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Robotic-assisted para-aortic lymphadenectomy: Technique and indications in gynecological oncology

Jordi Ponce, MD PhD [a, *, 2, 3, 4, 5], Sergi Fernández, PhD [a], Marc Barahona, PhD [a, 2, 4], José Manuel Martínez, PhD [a], Carlos Ortega, PhD [a], Lola Martí, MD PhD [a]

[a] *Gynecologic Department, University Hospital of Bellvitge (IDIBELL), University of Barcelona, Spain*

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A B S T R A C T

The benefits of minimally-invasive surgeries have been documented, and they have been established as the preferred approach for gynecological surgeries. With the development of robotic surgery, many highly complex surgeries can benefit from these advantages. Due to the complexity of aortocaval lymphadenectomy, surgical technique protocols have been described to reduce risks by maximizing benefits.

We describe the technique using five ports (4 robotic arms and an assistant) to work the upper abdominal field, and different instruments recommended in each of their positions to reduce errors and optimize surgical time. After the "step by step" description, we summarize indications of aortocaval lymphadenectomy for every gynecological cancer in different stages.

* Corresponding author. Hospital Universitario de Bellvitge, Servicio de, Ginecología, Planta 17, Carrer Feixa Llarga, S/N. CP 08097, L'Hospitalet de Llobregat, Barcelona, Spain.

E-mail addresses: jponce@bellvitgehospital.cat (J. Ponce), sfernandez@bellvitgehospital.cat (S. Fernández), mbarahona@bellvitgehospital.cat (M. Barahona), jmartinezgar@bellvitgehospital.cat (J.M. Martínez), cortega@bellvitgehospital.cat (C. Ortega), lmarti@bellvitgehospital.cat (L. Martí).

[2] Proctor of Intuitive.
[3] Proctor of Conmed.
[4] Proctor of Medtronic.
[5] Proctor of CMR.

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MCQs Questions

Nowadays, what is the main indication for performing para-aortic lymphadenectomy in patients with endometrial cancer?

a) Serous histology or abnormal p53 molecular subtype
b) Endometrioid carcinoma with extensive lymphovascular infiltration
c) Presence of myometrial involvement regardless of histology
d) Presence of confirmed pelvic lymph node metastasis
e) Suspicious of para-aortic lymph node involvement

(A) F (B) F (C) F (D) F (E) T.

Which of the following sentences regarding para-aortic lymphadenectomy in cervical cancer is true?

a) It is recommended to perform para-aortic lymphadenectomy as a staging method in patients with early-stage cervical cancer during a radical hysterectomy.
b) The subgroup of patients with FIGO stage IIB cervical cancer could potentially benefit the most from staging para-aortic lymphadenectomy.
c) If there is pelvic lymph node involvement, para-aortic lymphadenectomy is not indicated in any case. Extended radiation therapy is recommended.
d) Currently, there is no indication for para-aortic lymphadenectomy as it is a procedure with a high morbidity rate.
e) In patients with advanced cervical cancer, it is more important to perform para-aortic lymphadenectomy than to initiate early treatment with chemotherapy and radiation therapy.

(A) F (B) T (C) F (D) F (E) F.

Regarding para-aortic lymphadenectomy in ovarian cancer, it is false that.

a) Para-aortic lymphadenectomy is a surgical procedure where ureteral injury, intraoperative hemorrhage, or chylous ascites can occur among other complications.
b) Para-aortic lymphadenectomy may be omitted for staging in expansile mucinous carcinoma.
c) In recent guidelines, para-aortic lymphadenectomy may be omitted in initial stage I-II clear cell carcinoma or endometrioid carcinoma.
d) During cytoreductive surgery for advanced ovarian cancer, para-aortic lymphadenectomy may be omitted when there are no suspicious macroscopic lymph nodes.
e) In case of para-aortic isolated recurrence, there is no benefit of performing complete excision.

(A) F (B) F (C) F (D) F (E) T.

Introduction

The benefits of minimally-invasive surgery have been well documented in the literature [1]. There are many advantages attributed to the laparoscopic approach like a greater surgical precision with decreased blood loss and, of course, the absence of large incisions. All of these are relevant contributors to a faster postoperative recovery and consequently a tangible saving in hospital staging costs.

