

# Technical considerations to minimize complications of inguinal lymph node dissection

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**Abstract:** Penile cancer is a rare malignancy with a high propensity for regional dissemination. Current guidelines recommend inguinal lymphadenectomy in patients with penile cancer for palpable inguinal lymph nodes or in certain cases of nonpalpable inguinal lymph nodes. For many years, this procedure was performed with a traditional open approach and carried significant morbidity due to severe lymphedema, flap necrosis, wound infections, and seroma formation. The evolution of inguinal lymphadenectomy surgery for patients with penile cancer to a more minimally invasive approach has greatly reduced the morbidity of the procedure. Complications of inguinal lymphadenectomy can be minimized with modifications in surgical approach with the use of endoscopic, robotic, and various reconstructive methods. This review focuses on various intraoperative techniques to reduce morbidity in inguinal lymphadenectomies for penile cancer.

**Keywords:** Inguinal lymphadenectomy; groin dissection; penile cancer; lymph node excision; minimizing complications; saphenous vein sparing

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## Introduction

Penile cancer is a rare malignancy with an annual incidence of less than one in 100,000 men worldwide (1). The presence of inguinal adenopathy is a likely indication of metastatic disease as the earliest site of regional dissemination of penile cancer is the superficial and deep inguinal nodes followed by the pelvic lymph nodes, including the external and internal iliac nodes (2). However, metastatic disease to the groin can be present without palpable inguinal lymph nodes. In both circumstances meaning palpable and nonpalpable adenopathy, groin lymphadenectomy has become the procedure of choice as a diagnostic and therapeutic modality. Current guidelines recommend inguinal lymphadenectomy in patients with penile cancer for palpable inguinal lymph nodes or in the event of nonpalpable lymph nodes where pathologic stage

T2 or greater, the presence of lymphovascular invasion, or poorly differentiated histology (3). However, this procedure carries great morbidity and current literature estimates complication rates greater than 50% for radical inguinal lymphadenectomy (4). The most common complications are lymphedema, deep venous thrombosis (DVT), wound infection, skin necrosis, lymphocele, and seroma (5). Our aim is to identify complications of inguinal lymphadenectomy that may be minimized with modifications in surgical approach.

In 1988, Catalona first described the technique of saphenous vein preservation (6). The goal of Catalona's approach was to minimize lymphedema, a complication occurring in 13% to 55% of cases (7). Thereafter, an endoscopic technique for performing inguinal lymphadenectomy was described by Bishoff and associates in 2003 on human cadavers (8). Tobias-Machado *et al.*

demonstrated that surgical morbidity could be reduced while maintaining adequate oncological outcomes utilizing the endoscopic technique proposed by Bishoff *et al.* (4). In a comparison of video endoscopic inguinal lymphadenectomy (VEIL) versus the conventional open approach, Tobias-Machado found a 20% complication rate in the VEIL group versus a 70% complication rate in patients who underwent conventional open lymphadenectomy. Most notably, there was a decrease in wound breakdown in the patients who had undergone the endoscopic procedure versus those who had open surgery (9). In a larger series of patients in the United States, Master *et al.* demonstrated 14.6% major complication rate and no cases of severe lymphedema or mortality (10).

In an effort to further curb complication rates, several studies have focused on the use of a myocutaneous or omental flap in groin dissection (7). As demonstrated by Nirmal *et al.*, muscle flaps have the advantage of an improved blood supply and prevent wound necrosis (11). Meanwhile Benoit *et al.* believed that omental tissue could act as a drainage agent in order to prevent lymphedema (12).

In this review, we will focus on various intraoperative techniques to reduce morbidity in inguinal lymphadenectomies for penile cancer.

### Saphenous vein preservation

Catalona [1988] first described the technique of saphenous vein preservation with the goal of minimizing complications in inguinal lymphadenectomy (6,13,14). In a study of six patients, Catalona proposed a modified inguinal lymphadenectomy which focused on minimizing lymphedema. This approach also consisted of a shorter length of the incision and a flap superficial to Scarpa's fascia. Emphasis was placed on a smaller window for the dissection. In their study, the principal researcher did not extend the surgical area deeper than the fossa ovalis or lateral to the femoral artery in an effort to curb morbidity (1). Once the dissection was carried out, the main trunk of the saphenous vein was identified and preserved while the tributaries to the vein were ligated with silk suture ties. Of the six patients, none had debilitating lymphedema after ligation of the smaller branches of the saphenous vein. Catalona did note minor wound necrosis in one patient which healed without incident and cellulitis in a different patient which required surgical intervention to resolve (6).

