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RESEARCH ARTICLE

The Role of Lymphoscintigraphy in Lower Extremity Peripheral Edema

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ABSTRACT

Objective: Lower extremity edema (LEE) can arise from various conditions such as venous insufficiency, lymphedema, and systemic diseases, making its diagnosis challenging. Lymphoscintigraphy has become an essential tool in accurately diagnosing lymphedema by visualizing lymphatic function and identifying abnormalities.

Materials and Methods: In this retrospective study, we evaluated 66 patients with suspected lymphedema who underwent lymphoscintigraphy between January 2023 and April 2024. Patient demographic data, including age, gender, and body mass index (BMI), were collected, and the lymphoscintigraphy results were reviewed to assess lymphatic dysfunction. Lymphoscintigraphy findings were classified using the Lee Bergan and Chang classification systems, and statistical comparisons were made between patients with and without lymphedema.

Results: Of the 66 patients, 55 were diagnosed with lymphedema, with a higher prevalence in females (80%). Lymphedema was bilateral in 40% of the cases. No significant differences were found in age, gender, or BMI between patients with and without lymphedema. Lymphoscintigraphy detected inguinal lymph node pathology in 55 (83%), popliteal lymph node pathology in 49 (74%), main lymphatic duct pathology in 54 (82%), collateral duct pathology in 49 (74%), and dermal-backflow pathology in 48 (73%) of the patients. Most patients were classified as moderate-stage (G2, P2) lymphedema.

Conclusion: In conclusion, lymphoscintigraphy demonstrated high diagnostic efficacy, confirming lymphedema in the majority of cases. It not only facilitated early diagnosis but also provided valuable insights into disease staging, enabling more targeted interventions. This study supports the role of lymphoscintigraphy as a critical tool in the management of lymphedema, offering comprehensive information that aids in both diagnosis and treatment planning.

Keywords: Lower extremity, lymphedema, lymphoscintigraphy

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INTRODUCTION

Lower extremity edema (LEE) presents a significant diagnostic challenge due to its multifactorial etiology, which encompasses a diverse range of conditions such as venous insufficiency, lymphedema, and systemic disorders like cardiac or renal diseases.[1] The diagnostic complexity of LEE arises from the overlapping clinical manifestations of these conditions, making it difficult to determine the precise cause without employing specialized diagnostic tools.[1,2] Therefore, a comprehensive diagnostic approach is essential to accurately identify the underlying pathology and guide appropriate management strategies.[2] Several imaging modalities are available for the evaluation of LEE, each offering unique advantages and limitations.[2] Doppler ultrasound is widely used as a first-line imaging technique due to its ability to assess venous insufficiency and rule out deep vein thrombosis. However, while Doppler ultrasound is effective for evaluating the venous system, it lacks the sensitivity needed to diagnose lymphatic abnormalities.[3] Magnetic resonance imaging (MRI) and computed tomography (CT) are also employed in some cases, particularly for their ability to provide detailed anatomical images and identify structural abnormalities.[4–6] Despite their strengths, these modalities are often limited by their inability to offer functional insights into the lymphatic system.[7,8]

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Among these diagnostic tools, lymphoscintigraphy has emerged as a pivotal technique in the evaluation of LEE, particularly for its ability to differentiate lymphedema from other etiologies.[9] Lymphoscintigraphy, a nuclear medicine imaging procedure, involves the injection of a radiolabeled tracer that is subsequently visualized through the lymphatic system. This method provides detailed visualization of lymphatic function and architecture, enabling the identification of abnormalities indicative of lymphedema. Notably, lymphoscintigraphy boasts high sensitivity and specificity—reported as high as 96% and 100%, respectively—making it a reliable tool in clinical practice.[4,10] By facilitating the early and accurate diagnosis of lymphedema, lymphoscintigraphy allows for timely and appropriate intervention, which is crucial for optimizing patient outcomes.[6]

This study aims to review and analyze our local experience with lymphoscintigraphy in the evaluation of lower extremity lymphedema. By examining a cohort of patients who underwent this imaging modality, we seek to evaluate its diagnostic efficacy and value in distinguishing lymphedema from other causes of LEE. Additionally, this study will compare the utility of lymphoscintigraphy with other imaging modalities, highlighting its strengths and limitations in the broader diagnostic landscape. The findings from this analysis are expected to provide valuable insights into the role of lymphoscintigraphy within the diagnostic algorithm for LEE, underscoring its significance in enhancing diagnostic accuracy and informing clinical decision-making.[11,12] Through this study, we aim to contribute to the growing body of evidence that supports the clinical utility of lymphoscintigraphy in the context of lower extremity edema and its various underlying pathologies, thereby informing future guidelines and improving patient care.

