Robot-assisted Laparoscopic Pelvic and Paraaortic Lymphadenectomy

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Introduction

Pelvic and paraaortic lymphadenectomy is mainly used for staging of genital and other pelvic cancers. Both pelvic and paraaortic lymphadenectomy are well suited for laparoscopy with a low complication rate reported in large series from centers of excellence [1, 2]. Still, despite being described more than 20 years ago, traditional laparoscopic lymphadenectomy, in particular, the paraaortic type, has not been performed at most centers. This is probably due to the complexity of traditional laparoscopy and/or a lack of large enough volumes to introduce and maintain a new surgical approach. The da Vinci surgical robot (da Vinci ® Surgical System, Intuitive Surgical Inc., CA, USA) was approved for gynecological procedures in 2005. So far, four robot systems have been launched (da Vinci standard, S, Si and Xi systems) of which the first (standard) model is no longer kept active by the manufacturer. All models provide instruments with a wrist function at the tip, movement downgrading, tremor elimination, a stable 3-dimensional view of the operative field and an ergonomic working position. These features may help the surgeon overcome some of the limitations associated with traditional laparoscopic surgery.

As no prospective randomized studies compare robotic and laparoscopic pelvic and paraaortic lymphadenectomy alone, available data is restricted to case series with or without retrospective control groups, not seldom data from early robot adopters even using the first robot model with its limitations. Still, the overall conclusion is that robot assistance results in the same or better nodal yield, less bleeding and less conversions to open surgery, in particular in obese patients. [3–8].

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Robot Assisted Laparoscopic Pelvic Lymhadenectomy

All models of the da Vinci robots can be used, although preferably a da Vinci Si or Xi system adapted for the near infrared fluorescent technique (Firefly) which allows for the use of Indocynaine green for detection of sentinel lymph nodes [9]. Ports should be placed for standard pelvic surgery as recommended for the respective systems. The S-Si robot may be docked centrally or side docked at surgeons' discretion whereas the Xi robot can be docked at various positions, usually from the side of the patient. In case of a simultaneous paraaortic lymphadenectomy port placement is adjusted accordingly as described below. Suitable robot instruments are; a monopolar scissors, a bipolar forceps and a grasper. For the assistant one or two trocars are needed for suction/irrigation, grasping, insertion of sponges and for retrieval of lymph nodes, the latter usually requiring a 12–15 mm trocar diameter. The procedure starts with inspection of the whole abdomen and pelvis to rule out disseminated disease. This is best performed before the robot arms and instruments are docked as this allows a complete abdominal overview including the liver and diaphragm and avoids unnecessary cost for robot instruments in case an immediate conversion to open surgery should be indicated.

The pelvic lymphadenectomy starts with developing the avascular planes and identifying landmarks from the aortic bifurcation and distally before any lymphadenectomy is performed. Sentinel lymph nodes (if such technique is applied) or otherwise cancer suspect nodes should be looked for and removed separately for frozen section. Lymph nodes should always be retrieved in a protective bag. It is important to avoid grasping directly on the lymph nodes with robot instruments as this otherwise may crush a potentially metastatic node with risk of tumor spread. In general, the dissection is most easily performed if tension of the tissue is applied and with dissection close to the adjacent vessels.

The presacral and common iliac node dissection starts with opening the peritoneum medial of the right common iliac artery to the level of the aortic bifurcation (Fig. 77.1).

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This way, the right ureter and infundibulopelvic ligament are visualized and lateralized. The third robot instrument (usually the grasper) can be used to lift the sigmoid colon, the infundibulopelvic ligament and the ureter to expose the left common lymph node chain (Fig. 77.2). It is usually helpful to retract the sigmoid colon towards the left abdominal side wall with a sponge reinforced stitch. The hypogastric nerve should be identified at the level of the aortic bifurcation and saved (Fig. 77.3). With the whole presacral and common iliac nodal areas exposed the lymphadenectomy is performed starting with the area medial of the common iliac arteries and the presacral area (Fig. 77.4) followed by the lateral common iliac lymph node chains saving the genitofemoral nerves visualized as they run along the psoas muscles (Fig. 77.2).

The paravesical and pararectal spaces are then opened. This is most easily performed by lifting the round ligament cranially and medially creating a fold of the lateral broad ligament as a starting point (Fig. 77.5). The broad ligament is then incized laterally along the infundibulopelvic ligament and if needed the incision is prolonged lateral of the caecum/sigmoid colon for slight mobilization of the colon. The paravesical space, limited by the pubic bone, the obliterated umbilical artery, the upper paracervical tissue and the exter-

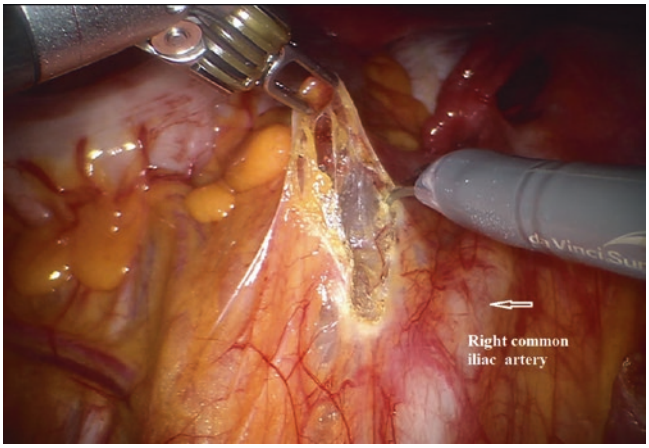

Fig. 77.1 The presacral and common iliac node dissection starts with opening of the peritoneum medial of the right common iliac artery

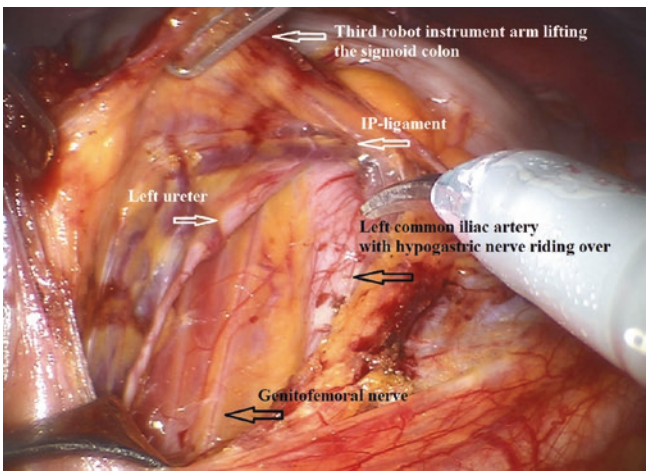

Fig. 77.2 The third robot arm is used for lifting the sigmoid colon to expose the left side common iliac area

