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Research Article

Comparison between Chest CT and X-ray Under 15 Years Old: Has Technological Progress Lead to Higher Radiation Exposure?

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Abstract

Objectives: PA chest X-ray is the first choice for evaluation of the lung pathologies in children. The use of computed tomography (CT) has been increasing due to defensive medicine approaches and diagnostic advantages such as multiplanar imaging. The most important situation in childhood imaging is avoiding high radiation exposure, which is the disadvantage of CT. In this study, diagnostic coherence between chest X-ray and CT and the necessity of chest CT were evaluated.

Methods: 644 patients under 15 years old who had admitted to emergency room and underwent chest CT between January 2017 and January 2019 were enrolled in this retrospective study. 348 of 644 patients had just chest CT without chest X-ray. All pathologies in chest CT and chest X-ray were examined by two radiologist (F.E.U, B.O). Lung pathologies were classified as radiologically. Statistical Package for the Social Sciences (SPSS, version 21 for windows) was used for the statistical analysis. The coherence between chest X-ray and CT was evaluated with Cohen's kappa test. P<0.05 was considered.

Results: Chest CT was performed only in 0.9% of under 15 years old patients who had chest X-ray between January 2017 and January 2019. Normal radiological findings were found in 288 of 348 patients (83%) who had only CT scanning. There were coherence for all radiological findings (atelectasis, consolidation, ground glass opacity, nodular infiltration, pneumothorax, pleural effusion, bone fracture, mass and cavitary lesions) in between two methods. In 8 patients who had both chest CT and X-ray, cavitary lesion was not detected in chest X-ray (Kappa: 0.490, p=0.002).

Conclusion: Patients had mostly normal findings when they were examined by just CT before not underwent chest X-ray. There was a coherence between two examinations in all lung pathologies. Radiation exposure significantly decreases when the patients examined firstly with PA chest X-ray. There are problems such as positioning and inspirium sufficiency in chest X-ray in children, but it is usually enough for evaluating lung pathologies, as seen in our study. We think that it is appropriate to perform chest X-ray firstly in stable patients. Further, we think that it is also appropriate to perform chest Ct when clinical findings was not regress or for excluding additional pathologies.

Keywords: Chest, coherence, computed tomography, X-ray

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Ionizing radiation exposure in childhood has potential carcinogenic effects. Considering these effects, acquiring acceptable diagnostic images with as low as possible radiation dose is very important. All clinicians and radiologists must ensure accordance of clinical indication with imaging for avoiding unnecessary examinations and decreasing radiation exposure on CT. PA chest X-ray is the first choice for the thorax pathologies, due to cost effectivety, lower radia-

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tion dose and scanning wide anatomical structure. In some cases, non-ionized examinations, such as ultrasonography and magnetic resonance imaging may choose instead of PA chest radiography.

Nowadays, CT is accepted most valuable diagnostic radiological technic for evaluating airways, lung parenchyma, mediastinal compartment and cardiac pathologies.[1,2] In pediatric patients, CT is more risky according to adults, because of increasing organ dose and increasing stocastic effect. For reaching the correct diagnose that will shape the treatment with lowest radiation dose is our common responsibility. In our study, radiological findings of chest CT in patients without PA chest X-ray and diagnostic coherence between PA chest X-ray and chest CT were evaluated.

Methods

Patients

The study was conducted in adherence with the Declaration of Helsinki and it was reviewed and approved by the institutional review board and protocol review committee of Sakarya University (71522473/050.01.04/1). From 1 January 2017 to 1 January 2019, 644 patients who admitted to emergency room and undertwent chest CT examination were enrolled this retrospective study. The inclusion criteria were (1) under 15 years old, (2) absence of scoliosis and vertebral anomalies and (3) presence of chest CT. The exclusion criteria were (1) poor quality of chest CT and chest radiography and (2) a delay between chest CT and radiography longer than 2 days.

CT and X-ray scanning

Chest CT was performed with 64-slice multidedector row CT scanner (Aquilion, Toshiba Medical Systems, Otawara, Japan) and chest radiography was performed with Shin Young SC 300 (Shin Young For M co, Ltd, Korea) X-ray scanner. Images were captured at window settings that allowed viewing of the lung parenchyma (window level, -500 to -700 HU; window width, 1200-1500 HU) and the mediastinum (window level, 20-40 HU; window width 350 HU) in CT system. The scanning range covered the area from the C1 vertebra to the diaphragm in both chest CT and X-ray examinations.

Radiological Imaging Analysis

All images were analyzed by two radiologist (F.E.U. and B.Ö., 5 and 6 years of experience respectively) who were blinded to the clinical informations. When their readings were not consistent, the final decision were determined by consensus.

All images were evaluated for the following characteristics: normal findings, atelectasis, consolidation, ground glass opacity, nodular infiltration, pneumothorax, pleural effusion, bone fracture, mass and cavitary lesion. All results were noted for evaluating coherence between chest CT and X-ray.

