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Role of lymphoscintigraphy and sentinel lymph node biopsy in the management of pediatric melanoma and sarcoma

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Abstract

Purpose—The purpose of this study was to describe the use of lymphoscintigraphy and sentinel lymph node biopsy for the management of children with melanoma and sarcomas. We report the experience of two children's hospitals that utilize this technique to identify sentinel lymph nodes for lymph node biopsy and dissection.

Methods—We identified 56 patients (median age 10.8 years) who underwent 58 lymphoscintigraphy procedures. There were 33 patients with melanoma and melanocytic lesions, and 23 with sarcomas.

Results—Of 58 lymphoscintigraphy procedures, sentinel lymph nodes were identified in 52 (90% success rate). Using the combination of intraoperative blue dye injection and lymphoscintigraphy, the success rate was 95% (55/58). Metastatic disease was found in 14 sentinel lymph nodes (13 patients with melanoma and melanocytic lesions, and 1 patient with rhabdomyosarcoma).

Conclusion—We have found that lymphoscintigraphy with sentinel lymph node biopsy is an effective method to identify patients who may benefit from more extensive lymph node dissection and to identify those patients who are unlikely to benefit from further lymph node exploration.

Keywords

lymphoscintigraphy; sentinel node; melanoma; sarcoma; pediatric

INTRODUCTION

The utility of lymphoscintigraphy and sentinel lymph node biopsy (SLNB) is well established in the management of melanoma and certain types of soft tissue sarcomas in the adult population[1-3]. However, there have been fewer studies describing their role in the pediatric population because melanoma is uncommon in children, and the number of pediatric patients with soft tissue sarcomas having a propensity to metastasize to regional lymph nodes is quite small[4-9]. Children and adolescents (ages 0-19 years) account for just 1.3% of all melanoma patients in the United States[10]. The International Multicenter Selective Lymphadenectomy Trial (MSLT-I) showed that the status of the sentinel node

(SN), the node whose afferent lymphatic channel is the first to receive lymph directly from the site of the primary tumor, is the most statistically significant predictor of survival for clinically localized (stage I/II) intermediate-thickness melanoma[11].

Children (<20 years old) with localized invasive cutaneous melanoma appear to have higher survival than young adults with thick primary lesions, suggesting that Breslow thickness may be less important prognostically in children and teenagers[4]. Although the management of children with melanoma and SN involvement is controversial, given the higher prevalence of positive SNs in younger patients, lymphoscintigraphy and SLNB should be considered[12,13]. Metastatic spread to regional lymph nodes is more common in certain types of sarcomas (extremity rhabdomyosarcoma (RMS), epithelioid sarcoma, clear cell sarcoma, and synovial sarcoma) than others[3].

The MSLT-I trial, which included a patient population from 18 to 75 years old, concluded that lymphoscintigraphy and SLNB were safe and associated with low morbidity for staging the regional nodal basin in early melanoma. The study further found that even after a 30-case learning phase and 25 additional lymphoscintigraphy procedures and SLNB, the accuracy of these procedures continued to increase[11]. Such a high experience would be difficult to obtain in most pediatric hospitals. The purpose of our study was to describe our experience at two large children's cancer centers with lymphoscintigraphy and SLNB in the management of pediatric patients with melanoma and sarcoma.

METHODS

A retrospective study of patients who underwent lymphoscintigraphy and SLNB between August 2004 and April 2010 at St Jude Children's Research Hospital, Memphis, TN, and at the Hospital for Sick Children, Toronto, Ontario, was performed with HIPAA compliance after local institutional review board and research ethics board waiver of informed consent. These two facilities were chosen from communications identifying these as institutions with the most experience. There were 56 patients and 58 lymphoscintigraphy procedures. None of the patients had palpable lymph node involvement or imaging evidence of metastatic disease. The procedure was similar at both institutions. Images and histology were reviewed at the originating institution. Preoperative lymphoscintigraphy was performed by experienced nuclear physicians (with 25 or 20 years of experience) or a pediatric radiologist (with 9 years of attending-level experience). All patients were transferred to the operating room (OR) immediately after successful lymphoscintigraphy. Patients with melanoma and melanocytic lesions who had metastasis in their SNs underwent complete lymph node dissection (CLND) of their regional lymph node basins in a separate operative session. Sarcoma patients with a positive SN did not undergo CLND and received radiation therapy to the nodal basin.

