Introduction

The incidence of melanoma, a malignancy of pigment-producing melanocytes located predominantly within the skin, is increasing in frequency. The lifetime risk of developing melanoma in the United States is 1 in 63, an increase of approximately 270% over approximately 35 years.¹ A portion of this increase may be attributable to heightened societal awareness and more aggressive detection; however, most is considered to be the result of factors such as increased natural or artificial ultraviolet light exposure and habits surrounding their use.

For patients with early-stage melanoma, the most important prognostic factor is the presence or absence of metastatic regional disease. When regional disease was clinically apparent or microscopically identified during sentinel lymph node biopsy, early detection and complete lymphadenectomy enhanced survival, especially in patients with intermediate-thickness primary lesions.² One can extrapolate the implication that dissection of a nodal basin alone may beneficially impact survival; however, such an implication has not been completely addressed. In the setting of node-positive disease, complete lymphadenectomy

Background: The standard treatment of care for melanoma metastatic to the inguinal lymph node basin is lymphadenectomy. However, up to 50% of patients forgo the operation partly due to concerns about morbidity. Videoscopic inguinal lymphadenectomy (VIL) is a minimally invasive technique designed to minimize wound complications while achieving comparable oncological control.

Methods: We reviewed pertinent literature related to open inguinal lymphadenectomy and VIL specific to melanoma, offering personal experience where appropriate.

Results: Despite efforts to minimize the complications of open inguinal lymphadenectomy, approximately 50% of patients experience a wound-related complication. However, performing minimally invasive VIL has led to a significant decrease in length of hospital stay, a decrease in complications, and equivalent or superior lymph node retrieval in patients with metastatic melanoma to the inguinal basin.

Conclusions: VIL is an alternative to open inguinal lymphadenectomy for patients with melanoma and regional metastases.

Videoscopic inguinal lymphadenopathy has led to decreased complication rates and hospital stays vs open lymphadenopathy with equivalent sample adequacy.
remains the standard of care and is recommended by the National Comprehensive Cancer Network.\textsuperscript{3} Despite this, up to 50% of patients with positive sentinel lymph nodes forgo complete lymphadenectomy,\textsuperscript{4} most likely due to the high morbidity associated with open lymphadenectomy (eg, wound-related complications).

Videoscopic inguinal lymphadenectomy (VIL) is a minimally invasive alternative to traditional open lymphadenectomy for regional metastases to the inguinal lymph nodes. The technique maintains an oncologically sound dissection of the lymph node packet while also minimizing wound-related morbidity. An adaption of the technique was originally described by Tobias-Machado et al\textsuperscript{5} for use in patients with genitourinary malignancies, which we reported elsewhere.\textsuperscript{6} In this article, we review a step-wise approach to the procedure.

**Open Inguinal Lymphadenectomy**

Inguinal lymphadenectomy (inguinofemoral, superficial groin, and groin dissections) encompasses the en bloc removal of all fibrofatty tissue within the femoral triangle defined by the inguinal ligament, the sartorius muscle, and the adductor longus. When performing open inguinal lymphadenectomy, a vertically oriented, curvilinear incision is made and skin flaps are raised to facilitate operative exposure. If care is not taken at this point, thinning of the skin flaps can occur, leading to vascular compromise of the tissue and flap necrosis. Established borders of dissection include (a) superolateral (anterior superior iliac spine), (b) superomedial (pubic tubercle), (c) inferolateral (sartorius), and (d) inferomedial (adductor longus). The crossing of the sartorius and adductor longus inferiorly is termed the “apex” of the femoral triangle. Most surgeons regularly sacrifice the saphenous vein although it can be spared. The saphenous vein is divided distally in the apex of the femoral triangle and proximally at the saphenofemoral junction. The femoral artery and vein are anteriorly skeletonized. Beyond the standard inguinal lymphadenectomy performed for urogenital cancers, melanoma-specific dissections also include tissue deep to the fossa ovalis and medial to the femoral vein, superiorly extending to the femoral canal. Dissection is extended superiorly 5 cm above the inguinal ligament to include all nodal tissue superficial to the external oblique aponeurosis. After removal of the nodal packet, sartorius muscle transposition is commonly performed to prevent vessel exposure in the case of wound dehiscence. A drain is placed within the wound bed and brought out through a separate stab incision in the skin. If indicated, deep or pelvic lymphadenectomy can be performed through the same skin incision, although access to the pelvis is regularly performed via a retroperitoneal approach through the abdominal wall.

