Ann Surg Oncol
DOI 10.1245/s10434-009-0816-7

Annals of
SURGICAL ONCOLOGY
OFFICIAL JOURNAL OF THE SOCIETY OF SURGICAL ONCOLOGY

ORIGINAL ARTICLE – MELANOMAS

Feasibility of a Novel Approach to Inguinal Lymphadenectomy: Minimally Invasive Groin Dissection for Melanoma

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ABSTRACT

Introduction. Inguinal lymphadenectomy for metastatic melanoma is reported to have a complication rate as high as 50%. Wound dehiscence has been reported to occur in more than half of these patients, and as a result many surgeons routinely use sartorius muscle transposition to protect against the potential for exposed vessels. We report feasibility of minimally invasive inguinal lymphadenectomy intended to minimize wound complications inherent to this procedure.

Methods. Five patients with histologically confirmed inguinal metastases from melanoma underwent minimally invasive inguinal lymphadenectomy. Procedures were performed via three ports: one at the apex of the femoral triangle, a second two fingerbreadths medial to the adductors, and the third two fingerbreadths lateral to the sartorius. No inguinal incision was utilized for the purpose of surgery. A standard melanoma dissection was performed through these ports: contents of the femoral triangle and 5 cm up onto the external oblique aponeurosis were removed. To validate this technique, sentinel node biopsy scars were excised to permit visual confirmation of adequate anatomic dissection.

Results. Five patients underwent minimally invasive inguinal lymphadenectomy for metastatic melanoma. Median operative time was 180 (range, 142–223) min, median hospital stay was 1 day, and two patients developed cutaneous erythema but neither suffered wound dehiscence. Median nodal yield was 10 (range, 4–13). Blood loss was <100 ml for all procedures. Median duration of drain usage was 8 (range 7–19) days.

Conclusions. Minimally invasive inguinal lymphadenectomy is feasible for patients with melanoma as demonstrated by nodal yield and visual inspection. This technique may reduce complication rates and wound dehiscence, and the risk of exposed vessels is minimized by eliminating the inguinal incision. This obviates the need for routine sartorius muscle transposition. A prospective, randomized trial comparing the open versus the videoscopic approach is currently in progress.

Surgical resection of regional metastases from melanoma is the standard of care and offers excellent control of regional disease. For patients with primary lesions of the lower extremity and occasionally the trunk, regional metastases involve the inguinal lymph nodes. Inguinal lymphadenectomy (inguinofemoral dissection, superficial groin dissection, groin dissection) for melanoma includes removal of all fibrofatty tissue within the femoral triangle, as defined by the inguinal ligament, the sartorius muscle, and the adductor longus. Dissection typically continues 5 cm up onto the external oblique aponeurosis. For most tumor types, dissection is typically limited to the tissues superficial to the deep fascia of the thigh and those surrounding the saphenofemoral junction; however, for melanoma, this and all tissue deep to the fossa ovalis and medial to the femoral vein, extending superiorly to the femoral canal, are routinely resected.

This approach offers excellent regional control but is associated with a high incidence of wound complications. Despite modifications to this procedure, the rate of wound complications (including dehiscence) remains as high as 50%.[1–6] Bishoff et al. first reported use of endoscopic technologies to perform groin dissection in 2003.[7] He

First Received: 15 September 2009

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Published online: 17 November 2009

reported his experience with videoscopic groin dissection (VGD) in two cadavers and one living patient in whom he converted the case to the standard open approach due to failure to mobilize the nodal mass superiorly. Further minimally invasive approaches were not described in the English literature until 2006 by Sotelo and Tobias-Machado from South America.[8] We modified the approach described by this group to allow for the dissection that would be anatomically appropriate for melanoma as previously reported for a variety of other malignancies.[9] In this report, we analyze the application of this approach for treating regional metastases from melanoma, with respect to reducing wound complications and overall surgical morbidity. We also report nodal yield and present images demonstrating adequate anatomic clearance of the inguinal nodes.

