Presentation of a new system in longitudinal tomography (micro layer tomography)

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ABSTRACT

Tomography or planigraphy is an X-Ray imaging system for preserving a certain plane of a radiography object by diffusing the other planes; however, the wanted plane does not obtain an optimum sharpness. Meanwhile, relatively nearer points to the rotating axes fixed point have lesser linear velocity than those of lying further from fixed point, consequently, Tomographic Bluring (obscuring) occur gradually, that gives rise the wanted plane to be somehow blurred that is known as "tomographic blurring", hence the clinical value of the image is diminished.This innovation could be an approach to improve current tomography systems by increasing image resolution and deep resolution and cost reduction. Micro layer tomography with benefit of fast X –Ray rotating velocity without tube movement has been designed to make images with deep resolution of millimeter fraction whilst, there is no need of digital images reconstruction instruments that allows statistical errors to fall off about zero, and high resolution images could be prepared in all planes (coronal, sagital and cross sectional. Likewise, the patient treatment and the system maintenance cost are much less by many degrees compared with those in CT scan and MRI. In this system with increasing evolution, quick operation is highly exception, hence the tomographic slices could be prepared in about less than 0.02 second. The laboratory samples of this system have been a unique result for proving the new device preference.

Keywords: Tomography; Deep Resolution; Blurring; Quick Rotation

INTRODUCTION

Diagnostic imaging systems are very important in medicine; therefore, affiliated specialists should attempt to elevate this system’s efficiency of diagnosis [1-3].
This project was done for access to more resolution, highly deep resolution, low cost, quick operation and more efficiency.

It should be understood that in tomography only one plane (objective plane) is exactly in focus; a plane having no thickness does not cast a shadow, thus, what is seen in a tomogram is formed by a number of planes sufficiently super imposed to present a recognizable image [4-6].
A tomogram is improved by virtue of the partial or complete elimination of redundant shadows [7].

Because of X-Ray beams’ divergence at the time of cone shaped radiation emission, image distortion occurs, meanwhile, relatively nearer points to the rotating axes fixed point have lesser linear velocity than those of lying further from fixed point, consequently, tomographic Bluring(obscuring) occur gradually, that gives rise the wanted plane to be somehow blurred that is known as tomographic blurring, hence image clinical value is diminished [8-10].

Likewise, with widening of rotating angulation, blurring is increased, and the deep resolution is increased, hence, on the other hand, reducing of tomographic layer thickness causes image blurring that could be considered as a system deficiency [11-13].
Invention of C.T Scan and then M.R.I

has given rise to discontinuation of longitudinal-tomography development, but, the mentioned devices are relatively costly either, in supply or maintenance, meanwhile, the patient treatment expense is much, besides this system has technical deficiency such as probable statistical error through several

intermediary stages of image reconstruction [14].
Thus, computerized imaging is uncertain, for medical regulation.
The system of our project has optimum resolution and it has been done to aces more image quality, low cost, quick operation more efficiency.[15-17]

MATERIALS AND METHODS

Micro layer tomography system is designed to solve two main problems of longitudinal tomography. In the new system, two mechanisms have been contemplated.
First, we made a phantom of special sponge and put a cone in central and several pig around it. Then we did my examination by it. These, examinations were as follow:
The tests were administered by one same phantom with rotation speed of 20, 100, 2800 rounds per minute.

In this innovation we had 2 purposes:

1-Elevation of radiation cone relative velocity: in longitudinal tomography, x-ray tube can not rotate quickly, because it is relatively weighted and the high voltage installed cable, the possibility of speed increasing is confined (often less than 10 rounds per minute).
But, micro layer tomography system is designed based on beam movement, although the tube is constant.

Consequently, the beam rotation relative velocity could be elevated up to ten thousand times per minute that is much higher than that in longitudinal tomography (fig.2).
In this matter, the closer points to the rotation center have even high linear velocity and their associated images are obscured at once, instead of gradual blurring. Only a thin clear layer of tissue image is remained without any tomographic blurring that usually occurs in longitudinal tomography.

2-Decreasing of radiation cone angle, increasing distance and collimating of the emitting beam slope angle, divergence for a field of 20 × 20 centimeter, and Source-Image-Distance of 150 centimeter is 3 degrees. In 70 centimeter distance, the tomographic layer is 1.4 centimeters.
As the time increases up to about 0.5 seconds, further circulation of closer point to the central rotating axes, the tomographic layer is reduced on account of the calculation: $0.125 \times 2.5 \approx 300\,\mu$.

RESULTS

The images are derived from phantom experience (Fig. 2-3-4-5) ascertain that only in rotation of 2800 round per minute, The image of the wire with about 0.5mm diameter remains, while the images of the nails disappear without any over lapping.
Meanwhile, in 2800 rounds per minute, there is no nail adumbration, except for the image of wire, no metal has been inserted in to the phantom, and the images of the nails are entirely obscured with no track.

As a sample, a circle is contemplated with the radial of less than 1 mm diameter and circumference of 3mm that is supposed to locate less than 1mm from center of rotation , for ten thousand rounds per minute the velocity is calculated as V=50 cm/ sec. (Figures 3-4-5), for 2800 rounds per minute, the image of nails with a circulation radial of 1.5 centimeter has been entirely obscured. Exposure time was 0.03, thus the covered distance came about 13.5 centimeters.
With reference to out come, the precedence of this system is as follow:
1-Its deep resolution is at least 200µ for bone tissue and 300µ for soft tissue.
2-The images could be prepared without digital reconstruction.
3-The possibility of imaging in three diminutions; coronal, sagital, and transverse section is available, however this is more confined in C.T. Scan.
4- The cost of system manufacturing, maintenance and consequently, patent expenditure is less compared with MRI..
5-The time of imaging is shorter than that in MRI.
The shadow of thin wire could be simply over lapped by the nails.
Blurring of the tissue which lies less than 1mm from objective tomographic layer is calculated as: $\frac{50}{135} - = \frac{1}{t}$,
thus t = 0.25sec. Phantom experience has brought a unique result proving the new system preference such as quick operation, that is highly exceptional and preparing the images of tissue thin slices to arising the possibility of small lesions diagnosis.

