THE CLINICAL ASPECTS OF DIABETIC FOOT*

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General information about diabetic foot

Diabetic foot is a serious chronic complication of patients with diabetes mellitus, particularly of patients with type 2 diabetes mellitus.

The clinical notion of diabetic foot includes a wide range of injuries, from hyperkeratosis, fissures, calluses and corns, trophic plantar and shin ulcers, dry gangrene, wet (moist) gangrene, and Charcot neuroarthropatia, that is often found in patients with diabetes mellitus [1–3].

According to global statistics, about 20 % of patients with type 2 diabetes mellitus are affected from diabetic foot [4, 5].

The base of the occurence of diabetic foot are: peripheral neuropathy of legs nerves, sudomotor autonomous neuropathy, microvascular and macrovascular damage of legs arteries, and the infection placing on the injured leg [6–11].

There is a big the number of patients with diabetic foot, in our country considering that the prevalence of diabetes mellitus is about 2.5 % of the population as a whole, as well as that from type 2 diabetes suffer around 90 % of diabetics in total [12, 13].

According to statistics, 5–75 % of ulcers lead to amputations, while the 5-year survival for inferior limbs amputations is around 40 % [14].

According to some studies, the cost of treatment for diabetic ulcers is around 7,000 euros, while the total cost of amputations is about 49,000 euro [15].

The purpose of the study. Our study is the first for diabetic foot in our country. The purpose of this study is to find the frequency of this complication, the most common clinical manifestation, as well as the effectiveness of conservative and surgical treatment in our country.

MATERIALS AND METHODS

This is a prospective study which was fulfilled in diabetic foot unit at the University Hospital «Shefqet Ndroqi» in Tirana. This unit was opened and has been working since March 1, 2013. We note that the diabetic foot unit at this hospital so far is the only one in our country.

To realize this study it was compiled a

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special file, based on clinical and scientific studies of the eminent endocrinologists and diabetologists of the world, and on the clinical and scientific studies presented at conferences of Diabetic Foot Study Group of EASD (European Association for the Study of Diabetes) held in the follow years 2010, 2011, 2012, 2013 and 2014.

The study was realised in the period, from January 10, 2014 until May 30, 2015.

During this period a total of 102 patients with diabetic foot was observed in the diabetic foot unit of our hospital. Only 53 of these patients, were hospitalized, constituting the object of our study; the other 49 patients were followed up, and they will be the subject of another study.

Neurological examination included the evalution of sensory and motor functions.

Evaluation of the sensory function was done with the help of Semmes-Weinstein monofilament (SWM), which is considered to be the gold standart to screen the loss of protective sensation, and pinprick testing. The motor function examination was conducted with neurological hammer, provoking achilles and patellar tendon reflexes.

The presence of autonomous diabetic neuropathy was estimated by the presence of dry skin of the damaged feet, lack of pilosity and hyperkeratosis too.

Blood circulation in the lower extremities was assessed with Doppler Ultrasound (Echo Doppler), while macroangiopathy (atherosclerosis) of lower extremities was accessed with CT Angiography.

Blood pressure was measured with sphygmomanometer in supine, seated and standing position.

Examination of bacterial flora and sensitivity testing was conducted in the microbiology laboratory of our hospital from samples taken from diabetic foot.

RESULTS AND DISCUSSION

Types of diabetes. Types of diabetes was established by the WHO criteria [16]. Six patients (11 %) from 53 hospitalized ones had type 1 diabetes mellitus, while 47 patients (89 %) had type 2 diabetes mellitus. Our data are in (consistence) with those of another authors [17, 18].

Gender. Based on the literature, diabetes affects both gender, predominantly male [17–20]. 41 of 53 hospitalized patients (77.3 %) were man, while 12 patients (22.7 %) were women.

The predominance of man with diabetic foot is explained by many reasons. The most important is the fact that the diabetic macroangiopathy, which actually is considered as a diabetic atherosclerosis, is affected more men than women [21, 22]. As seen, our data support the data of the above-mentioned authors [17–22].

Duration of diabetes. It is well known that the duration of diabetes mellitus is very important in the occurence of vascular and nervous complications. The estimation of type 1 diabetes duration is easy, because in this type of diabetes there are some permanent typical signs and symptoms: polyuria, polydipsia, polyphagia and weight loss. This onset of diabetes helps to determine the precise type of diabetes [23].