FIG. 1 Patient positioned with femoral triangle and sentinel node biopsy scar mapped out

PATIENTS AND METHODS

Patients

Patients with inguinal metastases diagnosed by sentinel lymph node biopsy were included in this five-patient validation analysis. Risks and benefits of groin dissection including, but not limited to: lymphocele, prolonged lymphorrhea, thromboembolic events, lymphedema, neuromuscular damage, and hemorrhage were discussed with each patient before the operation. Furthermore, the potential for incomplete lymphadenectomy was discussed. The fact that this was a novel way to perform this procedure was discussed with patients in detail and specifically that because of its novelty some of the risks may not be clearly anticipated was explained in detail. The report of the data was reviewed under the guidelines of the Emory University Institutional Review Board.

Preparation and Position

Patients were positioned on a split-leg table with the boundaries of the femoral triangle mapped out (Fig. 1). This marking is necessary for correct trocar placement, as well as to aid in determining the extent of dissection during the case. Shaving and prepping was via standard techniques, including preparation of the suprapubic skin so that development of crepitus could be monitored.

Surgeon and Room Setup

One of two experienced groin surgeons (VM, KD) was present for all procedures to ensure surgical standardization. Using a split-leg table, the assistant stands on the outside of the operative limb and the surgeon stands in between the patient's legs. Monitors are placed at the shoulders on either side of the patient, and all equipment (Ultrasonic dissecting scalpel, CO_2 source, light source, and electrocautery) is housed on the side of the operative limb when possible.

Trocar Placement

We use a three incision technique; the first is a 12-mm incision placed 3 cm distal to the apex of the femoral triangle. With a scalpel, we go through skin and Camper's fascia to Scarpa's fascia. Scarpa's fascia is incised and a finger is used to develop a space, in the same plane utilized to develop flaps in an open procedure; alternatively this can be done sharply. This is done to at least 5 cm on either side of our initial skin incision. In doing so, enough space is created to allow two additional 10-mm trocars to be placed under vision in a fashion analogous to opening the retroperitoneal space for retroperitoneoscopic surgery. Hemorrhage is not encountered during this sweeping maneuver. Once complete, a 12-mm balloon port trocar is placed in the original incision, and patient pressure is set at 25 mm Hg for 10 min. After 10 min, the pressure is reduced to 15 mm Hg to avoid transient, correctable, elevations in end-tidal CO_2 that were observed in some patients. A zero-degree, 10-mm laparoscope is typically used, because angled scopes tend to be cumbersome in the relatively small working space. Next, two 10-mm short bladeless trocars are placed, separated by a hands-breadth from the visualizing port and 3 cm outside of the medial and lateral boundaries of the femoral triangle (Fig. 2).

Ensuring dissection in the correct plane is critical to the success of the procedure. In addition to the digital dissection described above, this was achieved by finding the anterior clear glistening layer of Scarpa's fascia, and

FIG. 2 Trocar sites marked on the patient. A handsbreadth is used between the visualization port and the working ports. Working ports are at least 3 cm outside of the mapped femoral *triangle*

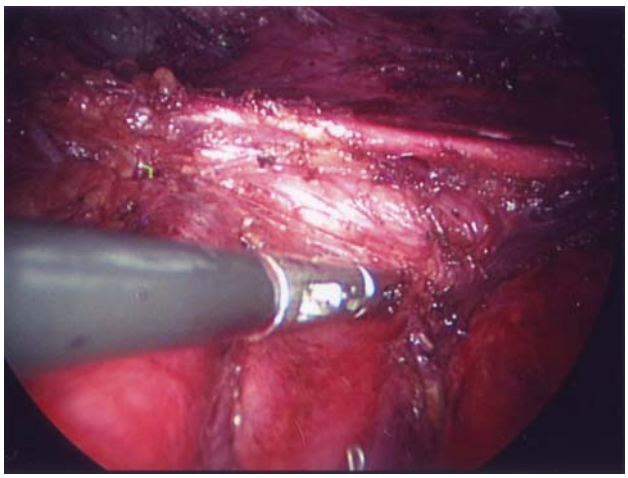

FIG. 3 Inguinal ligament is visible traversing the field in this image. The external oblique aponeurosis is visible beyond; the tissue covering it has been swept down into the femoral triangle as a part of the dissection

staying immediately below this layer. If this layer is violated it makes it easy to get into a rather superficial plane of dissection into the dermis, potentially resulting in skin necrosis, although we have not encountered this problem. Ultrasonic dissecting shears are used to perform the dissection. The assistant holds the camera and a grasper or laparoscopic sponge stick, as needed.