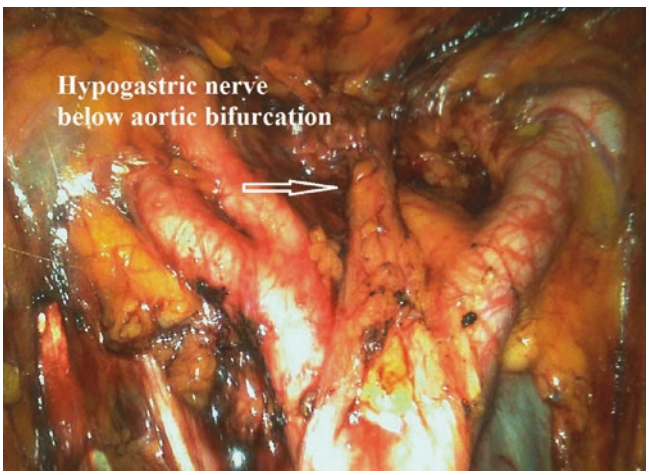

Fig. 77.3 The hypogastric nerve shall be isolated and saved

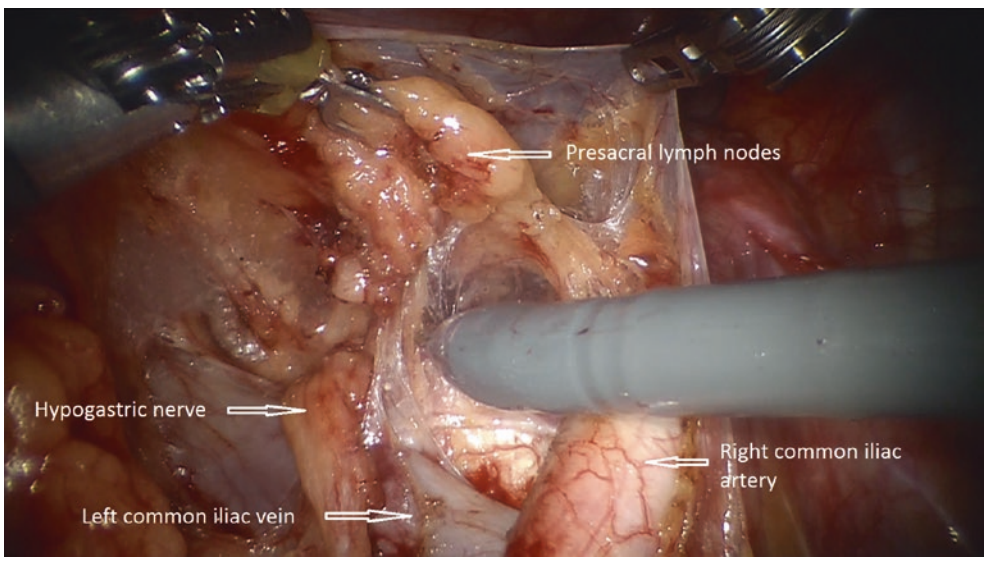

Fig. 77.4 Presacral nodal dissection

nal iliac vessels, is developed bluntly visualizing the course of the obturator nerve and associated deep blood vessels and lymph nodes (Fig. 77.6). Then the pararectal space is opened starting by identifying the ureter running along the medial broad ligament (ideally kept intact until later) and the hypogastric artery as medial and lateral borders (Fig. 77.7). Opened deeper, the pararectal space will display the deep uterine vein, the hypogastric nerve fibers and the origin of the obliterated umbilical artery where the uterine artery is usually found (Fig. 77.8). It is important to keep the upper parametrium (paracervical tissue) intact between the paravesical and pararectal spaces for a later radical hysterectomy or a separate upper paracervical parametrectomy and for not disrupting the lymphatics in case a sentinel node technique is applied (Figs. 77.7 and 77.9). The external iliac node dissection starts with the identification of genitofemoral nerve, usually serving as a lateral border. The superficial lateral lymph chain is then released from lateral to medial and folded over the external iliac artery and completed with the medial nodes and ideally removed en bloc (Fig. 77.10). The deep external nodes and the proximal obturator nodes are removed after the iliac vessels are mobilized medially to expose the obturator fossa and the proximal course of the obturator nerve (Fig. 77.11). Vessels from the ileopsoas muscle to the obturator nodal tissues can be coagulated at this stage as they are a common cause of bleeding during later lymphadenectomy in the obturator fossa (Fig. 77.11). Then, the remaining obturator nodes are removed en bloc following the obturator nerve sparing the obturator vein and exposing the pelvic floor (Fig. 77.12). A check of the whole pelvic retrieval area should be performed at the end.

Finally, it is worth mentioning some risks: It is important to avoid grasping the obturator nerve with the robot instruments as the constant grip force will risk damaging