MATERIALS and METHODS

This study was designed as a retrospective case series, aimed at reviewing our local experience in the use of lymphoscintigraphy for the evaluation of lower extremity lymphedema. The study was conducted at Şırnak State Hospital and encompassed all cases referred for lymphoscintigraphy due to suspected lower limb lymphedema from January 2023 to April 2024.

We retrospectively identified and included in our study all patients who presented to Şırnak State Hospital with clinical suspicion of lower limb lymphedema during the study period. A total of 66 patients met the inclusion criteria, and their case records, including demographic data and imaging studies, were thoroughly reviewed. Only those patients for whom lymphoscintigraphy was performed as part of their diagnostic evaluation were included in the analysis. Patient demographic data, including age, sex, and clinical history, were collected from the hospital's electronic medical records. The lymphoscintigraphic images and associated reports were retrieved from the hospital's radiology database. Each lymphoscintigraphy study was reviewed to assess the diagnostic findings and to determine the presence and extent of lymphatic dysfunction indicative of lymphedema. All applications and evaluations were carried out by an experienced nuclear medicine specialist.

Acquisition Protocol

A dose of 30–50 MBq of 99Tc-Nanocolloid (Senti-Scint; MEDI-Radiopharma, Budapest, Hungary) radiopharmaceutical was administered subcutaneously into the first webspace of both feet using a 1 ml 26-gauge needle, in a volume of 0.2–0.4 mL.[13] Following a 15-minute walking period after the injection, the patient was placed in the supine position. All subjects underwent planar scintigraphic imaging applying AnyScan S Flex dual-head gamma camera (Mediso, Hungary) which included a low-energy general purpose collimator set at 140 KeV with 20% window, 128×128 matrix, 1.0 zoom factor.[14] Planar images of the lower extremities started at the injection site in the caudo-cranial direction including the pelvis with an acquisition speed of 10 cm/min. After a brief walking period, the late scintigraphic scans were conducted at 120 minutes.[15] The images were evaluated by an experienced nuclear medicine specialist. The involvement density and main lymphatic activity flow rate of the ilio-inguinal lymph nodes were noted. Popliteal lymph nodes (Absent/Present), collateral flow (Absent/Present), or dermal backflow (Absent/Distal only, Whole Limb) were evaluated.[16]

The analysis of lymphoscintigraphy results was performed utilizing the Cheng and Lee Bergan classification system.[17] The Lee Bergan classification system comprises four pathological classes.[18] Grade I involves mild reduction of main lymphatics. Grade II, in Group A, includes distal dermal backflow, while in Group B, dermal backflow throughout the extremity is observed. In Grade III, main lymphatics are not observed, while weak collateral flow may be visible. Dermal backflow is present. Grade IV denotes complete absence of flow and absence of inguinal lymph nodes. The Taiwan lymphoscintigraphy staging, also known as the Cheng classification, consists of seven groups. The normal drainage (L-0) is classified as such. Partial obstruction is classified based on severity. Similar to Grade 1 in the Lee Bergan classification, P-1 denotes partial obstruction. Depending on the extent of dermal backflow, distal and proximal classifications are labeled as P-2 and P-3, respectively. Total obstruction is divided into three separate groups: T-4, T-5, and T-6.

Table 1. Distribution of lymphedema grading of patients according to the Lee-Bergan and Chang classification systems

	Lee Bergan									
	G1 count		G2 count		G3 count		G4 count		Total	
	n	%	n	%	n	%	n	%	n	%
Chang										
P-1	8		0		0		0		8	10.4
P-2	0		24		0		0		24	31.2
P-3	0		16		0		0		16	20.8
T-4	0		0		3		0		3	3.9
T-5	0		0		11		0		11	14.3
T-6	0		0		0		15		15	19.5
Total	8	10.4	40	51.9	14	18.2	15	19.5	n=77	

This study was conducted in accordance with the ethical standards of the Declaration of Helsinki. Ethical approval for the study was obtained from the Ethics Committee of the Faculty of Medicine at Beykent University, under the approval number E-45778635-050.99-148264.

