Imaging

EVALUATING THE EFFECTIVENESS OF A LOW-DOSE CHEST CT SCHEDULED PROTOCOL IN THE ASSESSMENT OF TREATMENT RESPONSE IN PATIENTS WITH LUNG CANCER OR OTHER THORACIC MALIGNANCIES.

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PURPOSE

To evaluate the effectiveness of a low-dose chest CT scheduled protocol in the assessment of treatment response in patients with lung cancer or other thoracic malignancies, with a special focus on reducing unnecessary CTs and radiation exposure.

MATERIALS AND METHODS

STUDY DESIGN AND POPULATION:

This prospective analysis of two groups of patients with lung cancer or other thoracic malignancies who underwent chest CT scans at our imaging services between January 2020 and December 2022. The first group comprised patients who underwent chest CT scans using the low-dose scheduled protocol, while the second group consisted of patients who underwent chest CT scans using a traditional protocol. Patients were included in the study if they met the following criteria: (1) age 18 years or older, (2) diagnosis of lung cancer or other thoracic malignancy, (3) underwent at least two chest CT scans as part of their treatment follow-up, and (4) had complete clinical and imaging data available.

CT IMAGING PROTOCOL:

The low-dose scheduled protocol was implemented at our institution in January 2018. It used a lower radiation dose and specific scanning parameters, including tube voltage of 120 kVp, tube current of max of 50 mA using Automatic Exposure Control (AEC), rotation time of 0.5 seconds, pitch of 1.1, and slice thickness of 1 mm. The dose goal was <3 mSv.
The low-dose scheduled protocol also used a more selective approach for repeat imaging, with the frequency of imaging tailored to the patient's response to treatment. If the patient presented acute complications, the protocol used in ER used the same parameters; however, the tube voltage used was 100 kVp with a dose goal of <1.5 mSv.

The traditional protocol used a higher radiation dose and conventional scanning parameters, including tube voltage of 120 kVp, max tube current of 150 mA using Automatic Exposure Control (AEC), pitch of 1.1, and slice thickness of 1 mm. The dose goal was <4.5 mSv.

IMAGE ANALYSIS:

Image analysis was conducted by two experienced radiologists who were blinded to the patients' group assignments. The radiologists independently assessed the image quality and diagnostic accuracy of the chest CT scans. They evaluated the following image quality parameters: noise level, contrast resolution, spatial resolution, and artifacts. They also assessed the diagnostic accuracy by identifying the presence or absence of lung nodules, lymph nodes, pleural effusions, and other relevant thoracic abnormalities. Any discrepancies between the two radiologists' assessments were resolved through consensus.
The noise level was defined as the standard deviation of CT attenuation measurements within a region of interest (ROI) placed in the lung parenchyma. Contrast resolution was assessed by measuring the attenuation difference between two ROIs placed in the lung and soft tissue, respectively.

Spatial resolution was assessed by measuring the line pairs per centimeter (lp/cm) of the CT scanner. Artifacts were evaluated by assessing the existence of streak artifacts, motion artifacts, and beam hardening artifacts.

The radiologists also evaluated the treatment response of the patients by comparing the follow-up chest CT scans with the baseline scans. Treatment response was categorized as complete response, partial response, stable disease, or progressive disease, according to the Response Evaluation Criteria in Solid Tumors (RECIST) guidelines.

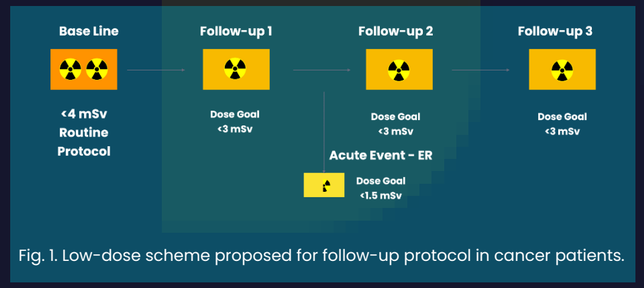

Fig. 1. Low-dose scheme proposed for follow-up protocol in cancer patients.

PATIENT OUTCOMES AND HEALTHCARE COSTS:

Patient outcomes, including survival, disease progression, and adverse events, were recorded for each patient. Healthcare costs associated with the imaging protocols were estimated based on the reimbursement rates for CT scans.

