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Computed tomography imaging-guided percutaneous argon–helium cryoablation of muscle-invasive bladder cancer: Initial experience in 32 patients ☆

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ABSTRACT

Purpose: To evaluate the initial clinical experience of computed tomography (CT) imaging-guided percutaneous cryotherapy of bladder cancer.
Patients and methods: This study was approved by the human subjects committee. Written informed consent was obtained from all patients. Thirty-two patients (22 males and 10 females; mean age, 62.7 years) with muscle-invasive bladder cancer were treated with CT imaging-guided percutaneous cryoablation. By using CT imaging system and local anesthesia in patients, a single or multiple 1.47 mm cryoprobes were used to freeze the target bladder tumor (mean tumor size, 2.8 cm; range, 1.3–4.5 cm) with a dual freeze–thaw cycle. Follow-up was performed to assess the clinical and technical outcome of patients treated with cryoablation for a minimum of 6 months (mean, 33 months; range, 6–48 months). Tumors were considered completely ablated if there was no evidence to suggest tumor enhancement at follow-up CT images.
Results: Bladder cryoablation was clinically and technically successful in all 32 cases, 30 of which required only one treatment session. Bladder integrity was maintained in all patients. Major complications were not observed in any patient.
Conclusion: Our initial experience of a minimally invasive method for ablating bladder tumors with CT imaging-guided percutaneous argon–helium cryoablation appears to be favorable, with acceptable operative and short-term clinical outcomes. The technique is safe and effective for the treatment of patients with muscle-invasive bladder cancer; however, long-term follow-up is needed.

Introduction

Bladder cancer is a relatively common malignant cancer in the urinary system, and shows an increasing tendency in Asia [15]. About 15 cases of bladder cancer occur per 100,000 persons worldwide and 0.13 million persons die of bladder cancer annually [23]. Although radical cystectomy and urinary diversion has been the gold standard of care for invasive bladder cancer, the technique is associated with significant morbidity and functional compromise [16]. Because of the perioperative morbidity and postoperative complications of radical cystectomy, many bladder-sparing options have been adopted for bladder cancer, including partial cystectomy, transurethral resection of bladder tumor (TURBT), chemotherapy, and/or radiation [9,5]. Imaging-guided percutaneous ablative methods have been proposed as an alternative to partial tumor excision, such as partial nephrectomy [13]. Methods such as using computed tomography (CT)- or magnetic resonance imaging (MRI)-guided radiofrequency ablation and cryoablation can be performed percutaneously, and are likely to play an important role in the treatment of multiple tumors.

Cryoablation is a well-characterized and understood ablation technology that has been applied clinically to treat both benign and malignant disease in many different organs, such as the kidney, pancreas, prostate gland, adrenal gland, lung, and liver [8,7,4]. Argon–helium cryoablation is a new local ablation technique based on in situ freezing and devitalization of tissues. This technology caused some authors to question its use in cancers, with consideration of a theoretical risk of post-procedure hemorrhage [24]. However, there has some evidence to suggest that there is no significant difference in the rate of hemorrhage following

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radiofrequency ablation versus cryoablation [19]. Following the gradual downsizing of cryoprobes, percutaneous argon–helium cryoablation has been feasible, and offers several advantages versus other approaches. First, the ablation zone of the percutaneous cryoablation approach can be carefully monitored and visualised using CT or MRI. Second, the percutaneous approach is less invasive and relatively painless compared with other procedures, such as laparotomic methods and heat-based ablation modalities [14].

A large body of evidence has suggested that imaging-guided percutaneous cryoablation is safe and effective for many cancers, such as liver tumors and renal tumors [20,21,25]. On the basis of the effectiveness and safety benefits of percutaneous cryoablation, and the advantages of CT in monitoring cancerous tissues effects of freezing, we treated patients' bladder tumors with CT imaging-guided percutaneous argon–helium cryoablation. In this investigation, we document our experience of percutaneous cryoablation for bladder cancer in 32 patients. The goal of the current study was to examine the safety and efficacy of CT imaging-guided percutaneous argon–helium cryoablation of bladder cancer.

Patients and methods

A total of 32 patients with bladder cancer who were treated for bladder cancer at the Radiology Department, Xijing Hospital, Fourth Military Medical University between April 2003 and June 2010 were included in this study. Bladder cancer was diagnosed based on imaging findings and confirmed by cystoscopy. Clinical staging was based on the tumor-node-metastasis (TNM) classification; all patients in our study had clinical stage T2-T4aN0M0 bladder cancer. The 32 patients had a total of 34 tumors of 1.3–4.7 cm in diameter (mean size 2.8 cm). The clinical characteristics of the patients are summarized in Table 1. All protocols in our study were approved by the Ethics Committee and the human subjects committee at Xijing Hospital. All patients participating in the study were Chinese in origin and provided written informed consent for the treatment.