Despite such evidences, many factors have limited the generalizability of this approach. This includes the surgeon's learning curve with long operating times and certain patient characteristics such as obesity, previous surgeries, or inability to achieve proper ventilation during a Trendelenburg position.

With the development of the da Vinci surgical system (Intuitive Surgical, Inc., Sunnyvale, CA) robotization facilitates endoscopic techniques, managing to improve some of their limitations. A direct

and intuitive operating pattern reduces learning curves [2] as well as the possibility of training in simulators; it displays all the degrees of freedom and movements of the forceps in 360°, and the magnified three-dimensional vision reconfirms microsurgery characteristics in real time.

For all these reasons, its application in gynecological oncology has been increasingly established, especially in the United States, where its use has become widespread despite the high costs [3]. Not only for oncologic procedures but in some benign surgeries with high complexity execution, such as sacrocolpopexy or myomectomy.

Due to the complexity of aortocaval lymphadenectomy, this procedure is performed with minimal invasion in very few centers, although robotics also has some limitations in this regard (especially the impossibility of offering a field of work that includes more than two abdominal quadrants). One of them is that optics and robotic arms cannot exceed 90° inclination with good versatility. The new Da Vinci Xi® system seems to offer better features in this regard, although this problem still has not been completely resolved. Actually, double docking is still recommended because it is not necessary to move the robot's arms from their initial position to the right of the patient [4].

The indications for staging aortic lymphadenectomy have been decreasing in recent clinical guidelines and this technique is being clearly superseded by detection of the sentinel node in most tumors. Nonetheless, we believe that knowing and standardizing the step by step process continues to have a practical use for the gynecologist-oncologist, who must always face complex situations, such as debulking end relapse surgeries in this complex anatomical territory.

This weakness is precisely the object of this chapter, converted into an opportunity for improvement. We describe the technique, position of trocars and evolution of the surgical field, affecting a double anchoring maneuver of the robot (double docking) in such a way that taking advantage of an adequate position of the trocars facilitates the rotation of the robotic system and with it access to both, superior abdomen and pelvic field.

We are also going to describe the main remaining indications for this technique, for each tumor and finally, we'll summarize the 10 key points that should always be taken into consideration.

Technique and step by step procedure

Para-aortic lymphadenectomy, exclusively

For the exclusive practice of aortic lymphadenectomy, only the “upper abdominal” field is required with the entry of the arms from the “right of the patient".

Five ports will be enough, all of them 8 mm robotic except for an auxiliary access of 5 mm or 10 mm (or for the Airseal® if available), for the assistant and for the final extraction of the pieces, as it is the one of bigger size. This removal maneuver can also be done through the enlarged umbilical port, if necessary.

We recommend starting the procedure with the placement of the umbilical trocar (or supra-umbilical if the patient's characteristics require it) in order to visualize the entire cavity and then place the rest of the trocars. We even recommend placing the rest of the ports under this viewing angle, which is more common in the conventional gynecological approach.

Another 8 mm robotic port is located 3–4 cm above and to the right of the pubic symphysis and two more (8 mm) are placed about 2 cm superior and medially to the anterior superior iliac crest. One conventional ancillary laparoscopic port (5 mm or 10 mm) can be placed for the assistant, between left iliac crest and suprapubic trocar. This port could be used for 8 mm Airseal® trocar, if available.

The following positioning of the instruments is recommended (Fig. 1).

- Monopolar scissors on the right arm of the robot (number 1)
- TipUp used as an intestinal/peritoneal retractor through the umbilical port (number 2)
- 30° optic in the suprapubic port (number 3)
- Fenestrated or Maryland bipolar forceps on the left arm (number 4)
- Auxiliary port for the assistant (aspirator, clamp, Airseal® …)

