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NEW TECHNOLOGY

Fascial space priority approach for laparoscopic total pelvic exenteration in patients with locally advanced rectal cancer

Yi Sun[1] · Hongjie Yang[1] · Zhichun Zhang[1] · Jian Li[2] · Hao Wei[2] · Peng Li[1] · Yuanda Zhou[1] · Qingsheng Zeng[1] · Chen Xu[1] · Xipeng Zhang[1]

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Abstract

Background Total pelvic exenteration (TPE) with intent to achieve a pathological R0 resection is now considered as the only chance of a long-term survival for locally advanced rectal cancer (LARC) invading into adjacent organs. Lately, laparoscopic total pelvic exenteration (LTPE) is performed and achieved in several specialized centers and showed a promising application prospect. Although this is universally realized by surgeons, there are only few specialized centers to perform this complex surgery, due to concerns about the high morbidity and mortality. The techniques associated need to be disclosed and facilitated.

Objective The aim of this article is to introduce a fascial space priority approach for laparoscopic TPE step by step (with video).

Methods We describe here a fascial space priority approach for LTPE in highly selected patients with locally advanced rectal cancer. The main principle of this approach is that all of the pelvic organs are considered as a whole, the non-vascular spaces surrounding it are separated in the first place, the vascular pedicle and nerve pedicle of pelvic organs can be isolated and then transected precisely. Meanwhile, the associated key landmarks of this approach are disclosed (see the video).

Results The ureterohypogastric nerve fascia (UHGNF) and the vesicohypogastric fascia (VHGF) are two vital embryological planes on the lateral compartment of pelvis. The spaces on either side of them together with the retrorectal space, the space of Retzius, are all non-vascular spaces, and dissection of these spaces in LTPE surgery can be achieved simply and practicably. The ureter, the umbilical artery, the arcus tendinous fasciae pelvis (ATFP), piriformis and the puboprostatic ligament (PPL) are all important landmarks during surgery. Step-by-step illustration with precise anatomical landmarks in the present video may lead to less intraoperative blood loss and complications.

Conclusions LTPE with fascial space priority approach might be a standard surgical procedure for total pelvic exenteration with clear anatomy and reduced blood loss.

Keywords Total pelvic exenteration · Fascial space priority approach · Laparoscopy · Rectal cancer

For patients with locally advanced rectal cancer (LARC) infiltrating adjacent organs, pelvic exenteration (PE) with intend to achieve histological R0 margins might be the only chance of a long-term survival [1, 2]. According to current data, a promising survival after PE is achievable in more than 50% of selected patients with locally advanced or recurrent pelvic malignancies [3]. The oncological role of total pelvic exenteration (TPN) for LARC infiltrating prostate or urinary tract in male patients is now well established [4]. However, TPN is a complex major surgery, which needs multidisciplinary collaboration, usually associated with significant complications. Cross-disciplinary skills are mandatory to this operation; surgeons who specialized in colorectal disease often hesitate to perform this procedure due to lack of a holistic understanding of pelvic anatomy especially relating to urology and gynecology. Therefore, the technique needs to be disclosed, which is the purpose of this story. After developing detailed cadaver autopsies, we adopted the fascial space priority approach for TPE that

✉ Xipeng Zhang
zhangxipeng@vip.tom.com

[1] Department of Colorectal Surgery, Tianjin Union Medical Center, Tianjin 300000, China

[2] Department of Urological Surgery, Tianjin Union Medical Center, Tianjin 300000, China

has been accomplished successfully in our institute. Fascial space priority approach means to separate the non-vascular spaces surrounding the tumor and the organs involved in the first place, which is beneficial to further determine the resectability and better display the anatomy of the organs; thus, the safety of the operation could be improved. We present here a surgical video of laparoscopic total pelvic exenteration (LTPE) with fascial space priority approach, and the surgical procedures and associated key landmarks of this approach are fully demonstrated.

