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Clinical Aspects of Transport Medicine

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THE USE OF RADIONUCLIDE METHODS FOR CONTEMPORARY DIAGNOSTIC IN ANGIOLOGY

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Apart from radiology, ultrasonography and pletysmography methods there are used also radionuclide methods in angiology diagnostics. In initial phases of vascular diseases there are present changes in functional character together with changed microcirculation. The aim of presented work is to point out on nuclear medicine methods, which enable to diagnose early phases of angiopathy, especially in lower extremities, by non-invasive way.

***Key words**: Radionuclide methods, Diagnostics, Diabetes, Microcirculation, Angiopathy.*

Introduction

Vascular diseases represent serious health, social and economic problems. Diabetic angiopathy forms an independent group in angiopathic problematics. Endothelial disfunction accelerated by diabetes represents the important source of angiopathic diseases. There are other factors being discussed like oxidative stress, excessive oxygen radical production, alterations of calcium homeostasis in vascular wall, etc. The result of pathogenic influences is prolonged microvascular disfunction, characterized by increase of idle vascular resistance, by deterioration of reaction on vasodilatal stimulus, it can be called as "microvascular stagging" [1]. The following vascular remodelation is the core of vascular complications in diabetes, hyperinsulinism, arterial hypertension, etc. Therefore the diagnostics of early functional angiopathy phase requires methods enabling to verify the changes on microcirculation level. The microcirculation state can be examined by:

a) capillarscopy,
b) laser-doppler fluxmetria,
c) thermometry,
d) radionuclide methods.

Microcirculation examination by radionuclides

In fact, it concerns two procedures:

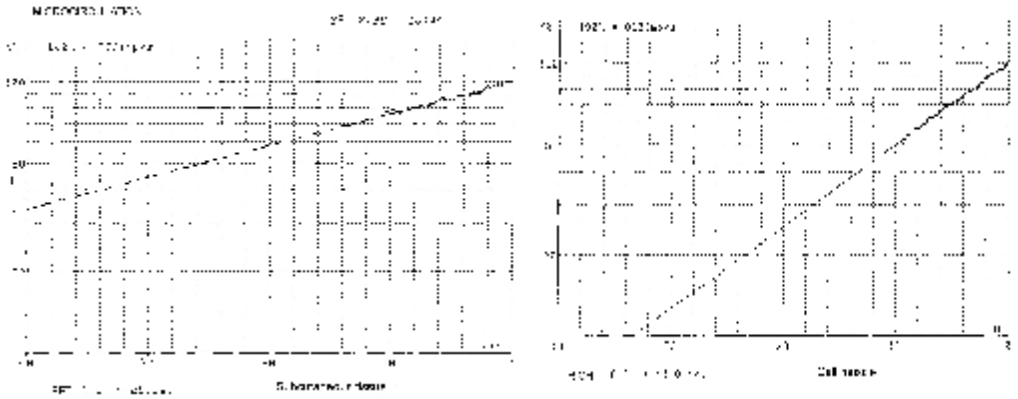
a) Intravascular application of microparticles, determined by radionuclid, which are caught in microcirculation of examined organ (e.g. lung perfused scintigraphy),
b) Tissue clearance of low-molecular substances — radionuclides ($Na^{131}I$, ^{133}Xe).

Microcirculation examination on lower extremities by tissue clearance method $Na^{131}I$

The method of tissue clearance $Na^{131}I$ was established by Kety [2], in Slovakia it was elaborated by Pechбт [3] and used in examination of extremities hyperemia in

hypertension, in diagnostics of diabetic angiopathy, in examination of capillary circulation in acute vein thrombosis [4, 5]. Low-molecular diffusible substance is after application in intersticium resorbing into blood almost quantitatively through capillary wall. The resorbance is performed by diffusion according Fick law (it is influenced by diffusive constant of substance, effective diffusive surface, length of diffusive way through capillary wall and by the concentration difference of administered substance on both sides of membranes). The speed of low-molecular substance diffusion from intersticium into blood depends mainly on blood flow speed in capillaries, on number of open capillaries, on their dilatation level, on capillary transmittance and on vascular wall conditions. The speed of resorbance $Na^{131}I$ represents the constant of resorb and rinse out radiopharmacum in examined tissue microcirculation. This can be evaluated by resorbance half-time ($T_{1/2}$) in minutes. Resorbance half-time is time during which half of total administered substance is resorbed from extravascular tissue into blood. It is simplified expression of clearance constant. The values $T_{1/2}$ in healthy individuals vary from 10 to 18 minutes (Picture 1).

