

# Landmarks in The Skull for Stereotactic Radiotherapy

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## ABSTRACT

Stereotactic radiotherapy is required to irradiate a small tumor accurately. The radiotherapy showing improves when making an accidental error little boundlessly. It is performed according to treatment planning that is established by the outside landmark of head. At present, when stereotactic radiotherapy for a head is done, the Leksell Flame is fixed on the head, and positioning based on the point and so on which it is in that fixed implement is performed. However, there are problems on the method done at present in the point such as reappearance when the fractionated irradiation method in which the Leksell Flame is removed and installed at every treatment is done because there are landmarks outside the head. Landmarks in the skull were decided, and that precision was examined for the purpose of the improvement of the radiation therapeutic gain. Linac-graphy with longitudinal and lateral view were taken with 6 MV photon beams. A distance to base point inside the skull, each film measured the angle from a center of the small irradiation field, and comparison was done. From the results, a large accidental error wasn't seen as a result of the measurement by every film. Stereotactic radiotherapy for a head treatment had an accidental error of about several millimeters when treatment positioning was done. Therefore, it was thought that there was no problem about an accidental error to arise by putting a landmark in the skull. And, because an accidental error was easy to discover, we thought that modification could be done easily. It was suggested that a landmark in the skull on thus study were useful for improvement of stereotactic radiotherapy.

**Keywords :** Radiotherapy, Stereotactic Irradiation, Landmark, Treatment Planning

## 1. INTRODUCTION

Stereotactic radiotherapy is a procedure that uses high dose smallest external beams for an improvement of therapeutic gain because of accurate dose irradiation for a small focus. The treatment volume is usually varied small and dose per fraction is very high. There are important that an intensive irradiation for the tumor and a geometrical precision. The Leksell Flame is used to fix a head in stereotactic radiotherapy and landmarks of the flame perform the positioning. Fractionated irradiation is difficult to irradiate precision well like single portal irradiation because the deflection to the landmarks when being attached or removed on a fixation tool every time. The purpose of this study is to minimize the deflection of landmark to be attached and removed, to establish a base point in the skull in addition to the outside of the skull, too.

## 2. MATERIALS AND METHODS

A diagnostic head phantom fixed the head support for therapy was established on the therapeutic couch of linear accelerator. This experiment was performed using 6 MV X-ray beams (Mitsubishi linear accelerator ML-6M). Linac graphy was taken using a cassette with lead (OKAMOTO JL 10×12 inch) that was put a intensifying screen (KYOKKO GS). Radiation field size was 1×1cm<sup>2</sup> (small field) because of we assume very small lesion in a head. Double irradiation was performed for field size of 30×30cm<sup>2</sup> and 1×1cm<sup>2</sup> about linac graphy. We assessed some films about longitudinal and lateral view. The upper edge of a sinus frontalis and sphenoidalis, the lower edge of a sinus sphenoidalis and maxillaris were choosing as the landmarks for longitudinal direction. In lateral view, the upper edge of a sinus frontalis and sphenoidalis, the lower edge of a sinus sphenoidalis, a protuberantia occipitalis externa and a foramen magnum were chosen as the landmarks. A distance between center of small field and each landmark in the skull were measured. From longitudinal view, a line that connects center of small field with the lower edge of a sinus maxillaris was designated as an angle of 0 degree and an angle between this line and a line that connects of small field with the each landmarks were calculated. From lateral view, a line that connects center of small field with protuberantia occipitalis externa was designated as an angle of 0 degree and each angle were calculated.