Surgical technique

After general anesthesia, the patient was placed in a modified lithotomy position with shoulder support and small bolster under the patient's buttocks. Then, a temporary urinary catheter was inserted. Placement of trocars (three 12 mm and two 5 mm) are shown in Fig. 1. Camera port was set at the umbilicus. The operator's position switched from left to the right side of the patient when operating in the right and the deep narrow pelvic. After bowel repositioning, dissection of rectosigmoid in a medial-to-lateral way was performed. The inferior mesenteric artery (IMA) was ligated and transected at its origin. The inferior mesenteric vein (IMV) was cut at a relative higher level, and the No.253 lymph nodes (lymph nodes along the root of inferior mesenteric artery) were resected at the same time. The detailed procedure was introduced in our previous article [5].

Then, the pelvic organs including the bladder, prostate, seminal vesicle, and rectum were treated as a whole organ; the non-vascular spaces surrounding it were fully dissected in a fascial space priority approach step by step.

Step 1: dissection of the retrorectal space

The retrorectal space is a non-vascular space that the colorectal surgeons have well mastered, so-called angle's hair. This space is entered and dissected sufficiently till the superior fascia of levator ani. During this procedure, the inner side of the ureterohypogastric nerve fascia can be isolated.

Step 2: dissection of the lateral pelvic fasciae

The lateral pelvic fasciae include the ureterohypogastric nerve fascia (UHGNF) and the vesicohypogastric fascia (VHGF). First of all, the ureter should be identified after incision of the peritoneum along the surface of the iliopsoas. Then, it is used as a landmark to dissect the non-vascular space between the UHGNF and the lymphoid adipose tissues surrounding the internal iliac vessels. With the enlarged view of the laparoscopy, this space is easy to identify. Few small vessels suppling the ureter can be coagulated and transected with an ultrasound knife. This space should be dissected sufficiently till the uterine artery crosses (females) or superior vesicle artery crosses (males) caudally and sacral fascia dorsally. Then, the umbilical artery could be identified and used as a landmark to dissect the space between the VHGF and the obturator lymphatic adipose tissues; this is also a non-vascular space. The space could be dissected sufficiently till the arcus tendinous fasciae pelvis (ATFP).

Note: With sufficient display of these two fasciae, the vascular pedicle and the nerve pedicle of pelvic organs were isolated (Fig. 2). Then, the nerves could be easily dissected from the root, and the vascular of pelvic organs could be transected one by one at their origin. Meanwhile, the NO.263D lymph nodes (lymph nodes along the internal