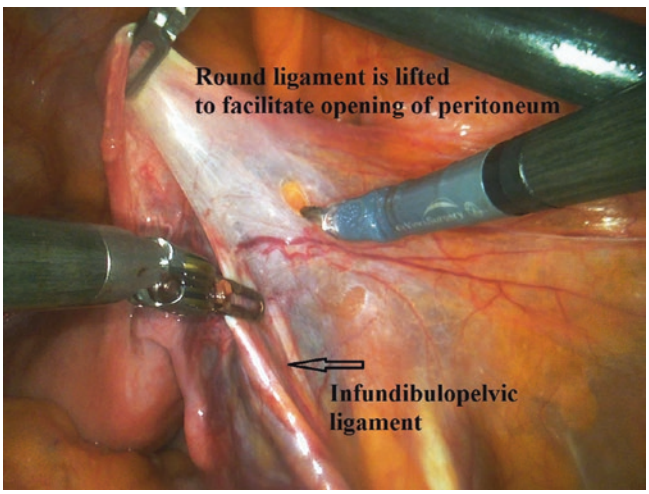

Fig. 77.6 The paravesical space

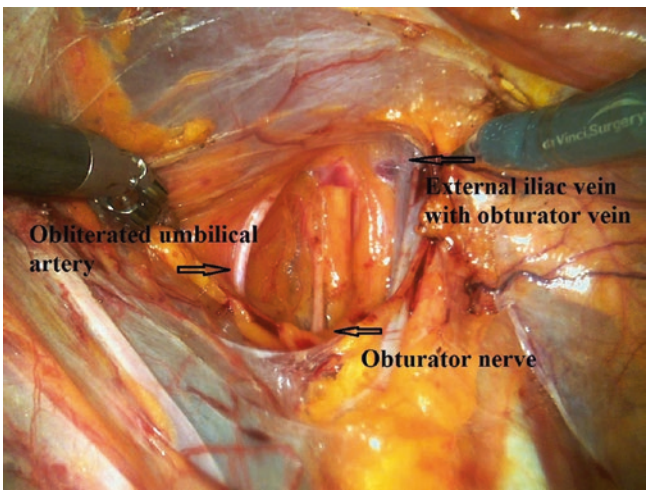

Fig. 77.7 The pararectal space

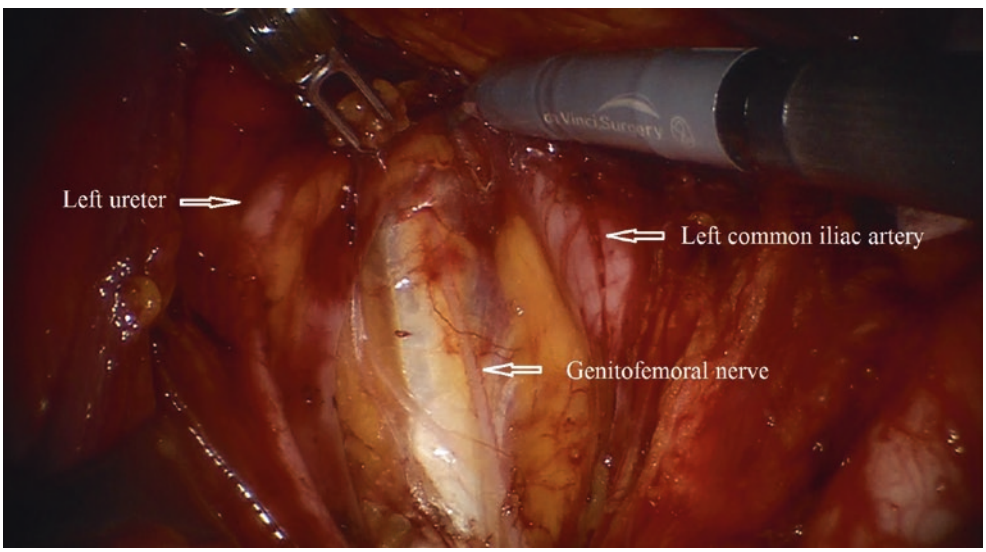

Fig. 77.5 Opening of the pelvic side wall avascular planes is facilitated by lifting the round ligament to create a fold of the lateral broad ligament

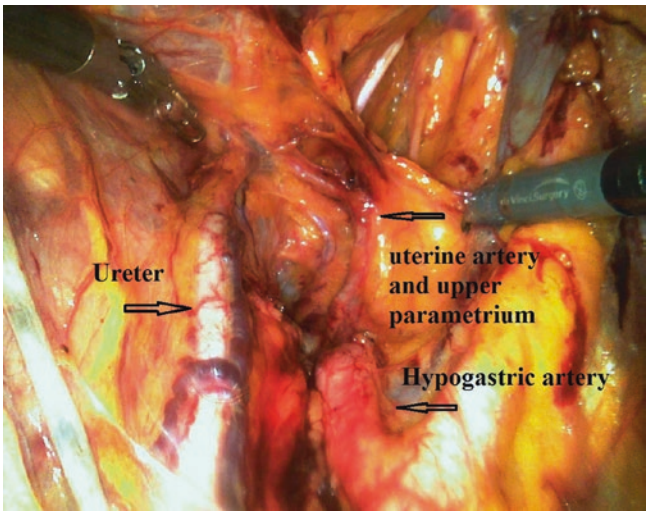

Fig. 77.8 Deeper dissection of the pararectal space

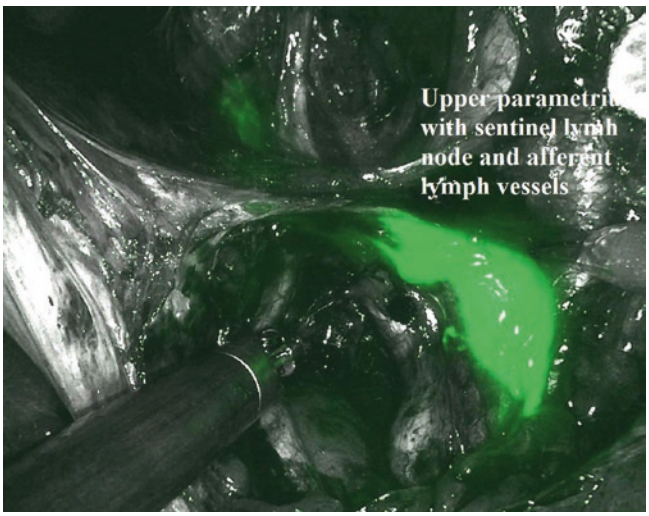

Fig. 77.10 Right side superficial external iliac nodes

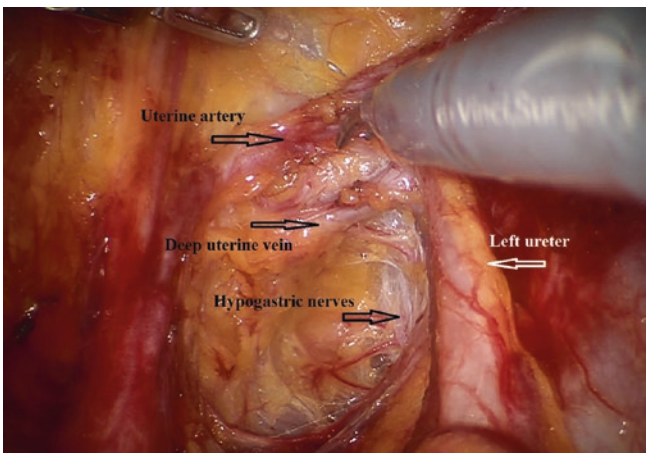

Fig. 77.9 Upper parametrial lymphatics and a sentinel lymph node displayed with the firefly technique

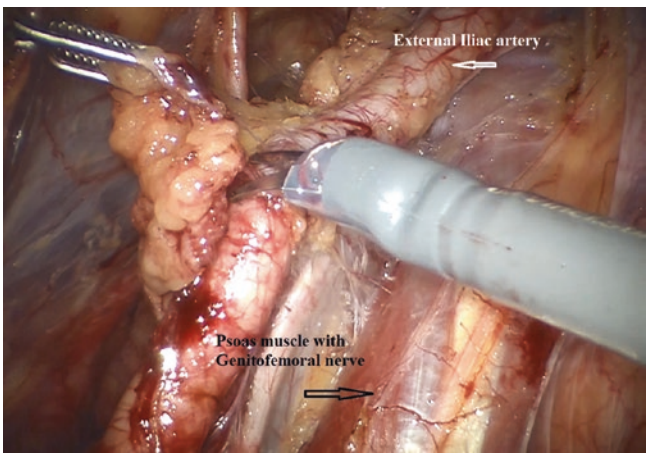

Fig. 77.11 Right side deep external and proximal obturator lymph nodes. *Black arrow* shows blood vessels from the ileopsoas muscle often causing bleeding during obturator node dissection

