Influence of different compression pressures on lymphatic drainage

Waldemar L Olszewski, Marzanna T Zaleska

Central Clinical Hospital and
Medical Research Center, Polish Academy of Sciences
Warsaw, Poland
waldemar.l.olszewski@gmail.com

Objectives

The aim of compression therapy of lymphedematous limbs is to move mobile edema tissue fluid to roots of extremities where it can be absorbed. Effects of compression methods are evaluated according to changes in limb circumference or volume. They don't provide information where edema fluid has been moved, neither whether there is a post compression edema fluid backflow in upright position. All this needs visualization of fluid movement especially in early stages of lymphedema when compression therapy is most effective.

Background

- The commonly used modalities for therapy of limb edema are manual lymphatic drainage, intermittent pneumatic compression (IPC) and bandaging. Necessary for validation of compression effect is imaging of moving edema fluid. Picture of edema fluid flow would allow the therapist to use force adjusted to the tissue volume and stiffness as well as identify sites of abundant accumulation of fluid.

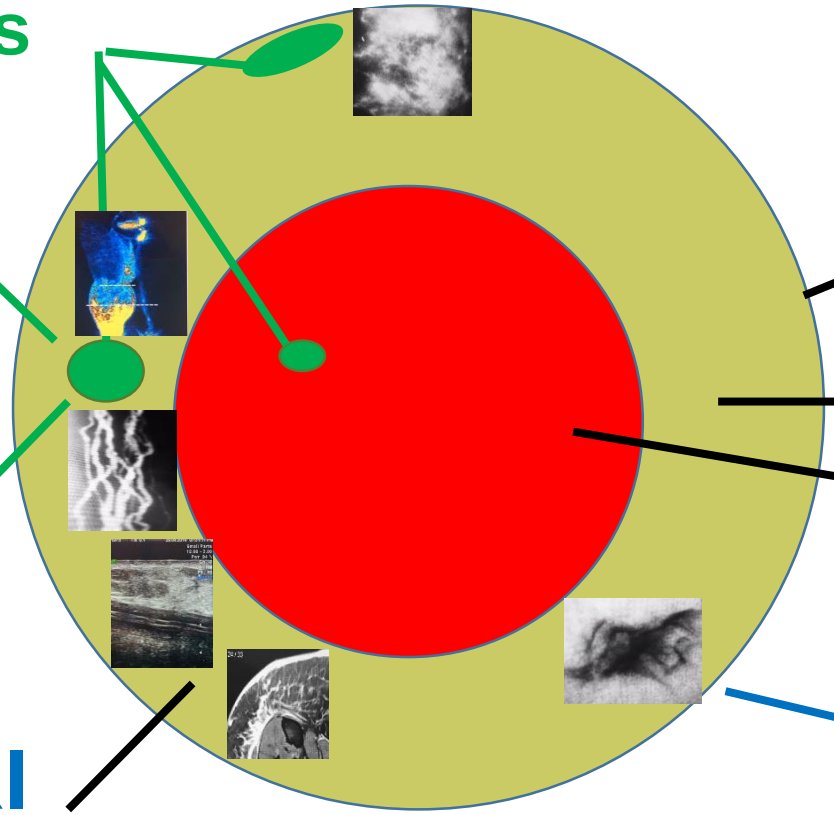
Aim

To visualize edema fluid movement during high pressure long inflation time pneumatic compression using indocyanine green fluorescence lymphography.

Material and methods

- Twenty patients with post-surgical (after hysterectomy and radiotherapy in uterine cancer and mastectomy in breast cancer) lymphedema of lower and upper limbs. Study was carried out in 2 groups: group I, manual lymphatic drainage (thumb or hand), and group II, intermittent pneumatic compression (8 chamber sleeve, each chamber inflated to 50, 80, 100 and 120 mmHg for 50 sec). ICG lymphangiography was done during each type of compression at a known force (pressure). The level of moved fluorescent fluid was measured.

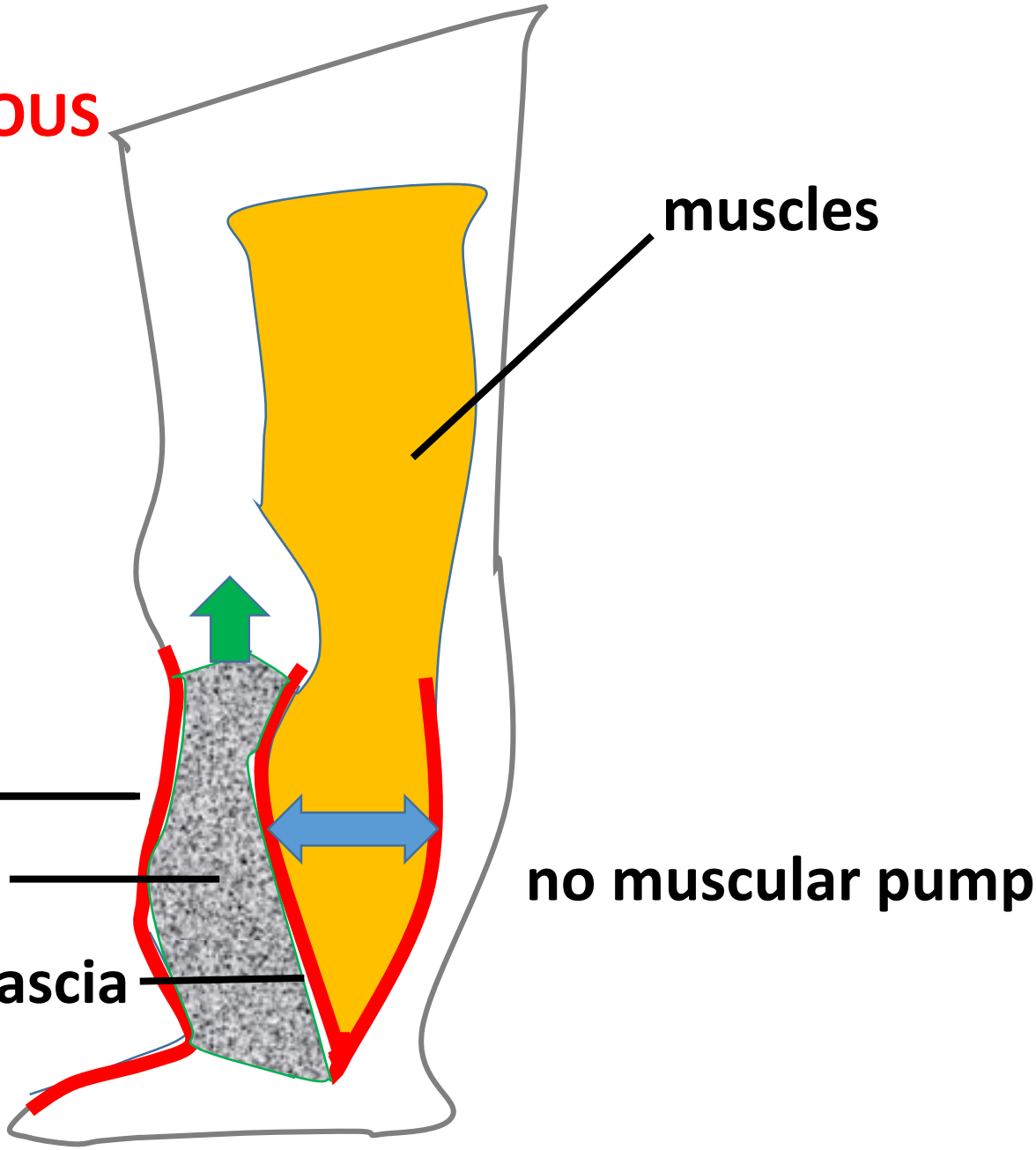
Visualization methods of edema fluid accumulation



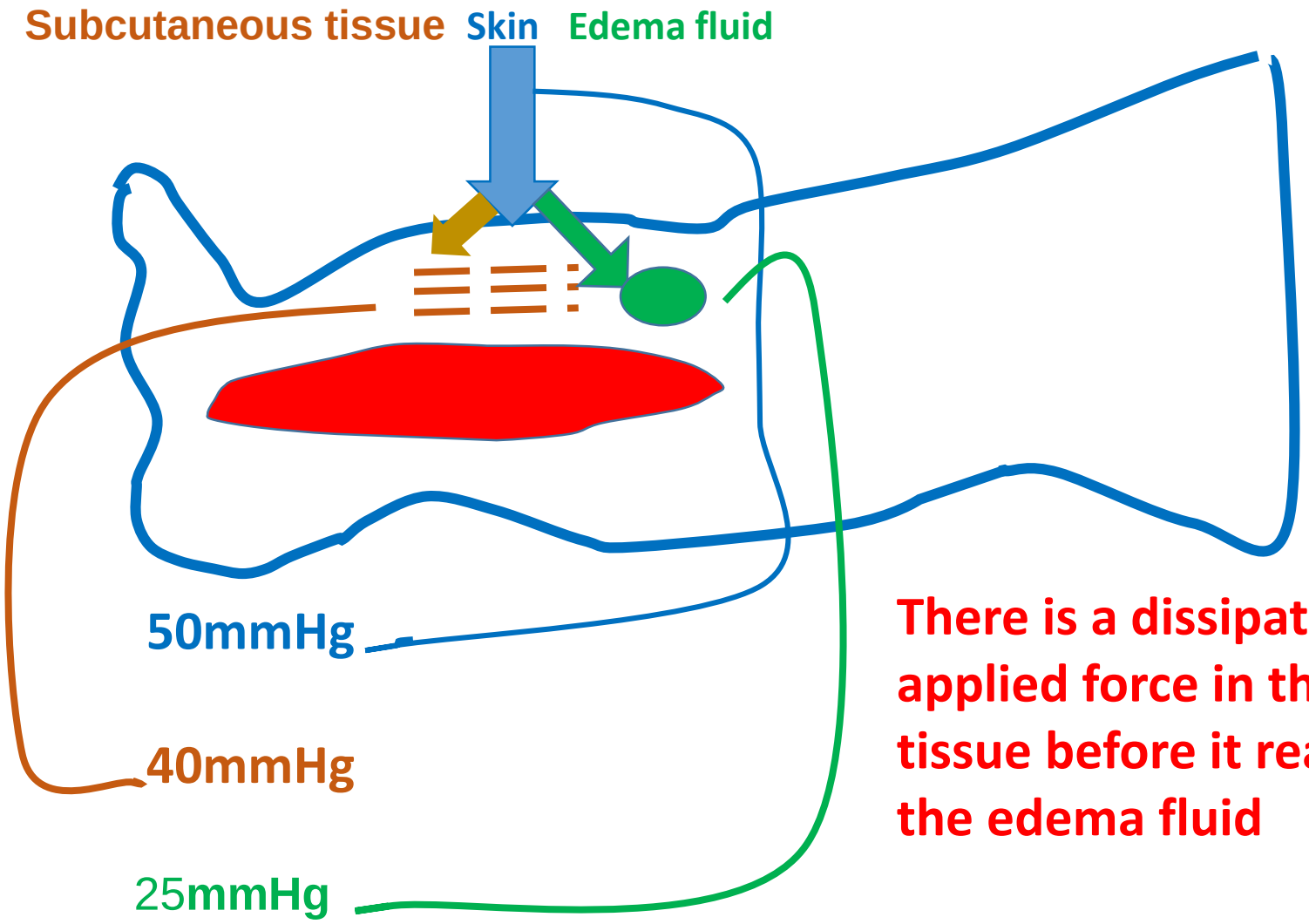
Indocyanine green (ICG) 0.25 ml 0.5% solution injected between toes or fingers showing pictures of profuse spread of dye along the whole limb.

