PREVENTION OF GEOGRAPHIC MISS DURING RADIOTHERAPY

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INTRODUCTION

In radiotherapy, the irradiating beam is aimed from outside of the body towards a neoplasm at some depth inside it. This is an entirely new situation facing the radiotherapist, not present in other branches of medicine. Paterson (1948) in analysing the causes of failure of radiotherapy, coined the term "geographic miss" to explain those cases " in which it can be shown that a small part of the treatment zone has in fact either escaped radiation or been inadequately irradaited. This may occur for a variety of reasons. In the first place it may occur because the total volume of tumor was not appreciated and hence an insufficient margin was taken at least at one point. In this way, tumor cells remain outside the effectively treated area. Again the plan of treatment, espesially where multiple x-ray fields are used may have been so conceived that low dosage resulted at one point. Alternatively the plan may be good, but it is in the execution which fails. This, I beleive happens frequently when radium' implants are not subsequently checked radiographically. It may occur with radium moulds because of poor fitting or because of their tendency to slip under the action of gravity. It may occur in x-ray therapy by faulty beam direction even when this has occured in only a few of the total number of exposures." However, geographic miss may be due to another factor, i.e., mobility of the organs inside the body. It thus becomes essential to study the mobility of the various organs and the factors that affect this mobility. The abdominal organs have tortuous blood vessels to allow their normal range of movement.

1. A normal organ enjoys mobility and in case fixation is detected, a pathological condition is diagnosed, be it inflammatory adhesions or neoplastic infiltration. We are accustomed to think and see the organs of the body in the dissecting room hardened by formalin in definite fixed sites as if cemented, a condition that does not exist at all in the living condition. The situation is further

complicated by the fact that all the viscera are shrunk and distorted.

2. In the living subject, the viscera are continuously filling and emptying and as they do so they move from their original empty positions, pushing adjacent organs.

3. When a person is lying down and then stands up his organs are acted upon by gravity and so descend to a lower level.

4. By breathing the diaphragm descends and consequently all subdiaphragmatic organs descend.

To get a true idea about the mobility of the organs they should be studied in groups and not singly, e.g. the pelvic organs the abdominal viscera and the theoracic organs.

Shanks (1953) stated that " In 1900, Sir James Mackenzie Davidson devised an ingeneous mechanism for renal radiographic examinations, an automatic cutoutwhich placed on the patient's chest, switched on the current when the subject took a deep breath and switched it off when he let go. This because the exposure was about two minutes." During such lengthy periods of exposure for radiography, the patient cannot hold his breath and to overcome this difficulty, certain devices were used to catch any organ in one position.

Apparatus

A simple device was constructed using a spring switch as that which turns the light on and off in the door of a refrigerator and was strapped to the patient's chest or abdomen as the case may be. It was connected to the control panel to switch the shutter on and off. The patient was instructed to breathe quietly so that the changes are minimal. In case he breathes deeply, the contacts touch and this actuates the shutter to close till he resumes quiet breathing. This was tested in every case in a dry run and then was applied during the actual treatment.

RESULT

This device proved quite satisfactory and practical without annoyance to the patient. No displacement of the central ray was detected as if the organs were so to speak frozen in their place during the whole length of treatment. The delivered dose was similar to that planned and calculated. This was proved by direct measurments using intracavitary ionisation chambers introduced inside the pharynx, oesophagus, stomach, bladder and rectum. Cases were divided into two groups :- 1. those where the apparatus was applied. They were ofurteen in number, six chest cases and eight abdominal cases. There was

practically no tumor shift of more than few mms either side ways in case of chest or up and down in case of abdomen, fig. 1. 2. Cases where the apparatus was was not applied. There was tumor shift up to 1 cm in 16 cases, 2 cms in five and 3 cms in one case, as illustrated in fig. 2. The treatment time was longer when the apparatus was applied by 14 to 25 seconds during which the treatment was turned off by this device.

