

A New Surgical Technique of Laparoscopic Retrograde Inguinal Lymph Node Dissection: Our Initial Experience

Qinxin Zhao

Department of Urology,National Center/National Clinical Research Center for Cancer/Cancer Hospital, Chinese Academy of Medical Sciences and Peking Union Medical College

Hu Han

Department of Urology,Beijing Chaoyang Hospital,Capital Medical University

Hongen Lei

Department of Urology, Beijing Chaoyang Hospital, Capital Medical University

Yajian Li

Department of Urology\National Cancer Center/National Clinical Research Center for Cancer/Cancer Hospital,Chinese Academy of Medical Sciences and Peking Union Medical College

Long Tian

Department of Urology, Beijing Chaoyang Hospital,Capital Medical University

Nianzeng Xing (✉ xingnianzeng@126.com)

National Cancer Center/National Clinical Research Center for Cancer /Cancer Hospital, Chinese Academy of Medical Sciences and Peking Union Medical College

Research article

Keywords: Penile cancer , Scrotal Paget's disease\ Laparoscope\ retrograde \ Inguinal lymph node dissection

Posted Date: September 15th, 2020

DOI: <https://doi.org/10.21203/rs.3.rs-67723/v1>

License:  This work is licensed under a Creative Commons Attribution 4.0 International License.
[Read Full License](#)

Abstract

Background To explore the clinical efficacy of a new laparoscopic inguinal retrograde lymph node dissection (LND) in treating penile cancer and scrotal Paget's disease.

Methods 12 patients with penile cancer and 1 with scrotal Paget's disease admitted and treated with laparoscopic retrograde inguinal LND in two medical centers from July 2018 to September 2020 were retrospectively analyzed. Thereafter, the basic clinical data, operation time, intraoperative blood loss, number of harvested lymph nodes and postoperative complications were evaluated.

Results 13 patients were performed laparoscopic retrograde inguinal LND successfully under general anesthesia. Among them, 4 cases received pelvic lymph node dissection (PLND) simultaneously through the same incision. The operation time was (220.00 ± 33.73) min, and the intraoperative blood loss was (15.38 ± 13.76) ml. (8.92 ± 4.00) lymph nodes were harvested in the left groin, (8.54 ± 5.04) lymph nodes were dissected in the right groin. Meanwhile, (5.00 ± 1.00) lymph nodes were harvested in the left pelvic cavity, and (8.50 ± 6.46) lymph nodes were dissected in the right pelvic cavity. All the 13 cases were successfully operated without conversions to open surgery. One case developed mild blister in subcutaneous skin, two had mild lower limb swelling, and one had lymph leakage; all these patients recovered favorably after symptomatic treatment, with no other surgery-related complications. The drainage tube removal time lasted for (13.23 ± 3.83) days. The postoperative follow-up time ranged from 2.5 to 19.5 months, and no primary lesion, inguinal or pelvic lymph node relapse or metastasis was reported.

Conclusion Laparoscopic retrograde inguinal LND can be applied to treat penile cancer and scrotal Paget's disease, and it is safe and effective. Moreover, inguinal LND and PLND can be performed through the same incision, which is worthy of being promoted in clinic.

Background

Penile cancer and scrotal Paget's disease are the two rare malignant tumors in the male urogenital system, and the most common metastatic site is inguinal lymph node, while lymph node metastasis (LNM) usually predicts the poor prognosis [1]. Therefore, inguinal lymph node dissection (LND) is recommended after local treatment for the primary lesion, when there is LNM or a high risk of LNM [2]. However, the traditional open inguinal LND is associated with severe complications, such as wound infection, skin necrosis, lymphocyst and lymphedema[3]. To reduce the incidence of complications, clinicians have improved various techniques, but the postoperative complication rate remains high [4].

With the development and progresses of laparoscopy, laparoscopic inguinal LND has been well developed in recent years. Several studies suggest that, laparoscopic inguinal LND has fewer complications and markedly lower incidence than open surgery [5–6]. Nonetheless, the traditional trans-huckle subcutaneous approach inguinal LND is also linked with certain limitations; for instance, the puncture channel should be reconstructed in the case of pelvic lymph node dissection (PLND). Therefore, this paper introduced a new technique, namely, the trans-hypogastrium subcutaneous approach laparoscopic retrograde inguinal LND.

We retrospectively analyzed the clinical data from 10 penile cancer cases and 1 scrotal Paget's disease case admitted and treated at the department of urology, Beijing Chaoyang Hospital, Capital Medical University and Cancer Hospital, Chinese Academy of Medical Sciences from July 2018 to September 2020. All patients had received laparoscopic retrograde inguinal LND, and favorable clinical outcomes were achieved after surgery, as reported below.

