1° Servizio di Radiologia e Diagnostica Radioisotopica
(Sezione Radioisotopi)
dell'Arcispedale S. Maria Nuova, Reggio Emilia
(Primario: Prof. G. P. ALBERTI)

DYNAMIC LYMPHADENOSCINTIGRAPHY OF THE LOWER LIMBS

(Notes on technique and normal findings)

GIAN PIERO ALBERTI DIANA SALVO FRANCO NICOLI
DESIDERIO SERAFINI

Radiological lymphadenography is the only diagnostic method of exploring some sectors of the lymphatic system and provides information on the course and potency of the ducts and the morphology, topography and structure of the lymph nodes. However, this method is very limited: it can only be applied to some parts of the lymphatic system and cannot be repeated because of the technique employed. In addition, it does not provide any information on the passage of the lymph from the interstitial tissue to the pre-collectors and from these to the pre-lymph node collectors.

The first radionuclide used for therapeutic purpose in the lymphatic system was ^{198}Au introduced by HAHN and SHEPPARD [7] in 1946 and by SHERMAN and TER POGOSSIAN [11] in 1953. ^{131}I was used by CHIAPPA et al. [3] to label Lipiodol combining, in this way, the diagnostic use of the compound and the therapeutic action of the radionuclide on lymph nodes. These techniques presupposed, like lymphadenography, the surgical isolation of the lymphatic collectors. After tissue injection the radionuclides were determined in the lymphatic system, in order to obtain a less traumatic and faster method. The first radionuclide used was colloidal ^{198}Au [9, 10, 12, 13]. The colloidal ^{198}Au, consisting of particles of variable size but not greater than 250 Å in diameter, was injected subcutaneously and conveyed through the lymphatic system of the pre-collectors and pre-lymph node collectors to the various lymph node groups. The researches of the above-mentioned workers were carried out by employing linear scanners which showed little sensitivity in exploring the deep lymphatic chains. In addition, the great differences in the concentration of radionuclide in each lymph

Key-words: Lower limbs; Lymph nodes; Lymphadenoscintigraphy; Lymphatic system; Neoplasias; Radionuclides.

Accepted for publication on July 31, 1978.
La Ricerca Clin. Lab. 9, 81, 1979.

node group, made it necessary to carry out a large number of scans in order to obtain satisfactory maps for each lymph node group.

It was only later that the introduction of scintillation cameras and the utilization of colloids labelled with ^{99m}Tc again made it possible to study the lymphatic system with radionuclides [6, 12].

MATERIALS AND METHODS

Our research was based on 148 lymphadenoscintigraphies of the lower limbs and its aim was to study the changes in the lymphatic vessels, caused by lymph node metastases and systematic lymphopathies, and in both lymphatic and venous oedema. The subcutaneous injection of radiocolloid makes this method 'indirect', and also more physiological than the radiological lymphadenography, allowing measurements to be made on the diffusion of the radiocolloid and on its passage from the pre-collectors to the pre-lymph node collectors.

As regards our study of the lymphatic vessels of the lower limbs, we determined: 1. the progression of the radiocolloid by periodically repeated photoscans; 2. the time of appearance of the radiocolloid in the inguinal lymph nodes; 3. the time of appearance of the liver uptake; 4. the flow curve of the radionuclide, selecting as areas of interest the mid-third of the thighs whatever their diameter, on account of the great normal variability in number and course of the main lymphatic collectors.

We used a scintillation camera, a micro-dot set to transfer the scintigraphic images to radiographic films of various size, and an istocorder set to record the flow curves. In addition, a scintiscan set for automatic 'whole body' scans allowed us to explore, in a single scan, the pre-lymph node collectors in an area 30 cm wide and from 100 to 200 cm long, and to follow the passage of the radiocolloid in these by periodically repeated photoscans. Our studies were carried out with antimony-sulphide labelled with ^{99m}Tc as introduced into the study of the lymphatic system by HAUSER et al. [8] and ZWOLD [15].

The radiocolloid was injected under the skin, after local anaesthesia, at a total dose of 6-8 mCi; we considered it incorrect either to use spreading substances or to make patients perform particular movements (walking, movements of the limbs) after the injection. The dose of radiocolloid was divided into equal parts for several sites of injection according to the lymphatic vessels to be explored:

superficial system: median group: I and II interdigital space; side group: III and IV interdigital space;

deep system: two injections: in submalleolar and in retromalleolar sites.

