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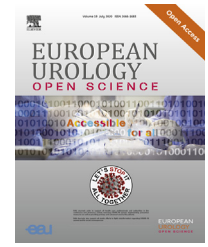

Testis Cancer

Nerve-sparing Robot-assisted Retroperitoneal Lymph Node Dissection: The Monoblock Technique

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Abstract

Background: Retroperitoneal lymph node dissection (RPLND) is a treatment option for men with stage 1 or 2 testis cancer and the standard of care for men with postchemotherapy retroperitoneal residual disease. Given the morbidity of RPLND, four important surgical modifications have been proposed: minimally invasive access, nerve-sparing resection, template resection, and en-bloc resection.

Objective: To describe the surgical steps and perioperative outcomes of robotic nerve-sparing unilateral template RPLND with en-bloc resection (roboRPLND-NS+).

Design, setting, and participants: From 2017 to 2019, five patients with suspicion of retroperitoneal metastatic testicular cancer on abdominopelvic computed tomography underwent roboRPLND-NS+ at a single referral center. All surgeries were carried out by a single surgeon who has performed more than 500 extended and more than 50 super-extended robot-assisted lymph node dissections.

Surgical procedure: A lateral transperitoneal robotic approach with a da Vinci Xi Surgical System (Intuitive Surgical, Sunnyvale, CA, USA) in six-arm configuration was used. The sympathetic chains, postganglionic sympathetic fibers, and hypogastric plexus were preserved as much as possible to ensure a nerve-sparing procedure. The template borders consisted of the renal vein cranially, the ureter laterally, the interaortocaval space medially, the common iliac artery caudally, and the psoas muscle dorsally for the right and left modified RPLND templates. Lymph nodes and the surrounding fatty tissue were progressively resected from the common iliac vessels and the abdominal aorta using the split-and-roll technique, and all of the template tissue was resected as a single specimen. Intraoperative and postoperative complications were recorded.

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Measurements: Lymph node yield and perioperative and postoperative oncological and functional outcomes were measured.
Results and limitations: The median patient age was 38 yr (interquartile range [IQR] 32–41) and the median operative time was 274 min (IQR 238–280). Node metastases were pathologically confirmed in three patients. The median number of lymph nodes removed was 19 (IQR 18–21), and the median number of positive lymph nodes was 2 (IQR 1–3). No patient experienced intraoperative or postoperative complications. The postoperative hospital stay was either 3 or 4 d. Maintenance of antegrade ejaculation was achieved in all patients. After median follow-up of 15 mo (IQR 14–30), all patients were alive and no recurrence was observed. Limitations include the low number of patients and the single surgeon experience.
Conclusions: RoboRPLND-NS+ is a safe and feasible technique that allows removal of a high number of lymph nodes with good functional outcomes. Short-term survival outcomes were excellent, with no recurrences or deaths recorded.
Patient summary: We describe a feasible and safe robot-assisted surgical procedure for removal of lymph nodes in patients with testicular cancer. Our technique has potential to decrease the medical problems arising as side effects of the surgery while achieving good cancer control.

1. Introduction

Retroperitoneal lymph node dissection (RPLND) is a treatment option for men with stage 1 or 2 testis cancer and the standard of care for men with postchemotherapy retroperitoneal residual disease [1]. The standard access is either via a median laparotomy or a chevron incision with a transabdominal approach and removal of all lymph node (LN) tissue from the hilar region down to the common iliac vessels [2]. Given the morbidity of this approach, four important modifications have been proposed. First, to decrease postoperative pain, ileus, and hospital stay, extraperitoneal [3] and minimally invasive approaches, including laparoscopic [4] and robot-assisted [5] techniques, have been introduced. Second and third, to improve ejaculatory function, both nerve-sparing RPLND and template resection are commonly used [6–8]. Fourth, to ensure complete resection behind the great vessels, en-bloc removal of all lymphatic tissue has been proposed more recently [1].

