

A Novel Way of Standardization of ICG Lymphangiography Reporting

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Abstract

Background Indocyanine green (ICG) lymphangiography is being increasingly employed to assess the severity of lymphedema, locate the areas of patent linear lymphatics and dermal backflow and plan treatment. This study suggests a novel method of reporting ICG findings in extremities to enable easy understanding among surgeons and physiotherapists and avoid repeat testing when a patient visits a disparate lymphedema center or clinician.

Methods A reporting protocol was developed in the lymphedema clinic of the plastic surgery department, and patients were asked to bring along the report in every subsequent review. The ICG findings were recorded on the fluorescence imaging system as well. The report was prepared by one and analyzed by two different clinicians without repeating the test on 10 consecutive patients.

Results The interrater reliability of findings in the report was found to be 98.7% among the three clinicians.

Conclusion The reporting system was found to be illustratable and reproducible

Keywords

- ICG reporting
- lymphedema
- standardization

Introduction

Lymphedema is being increasingly dealt by reconstructive and microsurgeons in the wake of increasing surgical treatment modalities. The plan of management depends on factors like level of subcutaneous fibrosis, associated skin changes, degree of increase in limb girth and, most importantly, availability of patent lymphatics or extent of channel destruction. Intradermal injection of indocyanine green (ICG) dye, followed by infrared scan, is a portable, quick and safe way of delineating the lymphatics, which does not employ any radioactive exposure. The findings can be recorded and shared among any number of clinicians. Although lymphedema can be classified universally, according to ICG findings, the system of reporting the findings is very exhaustive, nonspecific and not easily reproducible (► **Fig. 1**). This study proposes a reporting system for precisely locating different representations of the dye in the lymphatics, thereby minimizing uncertainty.

Materials and Methods

The patient was asked to change into a hospital gown and placed in a dark room. The Irilic.nm fluorescence imaging system (Irilic, India) was prepared and camera kept on a standby mode. Injection sites were sterilized with betadine solution. For upper limb, first and fourth web space, radial and ulnar aspect of the volar wrist were chosen as injection sites, whereas for lower limb, first web space and lateral to tendoachilles were injected based on cadaveric lymphatic studies.^{1,2} Additional injections near the elbow or knee can be given to hasten the proximal dye uptake, and in severe lymphedema, with diffuse dermal backflow distally. An amount of 0.5 mL of 2% lignocaine was injected, followed by 0.5 mL of Aurogreen dye (Aurolab, India) (ICG–25 mg vial diluted with 10 mL distilled water) injected intradermally into each site, using a 1 mL syringe with 31G needle. The patient was asked to walk around, massage manually and open or close a fist repeatedly. The scan was repeated every 15 minutes till the

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Fig. 1 Lymphedema classification based on ICG lymphangiography (Source: Chang DW, Suami H, Skoracki R. A prospective analysis of 100 consecutive lymphovenous bypass cases for treatment of extremity lymphedema. *Plast Reconstr Surg* 2013; 132:1305–14).

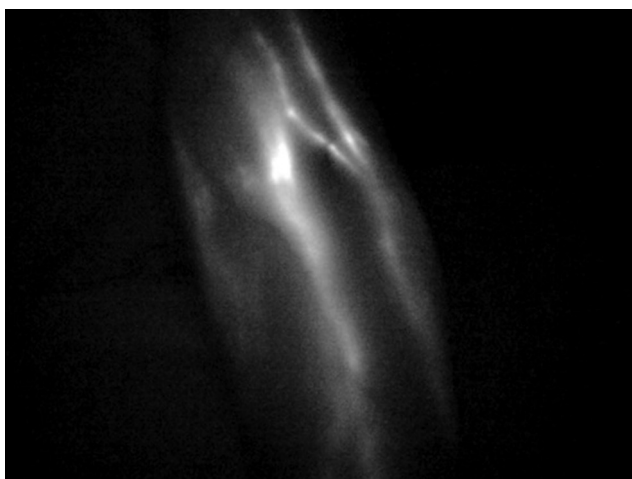


Fig. 2 Linear lymphatics.



Fig. 3 Splash pattern of dermal backflow.

dye reached axilla or groin or dye showed no progress for 45 minutes.

