DOSIMETRY OF ASYMMETRIC COLLIMATIORS

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= Abstract =

PURPOSE : To investigate the effect of asymmetric jaws for delivering a uniform accurate dose of radiation to the junctions.

METHODS & MATERIALS : A linear accelerator with a set of asymmetric jaws(varian 600C, 2100C, 2100CD with 4mev, 10mev, 10mev). Dose disribution was measured at the junctions with films in phantom. Total $10\times20cm^2$ with each $10\times10cm^2$ in deviation of $\pm$ 1mm jaws.

RESULTS : Film dosimetry showed the accuracy of asymmetric jaws depending on the machine.

CONCLUSION : Understanding the mechanical characteristics of the use of half-beam at the junctions, without hot or cold regions.

Key Words :

INTRODUCTION

In the treatment of head & neck and breast cancer, precise dose delivery is essential to achieve locoregional control and to minimize complications. All traditional techniques of field matching have the potential problem of cold or hot spots at the field junctions. This problem is particularly important when treating gross nodal disease or primary tumor. Cold spots are particulary problematic in the treatment of gross nodal disease or primary tumor, because they may compromise tumor control. In addition, Hot spot may include match-line fibrosis. Advantage of half-beam include dose homogeneity at the junctions.

This study used the asymmetric collimators(also known as an independent jaws) system provided with our Clinac 600C, 2100C, 2100C/D linear accelerator. This study was to investigate the effect of asymmetric jaws for a delivering a uniform dose at the junctions.

METHODS & MATERIALS

Equipment

- A linear accelerator with a set of asymmetric jaws.
  Clinac 600C, 2100C, 2100C/D(4MV, 10MV)
- Video Densitometer(Wellhofer dosimetric WP 700i)
- Film(Kodax X-omat V)
- Polystyrene phantom

Verification of dose uniformity

For our quality assurance program the usual digital display tolerance for a given field size is ±0.0, 0.1, 0.2mm. We measured this tolerance with the asymmetic jaws with or without gap. A films was placed between 1.0cm(Build up factor) top-15cm (Scatter ray factor) bottom in uses of 4MV and 2.5 cm(Build up factor) top-15cm(Scatter ray factor) bottom in uses of 10MV. The dose at a matching point was measured by setting the asymmetric jaws of the fields to the ±0.0mm, ±0.1mm, ±0.2mm position. The fields were defined by closing the superior half with the asymmetric jaws(① X1=0.0, X2=10, ② X1=0.0, X2=10, ③ X1=0.1, X2=10, ④ Y1=0.0, Y2=10, ⑤ Y1=0.0, Y2=10, ⑥ Y1=0.1, Y 2=10) the inferior half of this field was collimated (① X1=10, X2=0.0, ② X1=10, X2=0.1, ③ X1= 10, X2=0.1, ④Y1=10, Y2=0.0, ⑤ Y1=10, Y2=0.1, ⑥ Y1=10, Y2=0.1) were double exposured. These measurements were performed with 4MV & 10MV photons.

Verification of dose uniformity at the junction was the uses of Wellhofer system. films were scanned superior to inferior direction.

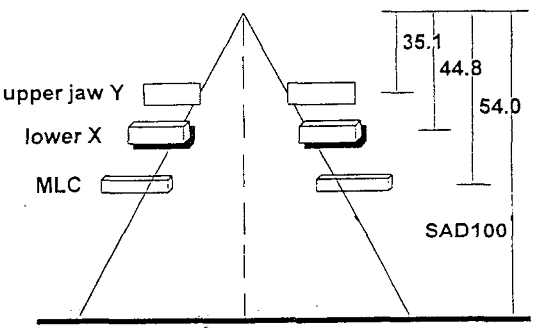


Fig. 1. Shows that the beam shaping system of Clinac. From source to upper jaw(Y field decision) is 35.1cm and to lower jaw(X field decision) is 44.8cm. The basis is SAD 100cm.

RESULTS

We have studied the dosimetry of asymmetric jaw system(provided with the Varian Clinac 600C, 2100 C, 2100C/D). Our study shows that the effect of the asymmetric jaw on the dose distribution. The accuracy of the asymmetric jaws may vary, depending on the machine. As a result of over or under dose of the field junctions. Dose inhomogeneity ranged from 80-111% when X1=0.0, X2=0.0(600C) and X1=0.0, X2=0.1(2100C) and Y1=0.0, Y2=0.1 (2100CD) was used between fields a ideal uniform dose detected at junctions(Table.1).

Table 1. Dose distribution of asymmetric jaws at the juntions.

