Transurethral Partial Cystectomy With Continuous Wave Laser for Bladder Carcinoma

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Purpose: To our knowledge we established a new technique to vaporize and incise the full-thickness bladder wall and peel off the entire muscular layers with a 2 μm continuous wave laser to treat bladder carcinoma.

Materials and Methods: Nine patients were treated transurethrally with a 2 μm laser under sacral block. This 2 μm laser was used to incise the full-thickness bladder wall around the tumors. The entire bladder wall was peeled between the detrusor muscle layer and outer connective tissues. Tumors with full-thickness detrusor muscle layers at the base were removed together and sent for pathological examination. Intraoperative hemorrhage and postoperative complications were observed, and pathological staging and postoperative followup were performed.

Results: All operations were successful. Mean $\pm$ SD operative time was 8.7 $\pm$ 2.6 minutes (range 7 to 15) per patient. Perioperative blood loss was minimal. There was no obturator nerve reflection and no hemorrhage was detected after surgery. Bladder perforation occurred in 1 case. Pathological stage of the tumors was T1 and T2a. Patients were followed for 6 to 9 months postoperatively with no recurrence at the resection site. This series included highly selected patients treated by a single high volume surgeon.

Conclusions: To our knowledge this is the first report of a 2 μm laser used to treat bladder carcinoma. It can be applied to precisely vaporize and incise the full-thickness bladder wall and peel it between detrusor muscle layers and outer loose connective tissues, thus completing partial cystectomy for bladder carcinoma.

Key Words: urinary bladder, urinary bladder neoplasms, carcinoma, lasers, cystectomy

The bladder wall includes 3 layers, that is the mucous membrane layer (inner), detrusor muscle layer (middle) and fibrous membrane composed of connective tissues (outer). The detrusor muscle layer is composed of 3 layers without obvious demarcations. There is an exchange of muscle fibers between adjacent muscle bundles. Therefore, the whole detrusor muscle layer can be considered an interlaced smooth muscle unit. There is no obvious sarcolemma between the muscle layers and they are difficult to separate.[1,2] The entire detrusor muscle layer can be simply peeled from the connective tissues in the bladder outer layer.

To our knowledge the RevoLix® 2 μm continuous wave laser system for medical use is the latest technology for treating urinary system diseases. It is an efficient solid-state, fiber coupled diode laser with a 2.013 μm

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wavelength. Laser energy can be absorbed fully by the water in tissues. Thus, energy can vaporize and cut tissues instantaneously. When applying 2 μm laser vaporization for surgical treatment for benign prostatic hyperplasia, we discovered that 2 μm laser vaporization is a minimally invasive treatment. This continuous wave laser has a 20 to 70 W output power range, and precise vaporization and cutting action.

The laser continuous working pattern is vaporization plus resection. In clinical practice it is effective for hemostasis, smoothing the injured area and removing tissue, and it has few complications.[3] The depth of tissue penetration is only 0.3 mm, which avoids damage to surrounding tissues. During vaporization the 2 μm laser forms a 1.0 mm coagulation layer on the tissue that can be effective for hemostasis but it does not form a large scab that would block vision and obstruct followup operations.[4]

Vapor resection with the 2 μm continuous wave laser has been done as minimally invasive treatment for benign prostatic hyperplasia in the last few years.[5] Due to its characteristics of simultaneous and precise vaporization, and resection as well as bladder wall anatomical characteristics we applied the 2 μm laser for endourological treatment for bladder carcinoma. To our knowledge we established a new method to vaporize and incise the full-thickness bladder wall and peel off the entire detrusor muscular layers to complete partial cystectomy.

MATERIALS AND METHODS

From December 2007 to September 2008 we screened and selected 7 male and 2 female patients with a mean ± SD age of 52.4 ± 8.5 years (range 42 to 63) who had bladder carcinoma. Preoperatively the 9 patients were examined with B style ultrasound of the urinary system, excretory urography and cystoscopy. Two tumors were in the bladder delta region, 7 were behind the delta region and side wall, and 2 were in the dome and anterior wall. Tumor diameter was between 1 and 3 cm.