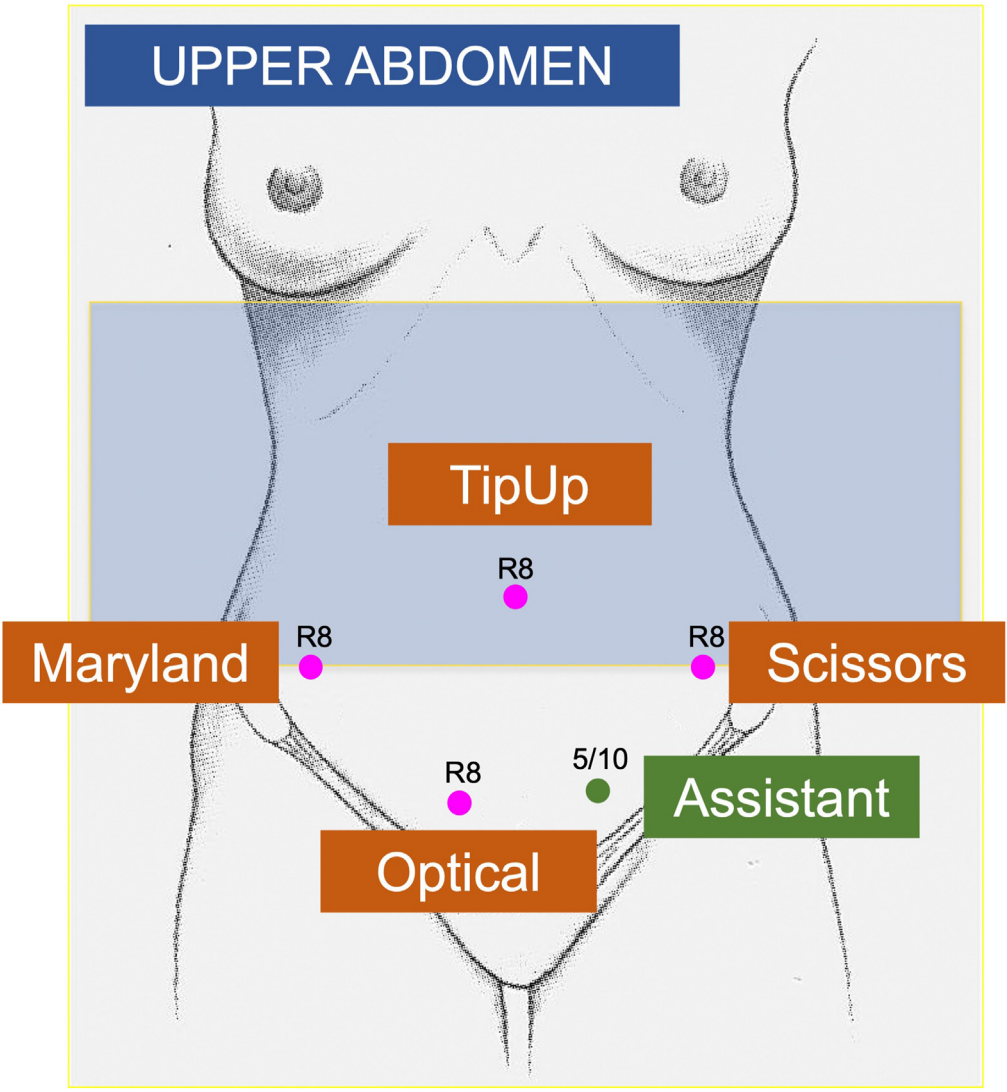

Fig. 1. Upper abdominal trocar and instrument's location.

Either device can be exchanged for an advanced sealer, if desired (Vessel Sealer Extend® or Synchroseal®).

The 30° optics oriented downwards offers better results than the 0° optics since it allows a superior view of the aortic field, usually parallel to the entry axis.