Biocompression pump and sleeve 8 chambers 100-120mmHg 50 sec/chamber were applied immediately. Level of fluorescence was measured sequentially in consecutive areas from ankle to groin (Pulsion, Munich).

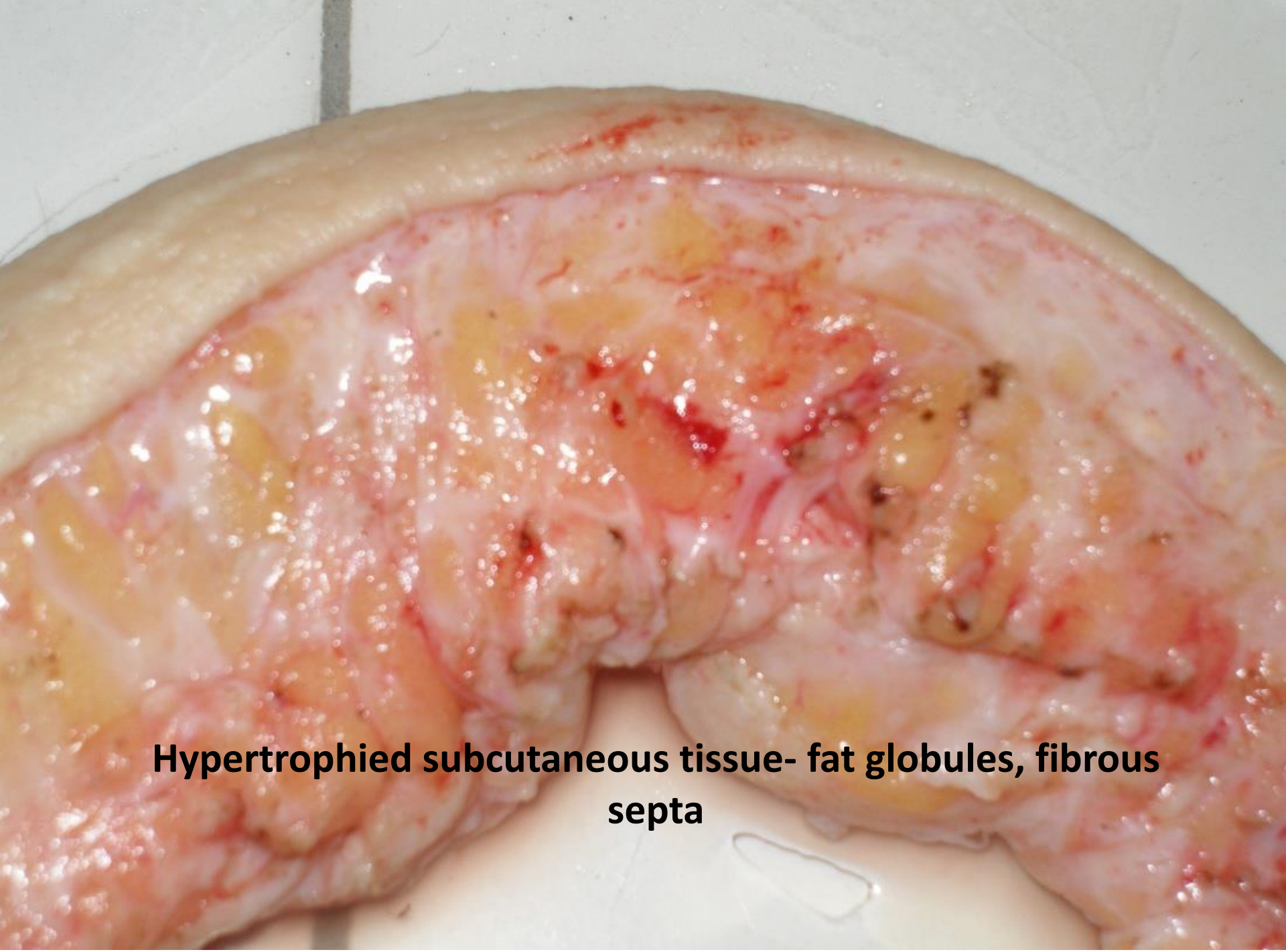
LYMPHEDEMATOUS LIMB



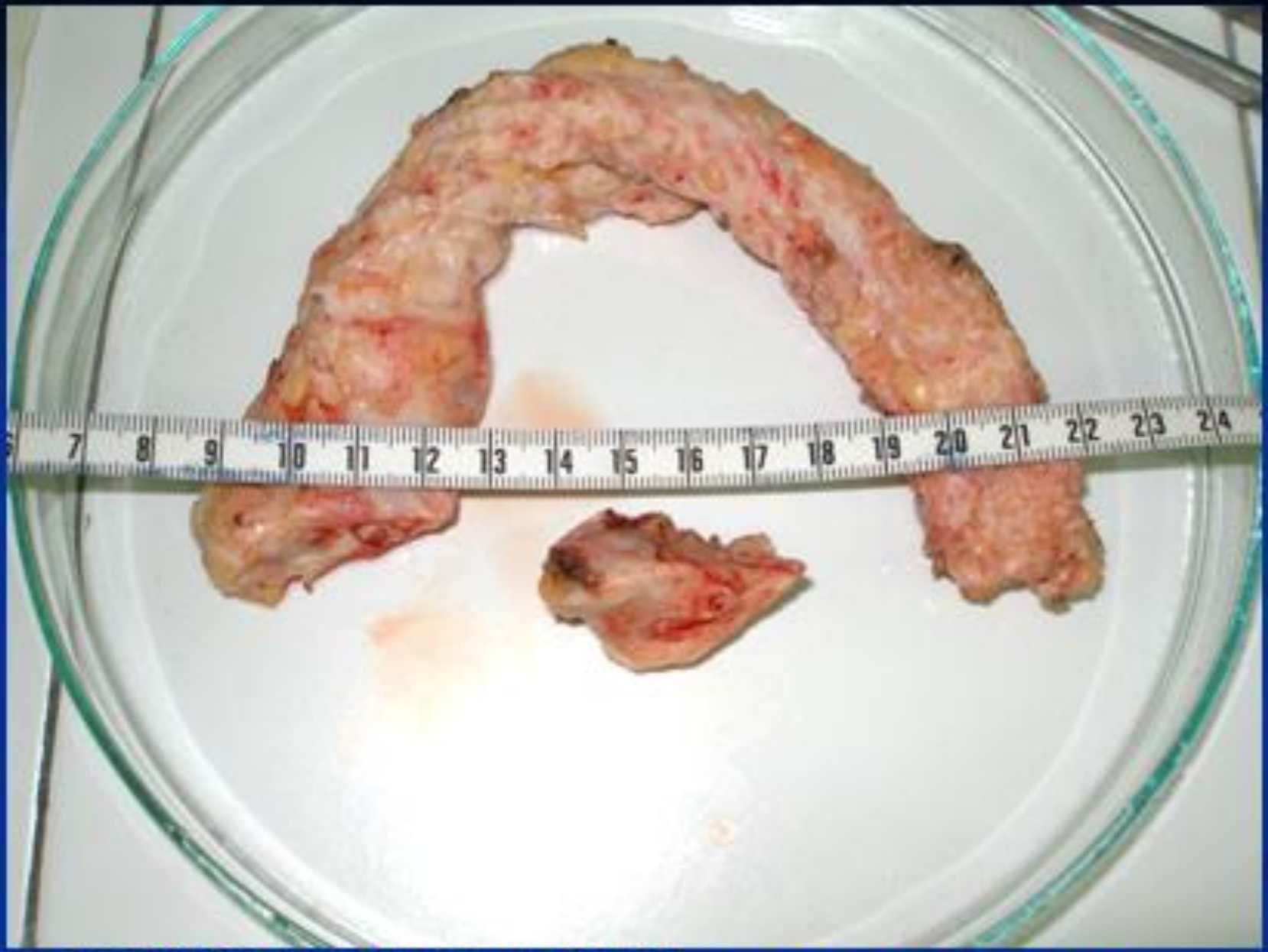
Pressure (force) distribution in the compressed leg tissues (pump chamber 50mmHg)



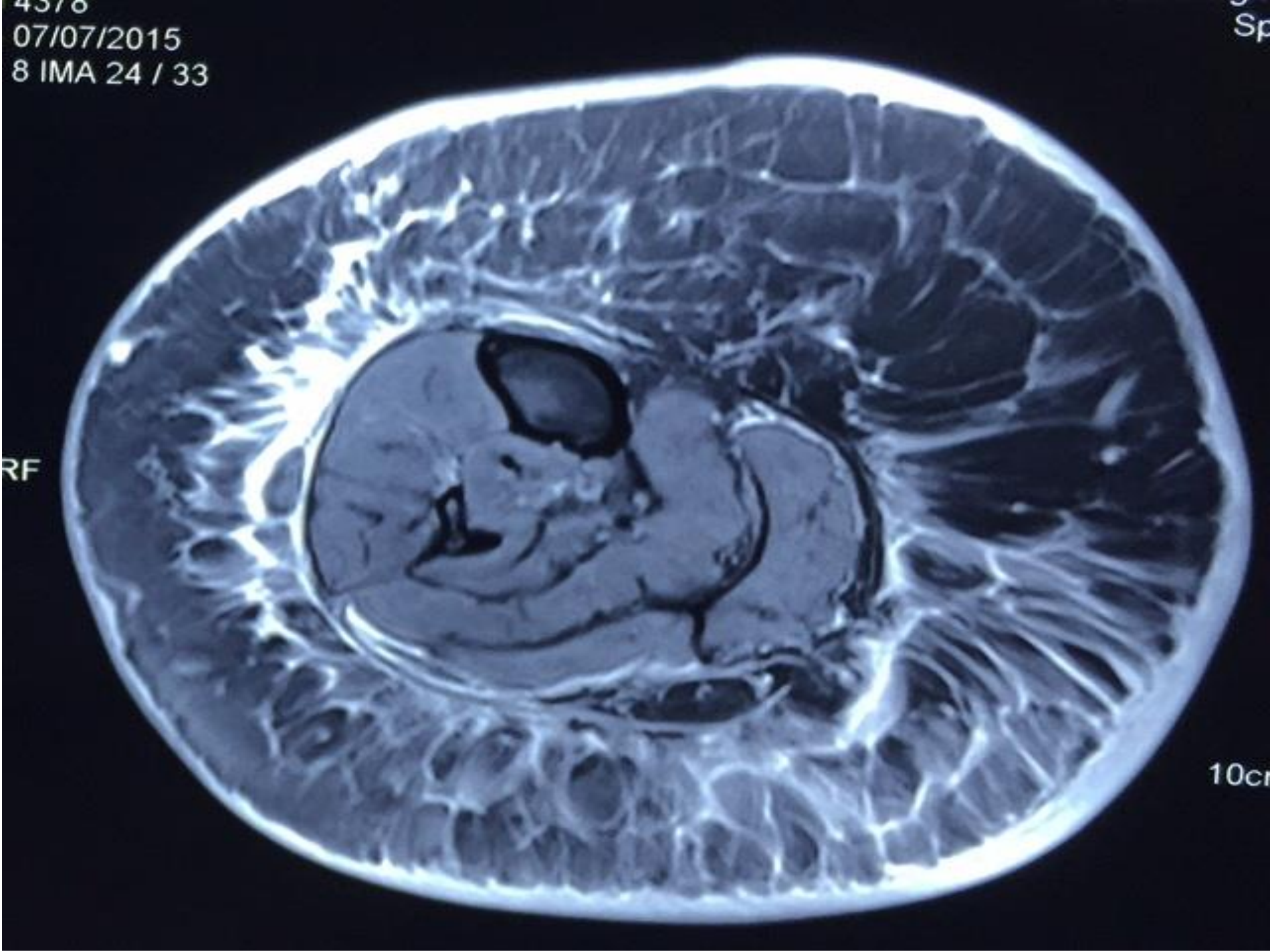
There is a dissipation of applied force in the solid tissue before it reaches the edema fluid



