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A Medicare cost analysis of MRI- versus CT-based high-dose-rate brachytherapy of the cervix: Can MRI-based planning be less costly?

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ABSTRACT

PURPOSE: While some institutions deliver multiple fractions per implant for MRI-based planning, it is common for only one fraction to be delivered per implant with CT-based cervical brachytherapy. The purpose of this study was to compare physician costs, hospital costs, and overall costs for cervical cancer patients treated with either CT-based or MRI-based high-dose-rate (HDR) cervical brachytherapy to determine if MRI-based brachytherapy as described can be financially feasible.

METHODS AND MATERIALS: We identified 40 consecutive patients treated with curative intent cervical brachytherapy. Twenty patients underwent CT-based HDR brachytherapy with five fractions delivered in five implants on nonconsecutive days in an outpatient setting with the first implant placed with a Smit sleeve under general anesthesia. Twenty patients received MRI-based HDR brachytherapy with four fractions delivered in two implants, each with MRI-based planning, performed 1−2 weeks apart with an overnight hospital admission for each implant. We used Medicare reimbursements to assess physician costs, hospital costs, and overall cost.

RESULTS: The median cost of MRI-based brachytherapy was $14,248.75 (interquartile range [IQR]: $13,421.32−$15,539.74), making it less costly than CT-based brachytherapy with conscious sedation (i.e., $18,278.85; IQR: $17,323.13−$19,863.03, $p < 0.0001$) and CT-based brachytherapy with deep sedation induced by an anesthesiologist (i.e., $27,673.44; IQR: $26,935.14−$29,511.16, $p < 0.0001$). CT-based brachytherapy with conscious sedation was more costly than CT-based brachytherapy with deep sedation ($p < 0.001$).

CONCLUSIONS: MRI-based brachytherapy using the described treatment course was less costly than both methods of CT-based brachytherapy. Cost does not need to be a barrier for MRI-based cervical brachytherapy, especially when delivering multiple fractions with the same application. Published by Elsevier Inc. on behalf of American Brachytherapy Society.

Keywords: Cervical cancer; Cervix; High-dose-rate brachytherapy; Magnetic resonance imaging-based planning; Computed tomography-based planning; Medicare; Cost analysis

Introduction

Cervical cancer is the fourth most common malignancy in females worldwide, with the World Health Organization estimating 520,000 new diagnoses and 270,000 deaths in 2017 (1). The standard of care for the treatment of locally advanced cervical cancer consists of concurrent chemoradiotherapy using external beam radiation therapy with weekly cisplatin followed by brachytherapy (2−8). Modern approaches to brachytherapy include three-dimensional-based treatment planning using either CT or MRI, as

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described by the recommendations from the Groupe Européen de Curiethérapie and the European Society for Radiotherapy and Oncology Working Group and the American Brachytherapy Society (9−11). Three-dimensional treatment planning allows for dose-volume evaluation of the target as well as organs at risk. MRI has been shown to provide a more accurate assessment of tumor size and configuration by virtue of better soft tissue contrast and thus permits superior delineation of the gross tumor volume (GTV) and high-risk clinical target volume (HR-CTV) (12, 13). These volumes have been well established as important prognostic factors for local control, and appropriate coverage of the GTV and HR-CTV correlates favorably with optimal local control (14, 15).

Although MRI has been established as a superior imaging modality for treatment planning in brachytherapy (16−19) and has been shown by numerous single-institution experiences to be feasible and effective (12,20−26), commonly cited barriers to the utilization of MRI are availability and cost (27, 28). MRI-based treatments have traditionally been considered to carry a greater expense than CT-based treatments because of the cost of MRI studies being greater than those of CT studies. As of 2017, the global Medicare reimbursement assigned for a CT of the abdomen and pelvis used for treatment planning is currently set at $278.86 as compared to global charges of $380.06 for an MRI of the pelvis without contrast and $512.13 for an MRI of the pelvis with contrast used as adjunct imaging studies (29). Because MRI-based high-dose-rate (HDR) brachytherapy is both resource and labor intensive, some institutions deliver more than one treatment fraction in a single implant. Conversely, because CT is readily available in most radiation oncology departments, CT-based HDR brachytherapy often involves delivery of one fraction per implant (30, 31).