In accordance with the protocol approved by the human subjects committee at Xijing Hospital, the criterion for the inclusion of patients in this study was that the subject was an adult with a metastatic neoplasm of the bladder, including advanced-stage bladder cancer, findings on CT that were interpreted as likely to represent a metastatic bladder tumor, and patients with recurrence after surgery. To be included in a study of an innovative therapy, patients should have correctable or normal hemostatic parameters and no contraindications to CT. The last criterion, but the most important, was that patients with a tumor of <5 cm in diameter were to receive cryoablation therapy in the study. Patients were ineligible for these protocols for several reasons [18]: distant spread of disease; hydronephrosis; use of other ablative therapies before cryoablation; a tumor of >5 cm in diameter; patient refusal to sign a consent form to approve the treatment; and patients with severe irritative bladder symptoms were not candidates for the bladder-preserving protocols.

Before the surgical procedure, we used the 18F flexible cystoscope working channel (CYF-2, Olympus Keymed, UK) to examine the location and number of tumors. Patients with larger tumors were examined by cystography. A preprocedural dual-source CT

Table 1
Descriptive statistics of bladder cryoablation patients treated on protocol.

No.	Gender/ Age	Mass size (cm)		Clinical stage	Pathology classification	Complications	
		Preoperative	Intraoperative			Before cryosurgery	After cryosurgery
1	M/52	1.3	1.5	T2a	G2	Hematuria	Hematuria
2	M/79	4.2	4.4	T4	G3	Hematuria, urinary irritation	Hematuria
3	F/55	4.5	4.4	T4	G3	Abdominal pain	Hematuria
4	M/61	1.4	1.7	T2b	G1	Hematuria, lumbago	Hematuria
5	M/60	1.4	1.3	T2a	G2		
6	M/53	3.1	3.0	T3	G3	Hematuria	
7	F/63	1.6	1.8	T2a	G2		
8	M/64	3.2	3.0	T3	G3	Hematuria	Abdominal pain
9	M/72	3.5	3.6	T3	G3	Abdominal pain	
10	F/57	4.0	3.9	T3	G3	Hematuria, urinary irritation	Urinary irritation
11	M/68	3.9	4.2	T4	G3	Hematuria, urinary irritation	Hematuria
12	M/66	1.8	2.1	T2b	G2		
13	M/61	2.3	2.2	T3	G1	Hematuria	Hematuria
14	M/59	2.5	2.6	T3	G1	Urinary irritation	
15	F/60	2.7	2.6	T3	G2		
16	M/73	3.3	3.5	T3	G1	Hematuria	Hematuria
17	M/64	1.6	1.8	T2b	G1		
18	F/66	2.2	2.4	T3	G2	Hematuria	Hematuria
19	M/58	2.8	3.0	T3	G3	Hematuria, lumbago	Abdominal pain
20	M/74	3.7	3.5	T3	G3	Abdominal pain	
21	M/60	4.3	4.4	T4	G3	Hematuria, abdominal pain	
22	F/57	4.7	4.4	T4	G2	Hematuria, urinary irritation, abdominal pain	Hematuria, urinary irritation
23	M/55	1.6	1.5	T2b	G1	Abdominal pain	Abdominal pain
24	M/69	2.9	2.7	T3	G3	Lumbago	
25	F/72	3.7	3.8	T3	G2	Hematuria, abdominal pain	Abdominal pain
26	M/65	3.1	3.3	T3	G3	Hematuria	
27	F/56	4.4	4.4	T4	G3	Hematuria, abdominal pain	Hematuria
28	M/76	3.0	3.1	T3	G2	Hematuria	Hematuria
29	F/58	1.5	1.6	T2a	G1	Lumbago	
30	M/53	1.4	1.6	T2b	G1	Hematuria, abdominal pain	
31	F/52	2.7	2.8	T3	G2	Hematuria	Lumbago
32	M/67	2.3	2.1	T3	G2	Hematuria, abdominal pain	Abdominal pain
Mean	62.7 (SD = 7.3)	2.8 (SD = 1.0)	2.9 (SD = 1.1)	/	/	/	/