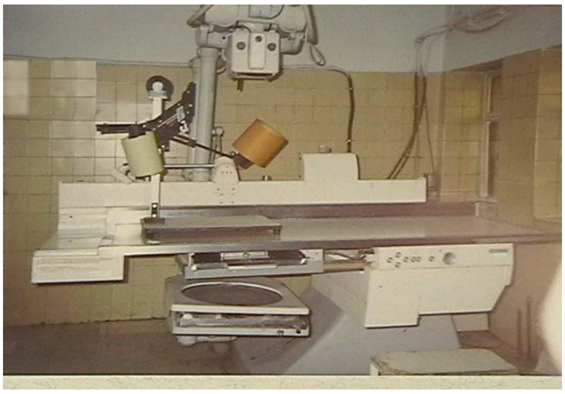

Fig (1): The first prototype of Micro Layer Tomography.

Fig (2): The constant radiographic image of a phantom with five pieces of metal and the thin wire lying on the rotation axes.

Fig (3): The usual Tomographic image of the same phantom with velocity of 20 rotations per minute.

Fig (4): The image of the same phantom with velocity of 100 rotations per minute and the times of 0.03 sec.; the thin wire image could be over lapped by the nails images.

Fig (5): The Micro Layer Tomography of the same phantom with velocity of 2800 rotations per minute; the image of all metal pieces are obscured, except the image of thin wire lying on the rotation axes. However, in the main device, the minimum rotating velocity could be adjusted about 5000 rounds per minute.

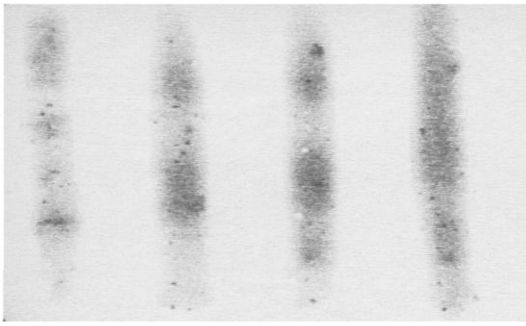

Fig (6): The radiographic image of compacted cellulose with pasted barium sulfate strips that both have the same thickness of 300µ. The atomic number and density difference between two materials is close to that between muscle and fat tissues.

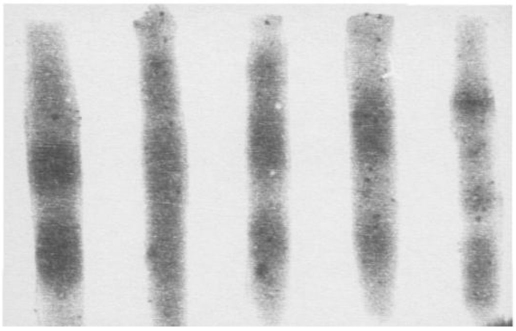

Fig (7): The radiographic image of sheet phantom that the density difference between strips and sheet is similar to that between bone and muscle tissues.

DISCUSSION

In common x-ray tubes, by increasing the Source-Image-distance, in usual terms, irradiation intensity is reduced. Compensation of the low intensity emission via elevation of exposure factors allows the tube useful life diminution. Construction nature of the new x-ray generator (intro spinning x-ray generator disk), in the shape of disk like, wide metal sides and coppery alloy made anode, with a large cylindrical tungsten target that causes higher heat capacity to compare with conventional x-ray generator tube. Thus, Source-Image-Distance could be simply increased to obtain a tomographic thinner layer to arise deep resolution, besides possibility of radiation field widening up to "35×35." The radiographic contrast of the exposed subject depends on its structure that is composed by substances with different thickness and radiation absorption index.

On this theme, the barium sulfate strips are diluted on compacted cellulose board sheet, with different thickness. For the soft tissue experience, the barium sulfate strips equivalent with atomic number of 9 and density of 1.2gr/cm^3. The effective atomic number for cellulose sheet was 7.5, with density of 1gr/cm^3. The atomic number and density between experimental materials that were utilized for the phantom were very close to those of natural tissues of the body. The effective atomic number difference between muscle and fat is about 1.5 and the density difference is about 0.1[4]. The thickness of strips for supposed soft tissue was 300µ (Fig 6). The exposure factors for soft tissue were 40kvp and 1.5 maps that is the same as common exposure factors for actual soft tissue. The next exposure was carried out for the supposed bone tissue, for this purpose we used a cellulose sheet of 250µ thickness and diluted barium sulfate strips are pasted on the sheet with atomic number of 13.5 and density of 1.9gr/cm^3 (very close to natual bone tissue). The radiation energy for supposed bone radiography was 70kvp and 1mA.s that is the same factor as common bone radiography (Fig 7). The out come images possesses distinguishable contrast that anyone can notice the detail without high definitude. The tomographic layer is acceptable for both, bone and soft tissue study, but to reach more desirable resolution the thinner slice for bone and soft tissue could be even prepared in 150µ up to 200µ .

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