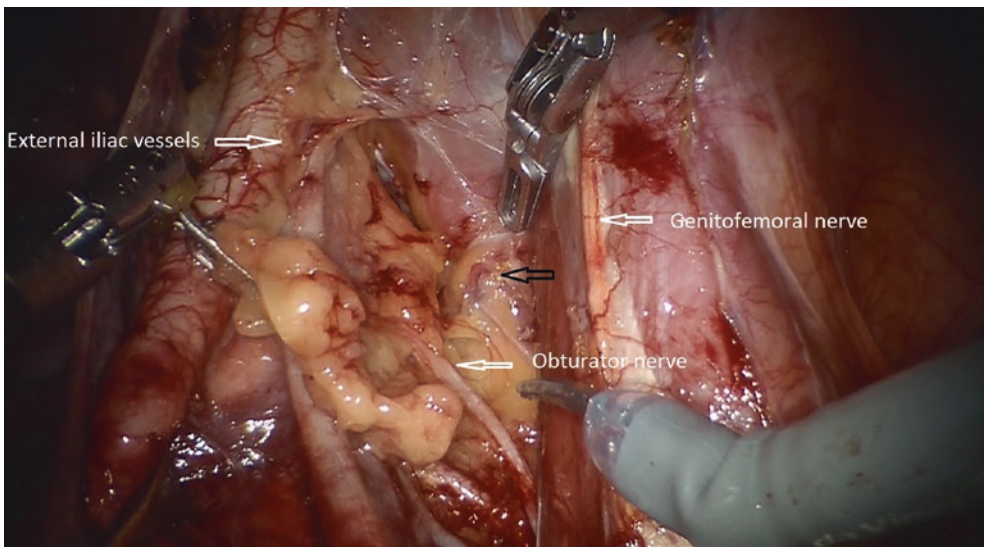

Fig. 77.12 Right side obturator lymph nodes

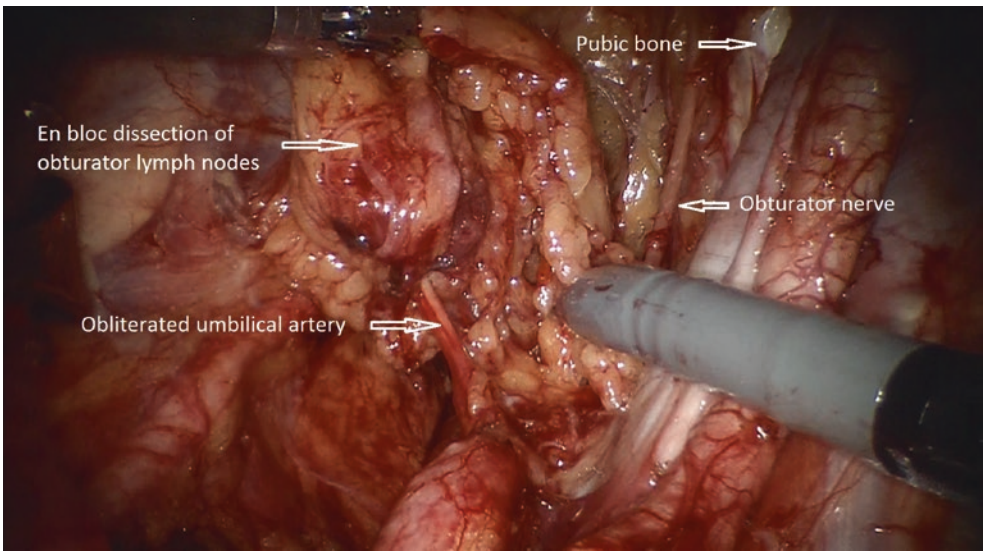

Fig. 77.13 Close proximity between obturator nerve and proximal obturator lymph nodes (left side)

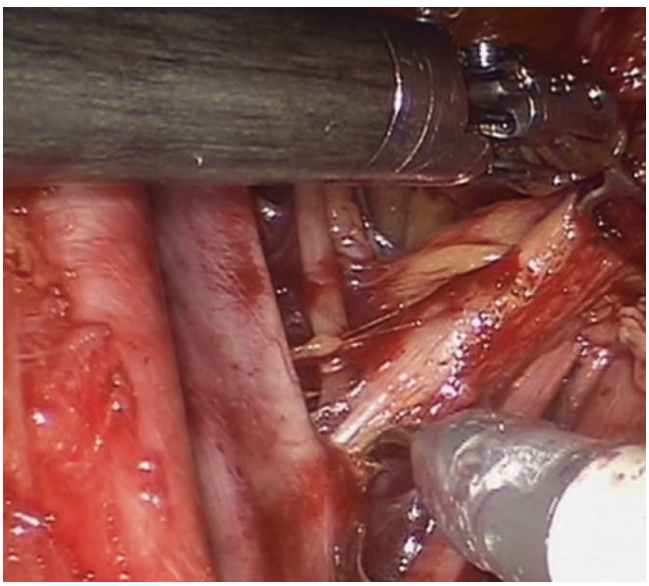

Fig. 77.14 Genitofemoral nerve and Lateralcutaneous femoral nerve (left side).

the nerve. During the final proximal part of the obturator node dissection, if performed from the medial side, extra attention should be given to the nerve to avoid damage of the obturator nerve and hypogastric vein due to their close proximity (Fig. 77.13). A too deep and lateral dissection during the external node removal risks harming the lateral cutaneous femoral nerve (Fig. 77.14).

