OUR EXPERIENCE IN USING A LOW DOSE CT AS A SCREENING OF LUNG CANCER

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Abstract
Lung cancer is one of the leading cause of death among all cancer types, killing approximately 34 000 people per year. By the time symptoms develop, the tumour is often at an advanced stage and the prognosis is bleak. Treatment at a less advanced stage of disease by surgical resection has been shown to substantially reduce mortality. Screening would be attractive if it could detect presymptomatic lung cancer at a stage when surgical intervention is feasible but has been the subject of scientific debate for the past three decades. Low-dose CT scan screening greatly improves the likelihood of detecting small nodules and, thus, of detecting lung cancer at a potentially more curable stage
Key words: lung cancer, low-dose CT, screening

Objective
The purpose of our study was to compare a image quality and radiation doses between low-dose CT and follow-up standard diagnostic CT for lung cancer screening.

Materials and methods
During 5 days we studied 50 patients (37 men, 13 women; mean age 61 years) with different risk factors like: 50+ years old, smokers, cough. Thay were admitted with hight risk of lung carcinoma underwent both lung low-dose CT (75 mA) and standard-dose CT (330 mA). Low-dose CT and standard-dose CT were independently reviewed, in a delayed fashion, by three radiologists for the characterization of the changes in the lungs (location, size) and for indirect signs in parenchyma. The presence of non-pulmonary-related disorders was also assessed. Informed consent was obtained from all patients.
We used a 64 Light Speed VCT – GE scanner. A modified Single breath - hold Routine chest – Low dose protocol was used for every patient. The pitch & speed, the kV and mA were reduced. Table 1 below shows the data which is performed research.

Table 1 - Parameters of research

Parameters	Standard protocol	Low-dose protocol
kV	120	80
mA	330	75
Scan type	Helical	helical
Rot. time	0.6	1.0
Rot length	Full	Full
Detector coverage	40.0 mm	40.0 mm
Thickness	5.0 mm	5.0 mm
Pitch & Speed	1.375:1/55.00	0.516:1/20.62
Interval	5.00 mm	5.00 mm
SFOV	Large body	Large body

DLP	570,13 mGy-cm	249,36 mGy-cm
Total exposure time	4.6 s	19.4 s

Results

Each of the three physicians analyzed 37 nodules by low-dose CT screening and follow-up standard diagnostic CT. There were no significant differences between low-dose CT and follow-upstandard diagnostic CT for lung cancer screening in all criteria. Agreement of the evaluation of all categories in the final diagnosis exceeded 94% ($p < 0.001$). Of the 17 subjects evaluated (8 men and 9 women; mean age, 62 years) there were 4 (3 men and 1 women; mean age, 57 years) malignant nodules and 14 (6 men and 8 women; mean age, 64 years) possibly benign nodules. The size of possibly benign nodules was 4 to 14.5 mm, and that of malignant nodules was 14 to 18 mm. The mean size of the four malignant nodules (16 mm) was larger than that of the 33 possibly benign nodules (9.5 mm).

Discussion

Lung cancer is one of the leading cause of death among all cancer types. By the time symptoms develop, the tumour is often at an advanced stage and the prognosis is bleak. Low-dose CT scan screening greatly improves the likelihood of detecting small nodules and, thus, of detecting lung cancer at a potentially more curable stage. [1]

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The estimates described here suggest that a single baseline CT screening examination for lung cancer would result in a fairly low risk (<0.06%) for radiation-induced lung cancer, and negligible risks for other cancers. The estimated risks are higher for current smokers than for former smokers, and the risks would be expected to be higher for heavy ever-smokers compared with light ever-smokers.

The only important radiation-related hazard from low-dose CT lung screening is radiation-induced lung cancer. Although the dose to the lung from a single low-dose CT lung examination is low (typically 2.5–9.0 mGy), the associated lung cancer risks are not negligible, for two related reasons: First, the excess risk for radiation-induced lung cancer is highest in those aged approximately 55 years at exposure, in contrast to the radiation-associated cancer risks for most other sites, which are highest at much younger exposure ages. Thus, for example, routine screening mammography, while delivering a similar dose to the breast (typically about 3 mGy) [5,16], probably results in a substantially lower risk, because the radiation-associated cancer risk to the breast at ages above 40 or 50 is much lower than that at younger ages. [2,6]

The second reason for concern regarding CT lung examinations in adult ever-smokers is the evidence that radiation damage and smoking damage interact synergistically. Although this interaction is hard to quantify, the results of most studies suggest that the interaction is near multiplicative. [4,7,9,10,11] An intermediate interaction, between additive and multiplicative, has also been suggested for radon exposure [5], and there is at least one report of an additive interaction. [14]

The radiation risks estimated are for radiation-induced lung-cancer incidence rather than mortality; however, because of the high mortality-to-morbidity ratio associated with lung cancer [9], it seems reasonable to use these incidence risks as a baseline for a minimum requirement in the reduction in lung cancer mortality through CT lung screening. Given the estimated upper limit of a 5.5% increase in lung cancer risk due to annual CT-related radiation exposure, a mortality benefit of considerably more than 5% may be necessary to outweigh the potential radiation risks.

