



Helical Tomotherapy with Intensity Modulated and Image Guided Radiotherapy in Skull Base Tumors: Two Case Reports

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Abstract

Inoperable malignant tumours of the skull base have poor prognosis. The aim of treatment is commonly to provide a better quality of life with the local control of the disease. This paper presents the case of 2 patients with skull base tumours who were admitted to our clinic and treated with intensity modulated radiotherapy with tomotherapy. In both cases, subjective side effects and complaints decreased through the application of an average dose of 54Gy. Our article concludes with an evaluation of the effectiveness of helical tomotherapy with references to the literature.

Key Words: Radiotherapy; skull base tumours; tomotherapy

Kafa Tabanı Tümörlerinde Helikal Tomoterapi İle Uygulanan Yoğunluk Ayarlı ve Görüntü Eşliğinde Radyoterapi: İki Olgu Sunumu

Özet

Kafa tabanı tümörlerinde cerrahi uygulanmazsa prognoz kötüdür ve tedavi çoğunlukla primer hastalığı kontrol altına alıp hasta için tatminkar yaşam kalitesi sağlamayı amaçlar. Kliniğimize başvuran 2 kafa tabanı tümörüne helikal tomoterapi ile uygulanan yoğunluk ayarlı radyoterapi sonuçları tartışılmıştır. Her iki hastamızda da subjektif yakınmalarda azalma görülmüştür. Hastalarımıza ortalama 54 Gy radyoterapi uygulanmıştır. Bu makalede kafa tabanı tümörü nedeniyle cerrahi rezeksiyon uygulanamayan 2 hastada helikal tomoterapinin etkinliği tartışılmaya çalışılmıştır.

Anahtar Kelimeler: Radyoterapi; kafa tabanı tümörleri; tomoterapi

INTRODUCTION

Surgery is the main option for patients with malignant skull base tumours. Prognosis is poor for patients who cannot be operated. In this case, radiotherapy is a treatment option for these patients. The reported survival rate following craniofacial resection due to malignant skull base tumours varies between 20% and 40%. If the malignant tumour occupying the skull base cannot be completely resected or surgical intervention is impossible due to potential life-threatening complications, radiation therapy or chemoradiotherapy could be regarded as two treatment options. Even with combined chemoradiotherapy, the 5-year survival rate without surgical intervention is very low and does not exceed 50% (1, 2). This article intends to present the case of two skull base tumour patients who did not undergo surgical resection but received IMRT (Intensity Modulated Radiotherapy) and IGRT (Image Guided Radiotherapy) with helical tomotherapy and to discuss the effectiveness and reliability of the treatment in the light of the relevant literature.

CASE REPORT

Case 1

A twenty-seven-year-old male patient was admitted to a nearby health centre with headache in October 2013.

The cranial MRI (Magnetic Resonance Imaging) conducted in that centre revealed a 55x40x30mm mass lesion located in the clivus which, extending to the anterior nasopharynx, destructed the clivus. According to the imaging results, the mass, which showed minimal enhancement after contrast injection, was posteriorly invading the brain stem (Figure 1). We learnt that the patient underwent endoscopic transsphenoidal mass excision for biopsy with the help of neuronavigation in the other centre. The pathology result was chordoma. The postoperative MRI showed that the mass persisted in a similar way. Due to the localisation of the mass, the patient did not undergo any surgery; instead, the previous centre decided to implement radiation therapy. As the localisation of the mass was a hindrance, the patient was referred to our clinic to be treated by helical tomotherapy in order to reduce the possible side effects of radiation therapy.

We applied a planning tomography in our Computed Tomography (CT) device in the supine position with a proper pillow and a patient-specific thermoplastic head-shoulder mask. After obtaining 3 mm slice thickness planning tomography images from the cranial region above down to the center of the sternum with and without contrast, we transferred the data to Velocity planning system. We then matched the MRI images with the results of the initial tomography on the Velocity

planning system and started the contouring process. Using the patient's CT and MR images, we determined the Gross tumour volume (GTV). We obtained the planning target volume (PTV) by expanding each of the GTV sizes by 10mm and the side of the brainstem by 5mm (Figure 2).



Figure 1. Pre-treatment MR image of our first patient.



Figure 2. Planning image of our first patient with skull base tumour.

The PTV median value was determined as 111,2cm³ (2435-4559 cm³). The contouring was carried out on Velocity software. The planned PTV dose included at least 95% of the volume fraction of the PTV. The average dose the brain stem received was around 34Gy. Each treatment was allotted a time period of around 378 seconds. With a Hi-Art helical tomotherapy device, our patient was given a total dose of 53Gy radiotherapy in 29 fractions. Prior to each treatment, we had PTV checks using the mega-voltage CT volumetric images. Our patient continues to be monitored with a stable mass for 3 months (Figure 3).

Case 2

The centre that admitted a sixty-year-old male patient with double vision in the left eye, inability to see the left side, and headaches since December 2013 found a mass in the clivus. The cranial MRI conducted in this centre showed a 23x21mm lesion with contrast on the right

side of the clivus. The biopsy performed brought about adenoid cystic carcinoma. The patient was not considered for a curative resection in the previous centre but instead was referred to our clinic for radiotherapy. Similar to the procedure we followed in our first patient, we planned and applied a course of radiotherapy with Hi-Art helical tomotherapy device. The median PTV value of our patient was 113,3cm³. The average treatment time was 165 seconds per fraction. The PTV of our patient was wider due to his pathology results and we tried to include the skull base as widely as possible. Similarly, our second patient also underwent 53Gy radiotherapy in 29 fractions. As of now, our patient has been followed for 4 months with a stable mass.