Hypertrophied subcutaneous tissue- fat globules, fibrous septa



PERILYMPHATIC TISSUE (SUPERFICIAL PLEXUS)
AND FASCIA IN LYMPHEDEMA


4378
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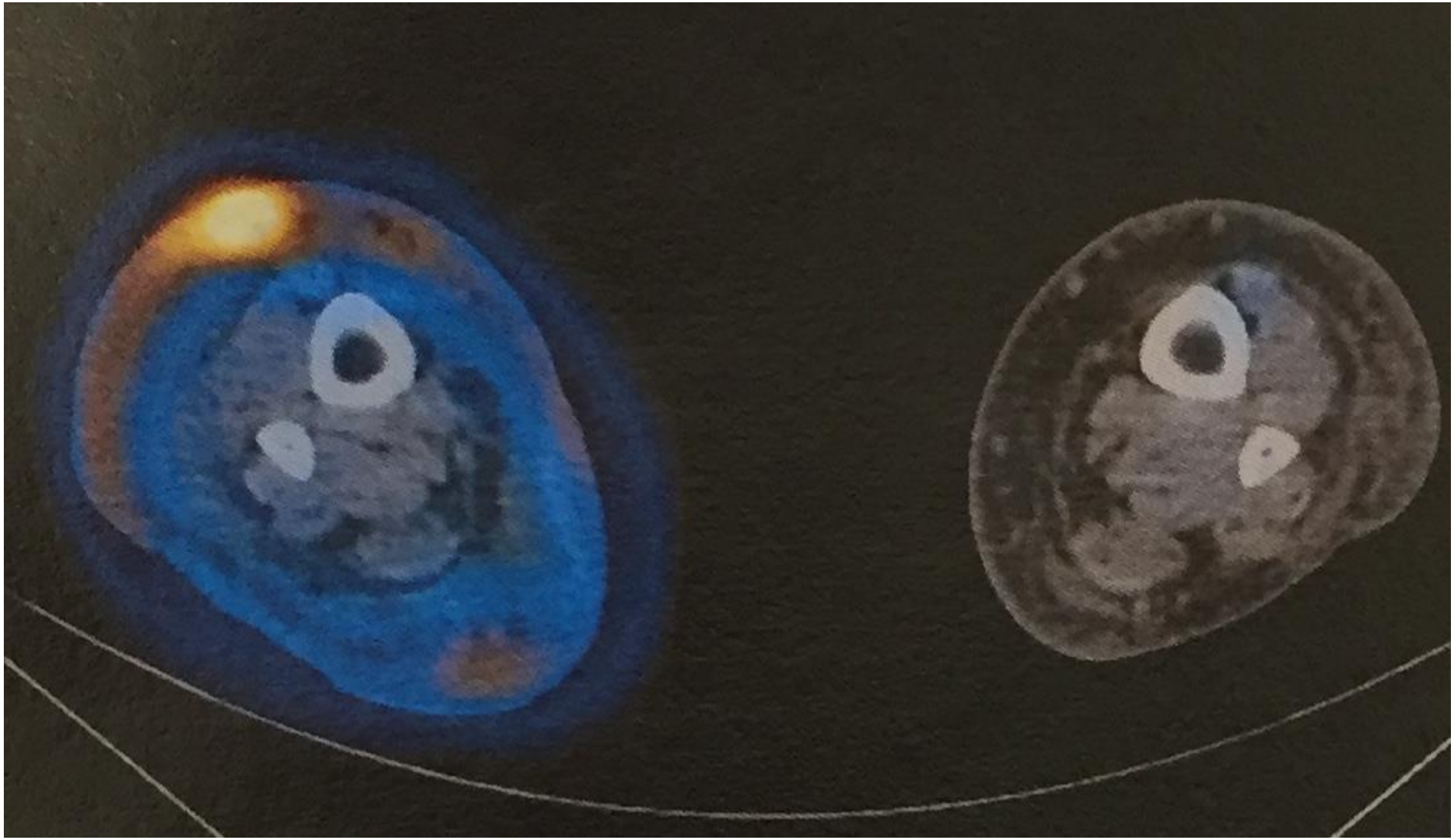
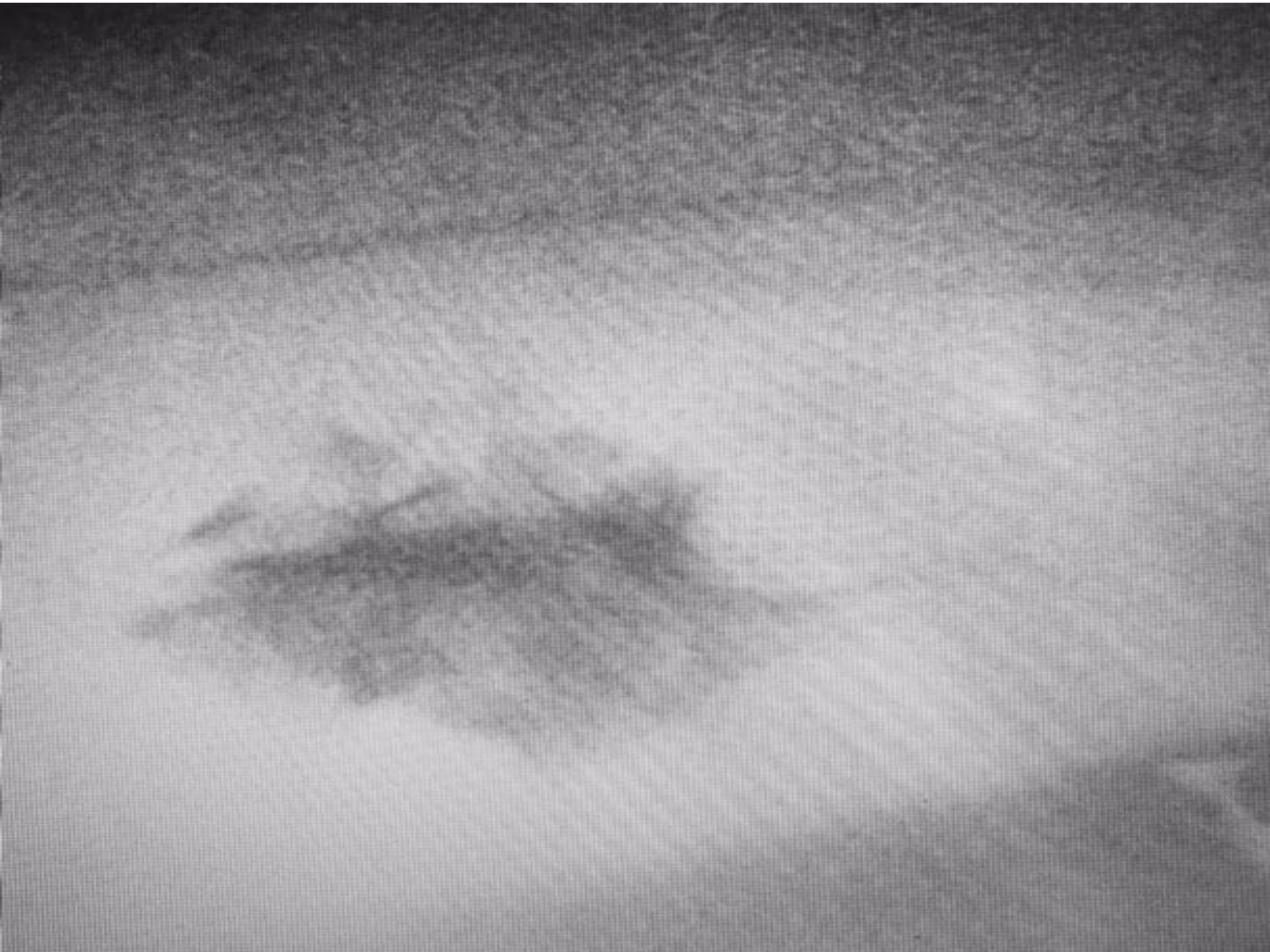
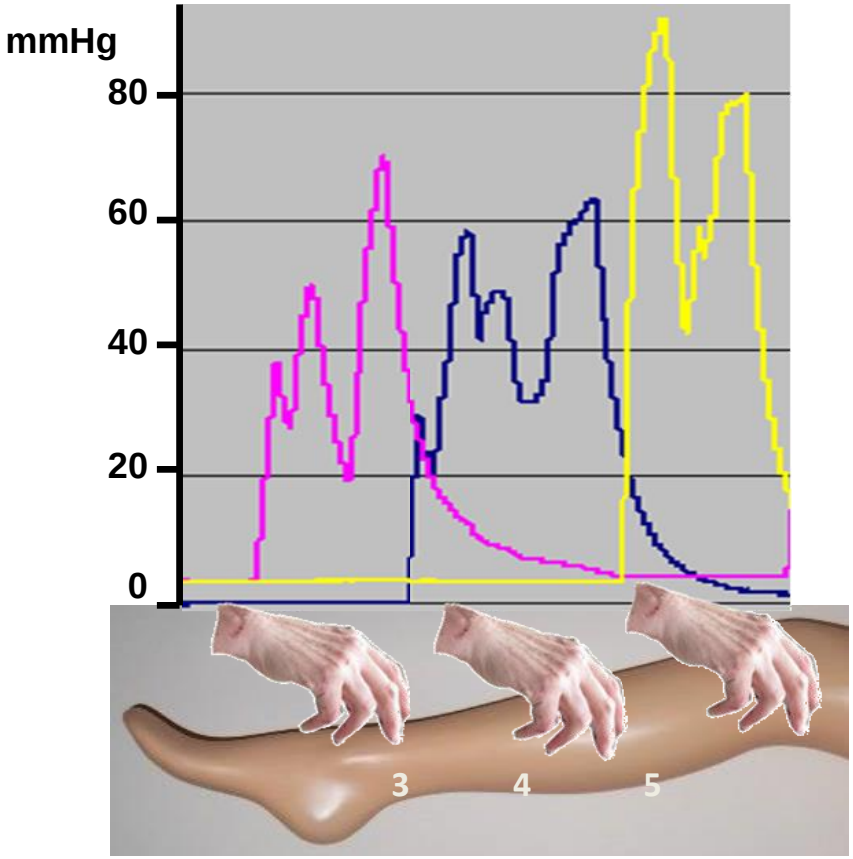
SPECT-CT lymphoscintigram of the lower calf