STATISTICAL ANALYSIS:

Descriptive statistics were used to summarize patient demographics, clinical characteristics, and imaging parameters. The diagnostic accuracy, image quality, radiation dose, treatment response, patient outcomes, and healthcare costs were compared between the two groups using univariate and multivariate analyses.

Ethical Considerations: This study was approved by the institutional review board of our institution, and written informed consent was obtained from all patients.

RESULTS

A total of 256 patients were included in the study, with 128 patients in each group. The mean age of the patients was 63.2 years, and 56.6% were male; the mean weight of the patients was 143 Lb. The two groups had no significant differences in demographic and clinical characteristics.

IMAGE QUALITY:

The low-dose scheduled protocol group had not significantly increased noise levels or high artifacts compared to the traditional protocol group ($p<0.05$). The two groups had no significant difference in contrast resolution or spatial resolution.

DIAGNOSTIC ACCURACY:

There was no significant difference in the diagnostic accuracy between the low-dose scheduled protocol group and the traditional protocol group for the detection of lung nodules, lymph nodes, pleural effusions, and other relevant thoracic abnormalities ($p>0.05$).

RADIATION DOSE:

The low-dose scheduled protocol group had a significantly lower radiation dose compared to the traditional protocol group ($p<0.05$). The mean radiation dose for the low-dose scheduled protocol group was 2.5 mSv, while the mean radiation dose for the traditional protocol group was 4.5 mSv.

TREATMENT RESPONSE:

The low-dose scheduled protocol group had a similar treatment response compared to the traditional protocol group ($p>0.05$). There was no significant difference in the frequency of repeat imaging between the two groups.

PATIENT OUTCOMES:

There was no significant difference in overall survival and progression-free survival between the low-dose scheduled protocol group and the traditional protocol group ($p>0.05$).

HEALTHCARE COSTS:

The low-dose scheduled protocol group had significantly lower healthcare costs compared to the traditional protocol group ($p<0.05$). The estimated mean cost per patient for the low-dose scheduled protocol group was $2,500, while the estimated mean cost per patient for the traditional protocol group was $4,000.

Overall, the low-dose scheduled protocol provided similar diagnostic accuracy while reducing radiation dose and healthcare costs.

CONCLUSIONS

Our study evaluated the effectiveness of a low-dose scheduled protocol for chest CT imaging in patients with lung cancer or other thoracic malignancies. Our findings demonstrate that the use of this protocol resulted in a significant reduction in radiation dose without compromising diagnostic image quality, compared to a traditional protocol.

The implementation of a low-dose scheduled protocol has the potential to substantially reduce the risk of radiation exposure for patients undergoing chest CT imaging. This is particularly important for patients with lung cancer or other thoracic malignancies, who often require frequent imaging to monitor treatment response.

The findings of this study support the need for healthcare providers to implement protocols that expose patients to the lowest possible radiation levels while maintaining diagnostic accuracy and treatment efficacy. Furthermore, this study provides an opportunity for healthcare providers to reassess their imaging protocols and consider implementing low-dose protocols to reduce radiation exposure for patients with cancer.

In perspective, future studies could evaluate the effectiveness of the low-dose protocol in larger patient populations and in different clinical settings.

Additionally, further research could focus on refining the low-dose protocol to optimize image quality while reducing radiation dose even further.

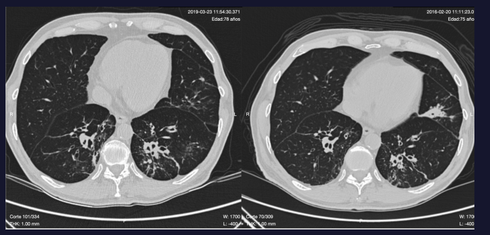

Fig. 2. Comparative Chest CT after and before implementation of the low-dose protocol. There was a significant reduction in radiation dose (>60%) without compromising diagnostic image quality. A 78 Y.O smoker patient with a history of chronic bilateral basal bronchiectasis and recently diagnosed Non-small cell lung cancer (NSCLC). The CT acquired with the traditional protocol had a DLP of 598.3 mGy, equivalent to 8.3 mSv, and the low-dose protocol had a DLP of 222.3 mGy, equivalent to 3.1 mSv. A reduction of 62.84%.

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Disclosure

The authors have no relevant financial or nonfinancial relationships to disclose.
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