Methods

1.1 Basic clinical data

A total of 13 cases were enrolled, including 12 with penile cancer and 1 with scrotal Paget's disease. The age of patients ranged from 38 to 83 years, with the average of (58.85 ± 13.32) years; and the body mass index (BMI) ranged from 18.94 to 34.89 kg/m², with the average of (25.02 ± 3.89) kg/m². Resection of the primary focus was performed in 13 cases and pathological analysis was carried out. Postoperative pathology suggested that 4 with highly differentiated squamous carcinoma cases, 1 with moderately differentiated squamous carcinoma, 4 with highly-moderately differentiated squamous carcinoma, 2 with moderately-lowly differentiated squamous carcinoma, 1 with verrucous carcinoma accompanying with condyloma acuminata, and 1 with skin invasive adenocarcinoma accompanying with Paget's disease. Preoperative physical examination or auxiliary examination revealed inguinal lymph node enlargement, among them, 4 cases had pelvic lymph node enlargement (Table 1).

Table 1
Demographic and clinicopathologic characteristics of all 13 patients

Number of cases	Age/years	BMI#/kg·m ²	Clinical Diagnosis	Pathology of primary lesion	Surgical methods for primary lesions
1	38	26.22	Penile Cancer	Verrucous carcinoma accompanying with condyloma acuminata	Excision of penile tumor and penile reconstruction
2	70	25.76	Penile Cancer	Squamous cell carcinoma	Excision of penile mass + urethroplasty
3	58	27.92	Penile Cancer	Squamous cell carcinoma	Excision of penile mass + urethroplasty
4	59	22.86	Penile Cancer	Squamous cell carcinoma	Excision of penile mass + urethroplasty
5	75	23.66	Penile Cancer	Squamous cell carcinoma	Excision of penile mass + urethroplasty
6	68	28.37	Scrotal Paget's disease	Skin invasive adenocarcinoma accompanying with Paget's disease	Excision of penile mass + urethroplasty
7	53	23.40	Penile Cancer	Squamous cell carcinoma	Excision of penile mass + urethroplasty
8	38	24.21	Penile Cancer	Squamous cell carcinoma	Excision of penile mass + urethroplasty
9	64	23.67	Penile Cancer	Squamous cell carcinoma	Excision of penile mass + urethroplasty
10	49	34.89	Penile Cancer	Squamous cell carcinoma	Excision of penile mass + urethroplasty
11	52	18.94	Penile Cancer	Squamous cell carcinoma	Excision of penile mass + urethroplasty
12	58	21.45	Penile Cancer	Squamous cell carcinoma	Excision of penile mass + urethroplasty
13	83	23.95	Penile Cancer	Squamous cell carcinoma	Excision of penile mass + urethroplasty

BMI=body mass index

1.2 Surgical method

1.2.1 Patient position and trocar location

The patients were given general anesthesia through tracheal intubation and were in supine position, their heads were 15° higher than their feet, the hips were raised, bilateral lower limbs were subjected to extorsion and abduction for 15°, and the bilateral upper limbs were adducted beside the trunk. After skin preparation in the abdomen and vulva, the catheter was indwelt. A 2-cm longitudinal incision was made below the umbilicus, the skin was then cut open, the superficial fascia (Camper fascia) was isolated to the deep fascia (Scarpa fascia), the vessel forceps were used for blunt dissection between these two layers, and the balloon was used to dilate this space downward. Then, a 10-mm cannula was indwelt in this incision, and then the laparoscope was placed. Later, the 10-mm Trocar was placed at the midpoint between the umbilicus and the pubis, while two 5-mm Trocar were placed at the midpoints between the left and right anterior superior iliac spines and the umbilicus (bilateral inguinal LND) (Fig.1).

1.2.2 Surgical procedure

The space between Camper fascia and Scarpa fascia was dissociated; to be specific, the right inguinal lymph nodes were dissociated first with the bipolar electrocoagulation machine in the left hand and the ultrasonic scalpel in the right hand, the upper boundary reached 2 cm above the inguinal ligament, while the lower boundary was the tip of the femoral triangle—the lateral border is the medial edge of the sartorius muscle, and the medial border is the lateral edge of the long adductor muscle. Then, the lymph nodes were completely dissected, and the surrounding fat tissues were also dissected to sufficiently expose the local site; the great saphenous vein, femoral vein and femoral artery were identified in the femoral triangle through exposing the fascia lata behind the saphenous-femoral junction, then the surrounding lymphatic fat tissues were raised and dissociated towards the tip of femoral triangle; the great saphenous vein, superficial iliac circumflex vein, medial femoral vein, lateral femoral vein, external pudendal vein and superficial epigastric vein were protected (Fig.2E); finally, the superficial inguinal lymphatic tissues in the femoral triangle were dissected. Later, the groin was opened along the femoral artery sheath, the deep inguinal lymph nodes were isolated and dissected, and femoral artery, femoral vein and femoral nerve were protected. Similarly, the left inguinal lymph nodes were dissected according to the same method. The pneumoperitoneum pressure was reduced, and no bleeding was observed in the surgical field; and then the lymphatic tissue specimens were labeled and dissected in succession. Bilateral inguinal drainage tubes were indwelt through the bilateral Trocar points, the vacuum drainage bottles were connected; finally, the incision and skin were sutured.

