CASE REPORT

Stereotactic Radiosurgery with an Upper Partial Denture

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Abstract

A 54-year-old male with partial denture underwent stereotactic radiosurgery with an infrared camera-guided system for a metastatic brain tumor arising from lung cancer. Although this method utilizes a biteplate mounted on the upper jaw to detect head movement, the patient only had four teeth in his upper jaw. In order to stabilize the biteplate, the maxillary denture was fixed to the biteplate with an autopolymerizing resin. In addition, the rest-occlusal position of the lower jaw was impressed on the inferior surface of the biteplate with an autopolymerizing resin. To assess reproducibility and stability, the distance between the left and right incus and left and right markers was measured during pre-planning, as well as before and after stereotactic irradiation. Wearing the biteplate ensures the accuracy of radiotherapy planning for the implementation of radiosurgery in patients who have many maxillary teeth missing. However, a large degree of error was observed when the biteplate was removed. (Keio J Med 58 (2) : 120−123, June 2009)

***Keywords*: stereotactic radiotherapy, biteplate, partial denture**

Introduction

Stereotactic radiosurgery (SRS) for cranial lesions was originally proposed by Lars Leksell[1] to deliver high-dose narrow beams to a target lesion with a gamma knife. More recently, SRS with a linear accelerator has been developed and many researchers have reported good results with intracranial lesions such as metastatic tumors,[2] vascular malformations,[3] and other malignant or benign lesions.[4,5] With the gamma knife, the patient's head is secured with screws in a metallic frame under local anesthesia and treated with a concentrated high dose of gamma rays delivered in a single session. This type of frame fixation method, which requires local anesthesia, is also used for SRS with a linear accelerator.[6]

However, stereotactic frames such as the original Leksell frame are impractical for long periods of application and thus are not suitable for fractionated stereotactic radiotherapy using linear accelerators.[7] Intracranial stereotactic positioning systems (ISPSs) are used to position patients for fractionated stereotactic radiotherapy or non-invasive radiosurgery.[7] Some ISPSs utilize a biteplate for the purpose of immobilization[8] or motion detection of the head,[9] using the maxillary teeth to support the biteplate. The reproducibility and stability of the biteplate depend on the number of teeth, teeth mobility, and residual ridge condition. Therefore, it is necessary to consider biteplate reproducibility and stability in patients who have lost a lot of upper teeth. In addition the elasticity of silicon impression affects biteplate stability. The stability of a denture base with clasps can be adjusted as required, and denture base reproducibility can be visually assessed based on the positional relationship between the denture base and the teeth.

We present a successful case of frameless stereotactic radiosurgery that made use of a denture base as a support system in a patient who was missing many of his upper teeth.

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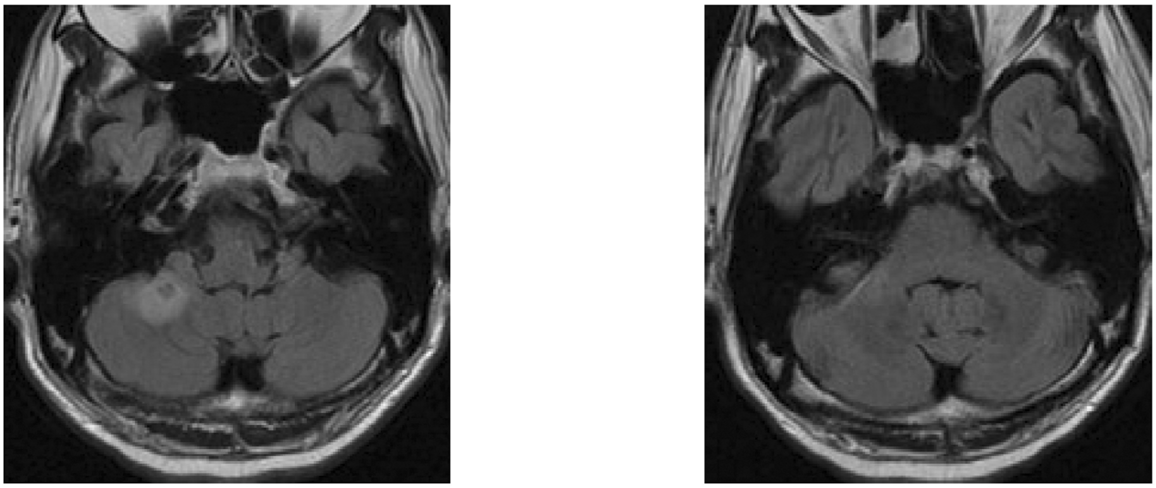


(a) (b)

Fig. 1 MRI shows a metastatic tumor in the right cerebellar hemisphere that originated from lung adenocarcinoma. Transaxial FLAIR images before stereotactic radiosurgery (a), and 6 months after radiosurgery (b).