DISCUSSION

In a symposium about the treatment of lung cancer by multiple small fields by the staff of the Royal Cancer Hospital of London, very careful radiographic localisation before and during treatment is described and commented upon " Under these circumstances displacements of a field so that the central ray was up to one cm from the position it should have occupied on the theoretical plan were frequent, up to two cms occasional but greater displacements rare. Ingenuity which goes into the design of beam directors couches, rests and clamps for setting and maintaining the treatment position may only give rise to a sense of false security unless it can be shown that they do in fact achieve their purpose. Skin reaction patterns often provide a chek on the accuracy of surface application of the fields but tell us nothing of the path of the beam through the patient. "

A plaster jacket of the chest with wax seatings for the applicator 's end to rest upon during treatment suffers from the same defect of sense of false security. The skinis taken as the landmark for aiming the beams and the degree of accuracy is judged by being able to repeat the same positioning. Here it is assumed that the patient is not breathing and the carina is fixed in space. The patient is breathing continuously and the tumor is moving up and down in relation to the skin while the treating beam is aimed at the skin. As the diaphragm moves from the position of inspiration to expiration, it is capable of several cms up and down movement. At the same time the anteroposterior and side to side diameters of the chest increase. The volume of the lung increases and the carina travels from the sixth to the eighth dorsal vertebra. Brown (1952) described the movements of the trachea caused by respiration and deglutition and during bronchoscopy, four types of tracheal movements are seen. Two of the tracheal movements are rythmic hein pulsatory and respiratory and two intermittent being bechic and deglutatory. This continuous movement of the trachea and bronchi during life with the varying diameters of the chest and increase of air content of the lung help to explain why the results of radiotherapy of bronchogenic carcinoma are far from satisfactory.

All the abdominal viscera enjoy a marked degree of mobility. The position of the stomach depends on the degree of filling, posture of the person and the condition of the adjacent viscera. The intestinal coils are freely mobile due

to their long mesentry. Although the kidneys are retroperitoneal in position yet they are capable of 3 cms up and down by breathing and about the same distance by standing up. Each time the diaphragm descends, all the abdominal viscera are pushed down for variable distances. This is not taken in consideration when radiologically localising a neoplasm of an organ. The patient is only instructed to stop breathing while making the radiograph.

The perineum forms the pelvic floor allowing the bladder rectum and uterus to expand in an upward direction as they fill up. When cystography is used to localize a bladder neoplasm, the bladder is filled up completely with the contrast medium and radiographs are taken and the treatment is planned in this position. However, the patient does not come for treatment with distended bladder. This explains why the actual dose received will be less than theoretically calculated.

CONCLUSIONS

It is possible to overcome the previously discussed difficulties by : 1. taking radiographs in full inspiration and full expiration so as to know the range of movement by breathing. 2. The radiographs must be made in the position which is going to be assumed during treatment whether sitting, lying prone or supine. 3. avoid distending the organ by the contrast medium and only use the least amount sufficient for localization . 4. The patient is instructed to come to treatment with an empty viscus whether it be stomach, colon, or bladder. 5. The described device is strapped to the chest or abdomen during treatment, so as to deliver the treatment during a narrow range of movement of the organ. This simulates the device used 70 years ago by Sir Davidson for radiography.

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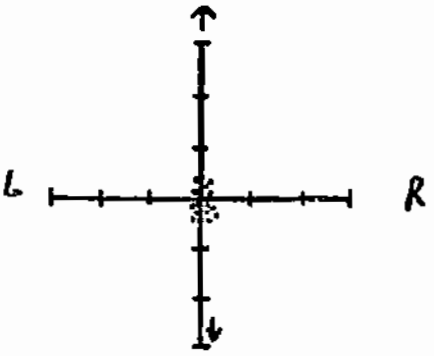

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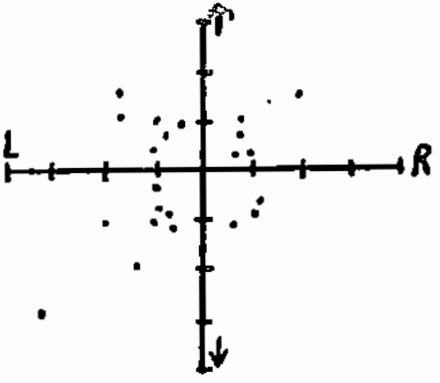

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