A Verification for Multiple Arc Stereotaxic Radiotherapy

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External stereotaxic irradiation of intracranial lesions has recently gained its interest in the fields of not only radiation oncolgy but also neurosurgery. Its main goal is to deliver large doses to a relatively small target volume.

Authors present methods of the stereotaxic radiosurgical irradiation using 6 MV linear accelerator (Nelac-6) and isodose distribution by therapeutic computer (Therac 2000). We attempt to demonstrate the dose distribution on verification films.

Key Words: Multiple arc stereotaxic radiotherapy, Linear accelerator, Therapeutic computer, Verification film

INTRODUCTION

The basic concepts of radiosurgery is applying a high dose of radiation to a very samll area of tissue[1~6]. This can be achieved using various special irradiation technique with a linear acce.

The technique is based on the principle that the beams can be focused from many directions onto target point to reach a high dose concentration in the target volume[1~6]. By superpositioning several moving beams at different table rotation angles, a spherical dose distribution with a steep dose gradient is produced in the isocenter, which is the point of intersection of the accelerator rotation axis and central beam, as described elsewhere[2,3].

The purpose of this paper is to show the methods of stereotaxic radiosurgical irradiation using 6 MV linear accelerator (Nelac-6) and isodose distribution by therapeutic computer (Therac 2000). We try to demonstrate the radiation pathway by way of overlapping the verification films (linacgram) on the subtracted brain CT images.

METHODS AND RESULTS

To perform multiple arc stereotaxic radiotherapy, the patient was required to be fastened with stereotaxic apparatus (Hitchcock®), and stereotaxic CT profiles at each arc directions were obtained [2,3] (Fig. 1). These CT data were utilized to get the isodose distribution through the therapeutic planning computer in every arc directions (Fig. 2).

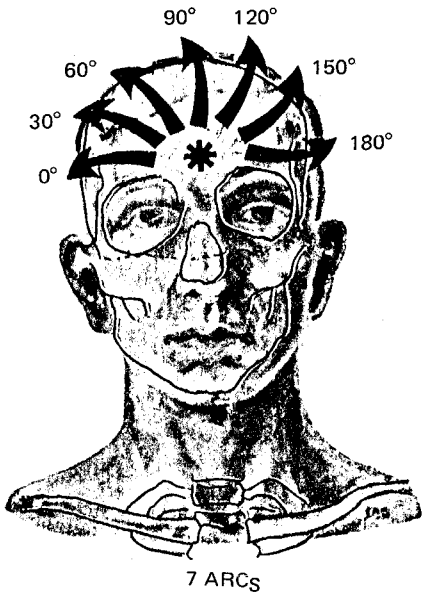

Fig. 1. Multiple arc treatment technique showing the volume that the beam focused on the target passthrough. (* : tumor isocenter)

A subtraction image of CT also was used to make the verification films showing a pair of the pathway of arc radiation (Fig. 3). The range of arc angles was decided after trial rotation of gantry of linear accelerator at each directions, following SAD setting of patient.

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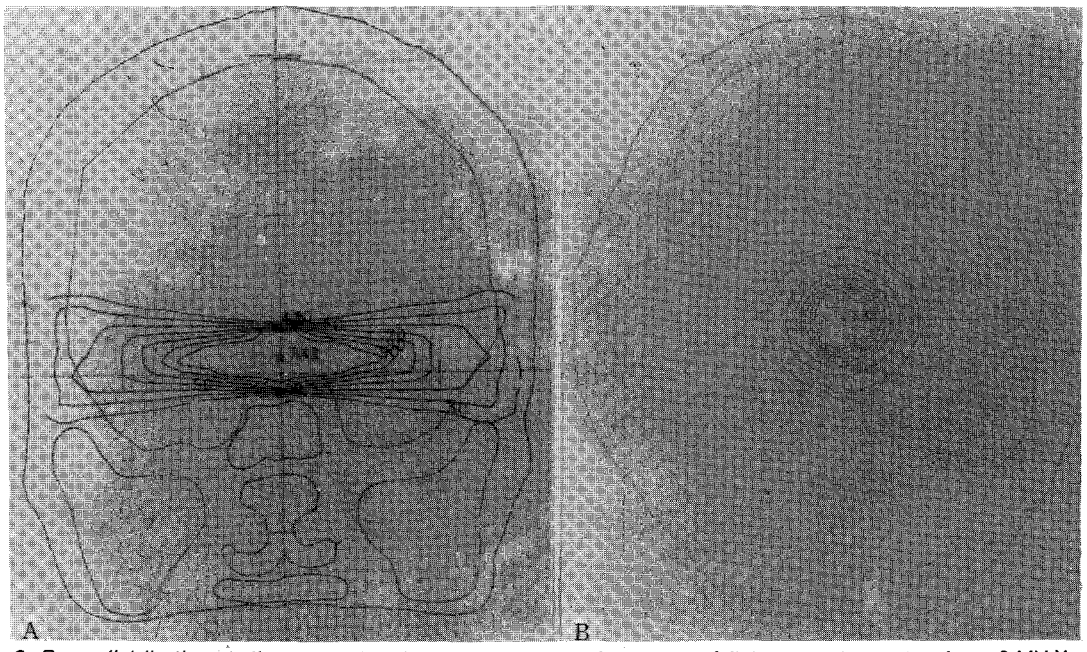

Fig. 2. Dose distribution on the coronal and transverse planes for 2×2 cm^2 field at the isocenter, for a 6 MV X-ray beam. A) coronal plane, B) transverse plane.