Anterior Working Space

Every effort is made to develop completely the anterior working space before proceeding with additional dissection. The anterior working space is characterized as the area created between the fibrofatty packet containing the lymph nodes and the "flaps" (in the videoscopic case, the "roof" of skin and subcutaneous fat) that are created when dissecting along Scarpa's fascia. This would equate to the area created by raising flaps during an open procedure.

For lesions arising on the trunk, the dissection is routinely carried approximately 5 cm up onto the anterior abdominal wall above the inguinal ligament. The inguinal ligament and fascia are identified by the transverse fibers that can be seen under the magnification of the camera (Fig. 3). A 10-mm endoscopic dissecting stick is helpful to identify the extent of dissection by gently palpating the fascia. Occasionally, in patients with proximal sentinel node biopsy cavities, visualization is impaired by the cavity and the dissection along the inguinal ligament (the last part of the dissection off of the abdominal wall) was delayed until the cavity was excised. Since completing this feasibility study, we reviewed the data about excision of the sentinel node biopsy cavity, discussed the matter with other melanoma surgeons, and determined that there has been no data published that implies that excision of sentinel lymph node biopsy cavities conferred any benefit to patients. We also recognized that the MSLT-2 trial design does not mandate reexcision of positive sentinel node biopsy sites either. Given this data, we have modified our approach and now take down the cavity with our initial dissection and no longer excise the scar. The cavity is now removed through the apical scar along with the specimen as described in the specimen removal description below.

Medial and Lateral Boundaries

The medial boundary is the adductor longus and the lateral border is the sartorius muscle. This dissection is best achieved by identifying the fascia of the respective muscles and correlating this to transillumination being superimposed on the previously established skin markings. Once the dissection is started the deep thigh fascia is seen immediately beneath. If one goes deep to this, then the reddish muscular fibers are immediately apparent. With deliberate blunt dissection using a rolled endoscopic sponge ("cigarette") or an endoscopic Kittner, the node packet can be rolled inwards on both sides. This maneuver is continued superiorly and inferiorly as much as possible, because it helps to define the posterior tail of the node packet. Small perforating vessels are routinely encountered and are controlled with the ultrasonic dissecting scalpel or clips. Lymph vessels also are sealed with the ultrasonic dissecting scalpel.

Division of the Apex, Saphenous Vein, and Vascular Dissection

The saphenous vein is visualized crossing the adductor near the apex of the femoral triangle. The vessel is divided

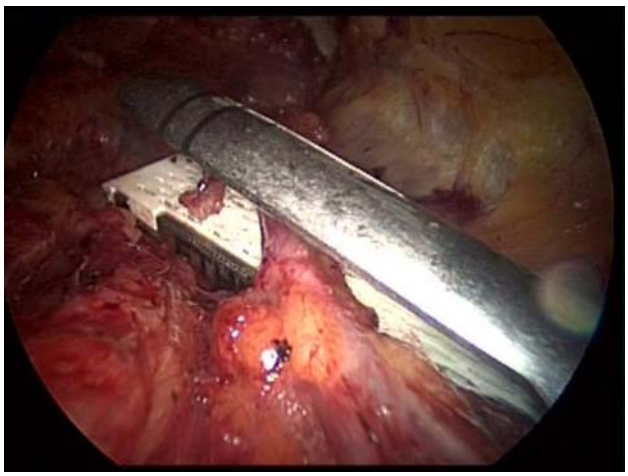

FIG. 4 Division of the saphenous vein as it crosses the adductor musculature using an endoscopic linear cutting stapler

with an endoscopic linear cutting stapler with a vascular load (Fig. 4). Although we routinely sacrificed the saphenous vein, it is technically possible to dissect and spare this vessel. Once this tail of tissue is developed, we then dissect carefully within the femoral triangle to identify the visible pulse of the femoral artery. The dissection is then carried from an inferior to superior direction directly on top of the artery. The femoral vein is identified using the artery as a landmark and then both vessels are skeletonized, along with all of the tissue medial to the vein and sitting between it and the adductor musculature. This can usually be easily accomplished by the assistant elevating the packet and the surgeon working below it in the dissection plane.