Step by step

Exposure of the aortic field. An important step is the identification of the root of the mesentery, which is facilitated by displacement of the small intestine, thanks to the Trendelenburg position. Even with everything, in patients with obesity, this maneuver can be laborious and requires the manual

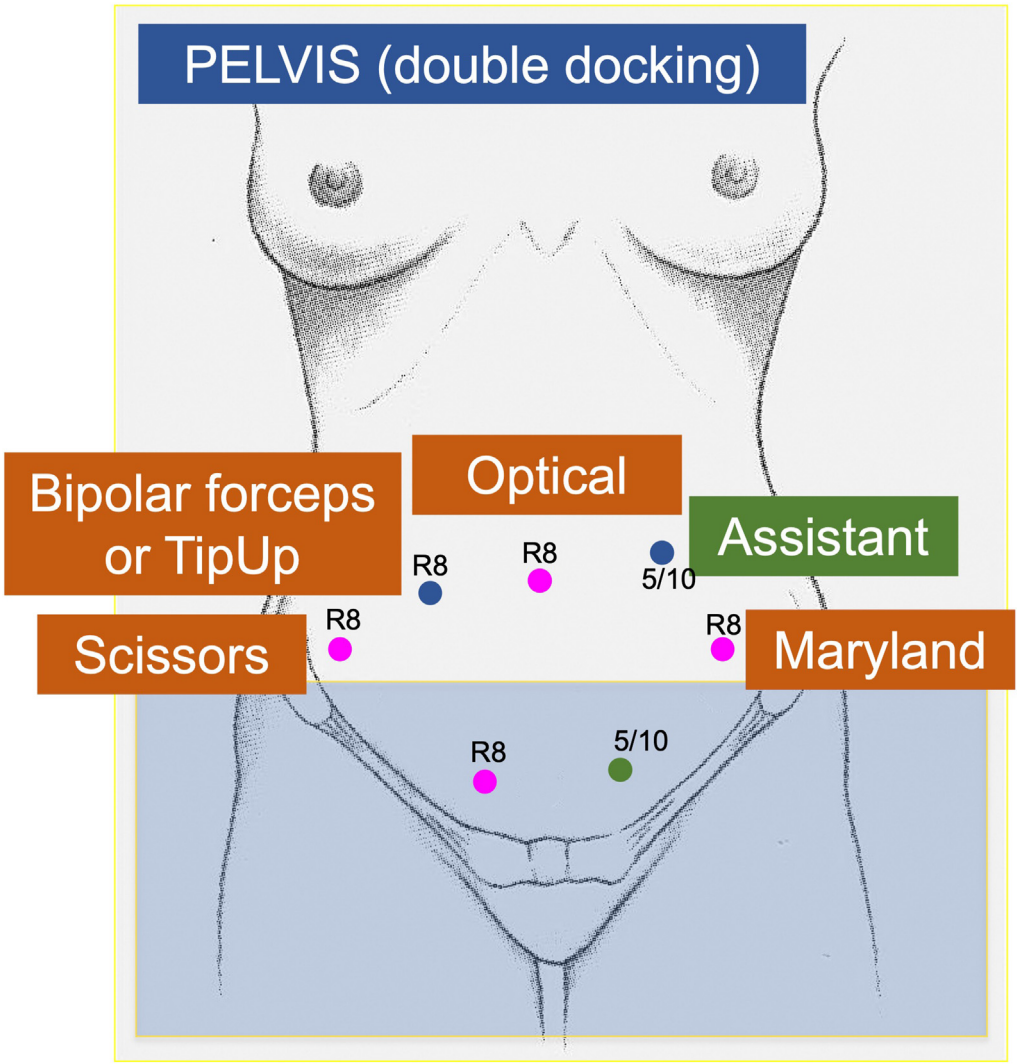

Fig. 2. Pelvic trocar and instruments' location (double docking).

movement of each of the loops towards a subdiaphragmatic position, taking care not to cause any accidental injury and moving them out of the field of work.

The root of the mesentery must be identified, and a longitudinal incision of the peritoneum must be made at the level of the aortic bifurcation, which will allow the subsequent introduction of the intestinal retractor on the roof of our access. Care must be taken not to lengthen the incision so that the patient's peritoneum can function as a tent and keep the loops out of the retroperitoneal dissection field.

Identification of anatomical landmarks. After opening the peritoneal window, a dissection plane is identified that separates the areolar lymphatic tissue from the peritoneal plane. This loose space allows ascending, leaving the lymph nodes still on the great vessels, but ensuring the identification of the limits of our dissection field.

- Caudal: aortic bifurcation, left common iliac vein.
- Left side: left ovarian vein and ureter. Vena cava until left renal vein.
- Cranial: left renal vein.
  -Right side: right ovarian vessels and ureter.