After the injection the first was carried out for a length of 100 cm, starting from the distal end and excluding the sites of injection and proceeding in a caudo-cranial direction at a speed of 12-16 cm/min. Immediately afterwards, a second scan was performed in the same way.

RESULTS

In normal subjects the pre-lymph node collectors resemble activity lines that exactly trace the normal course of the lymphatic vessels (figs 1 and 2). The appearance of the radionuclide at the level of the inguinal system occurs between 10 and 15 min

in a normal subject. Another important result is the time of appearance of the liver uptake of the radionuclide, which is normally between 15 and 20 min, and an assessment of its intensity (fig. 3). After the dynamic measurements, each lymph node group was examined using collimators with parallel or convergent holes in ventral and dorsal projection (fig. 4). The dorsal examination was of particular importance for study of the common iliac and lumbar aortic chains.

Further examinations were carried out at a 6-h and sometimes a 24-h interval. We drew graphs of the lymph flow, starting the measurement at the time of the injection of radiocolloid, with measurement intervals of 4 sec and a total observation period of 34 min 8 sec. The curves of the two limbs were, in a normal subject, exactly the same (fig. 5) and increased progressively: faster in the first, slower in those following. During the whole period of observation, the patient had to lie absolutely still; in fact, even simple contractions of muscle groups caused alterations in the lymphatic flow that could be clearly seen in the graphs.

The statistics we have so far studied have given us the first indications of how the method could be usefully employed in the investigation of changes in lymphatic flow in the lower limbs of patients with metastatic (fig. 6) or systemic lymphopathies and in the differential diagnosis of lymphatic and venous oedema (fig. 7).

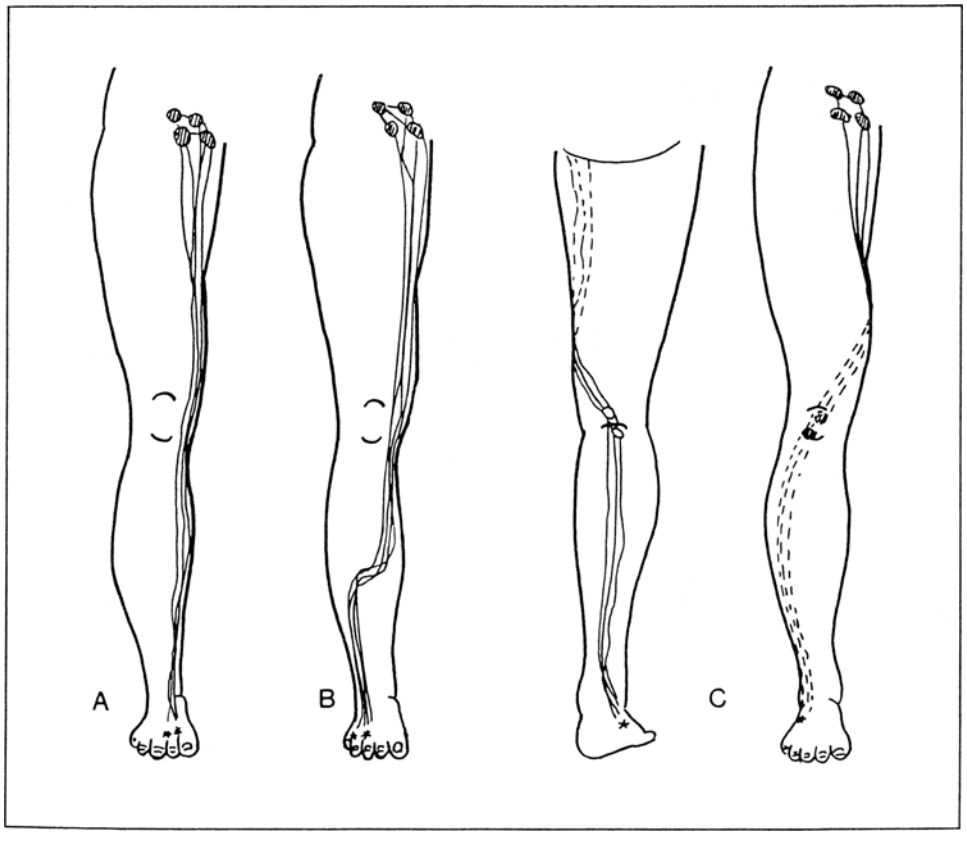

Fig. 1 - Diagram of the lymphatic ducts of the lower limbs: internal superficial group (A), external superficial group (B) and deep ducts (C).