DILATED TISSUE SPACES
(STAINED BLUE)

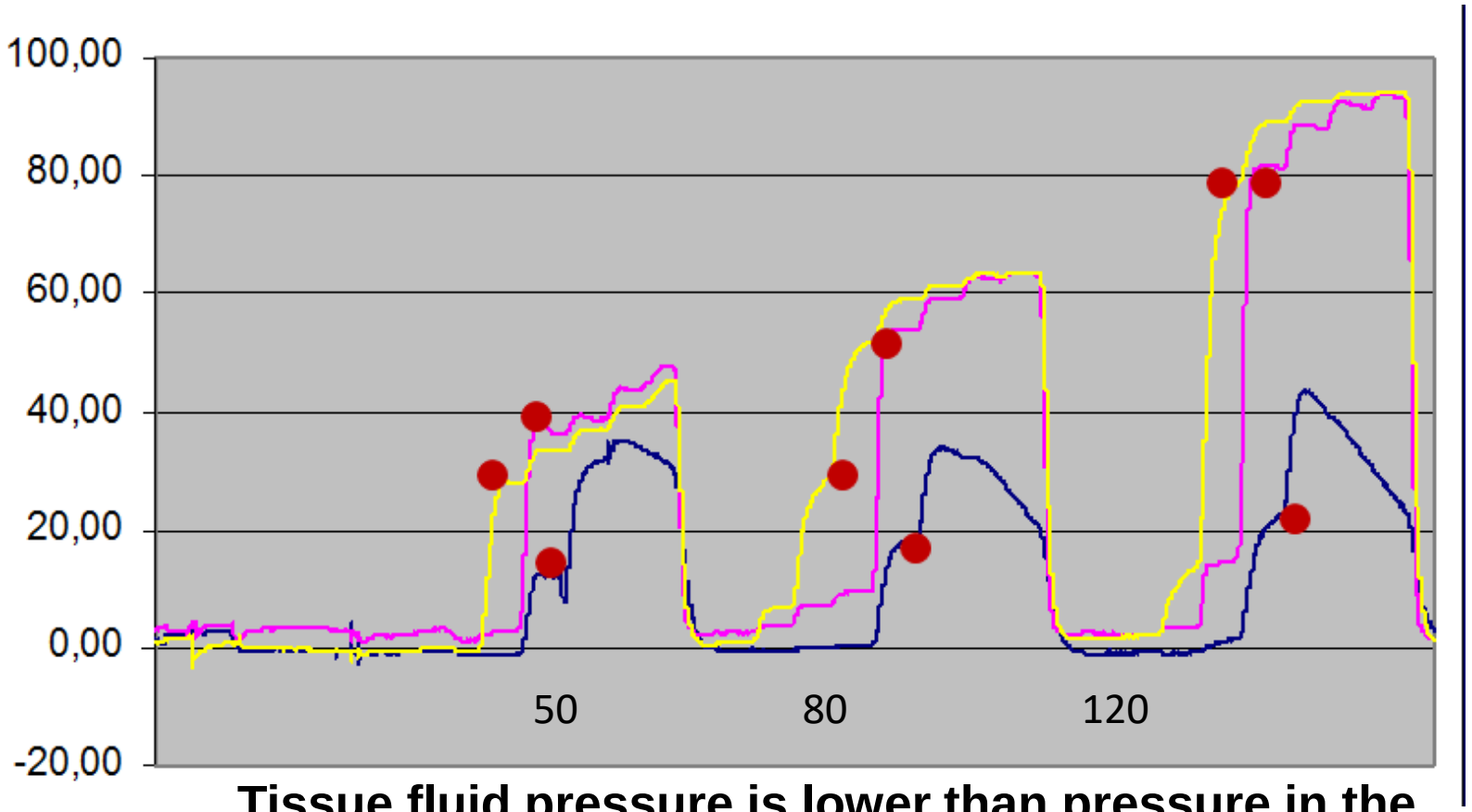




TISSUE FLUID PRESSURES DURING MANUAL MASSAGE

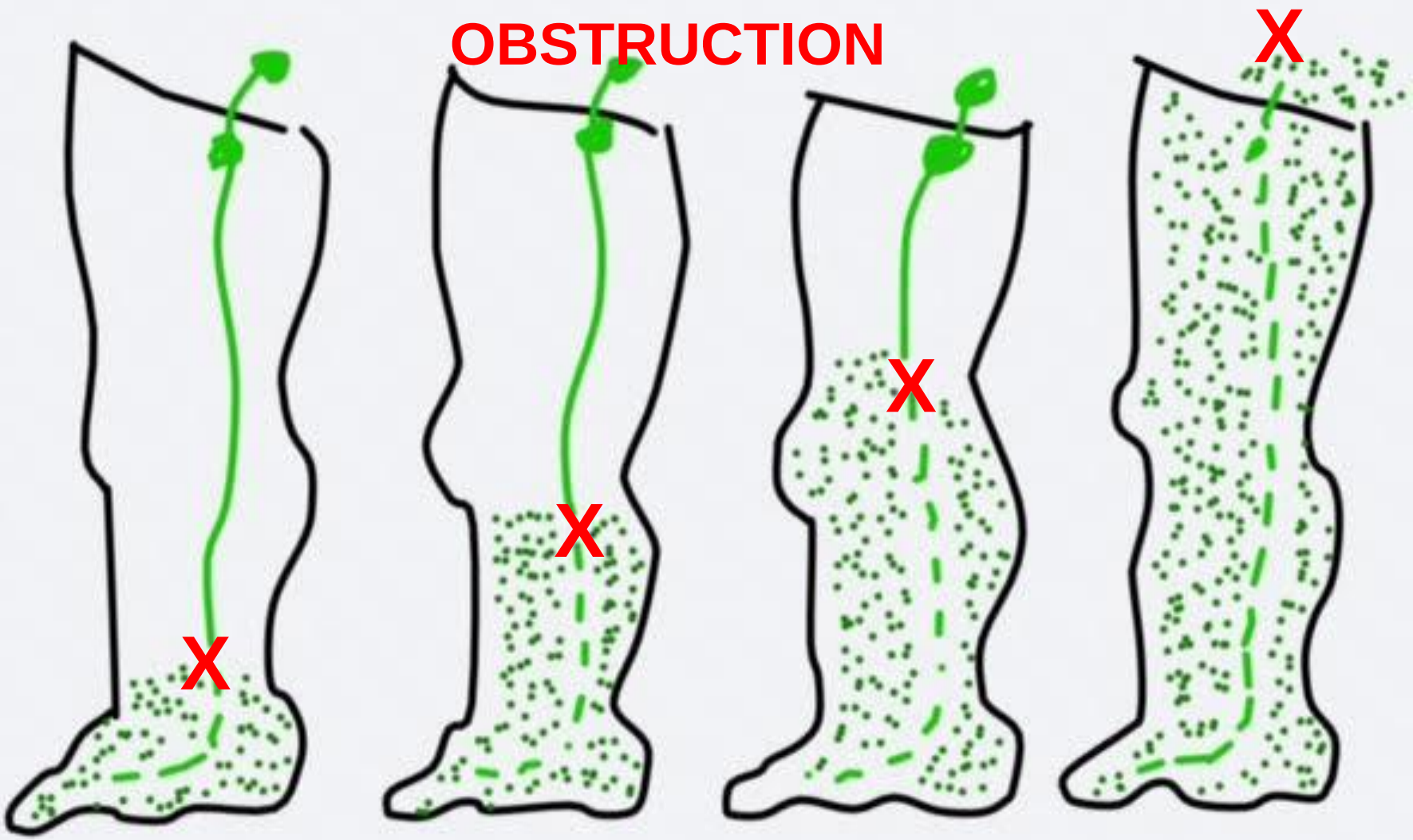
TISSUE FLUID HEAD PRESSURE DURING SEQUENTIAL COMPRESSION

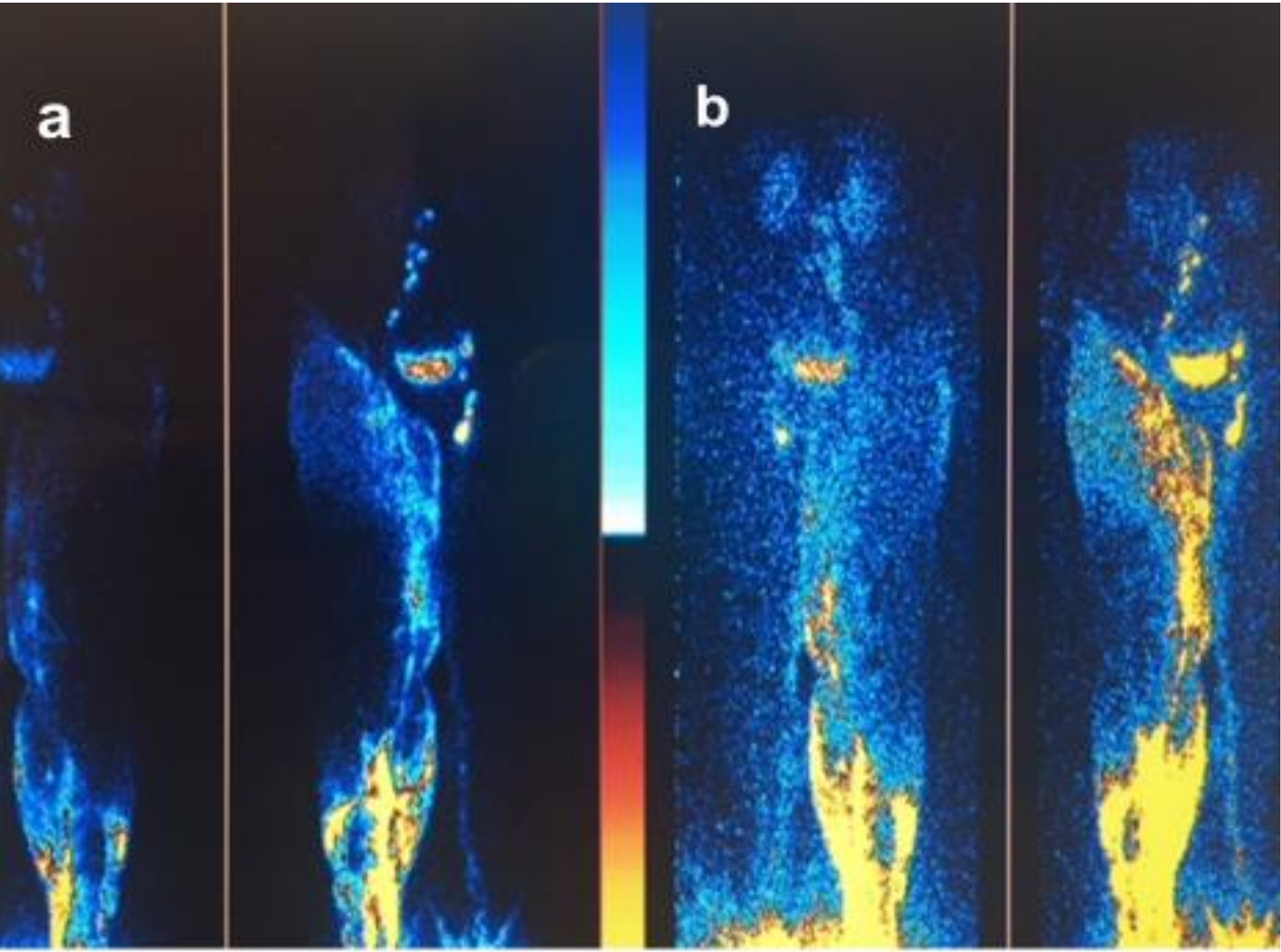
Red dots denote first inflation of chambers 3, 4 and 5. Inflation time 50 sec each chamber.
Curves represent sleeve pressures of 50,80 and 120 mmHg, n=12, x±SD



Tissue fluid pressure is lower than pressure in the sleeve. Cause: hard skin and dissipation of force in subcutis

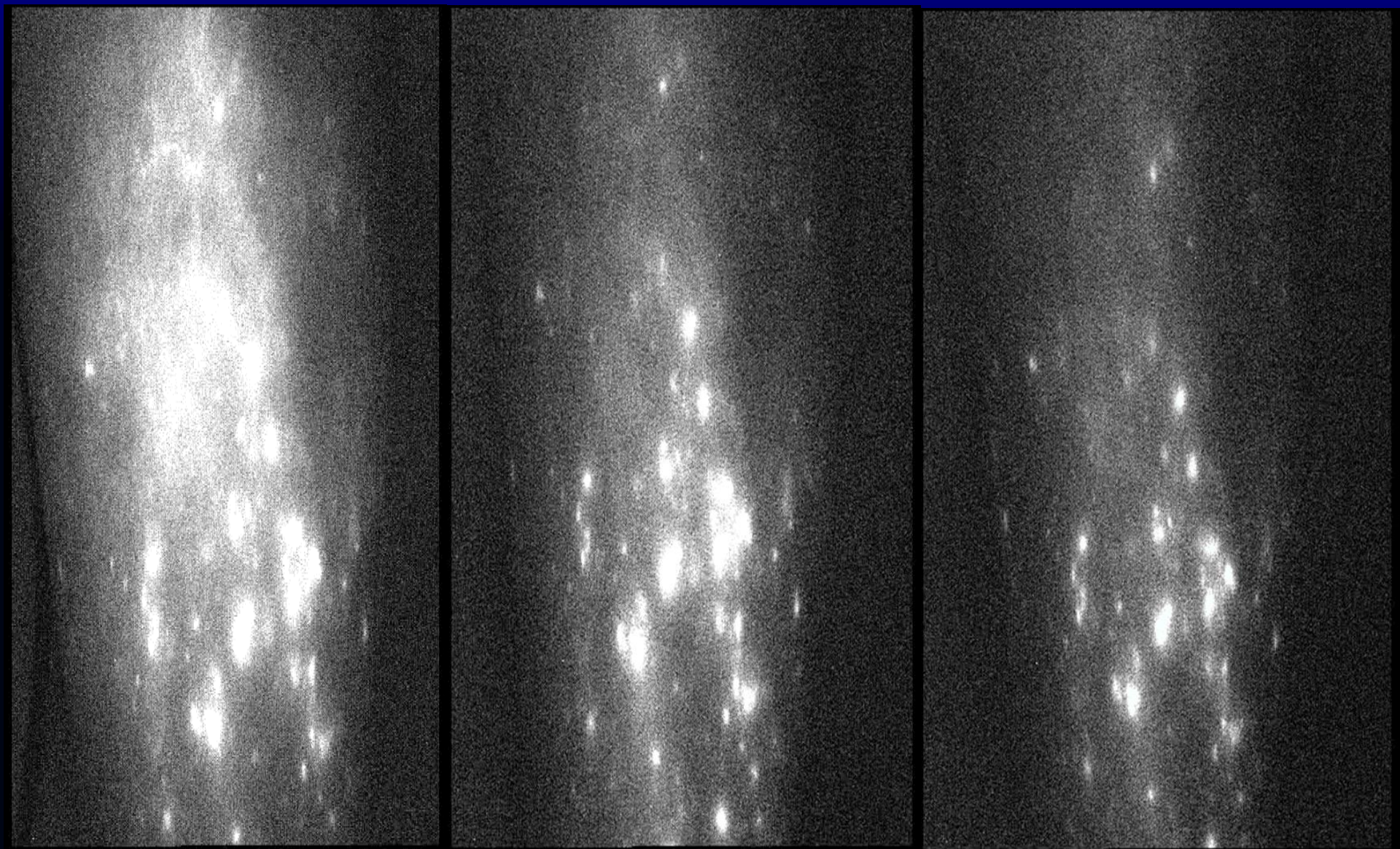
ACCUMULATION OF EDEMA FLUID ON ICG PICTURES DEPENDING ON LEVEL OF LYMPH COLLECTOR OBSTRUCTION