Statistical Analysis

Statistical Package for the Social Sciences (SPSS, version 21.0.0 for windows) was used for the statistical analyses. The fitness of numeric data set to normal distribution was determined by the Kolmogorov-Smirnov test. The agreement between chest CT and PA chest X-ray was determined by Cohen's kappa test. K value ≤0, 0.01–0.20, 0.21–0.40, 0.41–0.60, 0.61–0.80 and 0.81–1.00 were evaluated as indicating no agreement, as none to slight, as fair, as moderate, as substantial and as almost perfect of agreement, respectively. P smaller than 0.05 was considered statistically significant.

Results

In the years included in this study, 6.47% of patients had chest x-ray and 0.12% had chest CT in the age group that we assessed. Chest x-ray was performed approximately 55 times more from chest CT in our institution. Chest CT was performed 0.9% of patients after chest X-ray. Of 644 patients, 217 were girls (34%) and 427 were boys (66%). The mean age of patients were 7.04 (sd 4.37). 348 of 644 patients who enrolled this study had chest CT without X-ray imaging. There was a chest CT alone in 348 of 644 patients who participated in this study. 83% (n=288/348) of these patients had normal findings (Table 1).

There was a perfect agreement in consolidation, ground glass opacities, pneumothorax, pleural effusion and mass in kappa analysis (Figs. 1, 2). Statistically substantial agreement was found in normal findings and atelectasis (Fig. 3). There was a moderate agreement in nodular infiltration, bone fracture and cavitary lesion between CT and chest x-ray (Fig. 4). All results were summarized in the table (Table 2).

Table 1. Findings in chest CT without X-ray

Findings	n (%)
Normal findings	288 (82.75)
Atelectasis	12 (3.44)
Consolidation	0 (0)
Ground glass opacities	40 (11.49)
Nodulary infiltration	0 (0)
Pneumothorax	0 (0)
Pleural effusion	0 (0)
Bone fracture	8 (2.29)
Mass	0 (0)
Cavitary lesion	0 (0)

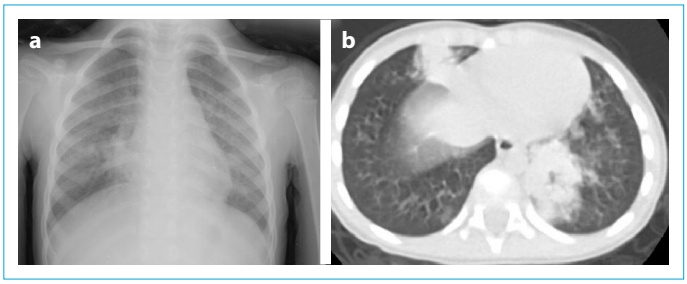

Figure 1. (a) 3 years old girl admitted to the emergency room with complaints fever and cough. There was a bilateral patchy consolidation areas in chest X-ray. **(b)** After two days from chest X-ray, there was a patchy consolidation area with air bronkpgrams on CT.

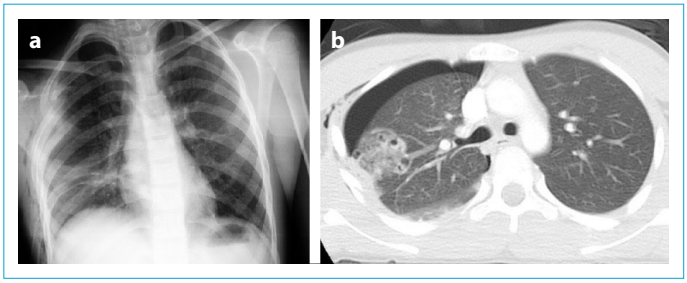

Figure 2. (a) 14 years old boy admitted to the emergency room after trauma. There were bilateral pneumothorax, bone fractures, subcutaneus emphysema and ground glass opacities in chest X-ray. **(b)** On chest CT, there were additional findings according to chest X-ray such as parenchymal laceration and contusion.

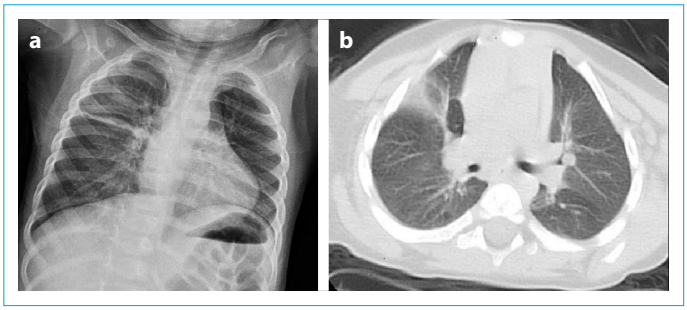

Figure 3. (a, b) 2 years old boy admitted to the emergency room with fever. In chest X-ray before performing CT, linear atelectasis was seen at the middle zon of right lung.

