CASE SERIES

Analysis of fiducials implanted during EUS for patients with localized rectal cancer receiving high-dose rate endorectal brachytherapy

Shalini Moningi, BA,[1] Amanda J. Walker, MD,[1] Ashkan A. Malayeri, MD,[2] Lauren M. Rosati, BS,[1] Susan L. Gearhart, MD,[3] Jonathan E. Efron, MD,[3] Elizabeth C. Wick, MD,[4] Nilofer S. Azad, MD,[5] Elwood P. Armour, PhD,[1] Yi Le, PhD,[1] Joseph M. Herman, MD, MSc,[1] Eun Ji Shin, MD[6]

Baltimore, Maryland, USA

Colorectal cancer is the third most common malignancy and the third leading cause of cancer-related death in the United States, with more than 40,000 rectal cancer cases diagnosed each year.[1] Standard treatment for localized (ie, resectable) rectal cancer includes 5-fluorouracil (5-FU)-based chemoradiation therapy followed by surgery. Improved radiation technology including image-guided radiation therapy (RT) and brachytherapy (contact therapy) can allow for the delivery of higher doses of RT to the rectal tumor over a shorter time period. These treatments may result in improved outcomes; however, they require fiducial markers to allow better localization and targeting of the rectal tumor. In this retrospective study, we evaluated the role of gold fiducial markers in patients receiving neoadjuvant endorectal brachytherapy in patients with localized rectal tumors.

BACKGROUND

The 2 major goals of treatment of rectal cancer include complete (margin-negative) resection of the tumor and sphincter preservation.[2,3] Neoadjuvant chemoradiation therapy results in downstaging in the majority of rectal tumors, and nearly 8% to 12% of patients achieve a pathologic complete response (pCR).[2,4,5] Patients who achieve a pCR after neoadjuvant therapy have been shown to have improved disease-free and distant metastases-free survival rates.[6] However, neoadjuvant chemoradiation therapy with conventional RT is typically associated with high rates of acute toxicity, which can lead to treatment breaks, decreased treatment efficacy, and delayed surgical resection.[7]

Recently, the use of a more localized form of RT called high-dose rate endorectal brachytherapy (HDR-EBT) has increased in popularity. HDR-EBT allows the delivery of high doses of radiation to the rectal tumor plus a margin over only 4 days instead of 6 weeks, as is the case with conventional RT. To ensure accurate dose delivery during HDR-EBT, radiographic markers, also called fiducials, are placed around the tumor to facilitate image guidance. Although there are no standardized techniques or formal guidelines for fiducial placement in rectal cancer patients, EUS-guided fiducial placement is often used in HDR-EBT planning because of its relatively noninvasive nature and its success in other types of cancer (eg, pancreas, prostate).[8-12] Inaccurate fiducial placement may lead to poor fiducial visualization or fiducial migration during the delivery of image-guided HDR-EBT. As a result, the precise target cannot be delineated, and dose delivery to the target volume and/or surrounding normal tissues (bladder, bowel) may be altered, thereby reducing treatment efficacy and compromising the clinical outcome.[2,3,13,14] Before the advent of fiducials, clips were placed near the tumor area; however, these clips were not compatible with magnetic resonance imaging (MRI) and led to difficulties when staging and simulating patients with MRI. This resulted in an increased interest and use of gold MRI-compatible fiducial markers.

To our knowledge, this is the first report to describe EUS-guided fiducial placement used in the management

Abbreviations: 5-FU, 5-fluorouracil; HDR-EBT, high-dose rate endorectal brachytherapy; IQR, interquartile range; MRI, magnetic resonance imaging; pCR, pathologic complete response; RT, radiation therapy; TF, traditional fiducial; XMF, X-mark fiducial.

DISCLOSURE: *All authors disclosed no financial relationships relevant to this publication.*

0016-5107/$36.00
http://dx.doi.org/10.1016/j.gie.2014.11.004

Received June 26, 2014. Accepted November 4, 2014.

Current affiliations: Department of Radiation Oncology and Molecular Radiation Sciences, Sidney Kimmel Comprehensive Cancer Center (1), Department of Radiology (2), Department of Surgery, Sidney Kimmel Comprehensive Cancer Center (3), Department of Pathology (4), Department of Oncology, Sidney Kimmel Comprehensive Cancer Center (5), Department of Medicine (6), Johns Hopkins University School of Medicine, Baltimore, Maryland, USA.

Reprint requests: Joseph M. Herman, MD, MSc, Department of Radiation Oncology & Molecular Radiation Sciences, Sidney Kimmel Comprehensive Cancer Center, Johns Hopkins Hospital, 401 N. Broadway, Weinberg Suite 1440, Baltimore, MD 21231.