Saphenofemoral Junction Dissection and Transection

After the anterior surface of the artery is cleaned off, we use blunt dissection until we could identify the inferior edge of the saphenous vein as it entered into the femoral vein. We then use a right angle dissector and Hunter grasper to dissect out the entire saphenofemoral junction. An endoscopic linear cutting stapler with a vascular load is again used to transect the vessel at this level. It is important to remember that this junction can be very long and that dissection should proceed meticulously until this is clearly visualized. During the exposure of the saphenofemoral junction, continued inferomedial dissection around the femoral vein will enable resection of the "deep inguinal nodes" as described by Ames.[10] This should be continued to the level of the femoral canal and until the pectineus muscle is seen to ensure complete nodal retrieval. This dissection permits biopsy of Cloquet's node for surgeons who choose to perform this as routine. We have abandoned routine biopsy of Cloquet's node as a component of the completion lymphadenectomy in patients with sentinel node-positive disease.

Dissection Along the Inguinal Ligament

At this point, some fascial attachments to the inguinal ligament may remain, depending on the initial extent of the anterior dissection. To completely separate the nodal packet requires manipulation of the tissue inferiorly or medially and laterally. This maneuver provides visualization to achieve a blunt dissection of the tissue off the fascia or, in some cases, dissection of the tissue from the inguinal ligament using the ultrasonic dissecting scalpel.

Removal of the Packet, Drain Placement and Postoperative Care

For this feasibility study, the sentinel node biopsy cavity and scar were left intact until the last step of the procedure. Once the entire dissection was complete, the scar was excised and the entire packet was removed through the scar. Direct visualization was used to confirm complete dissection of all lymphatic tissue within the boundaries of the standard open approach (Figs. 5a, b).

Since the completion of these initial patients, we have modified our approach to avoid the reexcision of the scar and the additional wound. We dissect the sentinel node biopsy cavity at the scar as a part of the anterior dissection so that the entire packet is released during the anterior dissection. Using this approach, the packet is completely free by the time the last of the inguinal attachments are dissected as described above. The packet is placed into a laparoscopic specimen retrieval bag and withdrawn from the apical port. Many times the packet is quite large and the extraction site may need to be extended. Finally, the procedure is concluded with placement of a 19-French fully fluted drain through the medial port site and skin closure.

The patient is allowed to ambulate the day of surgery and is given a regular diet. Discharge of the patient takes place the day after surgery, unless concomitant pelvic node dissection is performed. The drain stays in place until output is <50/ml per 24-h period.

RESULTS

Patient Demographics and Clinicopathologic Data

There were two men and three women. Median age was 57 (range, 37–66) years. Mean body mass index was 31 (range, 27–33) kg/m^2. Four patients had sentinel node-positive disease, and one presented with clinically detected metastases. The patient with the clinically detected