In the case of concurrent PLND, the original puncture channel was isolated by the vessel forceps to the extraperitoneal space after bilateral inguinal LND, Trocar was placed again into the extraperitoneal space, and the surrounding pelvic lymph nodes were isolated along the external iliac blood vessel.

1.3 Postoperative treatment and follow-up

After surgery, the groin was applied compression with elastic bandage, the inguinal drainage tube maintained vacuum drainage, and the drainage tube was removed when the drainage amount was < 40 ml for three consecutive days. After discharge, the patients were paid for regular clinic follow-up or received subsequent treatment.

Results

2.1 Surgery-related data

All the 13 patients successfully received laparoscopic retrograde inguinal LND under general anesthesia, among them, 4 received concurrent PLND. Among these patients, 3 cases had invaded subcutaneous connective tissue (T1 stage), 4 had infiltrative corpus spongiosum penis (T2 stage), and 3 had invaded the whole-layer (T3 stage); 1 invaded other adjacent tissues. Meanwhile, 7 cases were at N0 stage, 0 at N1 stage, 1 at N2 stage, and 4 at N3 stage, and 1 had distant metastasis (M1 stage). The operation time was (220.00±33.73) min, which ranged from 155 to 280 min; and the intraoperative blood loss was (15.38±13.76) ml, with the range of 5-50 ml. (8.92±4.00) lymph nodes were harvested in the left groin, with the range of 4-17; (8.54±5.04) lymph nodes were dissected in the right groin, with the range of 4-21; meanwhile, (5.00±1.00) lymph nodes were harvested in the left pelvic cavity, with the range of 4-6; and (8.50± 6.46) lymph nodes were dissected in the right pelvic cavity, with the range of 1-16 (Table 2).

Table 2
Perioperative and pathological results of 13 patients

Number of cases	Operation Method	Operation Time/	Bleeding Volume/	Number of postoperative lymph node dissection (positive / total)	Pathological Stage
		min	ml		
1	Laparoscopic bilateral inguinal lymph node dissection	230	20	Left groin 0/11 Right groin 0/8	TaN0MO
2	Laparoscopic bilateral inguinal lymph node dissection	240	30	Left groin 0/4 Right groin 0/11	T1aN0MO
3	Laparoscopic bilateral inguinal lymph node dissection+ pelvic lymph node dissection	280	30	Left groin 0/13 Right groin 0/8 Left pelvic cavity 0/6 Right pelvic cavity 0/11	T1aN0MO
4	Laparoscopic bilateral inguinal lymph node dissection	250	15	Left groin 0/10 Right groin 1/21	T2N2MO
5	Laparoscopic right inguinal lymph node dissection	185	5	Right groin 0/5	T3N0MO
6	Laparoscopic bilateral inguinal lymph node dissection	230	5	Left groin 2/10; Right groin 3/11	-
7	Laparoscopic bilateral inguinal lymph node dissection	210	10	Left groin 0/6; Right groin 0/10	T2N0MO
8	Laparoscopic bilateral inguinal lymph node dissection	220	50	Left groin 6/10; Right groin 8/10	T4N3M1
9	Laparoscopic left inguinal lymph node dissection+ pelvic lymph node dissection	250	10	Left groin 5/11 Left pelvic cavity 2/4; Right pelvic cavity 0/16	T3N3MO
10	Laparoscopic bilateral inguinal lymph node dissection	200	5	Left groin 1/6; Right groin 1/4	T3N3MO
11	Laparoscopic bilateral inguinal lymph node dissection	230	5	Left groin 2/17; Right groin 3/11	T1bN0MO
12	Laparoscopic bilateral inguinal lymph node	155	5	Left groin 0/4; Right groin 0/4	T2N0MO

	dissection+ pelvic lymph node dissection			Left pelvic cavity 0/6; Right pelvic cavity 0/6	
13	Laparoscopic bilateral inguinal lymph node dissection+ pelvic lymph node dissection	180	10	Left groin 3/5; Right groin 2/8 Left pelvic cavity 0/4; Right pelvic cavity 0/1	T2N3M0

2.2 Postoperative follow-up

All the 13 cases had successfully received surgery, among them, 1 developed mild blister in subcutaneous skin, 2 had mild lower limb swelling, and 1 had lymph leakage; all these patients recovered favorably after symptomatic treatments (dressing change, elevation of the affected limb, wearing stretch socks, and low-fat diet), with no other surgery-related complications. The drainage tube removal time lasted (14.55±6.03) days, with the range of 7-26 days. The drainage tube removal time (13.23±3.83) days, ranging from 7 to 20 days. The postoperative follow-up time ranged from 2.5 to 19.5 months, and no primary lesion, inguinal or pelvic lymph node relapse or metastasis was reported (Table 3).

