Intravaginal Radiation Therapy with Electrons

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電子線による子宮癌腟内照射の研究

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子宮頸癌手術後の腟断端部照射，及び同部の再発癌に対する照射法の一つとして電子線による腟内照射法を検討した．腟断端部から腟壁にかけて任意な範囲の表面照射を可能とする条件を求めた．その結果，腟壁を伸展させるために直径3 cmφ，4 cmφ，長さ7cmのアクリル製円筒状の先端閉鎖型アプリケータを挿入し，さらに電子線ツーブスをこの中の任意の深さにまで進め，鉛製スキャッタラーを電子線ツーブスの先端に置くことにより，側壁方向への線量分布を求めることが可能となつた．

Introduction

Radiation therapy of the carcinoma of cervix consists chiefly of the intracavitary radium therapy and external beam irradiation. Various dosage schedules of both treatments are established regarding to the extent of diseases.

Transvaginal or intravaginal radiation therapy were started early in the 1940's with X-rays and radium applicators, and recently electron beams have been used. The indications of these techniques are rather limited. H.L. Kottmeier[1] reported the relative merit of these techniques for the treatment of the paracervical or paravaginal extensions of the carcimoma of cervix. He obtained encouraging results by the intravaginal electron beam irradiation. F.N. Rutledge[2] used transvaginal radiotherapy for the purpose of the hemostasis of large fungating and ulcerated lesions prior to whole pelvis irradiation. Because of the rather rapid fall off of dose delivered by 250 KVp X-rays, almost all energies were absorbed by large external tumor mass.

Electron beam has the advantages in dose distribution which falls off rapidly, in that selection of proper energy is easy, and in that appropriate size of cone for the transvaginal irradiation is available.

This paper presents modified dose distribution of electron beam produced by 18 MeV Siemens Betatron for the carcinoma of cervix, carcinoma of stump and paravaginal extension.

Experiments and results

In this experiments, all effort was directed to obtain the dose distribution by which cervical stump and desired length of vaginal wall could be included in the same field. For this purpose intravaginal applicators into which a cone of electron beam therapy could be introduced to a desired distance were devised. As shown in Fig. 1., these are made of acrylate, form is cylindrical, closed ended and their internal diameters are 3.2 or 4.2 cm respectively, length is 7 cm, wall thickness is 2 mm, and these applicators have a supporting brim in order to fix them to the vagina. Treatment cone can be inserted into these applicators and tightly stuck to their internal wall to avoid any change in teatment position. Experimental studies were carried out with these applicators dipped into the water phantom but whose cavity was kept free from water and with the X-ray films held in the principal plane of the electron beam, in order that dose distribution from lateral to forward direction of electron beam corresponding to the longitudinal cross section of the applicators might be visualized.

As shown in Fig. 2, cone of Betatron was inserted into applicator in three different positions, namely at the entrance A, middle B and bottom C. X-ray films thus exposed were studied for the dose distribution.

Inherent scatterer of Betatron did not produce lateral scattering, enen when cones in the applicator were situated at the entrance A, or the middle B, thus the resulting dose distribution are almost the same in cases of A, B and C. When cones were placed at A, radiation dose measured by Siemens ionization chamber showed only 20% reduction of the dose in case of being placed at C. Removal of the scatterer showed almost similar results regarding to the change of dose distribution.

The best dose distribution could be obtained when the scatterer which were composed of 4 pieces of 0.2 mm thickness of lead plate being conically piled up were placed at the end of the treatment cone as shown in Fig. 2.

Radiographies in cases of 18 MeV and 12 MeV electron beam thus exposed are shown in Fig. 3. The dose distribution in the lateral part of applicators is fairly satisfactory. One difficulty is the less scattering to the oblique direction from the edge of apex of applicator. This is rather pronounced in lower energy as shown in Fig. 3, but when the insertion of treatment cone is beyond the middle of ap-

Fig. 1. Intravaginal applicators

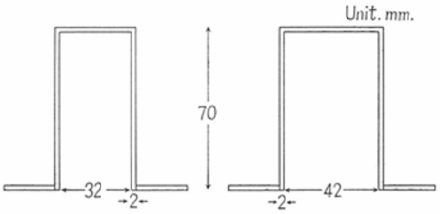
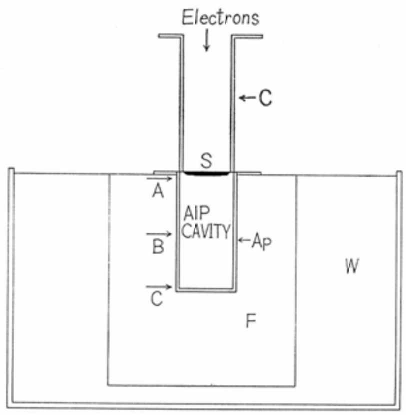
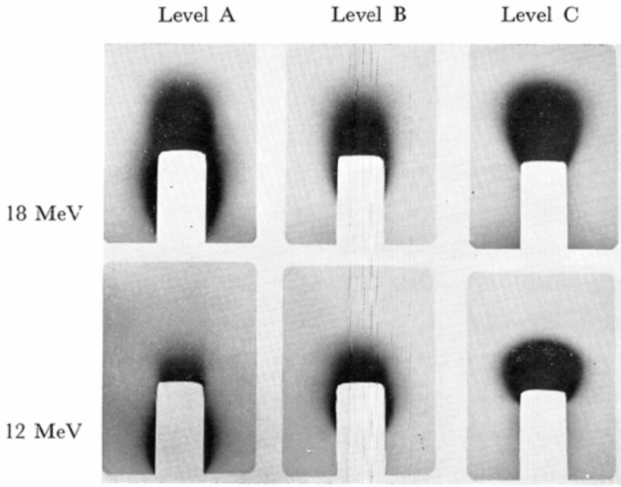


