Special Article*

Vivisection by Means of X-rays

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The roentgenological examination is essentially inferior to the post mortum pathological examination in following aspects; the roentgenological examinations provide not colorful, but black and white view, not three dimensional but two dimensional view and not magnified, but by naked eye view.

In order to improve these weak points of roentgenological examination, the investigations have been made by us on the chromatoroentgenography, axial transverse tomography and roentgenography in high magnification.

1. Chromatoroentgenography

A medical X-ray film, Fuji KX was exposed twice by X-rays. The photosensitive emulsion coated on the front of the film was faced to a patient. At the first exposure the film was closely contacted with the front piece of the intensifying screens Kyokko MS (medium speed screen), while there was set no intensifying screen at the back of the film.

After exposure, the front piece of intensifying screens MS was removed from the front of the X-ray film, and the back piece of the intensifying screens of Kyokko FS (fine grain screen) was next inserted between the back of the film and the cassette. The second exposure was made.

As the exposing condition of each exposure was about 60% of that of usual exposure, the total exposure dose to the patient was almost the same as that of the usual roentgenography.

For this experiment, new cassette, capable of changing the screens rapidly, was manufactured for trial and the cassette actually worked very well.

The roentgenogram was processed as follows: development, bleach, second exposure by light, second development, bleach, fixation, cleaning and water bath. After this procedure the front and the back of the film was stained with Magenta developer and Cyan developer respectively.

The X-ray image superimposed by two colors is well discernible and thus information obtained by this roentgenogram becomes more than twice as that of

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the normal black and white roentgenogram.

Our first paper on chromatoroentgenography¹⁾ as well as papers of several other authors dealt with roentgenography with color film. The present chromatoroentgenography²⁾ using the conventional medical X-ray film will be applicable to the clinical practice in advance, as the roentgenogram is taken with short exposure time and with good image quality.

2. Axial transverse tomography and solidography

An X-ray tube and turntables A, B, C ... are arranged in sequential order. The X-ray focal point and the rotating axes of the turntables are aligned along a vertical plane and the distances from the focal point to the rotating axes A, B, C ... are a, b, c ... respectively. A subject is placed on the turntable A.

The X-ray tube remains stationary and the turntables all rotate simultaneously while the radiation is emitted. In this way, it is possible to obtain invisible three-dimensional X-ray image on turntables B, C ... etc. which are analogous to the body on turntable A, but magnified by factors $\frac{a+b}{a}$, $\frac{a+b+c}{a}$, ... The difference between these X-ray images and the actual body is only the magnification; everything else is the same.

This is proved not only theoretically³⁾ but also experimentally^{4,5)}. As the three-dimensional X-ray image of the subject is formed on the turntable B, radiograms of inclined or curved sectional layer of the subject is obtained, in case an X-ray film is placed slant or with curvature on the turntable B. An axial transverse tomogram is taken, if a film is laid horizontally on the turntable B.

When the normal roentgenogram and the axial transverse tomogram of the interest are combined and examined, the three-dimensional knowledge of the lesion in the body is obtained.

In Japan the axial transverse tomograph of horizontal type has been manufactured and used. Axial transverse tomography has proven very effective in clinical work, although its use is not widespread as yet. One of the reasons why this method has not become popular in clinics is that the book with description of this method applied to entire body has not been yet published. A manual with charts of 130 axial transverse cross sections of the normal adult and examples of their application in clinical medicine was published⁶⁾. Thus the method will be more actively in the radiological examination and planning of radiation therapy⁷⁾.

3. Macroradiography in high magnification

For macroradiography it is the essential problem to get the X-ray tube having a very small focal spot. The smaller the size of the focal spot, the narrower the penumbra resulting the lack of sharpness in the X-ray image.

In order to obtain such a very fine focal spot tube, the electron beam, emitted from the heating filament was made narrow by the principle of bias phenomena.

For this purpose, the X-ray tube having a line focus (4×12 mm. in size) of a fixed anode tube of 6 kw. was used for trial. The lead wire was made connected with the focusing cap. When the potential of the focusing cap and that of the heating filament was made different up to 2,500 V, the size of the focal spot was decreased gradually to be less than $0.3 \text{ mm}^{8)}$. After that the tube was used clinically for macroradiography in two times magnification. After the success of the experiment the rotating anode tube having the small focal spot from 25μ to 50μ became commercially⁹⁾¹⁰⁾ manufactured under the guidance of our Department. In case of using this tube, the test pattern made with wires of 25μ in diameter arranged parallel each other with the interval of 25μ was resolved on the macroradiogram in 5 times magnification.

By means of the tube, the villi of the small intestine and the glomeruli of the kidney of the living human body which had been never seen radiographically are imaged on the macroradiogram in four times magnification¹¹⁾.

This method of radiography has been applied to the diagnosis of the early stage of the silicosis. In case of suspected cases but no findings of silicosis, the correct diagnosis is frequently established due to the small but clear findings¹²⁾.

For angiography of the tumor, such as skin-, uterus-, lung cancer and others, this method gives more findings¹³⁾.

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