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DOSIMETRIC PROBLEMS WITH RADIUM IN THE INTRACAVITARY TREATMENT OF CARCINOMA OF THE UTERINE CERVIX

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Intracavitary irradiation of the primary tumour is generally included in the radiation therapy of carcinoma of the uterine cervix. An intrauterine applicator in the form of a rod and one or several vaginal applicators are loaded with radioactive isotopes. The form of the rod is about the same regardless of the technique employed but the vaginal applicators vary. The Stockholm technique employs at flat or slightly curved applicator (KOTTMEIER 1964); the Paris and Manchester methods utilize ellipsoids or cylinders placed in the vaginal vaults and sometimes against the portio (TODD & MEREDITH 1953, FLETCHER 1966).

A number of means have been suggested for overcoming the difficulties inherent in ensuring that the applicators remain in position and in correct interrelationship; these include locking them together or fixing them so that only unimportant variations of positions are possible (NOLAN 1962, HENSCHKE & HILARIS 1965, SCOTT 1966, SCOTT & BETSCH 1966, CAMPBELL & DOUGLAS

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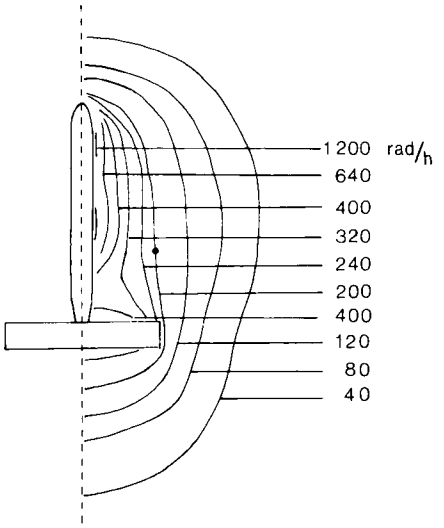


Fig. 1. Isodose distribution around the intrauterine and vaginal applicators in ideal position. The numbers represent the absorbed dose in rad/h. Point A, marked by a dot, lies 2 cm laterally and 2 cm caudally to the point of contact between the intrauterine and vaginal applicators.

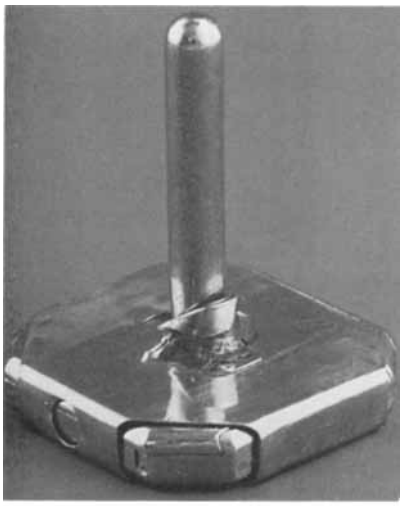
1966, LOISSEAU 1967). The purpose of the present investigation has been to demonstrate the importance of a well-defined fixed geometry for the intrauterine and vaginal applicators, and to present a method for its achievement.

Material and Methods. The intracavitary Stockholm method was employed. A rod-shaped applicator is placed in the uterus and a flat applicator fixed against the portio with gauze packing. The most commonly used applicators were examined: Intrauterine applicator: ∅ 7 mm × 68 mm, 90 mCi ^{226}Ra. Vaginal applicator: 5 mm × 44 mm × 44 mm, 110 mCi ^{226}Ra.

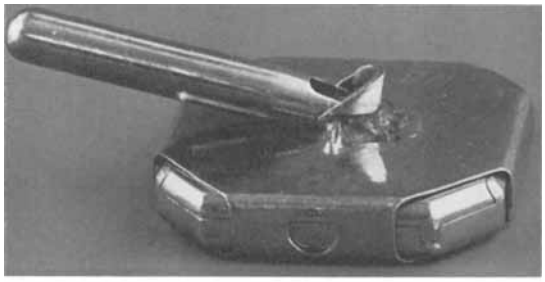
The resultant isodose distribution in water around these applicators, combined in four different geometries, was calculated: (1) 'Ideal position', that is the intrauterine applicator is placed orthogonally in direct contact with, and in the centre of the principal plane of the vaginal applicator (Fig. 1). (2) 10° and (3) 20° tilt from normal, parallel to one side of the intrauterine applicator. (4) The intrauterine applicator in an orthogonal position but at 1 cm distance from the vaginal applicator.

A point (A, Fig. 1) was chosen as the point of reference for indicating the absorbed dose; this lies 2 cm cranially and 2 cm laterally from the point of contact of the intrauterine and vaginal applicators (approximately at the external os of the cervix).

The dose at point A was calculated from films obtained during the actual treatment in 7 consecutive cases without any interfixation of the applicators.



a



b

Fig. 2. Interfixation of the applicators in position 0° (a) and 80° (b).

An arrangement for this purpose was later constructed (Fig. 2). A thin metal frame was drawn over the vaginal applicator and the intrauterine applicator, mounted with a cross-piece, fitted into a notch in the frame so that it could be moved through an angle of incidence only of 0° to 80° in a direction parallel to the side of the vaginal applicator. A catch prevented movements beyond the normal position (0°) in the opposite direction (Fig. 2). Frontal and lateral films were obtained in 47 patients during actual treatment in which the locking arrangement was employed.