	600C		2100 C		2100 CD	
X1=0.0 & X2=0.0	100	97	99	82	100	80
X1=0.0 & X2-0.1	109	100	100	97	100	92
X1=0.1 & X2=0.1	98	83	98	86	100	80
Y1=0.0 & Y2=0.0	100	88	100	92	100	93
Y1=0.0 & Y2=0.1	109	88	99	93	100	94
Y1=0.1 & Y2=0.1	111	100	99	85	99	87
	MAX	MIN	MAX	MIN	MAX	MIN

Clinac 600C used dose homogeneity ranged from 100-97%(when nogap. was used between X1=0.0, X2=0.0mm) there was 3% dose variation.

2100C used that from 100-97%(when ±0.1mm was used between X1=0.0, X2=0.1mm) there was 3% dose variation. 2100CD that from 100-94% (when ±0.1mm was used between Y1=0.0, Y2=0.1 mm) there was 6% dose variation. The origin of the graph represents the junction of matching fields with asymmetric jaws(Fig. 2).

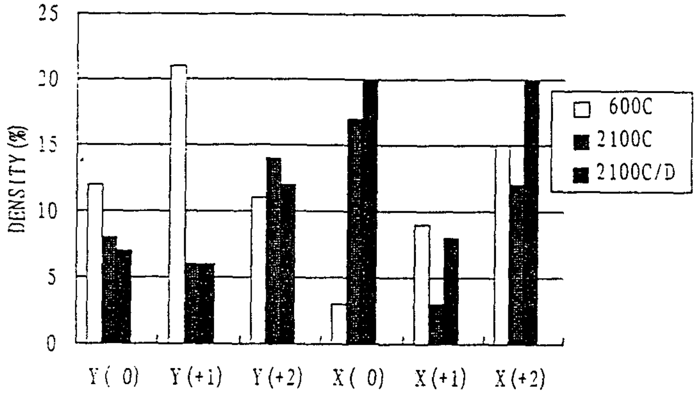
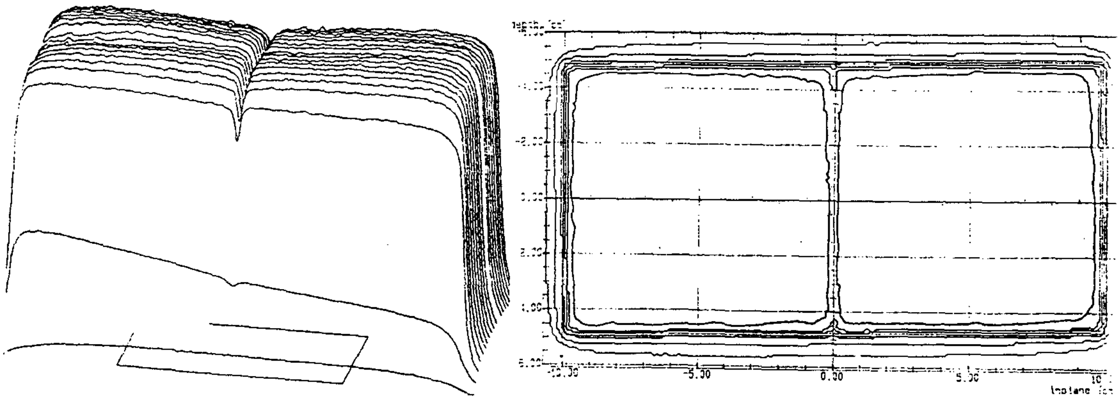
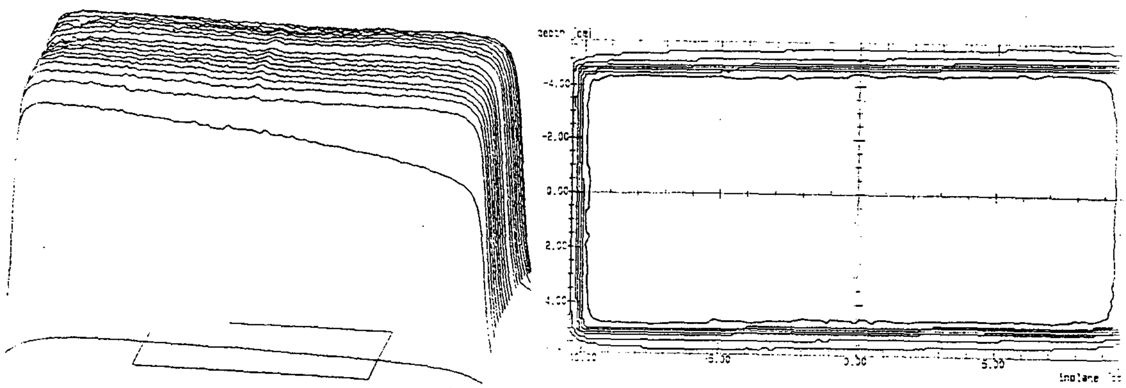


Fig. 2. Density difference of asymmetric jaws.

