Accuracy of Dose Estimation in High Dose Rate Intracavitary Radiotherapy of Carcinoma of the Uterine Cervix

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In brachytherapy of uterine cervical cancer using a high dose rate remote afterloading system, it is of prime importance to deliver a accurate dose in each fractionated treatment by minimizing the difference between the pre-treatment planned and post-treatment calculated doses. The post-treatment calculated point A dose was not much different from the pretreatment planned dose (500 cGy). The average±standard deviation was 500 ± 18 cGy and 84 percent of 82 intracavitary radiotherapy was within the range of 500±25 cGy.

Key Words: Brachytherapy, Intracavitary radiotherapy, Uterine cervical cancer, Radiotherapy planning, Point A dose

INTRODUCTION

The accuracy of the dose delivered in treating a tumor is very important. The concept that small variation in dose might result in a significant increase in tumor control or failure has been supported by several authors[1,2]. In intracavitary radiotherapy (ICR) of the uterine cervical cancer using high dose rate remote afterloading system (RALS), it is of prime importance for the applicators and radiation sources to be inserted at a constant location at every treatment of a series so that equal amount of radiation dose can be delivered at every fraction.

In high dose rate ICR, each radiation time is less than 10 minutes and the entire operation time is less than 30 minutes. Accordingly, the point A dose[3] is ordinarily estimated and planned from orthogonal radiographs of the first or previous insertion, and there is a possibility of difference between the actually delivered and pre-treatment planned point A doses[4].

The purpose of this paper is to analyze the conformity of the dose delivered to point A, and compare the difference of post-treatment calculated dose with the pre-treatment planned dose.

MATERIALS AND METHODS

From November 1986 through May 1987, twenty one patients of uterine cervical cancer were treated with external beam radiotherapy and high dose rate ICR (Ralstron®) using high activity automatic overriding Co^{60} point source (total 5 Ci).

According to the clinical stage, irradiation was performed as follows. The external photon beam irradiation consisted of two opposite AP and PA portals or box technique using 4 MV linear accelerator. The total dose of external beam radiation was 4,000-5,000 cGy/5-6 weeks to whole pelvis. One or two weeks after external beam irradiation, a total of 3,000-4,000 cGy to point A was delivered in 6-8 fractions of 500 cGy each. ICR was given twice weekly for a peroid of 3-4 weeks.

The applicators used for ICR were one metallic (aluminum, 5 mm diameter) tandem and two colpostats. Positions of the applicators were confirmed by fluoroscopy and orthogonal radiographs taken for dose planning (Fig. 1). After each ICR treatment, based on the computation by the first simulation film, positioning of the applicators were checked by orthogonal radiographs and the actual delivered dose to point A was calculated with a computer using the software devised by Huh et al[5].

RESULTS

Total eighty two point A doses in twenty one patients were calculated based on the post-treatment localization films. The post-treatment calculated point A doses reached near the pre-treatment planned dose (500 cGy). The average and standard deviation of calculated point A dose was 500±18 cGy. Eighty four perenct of the all treatments was within the range of 500±25 cGy (100±5%) of planned dose (Fig. 2).

DISCUSSION

Remote afterloading high dose rate ICR which can be achieved with high specific activity Co^{60} sources has made treatment of very short duration feasible. But the high specific activity Co^{60} sources and the larger number of fractionations per patient necessitate an exact and reproducible positioning of the applicators during the course of treatment of multiple insertions over several weeks.

The actually delivered point A dose can be different from the planned dose obtained from the pretreatment orthogonal film. This factor is suggested as one of the causes of the high frequency of complication in addition to dose rate effect in RALS. Inoue et al[4] reported that rectal bleeding was observed more frequently after high dose rate ICR than after low dose rate one. They also reported differences of calculated point A dose from planned dose maximum up to 25%. These differences can occur because of simulation error or distorted anatomy during a course of treatment such as parametrial shortening that can produce deviation of uterus with angulation of tandem[6].

