



Green-laser assisted laparoscopic partial cystectomy for selective muscle-invasive bladder cancer: technique and initial outcome

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Abstract

Purpose To describe a green-laser marking technique to assist partial cystectomy, which allows accurate identification of tumour margins, and provide our initial experience with ten patients.

Methods Between January 2014 and February 2018, ten patients suspected with muscle-invasive bladder cancer and request of bladder-preserving treatment were selected. In each case, bilateral pelvic lymphadenectomy was performed before green-laser assisted laparoscopic partial cystectomy. Under the direct view of cystoscope, the front-firing green-laser incision was performed 0.5–1 cm away from the exterior margin of lesion with adequate depth into the fat tissue. Tumours were then en bloc removed via laparoscope under the tracing of laser beam.

Results The location of 12 tumours in 10 patients was superior wall in 7 cases, lateral wall in 3 cases, anterior wall in 1 case, and posterior wall in 1 case. All procedures were completed without serious complications. The median operating time was 270 (210–360) min with a median haemoglobin decrease of 11 (3–38) g/L. Nine patients were high-grade transitional cell carcinoma and one patient was urachal carcinoma, and the clinical stage was pT1 in 1 case, pT2 in 4 cases, and pT3 in 5 cases. The pathological evaluation of tumour margins was negative in 10 patients. During the follow-up, no recurrence or metastasis were detected in 8 patients, but 2 patients presented regional recurrence.

Conclusion The use of green-laser marking technique during laparoscopic partial cystectomy is a feasible manoeuvre in assisting the accurate incision and minimizing injury to the remaining bladder.

Keywords Muscle-invasive bladder cancer · Partial cystectomy · Green-laser · New technique

Introduction

Radical cystectomy plus neoadjuvant chemotherapy is the current standard treatment for muscle-invasive bladder cancer. However, the values of radical cystectomy are reduced due to its high surgical risks [1], high complication rates [2, 3], and poor quality of life [4]. Recently, interest in patient

quality of life has promoted a trend towards bladder-preserving treatment modalities, including transurethral resection of the bladder tumor (TURBT), modern external-beam radiation therapy (EBRT), chemotherapy, multimodality treatment (MMT), and partial cystectomy (PC).

Partial cystectomy (PC) is superior to the other modalities due to the en bloc removal of tumor masses, adequate incision margins, absence of residual tumors, and accurate tumor staging. In selected patients with bladder carcinoma, an open PC can be performed with similar results and lower morbidity than a series of radical cystectomies [5]. However, making a precise initial incision distant from the tumor can be challenging when no assistance technique is applied for the PC [5]. To achieve a precise incision and minimize injury to the remaining bladder, we introduce a novel green-laser marking technique, and provide our initial experience and early outcomes using this new technique for treatment of muscle-invasive bladder cancer.

Jinhai Fan, Kaijie Wu, Pu Zhang contributed equally to this publication.

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Materials and methods

Institutional review board approval was obtained to perform green-laser assisted laparoscopic PC in 10 patients between January 2014 and February 2018. Prior to the surgery, all patients were diagnosed by pelvic CT scans and cystoscopy accompanied with biopsy to confirm the diagnosis of bladder cancer. In addition, CT scans of the chest and abdomen were also performed for any metastases. The selection criteria were as follows: patients with no more than two solitary tumors outside the trigone of the bladder, patients with no metastase, patients with stage T2 or T3 disease, and patients with a strong desire to preserve the bladder. All procedures were performed by a single surgical team. Perioperative data, including the operation time, intraoperative blood transfusion, decrease in hemoglobin level, intraoperative complications, surgical margins, and postoperative length of hospital stay were recorded and descriptive analyses were used to determine the medians of the collected data. Tumor recurrence or metastases were reassessed through cystoscopy and pelvic CT scans at follow-up.

The surgical procedure was conducted as follows: with the patient under general anesthesia and in the lithotomy position, the transperitoneal approach was applied with

five ports, similar to the technique described for laparoscopic radical prostatectomy [6]. Standard pelvic lymph-node dissection was performed before green-laser assisted laparoscopic PC (Fig. 1a). The bladder was then mobilized to expose the tumor-bearing area.