In a large multicenter review of patients with squamous cell carcinoma of the penis who underwent modified

inguinal lymph node dissection as described by Catalona with saphenous vein preservation, Gopman *et al.* analyzed 327 patients for postoperative complications (15). They determined that 181 patients (55.4%) had a postoperative complication with 119 (65.7%) determined to be minor and 62 (34.3%) considered major. Twenty-four (7.3%) cases required surgical intervention for either a wound infection, hematoma, lymphocele, seroma, or a fistula (15). Wound infections were the most common complication overall. Notably, the rate of wound infections was lower for subjects in the study who had undergone the procedure after 2008. The study showed the most statistically significant prognosticators for minor complications were pelvic node dissection ( $P=0.007$ ), total number of lymph nodes removed ( $P<0.001$ ), and pathologically positive lymph nodes ( $P=0.008$ ). For major complications, lymph nodes determined to be positive pathologically were predictive of major complications ( $P=0.02$ ). The rate of complications in this study was similar to previous data. Since lymphedema can occur as a later outcome of inguinal lymphadenectomy, it was excluded due to lack of adequate follow up time in the subjects (15).

Other retrospective reviews have also analyzed saphenous vein sparing in patients undergoing inguinal lymphadenectomy (7). In a comparison of 139 groin dissections, 62 underwent preservation of the saphenous vein while in the remainder the saphenous vein was ligated. The saphenous vein preservation subjects had lower rates of acute cellulitis (18%) versus the patients who had saphenous vein ligation (39%). In the six months after surgery, lymphedema was higher in the saphenous vein ligation group (70%) versus the vein-spared subjects (32%). In the long term, patients with vein ligation were also more likely to have chronic lymphedema (7).

A meta-analysis consisting of four studies of patients who have undergone inguinal lymphadenectomy with saphenous vein preservation showed a reduction in the rate of lymphedema (OR 0.24, 95% CI 0.11–0.53). Wound necrosis was also lower (OR 0.34, 95% CI 0.19–0.59) in comparison to patients who had a radical inguinal lymphadenectomy. Similarly, the meta-analysis also demonstrated lower rates of acute cellulitis in the saphenous vein preservation group (OR 0.4, 95% CI 0.16–0.96) (7).

### VEIL—a minimally invasive approach

A major change in radical inguinal lymphadenectomy came in 2006 when Tobias-Machado *et al.* and later Sotelo

described a minimally invasive approach for performing inguinal lymph node dissection in a patient series originating in South America (8,16). Master and colleagues modified and extended the template of their contemporaries to serve as a model suitable for complete inguinal lymph node dissection for melanoma and other cutaneous malignancies (17). More recently, an endoscopic approach to mitigate the risk and morbidity has become popular for the management of penile cancer. Here we briefly describe the approach which has been previously published (8,9,14,16,18).

### *Anatomic boundaries*

The anatomic landmarks for the inguinal lymphadenectomy procedure are defined in relationship to the femoral triangle. The adductor longus forms the medial border, the Sartorius muscle the lateral border, and the inguinal ligament forms the superior border of the triangle. The femoral vessels form the floor of the triangle and provide a surgical landmark for the depth of the procedure.

### *Positioning*

The patient is then placed on the surgical operating table in frog leg position with all borders of the femoral triangle carefully marked on the patient's skin. The triangle with the aforementioned borders is designed with the base extending from the anterior superior iliac spine to the pubic tubercle. One edge of the triangle courses along the Sartorius muscle (lateral border) and the other edge along the adductor longus muscle (medial border) inferiorly towards the apex of the triangle.

### *Trocar port placement*

A 2-cm skin incision is made distal to the apex of the femoral triangle of the extremity. The dissection is carried out until the level of Scarpa's fascia is reached. Here, a 10-mm trocar is introduced while an insufflation pressure of 15 mmHg is reached. The pressure allows for the creation of visual space after an endoscope is introduced into the port trocar. Once the endoscope is inserted into this visual space, it is important to ensure appropriate trans illumination to prevent damage to superficial blood vessels. Using digital dissection to reach the level of Scarpa's fascia can be beneficial in minimizing blood loss and obtaining an area for trocar placement. Next, from the apex, a mark is made

6 cm both laterally and medially. At the site of these two markings, a 1-cm skin incision is made again to the level of Scarpa's fascia. Next, a 5-mm trocar is inserted into each of these smaller incisions.