Inframesenteric pre-cava and pre-aortic dissection. The right ureter is identified and moved laterally. The dissection continues with the removal of the lymphatic tissue, initially on the arterial vessels (right common iliac and aorta). In our opinion, starting the dissection on the arterial walls, which are more resistant to surgical trauma, guarantees a better view of the venous field, which is always more fragile and with a greater risk of vascular injury and bleeding.

At this stage of the dissection, the optics with a 30° downward inclination provide a better viewing angle over the great vessels.

Dissection work progresses with the use of monopolar energy (medium power) and small pushing and dissecting movements with the tip of the scissors. When ascending through the anterior face of the aorta, the origin of the inferior mesenteric artery must be identified, which we dissect and preserve in most cases, although its section can be carried out safely if there are no other vascular alterations in the vascular arcade of Riolano.

Inframesenteric left para-aortic dissection. We start from the left common iliac artery, and we must dissect left para-aortic lymph nodes from the aorta until inferior mesenteric artery. Then we have to identify left ureter, lateralize it and complete the lymphadenectomy taking care of lumbar veins. Finally, we can section the lymph node packet at the level of inferior mesenteric artery, or cross it on the artery to continue the supramesenteric lymphadenectomy.

Infrarenal aortic dissection. Ascending cranially, we will reach the level of the left renal vein with a complete and direct view of it, thanks to the caudal positioning of the optics. It allows us a complete and safe dissection of the supramesenteric left para-aortic space until left ovarian vein. It is not uncommon to accurately visualize the major lymphatic ducts that carry the chylous, which we must avoid damaging. Said lymphatic ducts have a very peculiar wall anatomy that makes them refractory to sealing with conventional electrical energy, so their sealing using clips is recommended.

Para-aortic lymphadenectomy and pelvic surgery by double docking approach

In the case of requiring not only an aortic approach but conventional surgery on the pelvis, we recommend the double docking technique, in order to visualize both dissection fields in the most natural position and avoid conflicts between the instruments.

With our proposal, it will be necessary to place only two additional ports, since both the umbilical and those of both iliac crests take advantage of the previous aortic approach.

In other words, it will be necessary to add an 8 mm robotic port between the umbilical and the right iliac for our third robotic instrument. And a new assistant auxiliary port (5/10 mm or Airseal®) between the umbilical and left iliac (slightly more cranial to improve assistant accessibility between constantly moving robotic arms).

The following positioning of the instruments is recommended (Fig. 1).

- Monopolar scissors on the right arm of the robot (number 1)
- TipUp used as intestinal/peritoneal retractor through the umbilical port (number 2)
- 30° optic in the suprapubic port (number 3)
- Fenestrated or Maryland bipolar forceps on the left arm (number 4)
- Auxiliary port for the assistant (aspirator, clamp, Airseal® …)

Again, either device can be exchanged for an advanced sealer, if desired (Vessel Sealer Extend® or Synchroseal®)

In this case 0° optics could be more useful than 30ª one.

Step by step

To address the most complex part at the beginning and finish the procedure in the pelvis, where usually the practice of hysterectomy will provide us with a wide vaginal access for the extraction of all specimens we recommend starting the surgery through the aortic field.

In this sense, we recommend leaving the pieces obtained in different bags (lymphatic ganglions, omentum …) and extracting them through the vagina at the end of the surgery, just before suturing the vaginal cuff.

All the trocars are placed at the beginning of the procedure in order to reduce the initial time, preparing the accesses for the double field (pelvic and aortic) and facilitating the second coupling maneuver (rotation and redocking).

In the case of the Da Vinci Xi® model, arm chard is always located on the patient's right side and does not need to be repositioned for redocking.

To change to the opposite dissection field robot is simply rotated 180°, either by means of the joystick or by changing the default field. In other words, to access the aortic field, select "upper abdomen, patient's right" and for the pelvic field, change to "pelvis, patient's right". With this the arms are perfectly realigned and ready for use. If desired, the optics can be targeted to the target point for each of the fields, with which the robot will proceed to automatically correct small defects that could have persisted in the positioning of the arms.