Statistical analyses were performed using IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to summarize the demographic and clinical characteristics of the patients. Continuous variables were reported as mean±standard deviation (SD), while categorical variables were presented as frequencies and percentages. The chi-square test was employed to compare categorical variables, and Mann-Whitney U tests were used to compare continuous variables, including age and BMI, between patients with and without confirmed lymphedema. Statistical significance was set at $p<0.05$.

RESULTS

In this study, 66 patients were evaluated, of whom 54 (82%) were female and 12 (18%) were male, with a mean age of 44.6±16.6 years and a mean BMI of 29.2±7.6. At the time of admission, 27 patients presented with bilateral lower extremity edema, 21 with right-sided edema, and 18 with left-sided edema. Lymphoscintigraphy results confirmed the diagnosis of lymphedema in 55 patients, while 11 patients had normal findings.

Among the patients diagnosed with lymphedema, 44 (80%) were female and 11 (20%) were male, with a mean age of 44.0±17.5 years and a mean BMI of 28.9±7.8. Of these patients, 22 (40%) presented with bilateral lymphedema, 18 (33%) with right-sided lymphedema, and 15 (27%) with left-sided lymphedema. Statistical analysis showed no significant differences in age, gender, or BMI between patients with and without lymphedema. Venous insufficiency was the most common comorbidity in 33.3% of the patients, followed by diabetes in 26.7%, and hypertension in 24.4%. Lymphoscintigraphy detected inguinal lymph node pathology in 55 (83%), popliteal lymph node pathology in 49 (74%), main lymphatic duct pathology in 54 (82%), collateral duct pathology in 49 (74%), and dermal-backflow pathology in 48 (73%) of the patients.

In patients with unilateral lymphedema, the stages were classified according to the Lee and Bergan system: 6 patients (18%) were categorized as G1, 13 patients (39%) as G2, 9 patients (27%) as G3, and 5 patients (15%) as G4. Among 22 cases of bilateral lymphedema, involving a total of 44 extremities, 2 extremities (5%) were classified as G1, 27 extremities (61%) as G2, 5 extremities (11%) as G3, and 10 extremities (23%) as G4.

Based on the Chang classification, among the 33 extremities with unilateral lymphedema, 6 extremities (18%) were classified as P1, 10 extremities (30%) as P2, 3 extremities (9%) as P3, 2 extremities (6%) as T4, 7 extremities (21%) as T5, and 5 extremities (15%) as T6. Among the 44 extremities with bilateral lymphedema, 2 extremities (5%) were classified as P1, 14 extremities (32%) as P2, 13 extremities (30%) as P3, 1 extremity (2%) as T4, 4 extremities (9%) as T5, and 10 extremities (23%) as T6.

The grading of 77 extremities diagnosed with lymphedema in a total of 55 patients, according to both classification systems, is detailed in Table 1.

DISCUSSION

This study underscores the critical role of lymphoscintigraphy in the early and accurate diagnosis of lower extremity lymphedema (LEE), a condition that often presents significant diagnostic challenges due to its complex etiology.[1] Among the patients diagnosed with lymphedema in this study, 51.9% were classified as Grade 2. The ability of lymphoscintigraphy to detect lymphatic dysfunction early in the disease process is particularly valuable. Early diagnosis is crucial for initiating timely interventions that can halt or slow the progression of lymphedema, ultimately leading to improved patient outcomes and quality of life.[2,19] Additionally, in this study, a strong concordance was observed between the Lee-Bergan and Chang classification systems, resulting in consistency in diagnostic and staging outcomes. Both systems effectively delineated the pathological characteristics of lymphedema, providing robust support for clinical decision-making and treatment planning.

