ELSEVIER

CrossMark

BRACHYTHERAPY

Brachytherapy 13 (2014) 233–239

Implant time and process efficiency for CT-guided high-dose-rate brachytherapy for cervical cancer

Jyoti Mayadev[1,*], Lihong Qi[2], Susan Lentz[1], Stanley Benedict[1], Jean Courquin[1], Sonja Dieterich[1], Mathew Mathai[1], Robin Stern[1], Richard Valicenti[1]

[1]*Department of Radiation Oncology, University of California Davis Medical Center, Sacramento, CA*

[2]*Division of Biostatistics, Department of Public Health Sciences, School of Medicine, University of California Davis, Davis, CA*

ABSTRACT

PURPOSE: This investigation details the time and teamwork required for CT-guided tandem and ring high-dose-rate brachytherapy.

METHODS AND MATERIALS: From 2010 to 2012, 217 consecutive implantations were identified on 52 patients. We gathered key workflow times: preoperative, applicator insertion, CT image, treatment planning, treatment, patient recovery, and total time in clinic. Linear fixed-effects models were used, and key workflow times were the outcome variables and factors including age, body mass index, stage, outside referral, number of implant per patient, number of implants per day, and year of implantation were examined as fixed effects.

RESULTS: Of the 52 patients, 62% of the patients were Fédération Internationale de Gynécologie et d'Obstétrique Stage 2B, 88% were treated with concurrent chemotherapy, and 23% were treated at an outside facility and referred for the procedure. The mean times (minutes) for each step were as follows: preoperative evaluation, 93; insertion, 23; imaging, 45; treatment planning, 137; treatment, removal, and recovery, 115; total clinic time, 401. For the insertion time, the greater implant number per patient was significantly associated with a decreased total insertion time, with and without adjusting for other covariates, $p = 0.002$ and $p = 0.0005$, respectively. Treatment planning time was expedited with increasing number of implant per patient and comparing treatment times in 2012 with those in 2010, $p = 0.01$ and $p < 0.0001$, respectively.

CONCLUSIONS: Gynecologic brachytherapy requires a skillfully coordinated and efficient team approach. Identifying critical components and the time required for each step in the process is needed to improve the safety and efficiency of brachytherapy. Continuous efforts should be made to enhance the optimal treatment delivery in high-dose-rate gynecologic brachytherapy. Published by Elsevier Inc. on behalf of American Brachytherapy Society.

Keywords: Brachytherapy; Workflow; Image guided; Cervical cancer; High-dose rate

Introduction

The standard of care for the definitive management of locally advanced cervical cancer includes combined chemotherapy and radiation followed by brachytherapy (1, 2). With the widespread use of sophisticated imaging modalities in radiation oncology departments, the use of image-guided gynecologic brachytherapy planning is increasing (3–9). In 2008, the American Brachytherapy Society published a practice patterns survey regarding three-dimensional (3D) imaging in gynecologic brachytherapy (10). Of the survey responders, 70% obtain a CT scan during the implantation process (10).

Most of the research in image-guided brachytherapy focuses on advanced imaging and treatment optimization that may reduce the side effect profile of brachytherapy. However, there is a lack of data exploring the operational efficiency of an increasingly complex treatment planning and delivery process. By understanding the intricacies of new treatment delivery strategies, safe and effective workflows can be developed (11). There are several logistics associated with

Received 30 October 2013; received in revised form 7 January 2014; accepted 15 January 2014.

Funding support: This work was partially supported by the National Institutes of Health and National Cancer Institute (5P30CA093373-10).

* Corresponding author. Department of Radiation Oncology, University of California Davis Medical Center, 4501 X Street, Suite G140, Sacramento, CA 95817. Tel.: +1-916-734-8269; fax: +1-916-703-5069.

E-mail address: jyoti.mayadev@ucdmc.ucdavis.edu (J. Mayadev).

1538-4721/$ - see front matter Published by Elsevier Inc. on behalf of American Brachytherapy Society.
http://dx.doi.org/10.1016/j.brachy.2014.01.004

gynecologic brachytherapy, including patient preoperative evaluation, the use of an anesthetic, applicator placement, image acquisition, dosimetric planning time, patient transfers, treatment delivery, applicator removal, and patient recovery (2, 9, 10, 12). These efforts must be skillfully coordinated to ensure that the patient is treated in a safe and efficient manner.

