ELSEVIER

Brachytherapy 12 (2013) 311–316

BRACHYTHERAPY

Interstitial brachytherapy vs. intensity-modulated radiation therapy for patients with cervical carcinoma not suitable for intracavitary radiation therapy

Daya Nand Sharma*, Ajeet Kumar Gandhi, Seema Sharma, Goura Kisor Rath, Pandjatcharam Jagadesan, Pramod Kumar Julka

Department of Radiation Oncology, All India Institute of Medical Sciences, New Delhi, India

ABSTRACT

PURPOSE: Interstitial brachytherapy (IBT) is the standard alternative treatment for patients with cervical carcinoma not suitable for intracavitary radiotherapy. There is an emerging belief that intensity-modulated radiotherapy (IMRT) has the potential to replace IBT. We aimed to compare the dosimetry achieved by IBT and IMRT in such patients.

METHODS AND MATERIALS: The CT imaging data, previously used for IBT planning of 12 patients with cervical carcinoma, were transferred to IMRT planning system to generate parallel IMRT plans. Prescribed dose to the planning target volume (PTV) was 20 Gy delivered in 2-weekly high-dose-rate fractions of 10 Gy each with IBT (biologically equivalent dose [BED_{10}] 40 Gy) and 33 Gy/13 fractions/2.5 wk with IMRT (BED_{10} 41 Gy). For comparison, dose–volume parameters for target and organs at risk were recorded and expressed in terms of BED_{10} and BED_3, respectively.

RESULTS: For PTV, the mean D_{95} (dose received by 95% of PTV) was better with IBT (57.16 Gy vs. 41.47 Gy, $p = 0.003$). The mean conformity index was 0.94 and 0.90 with IBT and IMRT, respectively ($p = 0.034$). IBT delivered significantly reduced doses to 1.0 cc (D_{max}), 5.0 cc ($D_{5\ cc}$), 50% (D_{50}), and 75% (D_{75}) of bladder volume as compared with IMRT. The mean rectal D_{max} was significantly better with IBT as compared with IMRT (54.64 Gy vs. 62.63 Gy, $p = 0.02$).

CONCLUSIONS: IBT provides superior PTV coverage and organs at risk sparing to IMRT. Thus, IBT remains the standard treatment for patients with cervical carcinoma unsuitable for intracavitary radiotherapy.

Keywords: Cervical carcinoma; Interstitial brachytherapy; IMRT; Dosimetric comparison

Introduction

Intracavitary radiation therapy (ICRT) is an integral component in the radiotherapeutic treatment of cervical cancer (1). However, some patients are not suitable for ICRT because it is either not technically feasible (because of obliteration of the cervical os or narrow vagina) or it does not provide adequate dosimetric coverage of disease (extension of disease into the lower vagina or lateral parametria). These patients are often treated with interstitial brachytherapy (IBT) (2). Several recent series using IBT have shown encouraging results in terms of adequate local control rate and acceptable toxicity (3–5). However, IBT is still not widely practiced because of its invasive nature, lack of expertise, and robust literature.

The patients who can neither receive ICRT nor IBT because of various reasons are conventionally treated with external beam radiation therapy (EBRT) alone, although with moderate results (6, 7). The main limitation of conventional EBRT is the inability to achieve target doses beyond 50 Gy, as compared to 85–90 Gy with the combination of EBRT and ICRT, because of the risk of radiation-related morbidity. The local control rates have been dismal if the doses are not escalated above the standard 50–55 Gy (8). However, modern conformal EBRT techniques, such as intensity-modulated radiation therapy (IMRT), stereotactic body radiotherapy (SBRT), and so on, have the potential to escalate the doses to the areas of interest with reduced doses to the organs at risk (OARs) and therefore can be

Received 24 July 2012; received in revised form 27 September 2012; accepted 19 October 2012.

Financial Disclosure/Conflict of Interest Notification: None.

* Corresponding author. Department of Radiation Oncology, All India Institute of Medical Sciences, New Delhi 110029, India. Tel.: +91-11-26268213; fax: +91-11-26588663.

E-mail address: sharmadn@hotmail.com (D.N. Sharma).

1538-4721/$ - see front matter
http://dx.doi.org/10.1016/j.brachy.2012.10.003

an attractive alternate to IBT. IMRT has been explored to replace IBT in cancers of other sites such as head and neck (9) and prostate (10). A few studies using IMRT (11) or SBRT (12) have been carried out to match the dose distribution achieved by ICRT in cervical carcinoma. Therefore, it is very tempting to replace invasive brachytherapy procedures such as IBT with IMRT for patients with cervical carcinoma, particularly for those who cannot receive the IBT. The literature is extremely sparse as there is a single study (13) comparing IBT with IMRT dosimetry. We designed a study to compare these two rival modalities in patients with cervical carcinoma not suitable for ICRT. The endpoints of this study were dose conformity in the target and doses to the OAR.