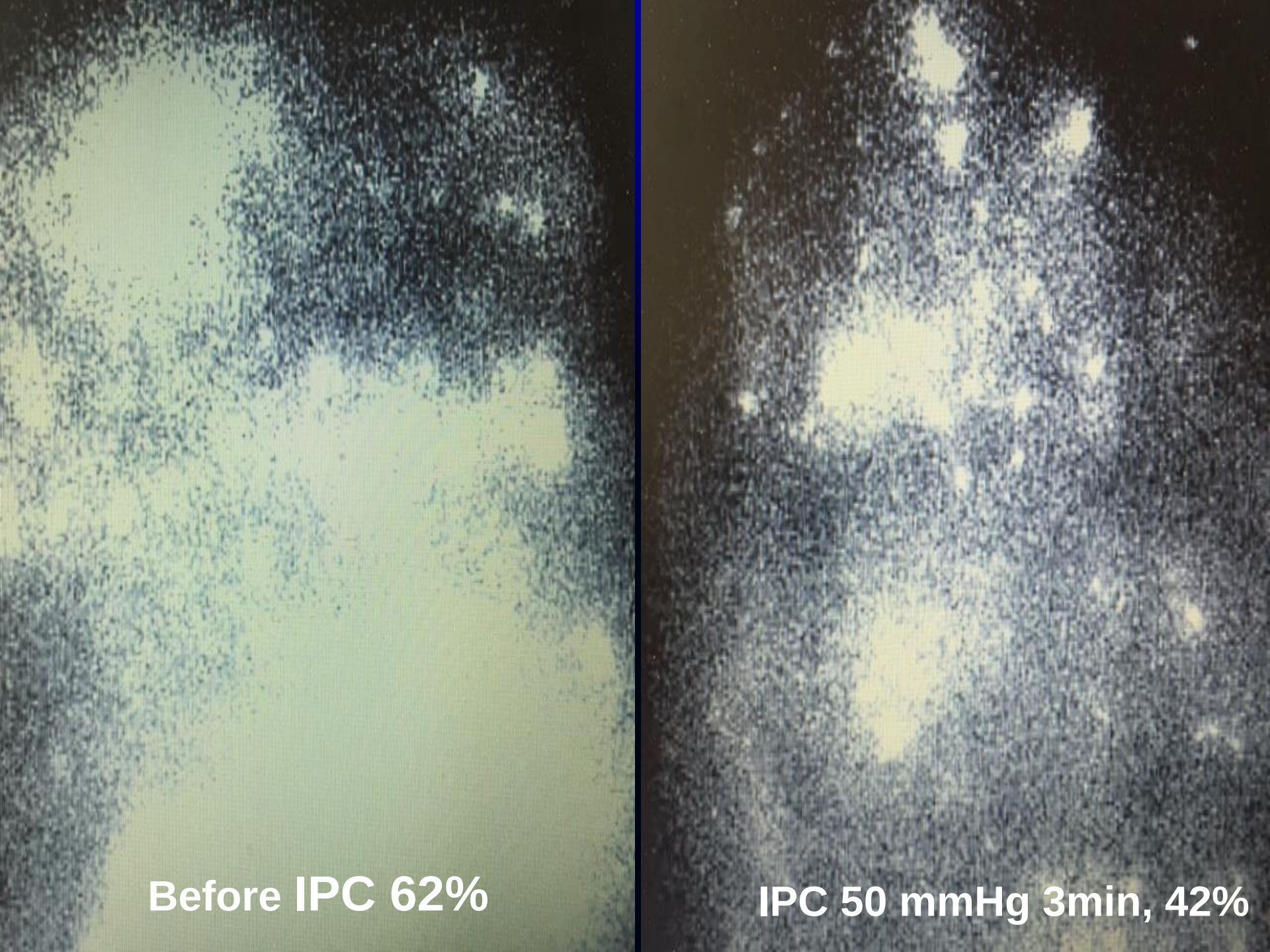


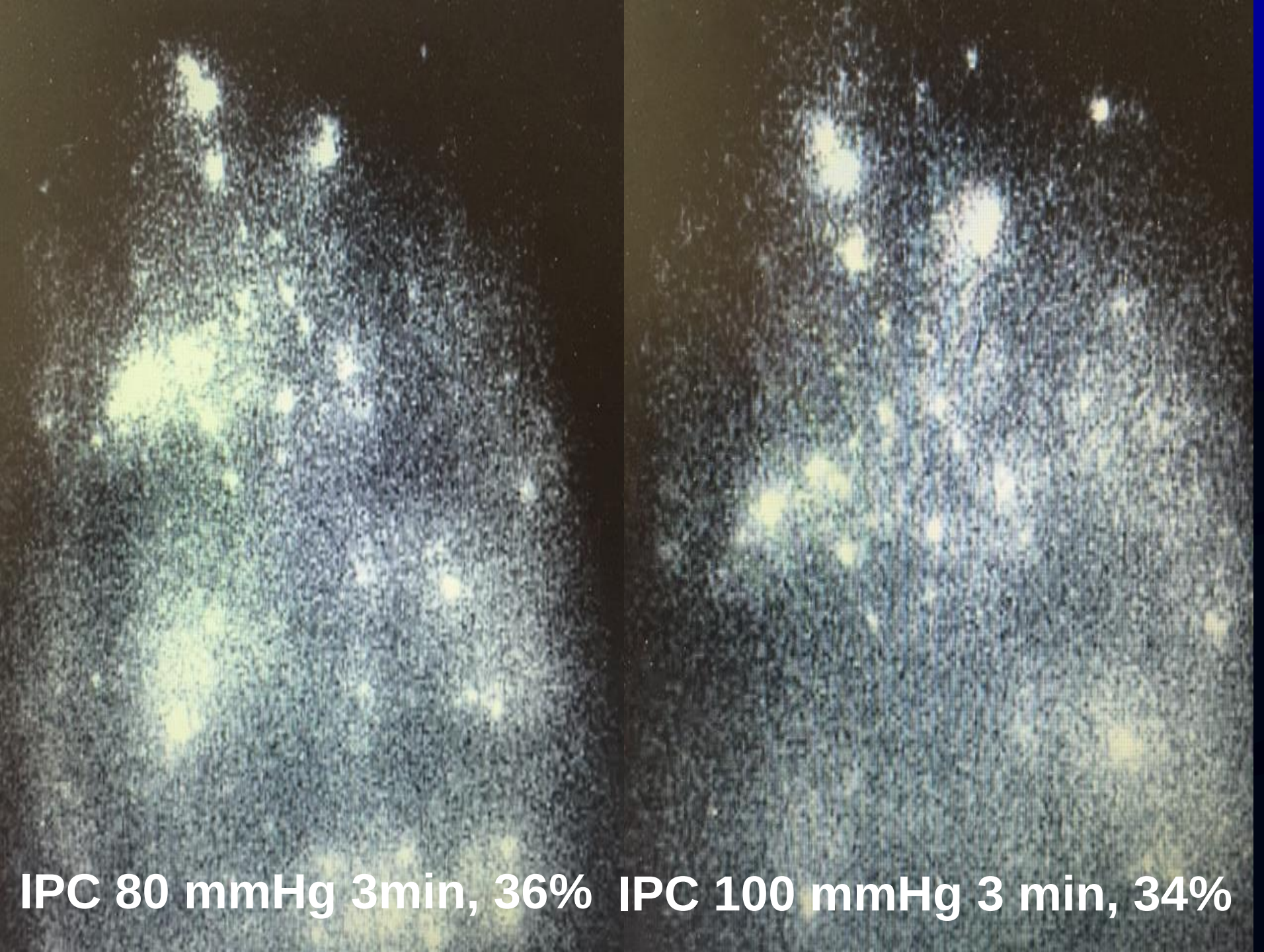

a
b

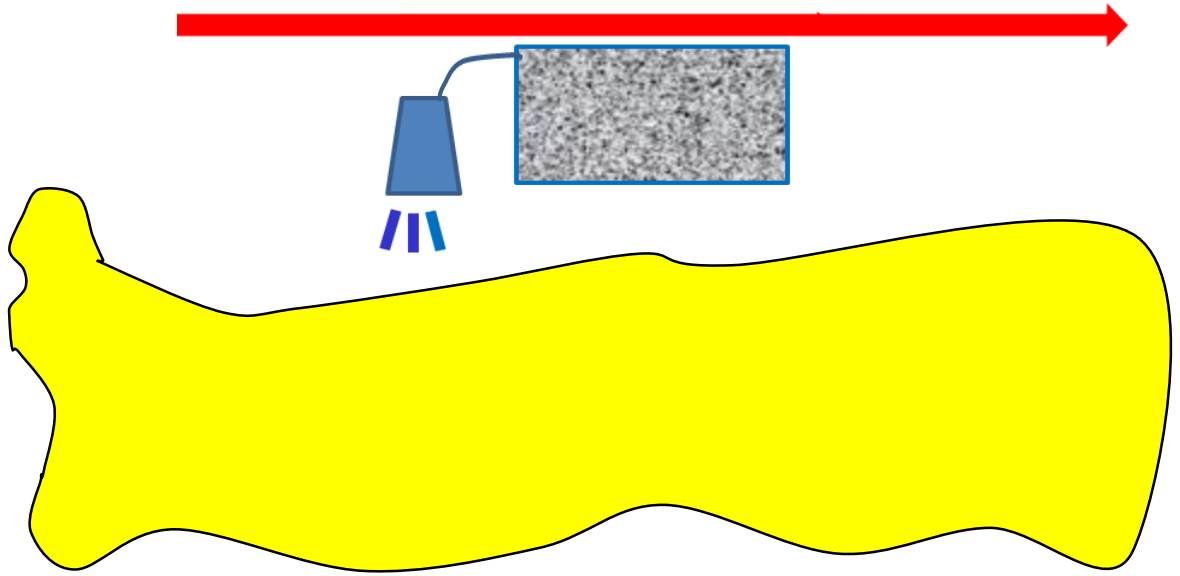
Compression (1 min)

