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High-dose-rate interstitial brachytherapy for T1–T2-stage penile carcinoma: Short-term results

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ABSTRACT

PURPOSE: Interstitial brachytherapy (IBT) is a preferred treatment option over partial penectomy in selected patients with T1–T2-stage penile carcinoma because of its organ preservation ability. Literature is mostly based on the use of low-dose-rate IBT, and experience with high-dose-rate (HDR) IBT is extremely limited. We studied the role of HDR-IBT alone in patients with T1–T2-stage penile carcinoma.

METHODS AND MATERIALS: Between April 2010 and July 2013, 14 patients with T1–T2-stage penile carcinoma were treated with HDR-IBT at our center. Size of the primary lesion ranged from 1.5 to 4.0 cm. A two-to-four–plane free-hand implant was performed using plastic catheters. The prescribed dose of HDR-IBT was 42–51 Gy in 14–17 fractions using twice-a-day fractionation schedule. Patients were followed up regularly for assessment of local control, survival, toxicity, and sexual function.

RESULTS: At a median followup of 22 months, 2 patients developed recurrent disease at locoregional site. The 3-year overall survival was 83% with penis preservation rate of 93%. All patients developed acute Grade III skin toxicity that healed during 6–8-weeks time. Urethral stenosis and soft tissue necrosis was not seen in any of the patients. A total of 4 patients experienced mild asymptomatic fibrosis in the implanted area. Around 10 patients had satisfactory sexual function status at the last followup visit.

CONCLUSIONS: Although it was a small sample size, our results have demonstrated excellent local control rate and acceptable toxicity with HDR-IBT in patients with T1–T2-stage penile carcinoma.

Keywords: Penile carcinoma; Brachytherapy; High-dose rate

Introduction

Penile carcinoma is relatively a rarer malignancy of the male urogenital tract. Incidence is reported to be higher in Asian countries as compared with the developed countries (4 vs. 1 per 100,000 men) (1, 2). In India, the age-adjusted incidence rate ranges from 0.6 to 3.1 per 100,000 men in different population-based cancer registries (3). Most present in advanced stages, and the results are disappointing in such patients (4).

For early-stage disease, surgery is traditionally the preferred method of treatment with excellent cure rates but associated with significant psychosexual morbidity (5, 6). Interstitial brachytherapy (IBT) has been used as an alternate to penectomy in early-stage disease with 5-year local control rates of 87% and penile preservation rate of 88% (7). For advanced lesions, those who deny surgery, IBT can be combined with external beam radiation therapy (EBRT) (8, 9). The existing literature on IBT is largely based on the experience with low-dose rate (LDR) IBT, and there is extremely limited experience with high-dose-rate (HDR) IBT in penile carcinoma (10). We studied the role of HDR-IBT in patients with T1–T2-stage penile carcinoma, and our addition of results to the existing single study (10) in literature would further define the value of HDR-IBT in penile carcinoma.

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Methods and materials

Between April 2010 and July 2013, 14 patients with T1–T2-stage penile carcinoma were treated with HDR-IBT at our center. Written consent was obtained from all patients. The various clinical characteristics of the patients are given in Table 1. Median age was 42 years (range, 35–56 years). Pretreatment evaluation consisted of detailed clinical examination, routine blood investigations, plain X-ray chest, CT scan of the abdominopelvic region, and histopathological examination of primary lesion. The TNM staging was done as per American Joint Committee on Cancer Staging 2010. All patients had T1–T2-stage disease without lymph node metastasis except one who had bilateral inguinal lymph node metastases. He underwent bilateral inguinal node dissection and simultaneously penile brachytherapy implant procedure followed by inguinopelvic EBRT to a dose of 50.4 Gy in 28 fractions over 5.5 weeks. Rest all patients were treated with HDR-IBT alone. A total of 2 patients underwent circumcision 2 weeks before implant procedure.

Brachytherapy implant procedure

All the patients were hospitalized 1 day before the procedure. The implant procedure was done under spinal anesthesia. After inserting the Foleys's catheter into the bladder, thorough assessment of the tumor dimensions was made. The area to be implanted included gross tumor plus a margin of at least 5 mm. A two-to-four–plane implant was performed depending on the implant area. We did not use single-plane implant as it can potentially lead to inadequate coverage of the tumor. The 16-G stainless steel needles along with trocars were inserted manually without using any template. The distance between the needles in a particular plane was kept between 1.0 and 1.2 cm. The interplanar distance of 1.0–1.5 cm was maintained, thereby avoiding injury to the urethra. Then, the trocars of the needles were removed and the tails of the plastic catheters having button at one end were negotiated through the hollow needles. Subsequently, the needles were removed and replaced by plastic catheters, which were fixed with buttons (Figs. 1a–1c). A single dose of 100 mg of hydrocortisone was administered intravenously to prevent the penile edema. Antibiotics and the analgesics were prescribed till the implant removal.

Table 1
Patient characteristics

Attribute	Values
Age, y	
Median	42
Range	35–56
Anatomical site, *n*	
Glans	12
Glans + prepuce	2
Histopathological grade, *n*	
Well differentiated	10
Moderately differentiated	3
Poorly differentiated	1
Size of primary tumor, cm	
Median	3
Range	1.8–4.0
Clinical T-stage, *n*	
T1	11
T2	3
Nodal status, *n*	
Node negative	13
Node positive	1
Surgery, *n*	
Circumcision	2
Inguinal lymph node dissection	1
Followup period, mo	
Range	6–40
Median	22

Note. *n* represents number of patients.

Brachytherapy planning and dosimetry

A planning CT scan of the implant area was done with slice thickness of 2.5 mm. Brachytherapy planning was performed on PLATO planning system, version 14.1 (Nucletron, Veenendaal, The Netherlands). The clinical target volume (CTV) was contoured and no planning target volume margin was given around the CTV. The implant catheters were also marked on each slice to reconstruct the catheter length. Using step size of 2.5 mm, a plan was generated for a prescription dose of 42–45 Gy to the CTV. If needed, both graphic and geometric optimization was done to achieve the best plan. The volumes receiving 100% (V_{100}), 125% (V_{125}), and 150% (V_{150}) of the prescribed dose were calculated. Similarly, proportion of the urethral volume receiving 115% (V_{115}) and 90% (V_{90}) of the prescribed dose was also calculated. We tried to restrict V_{150} below 25% of the treated volume.

Dose homogeneity index (DHI) was calculated using the following formula:

$$\mathrm{DHI} = \frac{V_{100} - V_{150}}{V_{100}}$$

Usually a dose of 42–45 Gy in 14–15 fractions, using 3 Gy per fraction, over 7–8 days was prescribed using twice-daily fractionation schedule. In 1 patient, dose was escalated to 51 Gy in 17 fractions owing to large tumor size (4.0 cm). Equivalent dose in 2-Gy fractions (EQD2) was calculated by using the following formula.

$$\mathrm{EQD2} = D\frac{d + (\alpha/\beta)}{2 + (\alpha/\beta)}$$

where D is the total dose, d is the dose per fraction, and alpha/beta (α/β) ratio is considered 10 for the tumor.

Brachytherapy treatment delivery

Treatment was delivered on HDR remote afterloading brachytherapy unit (Nucletron, an Elekta company [Elekta