Demographic details, procedural details, pathologic details, and outcomes were recorded for these patients (Table 1).

Lymphoscintigraphy

Lymphoscintigraphy was performed in the nuclear medicine suite prior to the SLNB. General anesthesia was used routinely in younger patients (<10 years) and others at the anesthesiologist's discretion. 0.5-1.0 mCi filtered technetium-99m sulfur colloid radiotracer was diluted in approximately 0.5-1 mL sterile saline and injected intradermally at 2 to 4 sites around either the melanoma lesion or a previous operative scar. For sarcomas, the radiotracer was injected at the lesion's four quadrants - the end of the diagonals of maximal longitudinal and transverse diameters. Emission and transmission images in the anterior-posterior, and lateral positions were acquired using a dual head gamma camera immediately

after injection and continuing for 30 minutes to 2 hours after injection. A cobalt-57 flood source was used to outline the patient for superimposition on the images. The location of the sentinel node activity was determined by aligning a radioactive source (radioactive marker) with the sentinel node activity while the patient was being imaged. When the activity of the radioactive source overlaid the sentinel node activity, the location of the radioactive source on the skin was then marked with nonirritating ink using a surgical marking pen. The nuclear medicine physician or pediatric radiologist communicated the results of the lymphoscintigraphy to the operating surgeon prior to SLNB. Whenever possible, the surgeon visited the nuclear medicine suite at the conclusion of the study, reviewed the images and observed the approximate location of the lymph node to be excised.

Sentinel lymph node biopsy

Immediately after lymphoscintigraphy, patients were transferred to the operating room. Patients studied under general anesthesia were transported under anesthesia. In patients studied awake, anesthesia was induced in the operating room. After positioning the patient on the operating room table, the surgeon injected approximately 0.5-1.0 mL of Lymphazurin 1% blue dye (isosulfan blue; CovidienAutosuture, Norwalk, CT, USA) or 0.5-1.0 mL of Patent Blue dye (Therapex Montreal Canada, E-Z-EM Canada, Inc) in a circumferential four-quadrant fashion around either the lesion or a previous operative scar, allowing 15-30 minutes for the blue dye to reach the draining lymph node region. Wide local excision (WLE) preceded sentinel node biopsy. The baseline radiation count at the primary site was recorded with a handheld gamma probe (Neo2000 gamma detection system, Neoprobe, Dublin, OH, USA or Navigator GPS lymphatic probe system, RMD Instruments Corp, Watertown, MA, USA). Subsequently the probe was placed over the skin where the SN had been marked. Radioactivity and prior skin marking guided the surgeon to make a small incision. A successful lymphoscintigraphy was the presence of a focal area of elevated uptake of radiotracer seen on gamma camera images, apart from the injection site, that was persistent and could be associated with a lymph node basin. A lymph node was considered to be a SN if it had either significant radioactivity on gamma probe (compared with surrounding background activity), appeared blue or had both features. This SN was carefully excised and sent for pathologic evaluation. Additional SNs were removed until the background radiation count was equal to or less than 10% of the highest SN activity count that was removed. The median number of SNs removed was one although one patient had 6 lymph nodes excised. Standard histopathology techniques were used to arrive at the diagnosis of a positive sentinel node. This was usually a day surgery procedure if only SLNB was being done. Patients remained overnight or longer if concomitant primary site excision was done. If CLND was indicated on the basis of the pathology report, it was performed in a separate operative session.

RESULTS

There were 56 patients in our study (29 males and 27 females). None had clinical evidence for regional lymph node disease. The median age at procedure was 10.8 years (range, 1.6-18.6 years). A total of 58 preoperative lymphoscintigraphy procedures were done (Figures 1-3). Two patients underwent the procedure twice, on two separate occasions. The first patient had a left neck melanoma. His initial lymphoscintigraphy showed no demonstrable radiotracer migration from the injection site. He underwent a repeat lymphoscintigraphy after 6 days and a left cervical SN was identified. The second patient had a right hand epithelioid sarcoma. He underwent lymphoscintigraphy on two separate occasions due to recurrent disease. The primary diagnosis for the 33 patients in the melanoma and melanocytic lesion group included melanoma (n=26), Spitzoid melanoma (n=3), atypical Spitz nevus (n=3), and pigmented epithelioid melanocytoma (n=1) (Table 1).

