Microcirculatory Disorders and Choice of Treatment Strategy for the Diabetic Foot Syndrome

E. Yu. Kurbanov* and V. G. Sergeyev**

Translated from *Byulleten' Eksperimental'noi Biologii i Meditsiny*, Vol. 152, No. 8, pp. 235-237, August, 2011
Original article submitted June 28, 2010

Radioisotope method with ^{99m}Tc pertechnetate is proposed for evaluation of the microcirculatory status of patients with the diabetic foot syndrome. The isotope (70-90 MBq) in 0.3-0.5 ml saline was injected subcutaneously into the interdigital spaces of the foot symmetrically on both sides. The severity of microcirculatory changes was evaluated by the rate of the radiopharmaceutical resorption using a computer-aided gamma counter. The data on the radiopharmaceutical half-resorption obtained by radioisotope study, serve as additional criteria for prediction of the disease course and choice of the treatment strategy for patients with the diabetic foot syndrome and diabetic gangrene of the lower limb.

Key Words: *diabetic foot; microcirculation; pertechnetate; gamma chamber*

The incidence of diabetes mellitus (DM) is increasing in a geometrical progression all over the world. According to predictions of the International Institute of Diabetes (Melbourne, Australia), the number of DM patients was expected to surpass 200 million people by 2010 [4]. However, more than 300 million patients suffered from the disease by 2005 [5]. Among frequent complications of DM are trophic and pyonecrotic involvement of the foot resultant from angiopathy and polyneuropathy and called "the diabetic foot". The diabetic foot syndrome (DFS) is diagnosed in 30-80% diabetics [4]. Steady increase in this patient population, formation of angiopathy with possible development of the diabetic gangrene of the lower limb (DGLL) necessitate comprehensive study of the problem.

Despite numerous instrumental methods for studies of diabetic angiopathy, the severity of microcirculatory disorders at different stages of DFS and DGLL development remains unclear. We studied the microcirculatory status of DFS patients and developed accessory criteria for choice of the treatment strategy for this patient population.

*Department of Surgery, Faculty for Continuous Medical Education, Samarkand State Medical Institute; **Department of Immunology and Cell Biology, Udmurtian State University, Izhevsk, Russia. ***Address for correspondence:*** erkin_kurbanov@rambler.ru. E. Yu. Kurbanov

MATERIALS AND METHODS

A total of 94 patients (79 with DFS and DGLL, 15 without DM), hospitalized at the Center of Pyoseptic Surgery of Municipal Medical Center of Samarkand, were examined.

The microcirculatory status was studied by the radioisotope method with ^{99m}Tc pertechnetate. We selected this radioisotope because it is very soluble in water and as a true solution easily penetrates (according to physical colloid chemistry laws) through tissue barriers (lymph and blood vessel walls). In addition, this radionuclide is a pure γ-radiation source with a low absorption coefficient, it is not selectively absorbed by vital radiosensitive tissues, it is not involved in biochemical processes, its half-life period is short, and it is rapidly eliminated from the body. The agent of 70-90 MBq activity in 0.3-0.5 ml saline was injected subcutaneously in the interdigital spaces of the foot symmetrically on both sides. The microcirculatory changes were evaluated by the rate of the radiopharmaceutical (RP) resorption using a computer-aided gamma counter. Dynamic recording of the RP resorption was carried out over 30

0007-4888/11/1522-0273

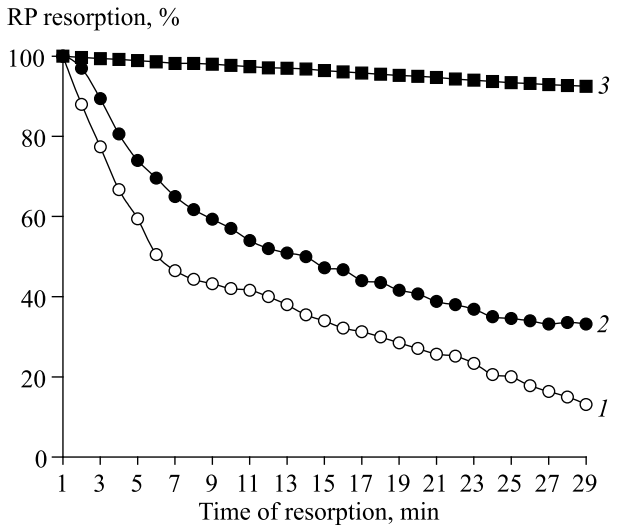

Fig. 1. Dynamics of RP resorption in diabetics. *1*) group 1; *2*) group 2; *3*) group 3.

min and the time of 50% RP resorption ($T_{1/2}$ or half-resorption) was recorded in all the patients. The patients were divided into 3 groups.