Various authors have found that in patients with type 1 diabetes mellitus, chronic complications appear not earlier than five years from the beginning of diabetes [23, 24].

Duration of type 2 diabetes mellitus can not be determined easily because, of the presence of long latent period which has two names: Impaired Glucose Tolerance (IGT) and Impaired Fasting Glucose Tolerance (IFGT). We note that often type 2 diabetes often is diagnosed in the late stages of vascular and nervous complications, that have started and developed during the period of latency mentioned above [17, 25].

According to our material, duration of type 1 diabetes was 13.9 years, while for type 2 diabetes it was 9.9 years. We emphasize that these data confirm those of another authors [17, 23–25].

The average age of patients. Clinical prac-

tice shows that the incidence of diabetic complications is related to the age of patients.

There are numerous mechanisms that explain this relationship, but the most important of them is the fact that clinical manifestations of diabetic macroangiopathy therefore diabetic atherosclerosis is more pronounced after the age of 40 years for men and after the age 60 years for women [18, 21, 27].

The women age of is explained by the fact that the level of estrogen after age of 60 years decreases more, while it is known that estrogens are hormones that inhibit atherosclerotic process [7, 26].

In our study, average age of 41 male patients was 59.51 years, while the female patients was 62.91 years. These data are similar to those of authors mentioned above [7, 18, 21, 27].

Rank equilibrium of diabetes. Working numerous experimental and clinical investigations have confirmed that the more balanced to be diabetes, the later show, and much easier will be its complications, and vice versa; less balanced to be diabetes the faster show and more severe will be complications [5, 27–30].

The most reliable indicator to assess the balance of diabetes mellitus is glucosilated hemoglobin (HbA_{1c}). Glucosilated hemoglobin (HbA_{1c}) expresses the average blood glucose memorial to three months ago, so that eritrocites live. Normal HbA_{1c} value is 6–6.5 % [27, 30].

Only 18 of 53 patients (11.4 %) had measured HbA_{1c}. The average value of HbA_{1c} in our patients was 8.4 ± 2.24 % (Standard deviation — SD). Despite of small numbers of our patients, these data confirm those of authors mentioned above [5, 27–30].

Smoking (over 20 cigarettes per day). Numerous clinical observations have shown that smoking increases the chances of atherosclerosis and in this case the possibility of the occurrence of diabetic macroangiopathy [8, 20, 21].

21 of 53 patients participated in the study, (40 %) did not drink and did not smoke, while 19 patients (36 %) had drunk earlier but had left at least 6 months to 2 years before hospitalization while 13 patients (24 %) had drank and drink regularly. Our data are similar to those of the authors who have been able to consult [8, 20, 21].

Arterial hypertension (TA $\geqslant$ 140 mm Hg systolic, while TA $\geqslant$ 90 mmHg diastolic). Countless studies have proved the important role of arterial hypertension in the appearance of vascular complications of diabetes, either micro or macrovascular.

Pathophysiologic mechanisms that explain these theories are numerous, but the most important is the mechanism, by which arterial hypertension favors and accelerates the development of atherosclerosis. According to our material 42 patients (79 %) had the arterial hypertension, while 11 patients (21 %) had normal blood pressure. Our data are consistent with the data of another authors [31, 32].

Infection. Infection caused by various pathogenic microorganisms is a key component, that is always present in the diabetic foot, especially in the wet ulcers and gangrene. The infection exacerbates many of the patient's clinical condition and in extreme cases the patients lead to septicemia, which can be complicated with septic shock [33–36].

According to bacteriological examination of patients with diabetic foot, microbial causes are given in the table 1.

Based on the above data, it appears that the microbial causes of diabetic foot are Gram positive bacteria. These data are fully comparable with those of the consulted authors.

Peripheral diabetic neuropathy. Peripheral diabetic neuropathy of the nerves of the lower extremities, sensory, motor or mixed, is quite common in patients with diabetic foot. In some cases it precedes the appearance of diabetes mellitus [37–39]. Peripheral sensory neuropathy had the patients, in which reflexes by Semmes-Weinstein monofilament (SWM) or by pinprick were reduced or missing. Peripheral motor neuropathy, had the patients in which achillian or patellar reflexes were reduced or missing.

Our data for peripheral diabetic neurophaty are given in table 2.