Table 3
Postoperative follow-up data of 13 patients

Number of cases	Duration of drain/ days	Follow-up time/ months	Postoperative complications	Treatment of postoperative complications
1	14	9	None	None
2	20	10	Lymph leakage	None
3	18	9	Mild blister in subcutaneous skin	Change dressing
4	16	8	Mild lower limb swelling	Raise the affected limb and take the medicine orally
5	10	6	None	None
6	16	6	None	None
7	14	3	None	None
8	15	2.5	Mild lower limb swelling	Raise the affected limb and take the medicine orally
9	13	19.5	None	None
10	10	13	None	None
11	7	11	None	None
12	9	10	None	None
13	10	10	None	None

Discussion

Penile cancer is a rare disease, its precise etiology remains unclear, and its risk factors mainly include poor hygiene practices, redundant prepuce, phimosis and long-term stimulation of smegma [7]. Extramammary Paget's disease is also a rare skin cancer that is mainly observed in the elderly, and it mostly occurs in the vulva and male genital organ; in clinic, it is usually misdiagnosed as dermatitis or eczema of scrotum, thus delaying treatment [8]. The primary lesion is mainly treated by surgical resection, and the surgical resection scope depends on the tumor size, infiltration depth, and the involvements of penis and surrounding tissues; theoretically, negative incisal margin should be guaranteed [9].

Regional lymph node metastasis (LNM) or not, the metastasis degree, and radical resection are the determinants that affect its survival rate. Some research suggests that, the postoperative 5-year survival rate of patients with no regional LNM reaches as high as 95%-100%, while that reduces to 80% in the

presence of a single inguinal LNM, to 50% in the presence of multiple inguinal LNM, and to 0% in the case of pelvic or peripheral LNM [10]. Inguinal LNM is the first metastatic region of penile cancer and scrotal Paget's disease, and about 20%-40% cases have LNM [11]. It is indicated in research that, inguinal LND prior to PN3 stage LNM is of curative effect, which can cure about 80% micro-metastatic cases [12]. Therefore, inguinal LND plays an important role in its treatment, which is a vital indicator that affects patient prognosis and survival rate [12]. For patients with LNM upon preoperative physical examination or imaging examination, inguinal LND should be carried out aggressively. Additionally, for patients with no LNM but are at high risk of micro-metastasis (\geq low differentiation (grade G3 and above); \geq stage T2 and above; \geq tumor with vascular and lymphatic infiltration), preventive inguinal LND is suggested [13]. Numerous studies demonstrate that, compared with delayed LND, preventive bilateral LND enhances the survival rate of patients with impalpable inguinal lymph nodes [13–15].

However, research indicates that, the traditional open inguinal LND is linked with obvious complications, such as wound infection, skin necrosis, lymphocyst, and lymphedema; the incidence rate is over 50%, which has restricted its clinical application [16].

To reduce the incidence of complications, clinicians have performed various technical improvements, such as reservation of great saphenous vein, prevention of sartorius displacement, dynamic sentinel lymph node biopsy and improved LND, and reduction in the anatomic vision. Nonetheless, these improved techniques may omit micro-metastasis, which may lead to considerable false negative rate and endanger the oncologic control. Additionally, the postoperative complication rate remains high, which ranges from 26.7–38.9% [17–19].

To reduce the incidence of open radical LND without affecting oncologic outcomes, minimal-invasively technique of laparoscopic inguinal LND emerges. This technique was first reported by Bishoff et al. in 2003; in 2006, Tobias-Machado further developed and applied laparoscopic inguinal LND in clinic, and the 0% skin morbidity and 20% overall morbidity were reported [20]. Since the introduction of VEIL, different institutions have shared their experience in using this technique, which suggest that VEIL is a safe and effective minimally-invasive method. Kumar et al. [21] compared the complications and oncologic outcomes between video endoscopy inguinal lymphadenectomy (VEIL) and open inguinal lymphadenectomy (OIL) in treating carcinoma of penis in males. Their results found that VEIL was an oncologically safe surgery, which was linked with rather low incidence (especially for leg swelling-related complications) and shortened length of stay. Russell et al. [22] retrospectively analyzed 34 patients with penile cancer undergoing endoscopic inguinal LND, analyzed and assessed the harvested lymph nodes, related perioperative indexes and postoperative complications. Their results discovered that, from the technical perspective, VEIL was feasible, and it was comparable to the open surgery in terms of the number of harvested lymph nodes. Importantly, compared with OIL, VEIL was advantageous in the reduced complication rate and rapid recovery. In our study, among those 11 patients receiving laparoscopic retrograde inguinal LND, (8.92 \pm 4.00) lymph nodes were harvested during left inguinal LND, while (8.54 \pm 5.04) lymph nodes were harvested in right inguinal LND; the patients were followed up for 2.5

to 19.5 months after surgery, and no tumor relapse or metastasis of primary lesion, inguinal or pelvic lymph node was reported.