Group 1 (normal subjects) were 15 patients without DM. This group served for evaluation of the radioisotope resorption under conditions of intact vascular status. Group 2 were DFS patients without DGLL (72 patients), and group 3 were patients with DGLL (7 patients).

Male individuals constituted 53.16% in these groups, *i.e.* DFS and DGLL were found mainly in men. The age of diabetics varied from 22 to 82 years, the overwhelming majority (89.87%) were patients aged 41-69 years. Patients with DM-2 predominated (92.41%).

The treatment was carried out with due regard for the severity of clinical manifestations of DFS. Organ-sparing operations on the foot (toe amputations) were carried out with high resection of the respective flexor and extensor tendons, sparing minimum resection of the muscles, and resection of the metatarsal heads. No exarticulations of Lisfranc and Chopart joints were carried out. Instead, we carried out transmetatarsal resection of the foot after Sharp. "High" amputations (at the level of the shin and femoral bone) were carried out in cases with DGLL. Amputation at the shin level was carried out in the upper third with extirpation of *m. soleus* [1].

RESULTS

In group 1, RP was rapidly resorbed from the tissue depot, the mean half-resorption period being 5.80±0.29 min ($T_{1/2}$ <10 min). The RP resorption curve was as a rule shaped like a hockey stick (Fig. 1).

In group 2 patients, RP resorption was rather slow and gradual. The mean time of RP half-resorption was 15.40±0.44 min ($T_{1/2}$ 11-30 min). The resorption curve was sickle-shaped or gradually decaying. The treatment of these patients included conservative therapy and minor organ-sparing operations on the foot (amputation of the toes, resection of the metatarso-phalangeal joints, transmetatarsal resection of the foot after Sharp) without "high" amputations.

In some patients of this group (4 cases), RP half-resorption period increased to 26 min and longer ($T_{1/2}$ 26-28 min). We characterized this state as critical ischemia. Only complex treatment with a wide spectrum of drugs improving tissue microcirculation led to improvement of this parameter. One month after therapy the RP half-resorption was 17.50±0.29 min.

In group 3 patients, RP resorption was extremely slow. No half-resorption of RP was attained in any case throughout the entire period of observation ($T_{1/2}$ more than 30 min). The curve was almost horizontal. We called this graphic presentation "necrosis horizon" (Fig. 1). The treatment of these patients consisted in "high" amputation (at the level of the shin and femoral bone).

Hence, radioisotope study with ^{99m}Tc provides reliable quantitative information (based on the RP resorption from tissue depot) about the microcirculatory status of patients with DFS and DGLL. The RP (^{99m}Tc pertechnetate) half-resorption serves as an accessory criterion for prediction of the disease course and choice of treatment strategy for patients with DFS and DGLL.

REFERENCES

1. I. I. Dedov, M. B. Antsiferov, G. R. Galstyan, and A. Yu. Tokmakova, *The Diabetic Foot Syndrome* [in Russian], Moscow (1998).
2. I. I. Dedov, G. A. Mel'nichenko, and V. F. Fadeev, *Endocrinology* [in Russian], Moscow (2000).
3. S. I. Ismailov, Z. M. Shamansurova, T. T. Kamalov, *et al.*, *The Diabetic Foot Syndrome* [in Russian], Tashkent (2005).
4. Sh. I. Karimov, B. D. Babazhanov, and M. S. Islomov, *Diabetic Gangrene of the Lower Limbs* [in Russian], Tashkent (2003).
5. D. Z. Rakhimova and N. A. Saidova, *Diabetes Mellitus* [in Russian], Tashkent (2006).
6. A. V. Pokrovskii, V. N. Dan, A. V. Chupin, and A. F. Kharazov, *Angiol. Sosud. Khir.*, No. 2, 19-25 (2000).
7. A. Boulton, P. Cavanagh, and G. Rayman, *The Foot in Diabetes*, 4th ed., Chichester (2006).