To the best of our knowledge, there is no case series reporting a combination of all four RPLND modification steps. Here we describe our experience with a robotic nerve-sparing unilateral template RPLND with en-bloc resection (roboRPLND-NS+) technique.

2. Patients and methods

2.1. Preoperative staging

The diagnosis of testicular tumor was suspected from clinical examination of the genitalia and testicular ultrasound and was confirmed via orchidectomy. Preoperative staging was performed using a computed tomography (CT) scan of the abdomen and thorax with contrast medium and measurement of serum tumor markers (α-fetoprotein, β human chorionic gonadotropin, and lactate dehydrogenase). For patients with seminoma, follow-up including tumor marker assessment and an abdominopelvic CT scan was performed twice a year. For patients with nonseminoma, follow-up included tumor marker assessment four times a year, and a chest X-ray and abdominopelvic CT scan twice a year.

2.2. Informed consent

Before surgery, patients are counseled about their diagnosis, prognosis, and different options for treatment, including nonoperative care and no treatment, with the expected benefits, risks, and likelihood of success for each option. Beside typical surgical complications—including nerve injury resulting in altered skin sensations or pain, infections, injury to vessels leading to bleeding/thrombosis, and cancer recurrence—some procedure-specific risks should be mentioned. These include injury to the ureter or kidney requiring stenting/nephrostomy or any form of urinary diversion or nephrectomy; bowel injury requiring a temporary colostomy; injury to the vasculature of the contralateral testicle leading to infertility and hypogonadism; injury to retroperitoneal nerves leading to retrograde ejaculation; and injury to lymphatic vessels leading to lymphocele, lymphedema, and/or chylous ascites requiring drainage and, in the case of the latter, a low-fat diet and/or parenteral nutrition. Ligation and clipping of lumbar arteries and veins may lead to spinalis anterior syndrome, which could result in lower spinal injuries. Finally, any complication or disease recurrence may require further lines of treatment including chemotherapy, surgery, and radiotherapy.

2.3. Surgical procedure and surgeon experience

A lateral transperitoneal robotic approach using a four-arm da Vinci Xi robotic system (Intuitive Surgical, Sunnyvale, CA, USA) was used in all patients. All surgeries were carried out by a single surgeon who has performed more than 500 extended and more than 50 super-extended robot-assisted LN dissections [9,10].

2.3.1. Patient positioning and approach

The patient is positioned laterally on the operating table. The hips, thighs, chest, and shoulders are carefully fixed to the operating table