Multiple studies from high-volume centers have shown the complication rate to be 50% or higher following open inguinal lymphadenectomy (Table).\textsuperscript{7-17} Most of the morbidity is directly related to the large incision required for adequate exposure and includes such complications as dehiscence (Fig 1), infection, seroma formation, and skin flap necrosis. Additional complications related to the operation include lymphedema and deep venous thrombosis. Technical modifications to reduce morbidity such as relocating the skin incision, creating thicker skin flaps, preserving the saphenous vein, and omitting sartorius transposition have not substantially decreased complica-

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<tr>
<th>Study</th>
<th>No. of Patients</th>
<th>Overall Wound Complications (%)</th>
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<tr>
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<td>Chang\textsuperscript{17}</td>
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Fig 1. — Wound dehiscence following open inguinal lymphadenectomy.
Sabel et al.14 showed a significant reduction in wound-related complications when comparing patients undergoing open inguinal lymphadenectomy for sentinel lymph node positive disease (microscopic) or clinically palpable (macroscopic) disease (14% vs 28%; \( P = .019 \)). Bulky adenopathy may necessitate a larger incision and thinner skin flaps, thus increasing wound-related morbidity. Conversely, the minimally invasive means of inguinal lymphadenectomy may reduce wound complications.

**Videoscopic Inguinal Lymphadenectomy**

In 2003, Bishoff et al.19 were the first to apply endoscopic technology to groin dissection in patients with penile cancer. Sotelo et al.20 subsequently reported a series of 14 minimally invasive lymphadenectomies for penile cancer in which no wound-related complications were noted. Based on these results, we extended and modified the procedure to include the extent of surgery appropriate for melanoma dissection.6,21 The following is a description of the standard VIL technique used.

**Preparation and Position**

After entering the operating room, patients are positioned supine on a split-leg table and the boundaries of the femoral triangle are mapped out with a surgical pen (Fig 2). Appropriate antibiotic prophylaxis is given, and the operative area is shaved and prepared in the standard fashion. The suprapubic region should be included in the field to monitor for crepitus. The surgeon is positioned between the patient’s legs and the assistant stands to the outside of the operative limb. Monitors are placed cephalad above each shoulder, with the laparoscopic tower strategically positioned on the side of the operative limb.

**Trocar Placement**

We prefer to use a three-incision technique, with the first 12-mm port placed 3 cm distal to the apex of the femoral triangle. A scalpel is used to incise the skin and sharply dissect down through the Camper and Scarpa fascias. A space analogous to the one created in the open procedure is then created with blunt-finger dissection, extending out 5 cm on each side from the incision (Fig 3). A balloon trocar is inserted into the 12-mm port site and the dissected space is insufflated to 25 mm Hg for 10 minutes, then the pressure is decreased to 15 mm Hg to prevent end-tidal CO₂ elevation. Under direct visualization with a 0-degree scope, two 10-mm short bladeless trocars are inserted approximately a hand’s breath from the visualization port. These are positioned 3 cm outside of the medial and lateral boundaries of the previously delineated femoral triangle.

