ISSN 0778-5569

OFFICIAL ORGAN
OF THE

EUROPEAN GROUP
OF LYMPHOLOGY
LATIN-MEDITERRANEAN
CHAPTER OF ISL
SOCIETÀ ITALIANA
DI LINFANGIOLOGIA

THE EUROPEAN JOURNAL OF lymphology

and related problems

VOLUME 15 • No. 45 • 2005

INDEXED IN EXCERPTA MEDICA

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Associate-Editors also can receive and promote articles and start the review process.

Publications languages
Official language of the Journal is English.

Publication rate
The EJLRIP is published on a quarterly basis.

Subscription rates - All members of European Group of Lymphology or of National societies (with which the GEL has a cooperation agreement and whose fee includes a subscription to the EJLRP) receive the Journal free of charge.
Subscription rate for non-members is:
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Graphics: Duògrafi snc, Rome - Printed by Arti Grafiche srl, Pomezia (Rome)

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THE EUROPEAN JOURNAL
OF
lymphology
and related problems
VOLUME 15 • No. 45 • 2005
INDEXED IN EXCERPTA MEDICA

HEMODYNAMIC RESPONSE TO MULTILAYERED BANDAGES DRESSED ON A LOWER LIMB OF PATIENTS WITH HEART FAILURE

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Proposed: April 2005 - Revised: May 2005 - Accepted: July 2005

BACKGROUND AND PURPOSE

Manual lymphatic drainage, intermittent pneumatic compressive therapy, multilayered bandages and garments are the main techniques of the conservative physical treatment of peripheral lymphedema (ISL consensus). Since 1988, we know that intermittent compression therapy applied to both lower limbs is prejudicial for subjects with heart failure because right atrial pressure and pulmonary arterial pressure increase to a critical point. In the present study, hemodynamics parameters are learned in patients wearing a multilayered bandage.

MATERIAL AND METHODS

We present a report of 5 cases, 4 men and 1 woman, 38 till 74 years old (average 54,8), hospitalized in Coronary Care Unit with heart failure class III or IV of the N-YHA Classification. All heart failures were left insufficiency mainly due to mitral incompetence (one case), aortic incompetence (one case) myocardial ischaemia (one case) and dilated cardial myopathies (two cases). Patients worn a right atrial catheter, for their medical treatment, they are in a clinical steady-state, well informed and they agree with the protocol of the study, in conformity of the Ethical Committee. Subjects suffered or not from lower limb oedema. Multilayered bandages are applied on one lower limb, according to Leduc's technique from toes to up of the thigh, patient lying supine, during one hour experiments. In order to check the pressure under the multilayered bandages, we've put a pressure transducer to the distal part of the leg. To optimize the effect of the bandages we ask the subject to perform some movements. Several parameters were recorded, mainly via the Swan-Ganz catheter: heart rate, cardiac output, systolic and diastolic blood pressures (SDP, DBP), mean blood pressure (MBP), right atrial pressure (RAP), cardiac index (CI), systolic index (SI), double product, systemic vascular resistances (SVR), pulmonary arterial systolic (PASP) and diastolic pressures (PADP), mean pulmonary arterial pressure (MPAP), pulmonary wedge pressure (PWP), pulmonary vascular resistances (PVR), and respiratory rate. These cardio-vascular variables were systematically determined before, during and after multilayered bandages dressing in our heart failure patients, according to the following schedule (table 1). We first seek the role of muscular contractions from one undressed leg on measured cardio-vascular variables and second we repeat the same measurements after muscular contractions from the same leg dressed with the multilayered bandages. The study was thus designed in order to assess whether or not this type of bandages might induce harmful cardio-pulmonary side effects in patients with severe heart failure which might eventually preclude their further use in the treatment of leg oedema.

Table 1: Timing of the experimentation.

Handling description	Timing of measurements
10 minutes rest	T1 - Baseline measurements
30 ankle motions (dorsal flexion)	T2 - 15th motion: measurements
5 min rest	T3 - rest measurements
Multilayered bandages dressing	–
5 min rest	T4 - measurements at rest with the bandages
30 ankle motions (dorsal flexion) with the bandages	T5 - 15th motion: measurements
5 min rest	T6 - measurements at rest with the bandages
10 min rest after removal of the bandages	T7 - rest measurements

STATISTICAL ANALYSIS

Data are expressed as mean +/- standard deviation. Repeated measures analysis of variance (ANOVA) was used to compare the means at different times by means of the “Statistica” software.

RESULTS AND GRAPHS

We present the evolution of mean variables in the following graphs:

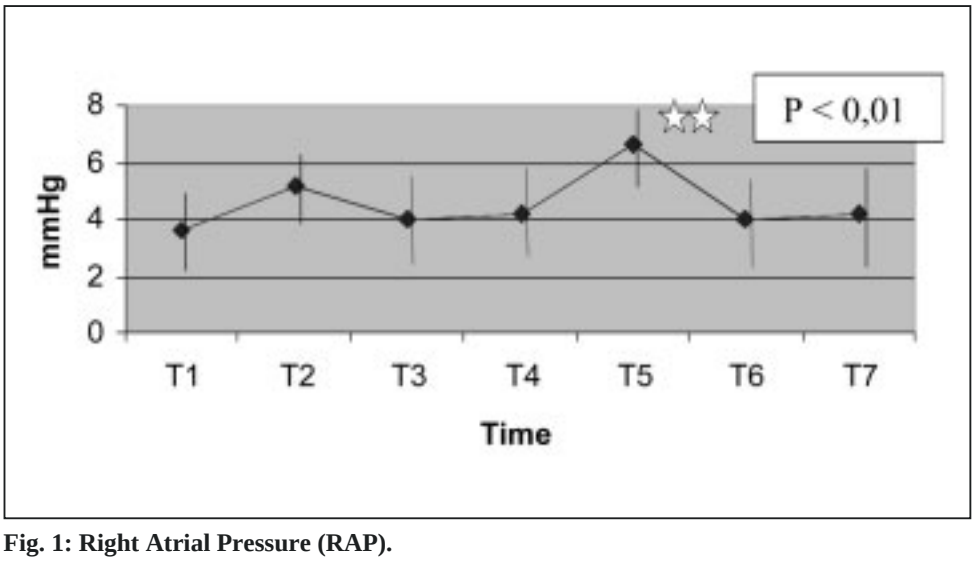

Fig. 1: Right Atrial Pressure (RAP).

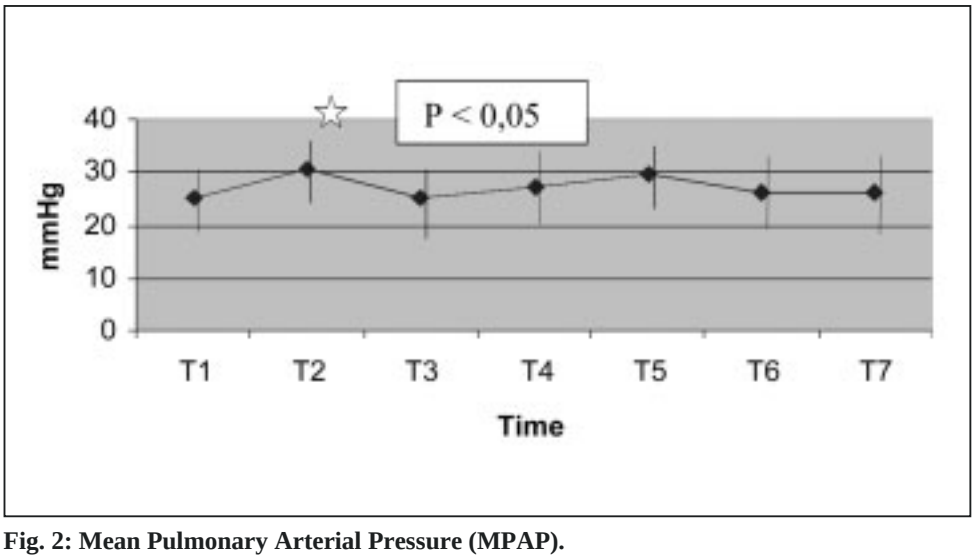

Fig. 2: Mean Pulmonary Arterial Pressure (MPAP).

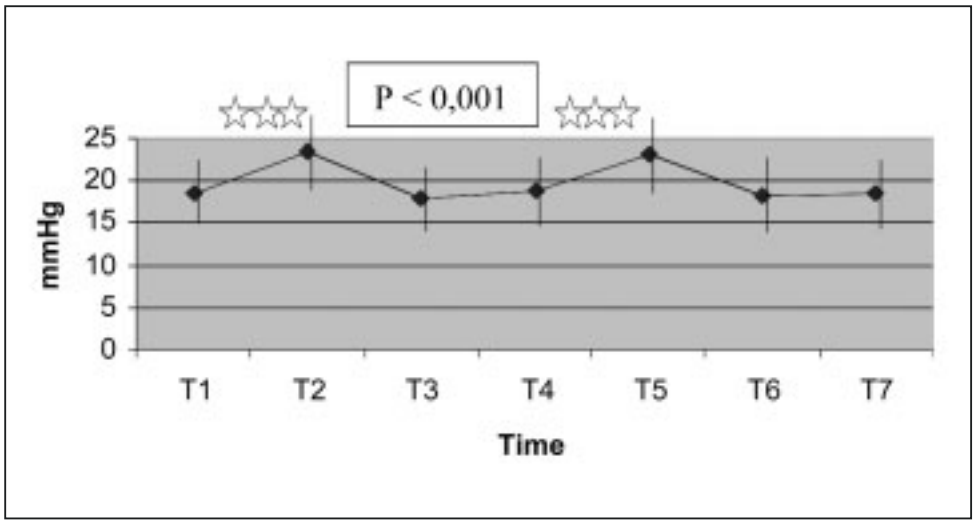

Fig. 3: Pulmonary Wedge Pressure (PWP).

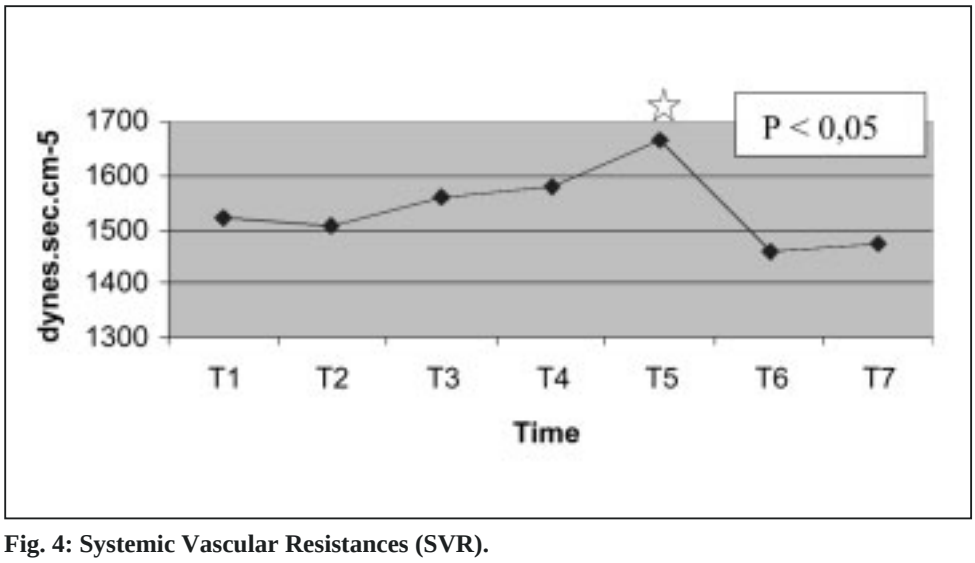

Fig. 4: Systemic Vascular Resistances (SVR).

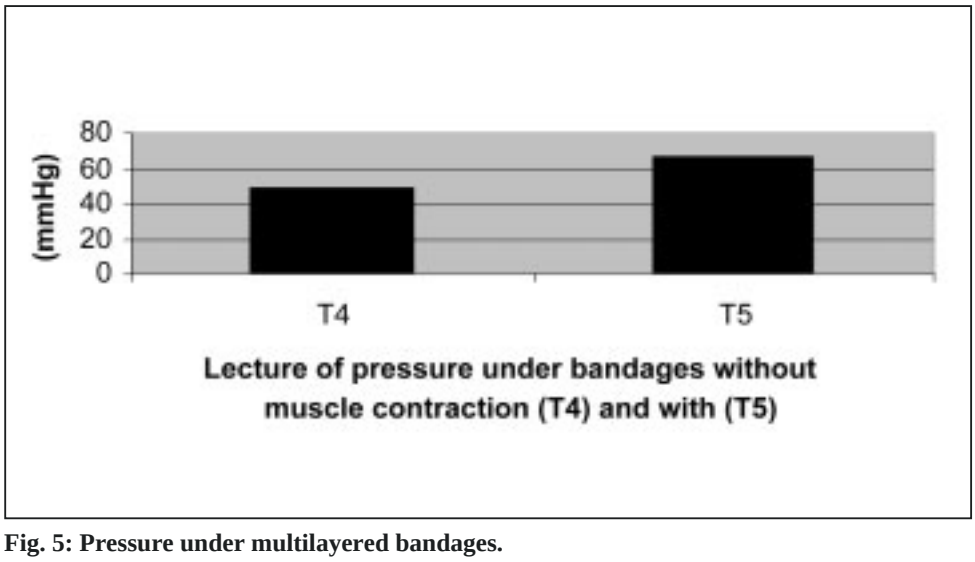

Fig. 5: Pressure under multilayered bandages.