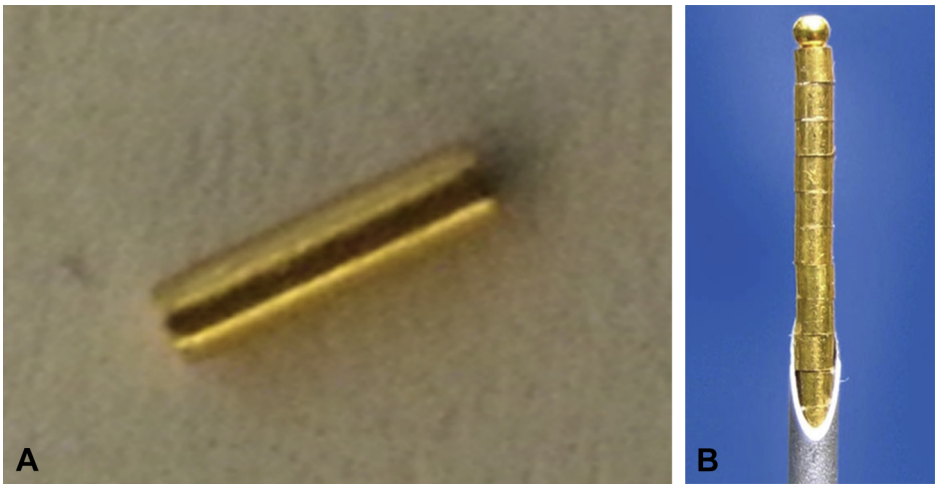

Figure 1. A, Traditional fiducial. **B**, X-mark fiducial (Published with permission from X-mark, Onc Solutions).

of rectal cancer with HDR-EBT. Here we present our experience with fiducial visibility and migration for HDR-EBT in a group of patients with localized rectal cancer.

METHODS

Patient selection

Data were collected and retrospectively analyzed for patients with localized resectable rectal adenocarcinoma T2N1-2 or T3N0-2 that was 12 cm or less from the anal verge. All patients underwent EUS-guided fiducial placement followed by HDR-EBT at Johns Hopkins Hospital from January 2010 to December 2013. This study was approved by the Johns Hopkins Hospital Institutional Review Board for Human Research.

Treatment intervention

After meeting eligibility requirements, patients were enrolled in the study. All patients underwent CT and MRI simulation, and treatment plans were fused by using the Oncentra brachytherapy planning system (Nucletron, Veenendaal, The Netherlands) (Supplemental Figure 1, available online at www.giejournal.org). After receiving 26 Gy (6.5 Gy × 4 fractions) of HDR-EBT, patients underwent total mesorectal excision with a lower anterior resection or an abdominoperineal resection 6 to 8 weeks later. After surgical resection, it was recommended that all patients receive adjuvant 5-FU and oxaliplatin chemotherapy.

Fiducial markers

Two fiducial markers were evaluated in this study: traditional fiducials (TFs) (Best Medical International, Inc, Springfield, Va, USA) (5 mm in length, 0.80 mm in diameter) and X-mark fiducials (XMFs) (ONC Solutions Inc, Acton, Mass, USA) (1, 2, or 3 cm in length, 0.85 mm in diameter) (Fig.1). All fiducials were preloaded onto a FNA needle and directly inserted into the tumor by using EUS guidance (Fig. 2). There was no specific methodology with regard to the choice of fiducials for this initial cohort of patients. To assist with delineation of the rectal tumor and HDR-EBT treatment planning, the compatibility of these fiducials with a 2 Tesla MRI was determined.

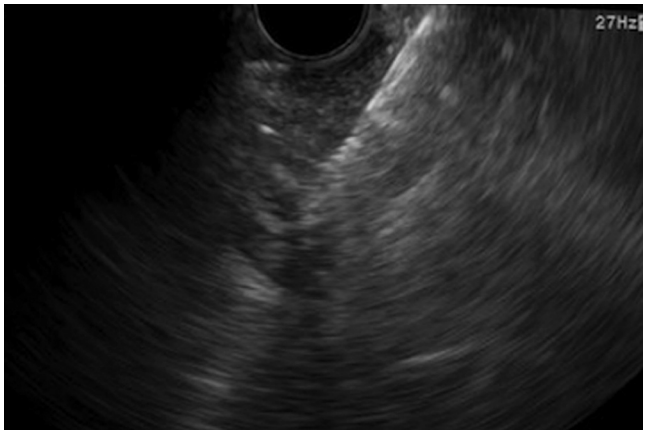

Figure 2. EUS of a fiducial placed in the rectum.

Fiducial placement

All fiducials were placed under EUS guidance by 1 of 3 gastroenterologists. Before the procedure, the risks and benefits were discussed with the patient, and informed consent was obtained. The patient was then placed under propofol-based sedation and monitored closely under the care of the anesthesia team. Prophylactic antibiotics were routinely given before fiducial placement.

A digital rectal examination was performed. A curvilinear-array echoendoscope (FG36-UA; Pentax