### 3. RESULTS

Table1 gives the deflection for longitudinal view in linac graphy. The deflection about a distance from small field for longitudinal view is  $\pm 2.1$  mm for the upper edge of a sinus frontalis,  $\pm 1.0$  mm for the upper edge of a sinus sphenoidalis,  $\pm 1.5$  mm for the lower edge of a sinus sphenoidalis and  $\pm 3.5$  mm for the lower edge of a sinus maxillaris. It is confirmed that the deflection about a distnce for a sinus sphenoidalis is smallest in each landmark. The deflection about an angle for longitudinal view is  $\pm 2.2$  degree for the upper edge of a sinus frontalis,  $\pm 1.2$  degree for the upper edge of a sinus sphenoidalis and  $\pm 1.0$  degree for the lower edge of a sinus sphenoidalis. It is suggested that the deflection about an angle for a sinus sphenoidalis is smallest in each landmark, too. Table2 gives the deflection for lateral view in linac graphy. The deflection about a distance from small field for lateral view is  $\pm 2.0$  mm for the upper edge of a sinus frontalis,  $\pm 0.5$  mm for the upper edge of a sinus sphenoidalis,  $\pm 1.0$  mm for the lower edge of a sinus sphenoidalis,  $\pm 1.2$  mm for a protuberantia occipitalis externa and  $\pm 1.2$  mm for a foramen magnum. It is confirmed that the deflection about a distnce for a sinus sphenoidalis is smallest in each landmark as longitudinal view. The deflection about an angle for lateral view is  $\pm 2.0$  degree for the upper edge of a sinus frontalis,  $\pm 1.7$  degree for the upper edge of a sinus sphenoidalis,  $\pm 1.8$  mm for the lower edge of a sinus sphenoidalis and  $\pm 1.5$  degree for a protuberantia occipitalis externa. It is suggested that the deflection about an angle for a sinus sphenoidalis and a protuberantia occipitalis externa is smallest in each landmark.

Table1 The deflection for longitudinal view in linac graphy

Landmark	The upper edge of a sinus frontalis	The upper edge of a sinus sphenoidalis	The lower edge of a sinus sphenoidalis	The lower edge of a sinus maxillaris
Distance	$\pm 2.1$ mm	$\pm 1.0$ mm	$\pm 1.5$ mm	$\pm 3.5$ mm
Angle	$\pm 2.2^\circ$	$\pm 1.2^\circ$	$\pm 1.0^\circ$	

Table2 The deflection for lateral view in linac graphy

Landmark	The upper edge of a sinus frontalis	The upper edge of a sinus sphenoidalis	The lower edge of a sinus sphenoidalis	A protuberantia occipitalis externa	A foramen magnum
Distance	$\pm 2.0$ mm	$\pm 0.5$ mm	$\pm 1.0$ mm	$\pm 1.2$ mm	$\pm 1.2$ mm
Angle	$\pm 2.0^\circ$	$\pm 1.7^\circ$	$\pm 1.8^\circ$	$\pm 1.5^\circ$	

### 4. DISCUSSION

The deflection about a distance for longitudinal view was below 3.5 mm and the deflection for lateral view was 2.0 mm. In conventional radiotherapy for head, the deflection at a patient positioning be within the limits of 3.5 mm. However, it is expected that the deflection for stereotactic radiotherapy be within the limits of 1.0 mm. If the deflection is within the limits of this distance, there is some possibility of improving that therapeutic gain. Therefore, it is suggested that landmark in the skull is the upper edge of a sinus sphenoidalis for longitudinal view and the upper or lower edge of a sinus sphenoidalis. This is reason that a cavity in the skull is distinguished on linac graphy in spite of a decline at contrast resolution. Hence, the deflection on the upper or lower edge of a sinus sphenoidalis as landmarks goes down. We are easy to discover the deflection and can repair a positioning for therapy thanks to a measurement of distance or angle between focus and landmark in fractionated irradiation method that has a main cause for the deflection. A confirmation for landmarks in the skull has no time. It is important for stereotactic radiotherapy that must improve therapeutic gain and decrease the deflection.

### 5. CONCLUSIONS

We discussed landmark in the skull using linac graphy for improve of therapeutic gain in stereotactic radiotherapy. Four landmarks at longitudinal view and five landmarks at lateral view were decided. A improve of therapeutic gain in fractionated irradiation method was expected due to landmark in the skull.