### *Identification of landmarks, dissection*

Once the ports are established and adequate pressure is maintained, the goal is to identify the significant anatomic landmarks for resection of the affected lymph nodes. The anterior working space consists of the femoral vessels that form the floor, the adductor longus muscle medially, the Sartorius muscle laterally, and the inguinal ligament superiorly. Removal of the nodes occurs in the femoral triangle and proceeds into fossa ovalis.

Postoperatively, antibiotics are usually discontinued within 24 hours but are generally given perioperatively if given at all. The drain is left in place until the output is less than 50 cc per day. In addition, all patients are instructed to wear compression stockings.

The work of early pioneers was significant as it established the feasibility of the endoscopic approach. Bishoff *et al.* performed studies on human cadavers but were not able to successfully complete the endoscopic approach on a patient (4). Later in 2008, Tobias-Machado and others compared their original endoscopic approach to the standard open procedure (9). In this study, they compared 20 VEIL to 10 open procedures to assess morbidity. The researchers found a 70% complication rate in the open approach versus 20% in the VEIL group ( $P=0.015$ ). Major complications within both groups included wound necrosis and varying degree of lymphedema. Overall, operative time was longer in the VEIL group due to technical demands of the approach described by the authors. However, hospital stay and time to resumption of daily activities was shorter in the VEIL group (9). Master *et al.* proved the feasibility of the endoscopic approach for groin lymphadenectomy in cutaneous malignancy as well as penile cancer. In a series of 41 groin dissections performed with a mean follow up of 2 years, there were five cases (12%) of seroma formation and five cases (12%) with mild to moderate lymphedema postoperatively. There were no cases of severe, debilitating lymphedema nor any deaths associated with the procedure. There was one case (2.6%) of flap necrosis while three patients (7.8%) required readmission for a 2-week course of intravenous antibiotics. A major limitation of this study was no randomized controlled arm comparing the endoscopic approach to open lymphadenectomy surgery.

The endoscopic approach has made a significant impact on reducing the morbidity and complications seen with the traditional open procedures.

### **Laparoendoscopic single-site (LESS) lymphadenectomy**

Yuan *et al.* combined the endoscopic techniques presented by Tobias-Machado and others with a laparoscopic approach to saphenous vein preservation which they termed LESS lymphadenectomy (14). In the method they described, a 2.5-cm incision is made distal to the apex of the femoral triangle, and a single multi-access port is placed within the incision. After careful dissection, the saphenous vein was identified and all smaller tributaries of the greater saphenous vein were ligated. In their study, 12 patients with penile cancer who were set to undergo bilateral inguinal lymphadenectomy surgery were followed and had the LESS procedure in one lower extremity and the conventional endoscopic approach in the opposite extremity. There was no significant difference in postoperative complications, operating time, or lymph node detection rate. None of the patients in this study suffered from lower extremity edema postoperatively. The patients who underwent LESS reported better cosmesis with the single incision than the patients in the conventional endoscopic group ( $P=0.039$ ) (14). Additional studies comparing LESS to other minimally invasive techniques are needed.

### **Robotic-assisted video-endoscopic inguinal lymphadenectomy (RAVEIL)**

A robotic approach to endoscopic inguinal lymphadenectomy surgery allows for 3-dimensional visualization of the surgical field and improved dexterity in comparison to laparoscopic techniques (19). The feasibility of the robotic technique for groin lymphadenectomy was first reported by Josephson *et al.* conducted in one patient (20). Later, Matin *et al.* demonstrated the oncological efficacy of performing RAVEIL. Of 19 inguinal lymph node dissections performed, 18 (94.7%) had an adequate dissection, measured by nodal yield (21). While anatomic landmarks remained the same for RAVEIL as compared to the VEIL approach, a 1–2-cm incision was created inferior to the apex of the femoral triangle to create a working space for three robotic ports and one assistant port.

Operative time is longer in RAVEIL cases but patients had a shorter duration of hospitalization

postoperatively when compared to the traditional open approach (22). Many of the initial studies conducted did not provide adequate follow up of patients undergoing lymphadenectomy using the robotic approach and thus complications such as lymphedema were not reported. In a comparison of RAVEIL and VEIL, Russell *et al.* examined 34 endoscopic inguinal lymphadenectomies. In the subjects who underwent RAVEIL ( $n=27$ ), two limbs had cutaneous complications while one patient suffered from a lymphocele. Each of these complications was found in the first 30 days after surgery. There were no long term complications, however, mean follow up in this study was less than 6 months. In the VEIL group ( $n=7$ ), there were 3 (43%) patients who suffered from complications, including DVT, lymphedema, and flap necrosis. The researchers concluded that an endoscopic approach, such as RAVEIL, may help to reduce complication rates while maintaining adequate surgical outcomes. Saphenous vein sparing decreased complication rates ( $P=0.02$ ) and RAVEIL resulted in a greater chance of successful saphenous vein preservation when compared to VEIL ( $P<0.01$ ) (23). Nonetheless, further studies comparing the two modalities are needed to make a definitive conclusion.