Robot Assisted Laparoscopic Paraaortic Lymphadenectomy

Paraaortic lymphadenectomy can be performed as a single procedure or in conjunction with pelvic lymphadenectomy and removal of pelvic organs. A retroperitoneal approach may be clinically beneficial in case the paraaortic lymphadenectomy is a single procedure, in particular in case of intraabdominal adhesions and in obese patients. However, with the retroperitoneal approach the space for robot arms is limited and there are no obvious overall advantages with the use of robots compared with traditional laparoscopy [9]. It is likely that the more slender robot arms of the new da Vinci Xi model will be advantageous but this remains to be seen. Therefore, and due to the fact that other procedures are often planned in the same session, a transperitoneal approach will most often be the choice for the robotic paraaortic lymphadenecomy. Principally, this can be performed in two ways: as a proximal prolongation of the pelvic lymphadenectomy along the aorta with the robot docked centrally between the patients legs or side docked for pelvic surgery. This requires ports placed higher than for pelvic surgery only and a steep Trendelenburg position of the patient (Fig. 77.15 and 77.16). This approach may be technically difficult, mainly due to obscuring bowel, and restricted access to the inframesenteric area particularly in obese and short patients [10, 11].

The alternative transperitoneal approach is to place the S or Si robot at the patients head or shoulder and dissect from caudal to cranial through a smaller opening of the

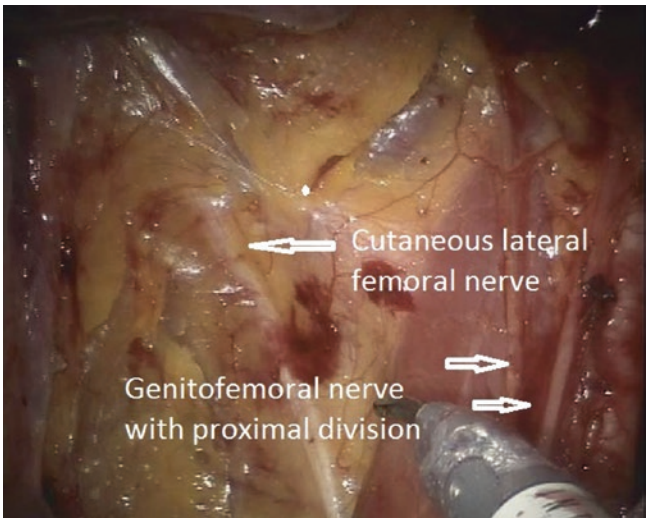

Fig. 77.15 Port placement for paraaortic and pelvic lymph node dissection with pelvic docking of a S-Si robot

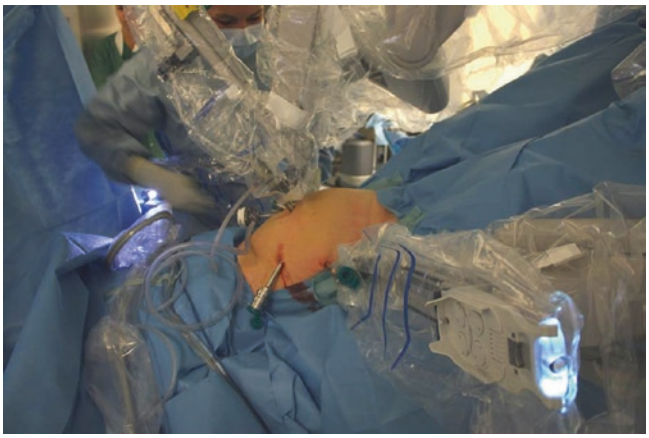

Fig. 77.17 A paraaortic lymphadenectomy with the Xi robot or S-Si robots with double docking starts with creating a tunnel under the bowel along the aorta starting opening the peritoneum below the aortic bifurcation.

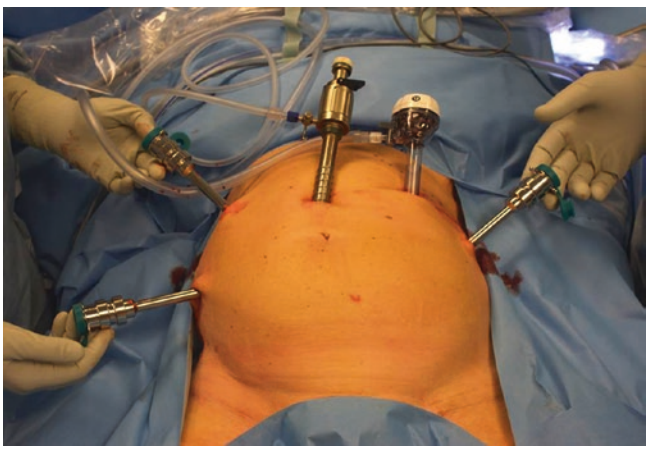

Fig. 77.16 The robot arms should be adjusted to reach the upper abdomen during paraaortic and pelvic lymph node dissection with pelvic docking of the S-Si robot

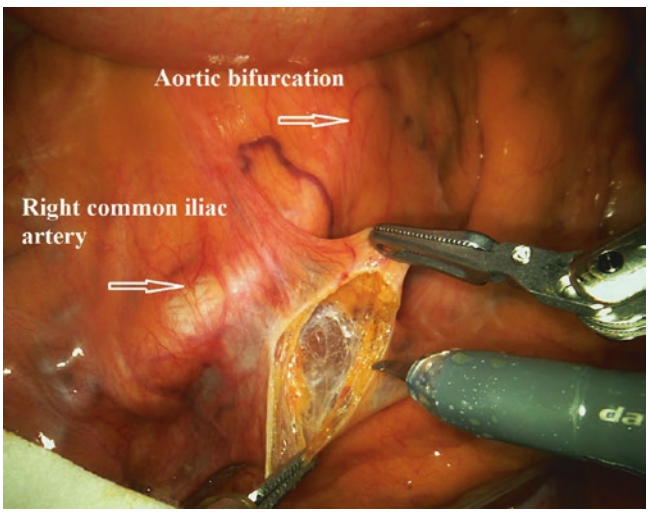

Fig. 77.18 The paraaortic lymph node dissection with the Xi robot starts with a small opening of the peritoneum just below the aortic bifurcation

peritoneum at the level of the bifurcation (Fig. 77.17). This may be beneficial to prevent the bowel from interfering with the surgical field but sometimes requires an additional higher port for optics and a separate upper abdominal assistant's port in case pelvic surgery will be performed during the same session. With the S-Si robots a de-redocking for later pelvic position after the patient has been rotated 180 degrees will be necessary ("double docking"). Alternatively, with the robot initially placed at patients shoulder it can be redocked in a pelvic side position with a smaller adjustment of patients position sideways ("double side docking") and a full 180 degree rotation, often time consuming and cumbersome for the anesthetist, can be avoided.

Using the da Vinci Xi model both these double docking alternatives can be omitted due to the " roof hanged" robot arm boom and the increased range of motion of the robot arms. Instead of a cumbersome rotation of the patient or double docking the robot arm boom can be rotated 180 degrees, either via a swift de-redocking and rotating the whole robot arm boom or by using the increased range of motion of the arms, with the robot fundament unchanged. A rotation of the whole robot arm set provides more space for the assistant using at least one suprapubic port which is necessary for assisting parallel to the robot instruments and for lifting the roof of the peritoneal tunnel created over the aorta (Figs. 77.18, 77.19 and 77.20).