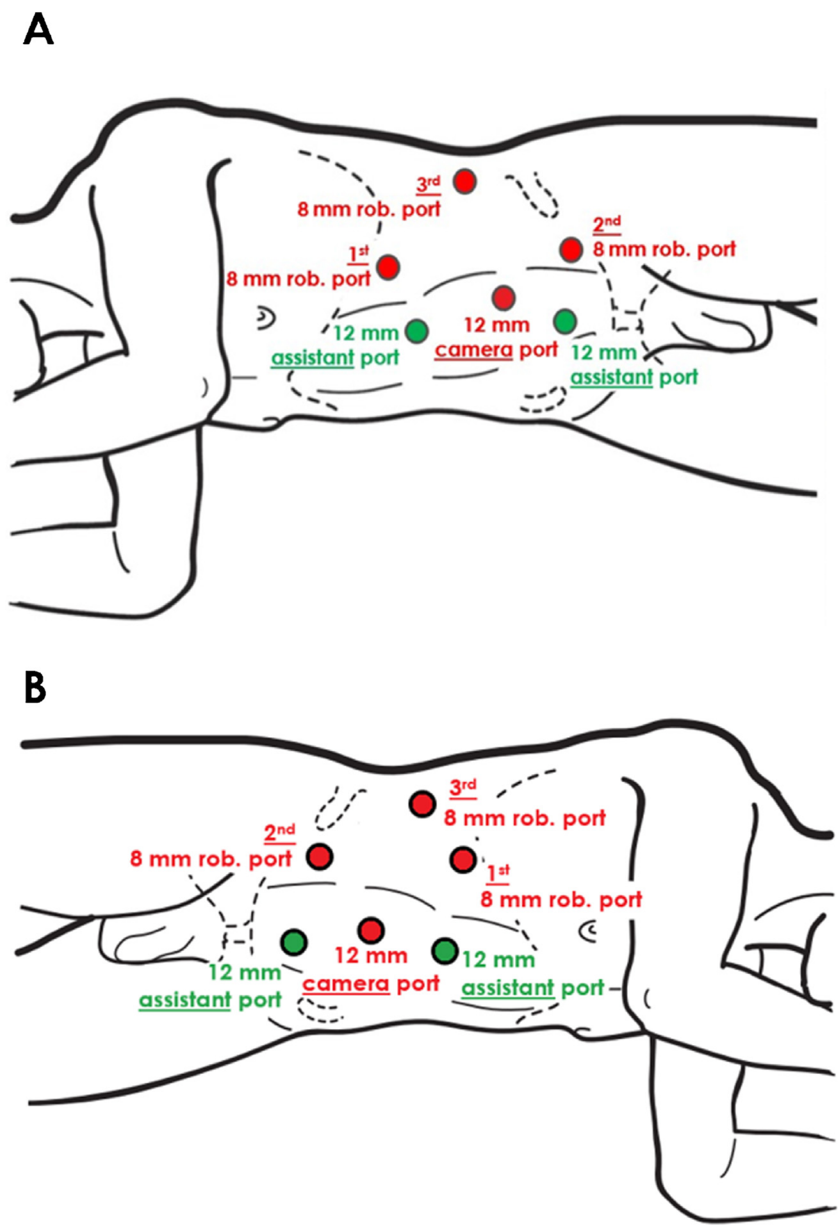


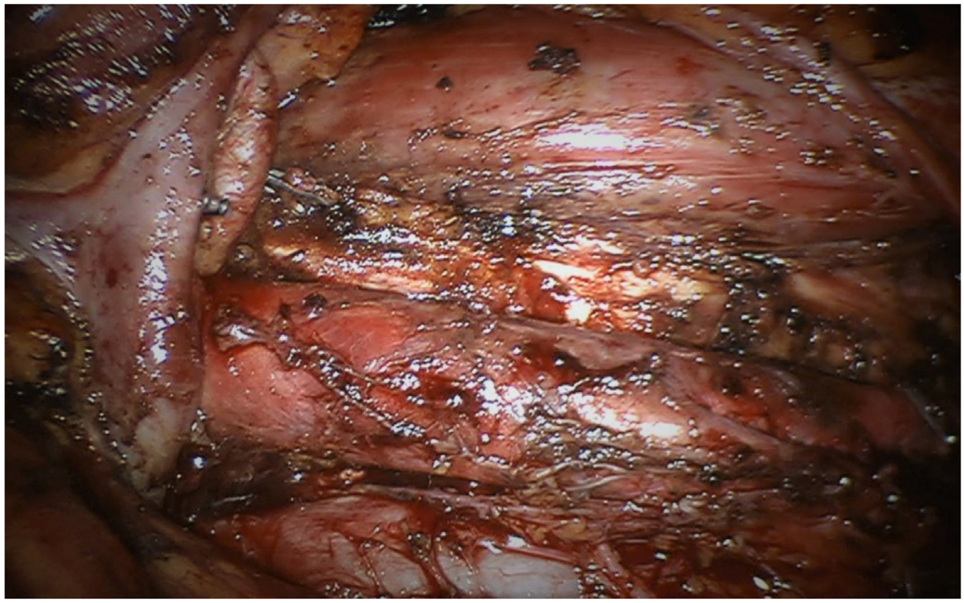
Fig. 1 – Patient positioning and port placement for the robotic nerve-sparing unilateral template RPLND with en-bloc resection technique. Intraperitoneal access is via puncture with a Veress needle at the supraumbilical crease in the midline, where the first port is placed and serves as the 12-mm trocar for the camera. The 8-mm robotic (rob.) ports are placed in a triangular fashion. (A) Left modified template. The first robotic operative port for the scissors is placed close to the lateral border of the left rectus muscle, 2 cm below the costal arch on the midclavicular line. The second robotic port (for the bipolar forceps) is placed as lateral as possible midway between the left anterior superior iliac spine and the pubic symphysis. The third port (for the robotic grasper) is placed midway between the left coastal arch and the left anterior superior iliac spine on the middle axillary line. Two more 12-mm ports for suction, clip device, and assistance from an atraumatic laparoscopic grasper are placed between the camera port and the left coastal arch midline and between the camera port and the pubic symphysis following the midline. (B) Right modified template. The first robotic operative port for the scissors is placed close to the lateral border of the right rectus muscle, 2 cm below the costal arch on the midclavicular line. The second robotic port (for the bipolar forceps) is placed as lateral as possible midway between the right anterior superior iliac spine and the pubic symphysis. The third port (for the robotic grasper) is placed midway between the right coastal arch and the anterior superior iliac spine on the middle axillary line. Two more 12-mm ports for suction, clip device, and assistance from an atraumatic laparoscopic grasper are placed between the camera port and the right coastal arch midline and between the camera port and the pubic symphysis following the midline. Image adapted from *The Hinman Atlas of Urologic Surgery*, 3rd edition (Philadelphia, PA: Elsevier Health Sciences; 2012). RPLND = retroperitoneal lymph node dissection.