Such results further proved the previously reported results, which verified the feasibility and safety of laparoscopic inguinal LND; besides, such technique achieved favorable oncologic control, with rapid recovery, few complication and short length of stay. The main reasons for this result are that, the small incision better preserve the skin blood supply; secondly, the tiny lymph vessels are amplified under laparoscope, which can be more thoroughly clamped, thus reducing the chance of lymph leakage; additionally, the incision is far away from major vessel, avoids sartorius translocation, and markedly reduces the surgical wound.

Through literature review, we found that, the trans-huckle subcutaneous approach VEIL is reported in almost all previous articles on laparoscopic inguinal LND, while the trans-hypogastrium subcutaneous approach VEIL is rarely reported. In the case of pelvic LNM of penile cancer or scrotal Paget's disease that requires simultaneous inguinal and pelvic LND, the traditional trans-huckle subcutaneous approach VEIL requires to disinfect again and to change patient position and the position of Trocar placed, which will inevitably extend the surgical operation time. Therefore, we reported a novel trans-hypogastrium subcutaneous approach inguinal LND in this study, in which only 4 Trocar were necessary to be placed at the puncture points in the hypogastrium (2 cm at the lower umbilical margin, midpoint between umbilicus and pubis, midpoints between the left and right anterior superior iliac spines and the umbilicus) for bilateral inguinal LND. Besides, any change was not required in the case of pelvic LNM, instead, only the Trocar position inside the extraperitoneal space was necessary to carry out PLND through the same incision. Additionally, this surgical approach also possesses the following superiorities: (1) great operation space, clear surgical field, clear anatomical layer, convenient operation, and reduced possibility of intraoperative injury; (2) it thoroughly eliminates the inguinal lymphatic and fat tissues, accurately distinguishes the flap level, preserves blood vessels and lymphatic vessels to provide blood supply for flaps, and reduces the postoperative complications such as flap ischemic necrosis and lymphatic fistula; (3) it also substantially shortens the operation time required for changing the body position and skin preparation; (4) there is no puncture incision in the leg, which is more beautiful and can theoretically further reduce the incidence of lower limb wound complications.

Inguinal lymph nodes include superficial inguinal lymph nodes and deep inguinal lymph nodes, which are located at the upper and medial side of anterior femur. The superficial lymph nodes are located inside the superficial subcutaneous fascia, which are divided into the upper and lower subgroups, among which, the upper subgroup is arranged along the inguinal ligament, while the lower subgroup is arranged along the great saphenous vein. Moreover, the upper subgroup lymph nodes close to the medial side were closely related to urinary surgery, which are located near the great saphenous vein and receive lymph from the external genital and the perineum. The output tubes of superficial inguinal lymph nodes infuse the deep inguinal lymph nodes. The deep inguinal lymph nodes are located at the deep surface of fascia lata of the medial femoral vein, and they are arranged along the upper segments of femoral artery and femoral vein. Apart from receiving the output tubes of superficial inguinal lymph nodes, they also accept the lower

limb deep lymphatic vessel, penis, scrotum, and lower anal lymphatic vessels. The output tubes of deep inguinal lymph nodes reach the extra-iliac lymph nodes upwards [23]. Retrograde inguinal LND refers to dissection at the opposite direction of other genital neoplasm LNM, namely, the opposite direction of lymphatic return. Laparoscopic retrograde LND is advantageous in that, it further prevents tumor diffusion along the lymph due to surgical stress; moreover, retrograde operation is more aligned with the operation habit of the operator.

In addition, the trans-hypogastrium subcutaneous approach in this study is superior in that, it allows to directly and conveniently search for the femoral artery and vein and the great saphenous vein from the avascular area behind the adipose lymphatic tissue. When dissecting the superficial inguinal lymph nodes, the skin and great saphenous vein should be protected as far as possible; in the case of deep inguinal LND, the saphenous vein gap should be exposed in anatomical structure to expose the great saphenous vein. Any damage to the great saphenous vein during the surgery can lead to obstructed blood circulation, which may result in postoperative lower limb lymphedema and scrotal edema. Numerous studies suggested that [24–25], preservation of the great saphenous vein and its branch will not affect the thoroughness of LND; on the other hand, it reduces the postoperative complication rates such as incision infection, seroma and lower limb edema.

To avoid or recognize the early deep lymphatic damage and reduce the postoperative lymphatic system-related complications, the homemade real-time fluorescence lymph-mapping developer (indocyanine green) was applied in the latest one surgical patient in this study, which was simple and convenient in intraoperative operation, and allowed for lymphatic vessel visualization. Thus, it is promising to become the conventional tool for inguinal LND. However, randomized controlled trials with larger sample sizes are warranted to further verify the comparative study with the trans-huckle subcutaneous approach VEIL.

