

Eliminating Preoperative Lymphoscintigraphy in Extremity Melanomas

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Background: Preoperative lymphoscintigraphy (LSG) is an imaging procedure routinely used to identify the draining nodal basin in melanomas. At our institute, we have traditionally performed preoperative LSG followed by intraoperative LSG for logistical and evaluative reasons. We sought to determine if preoperative LSG could be safely eliminated in the treatment of extremity melanomas, which exhibit consistent and predictable lymphatic drainage patterns.

Methods: We reviewed the Yale Melanoma Registry 1308012545 for cutaneous extremity melanomas treated at our institution. From this registry, we calculated the incidence of atypical lymph node drainage patterns outside the axillary and inguinal regions. Based on these data, we eliminated preoperative LSG in 21 cases (8 upper extremities and 13 lower extremities). Additionally, we calculated the potential hospital charge reduction of forgoing preoperative LSG.

Results: Upper and lower extremity melanomas treated at our institution exhibited atypical lymph node drainage at a rate of 3.4% and 2.0%, respectively. The sites of atypical drainage were to the epitrochlear and popliteal regions. In all 21 cases where preoperative LSG was eliminated, we were able to correctly identify the sentinel lymph node. The potential hospital charge reduction of forgoing preoperative LSG totaled \$2,393.

Conclusions: Preoperative LSG can be safely eliminated in the management of upper and lower extremity melanomas. Exceptions may be considered for primary lesions of the posterior calf, ankle, and heel as well as for patients with history of prior surgery or radiation. Forgoing preoperative LSG results in a hospital charge reduction of \$2,393 and provides additional benefits to the patient. Ultimately, there is potential for significant charge reduction if applied across health care systems. (*Plast Reconstr Surg Glob Open* 2018;6:e1681; doi: 10.1097/GOX.0000000000001681; Published online 6 March 2018.)

INTRODUCTION

Sentinel lymph node biopsies (SLNBs) are recommended for primary melanomas that are 1.0mm or greater in thickness or 0.75–1.0mm with certain high-risk features such as high-mitotic rate, ulceration, and lymphovascular invasion. Preoperative lymphoscintigraphy (LSG) is a minimally invasive imaging procedure used to help identify the draining nodal basin before SLNB.¹ LSG is performed anywhere between several hours to several

days before SLNB. A radiocolloid tracer, typically Technetium-99m (Tc-99m) combined with a gamma camera, is used to detect the draining sentinel lymph node. Sentinel nodes are classified as the first nodes that drain and retain the tracer on static imaging. Due to its high accuracy and reliability, LSG is recommended as a routine preoperative procedure to assist in accurate sentinel lymph node identification in the surgical treatment of all melanomas.^{2–5} At our institution, preoperative LSG is performed in the radiology and biomedical imaging department several days before the SLNB. During the SLNB procedure, intraoperative LSG using Tc-99m and blue dye or indocyanine green (ICG) is then used to confirm the preoperative LSG findings and to aid in the identification and dissection of the draining nodal basin.

While lymphatic drainage of truncal and head-and-neck melanomas is variable and sentinel lymph node identification is greatly assisted by LSG, drainage of up-

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per and lower extremity melanomas is relatively consistent and predictable.⁶ Multiple studies have shown that the vast majority of upper extremity lesions (81–98.6%) drain into the axillary region, and the vast majority of lower extremity lesions (85–98.5%) drain into the inguinal region.^{7–13} Due to the high consistency in drainage patterns of upper and lower extremity melanomas, we sought to determine if preoperative LSG could be safely eliminated in the treatment of extremity melanomas by examining the incidence of atypical drainage patterns of extremity melanomas at our own institution.

METHODS

The Yale University Institutional Review Board (IRB) approved an institutional review board exemption request for our study. We reviewed the Yale Melanoma Registry 1308012545, which houses data for patients treated for cutaneous melanoma at Yale-New Haven Hospital. From this registry, we calculated the proportion of patients with extremity melanomas who exhibited atypical lymph node drainage patterns. We defined atypical lymph node drainage as upper extremity melanoma drainage outside the axillary region (eg, epitrochlear region) and lower extremity melanoma drainage outside of the inguinal region (eg, the popliteal region).