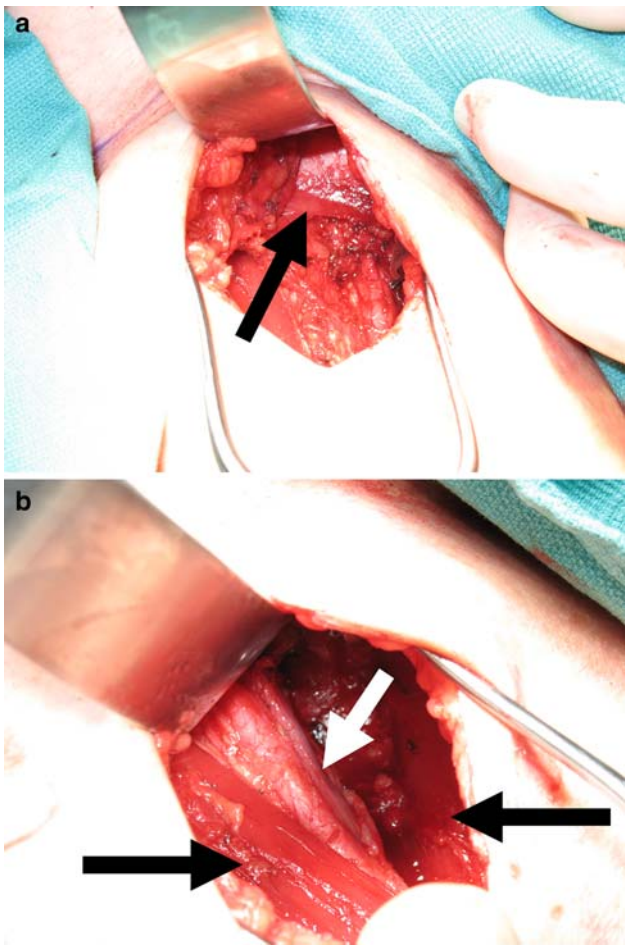

FIG. 5 Images through the sentinel node biopsy scar showing in **a** the upper aspect of the dissection at the inguinal ligament and the external oblique aponeurosis (*arrow*) near the sartorius insertion and in **b** the apex of the dissection demonstrating the sartorius and adductor muscles (*black arrows*) and the femoral vessels, skeletonized (*white arrow*)

metastasis underwent concurrent pelvic lymphadenectomy via an open approach due to the decision of the surgeon. There was nothing technically precluding a laparoscopic approach to the pelvic lymphadenectomy in this patient. The median Breslow depth was 3 (range, 1.4–3.8) mm, and three patients had ulceration as a component of their primary tumor. Four patients had primary lesions on the extremity, and one patient had a primary of the trunk. Clinicopathologic data and patient demographics are summarized in Table 1.

Operative Factors, Complications, and Drain Use

The median and mean operative time was 180 (range, 142–223) min. We have noted a progressive reduction in operative time, reflecting the learning curve, and expect that this will continue to improve. Estimated blood loss was <100 ml for all procedures. Hospital stay was 24 h for all patients, except for the individual who underwent concurrent pelvic lymphadenectomy; she remained in the hospital for 5 days, until her pelvic drain was removed.

Two of five patients developed cellulitis, one of whom had a severe infection in the sentinel node biopsy site before the completion surgery. The second patient was obese, with a body mass index of 32 but no other risk factors. Neither patient had wound dehiscence, and neither patient has measurable lymphedema currently, despite the infection. The median duration of the drain was 8 (range, 7–19) days (Table 2).

TABLE 1 Clinicopathologic and demographic characteristics of the five patients described in this feasibility study

Variable	Result ($N = 5$)
Median age (year)	57
Range	37–66
Female gender	3 (60%)
Mean body mass index (kg/m^2)	31
Range	27–33
Sentinel lymph node-detected	4 (80%)
Primary location	
Extremity	4 (80%)
Trunk	1 (20%)
Median Breslow depth (mm)	3.0
Range	1.4–3.8
Clark's Level IV or V	5 (100%)
Ulcerated	3 (60%)

TABLE 2 Operative and pathologic data from the five procedures performed during this feasibility analysis

Variable	Result
Median operative time (min) (mean)	180 (180)
Range	142–223
Median node count (mean)	10 (9)
Largest node removed (cm)	4
Median length of stay (days)	1
Duration of drain (days)	8
Range	7–19

Pathology and Follow-Up

Nodal yield remains a multifactorial statistic, dependent on patient anatomy, surgical technique, and pathologic analysis, and it persists as an objective data point for analysis. The nodal yield from this feasibility study demonstrated a median yield of 10 (mean, 9; range, 4–13). The patient who underwent surgery for clinically palpable disease has recurred with multiple visceral metastases since

her surgery. One additional patient has recurred in the limb outside of the nodal basin in an in-transit node, which was subsequently resected. Upon review of her lymphoscintigram, it is likely that this node was present at her original sentinel node biopsy.