A cystoscope was inserted into the bladder to identify the tumor, and under this direct view, the green-light laser incision was performed by surrounding the tumor at a 0.5–1 cm distance from the tumor edge (Fig. 1b). The incision was deepened until the fat tissue was reached (Fig. 1c). Occasionally, the operating plane was further extended to the satellite lesions, and the transurethral operation was performed under surveillance with a laparoscope to better determine the tumor location.

Along the pre-labeled border, the tumor and its satellite lesions could be easily distinguished by the tracing of the laser beam (Fig. 1d) and could be removed *en bloc* via a transperitoneal laparoscopy (Fig. 1e). All specimens were collected with an extraction pouch and subsequently removed. Closure was performed with continuous sutures using 2–0 V-Loc (Covidien) suture line (Fig. 1f). No urine leakage or bleeding was detected in the operative field. A tubular drain was placed in the vesical bed. A representative surgical procedure is shown in Online Resource-1.

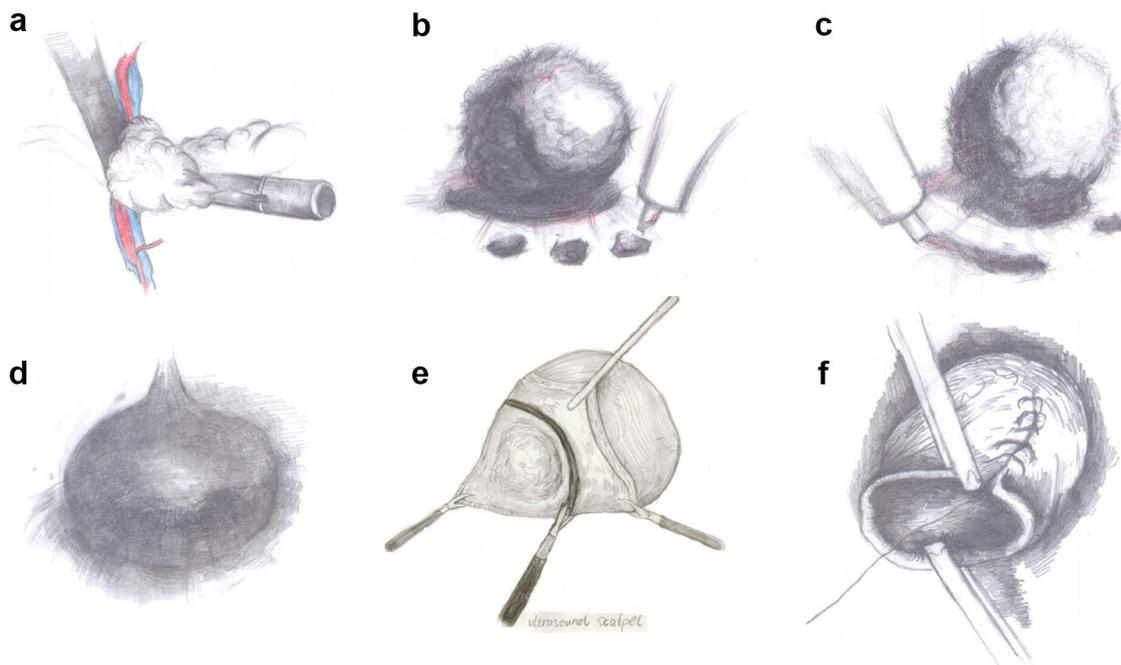


Fig. 1 Schematic diagram of surgical procedure. **a** Pelvic lymphadenectomy. **b, c** A laser-marked incision deepened into the fat tissue of bladder wall surrounding the tumour. **d** The tumour area could be

distinguished under surveillance with a laparoscope. **e** The tumour was *en bloc* removed along the pre-labeled border. **f** The bladder was sutured

Results

The green-laser marking laparoscopic PC was completed successfully in all 10 patients without open conversions. The median age of the patients was 61.5 (range 46–74) years with nine males and one female. The median score according to the POSSUM scoring system [7] was 15.5 (12–24). The American Society of Anesthesiologists physical status (ASA PS) classification was two in six patients, three in three patients, and one in one patient.