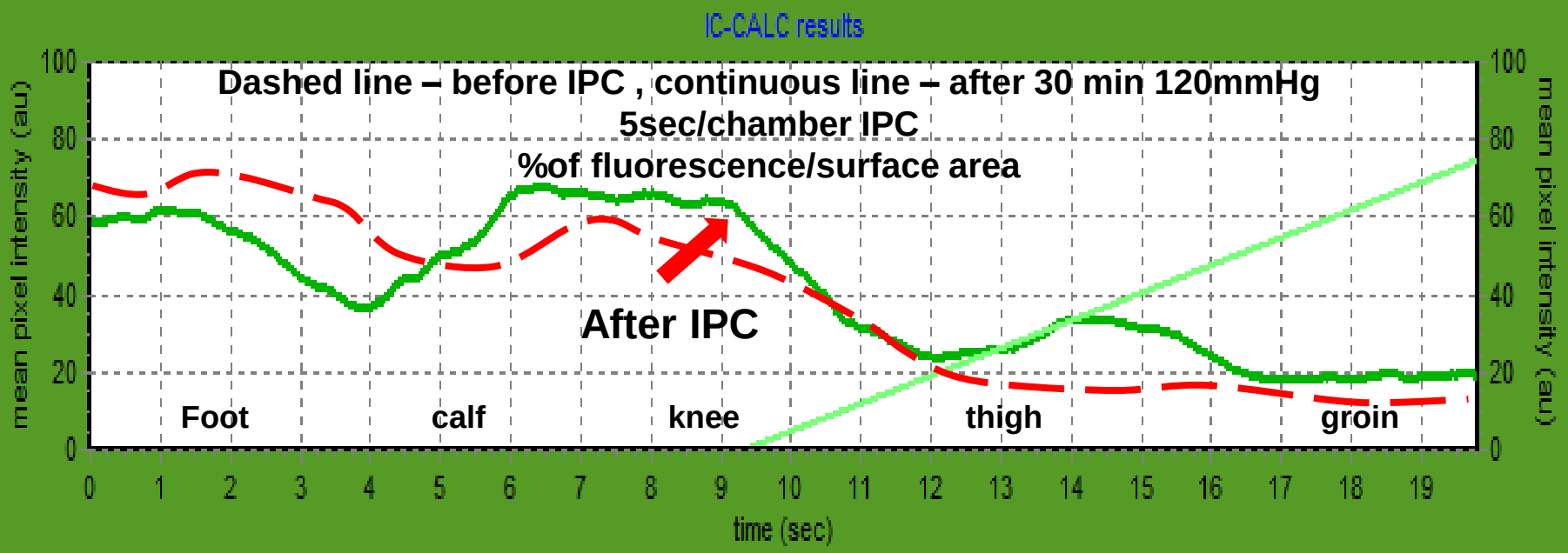
before 50 mmHg 80 mmHg

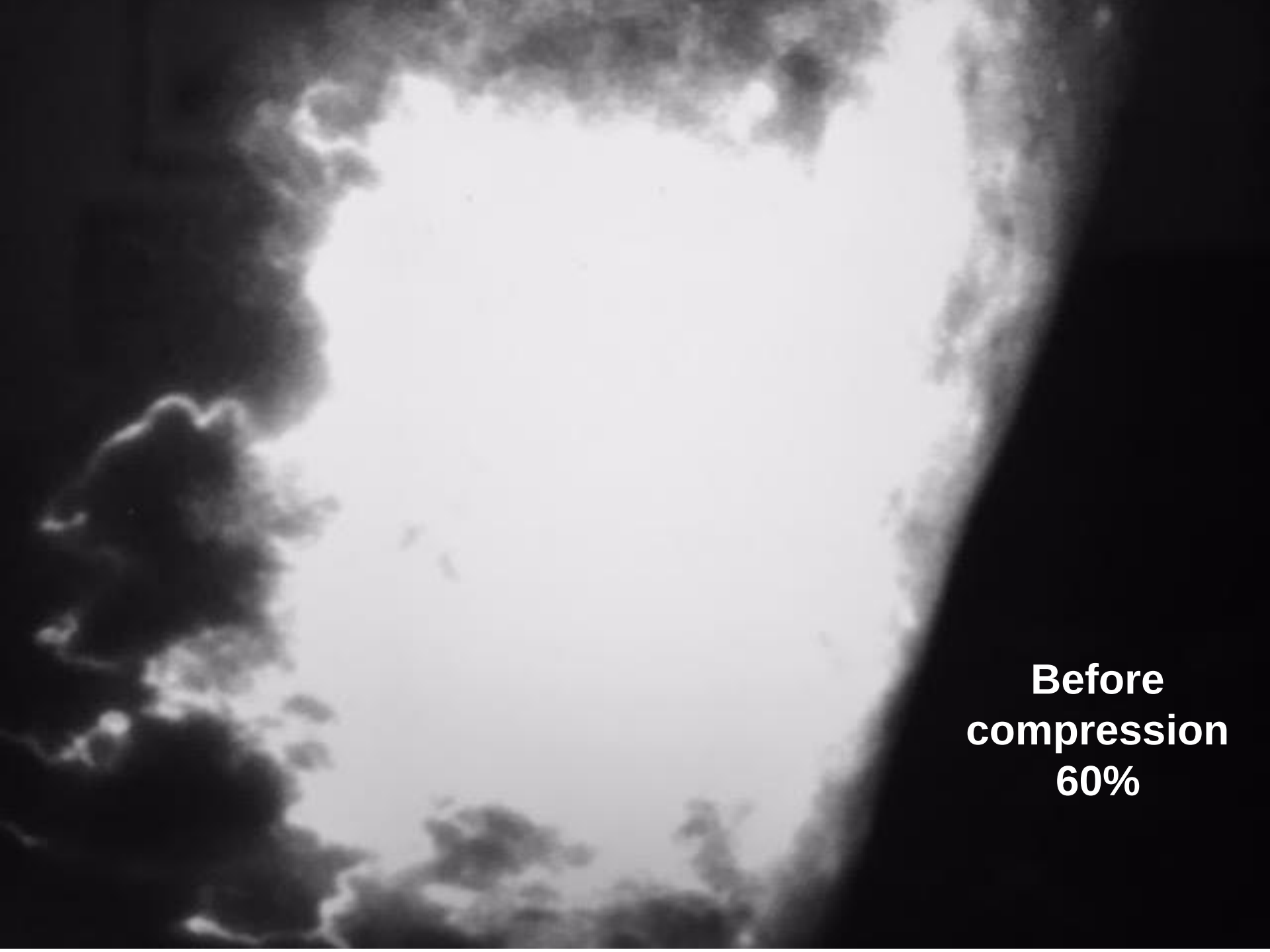



Before IPC 62%
IPC 50 mmHg 3min, 42%


IPC 80 mmHg 3min, 36%
IPC 100 mmHg 3 min, 34%

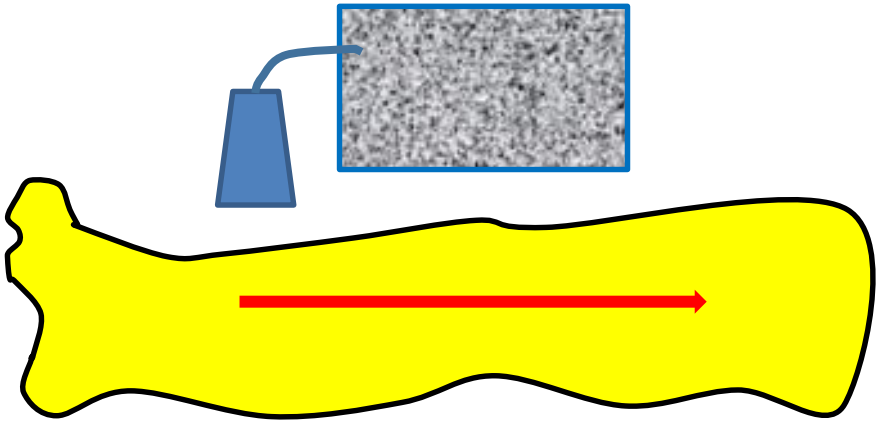


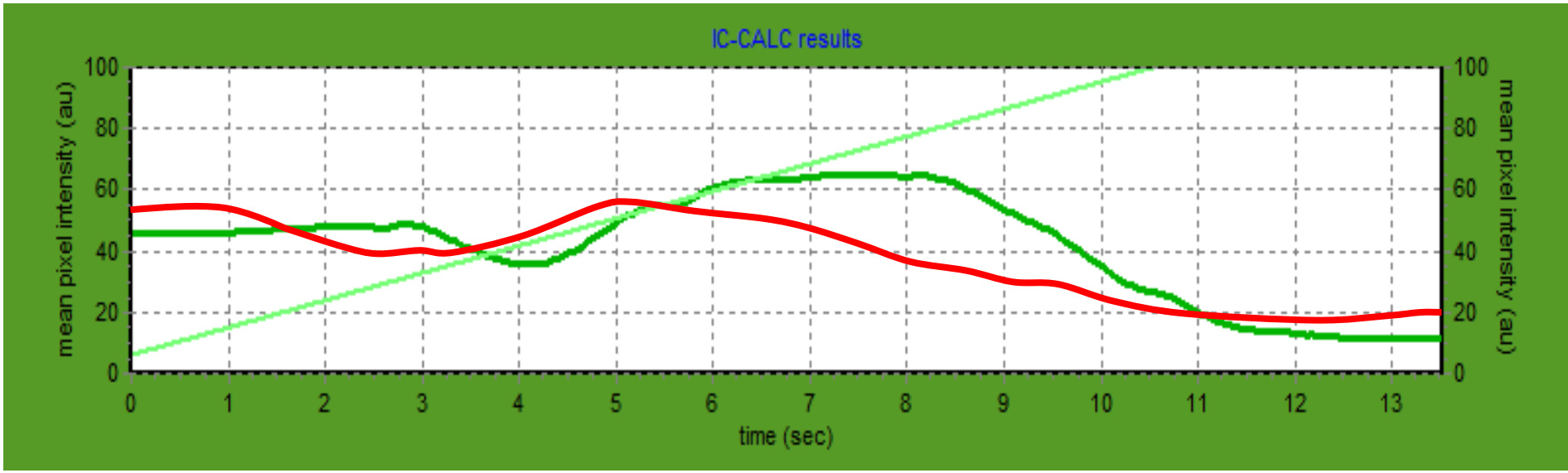

IC-CALC results
Dashed line – before IPC , continuous line – after 30 min 120mmHg
5sec/chamber IPC
%of fluorescence/surface area
After IPC
Foot
calf
knee
thigh
groin
mean pixel intensity (au)
mean pixel intensity (au)
time (sec)
0
20
40
60
80
100
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19