Each of the sarcomas studied was located in an extremity. The primary diagnosis for the 23 patients in the sarcoma group included epithelioid sarcoma (n=8), rhabdomyosarcoma (RMS, n=6), synovial sarcoma (n=3), clear cell sarcoma (n=2), high-grade sarcoma (n=2), sarcoma not otherwise specified (n=1), and Ewing sarcoma (EWS, n=1) (Table 2). All diagnoses were proven by histopathology. The primary sites of origin in the melanoma group were the extremities (n=16), head and neck (n=13), and the trunk (n=4). All sarcomas were located in the extremities (n=23).

In the 58 preoperative lymphoscintigraphy procedures, 52 SNs were localized successfully. This gives lymphoscintigraphy a 90% (52/58) success rate in detecting SNs preoperatively. Of the remaining six patients, three patients had SNs localized intra-operatively (by a combination of blue dye and gamma activity). One patient underwent a repeat lymphoscintigraphy approximately one week later resulting in successful SN localization. Two patients did not undergo SLNB or repeat lymphoscintigraphy after the initial failure to localize SNs with lymphoscintigraphy. The combined success rate of preoperative lymphoscintigraphy and intraoperative mapping (blue dye/gamma probe) in detecting SNs was 95% (55/58). The regional lymph node basins included the axilla (n=25), inguinal regions (n=18) and head and neck (n=12). The number of SNs for our study group ranged from one to six sentinel nodes with a median of one SN for each patient. Metastatic disease was detected in 14 patients, and the remaining 41 patients showed no evidence of metastasis. The diagnosis of the primary site in patients with metastatic SNs included melanoma (n=10), atypical Spitz nevus (n=2), Spitzoid melanoma (n=1), and RMS (n=1). Breslow thickness values were available for 19 patients with melanoma. Seven of these patients had sentinel node involvement. Breslow thickness ranged from 2.9 mm to 5.6 mm (mean 4.1, standard deviation 1.2, median 4). In the remaining 12 patients whose sentinel lymph nodes did not show evidence for melanoma, Breslow thickness ranged from 0.4 mm to 8.1 mm (mean 2.5, SD 2.3, median 2.2). The Breslow thickness of those patients with positive sentinel nodes tended to be higher than those without sentinel node involvement and the trend approached statistical significance (p=0.06).

None of the lymphoscintigraphy/SLNB-negative patients with melanoma and other melanocytic lesions in our study had nodal recurrence during a median follow-up of 21.5 months (range, 1-59 months).

The SN positivity rate for RMS patients was 16.7% (1/6) and 0% (0/17) for non-RMS sarcomas. Patients with metastatic SNs underwent a subsequent CLND, except for the single patient with RMS, who had additional radiation therapy to the regional lymph node basin. Three of these 14 patients remained under treatment at the time of this study (receiving chemotherapy), while the remaining 11 showed no evidence of disease on most recent follow-up, ranging from 7 months to 57 months (median 30 months). Of the remaining 41 patients without SN metastasis, one died of disease (high-grade sarcoma), 2 were alive with disease (epithelioid sarcoma, clear cell sarcoma), 5 were under treatment (receiving chemotherapy), and 33 showed no evidence of disease at their last follow-up (median duration 23 months; range, 1-59 months). Three patients had recurrence during the study period. One patient with left neck melanoma and another patient with left upper extremity clear cell sarcoma had recurrent disease at the primary site. One patient with a right hand epithelioid sarcoma had primary site recurrence followed by pulmonary metastases.

DISCUSSION

In our study, lymphoscintigraphy alone had a 90% (52/58) success rate in detecting SNs preoperatively. Although this is slightly lower than reported in large adult series, the small difference may be due to the initial limited experience using the technique and the relative