The basic surgical principle for all approaches is similar. All surgery requires a good anatomical knowledge and awareness that approximately one third of patients have some vascular anomaly in the paraaortic area [12–14]. A preoperative

Fig. 77.19 Paraaortic lymphadenectomy with the Xi robot. Note position of the robot arm boom

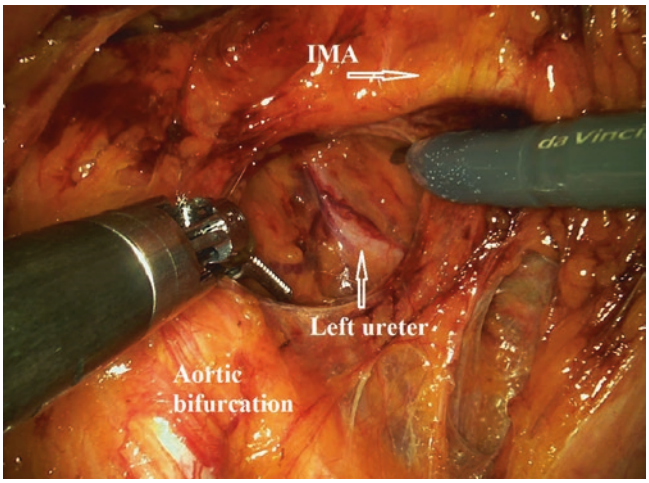

Fig. 77.21 Visualization of the left ureter and the IMA

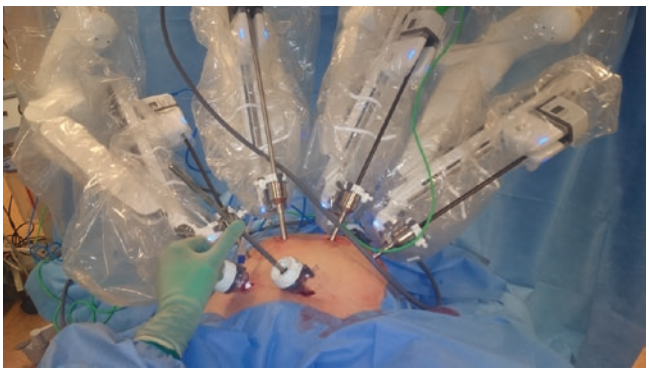

Fig. 77.20 Position of assistant and assistants trocars for a paraaortic lymph nodes dissection with the Xi robot

CT scan of the abdomen should include information on any major blood vessel anomalies and in case of enlarged lymph nodes an exact position of those related to easily identified vascular landmarks. It is particularly important that the whole staff is familiar with all used assistants instruments, hemostatic agents and that an emergency de-docking plan is implemented. Although conversion to open surgery due to bleeding rarely occurs, a laparotomy set including vessel repairing instruments should be readily available. The anesthetist should be asked to keep fluid balance on the negative side to avoid too distended veins. In all, everyone should be prepared and experienced with their respective tasks.

Usually, it is beneficial to use the Palmers' point entry and a similar position of the 12 mm assistants' trocar as this allows an intraabdominal overview of the position of the optics trocar and a partial removal of the lower falciform ligament that sometimes hinders an optimal position of the optics trocar. This entry point also allows for the release of midline oriented adhesions as well as diagnosing a previously unknown umbilical hernia. The incision for the optics trocar should be kept minimal to avoid leaking of gas and minimize the risk for the optics trocar to slide out if some retraction is necessary. For the same reason, it is often beneficial to use an optics trocar with outer ridges or a balloon trocar. The remaining trocars are then placed (Fig. 77.15). An overview of the abdomen to rule out disseminated disease should be performed before docking the robot instruments. The necessary degree of Trendelenburg is controlled from inside with the optics. After docking the robot the range of motion of the robot arms should be optimized to reach the paraaortic area (Fig. 77.16).

With the Xi robot or in case of double docking/patient rotation it is recommended to initiate the procedure as described above but also place at least one suprapubic assistant's port for the paraaortic dissection (Figs. 77.19 and 77.20). The paraaortic dissection starts with making a 5–6 centimeter peritoneal incision just below the aortic bifurcation as a tunnel opening (Fig. 77.18). With the aid of the fourth arm and instruments inserted via the supraumbilical assistant's port the roof of the tunnel is elevated simply by using the shafts of closed instruments inserted to the apex of the created tunnel. Then, before any attempts of lymphadenectomy, a gradual further cranial dissection to fully visualize the anatomical landmarks and potential vessel anomalies to the level of the left renal vein is performed (Figs. 77.21, 77.22 and 77.23). For finding the left supramesenteric part of the ureter, which is often runs deep, it is usually helpful to dissect the left ureter as far cranially as possible when exploring the left side inframesenteric part. The main left and right side hypogastric nerve branches is usually possible to preserve without compromising the lymphadenectomy (Fig. 77.24). The lymphadenectomy is performed from cranial to distal. The upper limit of the dissection can be marked with a titanium clip.

With this approach, the access is usually good, and with less obscuring bowel compared with the technique described

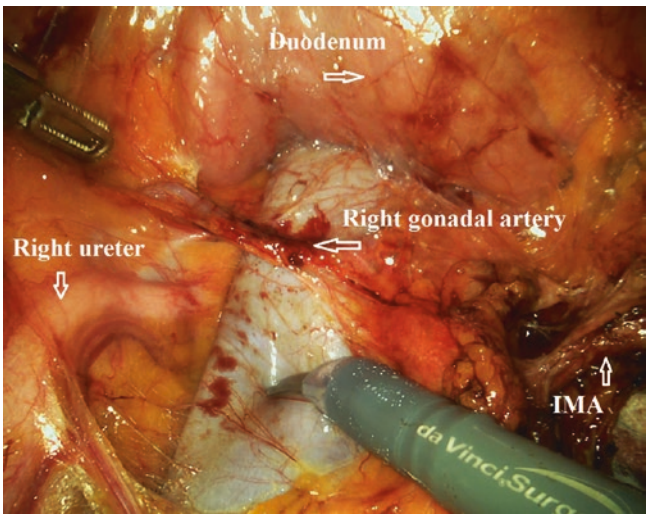

Fig. 77.22 Dissection of the paracaval right side visualizing the right ureter and gonadal vessels