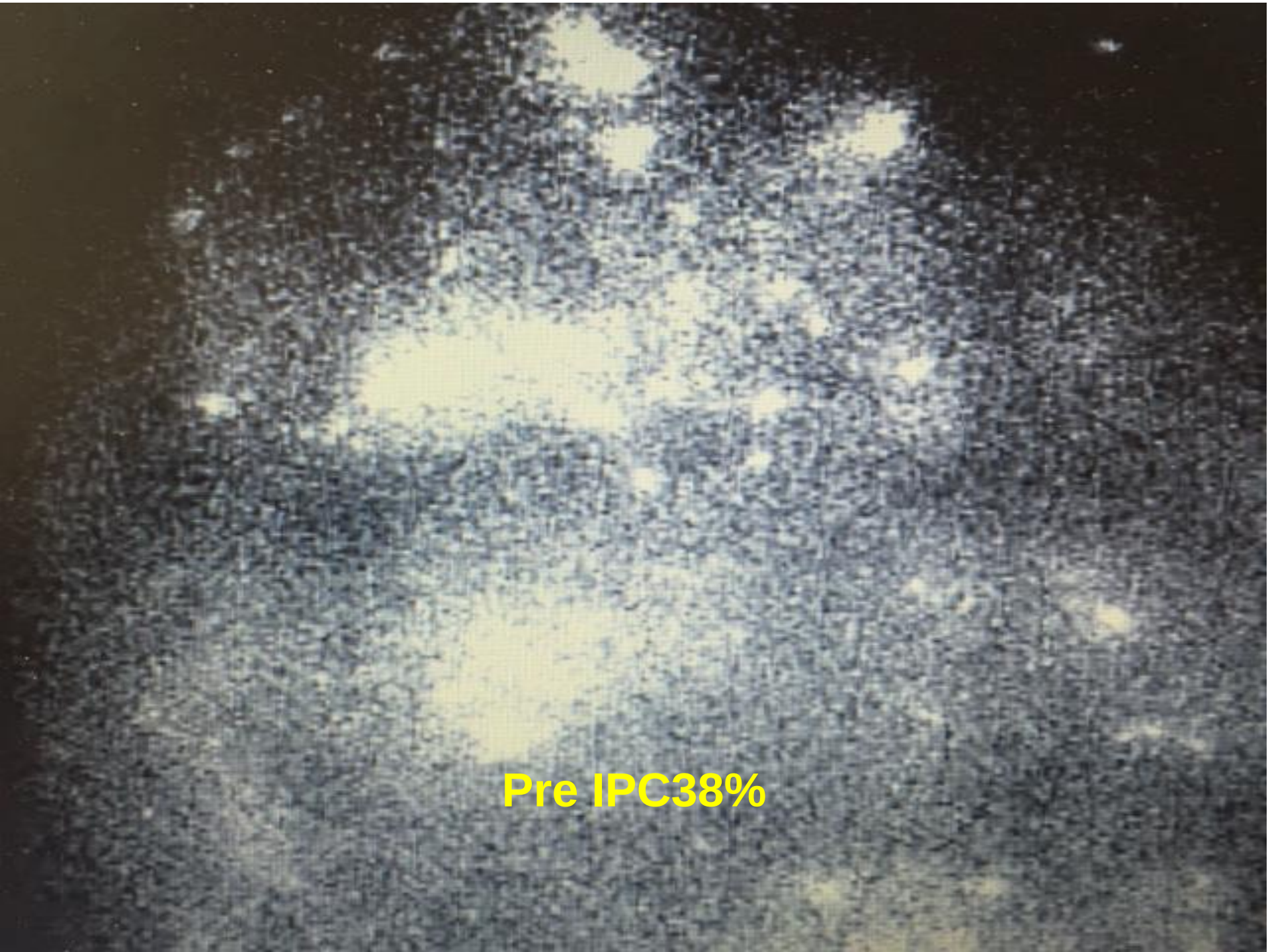

Before
compression
60%

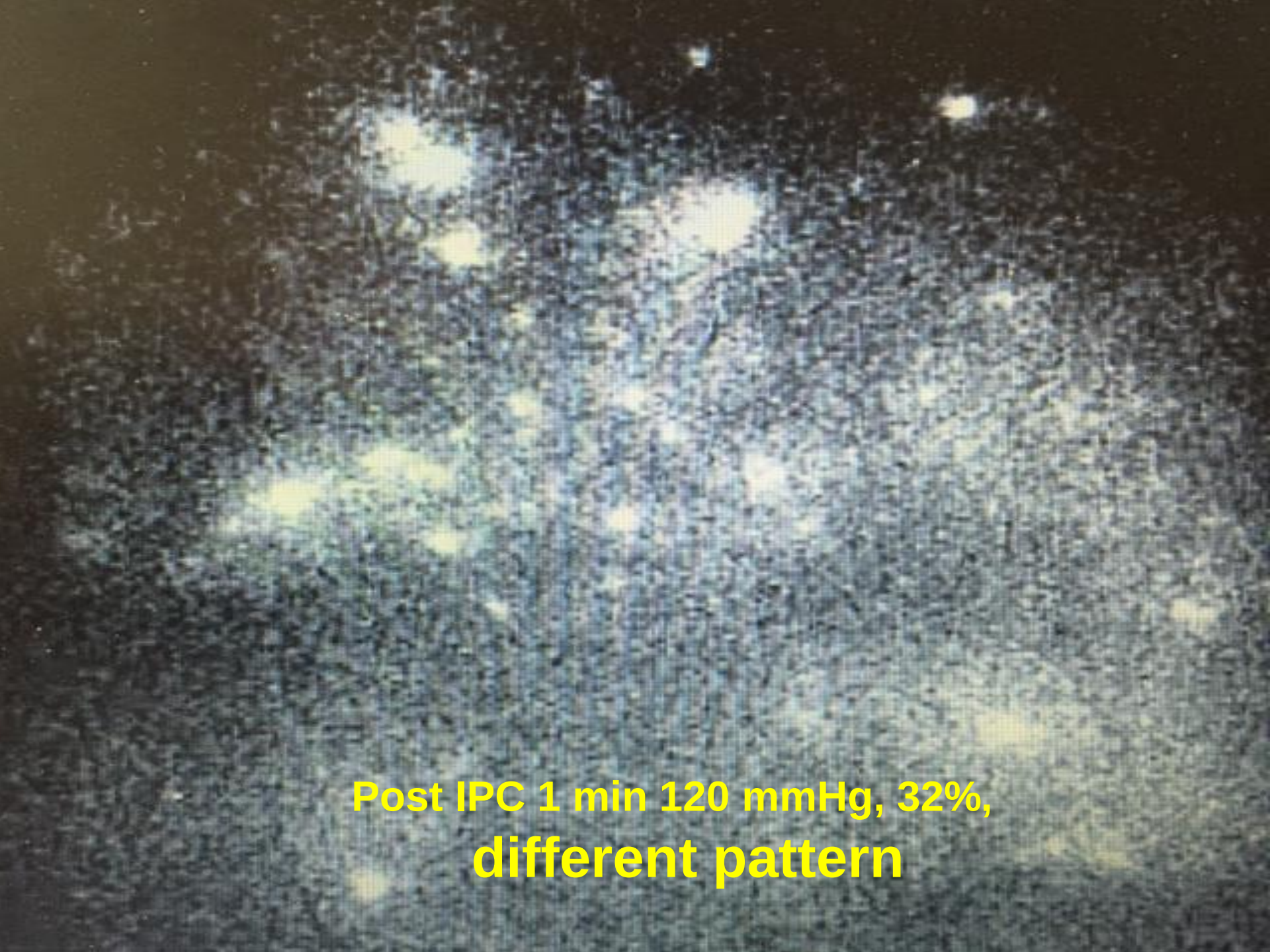

After
Compression
47%

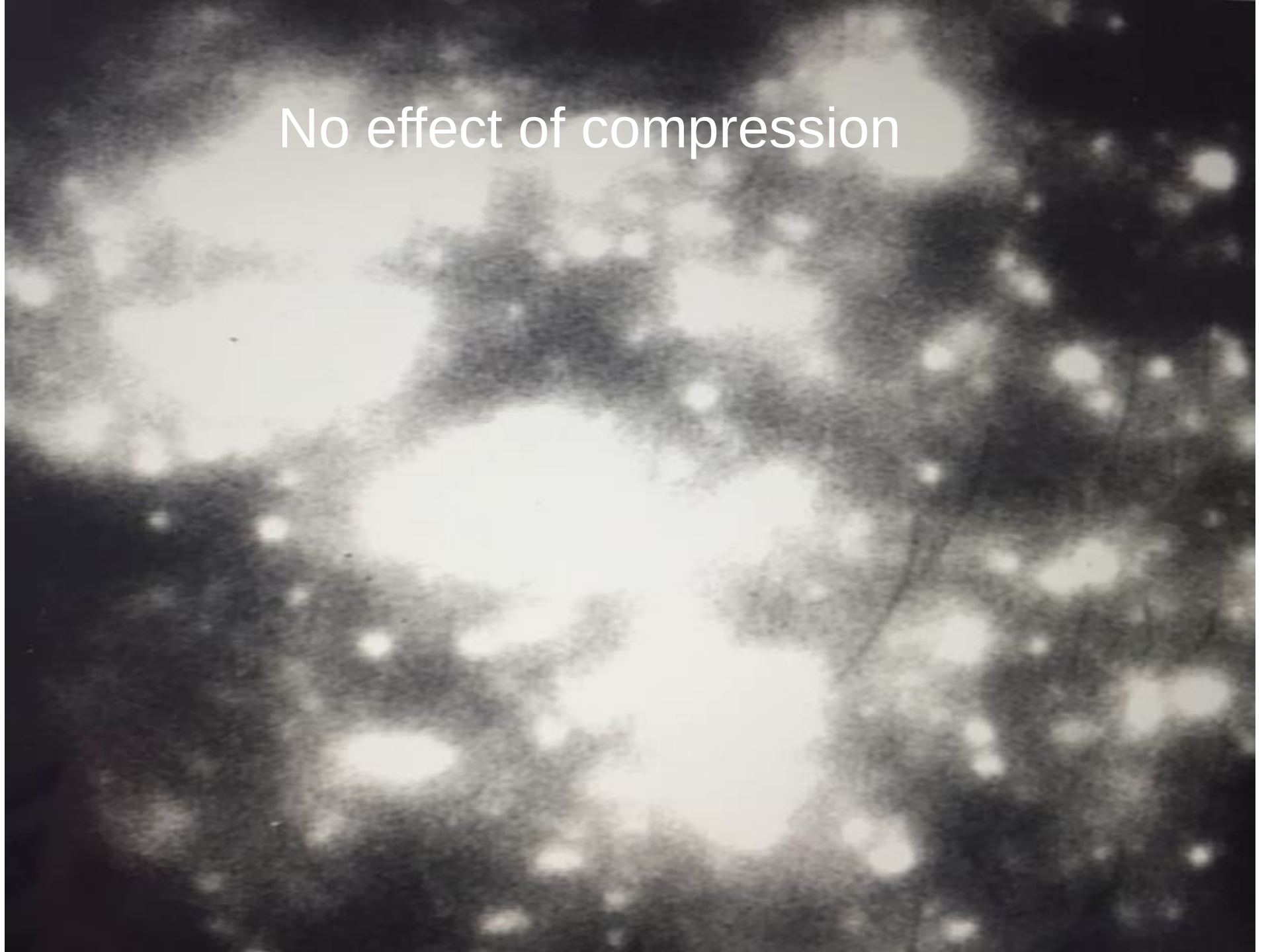
ICG fluorescence level before (green) and after (red) pneumatic compression



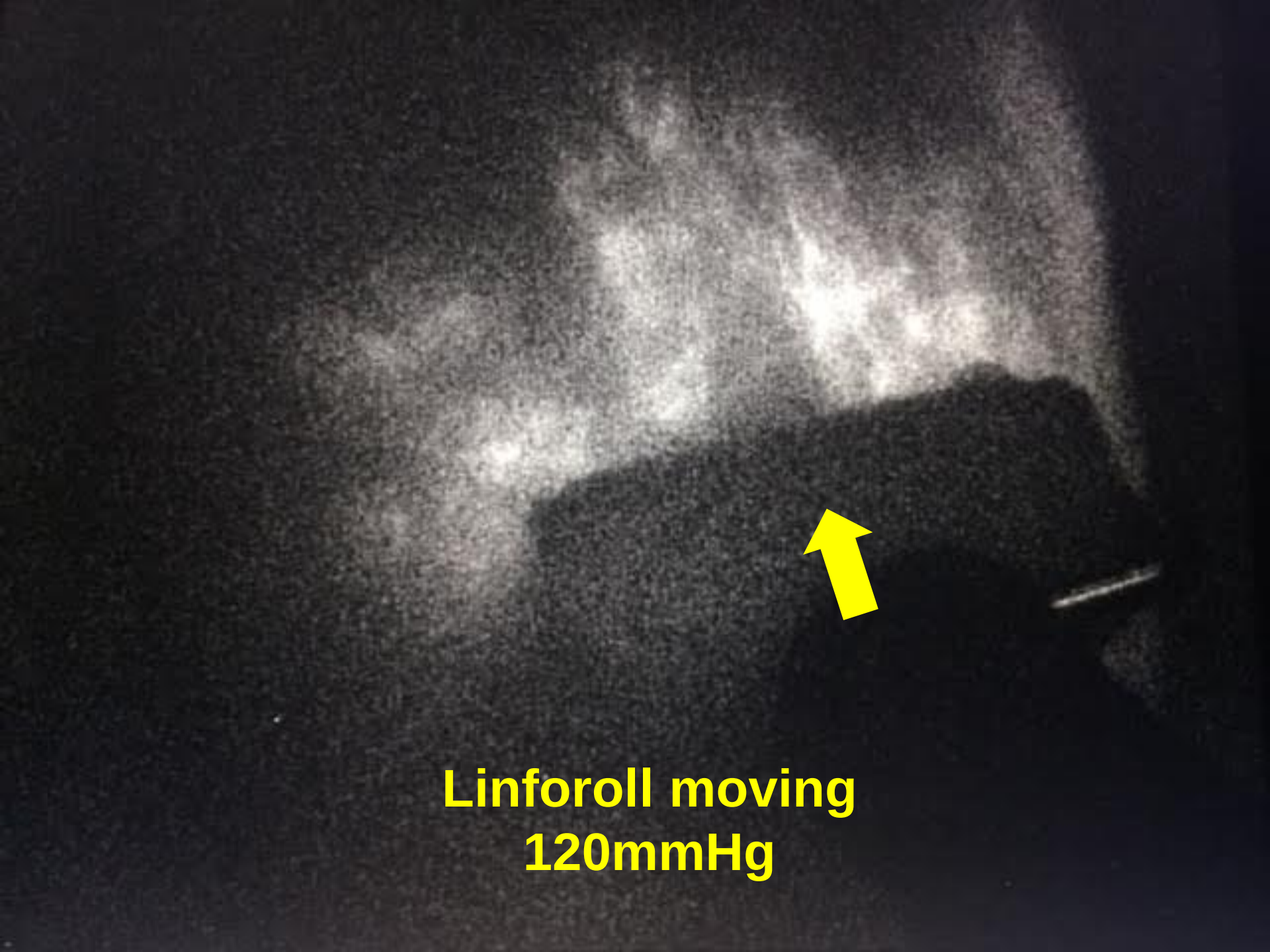



Pre IPC38%


Post IPC 1 min 120 mmHg, 32%,
different pattern


No effect of compression

Linforoll has installed pressure sensor in the handle. Apllied force can be adjusted during rolling to tissue hardness along the whole limb


Linforoll moving
120mmHg

Results

a) the possibility of real time observation of edema fluid movement under known pressure,
b) threshold pressures necessary to move edema fluid to be over 80 mmHg in compression device and over 40 mmHg in tissue fluid,
c) sites of fluid retention despite of compression
d) inefficacy of compression in some cases despite of applying high force.

Conclusions

These observations point to the usefulness of ICG lymphangiography before and after compression therapy. This gives assurance of effective compression therapy in a given patient.