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Case Report

Transport index in lymphoscintigraphy for patients with lymphedema: a case report

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A B S T R A C T

Background: Lymphedema is an interstitial edema caused by impaired lymphatic drainage. Lymphoscintigraphy is a functional imaging modality used to evaluate lymphatic flow and diagnose lymphedema, with interpretation performed qualitatively and semi-quantitatively using the Transport Index (TI).

Case Presentation: Four patients with progressive unilateral extremity swelling at RSUP M. Djamil Hospital underwent lymphoscintigraphy. Subcutaneous injections of 99mTc-albumin nanocolloid were administered into both extremities, followed by dynamic and delayed imaging up to three hours after injection. Two patients showed complete lymphatic obstruction with TI scores of 36, while contralateral extremities demonstrated normal lymphatic transport (TI 1.2). The remaining two patients showed delayed lymphatic drainage with TI scores of 10.2, whereas contralateral extremities demonstrated near-normal TI values (1.2–4.2). TI values <10 indicate normal lymphatic transport, whereas values ≥10 reflect lymphatic dysfunction.

Conclusion: Qualitative and semi-quantitative analyses using the Transport Index provide consistent results in evaluating lymphatic dysfunction. Lymphoscintigraphy combined with TI scoring offers an objective and reproducible approach to improve diagnostic accuracy and support clinical decision-making, including treatment planning and disease monitoring.

INTRODUCTION

Lymphedema is a chronic and debilitating condition resulting from obstruction or insufficiency of the lymphatic system.[1] It is characterized by the accumulation of protein-rich interstitial fluid, leading to chronic inflammation, adipose deposition, and progressive tissue fibrosis.[2] Globally, lymphedema affects approximately 250 million people and is often underdiagnosed, particularly in early stages when clinical manifestations overlap with other causes of limb swelling.[3,4]

Lymphedema may present as unilateral or bilateral limb enlargement and can be classified as primary (congenital) or secondary, most commonly following cancer surgery, lymph node dissection, or radiotherapy.[5,6] Secondary lymphedema frequently occurs in oncologic populations, particularly in women following axillary lymph node dissection or radiotherapy for breast and gynecological cancers, which significantly increases the risk of upper-extremity involvement.[7]

The diagnosis of unilateral lymphedema remains challenging because early manifestations, such as mild or intermittent swelling, may resemble other conditions including venous disease, lipedema, or nonspecific edema.[8,9] Clinical staging alone often shows limited correlation with objective disease severity and quality of life, increasing the risk of misclassification.[10] In addition, unilateral presentations may mask subclinical dysfunction in the contralateral limb. Early and accurate diagnosis is therefore essential to guide treatment and prevent irreversible tissue changes. However, variability in imaging protocols and interpretation criteria may affect diagnostic consistency and clinical decision-making.[11]

Lymphoscintigraphy, introduced in 1953, remains a widely used imaging modality and is considered a reference standard for assessing lymphatic function.[1,12] This technique provides functional information on lymphatic

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drainage pathways, obstruction sites, and flow dynamics, which are essential for diagnosis and treatment planning.[7]

To enhance diagnostic interpretation, Kleinhans et al. introduced the Transport Index (TI), a semi-quantitative scoring system that integrates tracer transport kinetics, lymphatic vessel visualization, lymph node uptake, and timing parameters.[13] When combined with qualitative analysis, TI improves diagnostic accuracy and enables more objective evaluation of lymphatic function.[9,13] Lymphoscintigraphy also supports preoperative assessment and may influence treatment planning.[14] The use of standardized indices such as TI enhances clinicians' ability to assess disease severity and predict therapeutic outcomes.[15]

Despite its role as a diagnostic reference standard, no universally accepted protocol exists for performing and interpreting lymphoscintigraphy, leading to variability in clinical practice.[16] Semi-quantitative evaluation using TI remains underutilized, and only limited studies have examined its role in clinical decision-making at the individual patient level. Therefore, this case report aims to demonstrate the diagnostic value of lymphoscintigraphy using qualitative assessment and Transport Index analysis in confirming lymphedema and supporting clinical management.