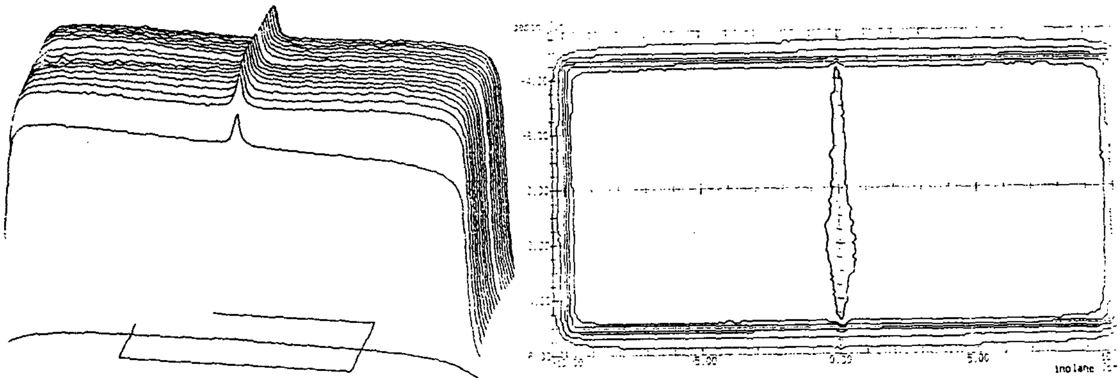
Fig. 3. Clinac 2100C/D were 3-D numerical analysis(left-side) and 3-D Plane analysis(right-side) shows that the films in phantom were scanned at Dmax with ±0.0mm, ±0.1mm, ±0.2mm gaps with 10 MV.



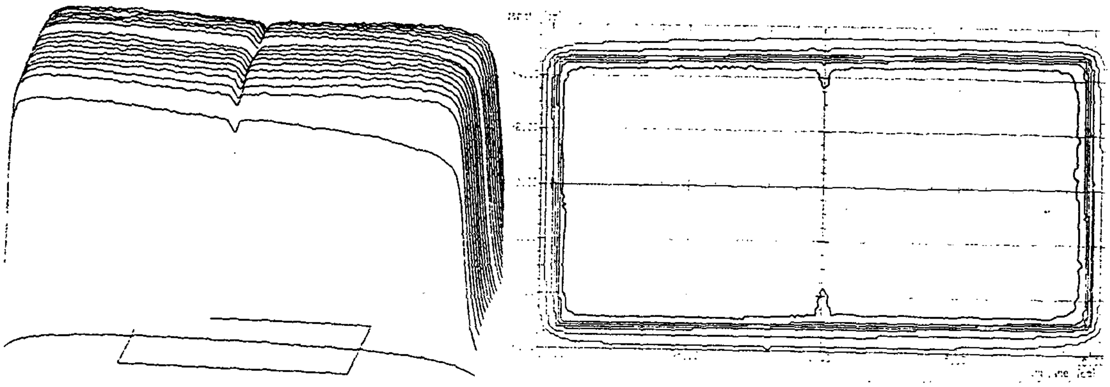
· X1=0.0, X2=0.0 ⇒ 99%-82%(17% underdose)



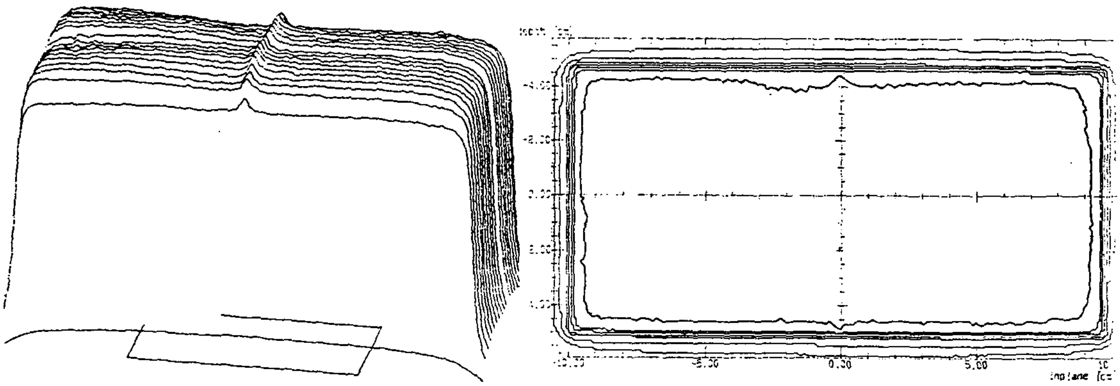
· X1=0.0, X2=0.1 ⇒ 100%-97%(3% dose veriation)