COMMENTS AND DISCUSSION

Concomitant multilayered bandages leg dressing and muscle contractions (fig 1, T5) induce significant increase in right atrial pressure (RAP) of our severe heart failure patients. This rise in RAP may be explained by the enhanced venous return to right sided heart which induces subsequent increase in right ventricular preload. Heart rate, cardiac index and systolic index remain stable all along the experiment which might suggest that the failed hearts are unable to adapt to an increased preload. Unlike we observed a rise in MPAP (fig 2, T2: 30,8 mmHg), also SPAP (T2: 48,6 mmHg, T5: 50,2 mmHg), DPAP (T2: 22,2 mmHg), suggesting that right ventricular afterload was consequently increased. The significant rise in PWP (fig 3, T2: 23,6 mmHg, T5: 23 mmHg) and DPAP (T2: 22,2 mmHg) is an indicator of enhanced left ventricular preload and in some case PWP reaches the level of pulmonary oedema (PWP ≥ 25 mmHg). Rhythmic muscular contractions of the multilayered bandages leg are thus responsible for a significant elevation of pulmonary pressures including PWP. The same phenomenon was however already observed merely by muscle contractions without bandages dressing. We've controlled pressure of placing of the multilayered bandage and found that mean value of pressure under the bandage increased from 49,2 ± 11,5 mmHg (fig 5-T4) to 67,2 ± 22,1 mmHg (fig 5-T5) with muscle contractions, in accordance with the concept of multilayered bandaging.

PVR do not change significantly during the experience while SVR were significantly increased at T5 (fig 4, 1664 dynes.sec.cm-5) together with significant rise in DB, SBP and MBP exhibited also some changes which did not reach the significant level. These significant changes in SVR observed at T5 might be induced by multilayered bandages dressing and muscle contraction responsible for an increase in left ventricular afterload.

Double product was also significantly increased during the experiment mainly at T5 (109,16 mmHg, initial value was 96,28 mmHg/min) and it is an indirect sign of unfavourable increase in left ventricular oxygen requirements which might be deleterious in these severely disabled patients. Respiratory rate increased significantly at T2 (29,6 thoracic movement/min, initial value was 22,4 /min) but not at T5 while PWP enhancements were comparable. It might thus rather suggest patient's apprehension than dyspnea. Other variables remained stable during the experiment. At T7, all the modified variables returned to initial steady state values proving that the hemodynamic changes were only transient and linked to the dynamic procedure and without any remaining deleterious effect.

CONCLUSION

This experiment was limited by the small number (n=5) of studied patients. Nevertheless, it disclosed a significant effect from multilayered bandages leg dressing and muscle contractions on transient deterioration of right and left ventricular functions both with a rise in preload and afterload. Subsequently, waiting for further results, we believe that it is recommended to limit the use of these multilayered bandages in severe heart failure patients. The limitation might even be more relevant in patients suffering from lower limb oedema where the amount of blood return might be much greater.

To complete the analyse of hemodynamic response to any compressive therapy, effects of elastic garments on cardiovascular function would be the subject of our further investigations.

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THE EUROPEAN JOURNAL
OF
lymphology
and related problems
VOLUME 15 • No. 45 • 2005
INDEXED IN EXCERPTA MEDICA

ANGIODYSPLASIC MACROPODIA
AN EXAMPLE OF A CONGENITAL CORPORAL SEGMENTARY HYPERTROPHY

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SUMMARY

We analyze the concept of congenital angiodysplasic macropodia, induces by or with a vascular malformation. This dismorphy means one or both feet hypertrophies, the real one with bone increase, which is express as a foot bigger than the other, proportionally harmonic, in opposition to the other out of proportions, nonharmonic.
Is angiodysplasic because is in association with one or more malformations of the three vascular system, and congenital, present since birth and genetically conditioned or not.
We analyze the necessity to get a similar volume of both feet, to wear a pair of shoes and to bring comfort to the patient.
We propose a surgical technique to achieve these objectives. With this surgical technique, for more than 25 years, we had have good results. This good results are an adequate stability, the absence of symptoms, the reduction of signs and the possibility to wear symmetric shoes. The previous dismorphy will be been part of the corporal diagram of the patient.

KEYWORDS: Macropodia, Angiodysplasia, Hypertrophy, Somatic Overgrowth.

INTRODUCTION

Segmentary corporal hypertrophy means volume increase of a corporal segment, with bone enlargement. It can be harmonic or nonharmonic, in relation to the normal proportions (1). It can be observed like a growth discrepancy uni or bilateral. None of this mentioned characteristics correspond to (match with) lymphedema, but to another malformations of the lymphatic system.
In pediatrics, the volume increases of the foot, as a congenital hypertrophic macropodia, angiodysplasic or not, has an enormous medical, physical and psychosocial meaning (2), which may restrict the education or the social integration of these patients. That why is the reason of frequents analysis and therapeutic proposals. (3)
The bone growth increase occurs during the general growth increase of the others tissues, with or with out edema. If it is only a bony increase, it is nonharmonic and means a real bone pathology. If it is only a soft tissues increase (of all or some of them), it is a pseudohypertrophy, disharmonic, with alteration of the proportions.
The 1st case, is observed at querubinism, osteopetrosis (4), Marfan Syndrome (S) or similar, bone tumors in general, bone vascular malformations, eg: Maffucci S. (5), Gorham Stout Haferkamp (6), dyschondroplasias, Klippel Trènaunay S., Proteo S. (7), among others.
The 2nd case belongs to soft tissues tumors, like sarcomas; vascular malformations, adipose tissue dystrophies or dysplasias, adipose tissue tumors, eg: lipobastomas (8); and edemas (9).
The real harmonic hypertrophy is an hemicorporal hypertrophy, eg: Wiedemann Beckwith S. (with others anomalies and pathologies associated: Wilms tumor, macroglossia, umbilical hernia), and simple corporal hypertrophies in which is very difficult to establish which is the normal side, even more in a society like ours plenty of different racial types; possibly up to 20% of the patients present any tumoral pathology (eg neurobastomas, hepatic carcinomas, ovarian teratomas, suprarenal simple homolateral cyst, nesidioblastoma.

If the hypertrophy affects only a corporal segment, like a finger or a foot; the diagnosis will be clear and the therapeutic considerations will be the same for others pathologies mentioned. The not proportional increase of the tissues is observed in the Big Angiodysplasic S. (BAS), which not exclude others pathologies, but is dominant.
We respect the classifications, eg: biological (J. Glowcki and J. Mulliken (10)) accepted by ISSVA consensus: vascular tumors and malformations; vascular anomalies (Hamburg 1988), and its modifications (11); the anatomofunctional classification (12) (CM Papendieck 1989) (CMP); and the concept of low flow and high flow vascular malformations (13) (J. Mulliken, Boston); important for the therapeutic vascular focus.
The CMP classification (Buenos Aires-1989) interpret the 1st classification and add three physiopathological aspects: the tumoral form, the distributive form, and the functional form, which permit to include concepts like lymphangioleiomiomatosis, arterial fibromuscular dysplasia (14), angioneurosis, venous or lymphatic disvalvulation, cirsoid aneurysm, among others.
The growth asymmetric discrepancy, uni or bilateral is important according to the corporal segment implicated. In this presentation the objective is the foot.
The foot gives the possibility of an erect attitude; the function of the foot is define by 27 bones and its articulations and muscles. There are three support's points (Haller Support Tripod), essential for a correct podal attitude. Different fibromuscular arches keep the balance between this three support's points, and share out the weight.
The volume discrepancy – macropodia – is a medical subject, and needs a diagnosis. It is a physical subject because an asymmetric support means instability, and for that reason the hip suffers; these patients could not use common shoes. Only those who have this pathology know what really it is.
This pathology is seen at the beach, is hidden with clumsy shoes, and is suffered like a malformation or a handicap.

With all this considerations and face to the traditional denominations, there are the BAS (15), in which group it can stand out the Klippel - Trènaunay S. like the description of both authors or its variables, eg: Servelle. Osteo-hypertrophic varicose angiomatosis, with venous hypertension, phlebectasias and varicous veins. At the Klippel Trènaunay Weber S. , in pediatrics, that is different. The phlebectasias are constant at the Klippel Trènaunay Servelle S. with distributive anomalies of the venous system, eg: E. Ayas marginal vein or AF. Albanese's fetus embryonic and permeable vein; or at the Proteo S. , the troncal veins doubling or agenesia, eg: cava, iliac, yugular, etc., that means a superficial venous circulation anomaly, characteristic as well in some facomatosis, eg: plexiform neurofibromatosis type II, verrucous angiomas, and flat facomas cafe-au-lait.
The deep venous hypertension since fetus embryonic period is expression of an almost inevitable association with a lymphangioadenodysplasias (LAD I,II, LAAD) (16). Flat angiomatosis is a constant sign of a S. (eg: Klippel - Trènaunay Weber S.), but the tuberous form is present in some of them (eg: Klippel Trènaunay Servelle S. , Proteo S. , Maffucci S.).

THERAPEUTIC PROPOSAL

This proposal contemplates an specific pathology approach, in accordance with the foreseeable biochronogram, which determine the macropodia type. In pediatrics, we must correct or temper the wide and thick foot discrepancy, and some times, if it is necessary the length. But the only way to correct the foot in length is sacrificing digital segments, only one or several. So for that reason come up a new podal dismorphy, but with the possibility to wear a pair of shoes.
This correction is achieved with surgery, but respecting the normal arches and supports points of the foot (anterior and lateral).
In summary, it must been correct initially two aspects:

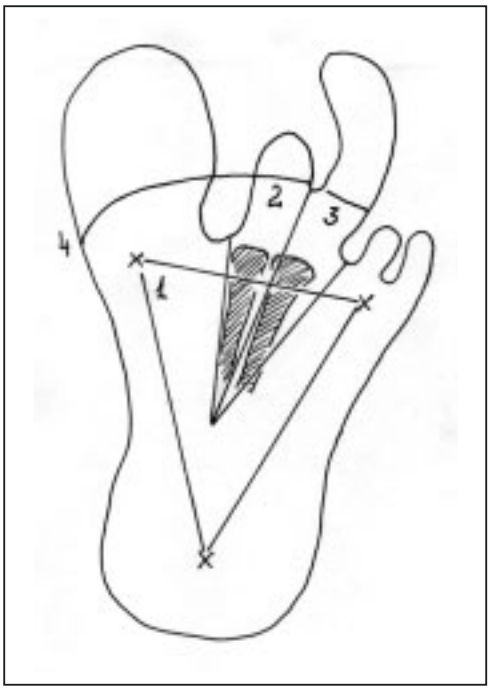
A - The correction of the podal vascular malformation, locally and/or in an etiopathological level, separately or included in B.

B - Resective surgery to correct the foot in wide, thick and length.

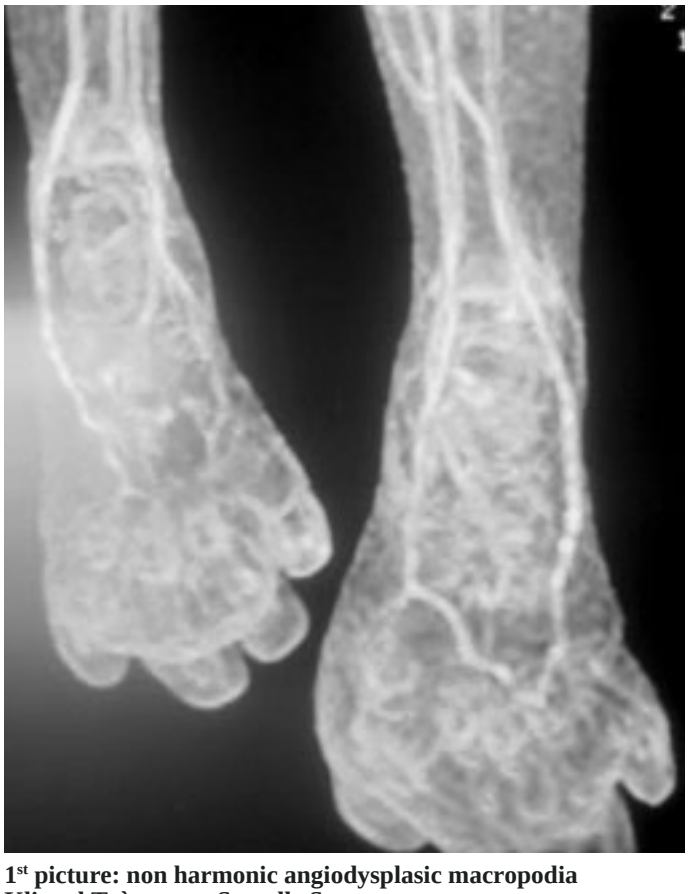
The wide can be corrected with a medium digital radio resection, preferably which one that the macrodactylia is included on, and even more a clinosindactylia. Digital radio means also, the metatarsal level, generally incomplete, to preserve the stability.
If the macrodactylia involve only one finger, generally with clinosindactylia, will be preferable the resection of the phalanges, from distal to proximal and not a medial phalange with vascular graft of the distal phalange (apparently better to preserve the nail). If the distal phalange is lost, the finger will be shorter.
Clearly sometimes, is necessary to resect two or more fingers, that way we always operate on in consecutive times, an excessive amputation is impossible to correct.
The macropodia is associated, generally, with others hypertrophies or pseudohypertrophies of the limb, of course this associations must be considered and treated (venous banding , staples, struts, transitory epiphiseal arrest, metaphiseal scraping, among others). In all these cases the age of the patients is very important. Length considerations are relevant if the discrepancy is greater than 3 cm. (final figure). Normative bone's measurements are put it into statistical tables, that allow to expected this detail (eg: Moseley's table).
We wish to include here all the considerations in relation to primary lymphedema, angiomas in general, cirsoid in particular, phleboangiomatosis and lymphangiomatosis, both low flow. This two subjects are very difficult, in the 1st case the presence of phlebolits; and in the 2nd case the possibility of futures endothelial neoplasias. The hypertension at the lymphatic circuit may result in angiosarcomas (Steward Treves S.).

When the increase of the foot volume is real, because there are a bone increase, the cuneiform resection could be performed at any age, been more aggressive the older the patient is. The same criterion is valid for others dismophies, like supernumerary fingers duplication, sindactyilia and consequently clinodactylias.
The multifocus metaphiseal scraping to small bones, generally leads to instability. The medial macrodactylia resections, with lateral conservation, sometimes cause shoes discomfort.
The volume increase in expense of the soft tissue increase, in general requires more than one surgery, with previous studies of the vascular circuits, with an angio-MRI.
Lymphatic manual drainage, bandages, elastic shoes, could be necessary during the adaptation, after surgery.