with either foam or pads to avoid pressure points. The operating table is then fully bent to increase space in the region between the iliac crest and the costal arch. After having established pneumoperitoneum, an initial 12-mm port is placed slightly cranially and laterally to the umbilicus, in line with the virtual axis of the renal hilus. The remaining ports are placed under direct vision: three robotic ports for the instruments and two additional ports for the bedside surgeon in a modified rhomboidal pattern (Fig. 1). The intra-abdominal pressure is set to 12 mm Hg.

2.3.2. *Left and right modified templates*

The borders of the left modified template are shown in Figure 2. They consist of the renal vein cranially, the ureter laterally, the inter-

(A)



(B)

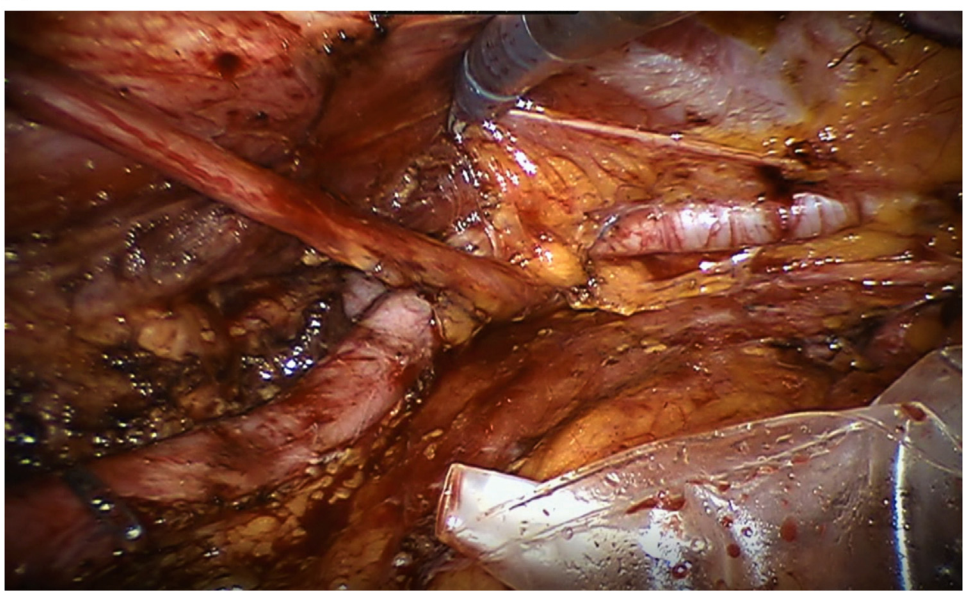


Fig. 2 – Description of the boundaries of the left modified RPLND template. (A) The margins of the left modified RPLND template consist of the left renal vein cranially, the left ureter laterally, the interaortocaval space medially, and the psoas muscle dorsally. (B) The inferior margins of the left modified RPLND template are represented by the left ureter inferolaterally and the left common iliac artery caudally. RPLND = retroperitoneal lymph node dissection.