Fig. 2. Experimental diagram



Ap : Acrylate applicator
C : Treatment cone
S : Scatterer
F : X-ray film
W : Waterphantom
A,B,C : Level of the end of treatment cone

Fig. 3. Radiography of electron beam 3 cmφ Applicator.

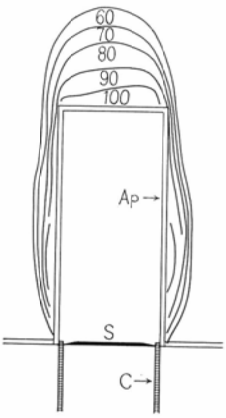


plicator, deficiency in the dose to the oblique direction can be recovered. The lower energy than 12 MeV could not produce any good dose distribution, in this cases amount of scattering to the lateral direction was larger than that to the foreward direction.

Dose distribution obtained by automatic density recorder is shown in Fig. 4. This is corresponding to the radiography of 18 MeV and at A in Fig. 3. Curves are shown in per cent of the maximum dose. Rapid fall off of dose to the lateral direction from the applicator is prominent and it goes down to 60% of the maximum dose at the site 5 mm from the surface of applicator. This is rather similar in 100 KVp X-rays by intracavitary X-ray tubes.

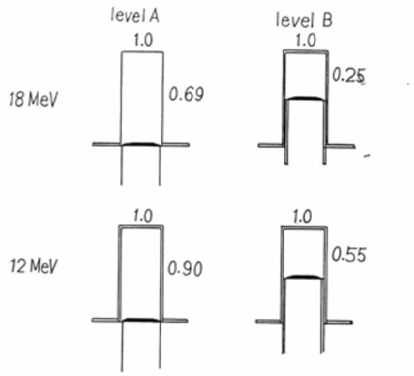
Radiation dose at the end and lateral side of applicator were measured with Siemens midget ionization chamber (diameter: 8 mm). As shown in Fig. 5, the ratio of lateral dose to frontal dose are 0.69,

Fig. 4. Dose distribution of 18 MeV electron beam



Ap : 3 cmo Acrylate applicator
S : Lead scatterer at the end of treatment cone.
C : Treatment cone, 3 cmo.

Fig. 5. Radiation dose at the front and side of applicator. Siemens midget thimble chamber was used.



0.90 for the position A, 0.25, 0.55 for the position B respective to 18 MeV and 12 MeV. The lateral dose are supposed to be roughly the average around at 0.4 cm aprt from the wall of applicator. Radiation dose to the forward direction is slightly reduced by the presence of air cavities. Dose reduction due to the scatterer placed at the top of treatment cone is above 20%, and if the dose at the top of applicator at the position C is 1, for 18 MeV electrons 0.42 and 0.27, for 12 MeV, 0.35 and 0.22 were obtained respective to the position B and A.

Discussion

Intracavitary radiotherapy with electron beam is suitable for the certain conditions of the carcinoma of cervix. But the dose distribution must be modified acording to the extent of disease. Recently Takayama[3] tried to irradiate the parametrial tissue with elctrons scattered by lead scatterer situated at the top of treatment cones, but dose distribution was not sufficinet for his purpose. Amino[4] devised the special treatment cones which could be widened at its top after insertion into vagina, by which some paracervical area and the wall of vagina could be included in the treatment field. Our purpose is to treat the cancer of cervical stump, superficial invasions of vagina and also to irradiate prophylactically the cervical stump after radical operation. Widening of vagina with acrylate applicator is the characteristics of this treatment, by which the wall of vagina can be stretched, and by this homogenous, superficial irradiation to desired extent can be achieved and localisation of tumors or treatment area can be seen.

Summary

Intravaginal electron beam therapy were designed with devised cylindrical applicators. Vaginal wall can be stretched and desired extent from cervical stump to the vaginal wall can be irradiated homogenously with electrons scattered by lead scatterer situated at the top of treatment cone. Dose distributions in this technique were demonstrated.

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