A Comprehensive Analysis of Lymphoscintigraphy Results for Lower Limb Edema in Pediatric Group of Patients at NINMAS

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ABSTRACT

Background: The diagnosis and treatment of pediatric lymphedema provide particular challenges. The defining feature of lymphedema is aberrant interstitial fluid collection, which can be caused by a variety of factors, including acquired illnesses and congenital defects. This study used lymphoscintigraphy to determine the source of lymphedema in children of various ages.

Patients and Methods: In this retrospective analysis, 53 children were included, who were referred to National Institute of Nuclear Medicine and Allied Sciences (NINMAS) for lower limb lymphoscintigraphy in the years 2022–2023. All pertinent facts and data were taken from the medical records. An average dosage of 1+1 mCi of 99m Technetium- (99m Tc) labeled nanocolloid was injected into the web spaces of the first and second toes of each foot. Spot views and delayed whole-body sweep images were acquired on time. Dual head gamma camera images were collected anterior and posteriorly. The assessment of the injection site, primary lymphatic channels, collateral vessels, dermal backflow, and quantity and strength of radiotracer absorption of the lymph nodes were all included in the qualitative image interpretation process.

Result: The mean age was 10.14 years ± 5.37 with age ranging from 0-17 years. In 48/53 cases (90.6%) of clinically positive leg swelling were found to be positive for lymphedema on lymphoscintigraphy, where 16 patients had unilateral and 33 patients had bilateral. Remaining 05/53 (9.4%) were scintigraphically normal. Among the positive patients, 48 cases (98%) were primary lymphedema and only one (2%) had secondary cause, who was a case of bilateral lymphedema, Grade-I in left lower limb (LLL) and Grade-III in right lower limb (RLL).

Conclusion: Lymphoscintigraphy, a non-invasive, straightforward imaging modality, is very helpful in precisely documenting and grading lymphedema for finding the etiology and subsequent treatment plans in patients with leg swelling. It also serves as a means of functional evaluation of lymphatic channels. Additionally, it can be crucial for individuals undergoing surgical procedures to relieve clinical symptoms early on in their recovery.

Keywords: lymphoscintigraphy, lymphedema, pediatric patients.

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INTRODUCTION

Lymphoscintigraphy is a distinct type of nuclear medicine imaging that provides images of the lymphatic system called scintigrams. This is a non-invasive, painless procedure that uses a small amount of a radiotracer to evaluate the body's lymphatic system and identify points of blockage if present for diagnosis, finding out the cause and severity of lymphedema.

Lymphedema is a chronic, progressive condition characterized by the abnormal accumulation of fluid, leading to swelling, particularly in the extremities. This occurs due to the dysfunction of the lymphatic vessels, resulting in the eventual development of fat and scar tissue, further contributing to the enlargement of the affected limbs. Children with lymphedema typically exhibit limb swelling, with the potential involvement of the genitalia or other tissues. Skin changes, pain, difficulties in daily activities, and the risk of infection are common consequences of this condition.

Primary lymphedema is hereditary and is caused by a developmental abnormality of the lymphatic system. Swelling may manifest at birth or later in life, such as during puberty or pregnancy, with a predilection for the legs but may occur in other body parts.

Primary lymphedema can be categorized into three subtypes: 1) congenital lymphedema, present at birth or recognized within two years of birth; 2) lymphedema

praecox (occurring at puberty or the beginning of the third decade); and 3) lymphedema tarda (onset after 35 years of age).

Primary lymphedema affects both genders equally, but the onset pattern differs, with men more likely to present in infancy and women in adolescence. Hereditary lymphedema type IA (Milroy disease) presents with lymphedema from birth to age 2 years, whereas hereditary lymphedema type II (Meige disease) presents from puberty to age 35 years.

Secondary lymphedema occurs after injury or trauma to the lymphatic system, typically resulting from infection, cancer, or surgical procedures associated with cancer. Common causes include radiation treatment for cancer in childhood (the most common), surgery, trauma, infection, malignant tumors, immobility, and chronic venous insufficiency.

Distinguishing lymphedema from other conditions is crucial. The differential diagnosis includes lipedema, vascular anomalies, tumors, chronic venous insufficiency, syndromes causing limb size discrepancies, myxedema, drug-induced swelling, obesity, and non-specific edema. Deep vein thrombosis should also be ruled out through ultrasound with color Doppler. A clinical diagnosis can be confirmed with lymphoscintigraphy, while magnetic resonance imaging (MRI) may reveal characteristic patterns. A CT scan (for a lymph node) can be done. A biopsy may be performed if malignancy is suspected.