The characteristics of the tumors are shown in Table 1. Postoperative complications were all classified as Clavien–Dindo grade 2 for regular antibiotic use [8]. The median operation time was 270 (210–360) min, with a median decrease in the hemoglobin level of 11 (3–38) g/L. Blood transfusion was not required during the operation

for ant of the 10 patients. The median postoperative length of hospital stay was 8 (4–12) days.

In total, nine patients were diagnosed with high-grade transitional cell carcinoma without lymph-node metastases, and one patient was diagnosed with urachal carcinoma; the clinical stages were pT1 in 1 case, pT2 in 4 cases, and pT3 in five cases. The pathological evaluation of the tumor margins was negative in ten patients. All patients received the adjuvant radiotherapy. As shown in Fig. 2 (two representative CT and cystoscopy images of patients), during the follow-up period of 22 (2–52.5) months, no recurrence or metastases were detected in eight patients. However, two patients presented with regional recurrence: one patient presented with in situ tumor recurrence and was given chemotherapy, subsequent radiotherapy, and, finally, conservative therapy due to poor tolerance of the former two therapies; the other patient presented with newly developed recurrence

Table 1 The characteristics of tumours

Patient	Tumour size/mm	Tumour location	Tumour stage	Tumour grade	Pathology
1	28×28.7×29/19×8×14	Right lateral/apex	T2N0M0	High grade	TCC
2	24×22	Superior	T2N0M0	High grade	TCC
3	8×6×2/–	Superior/basal	T2N0M0	High grade	TCC
4	33×31×27	Superior	T3N0M0	High grade	TCC
5	28×17	Superior	T2N0M0	High grade	TCC
6	24×37	Posterior	T3N0M0	High grade	TCC
7	13×9	Left lateral	T3N0M0	High grade	TCC
8	57×28	Superior	T3N0Mx	–	Urachal carcinoma
9	23×7	Anterior	T1N0M0	High grade	TCC
10	32×20	Right lateral	T3N0M0	High grade	TCC

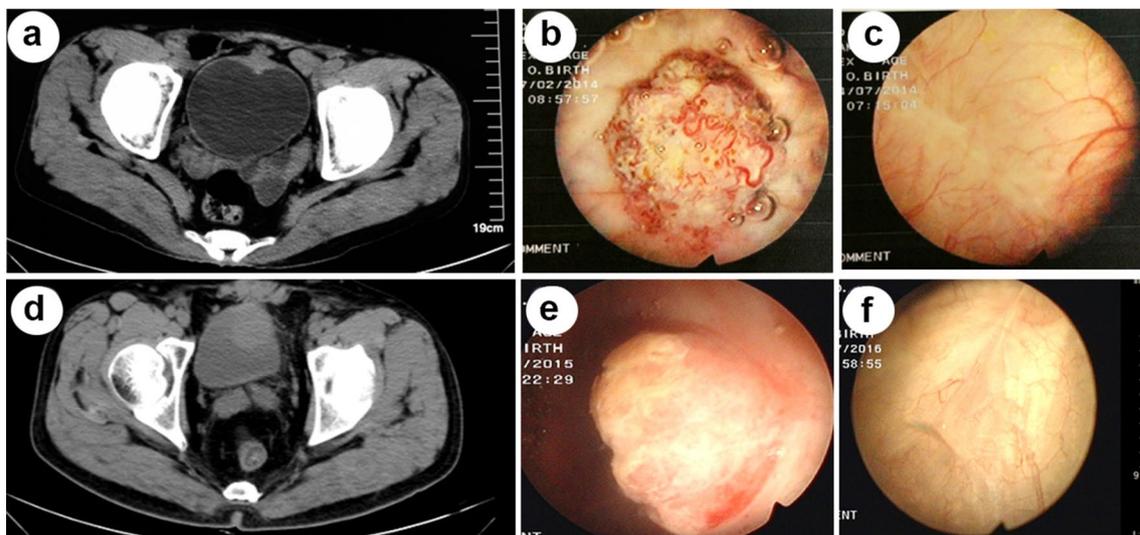


Fig. 2 Representative images of CT scans and cystoscopies. **a–c** Images of pelvic CT scan and cystoscopies before and after the surgery (patient 1, the tumour was located at the superior wall with the