Currently, there is a paucity of data analyzing the overall cost of MRI-based brachytherapy as it compared with CT-based brachytherapy. In this study, we compared the overall cost for patients at our institution treated with CT-based brachytherapy (delivering one fraction per implant) versus MRI-based brachytherapy (delivering two fractions per implant with an overnight observation admission); both of these regimens have been well described in the medical literature (31, 32). The purpose of this study was to determine if MRI-based brachytherapy delivering multiple treatment fractions per implant remains a financially feasible option even with the inclusion of diagnostic MRI studies and an overnight observation stay.

Methods and materials

Institutional review board approval was granted for this study, and all patients investigated provided informed consent for data to be gathered prospectively. The study population consisted of 40 consecutive patients treated with curative intent cervical brachytherapy from 2010 to 2015 at our institution, of which 20 patients received CT-based brachytherapy and 20 patients received MRI-based brachytherapy. Patients receiving CT-based brachytherapy were treated from 2010 to 2014 and received treatment with five fractions delivered in five implants on nonconsecutive days in the outpatient setting, with the first implant placed with a Smit sleeve under general anesthesia (Fig. 1). Of 20 patients receiving CT-based brachytherapy, 12 patients were treated using conscious sedation and 8 patients were treated using deep sedation induced by an anesthesiologist. In July 2014, our department transitioned to MRI-based brachytherapy. Patients included in this study were treated with MRI-based brachytherapy from 2014 to 2015 and received treatment using general anesthesia to optimize workflow given the layout of our medical center. We delivered four fractions with two implants performed 1−2 weeks apart with an overnight observation stay for each implant, as described by the University of Vienna group with excellent results (31, 32). Imaging for MRI-based brachytherapy at our institution during the time of this study consisted of a simulation CT scan for applicator reconstruction supplemented by a diagnostic MRI for target volume and organ at risk identification.

Our workflow for MRI-based brachytherapy has been previously described (Fig. 2) (33). Briefly, the cervix is dilated, and the intrauterine tandem is placed using transabdominal ultrasound guidance followed by placement of two gold seeds to mark the cervix. The vaginal applicator (ring or ovoids) are placed, and the system is assembled and then packed by the radiation oncologist. The patient is then returned to the supine position, and orthogonal radiographs are taken to ensure proper applicator positioning (34). Following verification of proper applicator placement, the patient is awakened and recovered from general anesthesia before receiving an MRI. The patient is then transferred to the radiation oncology department, where treatment planning and delivery of the first treatment fraction occur. The patient then undergoes an observation stay, with pain

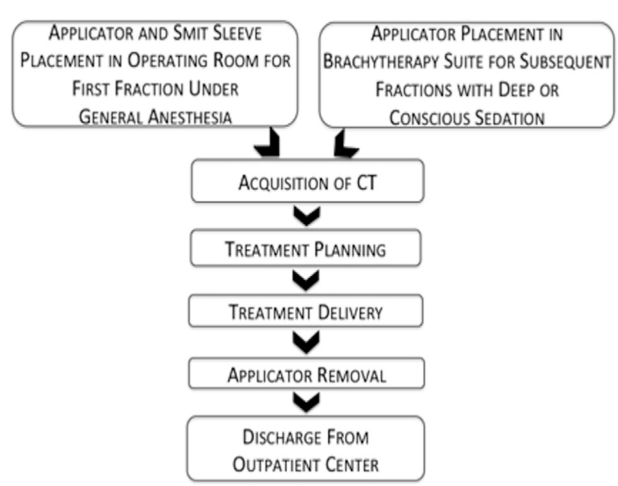

Fig. 1. Workflow diagram for CT-based HDR cervical brachytherapy. HDR = high-dose-rate.