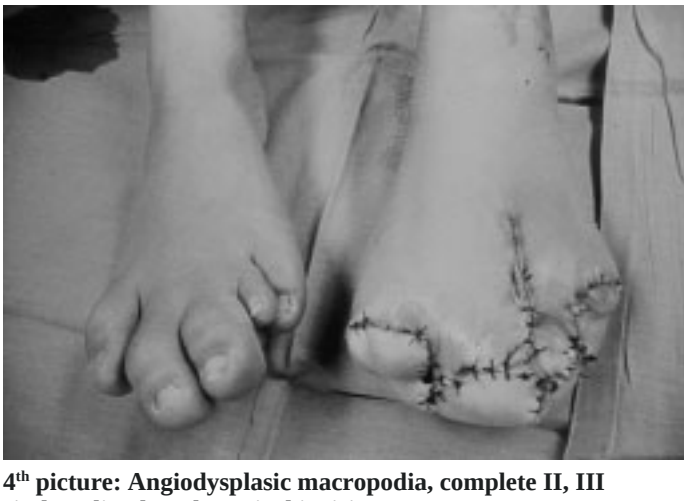
The aesthetic result, in general, is not satisfactory, but the functional one is adequate. It is difficult to assume, like parents or patient a hypertrophic dismorphy, harmonic or not from one or both feet (18).
Educate a child in the real context of this pathology; require a complete medical attention, with clinical, surgical, orthopedical, angiological, physical therapy, and of course psychological special attention. Possibly the angiological pediatric aspect is the most bereft of all, and the pedagogical one is an objective to assume for an adequate social integration of this patients.



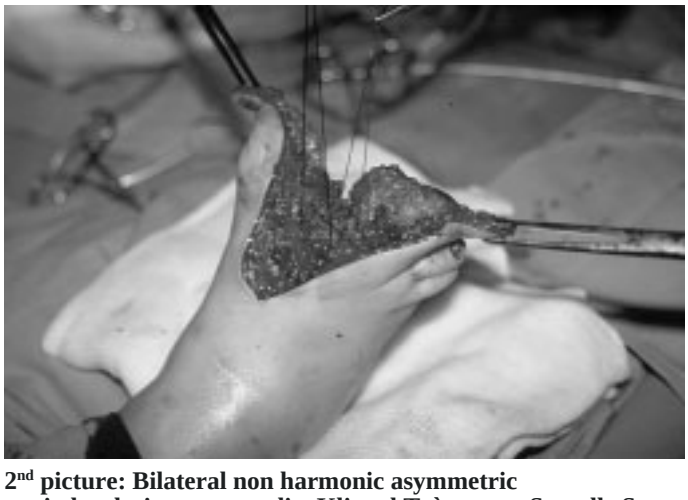
3rd picture: 2nd picture with an angio-MRI.



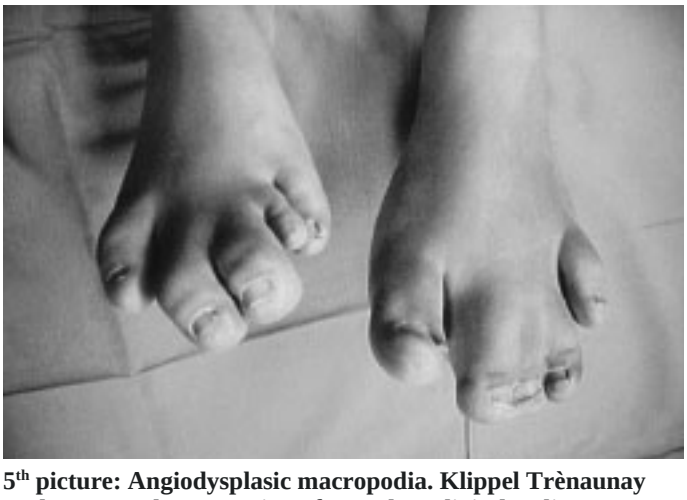
1st picture: non harmonic angiodysplasic macropodia Klippel Trènaunay Servelle S.



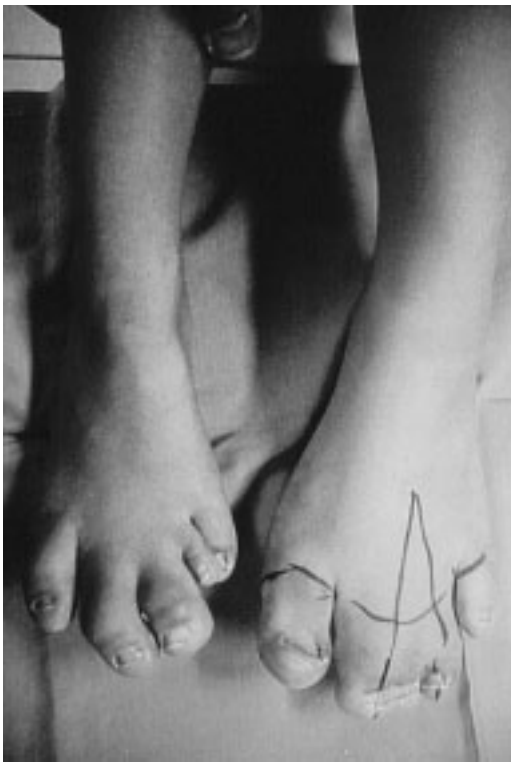
4th picture: Angiodysplasic macropodia, complete II, III sindactylia. dorsal surgical incision.



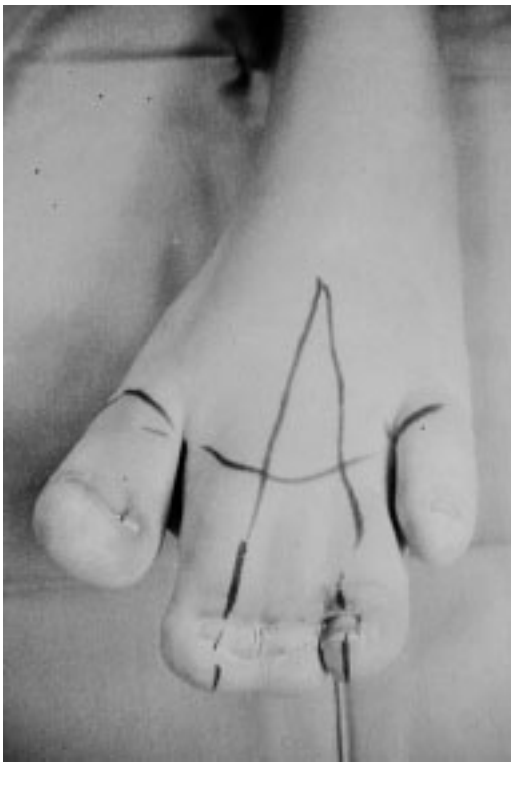
2nd picture: Bilateral non harmonic asymmetric angiodysplasic. macropodia. Klippel Trènaunay Servelle S.



5th picture: Angiodysplasic macropodia. Klippel Trènaunay Weber S. Wedge Resection of II and III digital radius.



6th picture: Macropodia 4th picture: 1st surgical resective time.



7th picture: Design of possible and proposed incisions.

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THE EUROPEAN JOURNAL
OF
lymphology
and related problems
VOLUME 15 • No. 45 • 2005
INDEXED IN EXCERPTA MEDICA

CUTANEOUS DRAINAGE LYMPHATIC MAPPING WITH INTERSTITIAL MULTIDETECTOR-ROW COMPUTED TOMOGRAPHIC LYMPHOGRAPHY USING IOPAMIDOL

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Proposed: May 2005 - Revised: July 2005 - Accepted: August 2005

ABSTRACT

Objective: *To evaluate the feasibility of the technique of multi-detector computed tomographic lymphography (MDCT-LG) with cutaneous injection of iopamidol for mapping cutaneous drainage lymphatic pathways.*

Methods: *MDCT-LG was obtained with cutaneous injection of a total of 1ml iopamidol at bilateral hind legs in 10 dogs. The locations of the first drainage lymph nodes (FDLNs) were marked on skin under MDCT-LG guidance. Five of these dogs were served for postmortem LN examination, and the remaining 5 dogs underwent MDCT-LG 7 days after surgical ligation of the afferent LVs of popliteal FDLNs. Clinically, MDCT-LG was attempted in 5 patients with cutaneous melanoma, compared with lymphoscintigraphy.*

Results: *MDCT-LG clearly visualized drainage lymph vessels (DLVs) and FDLNs from the injection sites on detailed underlying anatomy in all dogs. All 11 FDLNs of 10 dogs could be found or resected at predicted locations. After ligation of the afferent LVs in 5 dogs, MDCT-LG showed rerouting and increases of DLVs directing to inguinal or pelvic LNs. MDCT-LG also clearly visualized DLVs and FDLNs from cutaneous tumors; where lymphoscintigraphy misinterpreted the number of FDLNs in 3 patients.*

Conclusions: *This technique can provide detailed anatomy of cutaneous DLVs and sentinel LNs in cutaneous melanomas.*

KEYWORDS: Lymphatic pathways, Computed tomography, Lymphography, Contrast agent, Sentinel lymph node, Cutaneous neoplasms, Malignant melanoma.

INTRODUCTION

Surgical biopsy of the first drainage lymph nodes (FDLNs, i.e., sentinel lymph node, SLNs) encountered on the direct lymphatic vessels (LVs) from primary tumors is now becoming a standard practice for accurate staging and prognostic prediction of the disease and for minimally invasive surgery in cutaneous malignant melanomas (1-4). At present, SLN mapping and biopsy usually uses a lymphoscintigraphic technique with/without blue dye (3-13). However, in a scintigraphic method, the direct connection of SLNs and the drainage LVs (DLVs) from tumor sites and accurate location/number/size of primary SLNs can not be always confirmed due to poor spatial resolution of the images (6, 7, 10). Deep SLNs may be not delineated sufficiently due to photon attenuation effect in the body tissues (6, 8-10). Gamma probe survey has a difficulty in detection of SLNs close to the injection site of radiotracers because of shine-through radioactivity (7, 10). A blue dye is not able to objectively depict the direct lymphatic routes to SLN especially in fat-abundant tissues (7, 9). There is a risk of labeling non-SLNs due to further migration of radiotracers or blue dye (9). For an alternative technique, we recently developed a technique using multidetector-row computed tomographic lymphography (MDCT-LG) with interstitial injection of the widely-available, safe, water-soluble iodine contrast agent of iopamidol (14-18). In a group of breast cancer patients, the spatially high resolution MDCT-LG effectively localized primary SLNs on underlying detailed anatomy by clearly visualizing the direct connection of these nodes and DLVs from primary tumors, and showed favorable results for intraoperative navigation of SLN biopsy (18). This technique may be also applicable for SLN mapping in patients with cutaneous malignant melanoma. The aim of the present study was to evaluate experimentally and clinically the feasibility of interstitial MDCT-LG with iopamidol

for mapping DLVs and SLNs and for navigation of SLN biopsy in first animals and then as a preliminary study in 5 patients with cutaneous malignant melanoma. These patients also underwent a lymphoscintigraphy to compare with the findings of MDCT-LG.

MATERIALS AND METHODS

Animal study

In accordance with the guidelines for the care and use of laboratory animals (19) and with approval by the institution's animal use and care administrative advisory committee, 10 female beagle dogs [10.7 ± 1.3 kg, mean ± standard deviation (SD)] kept without food for 4-6 hours preoperatively, and were anesthetized with sodium pentobarbital (25 mg/kg, Dai-Nihon Pharmacy KK, Osaka, Japan) and ketamine hydrochloride (20 mg/kg, Bayer-Sankyo KK, Tokyo, Japan). The animals were placed in the supine position, intubated using a 7 mm cuffed endotracheal tube, and connected to a volume-cycled piston ventilator (Harvard Instrument Co., Cambridge Mass.) and set at 15/min with a tidal volume of 15 ml/kg. Small supplementary doses of sodium pentobarbital (total dose ranging from 3.1 to 5.9 mg/kg) were administered intermittently during the experiment as needed.

All these animals underwent MDCT-LG after cutaneous injection of a total of 1 ml of a widely-available, extra-cellular contrast agent iopamidol (Iopamiron-370, Nippon Shering, Osaka, Japan) into the target skin of the bilateral hind legs, as described below. Iopamiron-370 has a molecular weight of 777.09 Daltons, and the solute had an iodine concentration of 370 mg/ml, and an osmolarity of 780 mOsm/kg, a viscosity of 9.1 mPa/sec, and pH of 6.5 ~ 7.5 (20). The location of opacified FDLNs from the contrast injection sites were determined on MDCT-LG by consensus of two radiologists (K. S. and M.O.) with over 3 years experience regarding interstitial MDCT-LG evaluation of breast region, and the skin spots overlying these nodes were marked using a painting pen, using a laser light navigation system equipped with the CT unit. The size and depth of each of these nodes from the skin surface were measured on transaxial MDCT-LG images. Subsequently, 5 of these animals were euthanized for postmortem evaluation of lymphatic anatomy, as described below. In the remaining 5 dogs, MDCT-LG was repeated at 7 days after ligation of the efferent LVs of the popliteal FDLNs to evaluate the rerouting of the lymphatic pathways after lymphatic obstruction. All the animal experiment was performed by three investigators (Yu. K.,Y.Y. and KU) with over 5 years experience for a dog experimental study.

Clinical study

The interstitial MDCT-LG was also performed in 5 patients with cutaneous malignant melanoma (age range: 54 to 74 years) after obtaining the approval of the local ethics committee and informed consent, as described below (Table 1). These patients had primary cutaneous tumors with 1-4mm in thickness and without evidence of any distant metastases at the time of diagnosis. Similar to the animal study, the locations of FDLNs from primary tumors were determined on MDCT-LG by consensus of two observers (K. S. and M.O.), and were marked on skin. The size and depth of each of these nodes from the skin surface were also measured on MDCT-LG. Three days before MDCT-LG, these patients also underwent technetium-99m- human serum albumin (Tc-99m-HSA) lymphoscintigraphy to compare the results of MDCT-LG, as described below (21). Within 7 days after MDCT-LG, these patients underwent tumor resection and regional lymphadenectomy, as described below.