### **Fascia lata preservation**

Preservation of the fascia lata in inguinal lymph node dissections was recently examined and found to have a reduction in postoperative complications (24). Dissection was completed by preserving the fascia of the major anterior thigh muscles of the femoral triangle. Preserving the fascial layer of the muscles ensures that the unidirectional valves of the veins and lymphatics present within the muscles continue to allow blood and lymph toward the heart (24). This, in turn, would prevent lymphedema forming in the lower extremities after inguinal lymph node dissection. The researchers used an open approach with a curvilinear incision extending across the base of the femoral triangle. A flap was formed between the superficial and deep layers of Camper's fascia. This flap was later sutured to the fascia lata to eliminate dead space after removal of superficial and deep inguinal nodes. In this study of 201 dissections with preservation of the fascia lata, 31 (15.4%) ended with complications. Lymphedema accounted for 11.8% of these complications and was minor in most cases; however, there were five cases (3.3%) of severe lymphedema. Skin necrosis was seen in 11 cases (5.5%) and local infection in 5 dissections (2.5%). Oncological outcomes were not

compromised by this approach (13,24). Though this approach is not without complications, the rate was much lower than the traditional approach. It is vital to remember that oncological principles must not be compromised, and there are circumstances when fascia preservation is not possible.

### Omental flap pediculoplasty

Benoit *et al.* introduced yet another surgical technique to facilitate a reduction in lymphedema (12). They used a pediculated patch of omentum to cover the femoral vessels after removing the inguinal lymph nodes. To accomplish this, the researchers made a combined abdominal and inguinal incision. The omental flap was mobilized and passed deep to the inguinal ligament through the femoral canal. Once, the flap was medial to the femoral vein, it was sutured into place in the groin. The saphenous vein was not preserved in this study. Instead, they ligated the vein at its proximal and distal end and removed all lymph nodes in between. They believed that the omental flap could act as a drainage tissue in the area and could contain an active blood supply to further assist in wound healing. In their 7 subjects, Benoit and associates had no complications of lymphedema, tissue necrosis, or wound infections. After following the circumference of the mid-thigh of each subject, they reported a greater than 50% decrease in swelling in three patients. A clear disadvantage of this approach is the need for a transperitoneal operation. Also, many times the omentum, even with mobilization off the short gastric vessels, does not yield adequate length for creation of a flap. Further prospective trials are needed to validate these findings (12).

### Myocutaneous flap

There was a recent comparison of the efficacy of a tensor fascia lata flap versus primary closure for groin dissection (11). The tensor fascia lata was harvested near its origin anterior to the anterior superior iliac spine and rotated to cover the defect in the groin. The tensor fascia lata is presumed to be advantageous as a myocutaneous flap due to its vascular supply from the lateral circumflex artery and low donor site morbidity (7,11). In their study, the researchers compared 28 groin dissections which had undergone primary closure to 20 tensor fascia lata flap reconstructions after inguinal lymph node dissection. In the primary closure group, 4 dissections (14%) complicated with wound infection while

one patient (5%) in the tensor fascia lata closure group had a wound infection ( $P=0.38$ ). Nirmal *et al.* also demonstrated a decreased rate of flap necrosis in the subjects who underwent tensor fascia lata flap closure in comparison to those who underwent primary closure. Of the primary closure group, 14 groins (50%) had either minor or major flap necrosis while 3 dissections (15%) in the tensor fascia lata reconstruction group ended in flap necrosis ( $P=0.01$ ). Each of these cases of flap necrosis in the test arm of the study was minor. Rates of seroma formation were similar between both groups (11).

### Conclusions

The evolution of inguinal lymphadenectomy surgery for patients with penile cancer to a more minimally invasive approach has greatly reduced the morbidity of the procedure. Moreover, the strategy of saphenous vein preservation initially proposed by Catalonia has further reduced lymphedema in contemporary research. Additional surgical techniques and procedures including the creation of vascularized flaps as well as modified minimally invasive approaches have reduced the risk of surgical complications, hospital stay, and cosmesis. Further studies to assess postoperative complications associated with more recent minimally invasive techniques are needed.

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### Footnote

*Conflicts of Interest:* The authors have no conflicts of interest to declare.

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