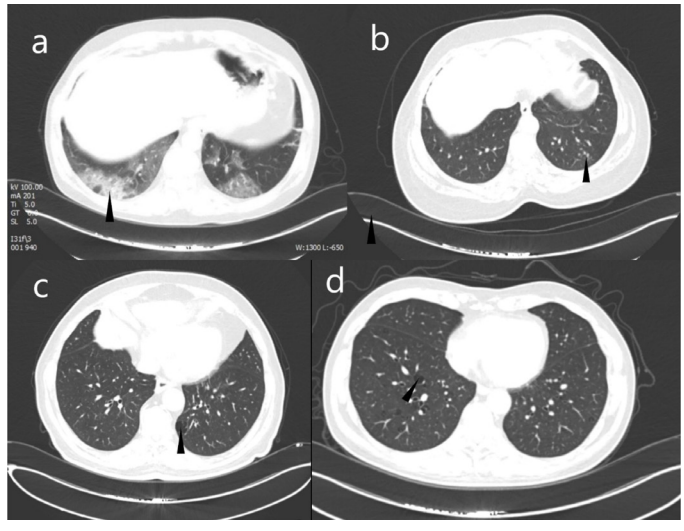

Figure 3. a) Bilateral GGOs and consolidations are compatible with COVID-19 pneumonia (arrowhead), b) Multiple millimetric nodules with halo in a patient with local infection (arrowhead), c) An air cyst located in the medial basal segment of the left lung (arrow head), d) Multiple air cyst. The big one is marked with an arrowhead.

GGO: ground glass opacity; COVID-19: coronavirus disease-2019

bilateral curvilinear bands in one patient. In addition, similarly, curvilinear GGO or band-like appearances of gravity-dependent atelectasis can be detected in the posterior. These are usually innocent findings. No follow-up is required. Our tree patients had evidence of dependant atelectasis.[29]

Focal pleural thickenings in 30 patients, pleural plaque and calcifications in four patients, and interlobular septal thickenings in one patient were seen without other findings. Although pleural calcifications and plaques are mostly attributed to asbestosis, sequels of previous infection, pneumothorax, haemothorax, empyema, mechanical irritation but may rarely be secondary to mesothelioma and pleural lymphoma. This finding may require detailed anamnesis as well as sometimes further clinical and radiological examination.[30,31]

Pathologies related to the diaphragm were also frequently encountered incidentally. Bochdalek hernia was present in 10 patients and partial eventration of diaphragm in 14 patients. Although Bochdalek hernia is the most common congenital hernia, it is more common, especially acquired due to increased intra-abdominal pressure. It rarely requires surgical treatment.[32]

Two of our patients had focal GGO. This entity can be associated with infection, carcinoma *in situ*, alveolar haemorrhage and etc. It is linked to mentioned diseases at a high rate and definitely requires further evaluation.[33,34]

Vascular malformation was detected in one patient. In the cases of the presence vascular malformation, the patient should be examined for the presence of accompanying vascular malformations.[35]

Emphysema is usually seen in the forms of centrilobular and paraseptal emphysema in the elderly patients, in relation to smoking, in localizations close to the apex of the lungs. Emphysema of the basal lungs is known as panlobular emphysema and is attributed to alpha-1 antitrypsin deficiency. However, this is a rare pathology. Emphysema, which usually enters the imaging field on urinary CT, is emphysema associated with air trapping areas or paraseptal emphysema areas that extend inferiorly. When combined with UIP, it is called combined pulmonary fibrosis. It often accompanies chronic obstructive pulmonary disease. It is a pathology that requires further evaluation.[36,37]

The pathologies that can be seen in mediastinal window are also evaluated in our paper. Hiatal hernia in 33 patients, lymph node in two patients, mitral calcification in one patient, aortic aneurysm in one patient, cardiomegaly in one patient were found (Figure 4).

Ultimately, in 103/152 (67.76%) patients, there was a pathology that required treatment, follow-up or further radiological examination. Seventy-eight of them were requested from the urology outpatient clinic, 62 were requested by the emergency service whereas only 12 examinations were requested by a department other than these two departments. Therefore, there was no detailed pulmonary examination and anamnesis when they referred to the radiologist. Given reporting rates, 83.3% of thoracic lesions observed in the mediastinal window were reported, while this rate decreased to 20.63% in the finding that can be seen in only lung windows. It follows from this that the evaluation in the lung window is rarely performed on urinary system CTs. Because of all these reasons, many pathologies remain untreated.