From our data results peripheral sensory diabetic neuropathy is discoreved more with pinprick (79 %) than with Semmes-Weinstein monofilament (SWM)(70 %); while mo-

tor peripheral diabetic neuropathy is discoverd equally, as with achillian reflex 77 % or with pateral reflex (78 %).

Based on this data, peripheral diabetic neuropathy is mix-type (peripheral sensory diabetic neuropathy and peripheral motor diabetic neuropathy). Our data are similar with data of other authors [37–39].

Diabetic autonomic neuropathy. Diagnostic criteria of autonomic diabetic neuropathy, are described in the rubric of *Material and Methods.*

According to our study, 36 patients (68 % of cases) had autonomic neuropathy, and 17 of them (32 %) were not affected by autonomic neuropathy. Our data are approximative with data of another authors [37–39].

Macroangiopathy (Atherosclerosis of the arteries) of lower extremieties. Just as peripheral diabetic neurophathy and autonomic diabetic neuropathy, macroangiophathy (atherosclerosis) of lower extremities, is very important component in the presence of diabetic foot, particulary in the presence of diabetic gangrene and plantar or shin trophic ulcers, too [1, 40–42].

As we described in rubric Material and Methods, disordes of blood circulation is evidenced by Doppler Ultrasound (Echo Doppler), based on intensity of noises, while macroangipathy (atherosclerosis), is evidenced by CT Angiography, based on occlusion of lumen of arteries or on narrowing of lumen of these arteries, as a result of thickening of intima layer of these arteries.

Our data show that in 13 patients (25 %), Doppler Ultrasound (Echo Doppler), didn't find the disorders of blood circulation, while CT Angiography didn't find the occlusion of lumen of arteries or does evidence narrowing of lumen of these arteries.

In 40 patients (75 %) Doppler Ultrasound (Echo Doppler), evidenced noises, while CT Angiography evidenced occlusion of lumen of arteries or narroing lumen of these arteries, too. Our data are comparative with data of other autors [1, 40–42].

The Clinical Manifestations of diabetic foot. The clinical manifestation of diabetic foot are described in the rubric: General information of diabetic foot

Our data for this manifestations are given in table 3.

As we can see from this table, more frequent (49 %) are dry and wet gangrene, and also plantar ulcers, and non plantar trophic ulcers, too. Our data in general are compatible with data of the other authors [1–3].

The system of classification of diabetic wounds. In the foreign literature there are numerous classifications of diabetic wounds, which are based on various clinical manifestations.

In our study, we used the classification by the University of Texas (USA). This system is based on the classification of its two key

Table 1

Microbial Causes of Infection in Diabetic Foot

Microbes	Nr. of cases	%
Staphylococcus aureus	14/53	27,78 %
Staphylococcus coagulase negative spp.	10/53	18,52 %
Streptococcus β haemoliticus	11/53	20,37 %
Enterobacteriaceae	11/53	20,37 %
Enterococcus spp.	3/53	5,56 %
Acinetobacter spp.	2/53	3,70 %
Pseudomonas aeruginosa	1/53	1,85 %
Corynebacterium spp.	1/53	1,85 %

elements: peripheral artery disease (PAD) and the presence of infection [43].

Our data are given in Table 4.

As seen from the table 4, in the appearance of diabetic foot, mainly for gangrene and ulcers manifestations, predominates stage are D. Even for other stages our data generally coincide with those of the authors to whom we have referred [46].

Treatment of diabetic foot

The treatment of diabetic foot with medicines. Treatment of diabetic foot with medicines includes the treatment of diabetes, the treatment of infection, local and general, as well as other medicines that affect positively additional medicines in the treatment of diabetic foot.

Treatment of diabetes mellitus accomplishes only with insulin. This means that patients who treated before with tablets, this medication was discontinued, and started treatment with insulin.

Treatment with insulin is based only on the concept, according to which, the emergence of a major late complications of diabetes requires medication with insulin only.

The treatment of diabetes with insulin is indicated and in the patients in which equilibrium of diabetes may be possible with the use of antidiabetic drugs.