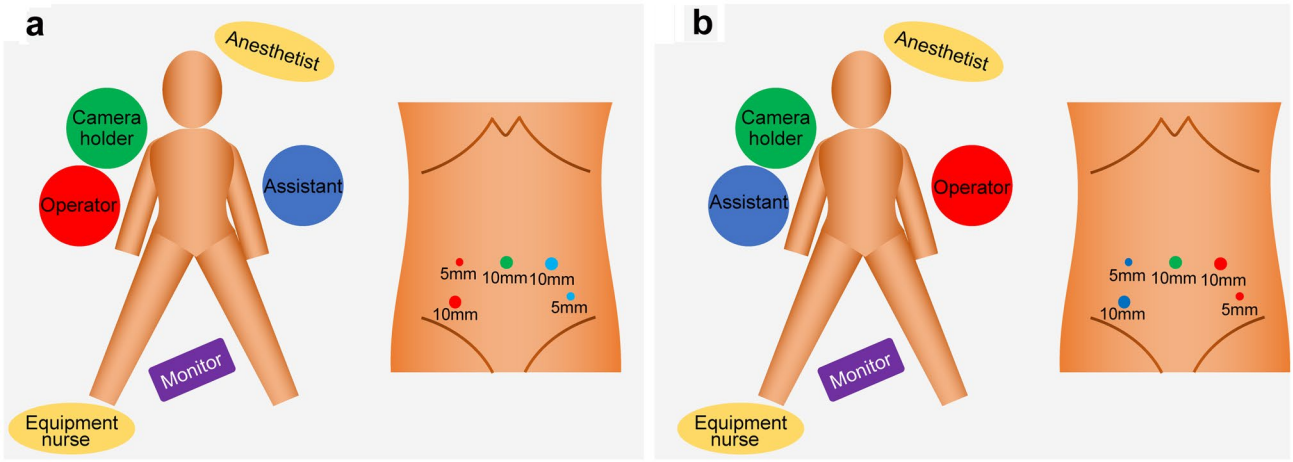

Fig. 1 Trocar placement and the positions of the operator and the assistants. The operator's position switched from left **a** to the right side of the patient **b** when operating in the right pelvic and in the deep narrow pelvic

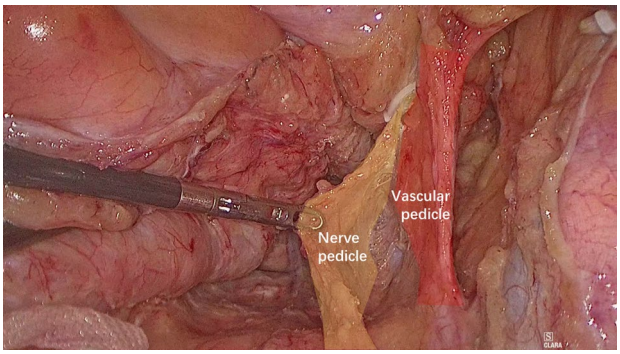

Fig. 2 The isolated vascular pedicle and nerve pedicle on the right

iliac artery visceral branches) were collected along with the vascular of pelvic organs. If systemic lateral lymph nodes dissection (LLND) is required, the third non-vascular space of the lateral pelvic compartment, that is the space between the parietal pelvic fascia and obturator lymph nodes, need to be separated, then the NO.283 lymph nodes (obturator lymphatic adipose tissue) and the NO.263P lymph nodes (lymph nodes along the main trunk of the internal iliac artery) were cleared away en bloc along with the specimen (Fig. 3).

During this procedure, arcus tendineus fasciae pelvis (ATFP) is an important landmark, and it should be fully exposed. In this patient we present here, his left ATFP was adhered to the tumor. To achieve a R0 resection, part of the coccygeal muscle and internal obturator muscle were resected. The other important landmarks are piriformis and internal pudendal artery (IPA); piriformis involved means unresectability of the tumor or higher risk of sciatic nerve injury. Fully Reveal of IPA is mandatory for a systemic LLND: this was introduced in our previous article [6].

Step 3: dissection of space of Retzius

The pace of Retzius is another well-recognized non-vascular space. By fully dissection of this space, the bladder could be mobilized from the abdominal wall till the puboprostatic ligament (PPL), which continues with the ATFP (Fig. 4), was revealed. After both sides of PPL are cut, the dorsal veins complex (DVC) can be revealed, coagulated, and clipped, and the Urethra was then cut with ultrasound knife. Thus, the laparoscopic separation is accomplished.

The en bloc specimen is removed through the perineal incision, the final surgical field and the specimen are shown in Fig. 5.

Discussion

Five percentage to ten percentage of new diagnosed cases of rectal cancer are confirmed as LARC at their presentation [7]. Preoperative chemoradiotherapy has been recommended as a standard treatment. Although neoadjuvant therapy has been shown to be helpful in tumor downstage and local control [8], surgery beyond the total mesorectal excision (TME) plane is mandatory in order to achieve a complete resection margin(R0), which is the single greatest predictor for a long-time survival [9, 10]. Partial resection of involved organs, such as prostate shaving for patients with prostate infiltration that may raise concern about positive margins and higher recurrence rate [11]. It is worth mentioning that, half of the recurred rectal cancer was locoregional disease only. Total pelvic exenteration (TPE) with intent to achieve a pathological R0 resection may promise a long-term survival for patients with LARC invading into adjacent organs. Although