size of 24×22 cm). **d–f** Images of pelvic CT scan and cystoscopies before and after the surgery (patient 2, the tumour was located at the superior wall with the size of 28×17 cm

originating from a pre-existing tumor lesion and was finally administered salvage cystectomy treatment. Currently, both patients are alive.

Discussion

In the classic PC procedures, making an initial incision distant from the tumor requires either palpation of the mass or previous knowledge of the tumor location. However, palpation is not efficient for patients who undergo TURBTs. Various techniques have been developed to precisely predict of tumor locations during PCs. The idea of using cystoscopic light to confirm the location of the tumors during surgery has been reported in a case of a patient with endometriosis [9]. Gofrit expanded this idea to the bladder cancer [10], and applied light via a flexible cystoscope pointed toward one edge of the planned elliptical resection area around the tumor, which avoided performing a cystotomy. Kim introduced the India-ink marking technique into the PC procedure [11]. Using India-ink, tattooing was performed 1 cm away from the outer margin of the lesion with adequate depth into the deep muscle layer. The tattooed area could be identified under laparoscopic vision. However, India-ink diffused into and invaded adjacent areas, and thus, a second injection was required [11].

Lasers have been widely used to treat multiple urologic disorders, including bladder cancer [12–13]. The green-light laser (532 nm) is a recent invention, and deemed a good fit for soft-tissue photovaporization due to its steadily delivered energy, "photoselective vaporization", and hemostatic function. In our previous study, we applied a green-light KTP Laser to en bloc enucleate non-muscle-invasive bladder cancer. In this study, we are the first group to apply this green-light laser to mark the initial incision of PC. Our modified marking technique does not involve contact during the operation and avoids the obturator nerve reflex, and offers a better laparoscopic vision due to the physical nature of the laser. In addition, our technique will not only assist with the accurate incision into and minimize injury to the remaining bladder, but also provide an accurate evaluation of tumor stage and lymph-node metastases.

In this study, two patients with two solitary muscle-invasive tumors experienced disease recurrence after less than 5 years follow-up, which was similar to the results reported by Kassouf in 37 patients who underwent PCs [14]. However, our experience indicated that green-laser assisted laparoscopic PC was not adaptable for patients with multifocal diseases (defined as tumors in two or more sites), because patients with were at a shigh risk of disease recurrence [15].

In addition, this technique will not be a preferred option for tumors located at the lateral wall, because the bladder is cushioned from the pelvic sidewall by perivesical

fat and loose connective tissue, where the lateral pedicles and branches of the vesical blood supplies are located. To minimize blood loss and adequately expose the resection area, the lateral pedicles should be divided, which would increase the difficulty and risks of the surgery. Therefore, our technique is mainly recommended for lesions located on the superior and posterior walls of the bladder [16].

One critical limitation is that the study had a small sample size and no long-term results. A further study is ongoing, which will include additional cases, and the follow-up period will be prolonged to determine the safety and effectiveness of the procedure.

Conclusion

To achieve precise incisions in PCs, we describe a novel modified technique of green-laser assisted laparoscopic PC. The technique was successful in our small number of cases. The modified technique is a feasible maneuver that assists in planning the incision and minimizes injury to the remaining bladder. The safety and effectiveness of this technique will be further evaluated. Additional cases and longer follow-up times are needed for adequate comparisons among techniques.

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Compliance with ethical standards

Conflicts of interest The authors declare that they have no conflict of interest.

Statement of human rights All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki Declaration and its later amendments.

Informed consent Informed consent was obtained from all individual participants included in the study.

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