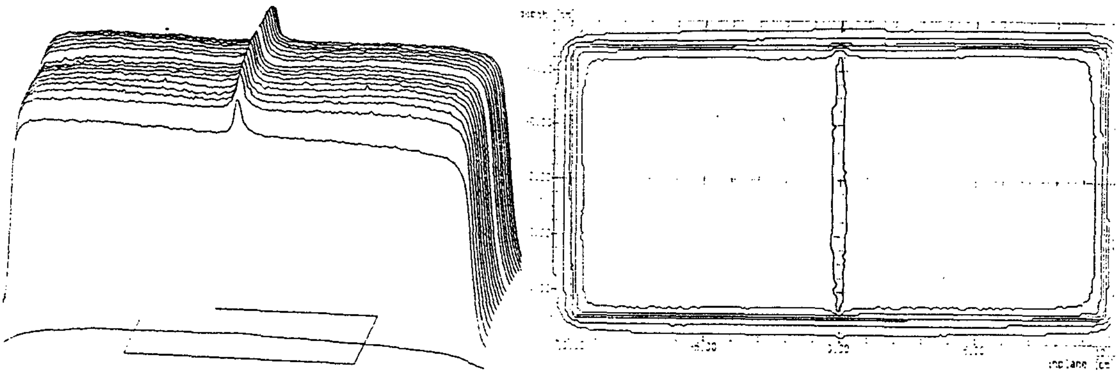
· X1=0.1, X2=0.1 ⇒ 98%-86%(12% overdose)



· Y1=0.0, Y2=0.0 ⇒ 100%-92%(8% underdose)



· Y1=0.0, Y2=0.1 ⇒ 99%-93%(6% overdose)



· Y1=0.1, Y2=0.1 ⇒ 99%-85%(14% overdose)

DISCUSSION & CONCLUSION

The uses a pair of asymmetric jaws to achieve a uniform dose at the junction of the lateral head & neck matching anterior supraclavicular lymphnode fields and breast(chest wall, intramammary) matching supraclavicular lymphnode fields.

Our study shows that the effect of use of half-beam at junction without hot or cold regions.

We recommend that the asymmetric jaws calibrated routinely when using half-beam technique.

Because the accurate uniform dose of junctions. The specification of the digital display should be kept to ±0.1mm to maintain a accurate dose variation from the prescribed dose at junctions.

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=국문초록=

비대칭 콜리메이터의 선량분포 측정

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두경부와 유방과의 접합부위인 쇄골상와(Supraclavicular lymph nodes)의 방사선치료(Half-beam techniques)에 있어서 비대칭 콜리메이터(Asymmetric collimators) 역할의 효용성과 접합부위에 균등한 선량(Uniform dose)을 유도하고자 본 측정을 시도하였다.

본 실험은 선형가속기(Clinac 600C, 2100C, 2100CD)를 이용하였고 에너지는 4Mev와 10Mev를 사용하였다. 에너지별로 최대선량지점(Build-up)과 후방산란선(Back scatter-ray)을 고려하여 필름의 위·아래에 판톰을 위치시키고, ±0.0mm, 0.1mm, 0.2mm로 콜리메이터의 간격을 두어 중심부위의 선량을 측정하였다.

측정결과 기계별로 비대칭 콜리메이터의 선량분포가 다름을 알 수 있었다. 즉, 600C에서는 X-jaw를 사용하여 0.0mm로 간격을 주지 않았을 때, 2100C에서는 X-jaw를 사용하여 0.1mm 간격을 주었을 때 가장 이상적인 선량분포를 나타냈고, 2100CD에서는 Y-jaw를 사용하여 0.1 mm 간격을 두었을 때 균등한 선량분포를 얻을 수 있었다.

따라서 본 저자들은 다음과 같은 결론을 얻을 수 있었다.

1. 비대칭 콜리메이터를 사용한, 접합부위의 방사선 치료시에는 정기적인 측정과 기계별 비대칭 콜리메이터의 특성을 파악하는 것이 중요하리라고 사료된다.

2. 접합부위의 방사선 치료시, 비대칭 콜리메이터의 사용은 접합부위에 선량과다(hot spots)와 과소(cold spots)없이 균등한 선량분포를 얻을 수 있어 Half-beam 사용시 임상적으로 유용할 것으로 사료된다.