Table 1: Summary of the results in 5 patients with cutaneous malignant melanoma

Patient		Tumor location	Tumor size (mm)	SLN location	No. / Size of SLN identified on MDCT-LG	No. of SLN identified on lymphography	Histologic nodal status of SLN and non-SLN identified on MDCT-LG
No.	Age						
1.	54/M	Lt-foot	19 x 13	Lt-inguinal	2 / 4.6, 5.6 mm	2	SLN (2/2) = Negative non-SLN (6/6) = Negative
2.	70/M	Rt-foot	24 x 14	Rt-inguinal	3 / 4.4, 5.3, 5.5 mm	3	SLN (3/3) = Negative non-SLN (5/5) = Negative
3.	74/F	Lt- foot	22 x 11	Lt-inguinal	3 / 6.4, 8.1, 7.2 mm	5	SLN (3/3) = Negative non-SLN (8/8) = Negative
4.	63/F	Rt-forearm	15 x 13	Rt-axillary	2 / 8.2, 6.2 mm	3	SLN (2/2) = Negative non-SLN (9/9) = Negative
5.	65/M	Lt-forearm	22 x 17	Lt-axillary	3 / 5.1, 7.3, 8.2 mm	1	SLN (3/3) = Negative non-SLN (7/7) = Negative

SLN = sentinel lymph node, MDCT-LG = multi-detector computed tomographic lymphography.

MDCT-LG and Tc-99m-HSA lymphoscintigraphy

MDCT-LG was performed using the MDCT scanner with a 0.5 mm x 4 detector rows (Siemens Volume Zoom, Siemens-Asahi Medical Ltd., Tokyo, Japan). In the animal study, each anesthetized animal was placed in the supine position on the CT table, and the lower legs were tightly and symmetrically fixed with cotton tapes. A total of 0.25 ml of 1% lidocaine hydrochloride was intra-/subcutaneously injected into the target skin of the distal portion of the bilateral hind legs, using a 26-gauge, 5/8-inch hypodermic needle attached to a tuberculin syringe, because a painless injection was favored in clinical setting. After local anesthesia, 1ml of iopamidol was injected intra-/subcutaneously in the anesthetized skin area. The administration dose of iopamidol was determined according to our previous breast MDCT-LG study in dogs (15). The contrast injection sites were gently massaged for 30 seconds to facilitate migration of the contrast agent to DLVs (15). Contiguous 2 mm-thick transaxial CT images from the feet to inguinal regions were obtained once prior to administration of the contrast agent and just after massage of the injection sites. The CT scanning was operated at 120 kV, 100 mA, and a 32-cm field of view, 512 x 512 matrix, section spacing of 3 mm, and table speed of 1.53 mm/0.5 sec. The number of sections was individually adapted to ensure coverage of the regions of interest and ranged between 51 and 61, and the acquisition time ranged from 38 seconds to 46 seconds. Then, multi-planar reconstruction (MPR) and three-dimensional (3D) surface- or volume-rendering maximum intensity projection (MIP) images were reconstructed from the 1.25 mm-thick post-contrast CT images.
In 5 of 10 dogs, MDCT-LG was repeated at 7 days after ligation of the efferent lymph vessels of popliteal FDLNs to evaluate lymphatic rerouting. In these animals, a 0.5 ml of 5% patent blue dye solution (Kanto Chemistry KK, Tokyo, Japan) was injected into the same skin areas of the contrast injection to stain the lymphatic pathways. Under sterile conditions, 3 cm incision was made in the popliteal region along the skin marker overlying popliteal FDLNs. After identifying the popliteal FDLNs, their efferent LVs were ligated with a silk thread.
In patients with cutaneous melanoma, Tc-99m-HSA lymphoscintigraphy was performed 30 min before MDCT-LG. After a local anesthesia with injection of a total dose of 0.25 ml of 1% lidocaine hydrochloride at 4 skin areas surrounding primary neoplasms, a 0.3 ml of 111MBq Tc-99m-HSA was injected intra/subcutaneously into these peritumoral areas, where, the volume of the radiotracer was almost equally divided between these 4 target areas (21). Then, dynamic scintigrams were obtained with an interval time of 30 seconds during 10 minutes after injection of the radiotracer. The hot spots of FDLNs were marked on skin under guidance of lymphoscintigraphy, by consensus of two radiologists (Ya.K, K.S) with over 5 years experience regarding lymphoscintigraphic evaluation. For MDCT-LG, a total of 2-5 ml of iopamidol was administered into the same 4 peritumoral areas, where, the contrast volume was also almost equally divided between these target areas. The administration dose of iopamidol was determined according to our previous breast MDCT-LG study in humans, and was varied according to the distance between the expected FDLNs and the injection sites in each patient. CT scanning covering the expected location of FDLNs was performed once prior to contrast injection, and just after 30 seconds massage of the injection sites. The CT scanning was operated at 100-120 kV, 20-260 mA, with a 45-cm field of view, 512 x 512 matrix, a section thickness of 3 mm and section spacing of 5 mm. The number of sections ranged between 36 and 40, and the acquisition time ranged from 22 sec to 25 sec. The MPR and 3D MIP images were reconstructed from the 1.25 mm-thick post-contrast CT images, similar to the animal study. All the procedures including image processing were completed within 15 minutes both in the animal and clinical studies.

Image interpretation

MDCT-LG in animals and patients was interpreted by the two radiologists (K.S., M.O.) on the image viewer (Yokogawa-GE Medical, Tokyo, Japan) connected to CT scanner. The locations of the opacified DLVs and FDLNs were reported independently by these observers. Visual assessment of enhancement in the structures other than the lymphatic pathways, such as the venous system and muscles, was also performed by these observers. In the animals who received surgical ligation of popliteal DLVs, the alteration of the drainage lymphatic pathways was also assessed by these observers. In the clinical study, the location and number of FDLNs from cutaneous neoplasms were compared between MDCT-LG and Tc-99m-HAS lymphoscintigraphy in each patient, by consensus of these observers.

Resection of lymph nodes

In postmortem examinations of 5 dogs, each animal was placed in the same position as in the CT study. These animals were then euthanized with a 50 mg/kg of sodium pentobarbital for postmortem examinations, and FDLNs identified on MDCT-LG were searched and resected with a small skin incision under the guidance of the skin marker. The number, location and size of FDLNs were compared with those on MDCT-LG by consensus of two observers (K. S. and Yu. K.).
For regional lymphadenectomy in patients with cutaneous melanoma, the surgeons referred to the anatomy of the lymphatic pathways on MDCT-LG to search for FDLNs, with a combined use of blue dye, where, cutaneous injection of a total of 5 ml of indigo carmine dye (Daiichi-seiyaku, Osaka, Japan) was performed into the peritumoral areas. The surgeons took care to preserve the blue lymphatics intact until FDLNs were identified by referring to the skin markers, and evaluated whether these nodes actually corresponded to the compatible position and size on pre-operative MDCT-LG. All the resected FDLNs and other distant nodes were separately sent for histopathologic examination of the serial 1 mm-thick section specimens.

RESULTS

In all 10 dogs, swelling at the injection sites was minor and quickly disappeared during MDCT-LG examination, without any late adverse effects. MDCT-LG showed excellent opacification of DLVs and FDLNs from the injection sites in all these animals (Figs. 1, 2). The lymphatic pathways appeared almost symmetrical between the right and left legs in the majority of the dogs. Among DLVs, the superficial lateral and medial LVs were

most clearly visualized, although the deep medial vessels draining from the large popliteal nodes were visualized only in one leg of one animal. The oval shaped, drainage nodes with greater diameters than those of DLVs were easily identified. The MPR or MIP MDCT-LG images often helped accurate identification of the detailed anatomy of these lymphatic pathways (Figs. 1, 2). As FDLNs, one distal popliteal node and one inguinal node in 12 legs of 7 animals, one distal popliteal node and 2 inguinal nodes in 4 legs of 3 animals, one distal and one proximal popliteal nodes and one inguinal node were found in 2 legs of 2 animals, one distal and one proximal popliteal nodes and 2 inguinal nodes in one leg of one animal, and one distal popliteal node alone in one leg of one animal. The location and numbers of all these 47 FDLNs were consistent between the two observers. Among FDLNs, the size was the largest for the distal popliteal nodes in all animals, with mean size of 22.4 mm +/- 1.7 in diameter (range: 18.4-25.3 mm), whereas the mean size of the remaining nodes was 4.2 mm +/- 1.5 in diameter (range: 3.4-7.2 mm). There was no noticeable contrast enhancement in the muscles and veins at any locations.

In the post-mortem examination of the 5 dogs, all the 23 FDLNs identified on MDCT-LG could be easily found and resected under the guidance of the skin markers in all these animals. The size of these nodes (average;13.7 mm +/- 9.8, range; 4.0-25.3 mm in diameter) was correlated well with those measured by preoperative MDCT-LG (average; 13.4 mm +/- 9.7, range; 3.7-24.7 mm in diameter).

In the remaining 5 dogs who received ligation of the afferent LVs of the distal popliteal FDLNs, various degrees of focal soft tissue swelling were seen at the ligated areas. Compared with the lymphatic pathways before lymphatic obstruction, the distal popliteal FDLNs were not visualized, but, instead, DLVs directing to the inguinal or pelvic nodes was increased in all these animals (Fig. 2).

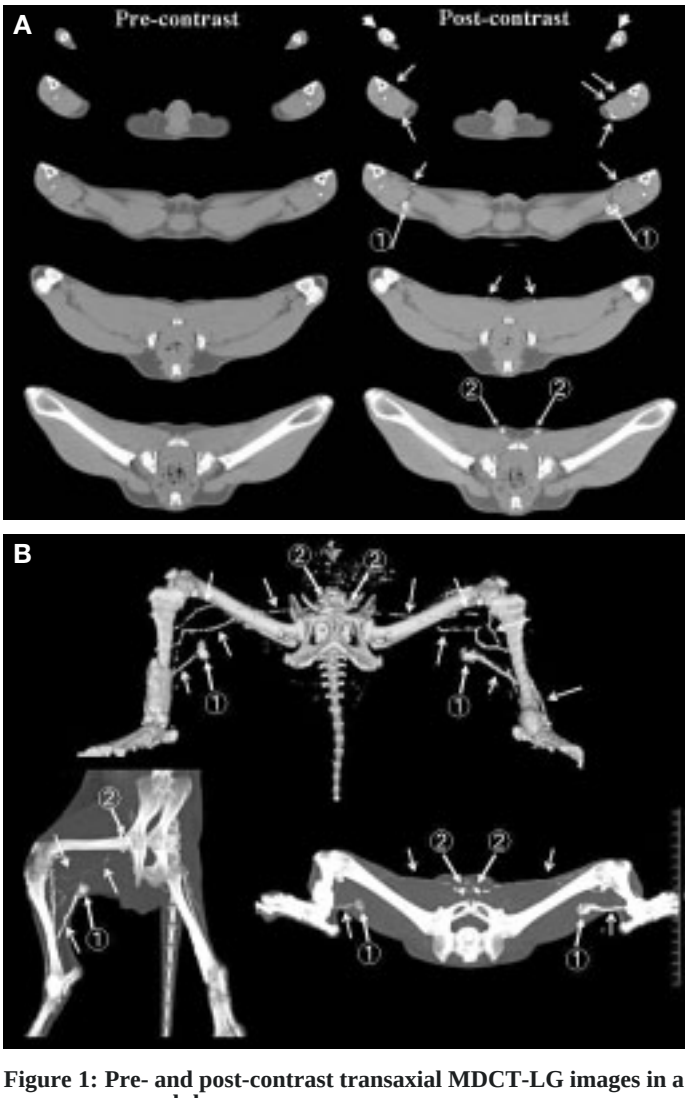

Figure 1: Pre- and post-contrast transaxial MDCT-LG images in a normal dog.

(**A**) Transaxial MDCT-LG images, which are obtained after 30 seconds massage of the cutaneous injection sites of a 2 ml of iopamidol in the bilateral dorsal feet of the hind legs (arrow head), visualize the draining lymphatic pathways. The draining lymphatic pathways are almost symmetric between the right and left legs. The oval shape popliteal (①:⟶) and superficial inguinal FDLNs with direct connection with DLVs (②:→) from the injection site are visualized.

(**B**) Multiple views of 3D surface- (top) and volume-rendering (bottom) MIP and MDCT-LG images reconstructed from transaxial MDCT-LG images provide the detailed anatomy of the lymphatic pathways. The popliteal FDLNs (①:⟶), the superficial inguinal FDLNs (②:→).

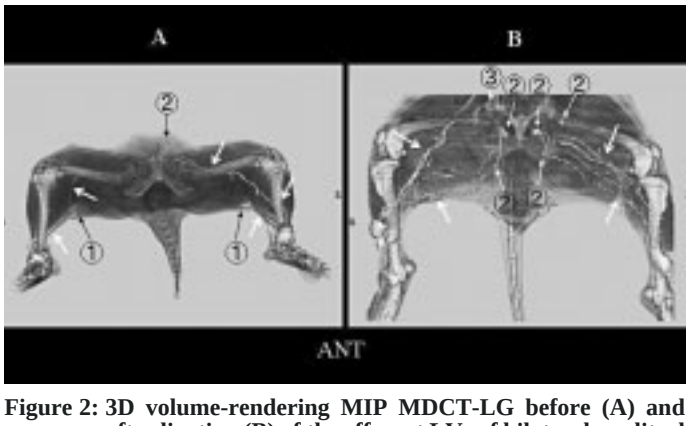

Figure 2: 3D volume-rendering MIP MDCT-LG before (A) and after ligation (B) of the efferent LVs of bilateral popliteal FDLNs in a dog.

On 3D MIP MDCT-LG images before ligation of the efferent LVs of popliteal FDLNs bilaterally (**A**), popliteal (①:⟶) and superficial inguinal FDLNs with direct connection with DLVs (②:→) from the injection site are visualized in the left limb. However, only the popliteal FDLN (①:⟶) and its efferent lymph vessels (→) are visualized in the right limb. After ligation of the efferent LVs bilaterally (**B**), the popliteal FDLNs are not visualized. Instead, DLVs directing to the inguinal nodes (②:⟶) or pelvic nodes (③:⟶) are increased.

Clinical study

In all 5 patients, MDCT-LG clearly visualized DLVs and FDLNs from peritumoral injection sites, without any late adverse effects (Figs. 3, 4). The MPR and 3D MIP images efficiently visualized the detailed anatomy of these lymphatic pathways (Figs. 3, 4). Overall, a total of 13 FDLNs were identified, with a consistency between the two observers (Table 1). The avid opacification of these lymphatic pathways remained for enough time to mark FDLNs externally. Between MDCT-LG and Tc-99m-HAS lymphoscintigraphy, the location of FDLNs appeared to be grossly consistent in all patients, but, there were dissociations in the number of FDLNs in 3 patients (Table 1).