**Boundaries of Dissection**

At this stage, it is critical to ensure that dissection proceeds in the correct anterior plane. The dissection should be carried superficial to the Scarpa fascia, despite the widely publicized concept that the dissection occurs within the Scarpa fascia.22 If the glistening undersurface layer of the Scarpa fascia is identified, the flap is too thick and the plane must be changed. The correct tissue plane will appear to have created “drops” of fat on the dermis; the actual thickness is approximately 3 to 5 mm in most patients and allows the surgeon to see the cutaneous vessels.
should be ensured by continuing the dissection to the level of the femoral canal until the pectineus muscle is visible. A biopsy of the Cloquet node may be done at this point, although we have abandoned this element of complete lymphadenectomy in patients with only sentinel node–positive disease. Fascial attachments may persist to the inguinal ligament (Fig 4). Dissection of the tissue off the fascia can be accomplished by inferior retraction of the nodal packet. Alternatively, this may be accomplished using an ultrasonic dissecting scalpel.

Packet Removal, Drain Placement, and Postoperative Management

At this point, the nodal packet is free and is withdrawn in a laparoscopic specimen bag through the apical port. A large packet may necessitate extending the skin incision to extract the specimen. To avoid creating an additional wound, we do not excise the biopsy scar. Instead, we dissect the biopsy cavity up to the level of the scar as part of the anterior dissection, releasing the tissue with the remainder of the node contents. The procedure is completed by placing a 19-French fluted drain through the medial port site. Patients are given a regular diet and encouraged to ambulate the day of the surgery. Discharge is routinely planned for the same day unless a deep pelvic node dissection was

Saphenous Vein Division and Vascular Dissection

The saphenous vein should be readily identifiable within the apex of the femoral triangle and divided with the vascular load of an endoscopic linear cutting staple. Careful dissection within the femoral triangle enables identification of the femoral artery pulse as well as the medial femoral vein. Proceeding inferior to superior, the vessels are skeletonized along with all the tissue between the femoral vein and adductor longus. This dissection is more easily made if the packet is elevated, thus allowing the surgeon to easily visualize the dissection plane underneath.

Saphenofemoral Junction Dissection and Transection

Once the vascular dissection is complete, blunt dissection in the saphenofemoral junction is performed to identify the inferior edge of the saphenous vein as it enters the femoral vein. A right-angle dissector and a Hunter grasper are the preferred tools for this maneuver. An endoscopic linear cutting stapler with a vascular load is then used to transect the vein at the saphenofemoral junction. Inferomedial dissection around the femoral vein will allow resection of the deep inguinal nodes, as described by Johnson and Ames. Complete node retrieval

Fig 4. — Release of tissue at the superior border along the inguinal ligament.
performed. The fluted drain stays in place until output is below 30 mL during a 24-hour period.

**Results**

We previously reported our initial experience in 32 patients undergoing 45 procedures to establish the feasibility of VIL. Of these procedures, 18 dissections (40%) were for melanoma, 19 (42%) for penile carcinoma, 4 (9%) for scrotal/urethral carcinoma, and 4 (9%) for other pathologies. The median patient age was 61 years (range, 16–87) and median body mass index was 30 kg/m² (range, 19–53). Eighty-nine percent of the patients with melanoma had primary disease located in the extremities, with a median Breslow depth of 2.8 mm (range, 0.6–9.9). Ulceration was present in 8 of these patients (44%). The diagnosis of regionally metastatic melanoma was accomplished by sentinel lymph node biopsy in 13 patients (72%). Median operative time for VIL was 165 minutes (range, 75–245). Two (4%) of the procedures were converted to an open approach. The first conversion occurred for high end-tidal CO₂ levels, and the other transpired in a patient with restricted hip mobility and clinically palpable lymphadenopathy. The median node count was 11 (range, 4–24), with the largest node removed being 5.6 cm. Median drain duration was 15 days (range, 7–25).

Detailed data from complications have been previously reviewed. The most common complication was readmission for the administration of intravenous antibiotics in 10.5% of patients. One patient (2.6%) experienced flap necrosis, which was conservatively managed with negative pressure wound therapy. Mild to moderate lymphedema occurred in 7.8% of patients; 2 of these required compressive stockings for symptomatic treatment. No episodes of wound dehiscence were noted following VIL (Fig 5).