Discussion

Radiation dependant carcinogenesis is a stochastic process and effect was correlated with radiation dose, but severity was dose independent. Children and adolescents are very sensitive to the syochastic effects of ionizing radiaiton because their cells divide more faster than adults. According to relatively long lifetime expectancy, potential radiation effects may come out easily in children and adolescents than adults.[3-5] Only 17% of all radiological procedure is CT in United States of America (USA), but 50% of total effective radiation dose, which is the biggest medical source

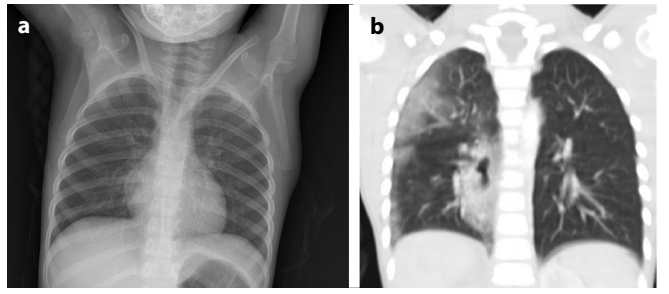

Figure 4. (a) 6 years old boy admitted to the emergency room after trauma. On the chest x-ray **(a)**, ground glass densities are observed in favor of contusion in the right lung upper zone. **(b)** In the thorax CT, which was taken later, the patient has an incidental cavitary lesion that is not observed by chest radiography.

Table 2. Pathologies in chest CT and X-ray and coherence between two modalities

	X-ray	Chest CT	Kappa	p
Normal findings	196	164	0.664	0.002
Atelectasis	4	8	0.661	0.001
Consolidation	28	32	0.926	0.002
Ground glass opacities	44	56	0.856	0.003
Nodular infiltration	8	20	0.554	0.002
Pneumothorax	4	4	1.0	0.001
Pleural effusion	12	12	1.0	0.001
Bone fracture	8	20	0.554	0.003
Mass	4	4	1.0	0.001
Cavitary lesion	4	12	0.490	0.002

of radiation exposure, originates from CT.[6] Increasing of awareness of potentially hermful effects is very important. Besides, according to "as low as reasonably achievable (ALARA)" principle for reducing radiation dose, CT scanning need to be justified and optimized.

Lifetime cancer risk caused by ionizing radiation derived from pediatric CT was evaluated by firstly Brenner et al in 2001.[7] They presume that 500 children who was performed CT will die from cancer attributed to ionizing radiation depending on radiological practices in USA. Berrington de González et al.[8] and Miglioretti et al.[9] predict that radiation depending on pediatric CT in a certain year in USA causes 4350-4870 cancer in the future. These risk guesses depends on datas from derived life time studies of Japanese people who survive from atom bombs.[10] Published studies showed that tere are potential evidence about dose-response relationship in the most common neoplasias developing with CT related radiation in the children.[11-13] Fortunately, pediatric CT was decreased in USA since 2007 because of campaign of "Image Gently", increased awareness about possible cancer risk and ALARA principle.[9]

Brenner et al.,[7] estimated that in 1 year old child, lifetime cancer mortality risk because of exposure to radiation were 0.18% for one abdominal CT imaging and 0.07% for one cranial CT imaging.

According to research of Arch and Frush,[14] settings of the tube voltage (kVp) and current (mAs) that uses since 2001, decreases the radiation doses in pediatric patients. However, there is few research about the effect of these changes. It has been reported that risk of the development of brain tumour increased 3 times with cumulative ionizing radiation doses of 2-3 cranial CT assuming typical doses. At the same study, it has been predicted that risk of the development of leukomia increased 3 times with 5-10 brain CT.[3] In our study diagnostic coherence between chest CT and chest x-ray was evaluated retrospectively and no dose study have been performed.

In study of Şentürk et al.,[15] atelectasis was the most frequent finding in CT. In our study, most frequent findings in CT examinations without chest X-ray were ground glass opacities, and atelectasis. In patients with both chest CT and radiography, the most frequent pathologies were ground glass opacities and consolidation. However, no pathological finding was determined in 70% of patients CT in both group (n=452). In the study of Sandal et al.,[16] it has been reported that in two patients there is a pleural effusion in CT despite of there is no finding in chest radiography. In our study, there was a perfect agreement for pleural effusion between two radiographic examinations. For the cavitary lesion, there was a moderate agremeent between chest CT and radiography was determined in our study but 8 cavitary lesions were not detected in chest radiography.

This study has few limitations. Firstly, this is a retrospective study. Secondly, radiation dose was not calculated for the chest CTexamination. Lastly, patients were not followed up in terms of the development of potential risks of radiation. Results of our study has revealed that most patients have normal findings in chest CT. However, chest CT is the first choice for most patients who admitted to emergency room, because it gives fast result and provides detailed anatomical information. We thought that similar studies like us raise awareness for potential risk of radiation.

Disclosures

Ethics Committee Approval: The study was conducted in adherence with the Declaration of Helsinki and it was reviewed and approved by the institutional review board and protocol review committee of Sakarya University (71522473/050.01.04/1).

Peer-review: Externally peer-reviewed.

Conflict of Interest: None declared.

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