Figure 4. a) Peripheral pleural irregularity (arrow head) and mosaic attenuation, b) Dependant atelectasis (arrow head), c) Hiatal hernia (white arrow), d) Bochdalek hernia in the right diaphragm (white arrow).

Study Limitations

Our study is a single-centre study. The number of our patients is sufficient but limited. Turkey is one of the countries with a high workload. Diagnosis rates may vary according to workload and experience.

CONCLUSION

Urinary CT's is an inevitable tool for physicians, especially for urology and emergency departments. However, this valuable technique includes many clues for accompanying pulmonary diseases especially in elderly patients. According to our study 67.8% of our patients had an accompanying pulmonary pathology which required further examination or consultation of pulmonologist. The frequency of lesion was dramatically increased with ageing. The patients belonging completely normal lung appearances in CT were young age group.

ETHICS

Ethics Committee Approval: Our retrospective study was approved by Muğla Sıtkı Koçman University Human Research Ethics Committee with the number of 210185/2021. The design and conduct of the study were in accordance with the general principles outlined in the Declaration of Helsinki.

Informed Consent: Retrospective study.

Peer-review: Externally peer-reviewed.

Contributions

Concept: E.D.; Design: E.D.; Data Collection or Processing: E.D., F.A.; Analysis or Interpretation: E.D.; Literature Search: E.D., F.A.; Writing: E.D.

DISCLOSURES

Conflict of Interest: No conflict of interest was declared by the authors.

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REFERENCES

1. Qin L, Xu J, Tang Y, et al. Value of noncontrast computer tomography in predicting the characteristics of obstructive uropathy. Clin Imaging 2022; 82: 53-7.
2. Diederich S. Chest CT for suspected pulmonary complications of oncologic therapies: how I review and report. Cancer Imaging 2016; 16: 7.
3. Reimer RP, Klein K, Rinneburger M, et al. Manual kidney stone size measurements in computed tomography are most accurate using multiplanar image reformatations and bone window settings. Sci Rep 2021; 11: 16437.
4. Rodger F, Roditi G, Aboumarzouk OM. Diagnostic Accuracy of Low and Ultra-Low Dose CT for Identification of Urinary Tract Stones: A Systematic Review. Urol Int 2018; 100: 375-85.
5. Brisbane W, Bailey MR, Sorensen MD. An overview of kidney stone imaging techniques. Nat Rev Urol 2016; 13: 654-62.
6. Zisman DA, Keane MP, Belperio JA, Strieter RM, Lynch JP. Pulmonary fibrosis. Methods Mol Med 2005; 117: 3-44.
7. Park CM, Goo JM, Lee HJ, et al. Focal interstitial fibrosis manifesting as nodular ground-glass opacity: thin-section CT findings. Eur Radiol 2007; 17: 2325-31.
8. Diederich S. [High resolution computed tomography of the lungs: ground glass opacity and its differential diagnosis]. Radiologe 2010; 50: 1141-52.
9. Luppi F, Sebastiani M, Salvarani C, Bendstrup E, Manfredi A. Acute exacerbation of interstitial lung disease associated with rheumatic disease. Nat Rev Rheumatol 2022; 18: 85-96.
10. Krishna R, Chapman K, Ullah S. Idiopathic Pulmonary Fibrosis. 2021. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2022.
11. Kifjak D, Leitner J, Ambros R, et al. [Chest radiography findings in diffuse parenchymal lung diseases]. Radiologe 2022; 62: 130-9.
12. Flume PA, Chalmers JD, Olivier KN. Advances in bronchiectasis: endotyping, genetics, microbiome, and disease heterogeneity. Lancet 2018; 392: 880-90.
13. Contarini M, Finch S, Chalmers JD. Bronchiectasis: a case-based approach to investigation and management. Eur Respir Rev 2018; 27: 180016.
14. Jin J, Yu W, Li S, Lu L, Liu X, Sun Y. Factors associated with bronchiectasis in patients with moderate-severe chronic obstructive pulmonary disease. Medicine (Baltimore) 2016; 95: e4219.
15. Visser SK, Bye P, Morgan L. Management of bronchiectasis in adults. Med J Aust 2018; 209: 177-83.
16. Bueno J, Landeras L, Chung JH. Updated Fleischner Society Guidelines for Managing Incidental Pulmonary Nodules: Common Questions and Challenging Scenarios. Radiographics 2018; 38: 1337-50.
17. MacMahon H, Naidich DP, Goo JM, et al. Guidelines for Management of Incidental Pulmonary Nodules Detected on CT Images: From the Fleischner Society 2017. Radiology 2017; 284: 228-43.
18. Cascella M, Rajnik M, Aleem A, Dulebohn SC, Di Napoli R. Features, Evaluation, and Treatment of Coronavirus (COVID-19). [Updated 2022]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2022.
19. Rossi SE, Franquet T, Volpacchio M, Giménez A, Aguilar G. Tree-in-bud pattern at thin-section CT of the lungs: radiologic-pathologic overview. Radiographics 2005; 25: 789-801.
20. Suárez I, Fünger SM, Kröger S, Rademacher J, Fätkenheuer G, Rybniker J. The Diagnosis and Treatment of Tuberculosis. Dtsch Arztebl Int 2019; 116: 729-35.
21. Araki T, Nishino M, Gao W, et al. Pulmonary cysts identified on chest CT: are they part of aging change or of clinical significance?. Thorax 2015; 70: 1156-62.
22. Park S, Lee EJ. Diagnosis and treatment of cystic lung disease. Korean J Intern Med 2017; 32: 229-38.
23. Okoh M, Khan R, Ahmad N. Multidisciplinary team approach to diagnosing lymphangioleiomyomatosis. BMJ Case Rep 2021; 14: e243793.
24. Hazim AZ, Ruan GJ, Hu M, et al. Mayo Clinic-University of Alabama at Birmingham Histiocytosis Working Group. Langerhans cell histiocytosis with lung involvement in isolation and multisystem disease: Staging, natural history, and comparative survival. Am J Hematol 2021;96: 1604-10.
25. Kasai H, Tanabe N, Fujimoto K, et al. Mosaic attenuation pattern in non-contrast computed tomography for the assessment of pulmonary perfusion in chronic thromboembolic pulmonary hypertension. Respir Investig 2017; 55: 300-7.