CASE PRESENTATION

Lymphoscintigraphy examinations were performed between December 2024 and July 2025 at the Nuclear Medicine Unit of M. Djamil Hospital in four female patients presenting with unilateral extremity swelling. The radiopharmaceutical used was technetium-99m (^{99m}Tc)–labeled albumin nanocolloid, with particle sizes suitable for efficient lymphatic uptake.

A dose of 30–50 MBq was administered subcutaneously into the first two interdigital web spaces of both extremities to allow comparison between affected and unaffected sides. Imaging included dynamic and delayed acquisitions up to 3–4 hours post-injection using a dual-detector gamma camera. Patients were encouraged to perform mild physical activity to facilitate lymphatic flow. Image interpretation was conducted qualitatively and semi-quantitatively using the Transport Index (TI), with values <10 indicating normal transport and ≥10 indicating lymphatic dysfunction.

Case 1

A 41-year-old woman presented with progressive swelling of the right lower extremity since the postpartum period, worsening over seven years. The swelling was associated with pain during prolonged walking and functional limitation. Physical examination showed non-pitting edema of the entire limb, abnormal skin texture, and signs of localized infection, including maceration and ulceration. Lymphoscintigraphy demonstrated a complete absence of tracer migration in the right lower extremity, consistent with total lymphatic obstruction (Figure 1).

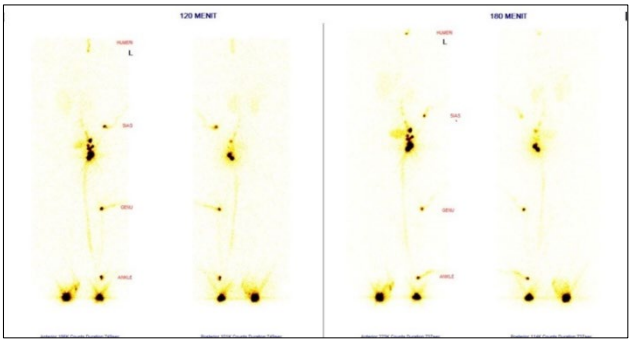

Figure 1. Lymphoscintigraphy images demonstrating absence of radiotracer uptake in the right lower extremity persisting up to 3 hours (black arrow), consistent with lymphatic obstruction.

Case 2

A 25-year-old woman reported right lower extremity swelling of nine years' duration, initially intermittent but persistent over the past four years. There was no history of trauma, infection, malignancy, or surgery. Examination revealed no lymphadenopathy and only mild skin discoloration. Previous compression therapy had not improved symptoms. Lymphoscintigraphy showed a complete absence of tracer migration in the affected limb, indicating total obstruction (Figure 2). SPECT/CT confirmed absence of right inguinal lymph node visualization, while normal tracer uptake was observed in the contralateral lymphatic pathway (Figure 3).

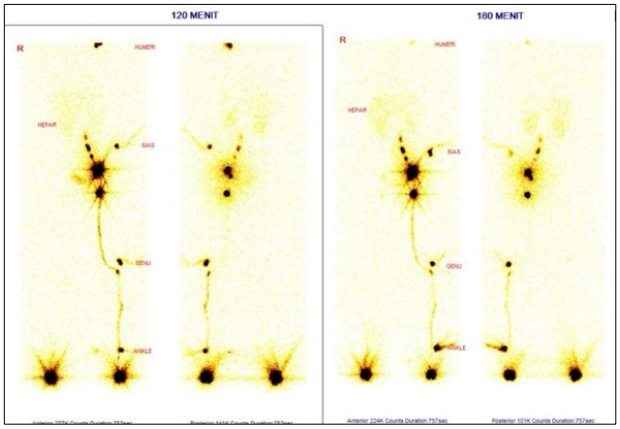

Figure 2. Lymphoscintigraphy images demonstrating absence of radiotracer migration in the right lower extremity persisting up to 3 hours (black arrow), consistent with complete lymphatic obstruction.

Case 3

An 18-year-old woman presented with a ten-year history of progressive right lower extremity swelling affecting ambulation. Physical examination revealed non-pitting edema of the thigh with skin discoloration and abnormal texture, along with signs of secondary infection. Lymphoscintigraphy demonstrated delayed lymphatic drainage, reduced visualization of inguinal lymph nodes, and the presence of collateral lymphatic pathways (Figure 4).