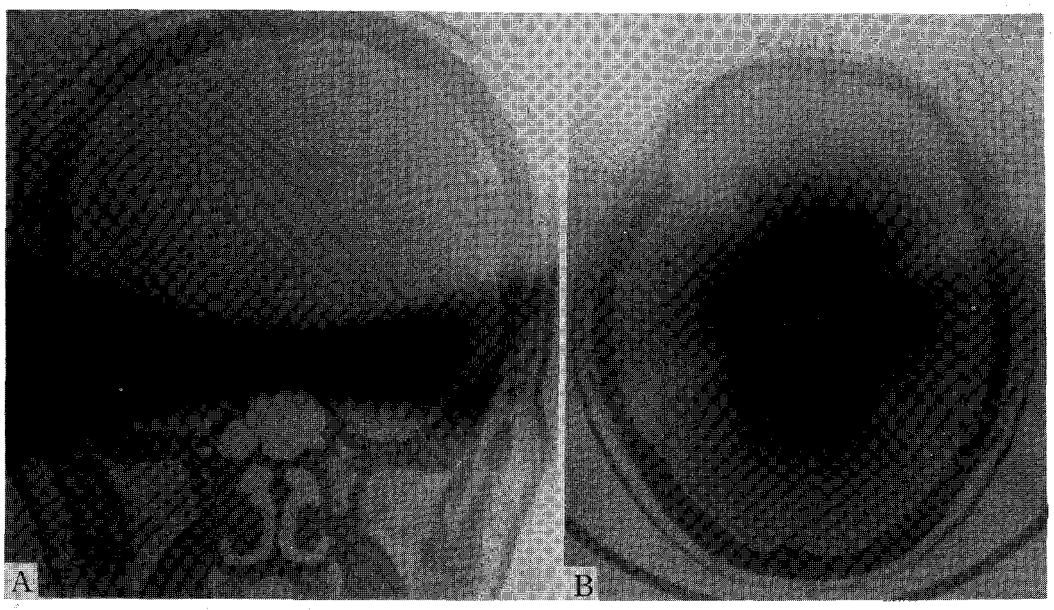

Fig. 3. Dose distribution in the three dimensional planes obtained with multiple arcs of 1×1 square centimeter field at the isocenter of a 6 MV X-ray beam. A) coronal plane, B) transverse plane.

DISCUSSION

The various radiosurgical techniques have a common goal to deliver a high dose radiation in a single fraction to a small defined intracranial volume without delivering significant radiation to adjacent normal tissue[1~6].

The external stereotaxic irradiation technique, originally proposed by Leksell et al[4], with apparatus consisting of 201 ^{60}Co sources placed on a spherical sector of 70°×160°, whose beams converging on a single focal point.

It has been known that the isodose distribution can be obtained by using single moving external beams very similar to that produced by the sum of large number of fixed fields focused on the isocenter. The dose received by healthy tissue can be reduced in proportion to the number of arc movments performed by treatment unit. Authors used to do multiple arc rotating stereotaxic radiation therapy using 6 MV linear accelerator[2,3]. This is possible if the treatment couch can be rotated around the isocenter of the gantry. At present time, we tried to verify the radiation pathways on the subtracted brain CT using linac gram technique.

Generally, radiosurgery has been used to treat a wide variety of benign and malignant lesions. The common treatment categories were arteriovenous malformation, acoustic neurinoma, craniopharyngioma, pineal or pituitary tumor and other malignancies, etc[1~6]. Many groups prefer to recommend radiosurgery only for patients who are not good candidate for standard therapy, or who refuse standard therapy. It is obvious that discussion of treatment options is best made with multidisciplinary team approach including radiotherapist, neurosurgeon, neuroradiologist and physicist etc [1~3].

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= 국문초록 =

정위 다방향 방사선조사의 선량분포를 위한 증명

가톨릭의과대학 방사선과학교실

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정위다방향 단일 고선량 방사선치료는 최근 치료방사선과 및 신경외과 영역에서 관심의 초점이 되고 있는 분야이다.

이 방법은 병소 부위를 중심축으로하여 여러 방향으로 다양한 각도의 회전조사를 하여, 주위 정상 뇌조직에는 최소한의 방사선을 주면서, 뇌병소 부위에는 집중적으로 1회 고선량을 조사할 수 있어서, 방사선 치료효과를 최대로 높아고자 시도되고 있다.

저자들은 6 MV 선형가속기와 치료 계획용 컴퓨터를 이용한 정위 다방향 단일고선량 방사선치료를 실시 함에 있어, 방사선 선량분포를 증명하고자, 등선량곡선 분포 및 뇌 CT 상에 방사선 통로의 증명을 위한 사진을 각각 시도해 보았기에 보고하는 바이다.