26. Worthy SA, Müller NL, Hartman TE, Swensen SJ, Padley SP, Hansell DM. Mosaic attenuation pattern on thin-section CT scans of the lung: differentiation among infiltrative lung, airway, and vascular diseases as a cause. Radiology 1997; 205: 465-70.

27. Gaeta M, Minutoli F, Girbino G, et al. Expiratory CT scan in patients with normal inspiratory CT scan: a finding of obliterative bronchiolitis and other causes of bronchiolar obstruction. Multidiscip Respir Med 2013; 8: 44.

28. Yoshimura H, Hatakeyama M, Otsuji H, et al. Pulmonary asbestosis: CT study of subpleural curvilinear shadow. Work in progress. Radiology 1986; 158: 653-8.

29. Morimoto S, Takeuchi N, Imanaka H, et al. Gravity-dependent atelectasis. Radiologic, physiologic and pathologic correlation in rabbits on high-frequency oscillation ventilation. Invest Radiol 1989; 24: 522-30.

30. Leung AN, Müller NL, Miller RR. CT in differential diagnosis of diffuse pleural disease. AJR Am J Roentgenol 1990; 154: 487-92.

31. Akira M, Yokoyama K, Yamamoto S, et al. Early asbestosis: evaluation with high-resolution CT. Radiology 1991; 178: 409-16.

32. Gue RS, Winkler L. Bochdalek Hernia. [Updated 2021]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2022.

33. Cozzi D, Cavigli E, Moroni C, et al. Ground-glass opacity (GGO): a review of the differential diagnosis in the era of COVID-19. Jpn J Radiol 2021; 39: 721-32.

34. Azzam ZS, Sznajder JI. Lung Edema Clearance: Relevance to Patients with Lung Injury. Rambam Maimonides Med J 2015; 6: e0025.

35. Saboo SS, Chamarthy M, Bhalla S, et al. Pulmonary arteriovenous malformations: diagnosis. Cardiovasc Diagn Ther 2018; 8: 325-37.

36. Takahashi M, Fukuoka J, Nitta N, et al. Imaging of pulmonary emphysema: a pictorial review. Int J Chron Obstruct Pulmon Dis 2008; 3: 193-204.

37. McGuinness G, Naidich DP, Leitman BS, McCauley DI. Bronchiectasis: CT evaluation. AJR Am J Roentgenol 1993; 160: 253-9.