An increasing number of radiation centers have switched from a two-dimensional treatment planning method to specific image-guided therapy with more complex delivery (1–3, 5–10, 12, 13). There are several institutions that have not transitioned to the 3D planning because of the complex workflow and time demands that a more sophisticated planning process would incur. Our findings in this report will be instructive for those institutions preparing to migrate to 3D techniques.

There are currently no data in the literature describing the workflow and time commitment for each step in the treatment process of gynecologic brachytherapy using CT-based image guidance. However, there have been efficiency studies examining prostate brachytherapy (14, 15). Furthermore, each step in the process requires meticulous quality assurance. Analysis of workflow facilitates the exploration of needed efficiency within each designated task for potential feedback and troubleshooting. In addition, the medical practitioner and brachytherapy industry are interested in developmental projects that aim to deliver safe and effective brachytherapy. In response to these demands, this study describes the prospective time gathering and workflow of our brachytherapy program. We also evaluate the novel steps that were implemented to ensure adequate treatment quality assurance and patient throughput.

Methods and materials

Patients and brachytherapy team

During 2010–2012, 217 tandem and ring brachytherapy procedures were consecutively performed at our institution on 52 patients with locally advanced cervical cancer. The procedures used a standard applicator without needle supplementation. The procedures were performed by one brachytherapist with various resident physicians. Conscious sedation was delivered by our nurses under the direct supervision of the brachytherapist. The radiation therapist team, dosimetrist, and physicist rotate on and are not solely dedicated to the brachytherapy service. The global treatment workflow of the total clinic time is shown in Fig. 1.

Procedural categorization

The components of the procedure were prospectively recorded during each tandem and ring brachytherapy procedure:

1. Preoperative evaluation—inclusive of patient check in, intravenous (IV) placement, nursing report, and conscious sedation or monitored anesthesia care evaluation and physician preoperative evaluation;
2. Insertion—insertion of applicator in the radiation oncology department procedure room and time requirement of proper applicator placement, ultrasound guidance, and applicator adjustments;
3. Imaging—inclusive of wait before entry into the CT simulator, patient transfer to the CT table, bladder/rectal contrast administration, fixation of external clamp mechanism, CT acquisition time (scan time), and applicator adjustments as needed;
4. Insertion finish to treatment—total CT time plus anatomic contouring, applicator registration, dosimetry, planning, plan optimization, physician check and adjustments, physics check, plan transfer from the planning platform to the treatment console, patient transfer to treatment room, pretreatment quality assurance checks, and procedural pause;
5. Treatment planning (CT finish to procedural pause)—anatomic contouring, applicator registration, dosimetry planning, plan optimization, physician check and adjustments, physics check, plan transfer from the planning platform to the treatment console, patient transfer to treatment room, pretreatment quality assurance checks, and procedural pause;

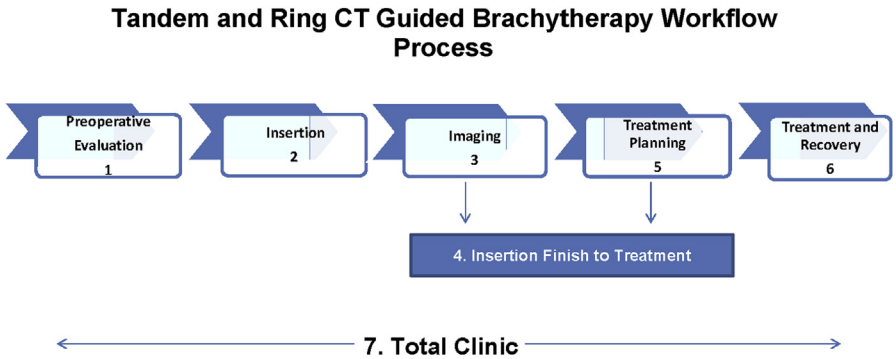

Fig. 1. Brachytherapy workflow schema.