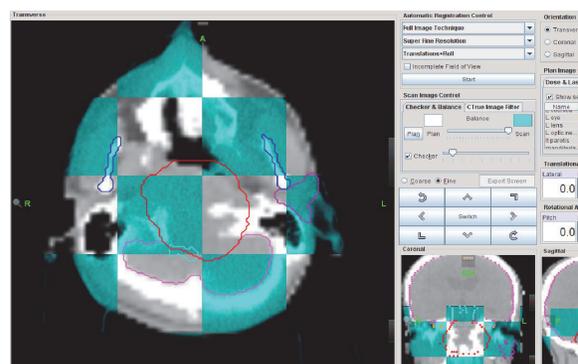


Figure 3. Pre-treatment volume matching image of our second patient with skull base tumour.

DISCUSSION

Skull base tumours have various different histological characteristics. Tumours in this region may be sourced in the bones, paranasal sinuses, nasopharynx, dura, cranial nerves, pituitary, or brain. Symptoms in these tumours usually develop complaints due to the compression the mass creates. The histology of these tumours may involve squamous cell carcinoma, nasopharyngeal carcinoma, mucoepidermoid carcinoma, chordoma, adenocarcinoma, sarcoma, adenoid cystic carcinoma, or plasmacytoma. The incidence of skull base tumour is higher in males (3). Both of our patients were males; and histologically, one of them adenoid cystic carcinoma while the other had chordoma.

Surgery should be performed if possible in malignant skull base tumours. Surgical intervention enables better local control and long-term palliation. However, in patients with advanced stage malignant skull base tumours, surgery carries the risk of ending up with residual tumour tissues on microscopic level around the operation area and recurrences associated with such tumour tissues due to the possibility that tumours may block critical anatomical structures and, thus, hinder large scale resections. Therefore, expectations for curing patients may not be high with solely surgical options. In addition, patients may even develop serious complications and cosmetic deformities due to surgical operations (4). When a choice has to be made between equivalent treatment options with similar outcome expectations in malignant tumours, it is clear that

practitioners will choose the one with lower mortality and morbidity rates and better quality of life during expected survival time for the well-being of their patients. Therefore, radiotherapy seems to be a more ideal treatment option in patients with malignant tumours occupying the skull base that cannot be completely resected or have life-threatening complications in the case of a possible surgical intervention (2).

Although molecular genetic studies concerning skull base tumours are fewer and relatively new, there are remarkable studies on chordomas, the most common type of skull base tumours. In particular, researchers have proved that the over expression of brachyury protein, a product of the T gene, is associated with chordoma. The studies have shown that T (brachyury) gene settles in 6q27 region and encodes a transcription factor. The expression rate of brachyury proteins in skull base chordomas is found to be in association with tumour stage, poor prognosis, and treatment resistance. There are also clinical studies that argue that brachyury protein may even be a therapeutic target (1, 2). Some molecular cytogenetic studies have shown that losses on the short arm of chromosome 1 (1p) and gains on the long arm of chromosome 1 (1q) along with gains on the short arm of chromosome 2 (1p) are associated with poor prognosis (5).

In skull base tumours, adjuvant radiotherapy can be applied in case postoperative residue takes place while curative radiotherapy can be an option for patients who cannot undergo surgical operations. Radiotherapy is important as far as proximity to critical organs, especially the brain stem, is concerned. Because of the tolerance doses of these organs, it is difficult to apply required high doses. As in the case of head and neck cancers and compared to other conventional and conformal radiotherapy methods, intensity modulated radiotherapy (IMRT) offers better dose distribution and provides a lower dose distribution to adjacent organs in treating skull base tumours. In addition to IMRT, image guided radiotherapy (IGRT) provides safer verification of the target area before each treatment while it also minimises possible errors caused by action between fractions and set up margins (6). Our patients were treated with Hi-Art helical tomotherapy device which enables both IMRT and IGRT. Studies report promising local control rates concerning the use of IMRT in skull base tumours as well as acceptable levels of long-term side effects during and

after the treatment. Combs et al.'s study on 507 patients with skull base meningioma report a 5-year post-radiotherapy local control rate of 95% in patients with benign meningioma and of 81% in patients with malignant meningioma (7). For patients with malignant skull base tumours, it is necessary to administer radiation doses as high as possible. If critical organs should make it possible, doses should be between 66Gy and 70 Gy. It is barely possible to go up to these doses (8). In the case of our patient, since the mass was invading the brain stem, an organ with a tolerance dose of 54 Gy, we were unable to apply higher doses. Cranial MRI shows that masses are stable in both of our patients and there is a clinically visible decrease in their complaints.

To conclude, radiotherapy applied with IMRT and IGRT techniques by using helical tomotherapy devices can be a safe and effective treatment option for patients with malignant skull base tumours when surgical resection cannot be applied.

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