The importance of early detection in lymphedema cannot be overstated. Lymphedema, if left untreated, tends to progress, leading to significant complications such as chronic swelling, skin changes, fibrosis, and recurrent infections, which can severely impact patients' quality of life.[20] Furthermore, advanced lymphedema can become increasingly resistant to treatment, making early intervention not only desirable but essential.[13] Timely and accurate diagnosis, guided by imaging modalities like lymphoscintigraphy, enables healthcare providers to implement interventions that can mitigate these complications, slow disease progression, and reduce the long-term healthcare costs associated with managing advanced lymphedema.[13,20]

Lymphoscintigraphy, by providing a detailed visualization of lymphatic function and architecture, offers a critical advantage over other imaging modalities used in the assessment of LEE. While Doppler ultrasound is widely used for evaluating venous insufficiency and ruling out deep vein thrombosis, it lacks the sensitivity required to detect lymphatic abnormalities, making it less suitable for the diagnosis of lymphedema.[2,21] Similarly, MRI and CT scans, though valuable for their ability to provide high-resolution anatomical images and identify structural abnormalities, are limited in their capacity to assess the dynamic aspects of lymphatic function.[13,22] In contrast, lymphoscintigraphy excels in both functional and anatomical evaluation, making it the most comprehensive imaging modality currently available for the diagnosis of lymphedema.[13,22]

The use of lymphoscintigraphy in this study not only confirmed the presence of lymphedema in the majority of patients but also provided detailed information about the affected lymphatic structures. This included critical insights into the condition of the inguinal and popliteal lymph nodes, the main lymphatic ducts, and collateral ducts.[21,22] Such detailed anatomical and functional information is crucial for the accurate staging of lymphedema, which in turn is essential for effective disease management. The staging of lymphedema in this study, using both the Lee and Bergan and Chang classification systems, emphasized the severity of lymphatic obstruction in our patient population, with most cases categorized in the moderate stages (G2 and P2). This underscores the utility of lymphoscintigraphy not only in confirming the diagnosis of lymphedema but also in guiding treatment decisions based on the severity and progression of the disease.[2,13]

Moreover, lymphoscintigraphy's ability to provide a comprehensive assessment of lymphatic function positions it as a cornerstone in the diagnostic algorithm for LEE. Its high sensitivity and specificity make it an essential diagnostic instrument in the early stages of disease, where clinical signs may be subtle or nonspecific.[20,23] By enabling the identification of lymphatic dysfunction at an early stage, lymphoscintigraphy allows for the initiation of therapeutic interventions that can significantly alter the course of the disease.[22,24] This is particularly important in preventing the progression to more severe stages of lymphedema, where treatment options may be more limited and less effective.[23,25]

While the findings of this study strongly support the use of lymphoscintigraphy in the clinical management of lymphedema, it is important to acknowledge the study's limitations. The retrospective design may introduce biases, and the fact that the study was conducted in a single institution may limit the generalizability of the results to other settings.[23,24] Additionally, while lymphoscintigraphy provides detailed functional and anatomical information, it is important to consider the role of emerging imaging technologies that may complement or enhance its diagnostic capabilities.[5,23] Future studies should focus on validating these findings in larger, multi-center cohorts and exploring the potential of combining lymphoscintigraphy with other imaging modalities, such as advanced MRI techniques or near-infrared fluorescence imaging, to improve diagnostic accuracy and expand its utility in broader clinical contexts.[26]

CONCLUSION

In conclusion, lymphoscintigraphy has proven to be a safe and effective diagnostic tool for evaluating suspected lymphatic disorders in patients presenting with lower extremity edema. Our local experience underscores its utility in diagnosing lymphedema, as evidenced by the significant findings

in our patient cohort. Lymphoscintigraphy remains an essential tool in the early diagnosis of lower extremity lymphedema, offering significant advantages over other imaging modalities. Its ability to provide comprehensive functional and anatomical insights into the lymphatic system makes it indispensable for accurate diagnosis, effective staging, and guiding treatment decisions. The findings of this study contribute to the growing body of evidence supporting the critical role of lymphoscintigraphy in the comprehensive management of lymphedema, underscoring its importance in preventing disease progression and optimizing patient outcomes.

Disclosures

Ethics Committee Approval: The study was approved by the Beykent University Non-interventional Clinical Research Ethics Committee (No: E-45778635-050.99-148264, Date: 16/05/2024).

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