infrequency that the study is indicated, requested, and performed. However, with the combination of lymphoscintigraphy and intraoperative blue dye injection, the success rate was 95% (55/58). This is consistent with findings in the large trial MSLT-I, which had an SN identification rate of 95.3% (1352/1419)[11]. The non-migration of the injected radiotracer agent was the cause of failure of the lymphoscintigraphy procedure in six patients. However, in three of these patients, we were able to locate a SN with subsequent blue dye injection. A fourth patient had successful SN localization with a repeat lymphoscintigraphy done approximately one week after the initial. The reason for non-migration of the radiotracer agent in these patients is unclear, perhaps related to injection technique, or the study halted prematurely, requiring longer than the two hours allotted for the procedure. Disrupting the lymphatic pathways due to prior extensive biopsy has been suggested as a cause of lowering the success rate. Therefore, it is recommended if that possible to perform lymphoscintigraphy before extensive or excision biopsy. Although none of our patients had palpable regional lymphadenopathy, we also believe that lymphoscintigraphy can be valuable in the presence of regional lymphadenopathy, as the enlarged lymph nodes may not be the sentinel nodes, and they may be enlarged for reasons other than tumor involvement.

A recent study described 55 melanoma patients younger than 20 years old who underwent SLNB with preoperative lymphoscintigraphy. The authors concluded that the SN positivity rate in the pediatric population was higher than in adults (25% vs. 17%)[9]. The SN positivity rate for melanoma patients in our study was 38% (11/29), and the SN positivity rate for other melanocytic lesions (atypical Spitz nevus, pigmented epithelioid melanocytoma) was 50% (2/4).

Melanocytic lesions such as atypical Spitz nevus with undetermined metastatic potential have been categorized with melanoma, although this grouping is controversial[14]. These lesions are difficult to manage clinically and SLNB may help in the therapeutic decision making process when metastatic nodal disease is identified. The SN positivity rate for these lesions has ranged from 44% to 50%[15,16]. Although the finding of SN metastasis is suggestive of melanoma-like biologic behavior, additional prospective trials are needed to determine the significance of this pathologic finding. Because of the uncertainty regarding the biological behavior of atypical Spitz nevus, CLND has often been recommended when SN metastases are present but its impact upon long-term survival remains unclear. In our study, 3 patients had atypical Spitz nevi, of whom 2 showed SN metastases. Both of these patients underwent CLND and had no evidence of disease at 9 and 27 months of follow-up. The third patient had an unsuccessful lymphoscintigraphy, did not undergo SLNB, but had no evidence of disease at 16 months of follow-up.

Spitzoid melanoma (SM) is a group of melanomas with features very similar to and difficult to differentiate from Spitz nevus. These lesions are also difficult to manage and SLNB helps in the decision making process when metastatic nodal disease is identified. We observed SN metastasis for these lesions in 33% (1/3) of our patients. A previous, larger study has reported a rate of 44% [15]. A review of the literature from 1949 to 2006 identified 82 cases of Spitzoid melanoma with regional or widespread metastasis in children 17 years or younger[17]. The 5- year survival rate in children between 0 and 10 years old with metastatic Spitzoid melanomas was 88%, compared with 49% in those between 11 and 17 years old. Paradela et al. reported their experience with 38 pediatric patients with SM, 71.4% of whom underwent SLNB[18]. Patients with metastatic SNs received regional lymph node dissection and interferon-alfa, and high risk patients received additional chemotherapy. There was not a significant correlation between Breslow thickness and positive SNs. In our study, one patient with a Breslow thickness of 3.5 mm had a positive SN, whereas another patient with a Breslow thickness of 2.8 mm had a negative SN.

Regional lymph node metastases occur in 46% of patients with pigmented epithelioid melanocytoma (PEM)[19]. PEM has been described as a low-grade melanoma with an indolent clinical course but SLNB has been advised to better characterize these lesions. Most patients with PEM and SN involvement have better outcome and survival than those with melanoma[20].

The importance of regional lymph node status in proper staging of RMS of the extremities has been previously described[21]. Neville and colleagues found that 17% of patients in the Intergroup Rhabdomyosarcoma Study (IRS) Group IV study with clinically negative regional lymph nodes on physical examination showed nodal metastasis on pathologic evaluation. The soft tissue sarcoma committee of the Children's Oncology Group recommends regional nodal sampling, but not nodal dissection, for patients with extremity RMS, and patients with nodal metastasis require nodal radiation therapy[22]. Neville found one patient with SN metastasis among three patients with RMS who had undergone lymphoscintigraphy/SLNB and commented that SLNB would provide a better assessment of the regional lymph node status than random node sampling[23]. McMulkin described a child with alveolar RMS who underwent lymphoscintigraphy/SLNB[24]. In a recent review of SLNB in 9 pediatric patients with RMS, a positive SN was found in 1 patient who received regional lymph node irradiation but died 40 months later due to systemic recurrence[6]. De Corti reviewed 5 children with RMS of the extremities who underwent lymphoscintigraphy and SLNB and found SN metastasis in one patient with an alveolar histology[5]. In our study, the SN positivity rate for RMS patients was 16.7% (1/6), similar to the rate seen in IRS-IV[21].