Table 2

The data on sensory peripheral diabetic neuropathy and motor peripheral diabetic neuropathy

Discovery of Motor Peripheral Neuropathy	With Patelar Reflex	Missing	18/53 (34 %)
		Reduced	23/53 (44 %)
		Normal	12/53 (22 %)
	With Achillian Reflex	Missing	21/53 (39 %)
		Reduced	20/53 (38 %)
		Normal	12/53 (23 %)
Discovery of Sensory Peripheral Neurophathy	With Pinprick	Missing	11/53 (21 %)
		Reduced	31/53 (58 %)
		Normal	11/53 (25 %)
	With Monofilament	Missing	16/53 (30 %)
		Reduced	21/53 (40 %)
		Normal	16/53 (30 %)

Table 3

Clinical Manifestations of diabetic foot in patients of our study

Clinical Manifestations	**Nr. of cases (%)**
Dry Gangrene	6/53 (11 %)
Wet Gangrene	20/53 (38 %)
Plantar Ulcers	13/53 (24 %)
Non Plantar Ulcers	18/53 (15 %)
Osteomyelitis	2/53 (4 %)
Phlegmons	2/53 (4 %)
Charcot Neuroarthropathy	2/53 (4 %)

In patients with diabetic foot, the use of insulin is indispensable from presence of infection in these patients [27, 44–46].

For treatment was used insulin with prolonged action (insulin glargine), injected once a 24 hours, as a rule in 23.00 combined with short action insulin (Insuman Rapid), that was applied in the morning, noon and evening, 20 minutes before each meal. This scheme mimics insulin secretion of pancreatic beta cells, and in our opinion, as well as in opinion of other authors, it is the best insulin scheme [47–49].

Dosage of insulin was made by levels of glycemias, that were measured before each meal, two hours after meal, or by glycemic profile (three times before each meal, three times after each meal and in midnight).

In treatment of diabetic foot with medicines, the treatment with antibiotics is very important, because all patients had infection of foot.

Based on pharmacological mechanisms, all antibiotics are classified in two groups: bacteriostatic group that inhibit multiplication of microbes, and bactericid group that kill the microbes [50–52].

The treatment with antibiotics was done on the basis of antibioticograms, clinical effect

Table 4

Classification of diabetic wounds

Peripheral Arterial	Disease	Infection	Nr. of patients (%)
Stage A	–	–	8/53 (15 %)
Stage B	–	+	5/53 (10 %)
Stage C	+	–	14/53 (26 %)
Stage D	+	+	26/53 (49 %)

Table 5

The used antibiotics in patients with diabetic foot

Antibiotic Classes	The used Antibiotics
Penicillins	
Penicillinase resistant penicillins	Flucloxacilline
Penicillin — β-Lactamase Inhibitor Combinations	Co-Amoksiklav
Antipseudomonal Penicillins	Piperacilline me Tazobaktam
Glycopeptides	Vancomycine
Carbapenems	Imipenem me Cilastatine Meropenem
Cephalosporins	Ceftriaxone Cefuroxime Cefotaxime
Aminoglycosides	Amikacin Gentamicin
Quinolones	Ciprofloxacin Levofloxacin
Tetracyclines	Doxycycline
	Tigecycline
	Metronidazole

of antibiotics, and on available antibiotics in our hospital, too.

The antibiotics were used in parenteral way, intramuscular(I/m) or intravenous (I/v). Dosage of antibiotics for each patient was in dependence of many factors, mainly in dependence of its clinical effect and repeated antibioticograms.

The used antibiotics are given on table 5.

By data of table 5, results that antibiotics used in our hospital generally were the same with antibiotics used in units of diabetic foot of different countries [53–55].

The surgical treatment of diabetic foot. Surgical treatment includes local treatment of diabetic wounds, microsurgical procedures, as well as those macrosurgical procedures too.

For local treatment were used flushing solutions with 0.9 % sodium chloride solution (irrigation solution of sodium chloride 0.9 %).

The local treatment of ulcers was done with bandages, with hydrogel (hydrogel dressings), and for treatment of wet ulcers were used saturated bandages with silver (silver dressings), dren, sponges Dren (drain sponge), and the local application of vancomycin.

Regarding microsurgical procedures, which are performed in the treatment room, were are applied: selective removal of dead tissue (necrectomy), debridement and minor amputations of fingers.

Regarding macrosurgical procedures which were committed in operating rooms, we mention: amputations transmetatarsale, transtarsale and the amputation of damaged extremity, as well as surgical interventions for Charcot neuropathy.

Amputations were applied in three patients with wet (moist) gangrene, in which the microsurgical procedures didn't have the result.

In two patients, amputation was made over the knee in a middle third of the thigh, while in one patient, the amputation was made under the knee, to a third of the shin.