DISCUSSION

Although the management of the regional nodal basin in patients with melanoma continues to evolve, the standard of care for those with both sentinel lymph node biopsy-detected and clinically detected metastases remains complete lymphadenectomy. Surgical extirpation of all known metastatic disease from melanoma has been associated with improvements in survival compared with historical results of best-known therapy.[11] Unfortunately, complete inguinal lymphadenectomy (with or without concurrent pelvic lymphadenectomy) has been reported to have complication rates as high as 50%,[1–6,12–14] and this has deterred many surgeons and medical oncologists from recommending the procedure at all.

A recently published article from a group of major melanoma centers and the American College of Surgeons reviewed the management of melanoma to determine whether national guidelines were followed. Only 50% underwent completion lymphadenectomy as recommended by national guidelines.[15] The authors speculate that some of this may be due to the remarkable morbidity observed in patients undergoing inguinal lymphadenectomy. Furthermore, at the most recent meeting of the World Melanoma Congress in Vienna as well as the 2009 Annual Cancer Symposium of the Society of Surgical Oncology, the morbidity of inguinal lymphadenectomy was the focus of several independent papers.

The application of minimally invasive techniques in oncology has expanded since the results of the COST trial were published.[16] Recently, Tobias-Machado and Sotelo reported a minimally invasive approach to inguinal dissection for patients with penile carcinoma.[8] Although the urologic dissection is slightly less-involved than the approach typically used for melanoma metastases, the report demonstrated the potential use of this technique. In a combined effort between our divisions (Urology and Surgical Oncology), we were able to plan an approach to perform the procedure using the techniques described by Sotelo and Tobias-Machado while modifying the methodology to include the extent of surgery appropriate for a melanoma dissection.

Despite the anatomic landmarks that were effectively able to ensure that we had performed a comprehensive dissection (visualization of the apex of the femoral triangle, skeletonization of the femoral vessel, including all of the tissue medial to the femoral vein to the femoral canal, and dissection 5 cm up onto the anterior abdominal wall superior to the inguinal ligament), we believed that visual confirmation of the adequacy of dissection for this initial feasibility study was crucial. As such, we excised the sentinel node cavity and removed the specimen through this incision at the completion of each of the five procedures as described in "Patients and Methods". This allowed us to confirm that the dissection was identical to one that we would have performed through an open approach. Furthermore, despite its limitations, we used nodal count as a benchmark to reaffirm the extent of dissection.

Although not the focus of this report, since the completion of the feasibility study we have performed more than 30 groin dissections and have removed nodes as large as 5.6 cm. We have applied this approach in a multitude of histologies in addition to melanoma, including extramammary Paget's disease, metastatic anorectal neuroendocrine carcinoma, penile carcinoma, and scrotal cancer. We have been able to perform this procedure in a patient with a body mass index of 43. Additionally, we have successfully performed a simultaneous bilateral inguinal procedure and have observed a significant reduction in operative time since our first procedure was performed, with the most recent procedure being performed in 85 min and a current median operative time of 172 min.

In a procedure with morbidity as high as 50%, which by most authors' accounts is predominantly related to the surgical incision, a minimally invasive approach should reduce wound complications. During surgery, the most substantial issue we have identified is a mild, reversible, increase in end-tidal carbon dioxide to levels as high as the upper 50 s. When concerning, we have been able to control this by reducing the patient insufflation pressure. It is our expectation that the use of a minimally invasive technique will significantly improve the outcomes of patients who undergo inguinal lymphadenectomy. If initial results prove to accurately reflect the reduction in complications, then this approach will drastically benefit these patients. To better analyze the potential of this procedure, a prospective, randomized trial comparing minimally invasive inguinal lymphadenectomy to an open approach has been initiated.

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