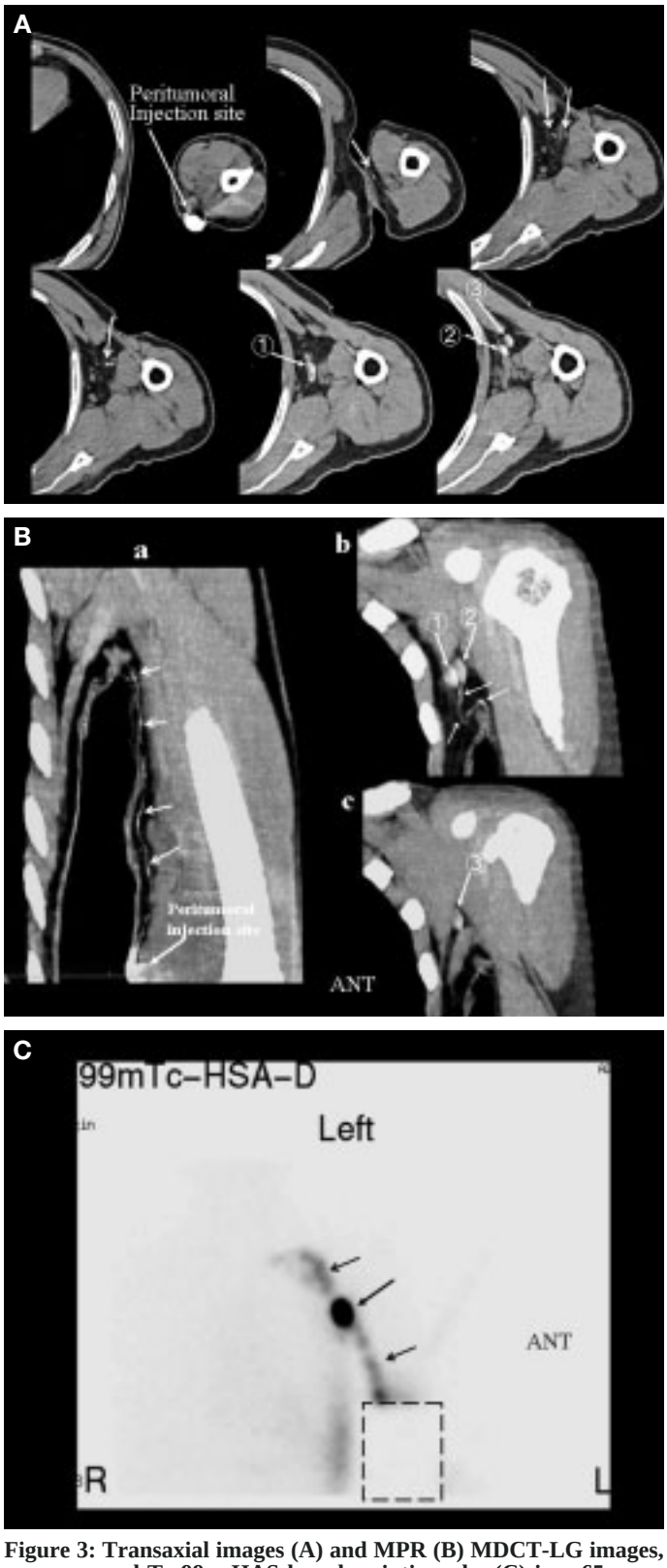

Figure 3: Transaxial images (A) and MPR (B) MDCT-LG images, and Tc-99m-HAS lymphoscintigraphy (C) in a 65-year-old male with melanoma in the left forearm (Patient No. 5 in Table 1).

Transaxial MDCT-LG images (**A**), which are obtained after 30 seconds massage of the peritumoral injection sites of a total of 2 ml of iopamidol, show DLVs (→) directing to 3 different axillary FDLNs (①-③:⟶). MPR MDCT-LG images (**B**; a-c) clearly visualized the complex anatomy of DLVs (→) and FDLNs (①-③:⟶) in the axillary region. On the Tc-99m-HAS lymphoscintigraphy (**C**), regardless of the multiple FDLNs identified on MDCT-LG, only one hot spot (⟶) connecting with the afferent and efferent lymph vessels (→) is seen, probably because of the overlapped radioactivity of these clustered drainage nodes. The dot line square represents the shield for the injection site of the radiotracer.

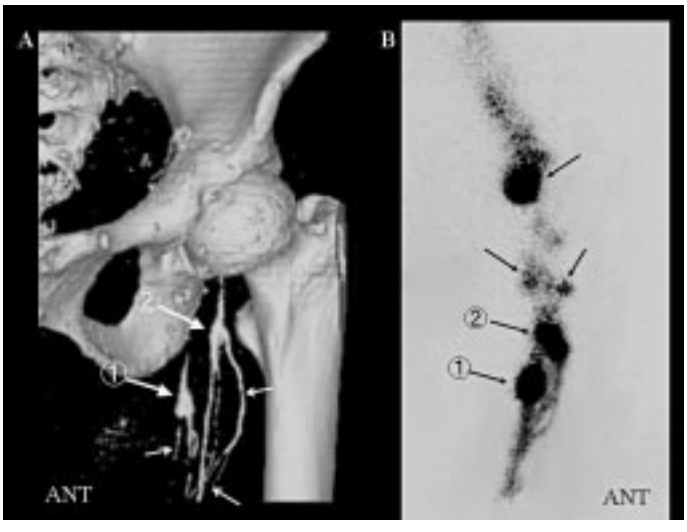

Figure 4: Surface-rendering 3D MIP MDCT-LG image (A), and Tc-99m-HAS lymphoscintigraphy (B) in a 54-year-old male with melanoma in the left foot (Patient No. 1 in Table 1).

3D MIP MDCT-LG (**A**), which is obtained with peritumoral injection of a 5 ml of iopamidol, clearly visualize the direct connection of the multiple DLVs (→) from injection sites and two FDLNs (⟶). On Tc-99m-HAS lymphoscintigraphy (**B**), two hot spots of these FDLNs (⟶) connecting with their afferent and efferent LVs (→) are also seen, with other hot spots representative of the subsequent distant nodes. However, the detailed anatomy of these lymphatic pathways is obscured because of the limited spatial resolution.

During operation, the routes of the blue LVs appeared well consistent with those on pre-operative MDCT-LG, and FDLNs were found at the accurate location under guidance of the skin markers and MDCT-LG in all patients. The size of these nodes (average; 6.5 mm +/- 1.4, range; 4.6 – 8.7 mm in diameter) correlated well with those measured by preoperative MDCT-LG (average; 6.3 mm +/- 1.3, range; 4.4-8.2 mm in diameter). In addition to these FDLNs, a total of 35 other distant nodes were resected (Table 1). Histologically, no tumor metastases were seen in all these resected nodes.

DISCUSSION

The present interstitial MDCT-LG with iopamidol quickly and sufficiently visualized the direct connection of DLVs and FDLNs from the injection sites in dogs and patients with cutaneous melanomas. Although this technique is a pre-operative procedure, these FDLNs could be accurately found at the predicted locations, under guidance of MDCT-LG. Although this is a preliminary study, this technique appears to have the excellent ability for objectively and accurately mapping drainage lymphatic pathways and SLNs and for navigation of SLN biopsy in patients with cutaneous melanomas.

The lymphatic anatomy on MDCT-LG in our dogs appears to be well consistent with that described in the previous anatomic text of dogs (22). The distal popliteal lymph node is the largest node of the pelvic limb and usually double, and the afferent lymph vessels to this node come from all parts of the pelvic limb distal to the

location of this node. Usually, two superficial inguinal LNs lie in the fat fills the furrow between the abdominal wall and the medial surface of the thigh. The afferent vessels to the superficial inguinal nodes come from the medial side of the thigh, stifle joint, and crus. The femoral LN is inconstant and small. Although asymmetric lymphatic pathways between the right and left legs were seen on MDCT-LG in our several dogs, it may be due to the difference in lymphatic route from the contrast injection sites. Although the efferent lymph vessels from the large distal popliteal nodes should exist and drain to the inguinal nodes as described in the previous text, these vessels were visualized only in one leg of our dogs on MDCT-LG. This rare visualization of these efferent lymph vessels on MDCT-LG may be related to slow transit and sequestration of iopamidol in the sinusoids of the large distal popliteal nodes. If more delayed MDCT-LG images were obtained or the greater dose of iopamidol were administered, these efferent lymph vessels might be more frequently visualized. The range of the visualized, drainage lymphatic pathways on MDCT-LG should be affected by the location of contrast injection sites, administration dose of iopamidol and timing of CT scanning. However, the present MDCT-LG obtained at early time after injection of relatively small dose of iopamidol appears to sufficiently reflect the main stream of lymph flow from the injection sites and to be at least effective to identify FDLNs.

Currently, cutaneous SLN mapping and biopsy are most widely performed in patients with cutaneous melanomas, and use a lymphoscintigraphic method with/without a combination of blue dye (6, 9-13). However, this technique has certain limitations (6-10). As seen in our several patients, a lymphoscintigraphy can not predict accurate location/number/size of SLNs because of the limitation of spatial resolutions and the overlapped radioactivity of clustered SLNs (8-11, 14). Spill-over of blue dye and radiotracers from primary SLNs to the subsequent distant nodes also may increase the number of labeling non-SLNs (7, 10). There is no definitive criteria for defining SLNs regarding to the level of radioactivity and blue staining (7, 9, 10). Lymph nodes with the highest radioactivity or blue staining are not necessarily defined as primary SLNs, because radioactivity and blue staining depend on the lymph node size and location (7, 9, 10). Intraoperative gamma probe survey has a technical difficulty in detection of SLNs close to the injection site because of “shine-through” radioactivity (7, 10). Blue LVs are not easily found in the deep, fat-abundant tissue (10). In contrast to lymphoscitigraphic or blue dye methods, the present MDCT-LG appears to more accurately provide the anatomic location and number of FDLNs (i.e., SLN) by visualizing the direct connection between these nodes and DLVs from the injection sites on detailed underlying anatomy. There were considerable dissociations (3 of 5 patients) between the number of FDLNs identified by MDCT-LG and Tc-99m-HAS lymphoscintigraphy, regardless of the current small study population. The feasibility of MDCT-LG for accurate SLN mapping also has been proven in our previous study of the large group of patients with breast cancer (16-18). MDCT-LG is sensitive to detect even small FDLNs surrounded by deep, fat-abundant tissue, and allows accurate identification of these nodes even when the subsequent distant nodes are variably enhanced due to spill-over of iopamidol, as frequently seen in our patients. Although not encountered in our patients, MDCT-LG would allow identification of FDLNs with poor enhancement due to lymph flow rerouting by gross nodal metastases, as has been previously shown in patients with breast cancer (16, 18). In the present study, all the targeted FDLNs could be found and resected at the predicted locations in our animals and patients, although MDCT-LG is a preoperative procedure. The detailed anatomic information of DLVs and the depth/size/number of FDLNs on MDCT-LG appears to contribute to this accurate prediction. This technique may be especially of value for SLN mapping in cutaneous melanomas of the trunk which often show lymphatic drainage to unexpected directions, although the current study did not include this type melanoma (11, 21). Although, we could find the preoperatively- identified FDLNs at accurate locations under guidance of the skin markers in all subjects, relative changes in SLN position pre- and intra-operatively might make this technique less effective especially in the deep-located nodes. The injection of carbon/lipiodol near the identified SLNs under MDCT-LG guidance may resolve this problem, since these agents remain at the injection site for log time and can be visualized intraoperatively by X-ray fluoroscopy.

The lymphatic flow alteration on MDCT-LG in our dogs after lymphatic ligation are consistent with the previous lymphoscintigraphic findings in patients with lymphatic obstruction (23, 24). The increased LVs seen after lymphatic ligation are indicative of accelerated collateral lymph flow or neovascularization analogous to those seen in veins in chronic venous insufficiency (24). MDCT-LG also showed the alteration of FDLNs after lymphatic ligation on several animals. These findings may provide an important suggestion for considering the complications associated with SLN biopsy procedure, because focal lymph edema after SLN biopsy or late nodal metastases after incomplete surgical resection of primary tumors were reported (25-28). MDCT-LG, which can clearly visualize the detailed anatomy of lymphatic rerouting after lymphatic obstruction, may be also helpful for evaluating patients with lymphatic edema in extremities.

Iopamidol is considered to drain from the interstitial space to lymphatic pathways through the thin-walled and fenestrated lymphatic microvessels, similar to other water-soluble low-molecular solutes (14-15, 29, 30). The distribution of iopamidol in the lymphatic pathways may depend on the complex interaction of the administered volume, compartmentalization with flow restriction, the number, size and integrity of associated peripheral LVs and nodes (14-15). The efficient opacification of FDLNs may be related to slow transit and sequestration of iopamidol in the lymph nodal sinusoids. A gentle massage of the injection sites facilitates lymphatic migration and nodal uptake of iopamidol (15). Although iopamidol may partly drain to the venous system, this volume appears to be negligible, as seen in this study. The current procedure of multiple peritumoral injections of iopamidol may be an effective way for accurately delineating the drainage pathways, as most investigators use multiple peritumoral injections of radiotracers in a scintigraphic method (3, 7, 9, 11). Intratumoral injection may be not preferred, because intratumor lymphatics are disorganized and relatively ineffective for lymphatic drainage (7). As shown in our patients with axillary SLNs, MIP/MPR images can simplify the image view of numerous transaxial MDCT-LG images, and may be indispensable to accurately identify FDLNs in cases with complex lymphatic pathways.

The present interstitial MDCT-LG with use of the nonionic iopamidol offers favorable safety and can be performed any time before surgery, within only short examination time (14-18). Interstitial MDCT–LG is also possible using iodinated, lymphotropic nanoparticulates with macrophage phagocytosis property, such as perflubron or chylomicron remnant-like emulsion (31-34). However, the majority of these contrast agents show delayed maximum nodal enhancement between 4 to 24 hours after administration, and barely visualize DLVs (31-34). Furthermore, none of these agents are not yet commercially available, and their safety profile remains unknown. Lymphatic mapping and SLN biopsy may be also possible using interstitial magnetic resonance (MR)-LG using a gadolinium contrast agent without radiation exposure for patients, as has been shown by several pilot studies (34-37). However, the ability of MR-LG for accurate localization of SLNs in cutaneous melanoma has not yet been established.