The report included the following findings:

1. Linear lymphatics (► **Fig. 2**).
2. Splash pattern of dermal backflow (► **Fig. 3**).



Fig. 4 Stardust pattern of dermal backflow.

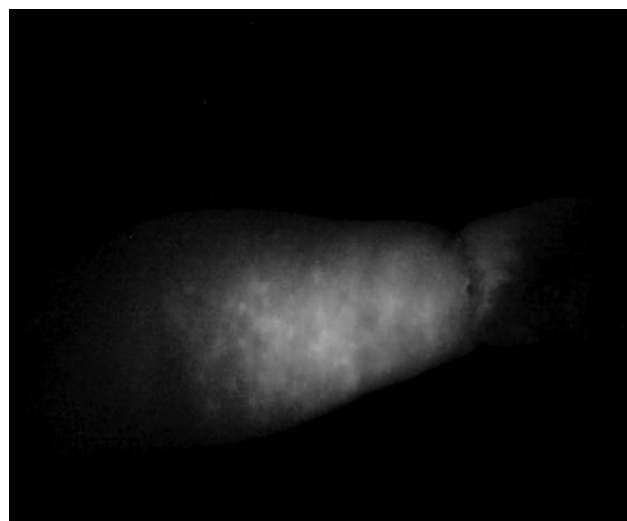


Fig. 5 Diffuse pattern of dermal backflow.

3. Stardust pattern of dermal backflow (► **Fig. 4**).
4. Diffuse pattern of dermal backflow (► **Fig. 5**).
5. Blank zone.

A four-component code was created for each of the above findings as depicted below.

1. Right/Left–R/L
2. Flexor/Extensor–F/E
3. Zone/Wrist/Ankle–Z/W/A (► **Table 1**) (► **Fig. 6**)
4. Radial/Ulnar/Medial/Lateral–R/U/M/L

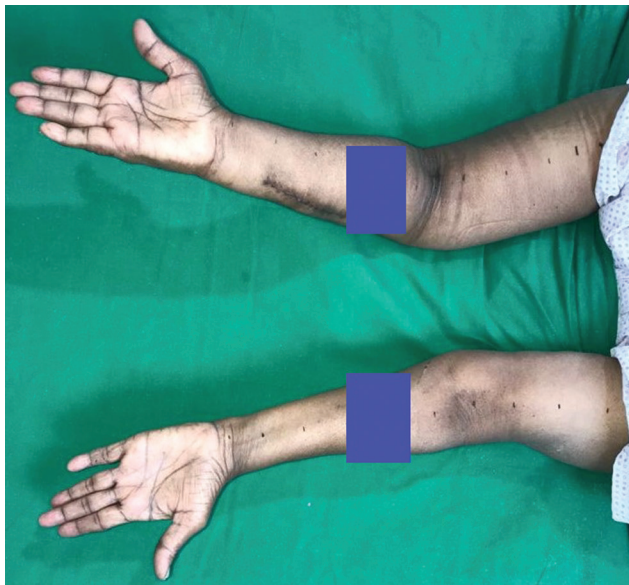
For instance, linear lymphatics on flexor aspect of the right forearm in zone 3, that is, within 8 to 12 cm from the wrist along the radial aspect was reported as Linear lymphatics–“RFZ3R.”

Splash pattern on extensor aspect of the left leg in zone 7 and 8, that is, within 24 to 32 cm from the ankle along the medial aspect was reported as Splash–“LEZ7+8M” (► **Table 2**).

The findings were charted on a reporting sheet prepared by the team, illustrating the patient identification details, relevant history, volumetric findings, proposed reporting format, and graphic representation of the ICG findings (► **Fig. 7**).

Table 1 Description of the limb zones

Zone/wrist/ankle	Distance from wrist/ankle (cm)
Midpalm/midfoot	Midpalm/midfoot
W/A	0
Z1	4
Z2	8
Z3	12
Z4	16
Z5	20
Z6	24
Z7	28
Z8	32
Z9	36
Z10	40
Z11	44
Z12	48
Z13	52
Z14	56

**Fig. 6** Marking the zones in upper limbs.

The same report was interpreted by two different clinicians, without any aid from the primary clinician, on a series of 10 patients, and interrater reliability was calculated using the following formula:

$$\text{Interrater reliability} = \frac{\text{Total no. of correct tests}}{\text{Total no. of tests}} \times 100$$

Results

The interrater reliability with which the ICG findings could be interpreted and charted among the three clinicians was 98.7%.