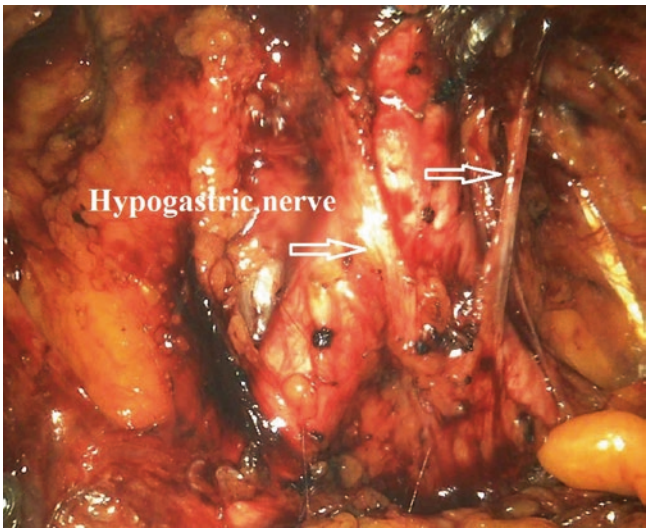

Fig. 77.24 The right and left branches of the hypogastric nerves can usually be preserved

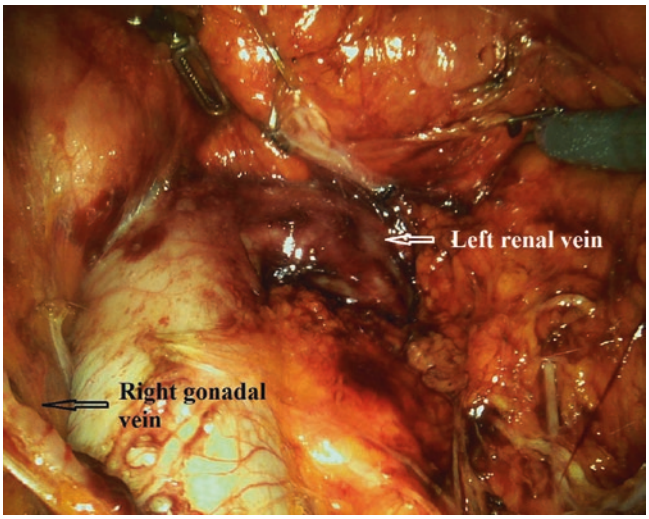

Fig. 77.23 Reaching the left renal vein with requires a gentle lift of the duodenum

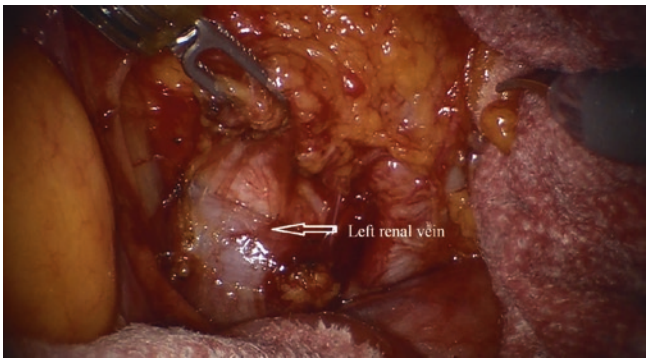

Fig. 77.25 Reaching the left renal vein with pelvic position of the S-Si robots usually requires help of two assistants retractors and sponges

below. The disadvantages are the need for one or two suprapubic assistant's ports, the need for rotation of the patient, and the lower robot port placement needed for an adequate angle related to the aorta. This results in a more perpendicular instrument angle for the lower paraaortic and upper pelvic lymphadenectomy and a shorter distance from the pelvic operative area to the optics with a decreased overview and more need for cleaning of the lens.

With the pelvic position of the robot, the operation starts with retracting the sigmoid colon against the left abdominal wall with one or two sponge reinforced sutures through appendices epiploicae. Then the caecum and ascending colon are mobilized by incizing the lateral peritoneum as far up as possible. The small bowel mesentery is often adherent to the IP-ligament and has to be released to allow the small bowel to retract cranially. The peritoneum is then opened medial of the right common iliac artery to the level of the aortic bifurcation and further to the inferior mesenteric artery (IMA) and the ureters, the IP-ligaments and the hypogastric nerve are visualized similar to the onset of a pelvic lymphadenectomy (Figs. 77.1, 77.2 and 77.3). The third robot arm grasper is useful for further lifting the sigmoid or retracting the right ureter and IP-ligament. The lower paraaortic and paracaval lateral areas are then opened carefully to clearly explore the vessel anatomy. Then the IMA is skeletonized and the dissection continued to reach the level of the left renal vein (Fig. 77.25). The role of the assistant at this stage is to lift the proximal peritoneal fold to prevent the small bowel from interfering with the surgical field, sometimes

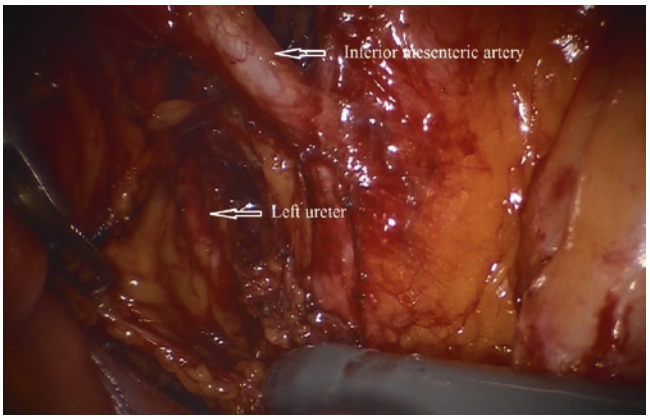

Fig. 77.26 The left supramesenteric part of the ureter must be visualized and lateralized before removing lymph nodes

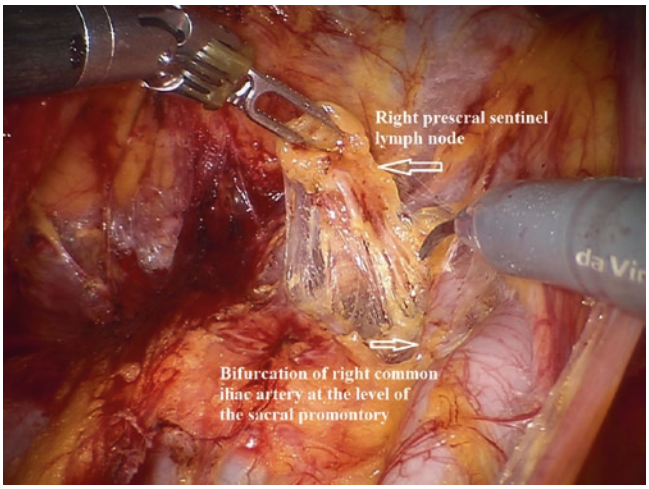

Fig. 77.27 Right side presacral dissection

requiring a second assistants' port and a several sponges. The third arm is used for retracting the left side of the peritoneal opening at desired level. The origin of the IP-ligaments and the gonadal arteries are identified as well as the ureters in the supramesenteric area, in particular on the left side where the course of the ureter is deeper (Fig. 77.26). The ureter must be lateralized before removal of the lymph nodes.