Microcirculation examination has been done in 3000 patients, mostly the diabetic ones. We compared the findings with clinic microangiopathic changes (retinopathy, nephropathy). The microcirculation changes in tissue clearance Na ^{131}I examination were recorded later [5].



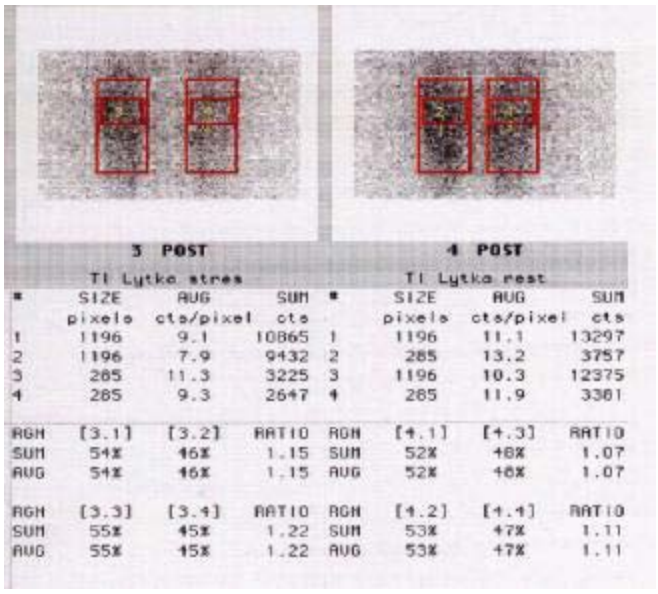
Pic. 1. Microcirulation examination by tissue clearance Na ^{131}I. By means of scintillation sounds we record the speed of pharmacum rinse-out applicated in subcutis or in calf muscle by local microcirculation. The result is resorbing curve and its manifestation is final resorbance value ($T_{I/2}$) in minutes. On the left graph there is an example of slowed-down resorbance Na ^{131}I in subcutis ($T_{I/2}$ 25,6 min.) and on the right side there is unchanged resorbance in calf muscle ($T_{I/2}$ 10,0 min.).

Examination of peripheral arterial system in endurance scintigraphy of heart

After cardio examination the examination of perfusion on lower extremities mostly in zone of shin-bone and thigh is started. The difference in flow can be determined by hyperemia ratio on basis of regional distribution of radiopharmacum in skeletal muscles (Picture 2). We compare perfusion state on the right and left lower extremity. This semiquantitative method enables to point out on early changes in skeletal muscle perfusion (in diabetic patients), on therapeutic effect in ischemic disease of low extremities [6].

Diagnostics of deep venous trombosis on lower extremities

Venous thrombosis on lower extremities is very often disease. As clinic symptoms enable to diagnose venous thrombosis only in 1/3 of patients, several non-invasive investigative methods have



3 POST
Tl Lytko stres

*	SIZE pixels	AVG cts/pixel	SUM cts
1	1196	9.1	10865
2	1196	7.9	9432
3	285	11.3	3225
4	285	9.3	2647
RGN	[3.1]	[3.2]	RATIO
SUM	54%	46%	1.15
AVG	54%	46%	1.15
RGN	[3.3]	[3.4]	RATIO
SUM	55%	45%	1.22
AVG	55%	45%	1.22

4 POST
Tl Lytko rest

*	SIZE pixels	AVG cts/pixel	SUM cts
1	1196	11.1	13297
2	285	13.2	3757
3	1196	10.3	12375
4	285	11.9	3381
RGN	[4.1]	[4.3]	RATIO
SUM	52%	48%	1.07
AVG	52%	48%	1.07
RGN	[4.2]	[4.4]	RATIO
SUM	53%	47%	1.11
AVG	53%	47%	1.11

Pic. 2. Hyperemia muscle examination of lower extremities in myocardium perfusion examination

been developed, which have made the venous thrombosis diagnostics more precise. They are:

