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IS LYMPHATIC RECONSTITUTION POSSIBLE AFTER MESHED SKIN GRAFTING?

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ABSTRACT

Restorative potential of lymph transport after skin graft has rarely been discussed. We report a case of lymphatic reconstitution across meshed, split-thickness skin graft performed for a patient with necrotizing fasciitis. The patient underwent extensive circumferential soft tissue debridement of the lower leg and resurfacing of the skin defect with meshed split-thickness skin graft. Indocyanine green fluorescence lymphography was performed 3 years after surgery and demonstrated that injected dye in the foot traveled across the skin graft and reached to the adjacent native skin in the proximal region. Our observation revealed that transferred split-thickness skin graft possessed some potential to allow for transport of lymph fluid possibly owing to the retention of lymphatic capillaries.

Keywords: lymphatics, skin graft, indocyanine green, lymphography

Lymphatic reconstitution during wound healing process is poorly understood. Severe trauma and burn can cause local lymphedema in the distal extremities and meshed split-thickness skin graft (STSG) is commonly applied for reconstruction of large skin defect associated with such injuries. Limited knowledge is available about whether meshed STSG has the potential to carry lymph fluid. The dense network of lymphatic capillaries is found in the superficial dermis and they are connected to the valved precollectors in the deep dermal layer and subcutaneous lymphatic trunks which help to bridge watershed areas and in turn drain towards the regional lymph node basin (1,2). STSG is a graft in which only the upper level of the dermis is harvested and STSG should retain the lymphatic capillaries because dermal lymphatics are located in the entire layer (3,4).

Indocyanine green (ICG) fluorescence lymphography has become a popular clinical instrument in demonstrating lymphatic flow in real time (5,6). We examined a patient having circumferential meshed STSG in the lower leg and observed the transport of dermal lymph fluid distal to skin graft site.

CASE STUDY

A 71-year-old patient presented with a history of left hemi-colectomy, pelvic node dissection, and adjuvant radiotherapy to the lower abdomen for bowel cancer 4 years ago. She developed bilateral leg swellings one year after the operation and was diagnosed with lower extremity lymphedema [International Lymphology Society (ILS) stage 2]. The patient wore grade 2 compression garments bilaterally and was able to maintain control of

her edematous legs.

She was admitted to hospital with leg cellulitis in the same year as her diagnosis. At the time of admission, the patient reported 4 days of spontaneous onset of cellulitis of the right leg extending from ankle to knee. This was associated with patches of ecchymosis and skin blisters filled with clear fluids. Despite being admitted for intravenous antibiotic treatment, her skin infection progressed over the subsequent 2 weeks with patchy areas of skin necrosis developing. At this point the plastic surgery team was consulted. The patient was taken to the operating theater for skin debridement. Extensive subcutaneous fat necrosis was noted. Tissue culture grew a mix of *Citrobacter roseri, Streptococcus pyogenes, Enterococcus faecalis, Pseudomonas aeruginosa*, and anaerobic gram-negative rods. In the ensuing three weeks, the skin necrosis continued to progress, necessitating multiple debridements which eventually halted the progression of the infection.

The final area of debridement included a circumferential excision of skin and subcutaneous tissues down to deep fascia from five centimeters above the malleoli to fifteen centimeter below the tibial plateau. The skin defect area was grafted with meshed, split-thickness skin graft (10/1000 inch, 1:1.5 mesh ratio) harvested from her right thigh.

Postoperatively 95% of the skin grafts healed well and the remaining areas reepithelialized over four weeks. As a result of the extensive circumferential subcutaneous tissue resection in the lower leg, the patient developed progressive lymphedema of her right foot. She was subsequently referred to a lymphedema specialist and rehabilitation center for complex decongestive therapy. She underwent a two-week period of inpatient lymphedema therapy. A 1.5cm circumferential reduction was recorded at the foot (metatarsophalangeal and tarsometatarsal) joints, and ankle (5 and 10 cm from heel respectively) *(Fig. 1, left)*.

Three years after the skin graft procedure, the patient was referred for ICG fluorescence lymphography (Photodynamic Eye Neo II, Hamamatsu K.K, Hamamatsu, Japan). 0.05ml of 25mg ICG diluted in 10 ml normal saline was injected intradermally into the first and fourth webspaces and 1st TMT joint of the right foot.

ICG tracer traveled proximally from the dorsum of the foot, traversing the skin graft zone and reaching the proximal native skin 60 minutes after injection and manual lymphatic drainage (MLD) *(Fig. 1, right)*. Magnified ICG image showed the presence of lymphatic capillaries within the skin graft, similar to dermal backflow pattern observed in lymphedematous limbs *(Fig. 2)*. This occurred throughout the skin graft zones.