Conclusion

To sum up, based on our research results and actual clinical practical experience, it is safe and feasible to treat penile cancer and scrotal Paget's disease through the trans-hypogastrium subcutaneous approach laparoscopic retrograde inguinal LND. Moreover, it is of great significance to patients requiring bilateral inguinal LND and PLND.

Abbreviations

LND:lymph node dissection; PLND:pelvic lymph node dissection;LNM:lymph node metastasis; VEIL:video endoscopy inguinal lymphadenectomy; OIL: open inguinal lymphadenectomy

Declarations

Acknowledgements

The authors would like to thank all the 13 patients who agreed to this study and completed the follow-up survey.

Authors'contributions

QXZ contributed to the project development, data collection and management, data analysis, and manuscript writing. HH,YJL contributed to the data collection and management. HEL contributed to the interpretation of results. LT and NZX contributed to the project development, and manuscript editing. All authors'read and approved the final manuscript.

Funding

This study was financially supported by the Capital Science and Technology Leading Talent Project (Project number: Z181100006318007) .

Availability of data and materials

Data can be provided upon reasonable request.

Ethics approval and consent to participate

The study was approved by Research Ethics Committee of Cancer Hospital, Chinese Academy of Medical Sciences and Beijing Chaoyang Hospital, Capital Medical University. All the patients in this study provided written informed consent.

Consent for publication

All participants have given their written consent to the publication of their personal or clinical data and details.

Competing interests

All authors report no conflict of interest regarding this work.

References

1. da Costa WH, Rosa de Olivera RA, Santana TB, et al. Prognostic factors in patients with penile carcinoma and inguinal lymph node metastasis. Int J Urol 2015;22:669-73.

2. Leijte JAP, Kirrander P, Antonini N, et al. Recurrence patterns of squamous cell carcinoma of the penis: recommendations for follow-up based on a two-centre analysis of 700 patients. *Eur Urol* 2008;54:161–9.
3. Koifman L, Hampl D, Koifman N, Vides AJ, Ornellas AA. Radical open inguinal lymphadenectomy for penile carcinoma: surgical technique, early complications and late outcomes. *J Urol*. 2013;190:2086-92.
4. Hakenberg OW, Comperat EM, Minhas S et al. EAU guidelines on penile cancer: 2014 update. *Eur Urol* 2015; 67: 142–50.
5. Kumar V , Sethia K K . Prospective study comparing video-endoscopic radical inguinal lymph node dissection (VEILND) with open radical ILND (OILND) for penile cancer over an 8-year period[J]. *Bj International*, 2017, 119(4).
6. Yadav S S , Tomar V , Bhattar R , et al. Video Endoscopic Inguinal Lymphadenectomy Versus Open Inguinal Lymphadenectomy for Carcinoma Penis: Expanding Role and Comparison of Outcomes[J]. *Urology*, 2017.
7. Tsen HF, Morgenstern H, Mack T, et al. Risk factors for penile cancer—results of a population-based case-control study in Los Angeles County, United States[J]. *Cancer Causes Control* 2001;12:267-277.
8. Wang Z , Lu M , Dong G Q , et al. Penile and Scrotal Paget's disease: 130 Chinese patients with long-term follow-up[J]. *BJU International*, 2008, 102(4):485-488.
9. McDougal WS. Phallic preserving surgery in patients with invasive squamous cell carcinoma of the penis. *J Urol*, 2005, 174:2218-2220.
10. Mohs FE, Snow SN, Larson PO. Mohs micrographic surgery for penile tumors. *Urol Clin North Am*, 1992, 19:291-30
11. Protzel C, Alcaraz A, Horenblas S, Pizzocaro G, Zlotta A, Hakenberg OW. Lymphadenectomy in the surgical management of penile cancer. *European urology*. 2009;55:1075-1088.
12. Wen S, Ren W, Xue B, et al. Prognostic factors in patients with penile cancer after surgical management. *World J Urol* 2018;36:435-40.
13. Hakenberg Oliver Walther, Dräger Desiree Louise, Erbersdobler Andreas et al. The Diagnosis and Treatment of Penile Cancer.[J] .*Dtsch Arztebl Int*, 2018, 115: 646-652.
14. Kroon BK, Horenblas S, Lont AP et al (2005) Patients with penile carcinoma benefit from immediate resection of clinically occult lymph node metastases. *J Urol* 173:816-819.
15. Milathianakis C, Bogdanos J, Karamanolakis D (2005) Morbidity of prophylactic inguinal lymphadenectomy with saphenous vein preservation for squamous cell penile carcinoma. *Int J Urol* 12:776-778.
16. Nelson BA, Cookson MS, Smith JA Jr, Chang SS. Complications of inguinal and pelvic lymphadenectomy for squamous cell carcinoma of the penis: A contemporary series. *J Urol* 2004;172:494-497.