Indications by tumor

Indications of para-aortic lymphadenectomy in ovarian cancer

Early stage

Despite the lymph node involvement rate of 15% (6%–30%), systematic pelvic and para-aortic lymphadenectomy is still part of early-stage epithelial ovarian cancer staging [5]. No clinical benefit of performing para-aortic staging has been demonstrated in randomized control trials. However, the addition of PARP inhibitors is frequently allowed when extra-pelvic disease is demonstrated. Therefore, in those patients with upstaging due to positive para-aortic lymph nodes [6], a clinical benefit may be achieved. Sentinel node mapping in ovarian tumors is currently in study and seems to be feasible with sensitivity rates around 90% [7,8].

Advance disease

Complete tumor resection in combination with chemotherapy is the standard treatment of advanced ovarian cancer [9]. In this clinical scenario, lymph node metastasis is present in up to 50% of patients and the most important prognostic factor is the presence of residual tumor after surgery [10]. Therefore, when para-aortic lymph node is macroscopically suspected, its removal is indicated. On the other hand, in a prospective, multicenter and randomized study (LION), no benefit from systematic pelvic and a para-aortic lymphadenectomy during primary debulking surgery was observed in patients with macroscopically completely resected advanced ovarian cancer [11]. Therefore, pelvic and para-aortic lymphadenectomy should be avoided for staging purposes when there are no bulky lymph nodes.

Recurrence

Two major prospective, randomized, and multicenter trials have assessed the role of surgery in the recurrence of ovarian cancer. GOG213 trial [12] did not demonstrate any benefit in overall survival nor disease-free survival among patients who underwent surgical treatment plus chemotherapy versus chemotherapy alone. However, a comparison of the complete gross resection subpopulation (150 patients) and the entire no-surgery group (245 patients) shows a median progression-free survival of 22.4 months and 16.2 months, respectively with HR 0.62; 95% CI, 0.48 to 0.80. Additionally, DESKTOP III

trial [13] showed that OS was 53.7 months in the surgery group and 46.0 months in the no-surgery group (HR for death, 0.75; 95% CI, 0.59 to 0.96; P = 0.02) and quality of life after 1 year of follow up did not differ between groups. Consequently, in case of para-aortic recurrence, to consider para-aortic lymphadenectomy seems to provide clinical benefit in addition with chemotherapy.

Indications of para-aortic lymphadenectomy in endometrial cancer

Early stage

The risk of lymph node involvement in patients with apparently early-stage endometrial cancer prior to surgery is between 15% and 25% depending on histology, molecular classification, and clinical risk factors [14,15]. In the last decade, sentinel lymph node biopsy has replaced systematic lymphadenectomy due to high sensitivity and negative predictive value. In a recent meta-analysis [16], overall detection rate observed was 95.6% (95% CI = 92.4%–97.9%), bilateral detection rate of 76.5% (95% CI = 68.1–84.0) and with a negative predictive value of 99% (95% CI = 98.8%–100%) in low- and intermediate-risk endometrial cancer patients. In addition, recent meta-analysis in high-risk endometrial cancer [17] has also reported sensitivity of 92% per patient (95% CI, 84%–96%; $I^2 = 0\%$), a false negative rate of 8% (95% CI, 4%–16%; $I^2 = 0\%$), and a negative predictive value of 97% (95% CI, 95%–99%; $I^2 = 0\%$). These findings suggest that sentinel lymph node biopsy can replace complete lymphadenectomies. However, if pelvic lymph node involvement is found intra-operatively, debulking of enlarged lymph nodes and para-aortic staging can be considered to assess the extent of disease and to provide information for adjuvant treatment decisions [18].

Advance stage

The level of LN metastasis or the substage (IIIC1 vs. IIIC2) clearly has impact on prognosis; the 5-year survivals were 70% among the patients with stage IIIC1 and only 50% with stage IIIC2 [19]. When advanced disease is present, two meta-analyses have concluded that complete cytoreduction to no gross residual disease is associated with superior overall survival [20,21]. Therefore, maximal cytoreduction should be considered only if macroscopic complete resection is feasible with acceptable morbidity [22].

