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INTRACAVITARY IRRADIATION IN TREATMENT OF CARCINOMA OF CERVIX WITH PARAVAGINAL EXTENSION

by

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Irradiation is the preferred initial treatment at Radiumhemmet for cases of carcinoma of the cervix. A combination of intracavitary radium application and external irradiation has generally been used with the aim of giving a sufficiently high dose to the growth without causing irreparable damage to normal tissue.

Special attention has been directed to the risk of radiation damage to the rectum and the bladder, particularly in those cases where the tumour extends to the paracervical or paravaginal tissues. Dose distribution studies on human subjects and on phantoms (KOTTMEIER 1951, WALSTAM 1954) have revealed that the intrauterine radium makes a greater contribution to the dose in the paracervical tissue than the vaginal radium, while the reverse is true for the paravaginal tissue. Experience has shown that an increase of the dosage from the radium inserted into the cervical canal has improved the cure rate in cases of endocervical carcinoma and of paracervical extension (KOTTMEIER 1964).

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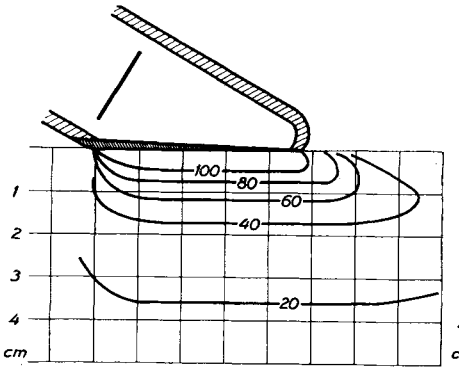

Fig. 1

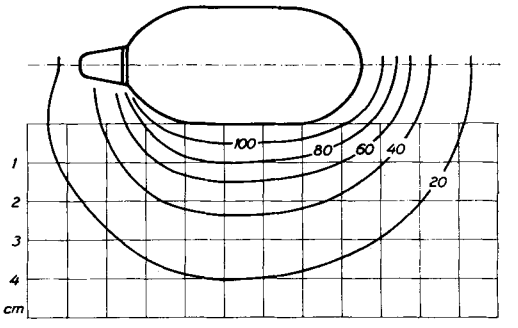

Fig. 2

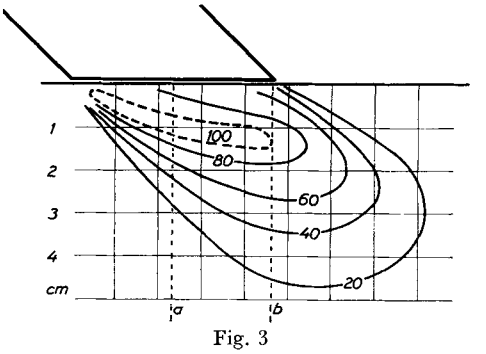

Fig. 3

Fig. 1. Dose distribution in a principal plane for an intracavitary roentgen tube working at 100 kV (according to KEPP).

Fig. 2. Dose distribution around a cylindrical radium applicator.

Fig. 3. Dose distribution in a principal plane for an oblique intracavitary electron tube at 15 MeV.

An increase of the dosage from the radium applied in the vagina, in cases of paravaginal extension, is generally impossible due to the risk of overdosage and consequent severe damage to the rectum.

The development of improved external irradiation techniques has made it possible to obtain better dose distribution in the paracervical and paravaginal tissues. In order to make full use of the advantages both of the improved external irradiation techniques and the various intracavitary irradiation methods, a combination of these is generally used. A detailed knowledge is required of the dose distribution both from the intracavitary and from the external irradiation to obtain the intended tumour dose and to avoid undesired radiation reactions.

Intravaginal roentgen techniques were worked out during the decade of 1940, especially in Germany, and several papers on this subject have been published. KEPP (1951) developed such a technique and described its clinical applications. At Radiumhemmet, intravaginal roentgen therapy has been administered only in a selected number of cases and the results have been unsatis-

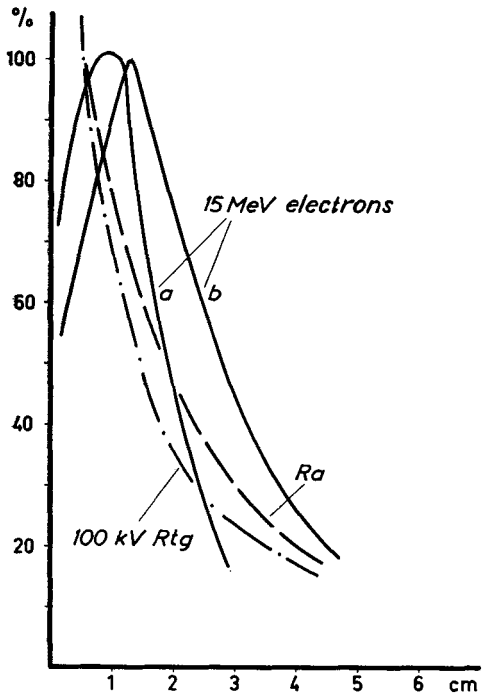

Fig. 4. Comparison between the relative depth dose in the principal plane for the irradiation techniques illustrated in figs 1, 2 and 3.

factory. The dose distribution figures for this technique, used for comparison in this paper with our own values, are obtained from the publications by KEPP.