In conclusion, this initial trial study indicates the potential ability of interstitial MDCT-LG with iopamidol for SLN mapping in patients with cutaneous melanoma. The excellent visualization of the direct connection between DLVs and FDLNs (i.e.SLNs) and the location/number/size of these nodes is of value for navigation of SLN biopsy. This technique may be also useful for evaluating complications associated with SLN biopsy procedure. Since a MDCT scanner is recently introduced in many hospitals, this technique can be expected to be widely used for SLN mapping and navigation. However, in this small population study, we could not confirm the accuracy of SLN biopsy using this technique, because metastases were negative in all resected LNs including pre-operatively identified SLNs. Further study is warranted to validate the clinical efficacy of this technique, compared with lymphoscintigraphic/blue dye methods.

ACKNOWLEDGEMENTS

This study was supported in part by a Grant for Scientific Research (16591206) from the Japanese Ministry of Education, Science, Sports & Culture.

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THE EUROPEAN JOURNAL
OF
lymphology
and related problems
VOLUME 15 • No. 45 • 2005
INDEXED IN EXCERPTA MEDICA

ELECTROMYOSTIMULATION COMBINED WITH INTERMITTENT PNEUMATIC COMPRESSION

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Proposed: March 2005 - Revised: May 2005 - Accepted: July 2005

ABSTRACT

Purpose: *to contribute to the study of the intermittent pneumatic compression (IPC), the authors aim to verify whether electromyostimulation (EMS) or ICP coupled with EMS favours the resorption of injected labelled proteins.*

Method: *an injection of 2ml H.S.A.-Tc^{99m} 0.5m Curie on the anterior side of the two forearms into the subcutaneous or in the intradermal space is realised on 12 young healthy men. After injection the axillary lymphnodes activity is counted each 20'. The protocol includes alternately periods of 20 min each: rest, EMS, rest, EMS + IPC, rest.*

Results: *No statistical significance has been revealed in the comparison of the different phases of the protocol*

Conclusion: *ICP, even combined with EMS, does not help the resorption of proteins concentrated in the subcutaneous tissue. In lymphoscintigraphic studies aiming at the evaluation of the IPC it seems highly important to control the modalities of the injected solution and the physical parameters of the IPC.*

KEYWORDS: Intermittent pneumatic compression, lymphoscintigraphy, protein resorption, injection modalities, pressure control.

INTRODUCTION

Intermittent pneumatic compression (IPC) has been suggested in the field of physical treatment of peripheric edema for a number of years.
IPC is known to provide effective prophylaxis against post-surgical deep-vein thrombosis : IPC promoted a significant increase in global fibrinolytic potential (8).
The capacity to increased venous flow velocity has been confirmed by several studies (6).

Our team has shown its efficiency on the resorption of the liquid part of the oedema (13).

In the field of physical treatment of lymphedema, IPC proved to be inefficient as far as the absorption of the macro-molecules is concerned (11).
Some authors have found other results (1,16); in their study the mode of injection of the radio-nucleide wasn't controlled or /and the pressure of the devices has never been controlled on the skin (15,18).

The muscular contraction realised under multi-layer bandages, favours the resorption of proteins (12,7).
One of the physical characteristics of manual lymphatic drainage manoeuvres is the simultaneous traction of the patient's skin, during the oscillating movement of the therapist's hand. This traction is considered useful for the mobilisation of the connective tissue where the initial lymphatics are localised.
The mobilisation brings about an alternation of closing and opening of the zonulae by traction and successive release of the Leak's filaments.
The integration of muscular contraction (17,14) as well as the traction of the skin under a pressurised cuff alternately, could help in the improvement of physical techniques applied to the treatment of oedema.

We are suggesting to realise this integration by subjecting the superficial muscles of the forearm to an infra-tetanic electromyostimulation (EMS) under IPC (10).
Infra-tetanic EMS has the advantage to provoke little jolts that mobilise the skin's surface, creating alternately pressure and depression.
We have tested twelve young healthy men in sessions of EMS only and EMS combined with ICP to whom we inducted a subcutaneous oedema in the area of the anterior forearm muscles,(2) by injecting H.S.A.-Tc^{99m}.

2. METHOD

2.1. Introduction

The below protocol has been accepted preliminarily by the ethics commission of the J. Bracops Hospital where the experiments have been realized.

2.2. Population

We have worked with twelve masculin individuals aged between 21 to 27 years (average 21,6 +/- 0,01). Right and Left arms (3,5) so n = 24.

2.2.1. Criterions of exclusion

Excluded are persons presenting vascular troubles of the upper limbs, traumatic antecedents of the upper limbs or playing volley-ball.

2.3. Material

2.3.1. EMS

2.3.1.1. Device and Electrodes

The EMS machine is of the trademark "Gymna", type duo 400®. We are using two auto-adhesive electrodes of a surface of 12 cm^2; the first is set in regard to the ulnar nerve at the level of its sulcus between the olecranon and the epitrochlea and the motor points of the inflector group of fingers and wrist. The second is placed on the abdomen.

The stimulating power is a rectangular biphasic one of the type T.E.N.S., the chronaxia being fixed at 250 µsec, 10 puls/sec, modulated between 6 and 12 mA, in order to obtain an imperfect tetanus, thus generating a vibration of the anterior muscles of the forearm.
The stimulation lasts for 20 minutes.

2.3.2. Compression therapy

IPC machine (eureduc TP 35 i) with 5 compartments, programmable, with parameters as follows:
Nominal pressure: 30 mmHg; gradient 3 mmHg; inflate time each chambers as necessary to reach nominal pressure.
Sequence: from distal to proximal.
Intercycle rest time: 15 sec.

2.3.3. Experimental edema

The proteic mass which we hope to see to pass in transit by the lymphatic network thanks to EMS combined with compression-therapy, is composed of a subcutaneous or intradermal injection (4, 9) of a solution of 2ml of albumin serum marked at H.S.A.-Tc^{99m} 0.5mCurie on the anterior side of the forearm (distal third).The injection is given into the left and right limbs with an interval of 10 min.

2.3.4. Gamma-camera

Sophy-camera®

2.4. Protocol

The total length of the protocol comes to 100 min.
Every 20 minutes the axillary lymphnodes activity as well as the activity at the injection point are measured with the help of dynamic images: 10 images per 5 sec for the injection sites and a static image of 60 sec for the axillary lymphnodes sites.

At the time "0" the subject gets the subcutaneous injection of the colloid. We measured immediately the activity on the injection area and in the axilla.
After that, a period of 20 minutes rest is respected.
Then starts EMS without compression-therapy during 20 minutes.
Subsequently, another period of 20 minutes strict rest has to be respected before taking up EMS combined with compression-therapy during 20 minutes.
One more period of 20 minutes rest follows this final phase.

2.5. Data and Statistic analysis

The signification of the differences of activity during the different phases of the protocol is analysed with the help of average comparing tests "t student" and paired Wilcoxon rank.

AX0 = first axillary of activity - immediately after injection -.
AX1 = second axillary counting - 20 min after AX0 = end of the 1st 20 min. rest period.
AX2 = third axillary counting - 20 min after AX1 = end of the EMS period
AX3 = fourth axillary counting - 20 min after AX2 = end of the 2nd 20 min. rest period.
AX4 = fifth axillary counting - 20 min after AX3 = end of coupled ICP and EMS period
AX5 = sixth axillary counting - 20 min after AX4 = end of the 3rd 20 min. rest period.

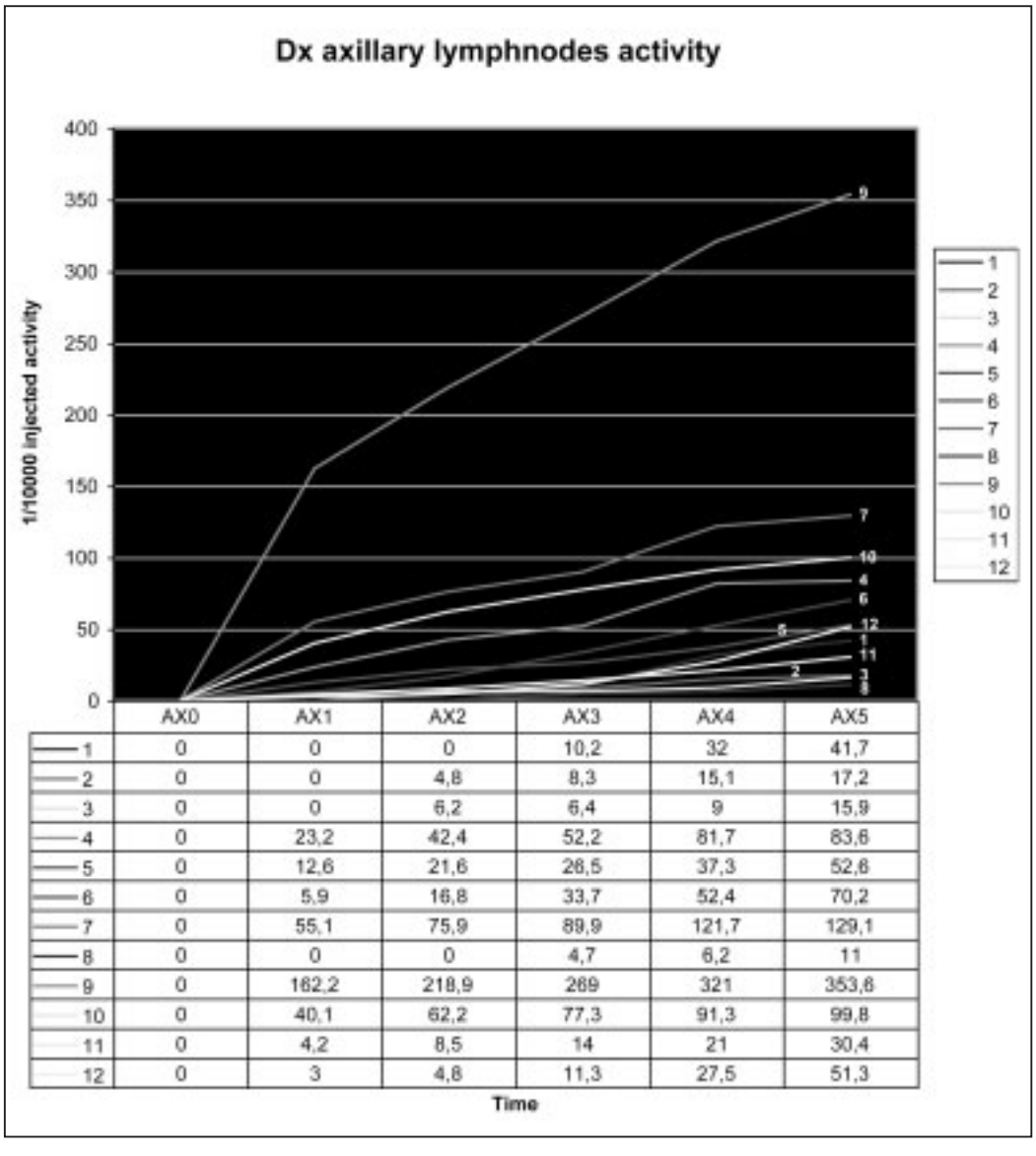
We also compare the curve resulting from axillary lymphnodes activity to a standard curve of passive resorption realised in a former study.

2.6 Distribution of the type of injection

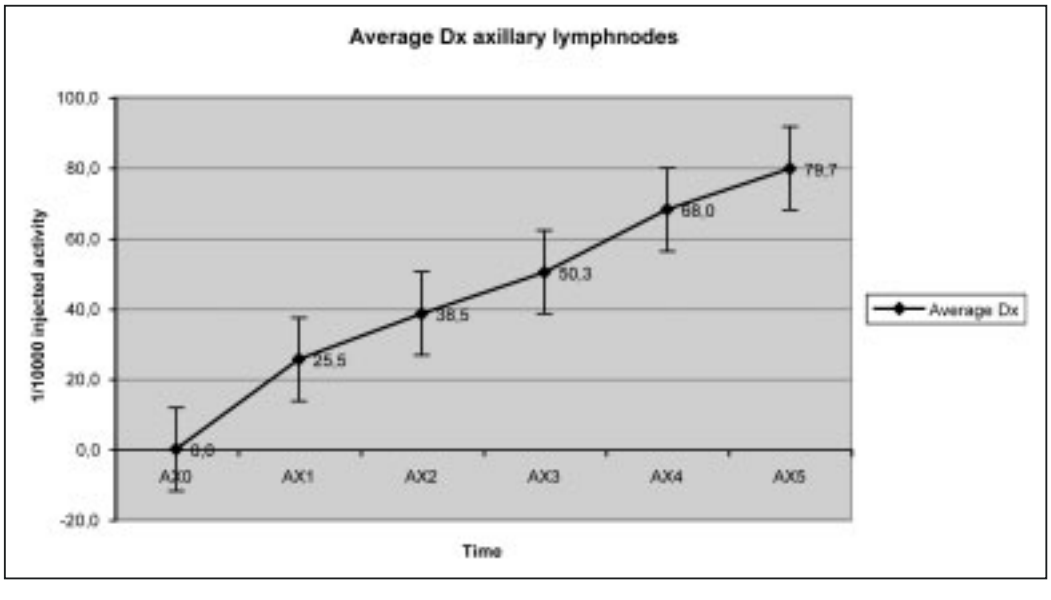
subject	Dx	Sx
1	SC	ID
2	SC	SC
3	SC	SC
4	SC	ID
5	SC	ID
6	ID	ID
7	ID	SC
8	SC	SC
9	ID	ID
10	ID	SC
11	SC	SC
12	SC	SC