Other reports have also concluded VIL to be a viable alternative to the standard open technique for melanoma patients. Abbott et al. published their VIL experience in a cohort of 13 patients, demonstrating a significant reduction in hospital length of stay and increased lymph node harvest when compared with open lymphadenectomy. One patient developed a wound infection and another required readmission for seroma formation. No wound dehiscence was noted.

We are currently reviewing our accumulated VIL experience in 67 patients undergoing 94 procedures for melanoma (n = 37), cutaneous malignancies of the genitourinary area, and lower extremities. It remains to be determined whether equivalent or better lymph node yields for patients undergoing VIL translate to comparable long-term oncological outcomes when compared with the traditional open inguinal lymphadenectomy.

**Discussion**

The oncological application of endoscopic and laparoscopic techniques has expanded in the wake of the Clinical Outcomes of Surgical Therapy trial, which favorably compared laparoscopically assisted colectomy with open colectomy for colon cancer. Extending these techniques to complication-prone procedures represents a logical evolution toward reducing associated morbidities. This is especially true for procedures in which the majority of complications are related to the wound. Multiple studies have demonstrated a 50% or greater rate of wound-related complications following open inguinal lymphadenectomy for metastatic melanoma, including dehiscence, infection, seroma formation, and skin flap necrosis (Table). This high morbidity may be a potential explanation for the poor rate of compliance with complete lymphadenectomy in these patients.

In combination with our reported experience with VIL and the recently published work of Abbott et al., we have shown a reduction in wound-related complications in patients undergoing VIL, equivalent or greater lymph node retrieval, and decreased length of hospital stay when compared with open lymphadenectomy. Despite the apparent advantages of VIL, barriers remain to its widespread implementation. Increases in operative time and the associated learning curve may make some surgeons reticent to adopt this approach. For many, lymph node retrieval may not be an adequate surrogate for oncological outcomes data that demonstrate equivalent or improved long-term regional control following VIL. A randomized controlled trial comparing open lymphadenectomy to VIL would be ideal and is ongoing (NCT01526486). However, despite our institutional study, many consider the application of an established technology (videoscopy or laparoscopy) to inguinal lymphadenectomy insufficient to warrant a randomized controlled trial that would deny...
patients access to this technique and incur significant trial-related costs.

Furthermore, a recent survey revealed that more than 30% of melanoma surgeons routinely perform ilioinguinal (superficial groin and deep pelvic) dissection for melanoma metastatic to the groin. This likely impacts surgical decision-making about the specific approach to a procedure. It is important to note that the decision to pursue pelvic lymphadenectomy need not preclude the use of VIL in which the superficial groin dissection can be videoscopically performed and the deep pelvic nodes removed via either an open approach or through a laparoscopic retroperitoneal approach. Moreover, we routinely perform cephalic lymphadenectomy in patients with bulky adenopathy in the groin. In the 4 patients who underwent groin dissection for bulky adenopathy in the groin, we performed open pelvic lymphadenectomy because our complication rate of the incision used for that procedure was low.

Conclusions

Although the utilization of videoscopic inguinal lymphadenectomy (VIL) reduces wound complications, other factors may reduce further complications in patients with melanoma and inguinal lymph node metastases. A timely diagnosis of disease at the microscopic stage via sentinel lymph node biopsy prior to the development of clinically palpable disease has been shown to decrease wound morbidity. For patients with clinically palpable disease, the utilization of fine-needle aspiration over excisional biopsy and avoiding incisions in the groin crease may reduce diagnostic-related morbidities. Systemic postoperative care regimens consisting of early ambulation and compression stockings are crucial components to preventing complications such as lymphedema and deep venous thrombosis.

Aside from VIL, no other modified surgical technique has been shown to substantially reduce the morbidity associated with inguinal lymphadenectomy for metastatic melanoma. Other investigations have included a limited dissection based on primary location, saphenous vein preservation, omission of sartorius transposition, and a minimal access, two-incision technique. At this time, VIL is a feasible alternative to open inguinal lymphadenectomy for patients with melanoma and regional metastases. Long-term oncological outcomes are forthcoming.

References