Methods and materials

The study is based on the data of 12 patients with primary cervical carcinoma (International Federation of Gynecology and Obstetrics Stage IIB–IIIB) who have been already treated with IBT after whole-pelvis EBRT. The CT scan imaging data used for their IBT planning were transferred to the IMRT planning system to create a parallel IMRT plan. The dosimetry achieved by the IMRT plan was compared with the IBT plan for an equivalent prescription dose for each patient.

The treatment consisted of whole-pelvis EBRT with a dose of 50.4 Gy in 28 fractions over 5.5 weeks by the four-field box technique with concurrent weekly cisplatin. After the EBRT procedure, they were assessed and found ineligible for standard ICRT application because of various geometric or dosimetric reasons and hence treated with high-dose-rate (HDR) IBT. Our institutional protocol of IBT, based on successful results in an earlier study (5), consisted of delivering 2-weekly HDR fractions of 10 Gy each. The IBT implant was performed under spinal/epidural anesthesia using the Martinez Universal Perineal Interstitial Template with the assistance of transrectal ultrasonography (TRUS). The details of the procedure have already been described in our previous publication (5). The number of needles to be inserted was determined by the target volume defined by pretreatment clinical and radiologic (CT/MRI) findings as well as operative, clinical, and TRUS findings. An average of 18 needles (range, 14–26) was implanted.

Brachytherapy planning

A planning CT scan of the whole pelvis was done with a slice thickness of 3 mm. The images were then sent through digital imaging and communication in medicine-radiation therapy to brachytherapy planning system (PLATO planning system, Version 14.3.7; Nucletron, an Elekta company, Stockhom, Sweden). Delineation of the clinical target and OAR was carried out in detail in our earlier publication (5). Briefly, target was contoured on individual CT slices joining the outermost surface of the needles (Fig. 1a).

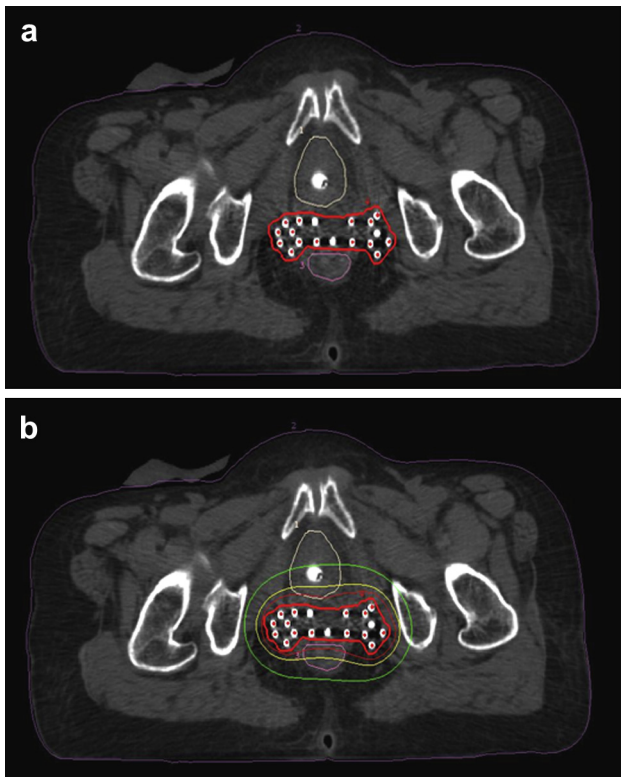

Fig. 1. CT scan–based brachytherapy planning on Plato system. (a) The contouring of bladder (brown), rectum (pink), and target area (red). Target area is delineated by joining the peripheral implant needles. (b) The isodose distribution showing the prescription line (thin red line) and 60% isodose line (green line) (please refer the online version of the figure for colors).

The upper and lower extent of target was decided according to the pretreatment clinical and radiologic findings as well as findings during the operative procedure. No margin was given to this clinical target volume while creating a planning target volume (PTV). The rectum was contoured from the anal verge to sigmoid colon. The entire bladder was contoured including the wall and lumen. The urethra was contoured from the base of the Foley's bulb in the bladder until two slices below the target. Because of overlapping of the target and OAR volumes, minimal modifications were done while finalizing the target volume. Using a step size of 2.5 mm, a plan was generated (Fig. 1b) for a prescription dose of 20 Gy to the target to be delivered in 2-weekly HDR fractions of 10 Gy each. Biologically equivalent dose (BED_{10}) of this regime was calculated to be 40 Gy. If needed, both graphic and geometric optimization was done to achieve the best plan.

IMRT planning

The CT imaging data used for IBT planning were exported to external beam IMRT Eclipse planning system (Version 6.5; Varian Medical System, Palo Alto, CA) through digital imaging and communication in medicine-radiation therapy. The OAR volumes remained same as in IBT planning. A PTV was created by giving a 3–5-mm margin to