PATIENTS AND METHODS

This study included 53 children exhibiting clinical manifestations of lower limb lymphedema who were referred to the Scintigraphy division of the National Institute of Nuclear Medicine and Allied Sciences (NINMAS) for lymphoscintigraphy of the lower limbs between January 2022 and December 2023. Retrospective data were obtained from the medical records for subsequent analysis.

The procedure involved injection of Technetium-99m (Tc99m) labeled nano-colloid into the web spaces between the first and second toes of each foot, with an average dosage of 1+1 mCi. Spot images were captured following a mild massage, and delayed whole-body sweep images were obtained two hours later. A dual-head gamma camera with an LEHR collimator was used for capturing anterior and posterior images, calibrated at 140 KeV with a 15% window and full-field zoom with a 256 × 256 matrix size. Spot view acquisition started before injection, and a whole body sweep image was taken 2 hours post-injection. Between the early and delayed scans, patients were instructed to take a brief stroll without engaging in strenuous activities.

The qualitative image interpretation involved assessing the injection site, main lymphatic vessels, collateral vessels, dermal backflow, and lymph nodes, considering both the number and intensity of radiotracer uptake. Additionally, evidence of skin change, if present, along with ultrasound and color Doppler findings and CFT for Filaria were considered. The compiled data were analyzed using Microsoft Excel software.

Patients were initially divided into two groups: scintigraphically normal with patent lymphatic channels and positive for lymphedema on lymphoscintigraphy, which was further divided into 4 sub-groups according to the grading (Grade I–IV).

RESULTS

The study evaluated 53 pediatric patients with an average duration of lymphedema of 41.46 months (3.45years). Age range was 1month (0 years) to 17 years, mean age was 10.14 ± 5.37 years.

Lymphoscintigraphy findings of the left lower limb (LLL) revealed visualization of the main lymphatic channel in 40 (75%) patients, indicating patency in the majority. However, in 13 (25%) cases, no main drainage channel was observed, suggesting an advanced, obstructed state. Popliteal lymph nodes were visualized in 19 (36%) patients. On the basis of obstruction, grades varied from I to IV (1), with Grade II (mild lymphatic impairment) being the most common (47%). Grade IV (severe obstruction) was observed in 25% of patients. Dermal backflow was seen in 13 (25%) patients.

In the case of the right lower limb (RLL), lymphoscintigraphy findings revealed visualization of the main lymphatic channel in 45 (85%) cases and

non-visualization in eight (15%) cases. Popliteal lymph nodes were visualized in 22 (42%) patients. Grade II was found in 21 (40%) and Grade IV in 12 (25%) children. Dermal backflow was seen in 12 (23%) patients. Figure 1 depicts the different grades of lymphatic obstruction in the right and left lower limbs. Figure 2 shows patent lymphatic channels in both lower limbs. Figure 3 shows grade I obstruction in the lymphatic channel in both lower limbs. Figure 4 shows bilateral grade III lymphatic channel obstruction, and Figure 5 shows G-II lymphedema in LLL and G-IV lymphedema in RLL.

Table 1. Lymphoscintigraphy findings of both lower limbs with grading (G-I to G-IV).

	LYMPHOSCINTIGRAPHY FINDINGS						
Site	**MLC**	**Popliteal LN**	**G-I**	**G-II**	**G-III**	**G-IV**	**DBF**
LLL	V = 40 NV = 13	V = 19 NV = 25 (P= 9)	Yes = 9 (P = 12)	Yes = 25 (P = 12)	Yes = 9 (P = 12)	Yes = 7 (P = 12)	Yes = 13 (P = 3)
RLL	V = 45 NV = 8	V = 22 NV = 16 (P = 15)	Yes = 6 (P = 11)	Yes = 21 (P = 16)	Yes = 7 (P = 14)	Yes = 5 (P = 12)	Yes = 12 (P = 3)

MLC- Main lymphatic channel; LN-lymph node; V-visualized, NV-non visualized, P- patent, DBF- dermal back flow