Table 2 The proposed four-component reporting code

Finding	Right/Left	Flexor/Extensor surface	Zone	Border
Linear lymphatics	R/L	F/E	Zx	R/U/M/L
Splash				
Stardust				
Diffuse				
Blank				

L = lateral; M = medial; R = radial; U = ulnar.

Discussion

Several methods have been reported to detect lymphatic channels, for example, including magnetic resonance imaging, computed tomography, ultrasonography, lymphoscintigraphy and ICG lymphangiography.³⁻⁸ ICG is a green fluorescent dye with no radioactive potential, which travels fast in the body, being a water soluble preparation. Up to 2 cm deep lymphatics can be visualized and assessed by ICG lymphangiography, based on the penetration level of near infrared rays.⁹ The camera handpiece consists of an excitation light source with a wavelength of 770 nm and a near infrared detector that filters and collects the fluorescence signals above 800 nm. When ICG is excited by the light source, the emitted fluorescence is captured and displayed in real-time using detector and a custom software. These fluorescence signals can be stored as images and videos and reviewed later. ICG lymphangiography findings include either fluorescent linear lymphatic channels or dermal backflow. Linear channels represent the normal functional superficial lymphatics. Dermal backflow is a pathological finding which presents as different patterns, as per the severity of damage. Splash pattern represents an early stage of valve destruction, with scattered dye and tortuous lymphatic channels. Stardust or milky way pattern is an indicator of progression with diffuse illuminated background and scattered bright fluorescent spots. Diffuse pattern of dermal backflow indicates a severe advanced stage of lymphedema with wall thickening and lumen stenosis. It is seen as a widespread fluorescence with no areas of bright spots.² These patterns map the areas with available lymphatics as well as areas of destruction, thereby dictating the surgical interventions feasible. Blank zone in proximal extremities indicates poor dye uptake and thus can either be interpreted as a higher grade of lymphedema or supplemented with additional proximal dye injections, in order to outline the backflow pattern in these zones. Despite being a patient and clinician friendly investigation, the interpretation of findings following ICG lymphangiography is time consuming and lacks standardization. The disorderly system of reporting makes it arduous to locate and mark the exact location and extent of linear channels and dermal backflow on any future follow-up unless the recorded findings are available. This can lead to needless repetition of the test when the patients seek

ICG REPORT Study date: 11-Feb-2020

Patient Name: P01
Hospital ID: 3243556
Age/Sex: 34/F
Affected limb: Right upper limb
Chief complaint: Progressive swelling of the right upper limb since 2 years
Relevant past history: Carcinoma right breast post right axillary node clearance 4 years back
Treatment history: On Compression garments since 4 years

No. of standard injection sites: Four * Six
Study start time: 12:05PM
Study end time: 12:50PM

FINDING	RIGHT LEFT (R/L)	FLEXOR/EXTENSOR SURFACE (F/E)	ZONE (Z0)	BORDER (B0/B1)
Lateral lymphatics	R	F	1, Z1-6 2, Z5-6 3, Z7-11	1, E 2, E 3, E

UPPER LIMB

LOWER LIMB

VOLUME DATA

ZONE/WRIST ANGLE	WRIST ANGLE (cm)	Right limb circumference (cm)	Left limb circumference (cm)
Midpoint/Midline	18.1	18.4	18.4
Z0	0	14.3	14.3
Z1	4	16.5	16.6
Z2	8	18.8	18.8
Z3	12	22.2	22.3
Z4	16	25.1	24.3
Z5	20	26	25
Z6	24	25	25.3
Z7	28	27.3	26.9
Z8	32	28.9	28.4
Z9	36	31.8	30.3
Z10	40	34.3	32.5
Z11	44	36.4	34.2
Z12	48	38	36.8
Z13	52		
Z14	56		
Limbs volume (cm ³)		2844.99	2806.11

Each volume was calculated using the "Frustum of cone" method:

$$V = \frac{\pi}{3} \cdot \left(\frac{Circ1}{2\pi} \right)^2 + \left(\frac{Circ1}{2\pi} \right) \cdot \left(\frac{Circ2}{2\pi} \right) + \left(\frac{Circ2}{2\pi} \right)^2$$

with h being 4 cm (the distance for each measure), Circ1 and Circ2 being the two neighboring circumference measures. Each volume corresponds to that of a 4-cm segment of the extremity. The sum of all volumes equals the total volume of the extremity.