It is clear that the radiation-related risks decrease rapidly with increasing age at commencement of screening. If the radiation risks prove to be a concern, an increase in the

minimum age at which screening is recommended, from 50 to 60 years, would reduce the risks considerably. Another alternative would be to screen every 2 years, which would reduce the radiation risk by about 50%. More lung cancers were diagnosed in the screening group, indicating some degree of overdiagnosis and need for longer follow-up. [16]

The present study indicated that low-dose CT screening provided diagnoses similar to standard diagnostic CT. The image quality of low-dose CT may be high enough for it to be used for the diagnosis of lung cancer as a method of repeated follow up.The dose to the lung in low-dose CT is less that of standard CT. Furthermore, it is suggested that in a high-risk population with the habit of cigarette smoking, annual low-dose CT for lung cancer screening is modestly recommended. It is important to create an effective low-dose CT protocol for lung cancer screening that takes into consideration both radiation dose and image quality.[12]

Conclusion

Low-dose CT achieves sensitivities and specificities close to those of standard-dose CT in assessing the diagnosis of lung cancer. Despite the reduced dosage, we got a satisfactory imaging. This study suggests that low-dose CT can be effectively used as a follow-up standard diagnostic CT in place of standard-dose CT in order to reduce the radiation dose.

References

1. Black C, Verteuil R, Walker S, Ayres J, Boland A, Bagust A, Waugh N. Population screening for lung cancer using computed tomography, is there evidence of clinical effectiveness? A systematic review of the literature Thorax 2007;62:131-138 doi:10.1136/thx.2006.064659
2. Brenner DJ, Sawant SG, Hande MP, et al. Routine screening mammography: how important is the radiation-risk side of the benefit-risk equation? Int J Radiat Biol 2002; 78:1065-1067.
3. Ford MB, Sigurdson AJ, Petrulis ES, et al. Effect of smoking and radiotherapy on lung carcinoma in breast cancer survivors. Cancer 2003; 98:1457-1464. CrossRef, Medline
4. Gilbert ES, Stovall M, Gospodarowicz M, et al. Lung cancer after treatment for Hodgkin's disease: focus on radiation effects. Radiat Res 2003; 159:161-173.
5. Hornung RW, Deddens J, Roscoe R. Modifiers of exposure-response estimates for lung cancer among miners exposed to radon progeny. Environ Health Perspect 1995; 103(suppl 2):49-53.
6. Kruger RL, Schueler BA. A survey of clinical factors and patient dose in mammography. Med Phys 2001; 28:1449-1454.
7. Law J, Faulkner K. Concerning the relationship between benefit and radiation risk, and cancers detected and induced, in a breast screening programme. Br J Radiol 2002; 75:678-684.
8. Melloni B, Vergnenegre A, Lagrange P, Bonnaud F. Radon and domestic exposure. Rev Mal Respir 2000; 17:1061-1071.
9. Merrill RM, Henson DE, Barnes M. Conditional survival among patients with carcinoma of the lung. Chest 1999; 116:697-703.
10. Morrison HI, Villeneuve PJ, Lubin JH, Schaubel DE. Radon-progeny exposure and lung cancer risk in a cohort of Newfoundland fluorspar miners. Radiat Res 1998; 150:58-65.
11. Neugut AI, Murray T, Santos J, et al. Increased risk of lung cancer after breast cancer radiation therapy in cigarette smokers. Cancer 1994; 73:1615-1620.
12. Ono K, Hiraoka T, Ono A, et al. Low-dose CT scan screening for lung cancer: comparison of images and radiation doses between low-dose CT and follow-up

standard diagnostic CT.Springerplus. 2013; 2: 393. Published online 2013 Aug 21. doi: 10.1186/2193-1801-2-393
13. Pershagen G, Akerblom G, Axelson O, et al. Residential radon exposure and lung cancer in Sweden. N Engl J Med 1994; 330:159-164.
14. Pierce DA, Preston DL. Radiation-related cancer risks at low doses among atomic bomb survivors. Radiat Res 2000; 154:178-186.
15. Saghir Z et al. CT screening for lung cancer brings forward early disease. The randomised Danish Lung Cancer Screening Trial: status after five annual screening rounds with low-dose CT . Thorax 2012;67:296-301 doi:10.1136/thoraxjnl-2011-200736
16. Samet JM, Pathak DR, Morgan MV, Key CR, Valdivia AA, Lubin JH. Lung cancer mortality and exposure to radon progeny in a cohort of New Mexico underground uranium miners. Health Phys 1991; 61:745-752.
17. Tokarskaya ZB, Scott BR, Zhuntova GV, et al. Interaction of radiation and smoking in lung cancer induction among workers at the Mayak nuclear enterprise. Health Phys 2002; 83:833-846.
18. Wisnivesky JP, Mushlin AI, Sicherman N, Henschke C. The Cost-Effectiveness of Low-Dose CT Screening for Lung Cancer: Chest. 2003;124(2):614-621. doi:10.1378/chest.124.2.614
19. Young KC, Burch A. Radiation doses received in the UK Breast Screening Programme in 1997 and 1998. Br J Radiol 2000; 73:278-287.