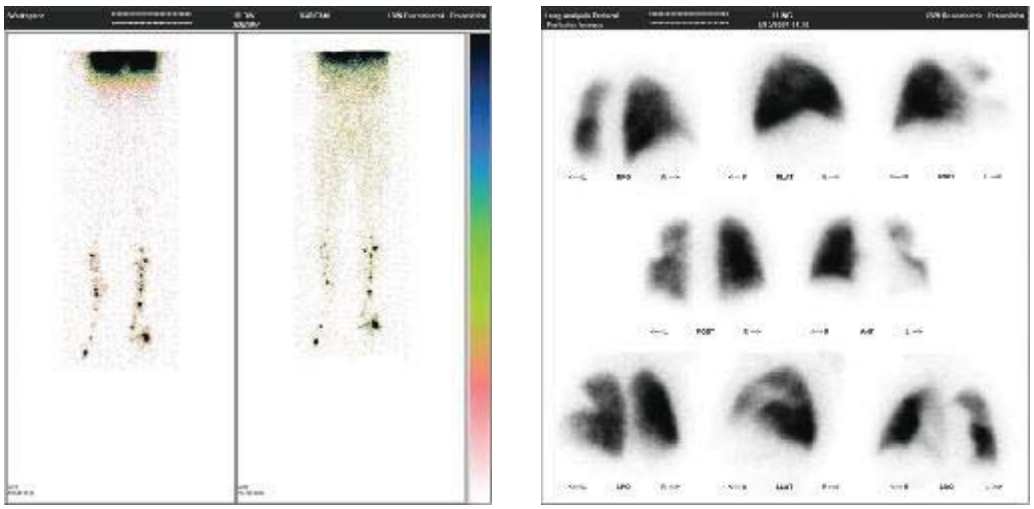
- clinical diagnostics (anamnesis and physical examination),
- ultrasound technics,
- pletysmographic methods,
- Xray flebography,
- Thermography,
- radionuclid methods.

Radionuclide methods

- Radionuclide venography ^{99m}Tc,
- Radionuclide flebography with ^{99m}Tc determined erythrocytes,
- Accumulative ^{125}I-fibrinogene test (FAT),
- Scintigraphy thrombosis determined thrombocytes.

Radionuclide venography ^{99m}Tc

Macroaggregate of human albumin marked as ^{99m}Tc (^{99m}Tc MAA) is used as radiopharmacum. After its application the scintigrams are being made in area of shin-bone, thigh, pelvis. When using tourniquets above ankle and below knee the deep venous system is displayed, without the emergency tourniquets it is superficial venous system. So-called **"stop in displaying deep venous system"** testifies the closing of deep venous system. Radiopharmacum is gathered under the shutter and its flow away is done through collaterals and superficial system [7]. In case the radiopharmacum stagnation occurs, the operational test and scintigrams



Pic. 3. Radionuclid flebography on lower extremities done after venous thrombosis treatment. Venous system is passable, so-called "hot spots" are visible, which are adherence signs ^{99m}Tc MAA on disrupted endothelium in valve area. They are considered as symptoms of thrombosis if they persist after repeated dorsal flexion longer than 5 minutes. On right there is a picture of perfused lung scintigram with pathologic finding of segmentary break-out of radiopharmacum accumulation, embolization signs into arterial pulmonalis.

are evaluated after activation of muscle pump, when a radionuclide is quickly rinsed out. Radionuclide venography does not provide sufficient information on thrombus duration, it does not reveal small and wall thrombus. The disadvantage is low reliability in shin-bone area, especially in insufficiency of venous connectors. The advantage of method is use-friendliness. The examination repetition is performed mainly to verify the treatment effectiveness. Radiopharmacum (^{99m}Tc MAA) does not irritate vascular endothelium. It is used mostly to verify the patency of deep venous system (Picture 3).

