Special Article

The Importance of Biplane 35 mm. Cinefluorography in Congenital and Acquired Cardiopathies

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SUMMARY

The biplane cinefluorography has been used for 320 cardiac patients. With the selective injection and the 9 inch image intensifier, this method makes surely smaller radiation loads to the patient. The transistor control in this apparatus takes an extreme correct activity. The external pulsing is not necessary to adjust the radiographic exposure factors before the injection. The television connecting with this apparatus is possible to use its magnetic image and to fix easily the position of the catheter tip. By this method a position change of patients is not necessary during examinations.

Our biplane cinefluorography has many remarkable advantages in comparison with other methods, especially for infants and small children, but also for certain congenital and acquired heart and coronary diseases of adults.

Additional Indexing Words :

Automatic development machine Cardiac movement Image intensifier
Impulse generator Pulsed radiation Quanta noise Television
camera Transistor control

THE PURPOSE OF CINEFLUOROGRAPHY

THE image quality of full-size sheet-film and roll-film changers is, of course, optimum. Their low exposure rate is, however, disadvantageous, particularly in the examination of children, in whom the velocity of blood flow and the heart rate are often very high. Here a quicker image sequence gives improved diagnostic facilities. The image formed on the viewing screen is filmed with a normal cine camera. To record and to reproduce the variations occurring during a movement process is a great aim of cinefluorography. The rapid succession of images will minimize risk of an important phase of

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movement being missed. It is possible, to obtain a great number of pictures in a short time in which a phenomenon occurs.

By the introduction to the image intensifier, the new radiography recording has been possible. The brightness of the observation screen can be reduced to about 1 : 10 by the electron-optical demagnification and also can be augmented 5,000 fold or more brightness of a usual roentgen fluorescent screen by a very high energy of accelerating electrons. On account of it, the image on the observation screen of the image intensifier can be easily reproduced for its great brightness.

THE QUALITY OF THE ROENTGENOGRAM

The quality of roentgenogram can be exactly defined by the concept of contrast and sharpness. Use of the image intensifier makes it possible to obtain images with essentially little quantity roentgen radiation. However, it must have regard to a new factor, namely the "quanta noise". This limits the reduction of radiation quantity, which can be attained by the image intensifier, and it also limits the factor of intensification.

For example, if the intensification of the tube is very great, a point of such brightness on the secondary screen is soon produced by the absorption of one roentgen quantum in the primary screen, namely 30 to 50 bromide grains in the development emulsion are activated, and then the perceptibility of details will become more little as a result of the "quanta noise". The number of X-ray quanta influences the aspect of graininess of the final image, and a small number of quanta increases the phenomenon of "quanta noise". Such an excess means nonsense.

It is doubtless that the image intensifier system is available for the cinefluorography of 35 mm. or 16 mm. films. In our cardiologic department, the biplane cineangiocardiology is used as routine researches since several years ago. A 9-inch image intensifier is employed for this research and also using a biplane technique makes smaller loading of the radiation dose to the patient than other methods. And then if the radiopaque medium is selectively injected, the duration of filming can be very short taken. If it is possible to utilize the television technique, magnetic image recordings can be also undertaken with other advantages.

METHODS

In roentgen cinefluorography, it is well possible to film the output screen of the image intensifier at 80 frames/sec. The transference of the image on

Fig. 1

the primary screen of the image intensifier to the secondary screen and from there via the optical attachment between the latter and the 35 mm. cine camera to the film is a fixed datum. When operated with pulsed radiation, the tube emits X-rays only at moments when they can reach the film, i.e. during the shutter open phase. In this way a reduction of the radiation dose as compared with cinefluorography with continuous radiation is possible which is given by ratio of the shutter closed phase to the whole cycle of 360° ; i.e. of a factor 2 at an open sector of the film of 180° .

Another advantage of cinefluorography with radiation pulses is that the exposure time per frame is no longer dependent on the frame speed. The shortest possible exposure time per frame with our technique is 1 msec. The duration of the pulse can be varied between 1 and 10 msec. The value of these short exposure times is clear, when it is considered that very rapid movements in angiocardiology have to be taken.

If films are shot in biplane, it is then possible so to phase-shift the opening and closing of the 2 shutters and thus the X-ray emission, that the radiation pulses have no mutual interference. The films in the 2 cameras are in fact exposed alternately (Fig. 1). This alternating rhythm was previously obtained either by mechanical or by auto-capacity coupling according to the rotary field instrument. Both methods are, however, not so suitable, especially for high speed films.