The role of SLNB in staging of regional lymph nodes is not yet definitive in synovial, epithelioid, or clear cell sarcomas. Maduekwe et al reported the findings of 29 patients (median age, 35 years) with non-metastatic synovial, epithelioid, and clear cell sarcoma who had SLNB[25]. They found that the incidence of occult lymph node metastasis is low for patients with these sarcoma subtypes in the absence radiologic evidence of nodal or distant metastases. In their study, a positive SLNB did not predict a nodal recurrence; however, patients without nodal metastasis had a similar outcome to those with nodal involvement. Kayton et al. reported their experience with SLNB in 31 pediatric patients with sarcoma and carcinoma[7]. All 12 patients with non-RMS soft tissue sarcoma had negative SLNB. Our group consisted of 13 patients with a diagnosis of epithelioid sarcoma, clear cell sarcoma, or synovial sarcoma, none of whom had SN metastasis. These subtypes have a reported frequency of regional lymph node metastasis varying from 11% to 44%[25]. We did perform lymphoscintigraphy and SLNB for these since these subtypes of sarcoma are known to spread to regional lymph nodes. In the first two IRS series, 8% of cases were diagnosed as undifferentiated STS, whereas this figure was 4% in the IRS III and IRS pilot IV studies, with 53% of these lesions occurring in an extremity[26]. Regional lymph node involvement was seen in 23% of patients with extraosseous EWS registered on the three IRS Group trials (I, II, and III), but, in our study the SN was negative in the single patient with extraosseous EWS[27].

Although our study had a much smaller sample size than the studies reported in adults, and was retrospective and multi-institutional in nature, it nonetheless qualifies as one of the larger series that addresses the role of lymphoscintigraphy and SLNB in the management of pediatric melanoma and sarcoma. We conclude that preoperative lymphoscintigraphy and SLNB is a minimally invasive method to evaluate regional lymph node status in children with melanoma and soft tissue sarcomas; it is an important test in staging and in determining the need for adjuvant therapy and it is useful in evaluating the metastatic potential of difficult to manage Spitzoid lesions. It also adds to the staging of RMS of the extremities and certain types of non-RMS soft tissue sarcomas and is an indication for adjuvant

radiotherapy to the involved lymph node basin. Due to the small number of pediatric patients with these diagnoses, prospective multi-institutional trials would be required to better define the role of lymphoscintigraphy and SLNB in the management of these patient populations, particularly in epithelioid, synovial, and clear cell sarcomas.