Case Presentation and Methods

The patient was a 54-year-old man who was scheduled for stereotactic radiosurgery due to a metastatic brain tumor located in his right cerebellar hemisphere that originated from lung adenocarcinoma (**Fig. 1**). We used a stereotactic fixation system (Linac Scalpel, Varian Medical Systems, Palo Alto, California, USA) that can be used for stereotactic radiosurgery or stereotactic radiotherapy.[9–11] With this system, patient localization is achieved through detection and digital registration of an independent biteplate system. The biteplate is linked to a set of spherical-shaped reflectors and the positions of these reflectors are detected by a pair of infrared cameras. In our case, the patient's upper jaw contained only four teeth (12, 13, 17, and 18). The degree of mobility for teeth 12 and 13 was within the physiological range, but that of 17 and 18 indicated advanced periodontitis and grade III° of teeth mobility of teeth mobility. Therefore, 17 and 18 were inadequate for biteplate support if they were fixed. Residual ridge absorption was of medium level, and there was flabby gum in the anterior maxillary ridge. Stability of the partial denture was inadequate. Therefore, a denture base with wire clasps was made for SRS support system, and its retainer was placed on teeth 12 and 13 alone (**Fig. 2a**). After adjusting the retainer, the maxillary denture base was fixed to the biteplate using an autopolymerizing resin. We also used this resin to obtain an impression of the rest-occlusal position for the mandible on the bottom surface of the biteplate (**Fig. 2b, c**).

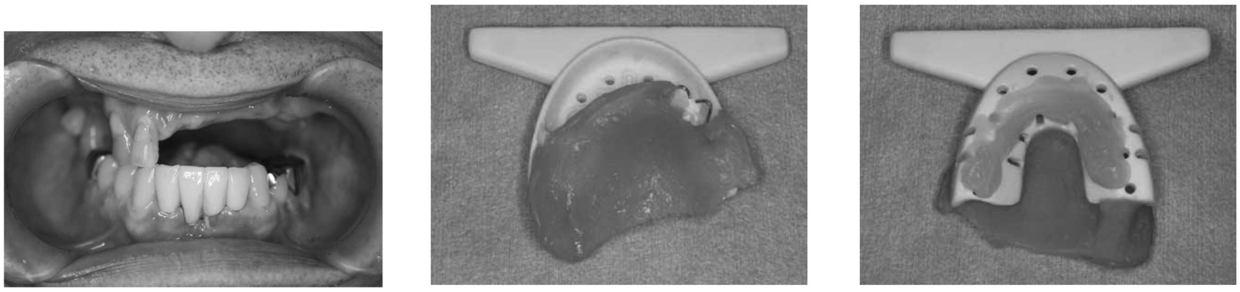
Stereotactic radiosurgery (26 Gy at the isocenter) was performed using a cylindrical collimator with a diameter of 16 mm. The dose concentration was carried out with five non-coplanar 120-degree arc rotations. The treatment time was approximately 40 minutes. Before starting stereotactic radiosurgery, the patient's denture and teeth 12 and 13 were fixed using the autopolymerizing resin. After stereotactic radiosurgery was completed, we removed the resin from around 12 and 13, as well as the biteplate. To assess reproducibility and stability, the distance between the left and right incus (**Fig. 3a**) and left and right markers (**Fig. 3b**) was measured during preplanning (CT1), and before (CT2) and after (CT3) stereotactic irradiation. All the procedures, including the CT scans as well as the dose delivery, were carried out within 4 hours in a single day.

Results

The difference in the distance between the left ball and the left incus before (CT2) and after (CT3) radiosurgery irradiation was 0.54 mm. The distance between the left ball and the right incus was 0.23 mm and that between the right ball and the right incus was -0.28 mm. These results suggest that the biteplate was very stable. However, the CT2-CT1 for each distance was $\geq$5 mm, indicating low reproducibility if the biteplate were to be removed.