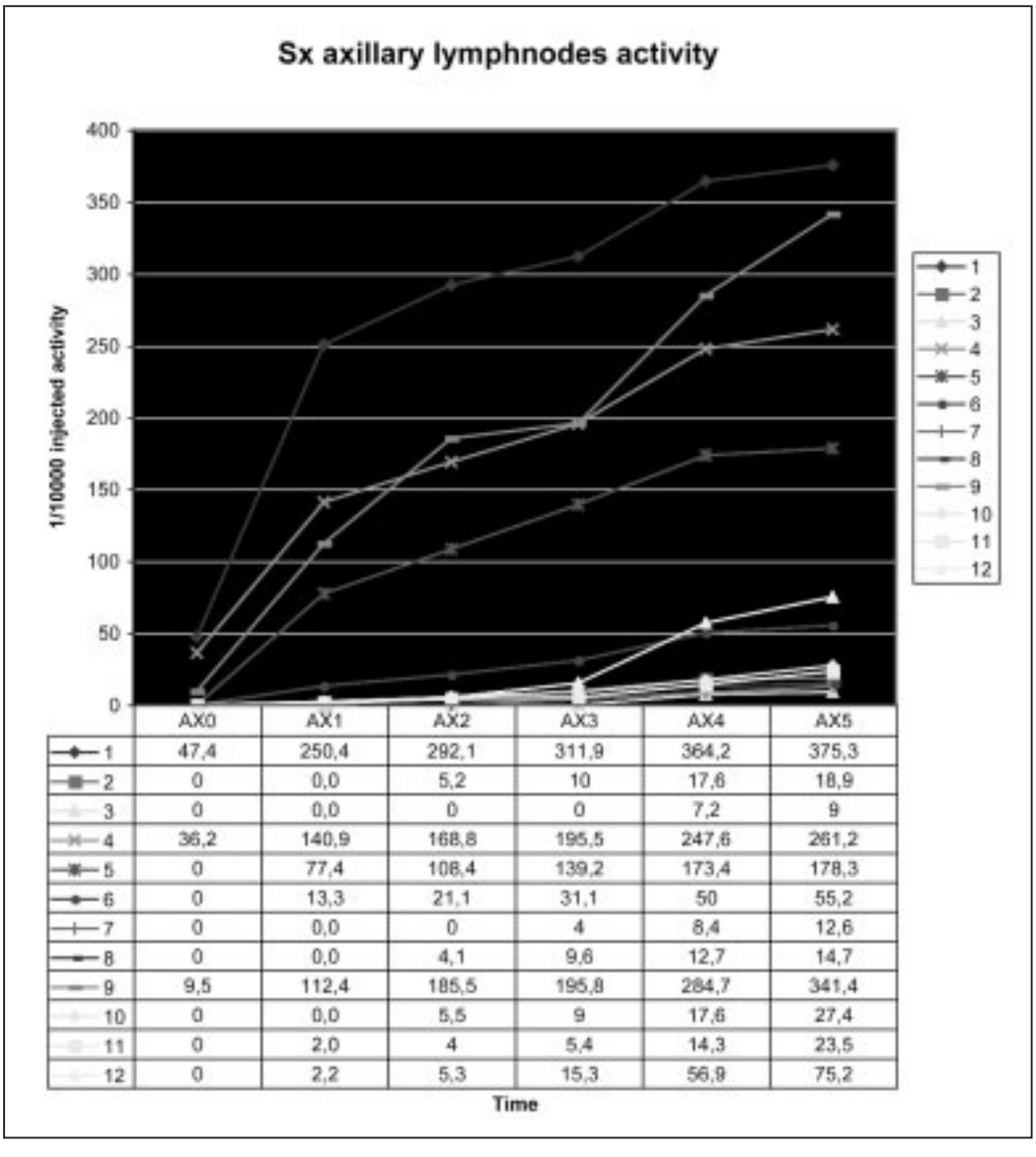
Note:
SC = sub cutaneous injection
ID = Intradermal injection
Dx = right; Sx = Left

ID injection is confirmed by the rise of a vesicle on the skin during the injection.

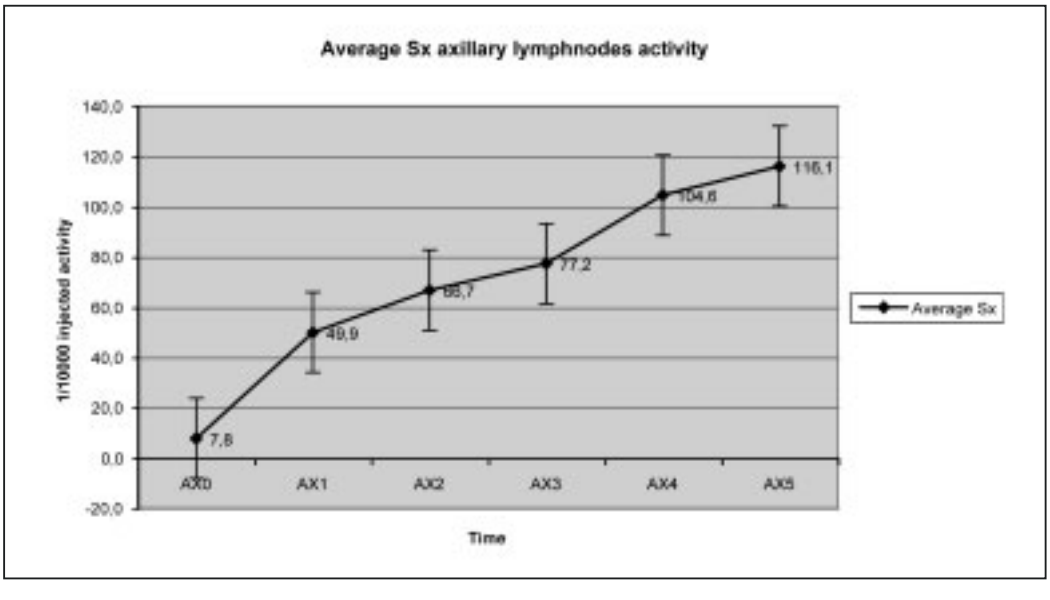


	AX0	AX1	AX2	AX3	AX4	AX5
1	0	0	0	10,2	32	41,7
2	0	0	4,8	8,3	15,1	17,2
3	0	0	6,2	6,4	9	15,9
4	0	23,2	42,4	52,2	81,7	83,6
5	0	12,6	21,6	26,5	37,3	52,6
6	0	5,9	16,8	33,7	52,4	70,2
7	0	55,1	75,9	89,9	121,7	129,1
8	0	0	0	4,7	6,2	11
9	0	162,2	218,9	269	321	353,6
10	0	40,1	62,2	77,3	91,3	99,8
11	0	4,2	8,5	14	21	30,4
12	0	3	4,8	11,3	27,5	51,3





	AX0	AX1	AX2	AX3	AX4	AX5
1	47,4	250,4	292,1	311,9	364,2	375,3
2	0	0,0	5,2	10	17,6	18,9
3	0	0,0	0	0	7,2	9
4	36,2	140,9	168,8	195,5	247,6	261,2
5	0	77,4	108,4	139,2	173,4	178,3
6	0	13,3	21,1	31,1	50	55,2
7	0	0,0	0	4	8,4	12,6
8	0	0,0	4,1	9,6	12,7	14,7
9	9,5	112,4	185,5	195,8	284,7	341,4
10	0	0,0	5,5	9	17,6	27,4
11	0	2,0	4	5,4	14,3	23,5
12	0	2,2	5,3	15,3	56,9	75,2



3. RESULTS

Evolution of the axillary lymphnodes activity

a. the twelve subjects individually

b. average of the twelve subjects

3.1. Comparison of the measured activities at the end of each state of 20 min

The comparison of the measured activities at the end of each state of 20 minutes of the protocol (EMS and compression-therapy) does not indicate any significant difference.
The obliquity of the graphic lines doesn't vary significantly between the 20th and the 100th minute.

• Left side
Comparison rest 20' vs EMS:
AX1 - AX0 vs AX2 - AX1 t = 1,76 → NS
Comparison EMS 20' vs ICP + EMS:
AX2 - AX1 vs AX4 - AX3 t = 3,27 → S

• Right side
Comparison rest 20' vs EMS:
AX1 - AX0 vs AX2 - AX1 t = 1,94 → NS
Comparison EMS 20' vs ICP + EMS:
AX2 - AX1 vs AX4 - AX3 t = 1,90 → NS

3.2. Comparison of these same values with those obtained during a passive resorption (passive protocole)

The comparison of these same values with those obtained during a passive resorption (passive protocol) has been evaluated in a study realised under the same experimental conditions where the strict rest was respected during 100 minutes.
It did not show any significant difference.
After the first 20 minutes of rest, the two curves can be superposed up to the end of the two protocols.

Only the curve of the first 20 minutes of the protocol of passive resorption is steeper.
We think that this difference could be justified by the fact that this protocol includes intradermic injections. It has been shown that during an intradermic injection (because of the effect of tissular pressure) the colloid migrates quicklier into the lymphatic system. This shows how important it is to respect a period of 20 minutes after injection before applying the suggested technique and the modalities of the injection - during the scintigraphical evaluation of physical techniques aiming at the resorption of the protein of oedema.

Further on, taking into consideration the characteristics of the injected solution (, it shows that after 100 minutes a plateau of resorption appears; this period of 100 minutes is therefore favourable for the analysis of the technique pointing to resorbe the edema. Apart from this time limit, it seems not very reasonable to us to draw any further conclusions recording that the majority of the colloid has migrated and reached the axillary area. This could lead to false interpretation of the results.

4. CONCLUSIONS

Under the experimental conditions described before, neither EMS alone, nor EMS combined to compression-therapy favours the resorption of injected proteins in the subcutaneous space of the forearm of healthy subjects.
This study confirms the precedent experimental results, which means that ICP, even combined with EMS, does not help the resorption of proteins concentrated in the subcutaneous tissue eventhough it decreases the volume by eliminating liquid part of the oedema.

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VOLUME 15 • No. 45 • 2005
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PATIENT EDUCATION : SELF CARE

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Proposed: May 2005 - Revised: June 2005 - Accepted: August 2005

ABSTRACT

Lymph-oedema is a chronic disease with evolutionary progression: it is therefore essential that the patient affected should be informed, clearly and simply, about the course of this pathology and the hygienic-behavioural rules to respect. Only motivated and carefully selected patients will be able to learn the simple self-drainage manoeuvres and self-bandaging techniques together with associated isotonic gymnastics. This allows a minor dependency on the rehabilitation equipe and a major psychological acceptance of the disease.

INTRODUCTION

Supposing that lymph-oedema is a chronic and progressive pathology with which the patient must learn to cohabit, highly specialized operators are not sufficient, the patient must cooperate actively and critically towards the disease outside the protective ambit of the treatment room. This collaboration must be intended as follows:

– the acquisition of hygienic-behavioural rules to be carried out routinely every day which should not be considered violations and restrictions, but as the safe-guard of the quality of life;
– the ability to apply easy self-drainage manoeuvres, self-bandaging and self-bandaging associated with gymnastics (self-management).

MATERIAL AND METHODS

Over a period of 4 years we have followed 490 patients (418 females - 72 males) 205 affected with upper limb lymph-oedema (3 primary - 202 secondary) and 285 affected with lower limb lymph-oedema (89 primary - 196 secondary) in our laboratory of lymphology.
It was possible to teach only 10% of the total number of patients the complete combined self-management method (self-drainage and self-bandaging associated with gymnastics), 70% only self-drainage and associated gymnastic, 20% no teaching was possible.

HYGIENIC-BEHAVIOURAL RULES

Following the clinical-instrumental evaluation carried out by the equipe, with subsequent rehabilitation project, a brochure is given to the patient which contains the above-mentioned hygienic-behavioural rules (Fig. 1).

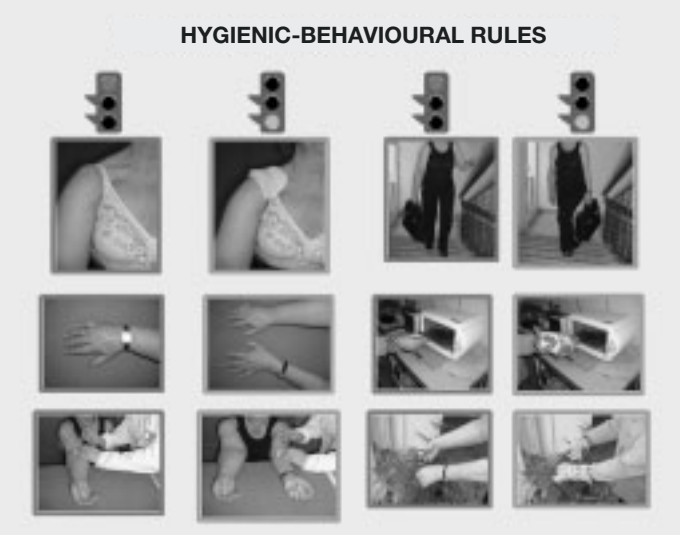

Fig. 1

After this the patient is placed in a group (5/6 patients, two physiotherapists and one psychologist) in which the operators explain to him the anatomy and physiopathology of the lymphatic system and, in depth, the importance of the hygienic-behavioural rules to follow, motivating him to conduct a lifestyle suitable to his pathology.
The patient is also informed on skin care to be carried out normally and immediately after an accident.

COMBINED SELF-MANAGEMENT

The patients learns the easy techniques of "combined self-management" (self-drainage, self-bandaging associated with gymnastics) after having been treated individually and therefore having experimented on his own body both DML and bandaging carried out by physiotherapists.
The number and the frequency of sittings, which are individual, vary according to the attention, manual and mnemonic capacities of the patient (from 3 to 6 sittings).
During the first sitting the patient is provided with a brochure in which the techniques taught are illustrated.

SELF-DRAINAGE

The patient is taught a few manoeuvres which respect the DML sequence; starting with the stimulation of the proximal lymph-node stations (terminus, axillary, inguinal) (fig. 2-3-4) ready to subsequently receive the lymph coming from the periphery area continuing with the stimulation of the watershed (fig. 5) and the alternative ways (fig. 6- 7-8).
The sequence is personalized when requested by the clinical case (eg. bilateral mastectomy, morphological and/or functional alterations on lymphoscintigraphical examination).