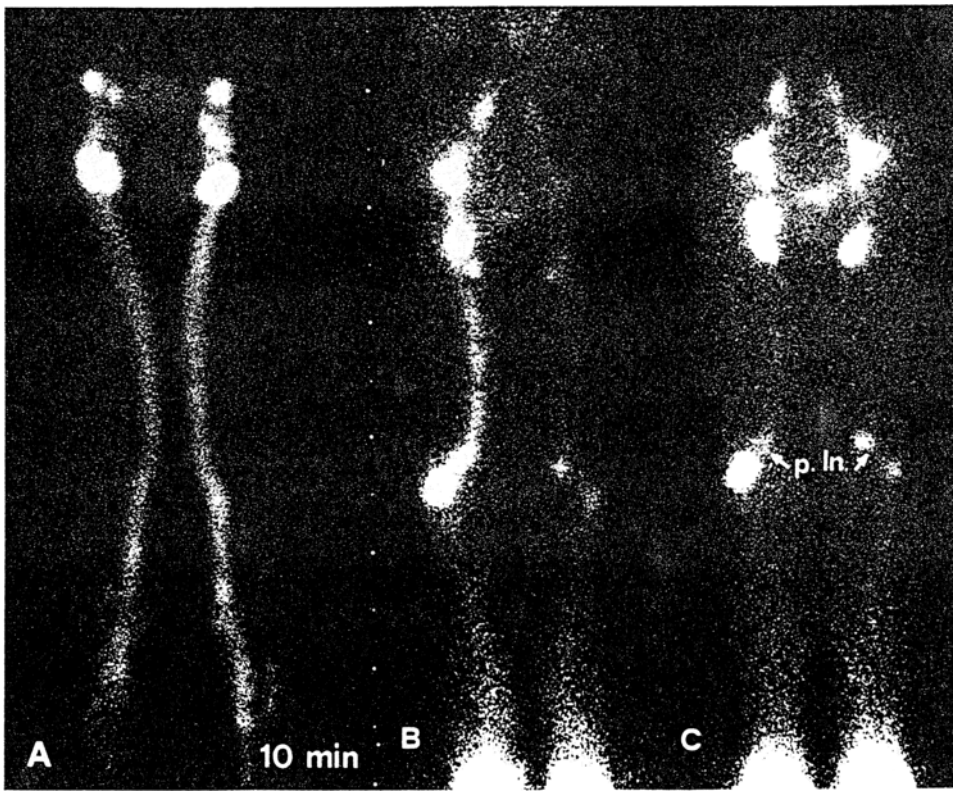

Fig. 2 - Photoscintigraphy of the superficial internal group (A) and photoscintigraphy of the deep lymphatic ducts taken at 15 min (B) and 6 h (C) after the administration of radiocolloid; p. ln. = popliteal lymph nodes.

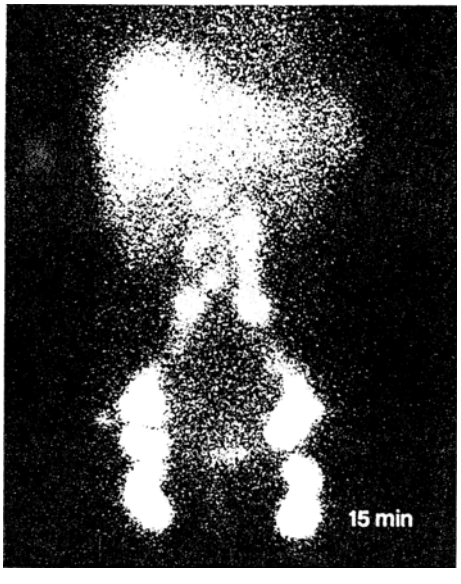

Fig. 3 - Photoscintigraphy taken 15 min after the administration of radiocolloid: normal liver uptake.