Endoscopic resection biopsies were done in all patients to confirm the histopathological diagnosis, which revealed that all tumors were urinary epithelioma with a stage between low and high grade papillary urothelial carcinoma. Importantly all patients were examined by pelvic cavity magnetic resonance imaging and all tumors were suspected of invading the detrusor muscle layer.

We used the RevoLix 2 μm continuous wave medical laser surgery treatment system. Energy is transmitted through a 550 μm optical fiber and power was set to between 40 and 50 W. We also used a 26Fr 30-degree laser resectoscope (Karl Storz, Tuttlingen, Germany).

Surgery was done using sacral block and guided by a television surveillance system. Patients were placed in the lithotomy position. Glycine solution (15 gm/l) was used as the operative rinse solution. After inserting the laser resectoscope into the bladder we inspected the bladder and determined tumor size, number, shape and position (fig. 1, *A*).

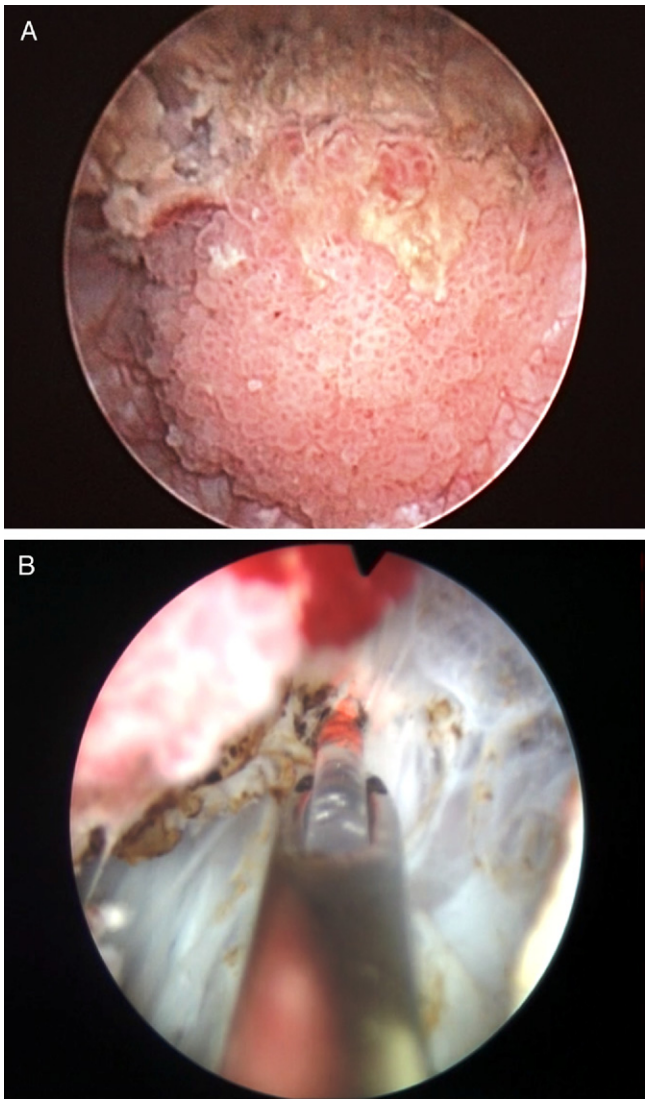

Figure 1. *A*, tumor range. *B*, incising and peeling full-thickness bladder wall.

The optical fiber probe was inserted into the bladder through the laser resectoscope operation channel. After starting the laser the operator adjusted the red aiming beam position. The normal mucous membrane, submucosa, muscle layer and fibrous connective tissues in the outer bladder layer about 0.5 to 1.0 cm to tumors were vaporized and incised. The demarcation between the sallow muscle layer and the ash gray connective tissue layer was clearly seen after incision (fig. 1, *B*). When the tumor was small, it could be peeled immediately. Blunt stripping was done with the laser resectoscope tip along the loose spaces between the detrusor muscle and outer connective tissue layers. When there was a fibrous zone that could not be separated, it was vaporized and incised. These procedures were continued until the entire tumor and the full-thickness bladder wall at the base were freed. When the tumor was large and difficult to strip, it was incised longitudinally or crosswise to cut the tumor and the bladder wall at the base into 2 parts or several parts. Peeling was then done.