Based on these collected data, we eliminated preoperative LSG in the management of 21 cases of extremity melanoma (8 upper extremities and 13 lower extremities) requiring an SLNB. We used a combination of intraoperative Tc-99^m and ICG injections around the primary melanoma site to identify the draining nodal basin during the SLNB.

Additionally, we gathered billing information from the department of radiology and biomedical imaging at our institution (where LSGs are performed) to calculate the potential hospital charge reduction of forgoing preoperative LSG.

RESULTS

A total of 3,648 patients were treated at Yale-New Haven Hospital from 1992 to 2012 for cutaneous melanoma and recorded in the Yale Melanoma Registry 1308012545. We identified 1,695 recorded cases of extremity melanomas from this registry. Seven hundred sixty-eight cases involved melanomas of the upper extremity, and 927 cases involved melanomas of the lower extremity. Two hundred thirteen upper extremity and 257 lower extremity melanomas were reported to have undergone SLNB. Reports for 203 upper extremity and 246 lower extremity preoperative LSGs were available from these cases. The other LSG reports could not be verified due to missing records. Of the 203 upper extremity melanomas with SLN biopsy and recorded preoperative LSG, 7 cases showed atypical lymph drainage to either the epitrochlear nodes or mid-arm nodes in preoperative LSG (3.4%). Of the 246 lower extremity melanomas with SLNB and recorded preoperative LSG, 5 cases showed atypical lymph drainage to the popliteal node in preoperative LSG (2.0%; Tables 1, 2). All cases of atypical drainage found during preoperative

Table 1. Lymph Node Drainage of Upper and Lower Extremity Lesions

Location of Primary Lesions	No. Patients	No. LSG and SLNB	Typical Drainage (%)	Atypical Drainage (%)
Upper extremity	768	203	196 (96.6)	7 (3.4)
Lower extremity	927	246	241 (98.0)	5 (2.0)

Table 2. Cases of Atypical Lymph Node Drainage and Primary Melanoma Site

Primary Melanoma	Draining Nodal Basin
Upper extremity	
Right wrist	Epitrochlear
Left mid-forearm	Epitrochlear
Left forearm	Epitrochlear
Left forearm	Epitrochlear
Right elbow	Upper arm interval
Left forearm	Epitrochlear
Right little finger	Epitrochlear
Lower extremity	
Posterior left lower leg	Popliteal
Right ankle	Popliteal
Right pretibial area	Popliteal
Right plantar heel	Popliteal
Left ankle	Popliteal

LSG were confirmed during SLNB. No extremity melanoma cases reported in the registry drained to nodal basins outside of the extremities.

In the 8 upper extremity and 13 lower extremity melanoma cases where preoperative LSG was eliminated, we were able to correctly identify the draining nodal basin during SLNB using a combination of Tc-99^m and ICG. The sentinel nodes were all identified in either the axillary (for upper extremity melanomas) or inguinal (for lower extremity melanomas) regions.

The hospital charges for preoperative LSG are broken down as follows for our institution: \$1,870 (procedure fee), \$553 (Tc-99^m injection), and \$75 (radiologist report). This amounts to a total charge of \$2,498 for preoperative LSG performed at our institution.

DISCUSSION

Preoperative LSG is a widely adopted method to map the nodal basin and provides preoperative guidance for SLNB in the surgical treatment of melanoma. However, its utility in upper and lower extremity melanomas is questionable given the low variability of lymph node drainage. Here, we present a survey of over 1,000 cases of upper and lower extremity melanomas and rates of atypical lymph node drainage. Our results show that the vast majority of upper and lower extremity melanomas drain to the axillary and inguinal regions, respectively. Otherwise, the epitrochlear and popliteal regions are the most frequent sites of atypical drainage.

Consistent with our results, other studies have reported similar rates of atypical drainage outside of the axillary and inguinal regions.^{14–16} Morris et al.¹⁴ found an atypical drainage rate of 6% to the popliteal and upper thigh region in 32 cases of extremity melanoma. The authors

advocated against the routine use of preoperative LSG in extremity melanomas. Fitzgerald et al.¹⁵, in a retrospective study which included 41 upper extremity and 35 lower extremity melanomas, found that all cases drained to the axillary and inguinal regions and the vast majority had a single draining nodal basin. They reported only 1 case in the upper extremity and 4 cases in the lower extremity, which had multiple draining basins, but none of these additional sites had evidence of metastasis on SLNB.¹⁵ They concluded that routine preoperative LSG provided little benefit for the management of extremity melanomas. McMasters et al.¹⁶ reported atypical drainage of upper extremity and lower extremity melanomas to interval nodes (eg, epitrochlear, popliteal) at a rate of 3.8% and 2.0%, respectively.