Recurrence

When recurrence is diagnosed in patients with endometrial cancer, radiotherapy is first line treatment depending on the site of disease and any previous treatment. Systemic treatment with chemotherapy, anti-angiogenics or immunotherapy should be evaluated. Para-aortic lymphadenectomy in cases of recurrence can be carefully considered in very selected cases [23].

Indications of para-aortic lymphadenectomy in cervical cancer

Early stage

The most important prognostic factor in early cervical cancer is lymph node status [24]. The probability of pelvic lymph node metastasis depends on the FIGO stage of the diseases, which are approximately 0–8%, 0–17%, and 12–27% in clinical stages IA, IB, and IIA cervical carcinoma, respectively [25]. Currently, the sentinel lymph node (SLN) identification is considered an effective method for this evaluation [25]. The SLN technique has a detection rate of 97% with no false negative in case of bilateral detection [26] and is associated with a lower rate of early lymph-related complications compared with full lymph node dissection [27]. The histological status of SLN should be representative for all other lymph nodes in the regional drainage area, thus, if metastasis is non-existent in the SLN, the risk of regional lymph nodes involvement is very low. Further, lymphadenectomy is therefore not necessary in this group of patients [28,29].

Advance stage

The first extra-pelvic site of spread in local advanced cervical cancer (LACC) is the para-aortic lymph nodes (PALNs), which is involved in 12–25% of cases [30]. Extended para-aortic field radiotherapy, in addition to standard chemoradiation therapy, is recommended for patients with metastatic PALNs [31].

In case of no suspicious PALNs on PET-CT or MRI, PALN dissection still identifies lymph node metastases in 11–12% of all patients with locally advanced cervical cancer, and in up to 21% of patients with pelvic nodal metastases [32]. Thus, it is associated with a significant rate of upstaging in patients, and it should be considered. However, further oncologic results of studies comparing clinical staging versus surgical staging in patients with locally advanced cervical cancer differ considerably. The Uterus-11 trial [33] showed that laparoscopic staging prior to primary chemoradiation in patients with locally advanced cervical cancer was not associated with improved disease-free survival or overall survival. Only patients with FIGO stage IIB benefit from surgical staging prior to primary chemoradiation (HR 0.51, 95% CI 0.30 to 0.86, $p = 0.011$).

Recurrence

Patients with multiple nodal or distant metastases are usually not considered candidates for curative treatment. In cases of localized para-aortic lymph nodes (PALNs), radiotherapy, if possible, in combination with concomitant chemotherapy may be considered. The therapeutic effect of nodal resection/debulking is unclear and should, if possible, always be followed by radiotherapy [34].

Practice points

10 Tips and tricks about robotics

1. Take care of trocar locations and try to take advantage of double docking approach.
2. Before docking arms, place the patient in a proper Trendelenburg position, retract bowels, and cut adhesions to ensure a good field exposure.
3. Never move patient's table with the robot docked.
4. Be careful with medial incisions, avoid cutting trocars. Epigastric vessels run really close to this location.
5. You must see all your instruments anytime on the screen. If you lose one arm, keep helping your assistant but never move your hand without direct visual control. Da Vinci is extremely powered but lacks tactile return.
6. Carefully choose your instruments, the best for each procedure. Take care of costs.
7. Use the medium or low power energy on monopolar Scissor along with bipolar Maryland or Fenestrated forceps.
8. A 10 mm-12 mm Hg pneumoperitoneum by CO2 is regularly used. Even less could be enough if Airseal Platform® is used.
9. Movements on robotics, must be based on your finger and wrist, not on your arms. This is not laparoscopy; you can take advantage of real microsurgery dissection.
10. Check your tower, camera, and all devices before start. You are the only one responsible for your successful or unsuccessful surgery.