Intravaginal radium application with the aim of improving the dose distribution in the paravaginal tissue has frequently been employed at Radiumhemmet. A number of irradiators of various lengths, diameters and radium distributions, have been used (KOTTMEIER 1953). Our interest has also been directed to the value of ^{137}Cs and ^{192}Ir as radiation sources for intravaginal gamma irradiation. Results from primary investigations and the advantages envisaged with these medium energy gamma emitters have recently been published (KOTTMEIER & WALSTAM 1963).

The interstitial application of radium needles or radioactive colloidal gold was tried in several cases in the years between 1940 and 1946. Although a cure was sometimes achieved, the results were in general unsatisfactory.

Electron beam irradiation became available at Radiumhemmet in 1957, when a 17 MeV betatron (Siemens) was installed. Intravaginal applications can

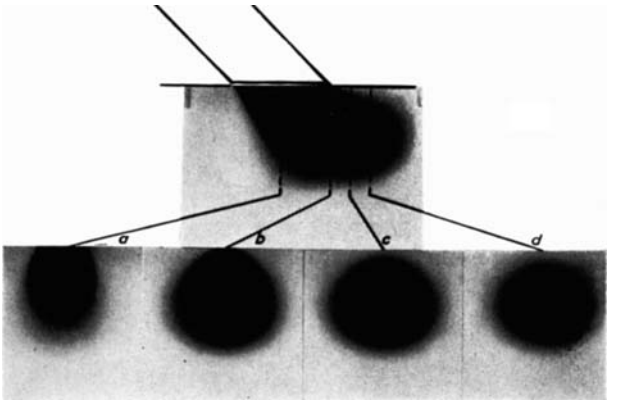

Fig. 5. Dose distribution in four sections, perpendicular to the principal plane of the 15 MeV electron beam, illustrated by a photographic method.

also be performed with this apparatus due to its small size and great mobility. Among the standard tubes for the apparatus, a tube with an oblique beam aperture has proved particularly suitable for intravaginal irradiation. This technique, using 15 MeV electrons, has been used in the last few years in 31 selected cases.

In the present communication, the dose distributions obtained with the various intracavitary irradiation techniques mentioned above are compared and their relative merits discussed on the basis of the experiences gained in this clinic with electron beam irradiation.

Dose distribution studies

A comparison between the dose distributions for the three irradiation techniques can be made in the diagrams of Figs 1, 2 and 3 which give the dose distributions in a central cross section for each of the three methods. In Figs 1 and 2, the dose distribution is expressed as a percentage of the dose at 5 mm 'tissue depth', and in Fig. 3 as a percentage of the maximum dose.

The distribution in Fig. 1 was obtained by calculation from data given by KEPP for a particular roentgen tube working at 100 kV. The dose distribution around the radium applicator containing 150 mg radium (Fig. 2) was obtained by measurements with an automatic isodose recorder (LARSSON, LIDÉN & STARFELT 1963). The dose distribution measurements on the electron beam (Fig. 3) were performed by using a thin emulsion film (Gevaert Dipos N 51) applied in a tissue-equivalent phantom (mix D). The film density was determined by means of an optical densitometer connected to a semi-automatic recording device and calibrated by comparison with ionization chamber measurements.

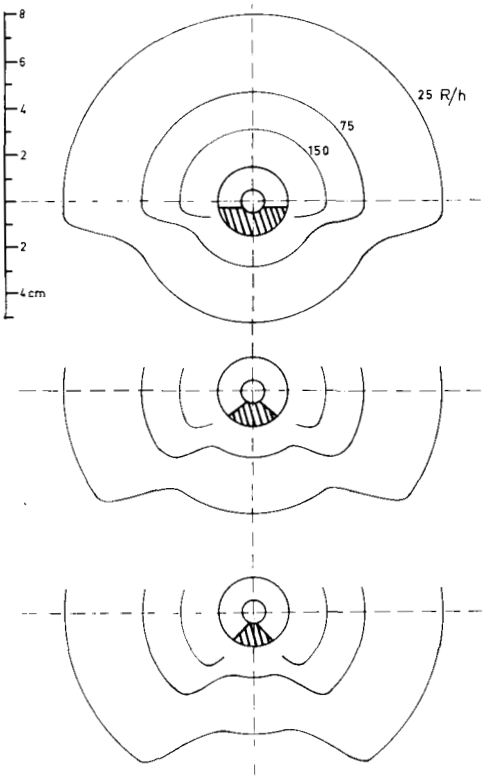

Fig. 6. Shielding effects obtained by supplying a cylindrical applicator with various sectors of lead.

The dosage was based on ionization chamber measurements with a special group of Bg-chambers (SIEVERT 1932) and a Victoreen chamber. The chambers on comparison with a sub-standard chamber (THORAEUS 1957) exhibited a small energy dependence in the HVL region from 0.1 to 14.5 mm Cu. The radiation exposure was expressed in terms of a provisional unit, R_β, obtained by using the ^{60}Co calibration factor for the chambers.

