ISSN 2618-1584 Vol. 1, Issue 3: 74-77, DOI: 10.25236/FMSR.2019.010311

Clinical Application Value of Low-Dose CT Scanning Technique

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ABSTRACT. *Low-dose spiral CT scanning technology can not only ensure the image quality, but also reduce the radiation level of patients undergoing examination. It is valuable to reduce the dose of spiral CT scanning properly, especially in adult chest, nasal sinus and children's brain, and it is worth popularizing. This article reviews the current situation and progress of low-dose spiral CT scanning technology in clinical application.*

KEYWORDS: *Low dose; Tomography; X-ray computed tomography*

1. Introduction

Naidich et al. first put forward the concept of low-dose CT in 1990[1], that is, when other scanning parameters remain unchanged, reducing tube current imaging can also meet the diagnostic requirements. At that time, this technology did not attract the attention of clinicians and patients. With the improvement of public awareness of radiation health protection, the World Health Organization (WHO), the International Radiological Commission (IRCP) and the International Organization for Medical Physics (IOMP) formulated quality assurance and quality control standards for medical irradiation in order to minimize the cost of human injury. The research and application of low-dose CT has attracted more and more attention only after obtaining the best diagnostic effect.

2. Basic Concept of CT Scanning Dose

Since 1970s, CT has been used in clinic and experienced several technological innovations. It has become an important means of medical imaging diagnosis. Compared with ordinary X-ray films, CT has significantly improved the detection ability of lesions, but its X-ray dose has also increased significantly. Worldwide, 5% of CT examinations produce about 34% of medical radiation doses[2]. In 1977, the International Committee on Radiological Protection (ICRP) proposed three principles of radiation protection, i.e. the justification of practice, the optimization of protection and the limit of individual dose. The aim is to obtain better image quality and reduce the patient's exposure dose through the implementation of the protection

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optimization and quality assurance plan for radiological diagnosis. In order to solve this problem, Naidich put forward the concept of low dose CT (LDCT) for the first time in 1990, that is, to reduce the tube current imaging to meet the diagnostic requirements and to reduce the radiation dose of the examinee when other scanning parameters remain unchanged. With the improvement of public awareness of radiation hygiene and self-protection, this technology has attracted more and more attention.

There are many factors affecting the radiation dose of CT examination. There are two main aspects: (1) The relationship between the tube current and the output dose of different CT machines is different. (2) Scanning strategies (such as layer thickness, interval, mAs, etc.) are different. There are three ways to reduce radiation dose: (1) Reducing tube voltage: lowering tube voltage and reducing X-ray energy, resulting in increased tissue X-ray absorption and reduced signal-to-noise ratio. Therefore, tube voltage should not be lower than 110 kV to 120 kV; (2) Increasing pitch: can reduce exposure time, thereby reducing radiation dose, but Too large pitch can lead to a decrease in Z-axis resolution, affect image quality, and easily lead to missed detection of small lesions; (3) Reducing tube current: Because of the linear relationship between current and radiation, reducing tube current can reduce radiation dose accordingly, so reducing tube current is the most potential method currently studied. How to express the dose of the patients caused by CT examination is still in the process of improvement. The weighted CTDIw and CT dose index length integral (DLP) were proposed by the European Community and the International Electrotechnical Commission (IEC) in 1997. Among them, the former reflects the dose distribution characteristics of the whole irradiated site, while the latter is related to the organ dose and effective dose of the irradiated site.

3. Clinical Application of Low Dose CT Scanning Technology

3.1 Chest

Because of the high natural contrast between alveolar cavity and pulmonary parenchyma, mediastinal lesions and mediastinal fat, and the low X-ray absorptivity, it lays a foundation for the application of low-dose CT in lung, so chest is very suitable for low-dose CT. Low-dose CT has been used to screen the general population and the high-risk population of lung cancer. Kaneko et al. reported that 1369 smokers over 50 years old were examined by low-dose spiral CT. The detection rate of lung cancer was 0.43%. 93% of the tumors belonged to early stage (stage I) [3]. Diederich et al. 817 asymptomatic smokers were screened for early lung cancer by low-dose spiral CT. The detection rate of lung cancer was 1.3%, and 58% were stage I[4]. The results showed that low-dose spiral CT could detect nearly 8 times more lung cancer than routine chest X-ray examination, especially more early lung cancer and non-calcified nodules.