After exploring the whole operative field a final view of the vessel anatomy is obtained before the lymphadenectomy begins. The order of dissection is optional but it usually a good idea to start cranially and with the left supramesenteric paraaortic area as this tends to be the most difficult part, followed by the intraaortacaval and finally the precaval parts. Any bleeding from previous distal dissection may also be cumbersome when the supramesenteric dissection is performed. In case leaking of large amount of lymphatic fluid occurs, in particular if opaque/chylous, it is important to find the leak and close it with clips as it may be associated with later development of chylous ascites. A metal clip marking the proximal limit for the dissection is often appreciated by the radiooncologists. Finally the inframesenteric nodal dissection is performed compartmentwize. Attention should be given to free nodal tissue under the IMA which is easily overseen. It is usually possible to free and save the main branches of the hypogastric nerve running from right to left over the inframesenteric aorta via the aortic bifurcation and then further on presacrally (Fig. 77.24).

Effort should be made to achieve good hemostasis throughout the procedure, not only to reduce the risk for a major bleeding and conversion but to avoid time consuming hemostatic actions. Before nodal dissection it is recommended to have a laparoscopic sponge in the abdomen practical for simultaneous suction and compression of smaller bleeds i.e. from Fellows veins that usually stops with compression with or without help of surgical hemostatic agents. Smaller arterial bleeds are best controlled with clips or bipolar diathermia whereas vessel damage considered inappropriate for compression or diathermia may be sutured. Any attempt to repair a larger bleed should include a temporary control, i.e. by grasping with the robot instruments and only after optimizing the surgical and anesthesiological situation the actual repair should be attempted. It is for safety reasons important to strongly discourage from repeated unsuccessful attempts to control a bleed.

The near infrared fluorescent technique for detection of sentinel lymph nodes is available with the Xi and Si systems. By the use of an adapted light source, optics and software the used tracer (Indocyanine green) will appear green against a grey background. So far, no standardized technique of injection sites, dosing and timing for the use within gynecology are agreed on but several centers perform studies. A standardization must include knowledge of the lymphatic anatomy, a clear definition of sentinel lymph nodes and a defined stepwise surgical algorithm. The tracer has a rapid spread leading to many coloured lymph nodes which cannot all be defined as sentinel lymph nodes. Therefore, the afferent lymph vessel in each major lymphatic chain must be identified to define the node closest to the tumour (the sentinel lymph node). Hence the retroperitoneal dissection must be performed meticulously to avoid cutting lymph vessels. To avoid disturbance from tracer leakage during sentinel node remove, dissection of nodes preferably starts cranially, i.e. with the presacral nodes (Figs. 77.27 and 77.28) followed by the pelvic side walls (Figs. 77.29 and 77.30). In case of no uptake of tracer a full lymphadenectomy shall be performed. In this situation it is particularly important to look for macroscopically cancer suspect nodes.

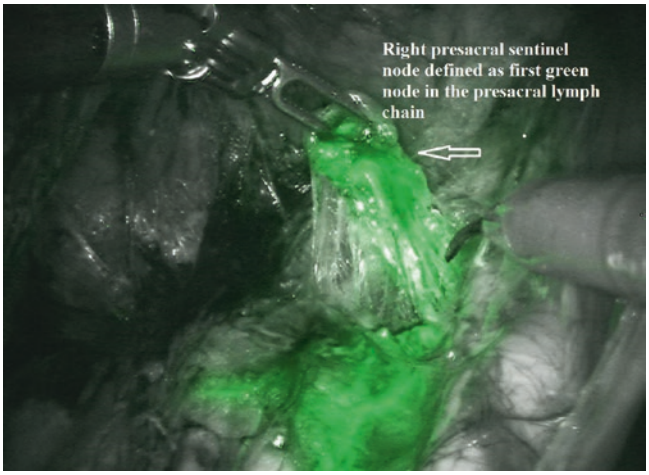

Fig. 77.28 Right side presacral dissection with the firefly technique

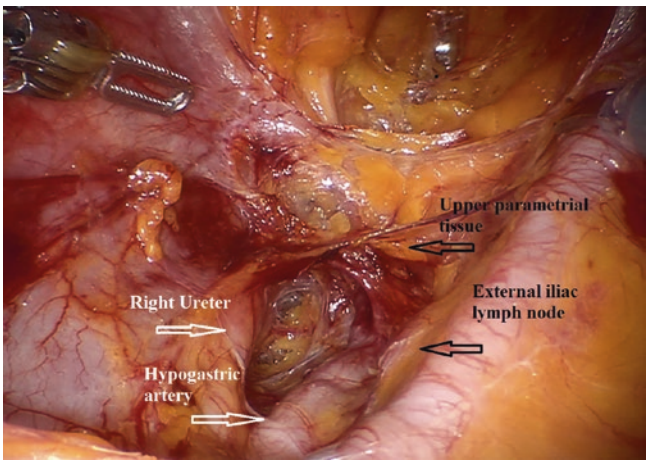

Fig. 77.29 Right upper paracervical/parametrial tissue

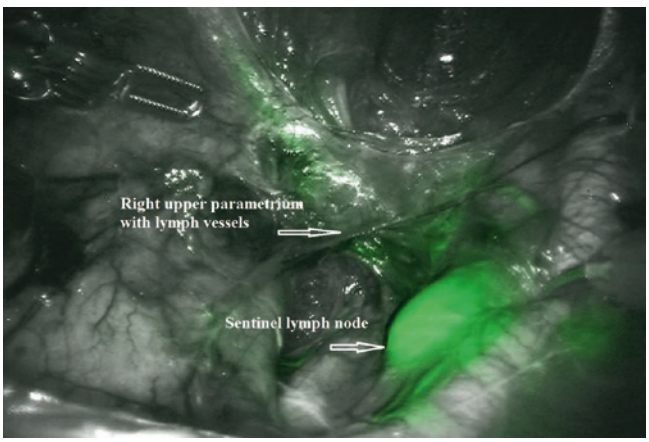

Fig. 77.30 Right upper parametrium seen with the firefly technique

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