Radionuclide flebography with determined erythrocytes ^{99M}TC (ULTRATAG RBC)

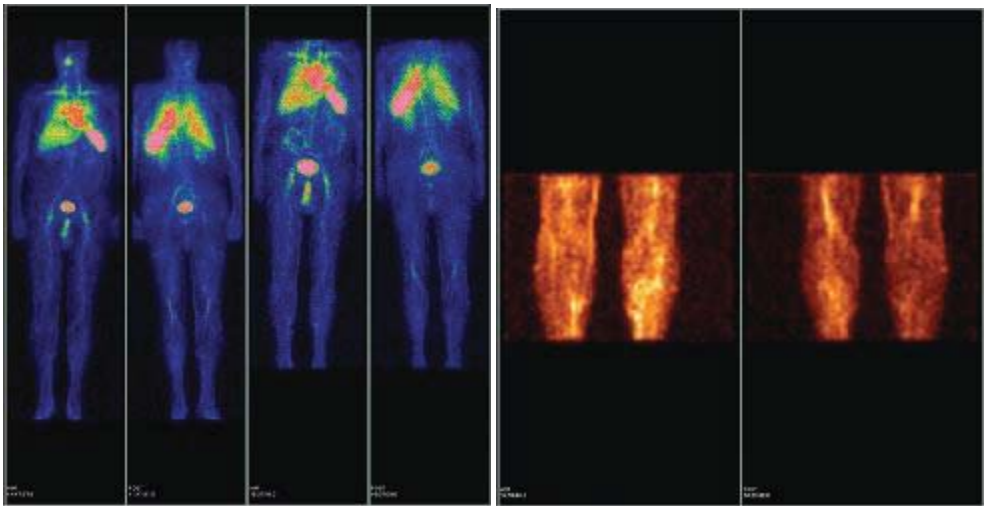
Venous system is displayed by using determined erythrocytes via UltraTag RBC. After taking 4ml of blood sample and consequent ^{99m}Tc UltraTag RBC erythrocyte determination these erythrocytes are applied intravenously back to the patient. Determined erythrocytes are used to display blood circulation, balanced radionuclide ventriculography, in liver lesion examinations, in ventriculography in case of venous thrombosis suspicion. Diagnostic criterion of thrombosis is filling defect of venous system in comparison with contralateral vessel and current presence of collaterals [9].

Thrombosis diagnostics by determined ^{99M}TC HMPAO thrombocytes

It is based on capturing of the patient's determined thrombocytes in active thrombus and its scintigraphic display. The ^{99m}Tc HMPAO (hexametyl-propylen-amino-oxim) thrombocytes are being used. The determined thrombocytes are applied intravenously to patient. After l, 2 and 24 hours the scintigrams of pelvis, thighs and calves [10] are performed. The thrombosis criteria are the following:

1. A good limited bearing of increased radioactivity in area of deep vein,
2. A sharp limited thrombocyte gathering in deep vein in 2 up to 24 hours comparing v contiguous surroundings,
3. An asymmetric image of venous system on early scintigrams and image of limited bearing after 24 hours (Picture 4).

Examination of venous system by here presented methods contributes to diagnostics of venous thrombosis. It does not have contraindications. The issue can be a worse availability of vein on leg in pharmacum application. The pharmacum application into venous system on legs and simultaneously the examination of venous system on lower extremities as well as examination of perfused lung scintigraphy



Pic. 4. The whole body scintigraphy by means of ^{99m}Tc HMPAO determined thrombocytes. On the left there is normal finding, on the right there is pathologic finding (in right shin-bone area the changed capacity of deep venous system, present collaterals).

when embolization into arterial pulmonalis suspected, all of them have a great merit.

Lymphatic system display

The radionuclide methods provide also the options of lymphatic system examination. The principle of these methods is tracking the resorbance speed of high-molecular substance from intersticium via lymphatic vessles. Nowadays the kit Nanocoll is used (important is the size of colloid particulars), called ^{99m}Tc. Newly determined microcolloid is applied into subcutis interdigitally on dorsal feet between the 1st and 2nd toe, or between 3rd and 4th toe. Lymphatic system can be examined also in other areas (upper extremity, chest, then the place of application is in corresponding areas).

The lymphatic system on lower extremity is displayed as a group of lymphatic vessels (collectors), determined as frontal superficial block. It is formed in area of dorsal part of foot and internal ankle. It goes along the vena saphena magna up to superficial ganglions in inquine. In area of shin-bone there are 4 collector types distinguished [11].