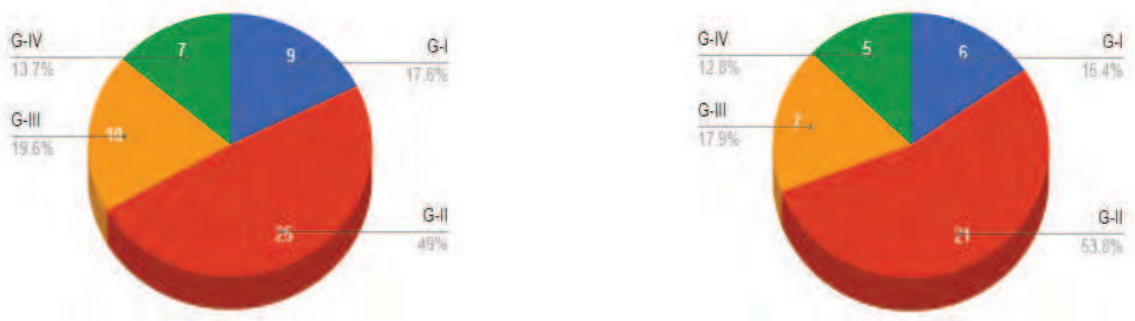

Figure 1: Grading of Lymphedema in Left and Right Lower Limbs

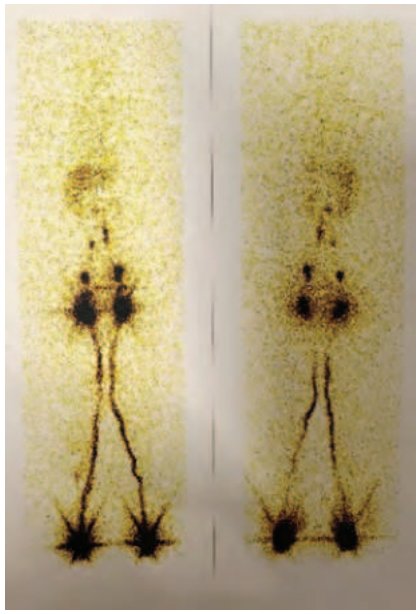

Figure 2: 17 years old male patient showing bilateral patent lymphatic channels with normal flow

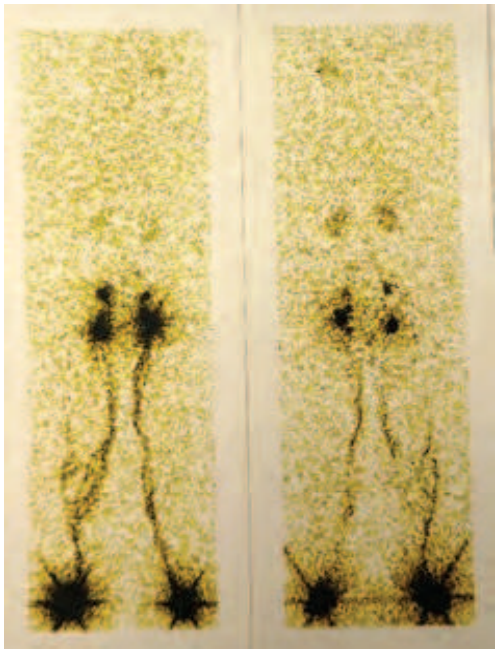

Figure 3: 12 years old female patient presented with bilateral leg swelling, lymphoscintigraphy revealed bilateral G-I lymphedema. Red arrow is showing collaterals.

When the findings of both lower limbs were compared, visualization of the main lymphatic channel and popliteal nodes were found slightly higher on the right side. While the left side showed a slightly higher percentage of mild impairment (Grade II), the right side showed more severe impairment (Grade IV) in a higher percentage. However, dermal backflow or abnormal dermal reflux were somewhat similar in both limbs. Table 1 shows the lymphoscintigraphy findings in both lower limbs in 53 pediatric patients.

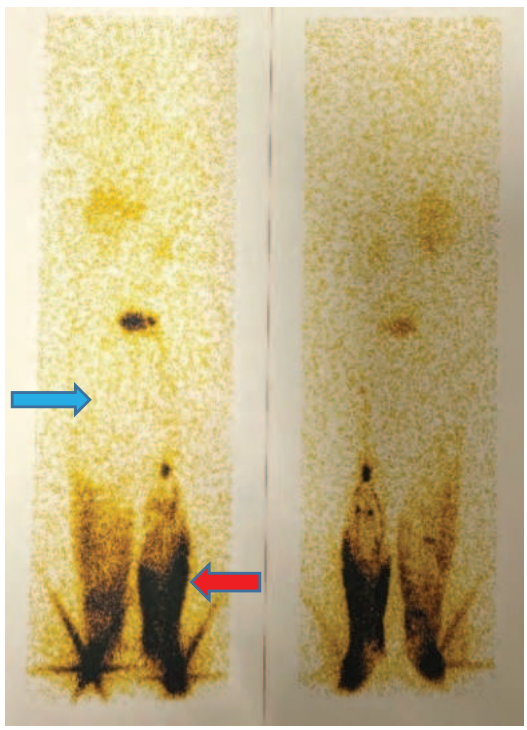

Figure 4: 16 years old female patient presenting with bilateral G-III lymphedema. Blue arrow showing non-visualization of main lymphatic channel and red arrow showing dermal backflow.