aortocaval space medially, the common iliac artery caudally, and the psoas muscle dorsally. The borders of the right modified template include the common iliac vessels inferiorly, the IVC medially, the ureter laterally, the psoas muscle posteriorly, and the right renal vein superiorly.

2.3.2.1. Step 1: mobilization of the colon. The line of Toldt is incised and the descending colon is gently mobilized to gain access to the retroperitoneal space. If the surgical planes are respected, most of this mobilization can be achieved via blunt dissection and gentle traction on the colon applied by the assistant surgeon. The colonic mobilization is completed by releasing the left colonic flexure (left template) or the right colonic flexure (right template) to gain safe and open access to the aortal axis. Colonic mobilization is pursued until the lateral border of the inferior vena cava (IVC) can be identified, which is the key anatomical landmark structure for this step.

2.3.2.2. Step 2: identification and dissection of the renal vascular axis. The key landmark structure on both sides is the testicular vein. Once identified, it is dissected and followed cranially up to its entrance into the renal vein. Caudally the vena testicularis is dissected up to its entrance into the internal inguinal ring. After having created safe

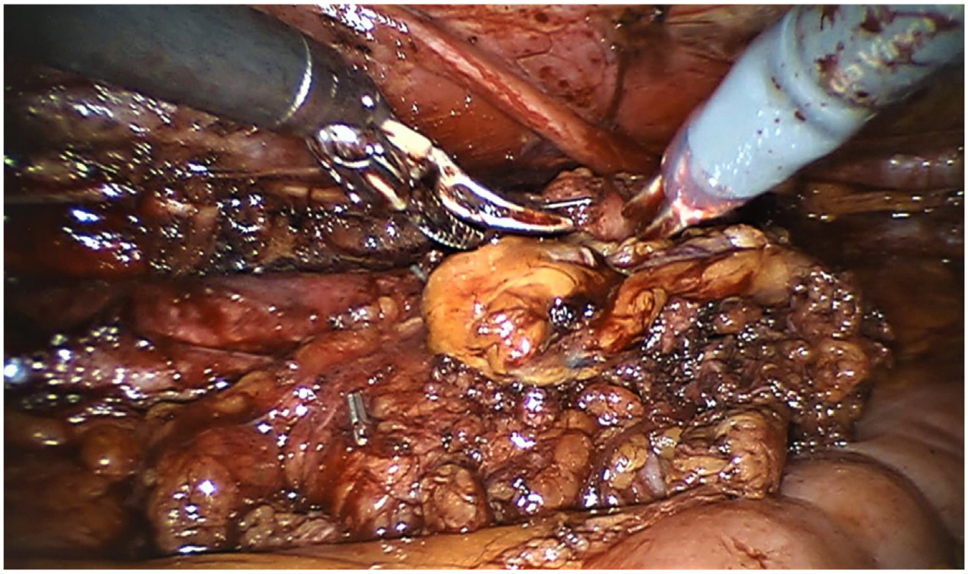


Fig. 3 – The nodal tissue is resected and removed as a single specimen.

suprahilar and infrahilar access to the retrorenal space and the psoas muscle, the renal vascular axis can be safely dissected.

2.3.2.3. Step 3: mobilization of the ureter. The ureter is carefully released from the medial portion of the lymphatic tissue down to its junction with the iliac vessels. Devascularization of the ureter must be avoided to prevent ureteral strictures.