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Reference List

1. Morton DL, Thompson JF, Cochran AJ, et al. Sentinel-node biopsy or nodal observation in melanoma. *N Engl J Med*. 2006; 355(13):1307–1317. [PubMed: 17005948]
2. Blazer DG III, Sabel MS, Sondak VK. Is there a role for sentinel lymph node biopsy in the management of sarcoma? *Surg Oncol*. 2003; 12(3):201–206. [PubMed: 12957624]
3. Andreou D, Tunn PU. Sentinel node biopsy in soft tissue sarcoma. *Recent Results Cancer Res*. 2009;17925–36.
4. Lange JR, Palis BE, Chang DC, et al. Melanoma in children and teenagers: an analysis of patients from the National Cancer Data Base. *J Clin Oncol*. 2007; 25(11):1363–1368. [PubMed: 17416855]
5. De Corti F, Dall'Igna P, Bisogno G, et al. Sentinel node biopsy in pediatric soft tissue sarcomas of extremities. *Pediatr Blood Cancer*. 2009; 52(1):51–54. [PubMed: 18819127]
6. Kayton ML, Delgado R, Busam K, et al. Experience with 31 sentinel lymph node biopsies for sarcomas and carcinomas in pediatric patients. *Cancer*. 2008; 112(9):2052–2059. [PubMed: 18338809]
7. Gow KW, Rapkin LB, Olson TA, et al. Sentinel lymph node biopsy in the pediatric population. *J Pediatr Surg*. 2008; 43(12):2193–2198. [PubMed: 19040933]
8. Roaten JB, Partrick DA, Pearlman N, et al. Sentinel lymph node biopsy for melanoma and other melanocytic tumors in adolescents. *J Pediatr Surg*. 2005; 40(1):232–235. [PubMed: 15868590]
9. Howman-Giles R, Shaw HM, Scolyer RA, et al. Sentinel lymph node biopsy in pediatric and adolescent cutaneous melanoma patients. *Ann Surg Oncol*. 2010; 17(1):138–143. [PubMed: 19672660]
10. Hamre MR, Chuba P, Bakhshi S, et al. Cutaneous melanoma in childhood and adolescence. *Pediatr Hematol Oncol*. 2002; 19(5):309–317. [PubMed: 12078862]
11. Morton DL, Cochran AJ, Thompson JF, et al. Sentinel node biopsy for early-stage melanoma: accuracy and morbidity in MSLT-I, an international multicenter trial. *Ann Surg*. 2005; 242(3):302–311. [PubMed: 16135917]
12. Pappo AS. Melanoma in children and adolescents. *Eur J Cancer*. 2003; 39(18):2651–2661. [PubMed: 14642927]
13. Strouse JJ, Fears TR, Tucker MA, et al. Pediatric melanoma: risk factor and survival analysis of the surveillance, epidemiology and end results database. *J Clin Oncol*. 2005; 23(21):4735–4741. [PubMed: 16034049]
14. Navid F, Furman WL, Fleming M, et al. The feasibility of adjuvant interferon alpha-2b in children with high-risk melanoma. *Cancer*. 2005; 103(4):780–787. [PubMed: 15660397]
15. Su LD, Fullen DR, Sondak VK, et al. Sentinel lymph node biopsy for patients with problematic spitzoid melanocytic lesions: a report on 18 patients. *Cancer*. 2003; 97(2):499–507. [PubMed: 12518375]
16. Lohmann CM, Coit DG, Brady MS, et al. Sentinel lymph node biopsy in patients with diagnostically controversial spitzoid melanocytic tumors. *Am J Surg Pathol*. 2002; 26(1):47–55. [PubMed: 11756768]
17. Pol-Rodriguez M, Lee S, Silvers DN, et al. Influence of age on survival in childhood spitzoid melanomas. *Cancer*. 2007; 109(8):1579–1583. [PubMed: 17326059]

18. Paradelo S, Fonseca E, Pita S, et al. Spitzoid melanoma in children: clinicopathological study and application of immunohistochemistry as an adjunct diagnostic tool. *J Cutan Pathol*. 2009; 36(7): 740–752. [PubMed: 19032380]
19. Zembowicz A, Carney JA, Mihm MC. Pigmented epithelioid melanocytoma: a low-grade melanocytic tumor with metastatic potential indistinguishable from animal-type melanoma and epithelioid blue nevus. *Am J Surg Pathol*. 2004; 28(1):31–40. [PubMed: 14707861]
20. Mandal RV, Murali R, Lundquist KF, et al. Pigmented epithelioid melanocytoma: favorable outcome after 5-year follow-up. *Am J Surg Pathol*. 2009; 33(12):1778–1782. [PubMed: 19773637]
21. Neville HL, Andrassy RJ, Lobe TE, et al. Preoperative staging, prognostic factors, and outcome for extremity rhabdomyosarcoma: a preliminary report from the Intergroup Rhabdomyosarcoma Study IV (1991-1997). *J Pediatr Surg*. 2000; 35(2):317–321. [PubMed: 10693687]
22. Donaldson SS, Meza J, Breneman JC, et al. Results from the IRS-IV randomized trial of hyperfractionated radiotherapy in children with rhabdomyosarcoma--a report from the IRSG. *Int J Radiat Oncol Biol Phys*. 2001; 51(3):718–728. [PubMed: 11597814]
23. Neville HL, Andrassy RJ, Lally KP, et al. Lymphatic mapping with sentinel node biopsy in pediatric patients. *J Pediatr Surg*. 2000; 35(6):961–964. [PubMed: 10873044]
24. McMulkin HM, Yanchar NL, Fernandez CV, et al. Sentinel lymph node mapping and biopsy: a potentially valuable tool in the management of childhood extremity rhabdomyosarcoma. *Pediatr Surg Int*. 2003; 19(6):453–456. [PubMed: 12740706]
25. Maduekwe UN, Hornicek FJ, Springfield DS, et al. Role of sentinel lymph node biopsy in the staging of synovial, epithelioid, and clear cell sarcomas. *Ann Surg Oncol*. 2009; 16(5):1356–1363. [PubMed: 19259743]
26. Pawel BR, Hamoudi AB, Asmar L, et al. Undifferentiated sarcomas of children: pathology and clinical behavior--an Intergroup Rhabdomyosarcoma study. *Med Pediatr Oncol*. 1997; 29(3):170–180. [PubMed: 9212841]
27. Raney RB, Asmar L, Newton WA Jr. et al. Ewing's sarcoma of soft tissues in childhood: a report from the Intergroup Rhabdomyosarcoma Study, 1972 to 1991. *J Clin Oncol*. 1997; 15(2):574–582. [PubMed: 9053479]