In addition to preoperative LSG, it is routine practice in some institutions to intraoperatively map the lymphatic drainage of the primary melanoma using radiocolloid (eg, Tc-99^m) with or without methylene blue dye during SLNB. The blue dye and radiocolloid injections aid the surgeon during the procedure by allowing direct visualization of the dye-stained nodal basin and by gamma scintillation using a handheld gamma probe, respectively. Several institutions have also adopted the use of ICG injections to further increase SLNB success rates. The fluorescence of the dye can be visualized with the use of near-infrared spectroscopy (NIRS) imaging systems as the dye courses through the lymphatics to the draining nodal basin. Studies have confirmed the clinical utility of ICG for SLNB in cutaneous melanoma, particularly in the identification of sentinel nodes not otherwise detected with the use of methylene blue or radiocolloid.¹⁷⁻¹⁹ It is the practice of the senior author to use ICG in lieu of the methylene blue dye for all SLNBs. In addition to visualizing the ICG using NIRS imaging, the teal color of the ICG can also be directly visualized in the draining nodal basin in the same manner methylene blue is visualized during the SLNB.

Because of the low rates of atypical drainage seen at our institution and the use of intraoperative ICG, it is now the practice of the senior author to forgo preoperative LSG for most upper extremity and lower extremity melanomas. We would recommend preoperative LSG in patients with a history of prior lymph node dissection, transposition flap reconstruction, or radiation treatment to the involved extremity. These procedures may alter the normal lymphatic drainage or induce fibrosis to the typical draining nodal basin, resulting in altered drainage to a nodal basin outside of the extremities. In addition, we recommend preoperative LSG for primary lesions of the posterior calf, ankle, or heel. Menes et al.¹² reported 10 lower extremity melanoma patients with lymph node drainage to the popliteal nodes. Seven of these melanomas were located on the posterior calf, ankle, and heel.¹² Based on these published data and our own data, the likelihood of posterior calf, ankle, and heel melanomas draining to the popliteal nodes appears high. While the use of intraoperative Tc-99^m and ICG can reliably detect these cases of atypical drainage to the popliteal nodes, having a priori knowledge of these cases of popliteal node drainage can

aid in the SLNB purely from the matter of patient positioning and convenience at the time of surgery.

At our institution, one can expect a reduction in hospital charges per patient of \$2,498 when preoperative LSG is not performed. While it is our practice to use intraoperative ICG and NIRS during the SLNB, the patient is only charged \$105 (for ICG vial and sterile drape) at our institution, still resulting in a total overall charge reduction of \$2,393. In addition to the potential reduction in charges, forgoing preoperative LSG provides other benefits to the patient. It is our practice to perform preoperative LSG at least a day before the SLNB to avoid potential operating room conflicts and delays during the SLNB and to assist in preoperative patient education. By forgoing preoperative LSG, the patient avoids an additional visit to the hospital for the procedure and the discomfort of the procedure itself, which is performed while the patient is awake. The patient also avoids additional radiation exposure. Although the radiation dosage of the Tc-99^m injection is small, the long-term effects of radiation exposure must always be considered, particularly for cancer patients who may accumulate large doses of radiation over the course of their treatment. Ultimately, there is potential for significant charge reduction by eliminating unnecessary testing if applied across health care systems.

CONCLUSIONS

Preoperative LSG can be safely eliminated in the management of upper and lower extremity melanomas. The rates of atypical drainage are extremely low and the intraoperative use of Tc-99^m and ICG ensure accurate identification of the draining nodal basin. Exceptions may be considered for primary lesions of the posterior calf, ankle, and heel as well as for patients with the history of prior surgery or radiation. Furthermore, forgoing preoperative LSG results in a hospital charge reduction of \$2,393 at our institution and provides additional benefits to the patient such as decreased travel requirements, discomfort, and radiation exposure.

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