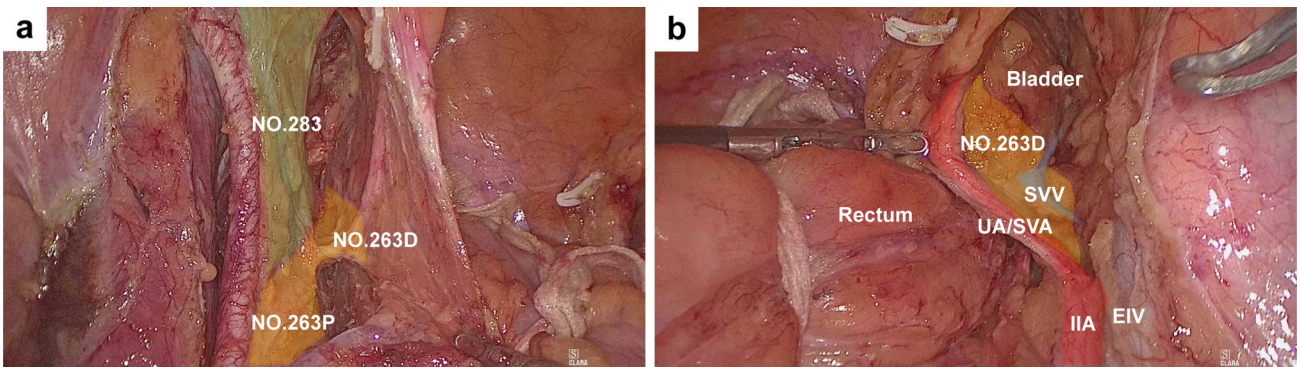

Fig. 3 The lymph nodes harvested in both sides. **a** During systemic LLND on the left side of pelvic, NO.283, NO.263D, and NO.263P lymph nodes were harvested. **b** Only NO.263D lymph nodes were harvested on the right side of pelvic. *UA/SVA* umbilical artery and superior vesical artery, *SVV* superior vesical vein, *IIA* internal iliac artery, *EIA* external iliac artery

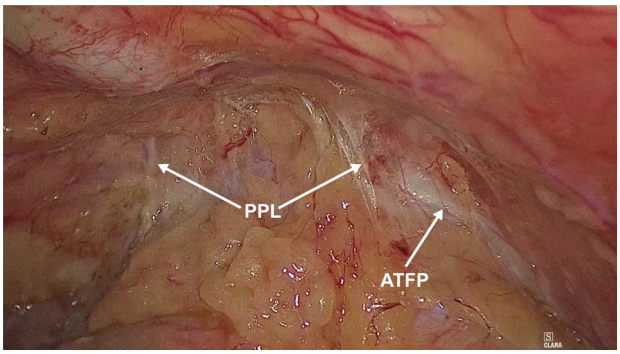

Fig. 4 Landmarks during surgery. PPL: puboprostatic ligament; ATFP: arcus tendineus fasciae pelvis

this is universally realized by surgeons, there are only few specialized centers to perform this complex surgery, due to concerns about the high complication rate. The techniques associated need to be disclosed and facilitated. Since the benefits of laparoscopy have been proven, with optimized visualization [12], meticulous sharp dissection deep in the narrow pelvic is possible. On the other hand, our team is an experienced surgical team and proficient in laparoscopic surgery, and our center is a tertiary care center, we progressed to minimally invasive TPN since the year 2016.

The main advantage of the fascial space priority approach for LTPE is that priority is given to the separation of the non-vascular spaces so as to preferential control of the vascular pedicle, which makes the surgery much safer. Intraoperative blood loss is remarkable less than the previous reports [13–15], preferential control of the vascular pedicle, minimally invasive surgery and properly selected patients [16] may contribute to it.