17. YuanJB, Chen MF, Qi L, et al. Preservation of the saphenous vein during laparoendoscopic single-site inguinal lymphadenectomy: comparison with the conventional laparoscopic technique. *BJU Int* 2015;115:613-8.
18. Yao K, Tu H, Li YH, et al. Modified technique of radical inguinal lymphadenectomy for penile carcinoma: Morbidity and outcome. *J Urol* 2010;184:546-552.
19. Kirrander P, Andren O, Windahl T. Dynamic sentinel node biopsy in penile cancer: initial experiences at a Swedish referral centre. *BJU Int* 2013;111:E48–53.
20. Tobias-Machado M, Tavares A, Ribeiro Silva MN, Molina WR Jr, Forseto PH, Juliano RV, Wroclawski ER (2008) Can video endoscopic inguinal lymphadenectomy achieve a lower morbidity than open lymph node dissection in penile cancer patients? *J Endourol* 22(8):1687-1692.
21. Kumar V , Sethia K K . Prospective study comparing video-endoscopic radical inguinal lymph node dissection (VEILND) with open radical ILND (OILND) for penile cancer over an 8-year period[J]. *Bj International*, 2017, 119(4).
22. Russell C M , Salami S S , Niemann A , et al. Minimally Invasive Inguinal Lymphadenectomy in the Management of Penile Carcinoma.[J]. *Urology*, 2017, 106.
23. Wein AJ, Kavoussi LR, Novick AC, et al. *Campbell-Walsh Urology*, 11th ed [M]. Philadelphia: WB SaundersCo,2016:856-861.
24. Zhu Y-Zhang SL-Ye DW,et a1-Prospectively packaged ilioinguinal lymphadenectomy for penile cancer—the disseminative pattern of lymph node metastasis[J] J Urol 2009;181(5):2103-2108
25. Zhou XL-Zhang JF-Zhang JF,et a1-Endoscopic inguinal lymphadenectomy for penile carcinoma and genital malignancy—a preliminary report[J] J Endourol 2013;27(5):657-661.