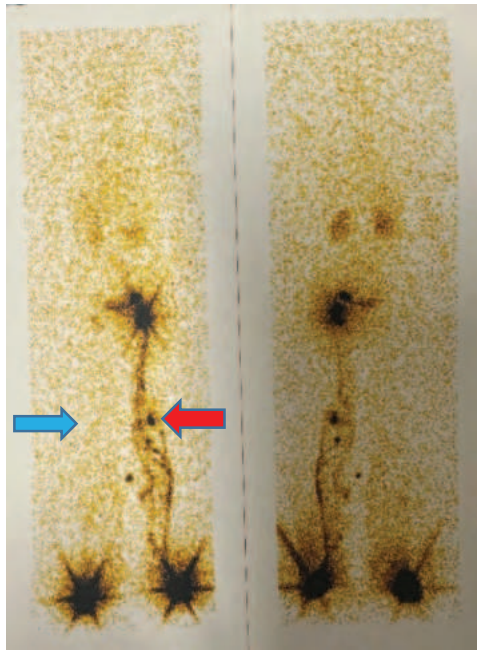

Figure 5: A 9 years old male patient presenting with congenital lymphedema. Lymphoscintigraphy finding reveals G-II lymphedema in left lower limb and G-IV lymphedema in right lower limb. Red arrow showing collateral lymphatic vessels and few lymph nodal uptake in left lower limb. Blue arrow indicating complete non-visualization of main lymphatic channel and dermal backflow or lymph node in right lower limb.

DISCUSSION

The study conducted lymphoscintigraphy on 53 pediatric patients with an average duration of lymphedema of 41.46 months (3.45 years), providing valuable insights into the lymphatic status of both lower limbs at NINMAS. The findings indicate variations in lymphatic anatomy and functional impairment, and a comparative analysis between the right and left lower limbs reveals interesting patterns.

Comparative analysis of lymphoscintigraphy findings among both limbs has shown the main lymphatic channel and popliteal nodes have slightly higher visualization on the right side. The left side showed a slightly higher percentage of patients with mild impairment (G-II), while the right side showed more severe impairment (G-IV) in a higher percentage. However, dermal backflow was kind of similar in both limbs.

The study discusses the lymphoscintigraphic evaluation of patients in the pediatric age group affected by primary lymphatic dysplasia. The lymphoscintigraphic studies revealed various pathological features consistent with congenital lymphatic dysplasia, such as delayed visualization, asymmetric or absent regional lymph nodes, dermal back-flow, asymmetric visualization of lymphatic channels, collateral lymphatics, lymph nodes of the deep lymphatic system, etc.

We highlight the importance of lymphoscintigraphy in the diagnosis of congenital lymphedema, especially in the pediatric population. Damstra RJ et al. also reported comparable findings with their study population (2).

Bellini et al., as well as several other authors (4-6), reported variable degrees of lymphatic obstruction among affected children, which could imply lymphatic dysplasia and are similar to our findings (3).

Nagy BI et al. found varying degrees of lymphatic blockage in 241 individuals under 15 years old, which could aid in treatment planning and evaluation (7-9).

Bellini C et al. emphasized the mild invasiveness, ease of performance, safety, and reliability of lymphoscintigraphy (3). They stress its value in distinguishing lymphatic pathology from non-lymphatic causes of peripheral edema, especially in cases of

congenital lymphatic dysplasia where other imaging methods may be challenging or potentially harmful. Lymphoscintigraphy's ability to offer a quantitative analysis through the transport index enhances its diagnostic and prognostic power, particularly in the early diagnosis of lymphatic disorders (11–13).

When compared to previous research, our data support the notion that lymphedema appears in varied degrees of severity. The increased prevalence of Grade IV impairment on the right side may necessitate additional research into potential contributing factors unique to this pediatric cohort (3-5, 7, 10, 13).

CONCLUSION

The lymphoscintigraphy results of this study contribute to our understanding of juvenile lymphedema. In summary, lymphoscintigraphy is a safe and effective diagnostic technique that parents and patients alike appreciate for its ability to reveal important details on lymphatic circulation abnormalities.

CONFLICT OF INTEREST: The authors have no conflict of interest.

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