Initial Experience in High-Dose-Rate Brachytherapy Treatment of the Esophagus Using a Novel Esophageal Applicator

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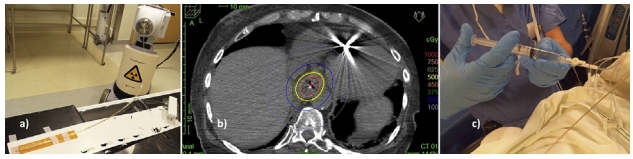

Purpose: The purpose of the study is to report the initial experience in the treatment of locally advanced esophageal carcinoma with high-dose-rate (HDR) brachytherapy using a novel transoral balloon centering esophageal applicator (E-APP, Ancer Medical).

Materials and Methods: Initially, the patient underwent chemoradiotherapy preoperatively for locally advanced esophageal carcinoma. Esophagectomy and resection were performed. Recently, the patient was diagnosed with malignant neoplasm of the middle third of the esophagus. Imaging showed an avid lesion at the anastomosis. The patient received a total of 26 Gy in external beam radiation therapy, so the HDR brachytherapy was used in the second course. To decrease the dose to the organs at risk in the upper gastrointestinal region, we used a novel disposable esophageal brachytherapy applicator with five independently inflatable balloons. The applicator was designed to allow for treatment lengths greater than 10 cm. Prior to the treatment, the applicator was commissioned and tested for clinical implementations. We tested: a) the visibility of the radio-opaque markers in the computer tomography images to assure proper placement, b) the repeatability and consistency of the water inflatable balloons, c) the absolute and relative accuracy (sequencing) of the source positioning in the applicator using the source position simulator and the radiochromic film. In addition, we tested the usability and accuracy of twelve radiopaque markers on the exterior side of the catheters for the proper source placement in the clinical target. The prescription dose for the HDR treatments was 15 Gy in 3 fractions to the distal esophagus with a 5 cm offset from the end of the applicator. The treatment was delivered twice a day. The treatment length was 15 cm, which resulted in 31 dwell positions having a step size of 0.5 cm. The prescription dose was planned to be delivered to a diameter of 1 cm with respect to the central catheter with minimal optimization to avoid critical structures in the anatomy.

Results: The commissioning showed sub-millimeter accuracy in the source positioning. The radiopaque markers of the applicators were visible in various windows and level setup configurations of the CT images. Distal position of the source (source extension) was 1270 mm for the microSelectron V.2. afterloader (Elekta Brachytherapy); the experimental setup is presented in Fig. 1a. The catheter reconstruction was uncomplicated due to the good visibility of the markers. The treatment planning resulted in a favorable dose distribution (Fig. 1b). Unlike in the standard bronchial and esophageal brachytherapy treatments in which the applicators are placed transnasally, this esophageal applicator was placed transorally. Therefore, it was not necessary to remove the applicator after each fraction, so the applicator stayed in place during the entire course of treatment. Each balloon was filled with 5 cm3 of water prior to the dose delivery (Fig. 1c) so that the catheter could be placed centrally while a constant distance to healthy tissue was maintained. The balloons were emptied after each fraction. Prior to the dose delivery, catheter measurements were taken for the purpose of quality assurance. The total treatment time was less than 6 minutes with a source activity of 9.2 Ci. The patient tolerated the treatment fairly well.

Conclusions: We presented the relevant steps in commissioning, clinical implementation, treatment planning, and QA for a novel esophageal applicator. The initial experience revealed that such technique was beneficial in the treatment of the curvy anatomy of the lesion due to the improved repeatability and consistency of the delivered fractional dose to the patient since the radioactive source was placed centrally with respect to the clinical target. A larger cohort of patients is required for additional conclusions.