2.3.2.4. Step 4: dissection of lymphatic tissue along the aortal axis and caval axis. The lateral borders of the aorta (left) and the IVC (right) are carefully dissected and the entrance of the renal artery into the aorta identified. The lymphatic tissue is then carefully dissected using the split-and-roll technique to clear the tissue along the big vessels. The lymphatic vessels are dissected and microclips are used along the renal artery to seal them. The dissection is pursued until the ligamentum flavum is reached, sparing the hypogastric nerve branches. The hypogastric nerve branches are most easily identified at the lateral border of the IVC and spared along their course crossing the aorta.

2.3.2.5. Step 5: dissection of the testicular vein. After completion of the dissection along the lateral border of the aorta (left) or the IVC (right), dissection is continued along the common iliac artery up to the internal inguinal ring. The posterior portion of the specimen is released from the psoas muscle. Finally, the vena testicularis is double-clipped cranially and caudally and then dissected. The specimen is placed in an Endobag and extracted (Fig. 3).

2.3.3. Conclusion of the RPLND: drains, closure, and dressing

Any possible source of bleeding is identified by lowering the intra-abdominal pressure to 6 mmHg. No drains are placed and the fascia of any port ≥5 mm is closed with one or two sutures. Subcuticular wound closure is performed with a 3-0 monofilament synthetic absorbable suture. The wound is covered with an adhesive film dressing.

2.3.4. Postoperative care

Patient mobilization, enteral nutrition, and intake of oral fluids start on the day of surgery. No further empiric antibiotic prophylaxis is required. Thromboprophylaxis with dalteparin sodium 5000 U is prescribed until discharge. Adhesive film dressings can be removed on the first day after surgery.

2.4. Cohort study and video

The indication for RPLND was discussed preoperatively at our local interdisciplinary tumor board. The patients consented to the use of both photographic and videographic material and the ethics committee approved this retrospective cohort study (BASEC ID 2020-02237). Recurrence-free survival, cancer-specific survival, and overall survival and data for perioperative and postoperative complications were extracted from medical charts by a board-certified urologist. Intraoperative and postoperative complications were assessed according to the Clavien-Dindo classification system [11]. Antegrade ejaculation was assessed at a clinical visit during postoperative follow-up. Operative time was defined as the time from skin incision to the end of skin closure. A detailed pathological evaluation was performed by a dedicated uropathologist at our institution and included the histology and the total number and number of positive LNs removed. Length of hospital stay was defined as the time from surgery to discharge.

3. Results

Between 2017 and 2019, five patients with a median age of 38 yr (interquartile range [IQR] 32–41; Table 1) underwent roboRPLND-NS+.

Previous orchidectomy specimens showed nonseminoma in three patients and seminoma in two. Primary RPLND was performed after recurrence during active surveillance for stage 1 disease in one patient with pure seminoma and in one patient with nonseminoma, with a retroperitoneal node size of 31 and 9 mm, respectively. Postchemotherapy RPLND was performed in three patients with nonseminoma: one with IGCCCG good prognosis, one with IGCCCG intermediate prognosis, and one with IGCCCG poor prognosis. Chemotherapy included three cycles of

Table 1 – Data for five patients treated with robot-assisted nerve-sparing monoblock RPLND

Parameter	Patient				
	1	2	3	4	5
Age	50	38	32	27	48
Disease stage	Primary	Primary	Post-CTx	Post-CTx	Post-CTx
Orchidectomy histology and side	Nonseminoma, left	Pure seminoma, right	Nonseminoma, left	Mixed GCT, right	Nonseminoma, left
IGCCCG risk	Good	Good	Good	Intermediate	Poor
Largest LN diameter (mm)	9	31	34	10	13
ORT (min)	135	327	238	274	280
LNs removed	7	19	24	18	21
Positive LNs	2	1	0	3	0
RPLND histology	Seminoma	Seminoma	Necrosis	Seminoma	Necrosis
LOS (d)	3	4	4	3	4
Antegrade ejaculation	Yes	Yes	Yes	Yes	Yes
Adjuvant CTx	No	Yes	No	No	No
Follow-up (mo)	35	30	15	14	13
Status	Alive, no RCR	Alive, no RCR	Alive, no RCR	Alive, no RCR	Alive, no RCR

RPLND = reptroperitoneal lymph node dissection; IGCCCG = International Germ Cell Cancer Collaborative Group; LN = lymph node; ORT = operation room time; LOS = length of stay; CTx = chemotherapy; RCR = recurrence.

bleomycin, etoposide, and cisplatin for the two patients with good or intermediate prognosis, and four cycles of etoposide and cisplatin for the patient with poor prognosis. The postchemotherapy residual node size was 34, 10, and 13 mm, respectively.