Fig. 1.

Seven year old girl with Spitzoid melanoma of the left parieto-occipital scalp. The left panel shows a posterior view of the upper body with a cobalt-57 source image depicting the body outline. The right panel is a left lateral view. There is radioactivity at the injection site (small arrow) and sentinel node (large arrow) in the left posterior-auricular area. This node was positive for metastatic disease.

Fig. 2.

Two year old boy with epithelioid sarcoma of the right forearm. Injection site (short arrow) and sentinel lymph node (long arrow). Left panel: Activity is noted extending from the injection site to the sentinel lymph node. Activity at the elbow was transient and may have resided in an intransit lymph node. Right panel: A cobalt-57 transmission source was used to provide an outline of the body. The sentinel lymph node is localized to the right axilla. Note the activity at the elbow has resolved. The sentinel lymph node did not contain metastatic disease.

Fig. 3.

Two year old girl with right lower leg melanoma. Injection site (short arrow) and sentinel lymph nodes (long arrow). Left panel: Activity is noted extending from the injection site to the sentinel lymph nodes. Right panel: A lead lined shield has been placed over the injection site. A cobalt-57 transmission source was used to provide an outline of the body. The sentinel lymph nodes are localized to the right inguinal region. These lymph nodes did not contain metastatic disease.

Table 1

Melanoma and melanocytic lesions: patient demographic details

Demographic data	Number (unless otherwise specified)
Patients	33
Male	17
Female	16
Age	
Median	9.2 years
Range	1.6–15.8 years
Diagnosis	
Melanoma	26
Spitzoid melanoma	3
Atypical Spitz nevus	3
Pigmented epithelioid melanocytoma	1
Primary site of lesion	
Extremity	16
Head/Neck	13
Back	4
Number of Lymphoscintigraphies ^a	34
Lymph node basin ^b	
Head/neck	12
Inguinal	11
Axilla	9
SN pathology ^c	
Metastasis present	14
No metastasis	19
Follow-up duration	
Median	24 months
Range	1-59 months
Breslow thickness ^d	
Median	2.8 mm
Range	0.42-8.1 mm
Outcome (at last follow-up)	
No evidence of disease	29
Under treatment	4

^aOne patient had lymphoscintigraphy twice.^bOne patient had no migration of radiotracer agent after injection during the first lymphoscintigraphy session.^cOne patient had lymphoscintigraphy done with no migration of radiotracer agent after injection; no subsequent lymphoscintigraphy was done.^dBreslow thickness was known in 19 patients

Table 2

Sarcoma: patient demographic details

Demographic data	Number (unless otherwise specified)
Patients	23
Male	12
Female	11
Diagnosis	
Epithelioid sarcoma	8
Rhabdomyosarcoma	6
Synovial sarcoma	3
Clear cell sarcoma	2
High-grade sarcoma	2
Ewing sarcoma	1
Sarcoma, not otherwise specified	1
Primary site of lesion	
Upper extremity	15
Lower extremity	8
Number of lymphoscintigraphy done ^a	24
Regional lymph node basin	
Axilla	16
Inguinal	7
SN pathology	
Metastasis present	1
No metastasis	22
Follow-up duration	
Median	12 months
Range	1-57 months
Outcome (at last follow-up)	
No evidence of disease	16
Under treatment	4
Alive with disease	2
Died of disease	1

^aOne patient underwent lymphoscintigraphy twice.