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Technical Report

# A custom-made mouthpiece incorporating tongue depressors and elevators to reduce radiation-induced tongue mucositis during carbon-ion radiation therapy for head and neck cancer

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**Summary** We introduce a custom-made mouthpiece for carbon-ion radiation therapy for head and neck malignancy. The mouthpiece incorporates either a tongue depressor or elevator depending on tumor location. The risk of tongue mucositis may be reduced without compromising therapeutic efficacy through mouthpiece shaping.


## Introduction

In external photon radiation therapy, the use of intraoral devices to spare adjacent tissues is well described.[1-3] Additionally, reports demonstrate that the mouthpiece reduces intrafraction positioning error as well as interfraction setup error.[4,5] As such, mouthpieces have been incorporated into the treatment of head-and-neck disease with carbon-ion radiation therapy (CIRT) at our institute. To date, the efficacy of mouthpiece use with CIRT has not yet been reported.

CIRT is well-indicated for non-squamous cell carcinoma of the oral and nasal cavities and the paranasal sinuses.[6] To prevent severe complications, such as tongue mucositis and taste disorders, the dose to normal tissue needs to be attenuated using intraoral devices as a means of fixing and establishing placement of the tongue.

In our hospital, we create custom-fit mouthpieces for all patients with head and neck cancer. Since 2012, 2 types of intraoral devices, including either a tongue depressor or elevator, have been constructed in accordance with tumor

Conflicts of interest: None.

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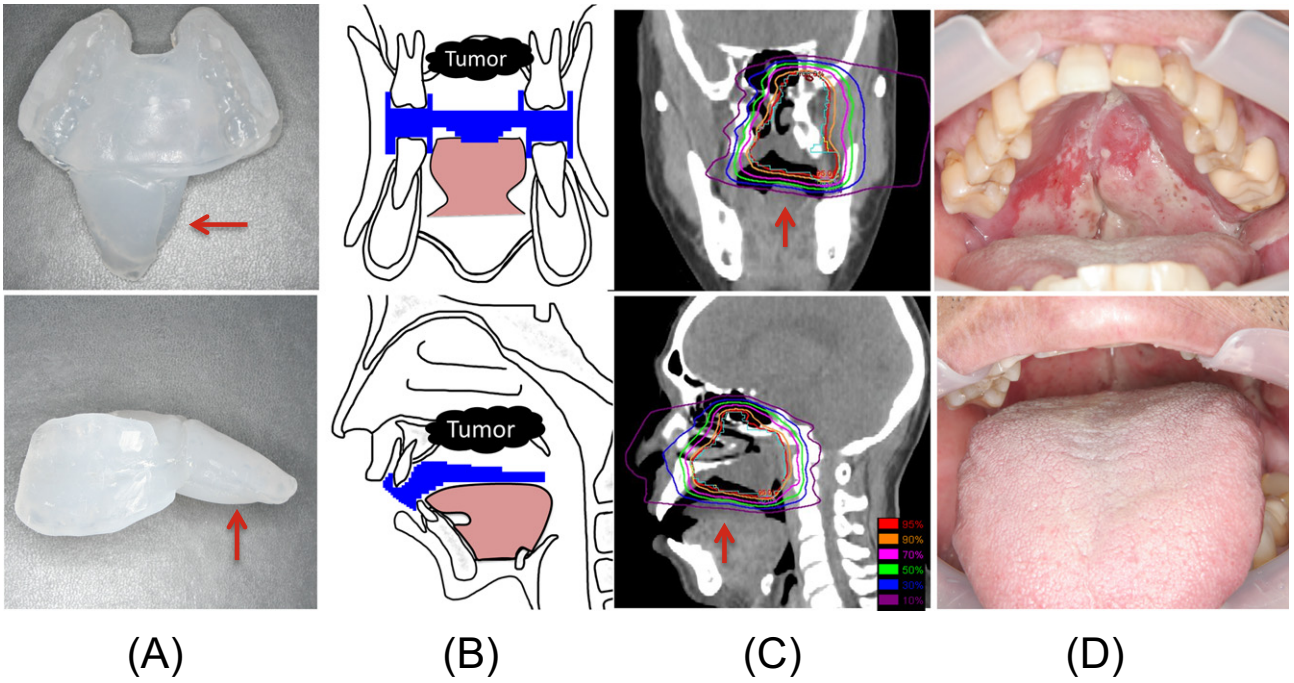


**Figure 1** An adenoid cystic carcinoma (T3N0M0) of the tongue, with the tongue requiring depression. The primary tumor was located in the left palate and protruded into the oral cavity. Carbon ion radiation therapy consisted of 64 Gy (RBE) in 16 fractions via 4 portals. Treatment course was uneventful. (A) Mouthpiece with tongue depressor (arrow). (B) Depressed tongue position with custom-made mouthpiece. (C) Clinical results of dose distribution. (D) Mucosal finding after carbon ion radiation therapy.

location to shield tongue tissue. This is the first time that radiation dose to the tongue has been compared with and without use of the mouthpiece.

In this technical report, we introduce the efficacy of these custom-made mouthpieces in reducing radiation-induced tongue mucositis caused by CIRT.

## Methods and materials

### Mouthpiece description

Mouthpiece construction consists first of taking a teeth arch impression using an alginate impression material (Algiace Z; Dentsply Sirona K.K., Tokyo, Japan) as well as impression trays (Net tray premium; YDM Corporation, Tokyo), with a plaster mold constructed thereafter using dental stone (New Fujirock, GC Corporation, Tokyo). Then, a thermoplastic ethylene-vinyl acetate (EVA) copolymer (Dental Mouthpiece; Cogit Corporation, Osaka, Japan) splint is created from the plaster mold of the patient's maxilla and mandible. Mouthpieces made from EVA are widely used in radiation therapy, and their characteristics are well understood.[7] The EVA splint includes the residual teeth as a means to anchor the device. Next, it is necessary to establish a fixed-bite position for treatment. To preserve the untreated maxilla or mandible (depending on disease location) from radiation damage, an open-mouth position is recommended.[1,3] To accomplish this, a splint is set, and a heated EVA wedge is placed into the patient's open mouth. Finally, a tongue depressor (Fig 1A) or elevator (Fig 2A) is applied to the mouthpiece according to the tumor position, completing the device, with a total construction time of approximately 100 minutes.

The function of the tongue depressor is to keep the tongue in a more recessed than usual position (Fig 1B). In contrast, the function of the tongue elevator is to keep the tongue raised out of the treatment target area (Fig 2B). For the tongue elevator, the EVA base occupies the entire sublingual space, except for the lingual frenulum.

### Costs

The impression materials and dental stones for making the mouthpiece are identical to those used in standard dental treatment. As such, the principal cost consists predominantly of the EVA, which is estimated at less than $100 US at time of publication.

### CIRT

The CIRT method used at our institute has been described previously.[6] Patients are positioned and immobilized, with tumor identification on magnetic resonance imaging scans establishing the gross tumor volume. This was identified on 2.5-mm computed tomography (CT) imaging. The clinical target volume consisted of the addition of 5- to 7-mm margins to the gross tumor volume. Planning target volume had margins of 2 to 3 mm to the clinical target volume. For head