10 Tips and tricks about lymph vascular dissection

1. Peritoneal opening should reach the level of common iliac artery bifurcation.
2. Make only a minimal opening on the peritoneum to create an adequate working tunnel. The peritoneum itself, in a tent, can be very useful to keep the bowels out of the working field.
3. Dissection is facilitated if the vascular sheath is opened properly, avoiding collateral vasa vasorum, which may cause some bleeding that avoids correct vision.
4. Artery wall is more resistant than vein wall; it should be better to start dissection on arterial surface.
5. If you find fixed nodes, try to go around, and dissect vascular structures on easier plane before you try to detach the fixed part.
6. If some bleeding occurs, keep calm. First step is control bleeding and assure good vision. If not, you must do a laparotomy, quickly.
7. In case of venous injury, use a gauze, press the hole carefully and wait. Most venous bleeding will stop just by pressing for a couple of minutes. Never apply electric coagulation on a vein wall and

be careful with clips. It should be better to stitch (monofilament suture 4 or 5 zero). Press cranial and caudal the defect to decrease bleeding flow.

8. Around renal vein and going up through mesenteric root, there are a lot of chylous ducts, be careful not to damage those or use clips, selectively. Take into account that standart or advanced vessel sealer devices cannot avoid chylous drainage and obstructing chylous ascites.
9. Protected extraction of dissected tissue is recommended, preferably in endobag device, designed exclusively for this purpose. Avoid inventing handmade devices.
10. The extraction of the bag can be made through the port of greater caliber or, better, vaginally, if hysterectomy is associated.

Research Agenda

- To validate the sentinel node biopsy technique for every gynecologic cancer
- Extend the use of sentinel node biopsy, by using different dyes and detection systems to maximize detection and minimize false negatives
- To describe a technique that is reproducible and with a short learning curve that helps to prevent complications such as vessel injury
- To describe and promote fluorescent-guided aortocaval lymphadenectomy

Mcqs Answers

Nowadays, the sentinel lymph node biopsy has demonstrated an overall detection rate of 95.6% (95% CI = 92.4%–97.9%), a bilateral detection rate of 76.5% (95% CI = 68.1–84.0) and with a negative predictive value of 99% (95% CI = 98.8%–100%) in low- and intermediate-risk endometrial cancer patients. In addition, recent meta-analysis in high-risk endometrial cancer (such as abnormal pf3 or serous histology) has also observed sensitivity of 92% per patient (95% CI, 84%–96%; I2 = 0%), a false negative rate of 8% (95% CI, 4%–16%; I2 = 0%), and a negative predictive value of 97% (95% CI, 95%–99%; I2 = 0%). Therefore, the main indication for para-aortic lymphadenectomy in endometrial cancer is when *suspicious enlarged lymph nodes are suspected in imaging. Macroscopic disease affecting lymph nodes should be resected if complete resection is possible with acceptable morbidity. Complete macroscopic resection is the standard of care and it has superior overall survival compared to no complete resection.*

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The probability of having the para-aortic disease in early-stage cervical cancer is about 0–3%, therefore Pao lymphadenectomy is not recommended in during radical hysterectomy. Despite Pao lymphadenectomy for staging purposes is under debate, the Uterus-11 trial showed that laparoscopic staging prior to primary chemoradiation in patients with locally advanced cervical cancer was not associated with improved disease-free survival or overall survival. Only patients with FIGO stage IIB benefit from surgical staging prior to primary chemoradiation (HR 0.51, 95 %CI 0.30 to 0.86, $p = 0.011$). In addition, this procedure has been described with a low morbidity with <5% in experienced centers. And finally, quick start of systemic therapy in patients with advanced disease has been related with independent factor of survival.

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The most common injuries when performing PAo lymphadenectomy are ureteral injury, lymphoceles, chylous ascites, and vascular injury. It has been well reported with an incidence of 5–20% of the cases. Nowadays, this procedure can be omitted for staging in mucinous carcinoma, clear cell carcinoma, and endometrioid carcinoma because lymph node involvement in this tumor is <10%. LION trial demonstrates that para-aortic lymphadenectomy was not associated with any benefit in terms of overall survival or disease-free survival when there are no suspicious macroscopic lymph nodes during complete cytoreductive surgery by advanced ovarian cancer. Finally, DESKTOP III trial demonstrates a significant benefit in overall

survival when performing complete cytoreductive surgery in addition to chemotherapy for recurrence disease.

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Conflict of interest

Proctor of Intuitive.
Proctor of Conmed.
Proctor of Medtronic.
Proctor of CMR.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.bpobgyn.2023.102401.

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