Opinions on the minimal tube current that low-dose CT can be used in clinic and the effect of low-dose CT on the detection of pulmonary lesions are still inconsistent,

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because the performance and configuration of CT machines from different manufacturers are different, and the minimal tube current required for different anatomical sites is different. Naidich et al. have shown that when the current of common CT tube drops to 20 mAs under the condition of other scanning parameters unchanged, lung images can be obtained for diagnosis. Mayo et al. reported that when the current of common CT tube drops to 20 mAs, the image quality decreases due to the increase of noise, but it does not affect the detection and diagnosis of pulmonary nodules. Yu Jianqun et al. showed that low dose (17 mAs) multi-slice spiral CT could detect small lesions in hilar bronchial wall. Although low-dose CT can produce linear artifacts, compared with conventional CT, low-dose CT has no significant reduction in the diagnosis of various lung diseases, such as airway diseases and chronic diffuse lung diseases. Zhu Xiaohua et al. considered that the scanning conditions of 25 mAs in multi-slice spiral CT chest scan were reasonable, and the image of lung window was better than that of mediastinum window under the same scanning conditions. When the post-processing image was scanned, the current could be reduced to 25 mAs-40 mAs, so the quality of post-processing image would not be significantly reduced[5].

Wu Xiaohua et al. considered that the tube current of 50 mAs was reliable enough to save nodal energy with diameter less than 5 mm, and that 30 mAs was the best condition for both clinical diagnosis and patient radiation dose. Itoh et al. considered that in order to ensure the image quality, the minimum tube current should vary with the location. The upper field is 20 mAs, the middle field is 12 mAs, and the lower field is 8 mAs. The ideal scanning scheme needs to change the tube current according to the position during scanning. Zwirewich et al. analyzed 31 cases of high resolution CT (HRCT) with low dose and conventional dose. The scanning conditions were low dose 40 mAs, conventional dose 140 mAs to 200 mAs, and slice thickness 1.5 mm. It was considered that low dose CT could provide exactly the same image information, but the spatial resolution and image quality did not decrease significantly, although 94% of the low dose CT was low. Strip artifacts appeared on HRCT, but only 3% of them affected the diagnosis significantly. Wang Minjie et al. showed that under the condition of other scanning parameters unchanged, low dose (10 mAs) whole lung scanning and conventional dose (120 mAs) target CT thin slice scanning for suspicious lesions can reduce the radiation dose of patients, and obtain more imaging diagnostic information, which greatly improves the detection rate and diagnostic accuracy of lesions[6].

3.2 Head

The contrast resolution of adult skull and brain is low. Reducing the tube current will affect the image quality. The development of infant skull and brain tissue is still immature. The corresponding tissue density is not as high as that of adult, and the natural contrast between skull, brain tissue and ventricular system is very good. Therefore, low-dose CT scan of head is mainly used in children. When children's craniocerebral lesions are examined by radiography, their carcinogenic effects will be greatly increased when they are irradiated unnecessarily or excessively because

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their organ systems are immature, especially some radiation-sensitive organ systems such as ophthalmic lens, thyroid, gonad, blood and hematopoietic system. Add. There are few reports about the dose and radiation dose of CT examination in children abroad. In China, Li Zhenlin et al. 120 cases of children's brain were scanned by low-dose CT. The tube current was 90 mAs (0-6 months) and 150 mAs (6 months-6 years old). Compared with the conventional dose of 260 mAs, more than 98% of them met the requirements of clinical diagnosis, and their image quality and routine were satisfactory. There was no significant decrease in scanning[7]. Mullins et al. performed routine dose (170 mAs) and low dose (90 mAs) scans on 20 patients over 65 years of age with non-central nervous system diseases. It was found that although the noise of low dose CT scans was significantly higher than that of routine dose CT scans, it had no significant impact on diagnosis[8].

In summary, although the image noise of low-dose CT scans has increased, the image quality and image information obtained in many parts of the scans can fully meet the requirements of diagnosis, and greatly reduce the radiation dose of the patients, especially in the adult chest, nasal sinuses and children's craniocerebral application is very valuable.

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