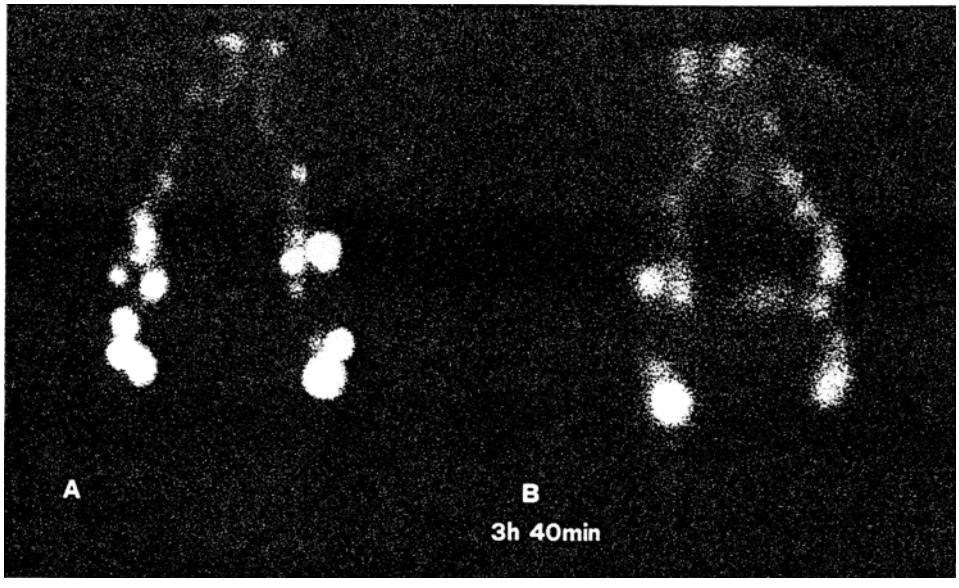

Fig. 4 - Photoscintigraphy of the iliac and lumbar aortic lymph nodes in the ventral (A) and dorsal (B) projection.

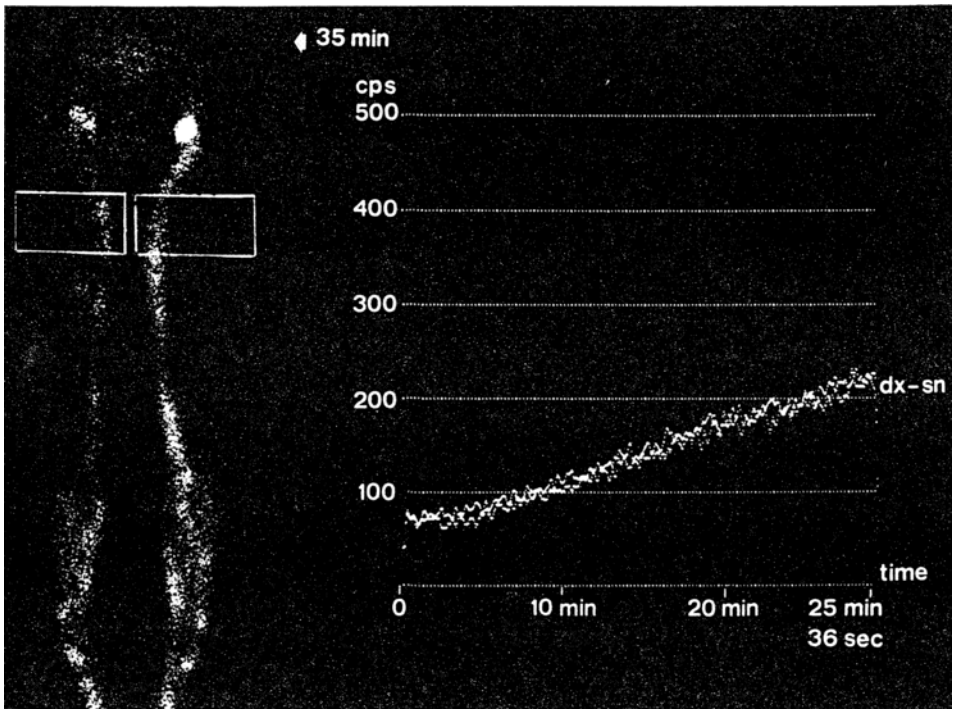

Fig. 5 - Graphs of normal lymph flow: precise superimposition of the right and left curves.