Figures

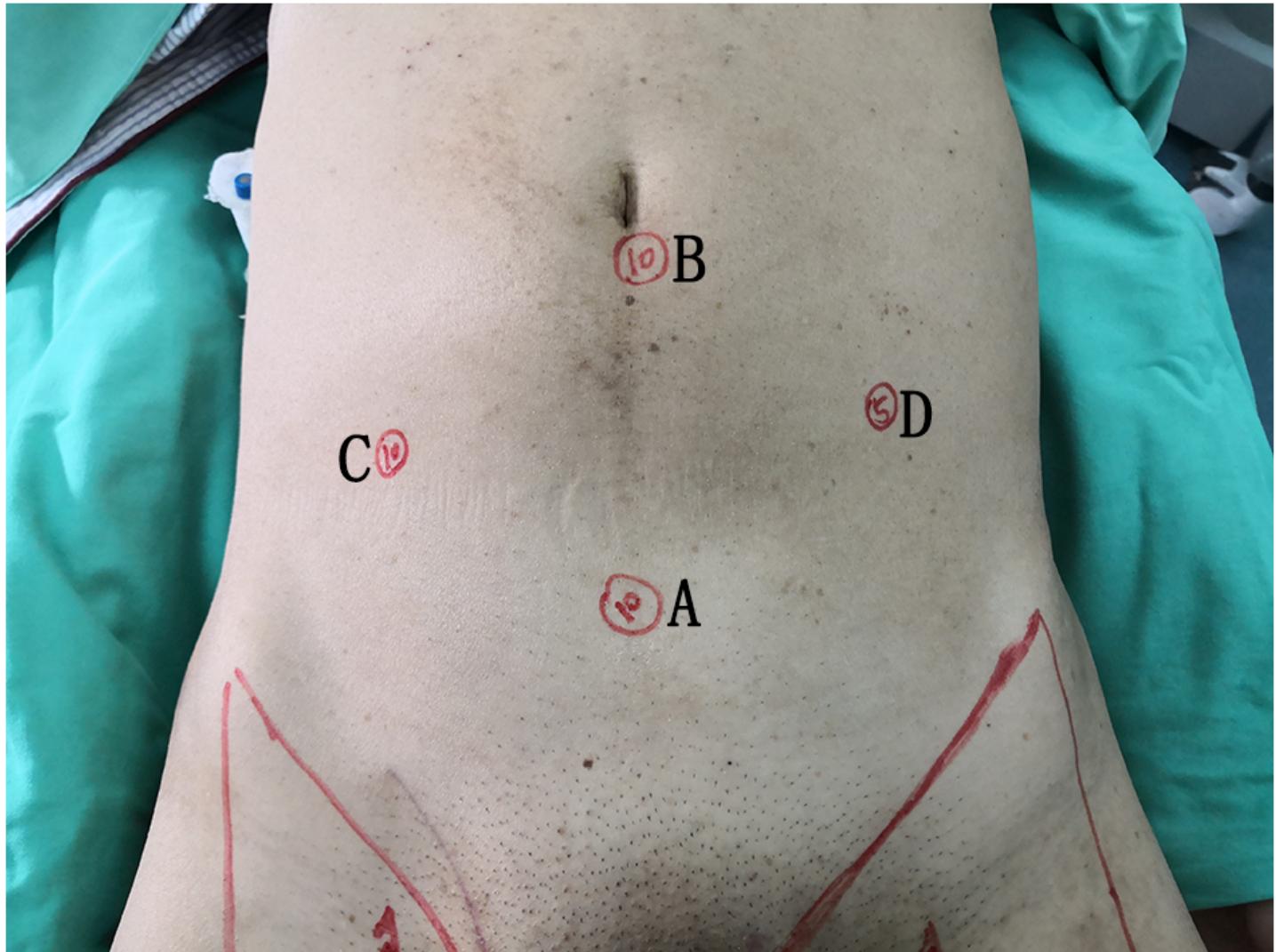


Figure 1

Patient positioning and ports placement. The patients were in supine position, their heads were 15° higher than their feet, the hips were raised. Trocar placement: A 2-cm longitudinal incision was made below the umbilicus (port B), a 10-mm Trocar was placed at the midpoint between the umbilicus and the pubis (port A), two 5-mm Trocars were placed at the midpoints between the left and right anterior superior iliac spines and the umbilicus (port C and port D) (Fig.1).

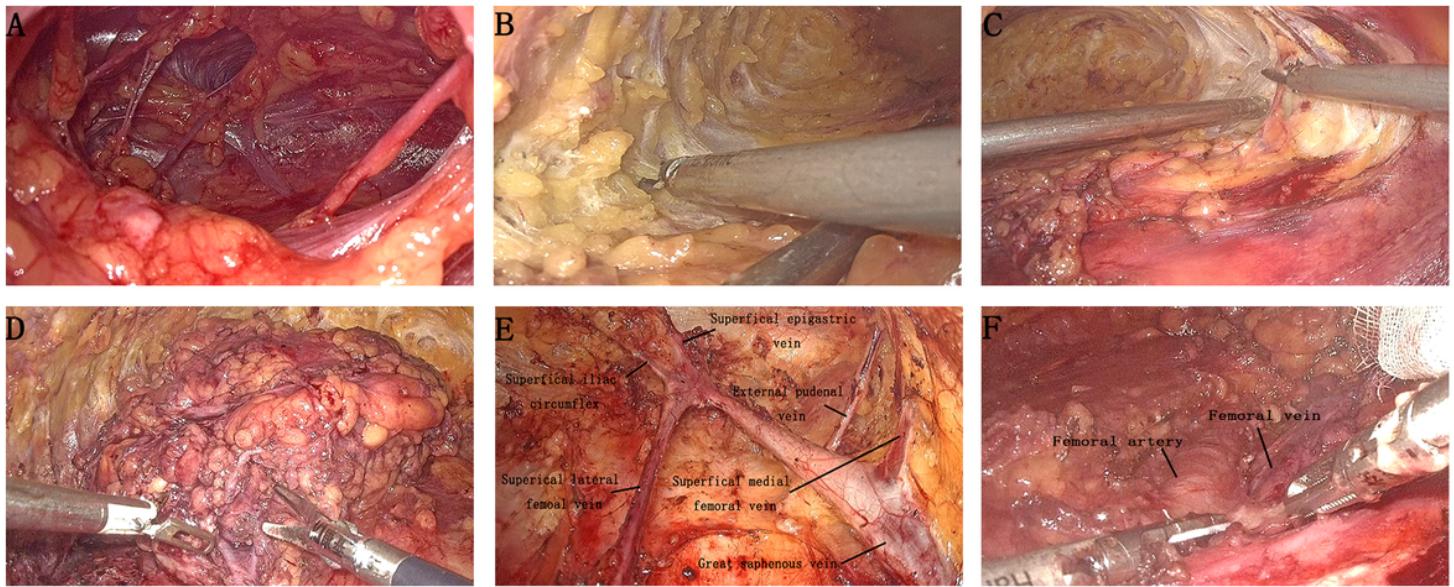


Figure 2

The procedure of laparoscopic inguinal lymph node dissection. Fig2.A, establishment of extraperitoneal space, which is between Camper fascia and Scarpa. Fig2.B, Fig2.C, dissection of the inner and outer boundary of the inguinal triangle. The lateral border is the medial edge of the sartorius muscle, and the medial border is the lateral edge of the long adductor muscle. Fig2.D, dissection of lymph nodes in superficial inguinal region. Then, the lymph nodes were completely dissected, the great saphenous vein and its tributaries are fully exposed (Fig2.E). Fig2.F, deep inguinal lymph node dissection and protection of femoral artery and vein.