On account of this, the Phillips Müller Company devised a transistor-

Fig. 2

Fig. 3

control, which has an effect on the electromotorical forces of both cameras and takes an extremely correct activity. This control can be applied for all types of camera, having its film speed as far as 200 frames/sec. (Fig. 2). In the high speed cinefluorography as well as other radiographic methods, it is necessary to adjust the radiographic exposure factors before the injection of the radiopaque medium. Only with the impulse technique, however, this adjustment is possible, if the camera gives impulse. A great loss of film in the high speed can be protected by an so-called "external pulsing". An impulse generator compensates for the camera contact and simulates the running cine-camera. After determining the factors, the camera is again switched and the suitable cinefluorography can start with the injection of radiopaque medium.

By the apparatus as shown in Fig. 3, we have taken the biplane cinefluorography for 320 cases, children and adults, having congenital or acquired cardiac diseases.

COMMENT

Several reports have been written about the biplane cinefluorography.¹⁾⁻⁶⁾ Our own experiences of this with its advantages and disadvantages should be shortly reported.

For the preoperative diagnosis, it must be remembered that the cardiac function is rapid. A cardiac movement has its range of rates between 4 and 50 cm./sec. An unsharpness of 0.2 mm. in its 2 cm./sec. movement, then an exposure time is necessary for 1/100 sec. At one msec. (1/1,000 sec.), if an object moves at most 20 cm./sec., an unsharpness of an exposure, corresponding with about 25 periods/cm. can be possible.

Our experiences and compared examinations by ourselves showed that not only in infants with complex congenital cardiac disease the biplane cinefluorography is certainly superior to the full-size shut-film changers (6 pictures/sec.).

If the television camera can connect with the distributor of the image intensifier, the position of the catheter tip can be fixed on the 2 monitors before the injection of the radiopaque medium in biplane and the flow of the radiopaque medium can be surely followed up. Then a suddenly occurred accidents during the examinations, i.e. a depot of radiopaque medium in the myocardium, can be at once noticed and the suitable therapy can be promptly applied. By the direct visual check, the process of examinations in many cases is essentially able to shorten and then the radiation dose can be considerably reduced.

It is very advantageous that a position change of patients is not necessary. Each displacement in biplane saves from the risk of the catheter position's change and then the appearance of arrhythmia. For example, if it is a plan to inject the radiopaque medium in the left ventricle after a transseptal puncture of the left atrium and to change the position of a patient before the injection, the catheter returns to the left atrium and a second injection must be undertaken. Such a position change is very dangerous to the selective coronarography, i.e. impossible.

By the cineangiocardiology, the full size of a 9 inch image intensifier is used, especially for adults. For children or special cases, also smaller image areas can be sufficed. The resolving power is improved by a 5 inch image intensifier with a little reduced fluoroscopic images or by an electronic

enlargement of a fixed excision on a 9 inch image intensifier. Then the resolving power gets factors admitting maximal unsharpness of motion until 0.4 mm. The admitting exposure times until 1/1,000 sec. correspond to an object of cardiac movements from 6 to 50 cm./sec.⁷⁾ By the pulsed radiation, such exposure times can be obtained easily. Consequently, high speed images can be selected and then a very good slow motion reproduction can show the fast cardiac phenomenon. This is very important for children, whose heart rate and blood flow rate are often very fast, by which the radiopaque medium flows off quickly.

An essential advantage for the cinefluorography is the direct observation of phenomenon by cardiac motions. The mode of cardiac valves, the direction and largeness of shunts or the volume change of the atria and the ventricles during the cardiac cycle can be correctly followed up. This is very useful for the diagnosis of complex congenital anomalies in infants and small children or, for example, the recognition of valvular insufficiencies and functional hypertrophic subvalvular stenosis.

For saving in film, the biplane cinefluorography is essentially superior to the full-size sheet-film and roll-film changers. Although there are considerable technical problems and then financial expenditure, its total costs are remarkably cheaper than other methods.

This method is very suitable for the demonstration of the moving process and can be especially used for the lecture. Furthermore, this offers great possibilities to resolve the academic difficult problems.

We develop our 35 mm. films by a perfect automatic development machine and then can see the films on a projection table shortly after the examination. Each method has of course its disadvantage. Surely the biplane cinefluorography also has it.

The detail perceptibility of each picture is clearly worse than that of the full size films. The photographic recording with a 35 mm. film on a 9 inch image intensifier shows a little resolving power of more than 50% compared with an exposure in a full-size film. In the cinefluorography, however, the detail perceptibility of each picture is not so important. It is clear that diminution of unsharpness in motion can be obtained by very short exposure times, but also "quanta noise" and film grain are not all suppressed by a subtle technique of development. On the basis of our own compared experiences, we can establish that it depends not on the detail perceptibility of each image in the reproduction of fast elapsed cardiac phenomenon. If it is filmed at high speed, in contrast with that of large size, at each cardiac movement having different velocity, it is perceived details, which can not be diagnosed on each image even though using the better resolving power.

Another disadvantage of it is that the development process continues longer than those by other methods. The interpretation is also not easy. A dark room is necessary and the film must be more often observed and reeled back.

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