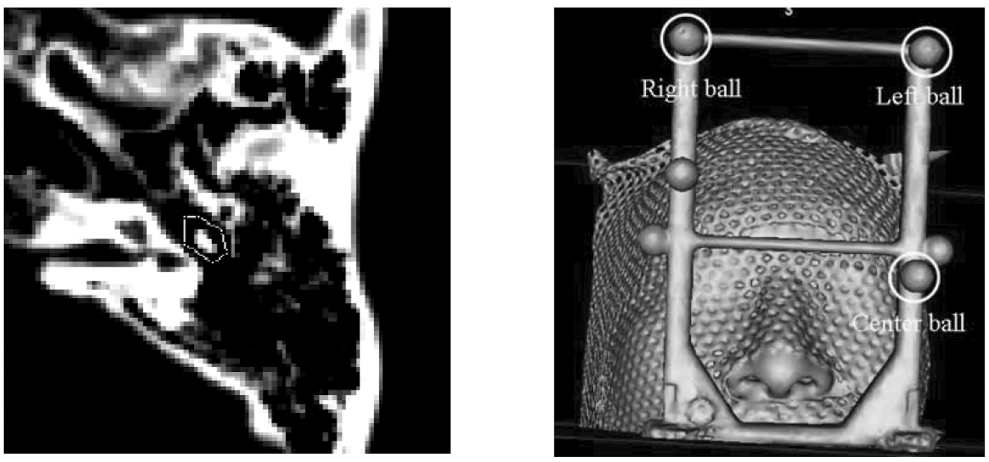
Discussion

Some reports have been published examining non-in-



(a) (b) (c)

Fig. 2 (a) The patient had four teeth (12, 13, 17, and 18) in the maxilla. The mobility of teeth 12 and 13 was within physiological range, but 17 and 18 were beyond it. (b) The maxillary denture was fixed to the biteplate with an autopolymerizing resin and a denture retainer was placed on teeth 12 and 13. (c) The rest-occlusal position was impressed on the inferior surface of the biteplate with an autopolymerizing resin.



(a) (b)

Fig. 3 To assess reproducibility and stability, the distance between the left and right incudes (a) and left and right markers (b) was measured from three series of CT scans; during pre-planning, before stereotactic irradiation and after it. The markers worked as reflectors for infrared rays from a light source fixed to the wall of the treatment room.

vasive repositioning methods applied to stereotactic radiotherapy, including frameless[9,12] and frame-based relocatable immobilization systems.[13,14] Frameless relocation of the head utilizes image guidance systems[12] and fiducial markers visualized with room-mounted cameras.[9]

Immobilization of the patient's head is generally achieved by a head mold and thermal plastic mask. Reports have shown that the repositioning error of the biteplate in denture patients was within 1 mm.[10,11] Because maxillary dentition is a part of the skull with a particularly complicated convexo-concave shape, fixation using a dental cast that conforms to maxillary dentition can increase positioning reproducibility. However, in cases where there are few or no teeth, in the maxillary, the reliability of the biteplate has been believed to be insufficient for radiosurgery, since the residual ridge support might cause more biteplate instability than teeth support in the mouth. In addition, the elasticity of silicon could be an unfavorable factor regarding biteplate stability in these cases. Thus, biteplate stability is important for the accuracy and reproducibility of stereotactic radiosurgery.

There is a probability that the relationship between maxilla and the biteplate will change depending on the force exerted on the biteplate; for example, when swallowing. Obstruction of denture space causes instability of the denture, and biteplates often present an obstacle to denture space. In such cases, it should be possible to shape the biteplate down. In addition the denture base with retainer is useful for ensuring biteplate stability, due to the fact that it allows for a greater degree of control over retention of the biteplate than with a silicone impression.

Stereotactic irradiation using a biteplate is thought to be impossible in patients who have lost upper teeth. However, in this case, there was enough geometrical accuracy for a single-fraction stereotactic radiosurgery to be maintained from planning CT to the therapy using a biteplate in a patient who was missing many maxillary teeth. On the other hand, replacement of the biteplate led to poor reproducibility of biteplate attachment. Although this is a single case report, it indicates the possibility that successful frameless radiosurgery can be applied to patients with just a few maxillary teeth using a dedicated biteplate customized by a dentist, and with repeated CT confirmations.

Conclusion

Stereotactic irradiation using a biteplate has been thought to be impossible in patients who have lost many teeth. However, the CT measurements proved that our proposed method has enough stability for a single-fraction stereotactic radiosurgery in a patient who was missing many maxillary teeth.

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