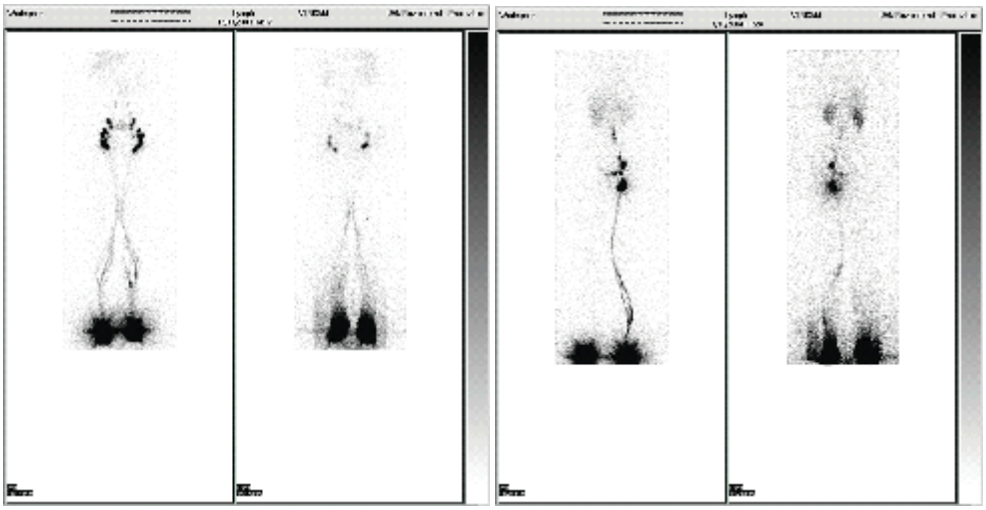
We examine both extremities at the same time. Until 30 minutes after the radiopharmacum application we speak about idle phase, from 30th to 60th minute it is motion phase. The evaluation is qualitative, we evaluate morphology of lymphatic system (asymmetry in lymphatic block, filling, lymphatic collector dilatation, interruption of filling in lymphatic flow blockade, radiopharmacum back flow into dermal lymphatic vessels, asymmetry in lymphatic ganglions display, etc.).

In quantitative evaluation we observe time, which is necessary to transport radiopharmacum from application point to regional lymphatic ganglions, amount of radiopharmacum, which is accumulated in regional lymphatic ganglions at the end of idle and motion phase. By evaluating morphologic and functional finding we rate the state of lymphatic system in the area under examination (Picture 5).

Lymphoscintigraphy helps in differential diagnostics of edemas. It informs about function state of lymphatic system, about its transitoriness, transport function. The examination does not have contraindications.

Conclusion

The above mentioned radionuclide methods are significant contribution in diagnostics and treatment of vascular diseases. They are available on nuclear medicine workplace.



Pic. 5. Radionuclide lymphography on lower extremities, on the left there is normal finding in AP and PA projection, on the right there are signs of obstructive lymphatic system on right lower extremity in AP and PA projection.

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Резюме

ИСПОЛЬЗОВАНИЕ СОВРЕМЕННЫХ ДИАГНОСТИЧЕСКИХ РАДИОНУКЛИДНЫХ МЕТОДОВ В АНГИОЛОГИИ

Антон Лацко, Ян Антони Рутовски

Помимо методов радиологии, ультрасонографии и плетизмографии в ангиологи в диагностике используют также радионуклидные методы На начальных этапах сосудистых заболеваний наблюдаются изменения функционального характера вместе с измененной микроциркуляцией. Цель представленной работы — указать методы ядерной медицины, которые позволяют диагностировать ранние фазы ангиопатии, особенно в нижних конечностях, неинвазивным способом.

Ключевые слова: *радионуклидные методы, диагностика, диабет, микроциркуляция, ангиопатия.*

Резюме

ВИКОРИСТАННЯ СУЧАСНИХ ДІАГНОСТИЧНИХ РАДІОНУКЛІДНИХ МЕТОДІВ В АНГІОЛОГІЇ

Антон Лацко, Ян Антоні Рутовські

Крім методів радіології, ультрасонографії та плетизмографії в ангіології в діагностиці використовують також радіонуклідні методи На початкових етапах судинних захворювань спостерігаються зміни функціонального характеру разом зі зміненою мікроциркуляцією. Мета представленої роботи — вказати методи ядерної медицини, які дозволяють діагностувати ранні фази ангіопатії, особливо в нижніх кінцівках, неінвазивним способом.

Ключові слова: *радіонуклідні методи, діагностика, діабет, мікроциркуляція,*

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