The median operative time was 274 min (IQR 238–280); no intraoperative complications, blood transfusions, or conversion to conventional laparoscopic or open surgery were observed. Nerve-sparing was successfully performed in all patients. All patients were discharged on the third or fourth postoperative day.

Pathological analysis revealed a median of 19 LNs (IQR 18–21) removed. The two men in the primary setting both showed viable seminoma; adjuvant chemotherapy with three cycles of bleomycin, etoposide, and platinum was administered in one patient. In the postchemotherapy setting, one patient showed viable seminomatous germ cells. After median follow-up of 15 mo (IQR 14–30), overall survival, cancer-specific survival, and recurrence-free survival were 100%. All patients reported antegrade ejaculation.

4. Discussion

This report summarizes our experience with roboRPLND-NS + and describes important preoperative, intraoperative, and postoperative steps. The advantages of our surgical technique include high LN counts, low perioperative morbidity, and preservation of antegrade ejaculation in all men.

The two classical indications for RPLND are residual disease after chemotherapy [5,12,13] and cases with late relapse [14]. However, as evidence continues to mount regarding the long-term morbidities associated with radiotherapy and chemotherapy [15], several groups have looked to surgery as a treatment option with potentially more short-term but lower long-term toxicities. This change in paradigm is reflected in our series describing a new RPLND technique incorporating the most recent technical modifications, including robotic surgery [14], nerve-sparing and template resection [6–8], and en-bloc resection of all lymphatic tissue to ensure complete resection around the large vessels [16]. Those modifications reduce the morbidity of the procedure and could pave the way to reconsideration of RPLND in different settings, including stage 1 nonseminoma [4,17,18], stage 2 seminoma with [19] or without adjuvant chemotherapy [20], and stage 2 nonseminoma at presentation [21] or recurrence after initial surveillance [22].

Ideally, any RPLND modification should be evaluated in randomized controlled trials or at least prospective studies with a suitable comparator group. These studies must have well-defined inclusion criteria and endpoints, including a definition of complications. The present study has insufficient statistical power for drawing conclusions on most outcomes; our results should be regarded as hypothesis-generating and the primary goal of the report is to illustrate the surgical technique. Moreover, our study represents a small surgical series performed by a surgeon experienced in robot-assisted RPLND and the results might not be comparable to surgeons at the beginning of their learning curve. Therefore, our RPLND modifications require validation in larger studies and further modification of the surgical technique (eg, extraretroperitoneal [23]) or the preoperative and postoperative pathways (eg, an emergency conversion checklist [24]) should be considered.

5. Conclusions

RPLND using the roboRPLND-NS+ technique is feasible and safe. Short-term survival outcomes proved to be excellent, with no recurrences or deaths recorded. Favorable perioperative functional outcomes and preservation of antegrade ejaculation suggest that surgical trials with this technique should be considered for several indications for men with germ cell tumors.

Author contributions: Agostino Mattei had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: Mattei, Afferi.
Acquisition of data: Afferi, Baumeister.
Analysis and interpretation of data: Afferi, Mattei.
Drafting of the manuscript: Afferi, Mattei, Fankhauser, Moschini, Baumeister, Mordasini, Aschwanden.
Critical revision of the manuscript for important intellectual content: Afferi, Mattei, Baumeister, Mordasini.
Statistical analysis: Afferi.
Obtaining funding: None.
Administrative, technical, or material support: Mattei, Afferi.
Supervision: Mattei.
Other (video editing and sound): Afferi.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.euros.2021.07.004.

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