But usually, good conformity, less than 10% difference between the post-treatment calculated and pre-treatment planned dose, has been reported[14]. Authors' data also shows satisfactory result that post-ICR calculated doses were within ± 5% of planned dose in 84% of applications. This can be carried out by a careful positioning and localization of the applicators and the position of

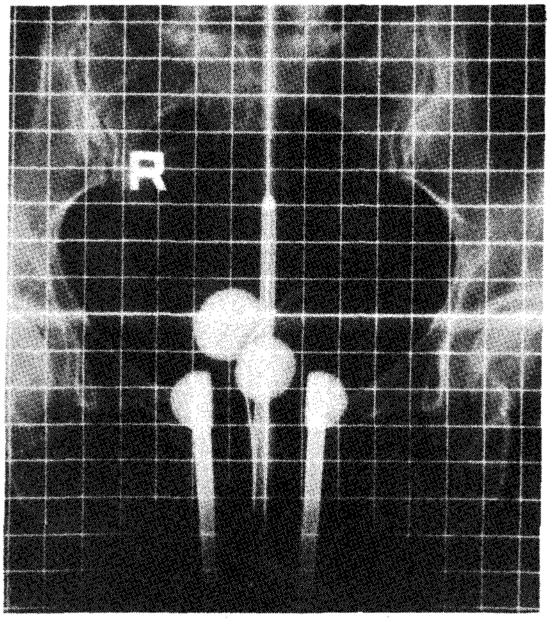

Fig. 1. AP radiograph of high dose rate ICR.

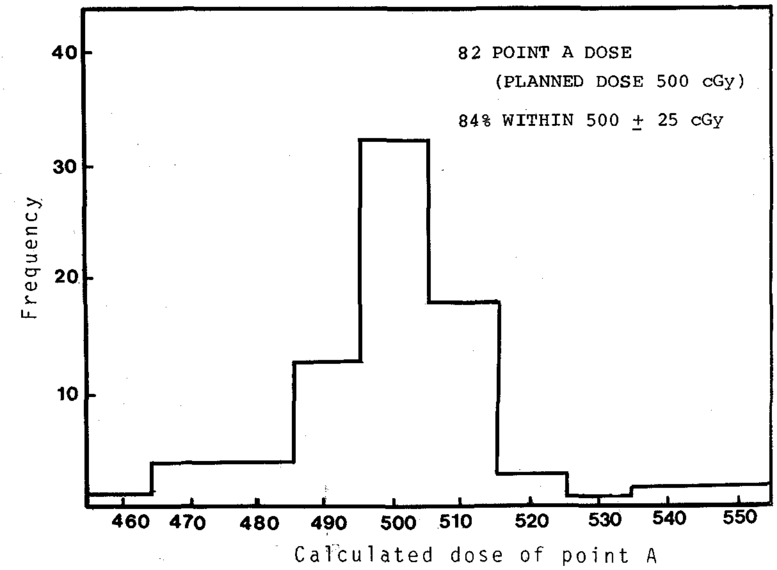

Fig. 2. Histogram showing the post treatment calculated dose at point A, computed from orthogonal radiographs.

the applicators can be corrected if necessary before each treatment with localization radiographs or fluoroscopy.

The hypothetical advangage of using a rigid applicator assembly to impose a dose distribution closer to the ideal has long been apparent. In addition, their rigidity provides the operator some degree of control over the prevailing anatomy; for example, a uterus lying naturally to the left in contact with the sigmoid colon can often be induced to occupy a midline position by torsion, similarly a naturally retroverted uterus is carried safely away from the sigmoid colon by the fixed anteverted tandem[7].

The applicators used by authors is a metallic one and can obtain the ideal geometry than the flexible polyethylene tandem[8,9]. The metallic tandem applicator used by authors is placed and fixed to a holder on the treatment table. This guarantees a constant position of the applicator during each tretment.

In summary, authors' experience with RALS ICR with high dose rate leads to the following views;

1. Accurate positioning and localization of the applicators can be carried out carefully. Utilizing radiographs and fluoroscopy, position of applicators can be corrected before each treatment if necessary.

2. The shorter radiation time provides much greater exactness of the applicator position in contrast to conventional low dose rate technique by exact localization of the applicator position at each insertion.

3. Post-treatment calculated point A dose is close to the pre-treatment planned dose. And if any difference is detected, treatment time can be easily corrected for next insertion.

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=국문초록=

자궁경부암 고선량율 강내치료의 치료선량 정확도에 관한 연구

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자궁경부암의 고선량율 강내치료의 매 분할 치료시마다 강내 applicator의 위치 차이로 인하여 조사 선량이 치료전 계획된 선량과 차이가 있을 수 있다. 저자는 자궁경부암 환자의 강내치료시 치료전 계획된 A점 선량 500 cGy와 치료직후에 촬영한 전후 및 측면 X-선 사진을 이용하여 계산된 A점 선량을 비교한 결과, 82예의 강내치료에서 치료후 계산된 조사 선량과 계획 선량은 500±18 cGy이었으며 84%에서 500±25 cGy의 범위에 포함되었다. 이러한 결과에서 계획 선량과 치료후 계산된 조사 선량사이에 비교적 높은 일치율을 확인할 수 있었다.