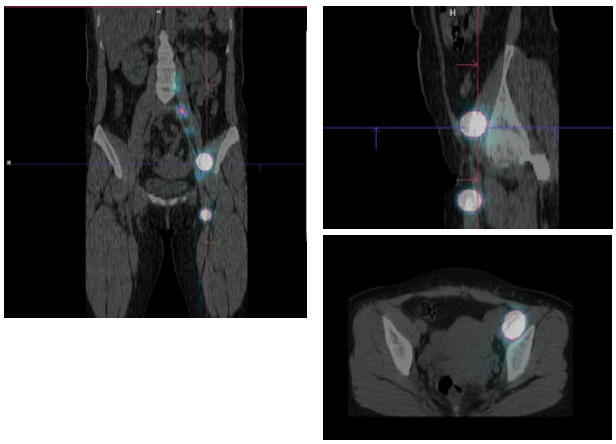

Figure 3. SPECT/CT lymphoscintigraphy images showing absence of lymphatic flow and lack of visualization of the right inguinal lymph node, while tracer uptake is observed in the contralateral lymphatic pathway (arrows).

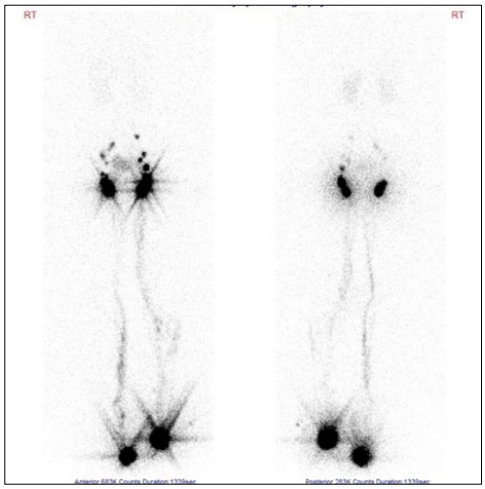

Figure 4. Lymphoscintigraphy images demonstrating reduced radiotracer uptake in the right inguinal lymph node and the presence of collateral lymphatic pathways in the contralateral limb (arrows).

Case 4

A 38-year-old woman developed right upper extremity swelling one year after a radical mastectomy. The swelling was non-pitting and associated with discomfort during arm elevation. Physical examination showed intact skin without signs of infection. Lymphoscintigraphy demonstrated delayed lymphatic drainage with reduced visualization of axillary lymph nodes (Figure 5).

Transport Index Findings

The Transport Index (TI) scores for all patients are summarized in Table 1. Two patients showed complete lymphatic obstruction in the affected extremities, with TI scores of 36, while the contralateral limbs demonstrated normal lymphatic transport (TI 1.2). The remaining two patients showed delayed lymphatic drainage, with TI values of 10.2 in the affected extremities. In contrast, the contralateral limbs demonstrated normal or near-normal TI values (1.2–4.2). Overall, pathological TI values (≥10) were consistently observed in the affected extremities, whereas contralateral extremities showed normal or near-normal lymphatic transport.

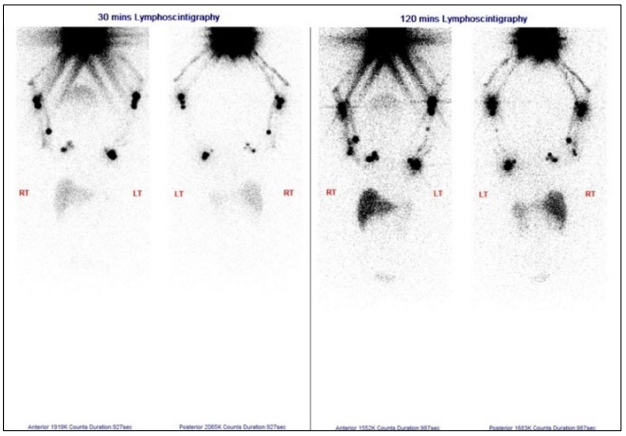

Figure 5. Lymphoscintigraphy images demonstrating reduced visualization of axillary and in-transit lymph nodes, with decreased visibility of lymphatic vessels in the contralateral upper extremity (arrows).