CONCLUSIONS

1. As for other countries, for our country diabetic foot is a medical problem that requires a solution step by step.
2. According to our study, in the emergence and in the progress of diabetic foot was evidenced the primary role of peripheral artery disease, namely ischemia of lower damaged extremity and the role of infection on this extremity.
3. From clinical manifestations of diabetic foot, dry and wet gangrene are 49 %, while plantar and non plantar ulcers are 39 %. These manifestations were more prominent in our patients with diabetic foot.

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КЛІНІЧНІ АСПЕКТИ ДІАБЕТИЧНОЇ СТОПИ

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У даній статті наведені результати обстеження 102 пацієнтів, які страждають на цукровий діабет 1 і 2 типу з синдромом діабетичної стопи. Середня тривалість ЦД 1 типу склала 13,9 років; ЦД 2 типу — 9,9 років. Середній рівень HbA_{1c} $8{,}4 \pm 2{,}2\,\%$. У цих пацієнтів в динаміці визначені моторна і сенсорна функції, виконано допплерографичне дослідження судин нижніх кінцівок, мікробіологічне дослідження з визначенням чутливості до антибіотиків. У 68 % пацієнтів діагностована автономна нейропатія. При допплерографиченому дослідженні у 75 % — оклюзія артерій; у 25 % — порушення кровотоку не виявлено. У 49 % — суха і волога гангрена. Проведене лікування спрямоване на компенсацію вуглеводного обміну, пригнічення інфекційного процесу, усунення виразкових дефектів. У 3-х пацієнтів консервативна терапія була неефективною, в зв'язку з чим, їм була виконана ампутація. Даним дослідженням, виконаним вперше в Албанії, ще раз підтверджена важливість проблеми синдрому діабетичної стопи та необхідність враховування даної патології в повсякденній лікарській практиці.

К л ю ч о в і с л о в а: цукровий діабет, діабетична стопа.

КЛИНИЧЕСКИЕ АСПЕКТЫ ДИАБЕТИЧЕСКОЙ СТОПЫ

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В данной статье приведены результаты обследования 102 пациентов, страдающих сахарным диабетом 1 и 2 типа с синдромом диабетической стопы. Средняя продолжительность СД 1 типа составила 13,9 лет; СД 2 типа – 9,9 лет. Средний уровень HbA_{1c} $8{,}4 \pm 2{,}2\,\%$. У этих пациентов в динамике определены моторная и сенсорная функции, выполнено допплерографическое исследование сосудов нижних конечностей, микробиологическое исследование с определением чувствительности к антибиотикам. У 68 % пациентов диагностирована автономная нейропатия. При допплерографическом исследовании у 75 % — окклюзия артерий; у 25 % – нарушение кровотока нижних конечностей не выявлено. У 49 % – сухая и влажная гангрена. Выполняемое лечение направлено на компенсацию углеводного обмена, подавление инфекционного процесса, устранение язвенных дефектов. У 3-х пациентов консервативная терапия была неэффективной, в связи с чем, им была выполнена ампутация. Данным исследованием, выполненным впервые в Албании, еще раз подтверждена важность проблемы синдрома диабетической стопы и необходимость учитывать данную патологию в повседневной врачебной практике.

К л ю ч е в ы е с л о в а: сахарный диабет, диабетическая стопа.

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This article presents the results of a survey of 102 patients with diabetes mellitus type 1 and 2 diabetic with diabetic foot syndrome. The mean duration of type 1 diabetes was 13.9 years; type 2 diabetes — 9.9 years. The average level of HbA_{1c} was $8{,}4 \pm 2{,}2\,\%$. We examined motor and sensory functions of these patients, performed Doppler examination of the lower extremities vessels, microbiological examination with sensitivity to antibiotics. 68 % of the patients were diagnosed with autonomic neuropathy. Doppler examination revealed occlusion of the arteries in 75 % of cases. 49 % of patients suffered from dry and wet gangrene. The aim of the treatment was compensation of carbohydrate metabolism, inhibition of the infection process and elimination of ulcers. In 3 patients, conservative therapy was ineffective, and therefore, the amputation was performed. This study like previous one performed in Albania, once again confirmed the importance of the problem of diabetic foot syndrome and the need to address this pathology in everyday medical practice.

K e y w o r d s: diabetes mellitus, diabetic foot.