The depth doses in the central cross-section perpendicular to the surface of the applicator or the tube openings are summarized in Fig. 4. Regarding the electron beam, the distribution being more irregular, the depth dose is drawn in two sections, *a* and *b*, the positions of which are illustrated in Fig. 3. As shown in Fig. 4, the electron beam gives in this cross-section the highest dose at a depth of 1 to 2 cm and a low surface dose. The other two techniques are characterized by high surface doses and a rather steep dose fall-off in the first

centimetres of irradiated tissue. In clinical application it is not enough to consider the depth dose or the dose distribution in a central cross-section; the three-dimensional dose distribution must be taken into account.

The dose distribution around a vaginal cylinder of the type demonstrated in Fig. 2 is symmetrical around the axis of the cylinder and thus fully determined by the isodose diagram given in the figure. The three-dimensional dose distribution, when using the other two techniques, requires more information than given in Figs 1 and 3. An example of such information, obtained by a photographic method, is illustrated in Fig. 5. It is obvious from this figure that only a small volume can be homogeneously irradiated with this technique. It is therefore important that such a technique be applied only on carefully selected patients. Similar considerations are valid also for the intracavitary roentgen irradiation technique.

If the tumour mass involves greater parts of the vaginal wall than can be successfully irradiated with the other methods, intracavitary irradiation with a suitable gamma applicator might be considered. Compared with the other techniques, the radium application has the disadvantages of causing considerable radiation protection problems and giving approximately the same radiation intensity in directions where the irradiation should be kept to a minimum. A significant reduction of the radiation can be obtained by employing screens of heavy metals, a condition that may be further improved by using artificial isotopes (KOTTMEIER & WALSTAM 1963). In Fig. 6, examples are given of the dose distribution that can be obtained by supplying an applicator of the type shown in Fig. 2 with various sectors of lead, and using ^{137}Cs as the radiation source. It is obvious from these diagrams that the dose may be significantly reduced in some directions, i. e. towards the bladder and the rectum, so that a kind of 'beam-irradiation' can also be obtained with this technique. The application may easily be performed by using an afterloading technique, possibly remotely controlled, as described by WALSTAM (1962), and thus considerably reducing the radiation protection problems.

Clinical experience

Intravaginal electron beam irradiation has been administered in addition to the standard radiation therapy in 18 cases of carcinoma of the cervix, stages II and III, in the period between 1957 and 1961 and this irradiation technique has also been tried in 13 cases of recurrences following previous irradiation of a cervical carcinoma. Cases of clinically defined paravaginal extension of the growth have been selected for this trial. A tube with an oblique 24 by 34 mm beam aperture has been inserted into the vagina after careful

clinical examination. The positioning of the tube aperture towards the growth can be checked by palpation and inspection. The application of the tube has not caused the patients much discomfort. A total of 3 500 to 4 500 R_β (maximum exposure of Fig. 3) has been administered in irradiations with 400 to 500 R_β, every day or every second day.

Eleven out of 18 patients who received the intravaginal electron irradiation, in addition to the standard radiation technique, are living without any evidence of disease 3 to 6 years after initial irradiation. No improvement was seen in 3 patients. In the remaining 4 patients primary healing of the carcinoma was achieved but the patients died later from pelvic recurrences. A slight late radiation reaction has occured in 3 patients and a vesico-vaginal fistula in one patient with a stage III carcinoma; it may be questioned whether the fistula was due to the radiation or to the electrosurgery which was performed later.

Intravaginal electron therapy has also been tried, as mentioned, in 13 patients with recurrences in the paravaginal tissue in the period 1957—1961. The technique applied was similar to that just described. The authors did not anticipate any permanent healing effect from this irradiation. All these patients have succumbed to the cancer but some improvement was achieved in two of them.

SUMMARY

Various methods for improving the dose distribution to the paravaginal tissue in the irradiation of carcinoma of the cervix are discussed and a comparison is made between them. An intravaginal electron beam irradiation technique has been tried during a 5-year period, with encouraging results, in 31 selected patients with carcinoma of the cervix with paravaginal extension.

ZUSAMMENFASSUNG

Verschiedene Methoden zur Verbesserung der Dosisverteilung im paravaginalen Gewebe bei der Strahlenbehandlung des Cervix-Carcinomes werden besprochen und verglichen. Eine Behandlungsmethode mit einem intravaginalen Elektronenstrahlenbündel wurde an 31 ausgewählten Patientinnen mit Cervixcarcinom mit paravaginaler Ausbreitung während einer Periode von 5 Jahren mit ermutigenden Resultaten angewandt.

RÉSUMÉ

Les auteurs étudient et comparent diverses méthodes destinées à améliorer la distribution de dose au tissus paravaginaux dans l'irradiation du cancer du col de l'utérus. Ils ont essayé pendant une période de 5 ans, avec des résultats encourageants, sur 31 malades sélectionnées atteintes de cancer du col avec extension paravaginale, une technique d'irradiation intravaginale par un faisceau d'électrons.

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