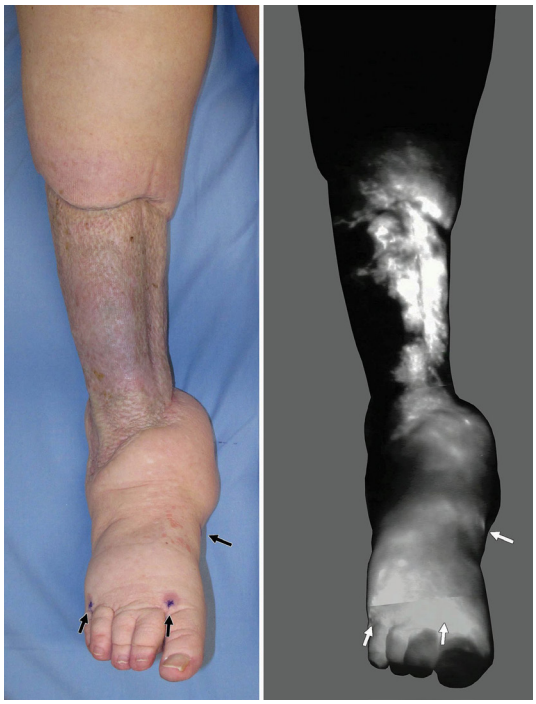

Fig. 1. Left: The right leg 3 years after meshed split-thickness skin grafting. Arrows point injection site of ICG. Right: ICG fluorescence lymphography image 60 min after the ICG injection with manual lymphatic drainage. ICG tracer crossed the skin graft and reached to the proximal native skin.

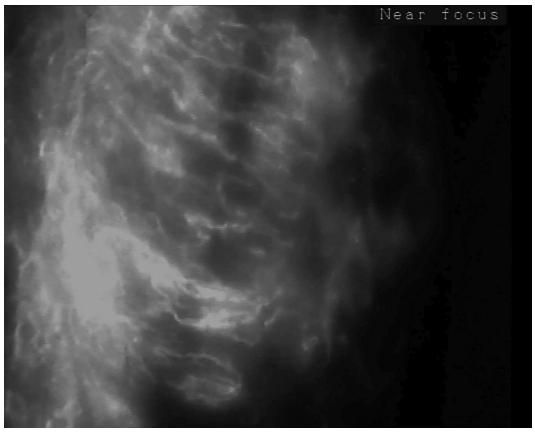

Fig. 2. Magnified ICG image in the skin graft. ICG travelled possibly via dermal lymphatics.

Ethical Considerations

Formal written informed consent was obtained from the patient for the publishing of deidentified photos and findings. Ethical approval for this case report to be published was obtained from Macquarie University Human Research Ethics Committee (Medical Sciences) on April 6, 2017.

DISCUSSION

Restoration of the lymphatic system between skin graft and recipient site was observed in a cadaver model (3). Post-traumatic lymphedema is one of several debilitating complications after deep burn injury. However, very few studies have looked at the lymphatic system in skin grafts and its potential for lymphatic reconstitution. Split-thickness grafts are usually taken between 8-12/1000 inch, or in the order or 200-300 microns thick. This captures only the papillary dermal layer and the superficial-most layer of lymphatics which is valveless (7). This superficial network extensively anastomoses within itself before draining into deeper lymphatic networks, the larger of which are valved (2). Limited information is available regarding whether transferred STSG can retain lymphatic structures and the retained or regenerated lymphatics from the recipient site can transport lymph fluid. Firstly, the lymphatic endothelial cells are connected to stromal collagen fibers, which are important for their ability to dilate and drain interstitial fluid (8). The extracellular matrix and stromal support are important in sustaining functioning lymphatics, and some of this is inevitably disrupted during the graft harvesting as well as meshing process. Secondly, the fine lymphatic network within the graft might not be capable of forming a sufficient lymphatic bridge to restore the lymphatic flow across the wound edges.

Butcher et al injected blue dye into 22 split-thickness skin grafts on patients with venous stasis ulcers (9). Dermal lymphatics within the graft were seen within 1-3 week of grafting. Whether these presents connection between lymphatic network within the grafts and adjacent native skin or new ingrowth of lymphatics is not certain. Fluorescence microlymphography technique was used to investigate lymphatic structures in STSG of patients with burns and chronic venous insufficiency (10,11). Rapid demonstration of lymphatics in STSG was found and this extended to the surrounding recipient skin in most of the cases.

In our patient, the ICG demonstration of lymphatic network connecting distal skin flap across the graft bed and onto the proximal skin flap showed that lymphatic reconstitution could occur within STSG. It was also interesting to note that a dominant lymphatic channel along the antero-medial leg was outlined much earlier than the rest of the foot during ICG injection. It is uncertain whether this lymph 'channel' developed within the graft or was a residual lymphatic channel in the leg after debridement. The fact that it lies along the course of the long saphenous vein is suggestive of the latter. Although data are supportive, ultimately what is needed is tissue histology and lymphatic-specific antibody use (e.g., D2-40) to clearly identify if these are lymphatic channels or tissue planes.

Due to a lack of valved lymphatic vessels

in STSG, capacity of lymphatic transport through STSG may be very limited against the effect of gravity. This is evident in the exacerbation of foot edema in our patient after surgery. However, decongestive lymphatic therapy was able to provide improvement of the edematous foot. This response indicated that the lymphatic channels were functioning and appropriate manual drainage was able to push fluid along these channels or through tissue planes.

Our finding suggests the possibility that lymphatic reconstitution may occur within split-thickness skin grafts, and lymphedema patients with STSG reconstruction should not be excluded from decongestive lymphatic therapy.

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CONFLICT OF INTEREST AND DISCLOSURE

No competing financial interests exist.

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