Diagnosis: Stage 3 lymphedema of the right upper limb

Plan:

1. Lympho-venous anastomosis followed by Decongestive physiotherapy and compression garments for 3 months
2. Reassessment after 3 months

Clinician's signature:

Fig. 7 The proposed reporting system sheet.

a different clinician or center or the same clinician encounters the patient after a routine follow-up of months. Likewise, the report can also facilitate better communication and coordination among the surgeons and physiotherapists regarding the type and intensity of physiotherapy needed and in outlining common treatment goals. Like the standardization of classification of lymphedema has been in practice and enables better understanding of the severity and progression of the disease, the findings of the lymphography, if standardized, can ensure a quick and systematic management of lymphedema patients. This does not substitute on table ICG marking but helps in preoperative patient counselling with reference to the need for surgery, planning the type of surgery, guiding the physiotherapist in decongestive physiotherapy, comparing the progress of the disease, and monitoring postoperative progress in case the old ICG recordings are not available. As the ICG test is a dynamic investigation whose results vary with time, this reporting system is aimed at avoiding unplanned repeat studies before the stipulated time due to lack of reliable information about the previous dye study. As depicted by this study, the extent of interpretation of an ICG scan reported using the proposed symbolic representation system among multiple clinicians was found to be reliable and obviated the need for a repeat scan, thereby empowering consistency to a clinician's assimilation.

Financial Disclosures

None.

Earlier Presentation

None.

Conflicts of Interest

None declared.

Acknowledgments

None.

References

- 1 Suami H, Heydon-White A, Mackie H, Czerniec S, Koelmeyer L, Boyages J. A new indocyanine green fluorescence lymphography protocol for identification of the lymphatic drainage pathway for patients with breast cancer-related lymphoedema. *BMC Cancer* 2019;19(1):985
- 2 Narushima M, Yamamoto T, Ogata F, Yoshimatsu H, Mihara M, Koshima I. Indocyanine green lymphography findings in limb lymphedema. *J Reconstr Microsurg* 2016;32(1):72-79
- 3 Henze E, Schelbert HR, Collins JD, Najafi A, Barrio JR, Bennett LR. Lymphoscintigraphy with Tc-99m-labeled dextran. *J Nucl Med* 1982;23(10):923-929
- 4 Szuba A, Shin WS, Strauss HW, Rockson S. The third circulation: radionuclide lymphoscintigraphy in the evaluation of lymphedema. *J Nucl Med* 2003;44(1):43-57
- 5 Tomczak H, Nyka W, Lass P. Lymphoedema: lymphoscintigraphy versus other diagnostic techniques—a clinician's point of view. *Nucl Med Rev Cent East Eur* 2005;8(1):37-43
- 6 Case TC, Witte CL, Witte MH, Unger EC, Williams WH. Magnetic resonance imaging in human lymphedema: comparison with lymphangioscintigraphy. *Magn Reson Imaging* 1992;10(4):549-558
- 7 Gamba JL, Silverman PM, Ling D, Dunnick NR, Korobkin M. Primary lower extremity lymphedema: CT diagnosis. *Radiology* 1983;149(1):218
- 8 Doldi SB, Lattuada E, Zappa MA, Pieri G, Favara A, Micheletto G. Ultrasonography of extremity lymphedema. *Lymphology* 1992;25(3):129-133
- 9 Unno N, Nishiyama M, Suzuki M, et al. Quantitative lymph imaging for assessment of lymph function using indocyanine green fluorescence lymphography. *Eur J Vasc Endovasc Surg* 2008;36(2):230-236