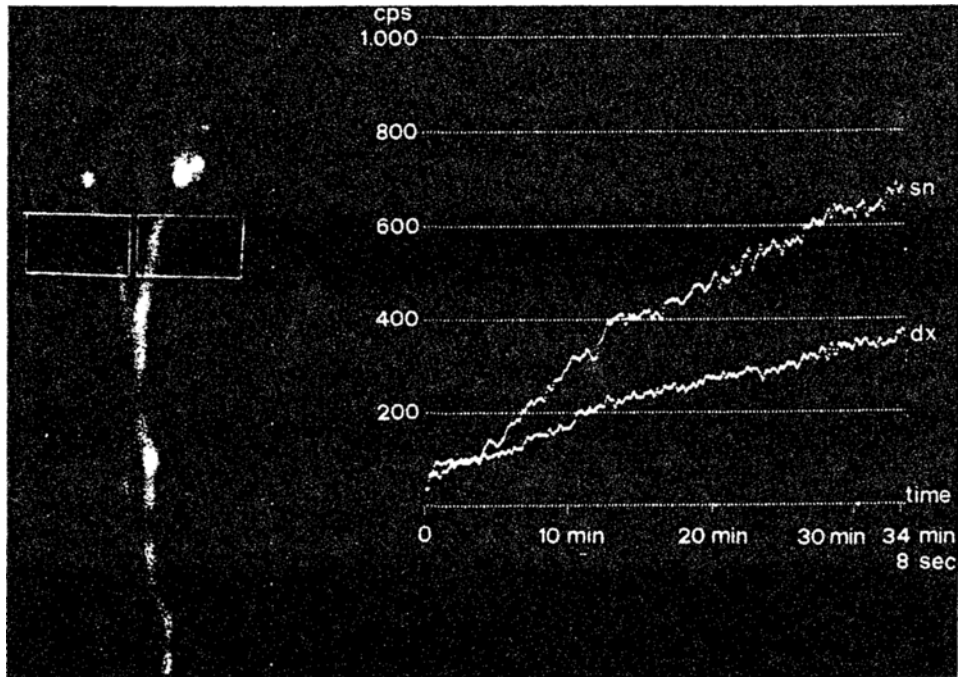

Fig. 6 - Uterine carcinoma: metastases in right iliac lymph nodes with delayed lymphatic flow.

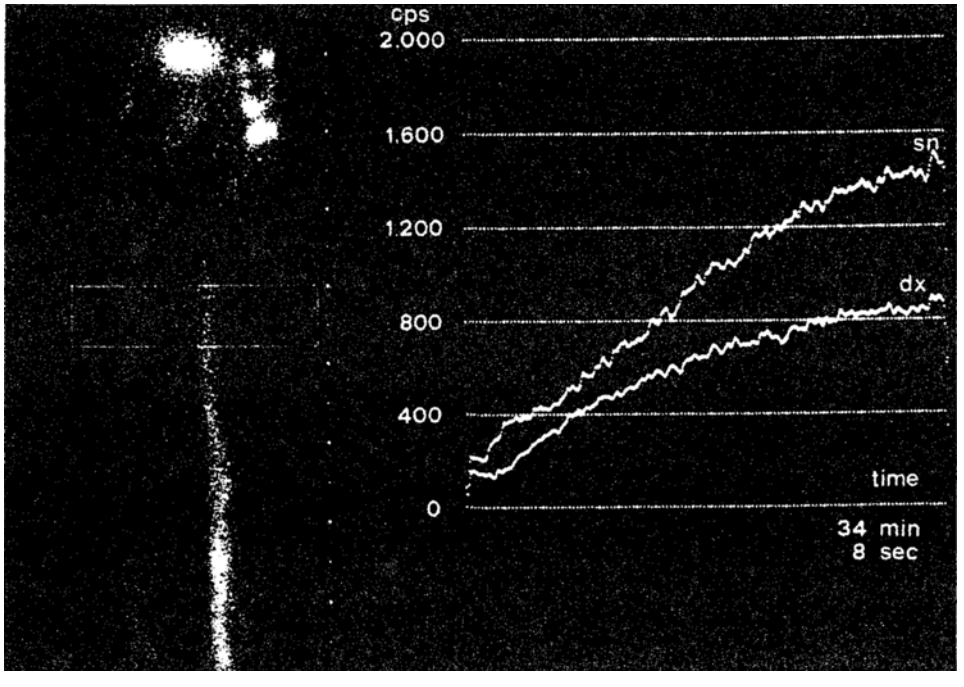

Fig. 7 - Phlebothrombosis of the left lower limb with increased lymphatic flow.