Results

The isodose distribution around the combination of applicators in the ideal position (Fig. 1) indicates a steep dose gradient. An absorbed dose which at point A was 6 500 rad had at only 5 mm lateral to the point sunk to 5 000 rad.

Inclination of the intrauterine applicator 10° from normal deforms the isodose pattern so that the absorbed dose at the two points A given above for the ideal position is increased to 8 000 and decreased to 5 000 rad, respectively, for the same treatment time. An inclinication of 20° from normal gives corresponding absorbed doses of 12 000 and 3 500 rad, respectively. If the lower end of the intrauterine applicator is withdrawn 1 cm from the vaginal applicator, a waist arises in the isodose pattern, and the dose at point A falls to 3 500 rad.

Calculations of the absorbed dose in 7 patients in whom the applicators were not interlocked disclosed 3 600 to 6 800 rad, mean value 4 900 rad, at point A

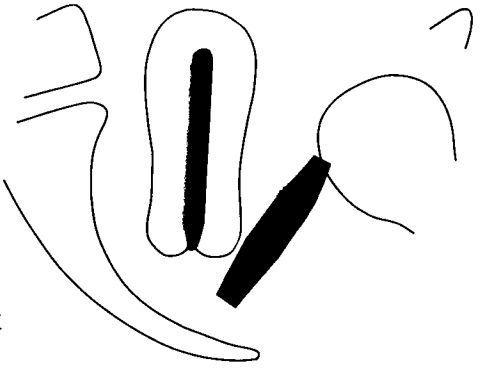


Fig. 3. Applicators inserted without interfixation. The vaginal applicator has almost slid off the portio.

on the side on which the dose was lowest, and 6 200 to 14 600 rad, mean value 8 500 rad, on the side where the dose was highest. The applicators failed to lie in the ideal position even if the deviations were not so great as depicted in Fig. 3; a calculation of the dose had not been performed in this instance. The treatment period for these 7 patients gave about 6 500 rad at point A with ideal positions of the applicators.

The applicators with the locking arrangement described are inserted at 80° and the bar is turned ventrally. When the vaginal applicator is lightly pressed against the portio above, the uterus usually becomes slightly anteflexed and the intrauterine applicator is locked in position at 0°. Where the portio is not prominent and the uterus lies retroflexed, it is sometimes necessary to rotate the combination half a turn after insertion so that the bar is turned dorsally. The uterus may then be straightened into middle position to light anteflexion. If the intrauterine and vaginal applicators can be inserted individually, that is when the space in the vagina is sufficient, the applicators may also be interlocked in the manner described.

Roentgenograms obtained at actual treatments indicate that the angle between the intrauterine and vaginal applicators always deviates under 10° from the ideal position.

Discussion and Conclusion

The distribution of the absorbed dose around the combination of applicators has an extremely steep gradient. Only primary tumours lying schematically with a hemispheric volume with a radius of 2 cm around the external os of the cervix can be expected to be eliminated by the doses indicated (6 500 rad at point A). Calculation of the dose distribution around the applicators in

different positions in relation to one another revealed that even quite small variations of these positions cause marked changes in the distribution of the dose. When the applicators were individually placed in the uterus and the vagina, their interrelation positions varied to a high degree (UNNÉRUS et coll. 1964, SCOTT & BETSCH 1966, LOISSEAU 1967). Such alterations might lead to parts of the tumour receiving too small a dose, and the bladder or intestines given excessive irradiation.

The intrauterine and vaginal applicators must be interfixed in a predetermined position in order to guarantee an adequate distribution of the dose around the portio—cervix (Fig. 1).

The coupling arrangement described is uncomplicated and allows the use of applicators already available, so that it is possible to work with the distribution of dose (theoretically) and the dose levels already in use.

The investigation indicates that the relative positions of the intrauterine and vaginal applicators with the coupling used are almost ideal. The arrangement has been in routine use in our clinic for four years.

SUMMARY

The distribution of dose around intracavitary applicators (Stockholm technique) has been investigated. Both applicators must be fixed in predetermined positions in order partly to guarantee a satisfactory distribution of dosage in the area of the tumour, and partly to protect the bladder and intestines. An uncomplicated but effective coupling arrangement for such fixation is presented.

ZUSAMMENFASSUNG

Die Dosisverteilung um intrakavitäre Applikatoren (Stockholm Technik) wurde untersucht. Beide Applikatoren müssen in einer vorausbestimmten Position fixiert werden, teils um eine zufriedenstellende Dosisverteilung im Tumorgebiet sicherzustellen und teils um Blase und Darm zu schützen. Eine unkomplizierte, aber effektive Kupplungsanordnung für diese Fixation wird angegeben.

RÉSUMÉ

Les auteurs ont étudié la distribution de dose autour d'applicateurs intracavitaires (technique de Stockholm). Les deux applicateurs doivent être fixés dans des positions prédéterminées de façon à garantir une distribution satisfaisante de la dose dans le volume tumoral d'une part et de façon à protéger la vessie et l'intestin d'autre part. Les auteurs présentent un dispositif de couplage simple mais efficace pour cette fixation.

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