Table 1. Transport Index (TI) values in all patients

Patient	Extremity	TI score	Interpretation
1	Right lower	36	Complete obstruction
	Left lower	1.2	Normal
2	Right lower	36	Complete obstruction
	Left lower	1.2	Normal
3	Right lower	10.2	Delayed drainage
	Left lower	1.2	Normal
4	Right upper	10.2	Delayed drainage
	Left upper	4.2	Near-normal

DISCUSSION

Case 1–2: Complete Lymphatic Obstruction

The first and second patients presented with progressive unilateral lower extremity swelling. Lymphoscintigraphy demonstrated the absence of lymphatic drainage in the affected limbs, corresponding to a pathological Transport Index (TI) score of 36, while the contralateral extremities showed normal transport (TI 1.2).

A TI value >10 indicates pathological lymphatic transport, and values in this range are consistent with complete obstruction.[13] These findings align with previous studies showing that high TI values reflect severe impairment of lymphatic function and may influence clinical decision-making, particularly in determining candidacy for lymphatic reconstruction surgery.[12] In the second patient, additional SPECT/CT imaging improved anatomical localization and confirmed the absence of lymphatic drainage in the affected limb.

Case 3: Delayed Lymphatic Drainage

The third patient demonstrated delayed tracer transport in the affected limb, with a TI score of 10.2. This value indicates pathological lymphatic dysfunction consistent with delayed drainage.[16] Multicenter studies have validated the TI cut-off value, showing that TI ≥10 is associated with

delayed or absent tracer transport, dermal backflow, and reduced lymph node visualization.[17]

Collateral lymphatic pathways were observed in the contralateral extremity, suggesting a compensatory response to partial obstruction. Previous studies have shown that asymptomatic limbs in unilateral lymphedema frequently exhibit abnormal lymphatic patterns, with up to 81% demonstrating collateral pathways.[18,19]

Case 4: Delayed Drainage After Surgery

The fourth patient developed upper extremity lymphedema following radical mastectomy. Lymphoscintigraphy showed delayed drainage with a TI score of 10.2 in the affected limb and near-normal values in the contralateral limb. Reduced visualization of axillary lymph nodes may be explained by surgical disruption of lymphatic pathways following axillary lymph node dissection and post-surgical fibrosis.[20] These changes alter lymphatic drainage and may lead to delayed tracer transport and collateral pathway formation.

Reduced lymphatic vessel visibility in the contralateral extremity may reflect adaptive rerouting rather than technical imaging failure. Similar findings have been reported in studies demonstrating collateral lymphatic pathways in up to 40.7% of patients.[21] Long-bundle Mascagni–Sappey pathways may also contribute to compensatory drainage in upper extremity lymphedema.[22]

Clinical interpretation of Transport Index

Across all cases, TI values ≥10 were consistently observed in affected extremities, indicating lymphatic dysfunction ranging from delayed drainage to complete obstruction. In contrast, contralateral extremities showed normal or near-normal TI values.

These findings highlight the clinical utility of the Transport Index as a semi-quantitative tool that complements qualitative lymphoscintigraphy interpretation. TI scoring enables objective differentiation between normal and pathological lymphatic transport and may support clinical decision-making, including diagnosis, treatment planning, and disease severity assessment.

CONCLUSIONS AND RECOMMENDATION

Lymphoscintigraphy with semi-quantitative Transport Index (TI) analysis effectively distinguishes normal from pathological lymphatic transport. In this case series, TI values ≥10 were consistently associated with delayed lymphatic drainage or complete obstruction, whereas contralateral limbs showed normal or near-normal values.

These findings support lymphoscintigraphy as a functional reference standard and highlight the TI as an objective and reproducible parameter that enhances diagnostic accuracy beyond qualitative interpretation. TI should be interpreted in conjunction with clinical findings and standardized imaging protocols. When available, complementary imaging such as SPECT/CT may further improve anatomical localization and diagnostic accuracy, particularly in complex cases.

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