SUMMARY

The use of dynamic lymphadenoscintigraphy is proposed for the study of the lymphatic flow in the lower limbs. The method is based on the determination of the flow curves of radiocolloid (antimony-sulphide labelled with ^{99m}Tc) in the lower limbs, on the time of its appearance in the inguinal lymphatic vessels and in the liver, and also on the recording by periodically repeated photoscans of the progress of the radiocolloid in the pre-lymph node ducts. Thus, the method is suggested for use in the observation of flow variations as an expression of metastatic or systemic lymph node diseases and in the differential diagnosis of lymphatic and venous oedema.

REFERENCES

1. CHIAPPA S., GALLI G., BARBAINI S., RAVASI G.: La radioterapia endolinfatica: primi risultati di una nuova metodica - Radiol. med. (Torino) *48*, 663, 1962.
2. CHIAPPA S., GALLI G., GUARINO M., BARBAINI S.: Quelques possibilités de la radiothérapie endolymphatique dans le domaine de la gynécologie - J. Radiol. Électrol. *44*, 157, 1963.
3. CHIAPPA S., GALLI G., GUARINO M., BARBAINI S., RAVASI G.: Prime osservazioni istologiche di linfopatie sistemiche trattate con Lipiodol F ^{131}I per via endolinfatica - Tumori *49*, 87, 1963.
4. CHIAPPA S., GALLI G., PALMIA C., SEVERINI A.: Lymphangiography with radioactive contrast medium in lymphosarcoma and reticulosarcoma - Brit. J. Haemat. *11*, 32, 1965.
5. CHIAPPA S., GALLI G., SEVERINI A.: Lymphadenography with radioactive contrast medium in retroperitoneal localization of malignant lymphogranulomas - Amer. J. Roentgenol. *92*, 134, 1964.
6. COATES G., RAYMONDS S. B., ASPIN N.: A study of ascites using lymphoscintigraphy with ^{99m}Tc-sulfur colloid - Radiology *107*, 577, 1973.
7. HAHN P. F., SHEPPARD C. W.: Selective radiation obtained after intravenous administration of colloidal radioactive isotopes in disease of lymphoid system - Sth. med. J. (Bgham, Ala.) *39*, 558, 1946.
8. HAUSER W., ATKINS H. L., RICHARDS P.: Lymph node scanning with ^{99m}Tc sulfur colloid - Radiology *92*, 1369, 1969.
9. SAGE H. H., WIZILOY D., MIYAZAKI M., SHAPIRO G., SINHA B.: Lymphonode scintigrams - Amer. J. Roentgenol. *84*, 666, 1960.
10. SEAMAN W. B., POWERS W. E.: Studies of distribution of radioactive colloid gold in regional lymphonodes containing cancer - Cancer (Amst.) *8*, 1044, 1955.
11. SHERMAN A. I., TER POGOSSIAN M.: Lymphonode concentration of radioactive colloidal gold following interstitial injection - Cancer (Amst.) *6*, 1238, 1953.
12. SPREAFICO G., COLOMBO L., PURICELLI G., LUALDI M., BALLARATI U.: La linfoscintigrafia con *gamma-camera* nello studio dei linfomi addominali - La Ricerca Clin. Lab. *4*, 1063, 1974.
13. SPREAFICO G., LUALDI M., PURICELLI G.: Studio morfologico e funzionale del sistema linfatico con radioisotopi - Radiol. med. (Torino) *56*, 924, 1970.
14. ZINA G., BOSSI G., BANNI G., MARTINO G.: Studio funzionale del sistema linfatico dell'arto inferiore con ^{198}Au colloidale - Minerva derm. *37*, 361, 1962.
15. ZWOLD D. E.: Lymphoscintigraphy with technetium sulfur colloid - J. nucl. Med. *8*, 361, 1962.

Requests for reprints should be addressed to:

GIAN PIERO ALBERTI
1° Servizio di Radiologia e Diagnostica Radioisotopica
(Sezione Radioisotopi)
dell'Arcispedale S. Maria Nuova
Viale Risorgimento 80, 42100 Reggio Emilia - Italia