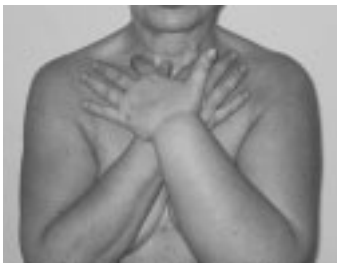

Fig. 2

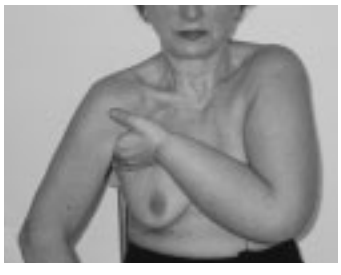

Fig. 3

Fig. 4

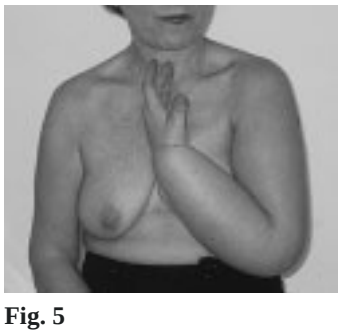

Fig. 5

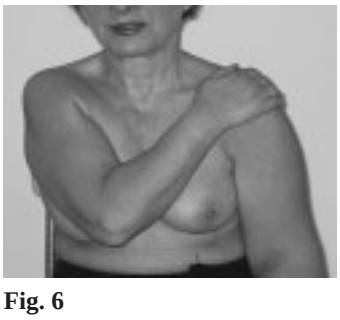

Fig. 6

Fig. 7

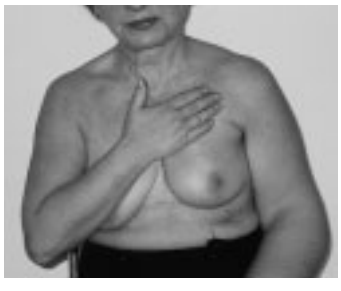

Fig. 8

SELF-BANDAGING

The patient is taught a self-bandaging method which is simplified both for the execution as well as for the number of bandages used (Fig. 9-10-11-12).

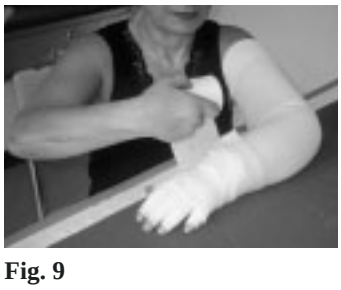

Fig. 9

Fig. 10

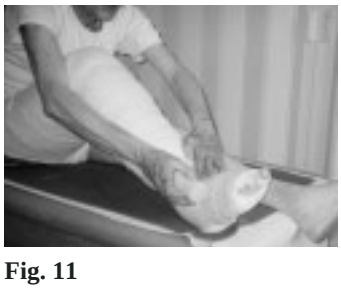

Fig. 11

Fig. 12

SELF-BANDAGING WITH ASSOCIATED GYMNASTICS

After self-bandaging or after putting on the elastic tutor the patient carries out a few selective gymnastic exercises which stimulate venous and lymphatic return which re-enforce the effect of self-drainage (Fig. 13-14-15-16-17-18).

NB - The images shown represent a part of the entire sequence of the various techniques.

Fig. 13

Fig. 14

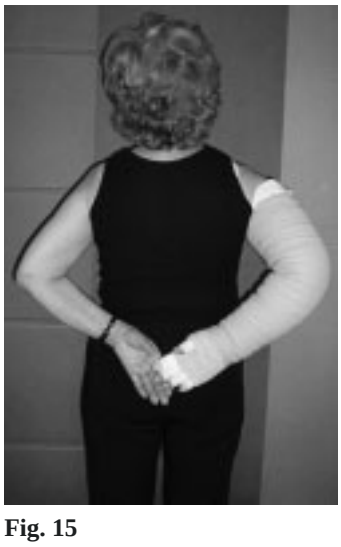

Fig. 15

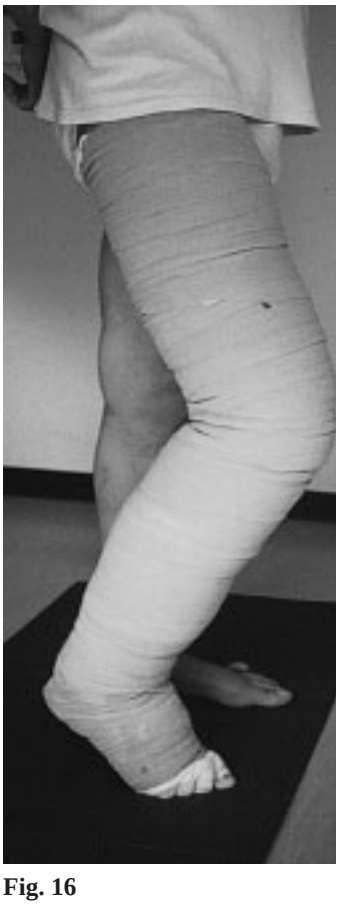

Fig. 16

Fig. 17

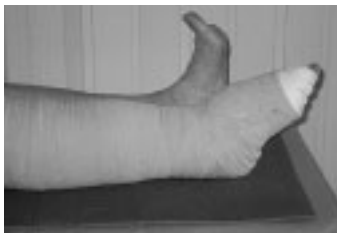

Fig. 18

DISCUSSION AND CONCLUSIONS

Considering that lymph-oedema is a chronical evolutive pathology, it is important that the patient receives as much information as possible about it and, where possible, he should acquire manual ability indispensable for self-management.
This does not mean replacing the rehabilitation group, which will intervene in the intensive treatment in lymph-oedema when necessary and with periodic monitoring, but collaborating with staff in lymph-oedema management.
This is the only way to contain and avoid clinical worsening and at the same time make the patient aware of his own body in the pathology and allow him to live a satisfactory and adequate existence.
During this four-year period we noticed that the patients to whom combined self-management was taught, acquired a major awareness of the pathology and learned to accept the chronicity of their disease.
Furthermore the patients understood the importance of bandaging, which were therefore accepted and worn more willingly, and of the elastic tutor which became an indispensable garment to be worn everyday.
Finally the patients forwarded fewer requests for repetitive and useless treatment over a short period of time and in the meantime the results obtained with intensive treatment remained more stable until the following check-up.

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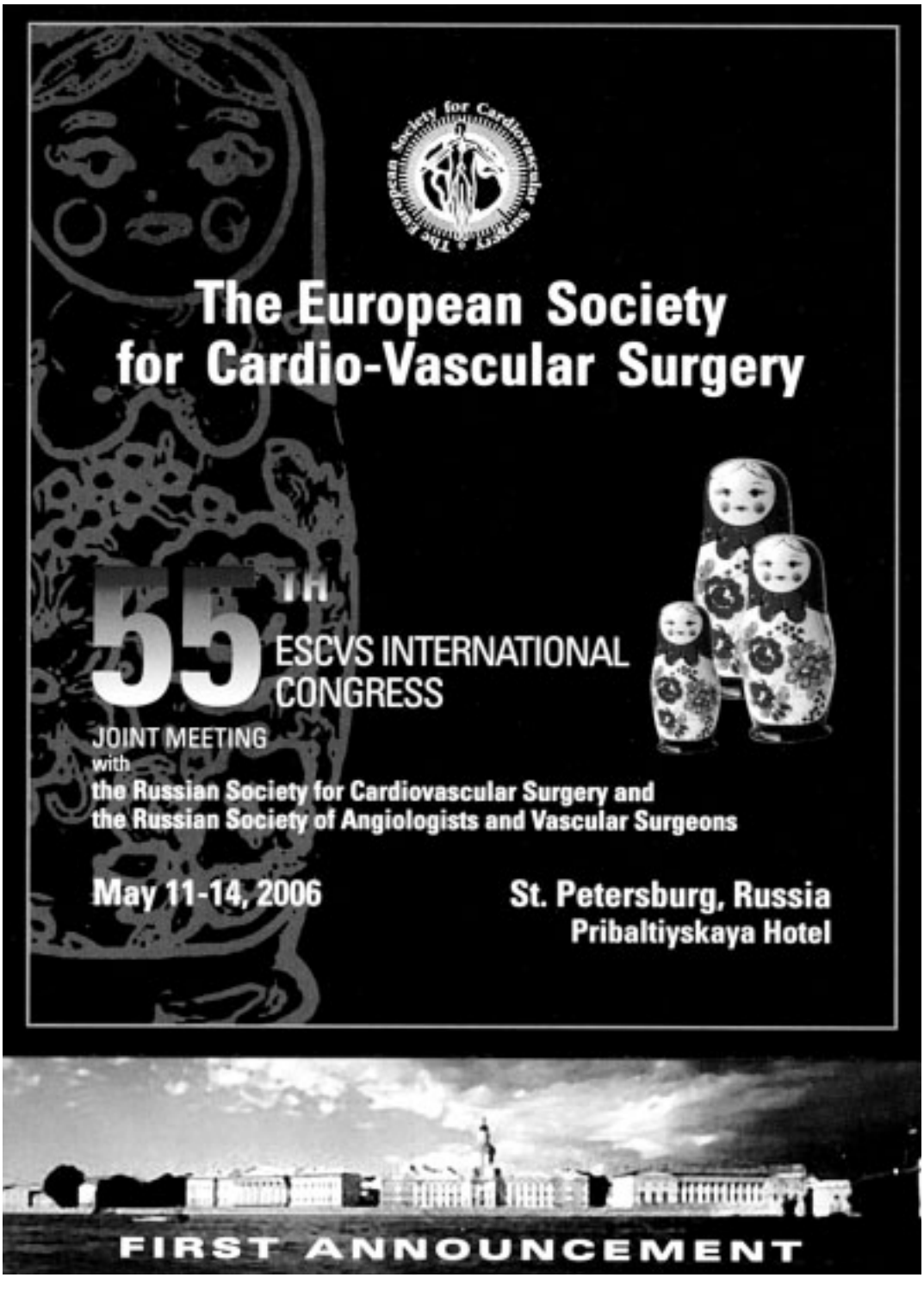

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Live surgery seminar
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May 11, 2006

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Best Young Investigator Award (<36y.o.) in Cardiac Surgery

Reynaldo Dos Santos Prize
Best Young Investigator Award (<36y.o.) in Vascular Surgery

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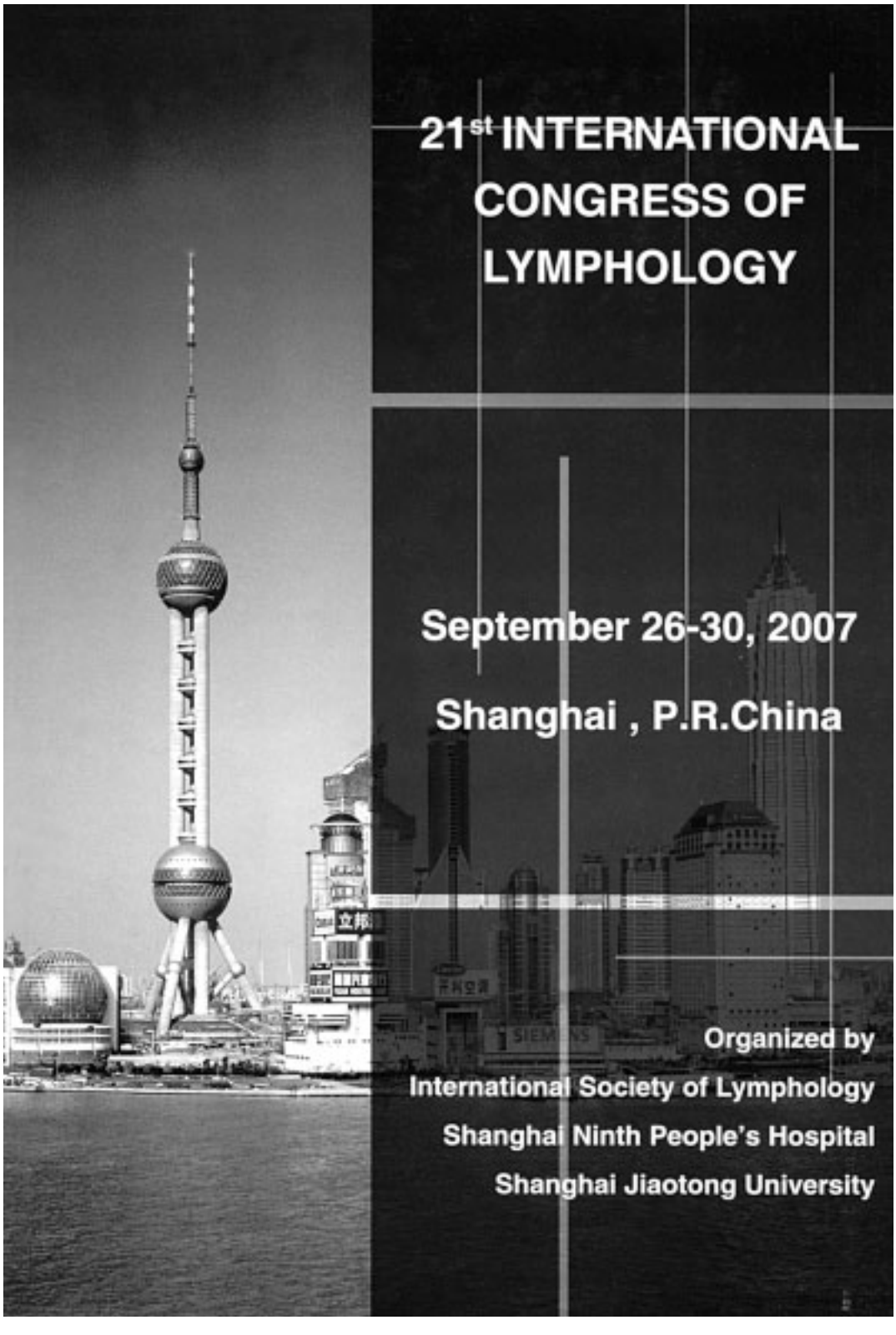

I am pleased to welcome you to the 21st international congress of lymphology scheduled from September 26-30, 2007 in Shanghai, China.

We wish to have one of best ISL meetings with the best quality of science.

Meanwhile, we also would like to provide you a good opportunity to know Chinese culture.

Sincerely
Dr. Ningfei Liu
Chairman

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