During TPE, ATFP is a vital intraoperative key landmark, with fully reveal of it, the external aspect of the vascular pedicle is isolated and the relationship of the tumor and the pelvic sidewall can be evaluated. ATFP is a dense connection between the pelvic organs and the pelvic side wall. During TPE, bilateral ATFP should be cut open to meet the levator ani muscle. At the same time, anteriorly, ATFP continues with the puboprostatic ligament (PPL), with dissection of bilateral PPL, the deep dorsal venous (DVC) plexus can be clearly exposed. The right ATFP of this patient was normal, while the left ATFP was involved; the lateral lymph nodes enlarged on the left lateral pelvis (in need of performing lateral lymph node dissection) while normal on the right, with different status of both sides, is good for presenting the benefit of the fascia space priority approach. The other important landmarks are piriformis and IPA; piriformis involved means unresectability of the tumor or a higher risk of sciatic nerve injury. Revealing of IPA fully is mandatory for a systemic LLND.

One of the limitations of a fascial space priority approach is that it is suitable to be performed in highly selected patients with anteriorly or anterior-laterally infiltration, but not suitable for the cases with sacral involvement.

This video is accompanied with narration and illustration to disclose the main steps and important anatomical landmarks of the procedure clearly and precisely qualified educational value. Some tips for laparoscopic TPN are as follows: All of the pelvic organs are treated as a whole; non-vascular spaces surrounding it are dissected at the first place; the vascular pedicle and nerve pedicle are isolated and transected; and important landmarks should be fully revealed during the procedure.

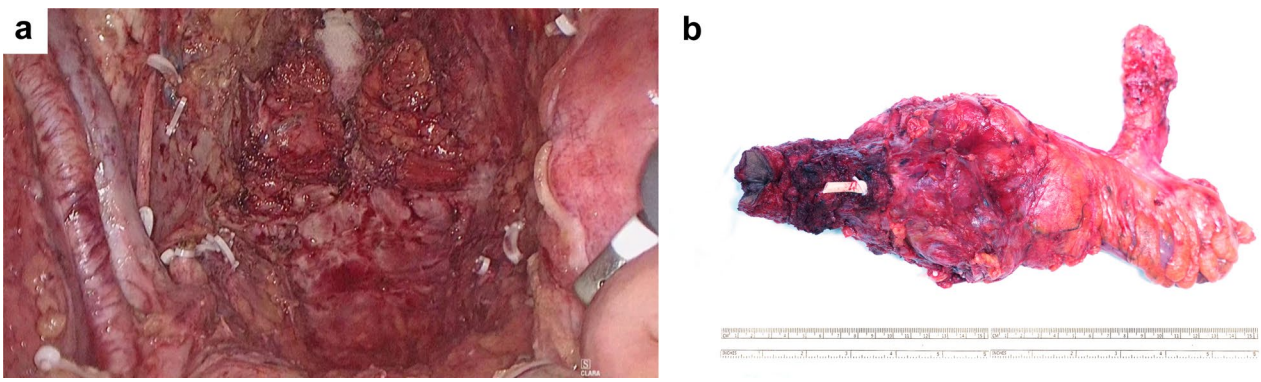

Fig. 5 Ultimate surgical field (**a**) and en bloc specimen (**b**)

Conclusions

LTPE with fascial space priority approach might be a standard surgical procedure for total pelvic exenteration with clear anatomy and reduced blood loss.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s00464-022-09216-8.

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Declarations

Disclosures Yi Sun, Hongjie Yang, Zhichun Zhang, Jian Li, Hao Wei, Peng Li, Yuanda Zhou, Qingsheng Zeng, Chen Xu, and Xipeng Zhang have no conflict of interest or financial ties to disclose.

Ethical approval All human studies have been reviewed by the appropriate ethics committee and have therefore been performed in accordance with the ethical standards laid down in an appropriate version of the 1965 Declaration of Helsinki.

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