DOI 10.26724/2079-8334-2024-4-90-112-117
UDC 616.379–008.64–06

R.A. Prykhidko, O.H. Krasnov, M.O. Dudchenko, M.I. Kravtsiv, S.M. Zaiets, D.M. Ivashchenko, O.I. Krasnova
Poltava State Medical University, Poltava

CURRENT PRINCIPLES OF DIAGNOSIS AND TREATMENT OF BONE LESIONS IN PATIENTS WITH DIABETIC FOOT SYNDROME

e-mail: krasnovoleh0601@gmail.com

One of the most unresolved issues in patients with diabetic foot syndrome is the diagnosis and treatment of bone tissue lesion. The aim was to compare the results of treatment of bone tissue lesions in patients with diabetic foot syndrome and to highlight the factors of prevention of limb amputation. We have carried out treatment of 658 patients with diabetic foot syndrome. High amputation of lower limb in the control group were performed more often. Mortality was higher in the control group. At the same time, the supporting function of the foot in patients was preserved more often in the main group. Radical surgical treatment of osteomyelitis leads to a reduction in the duration of treatment of patients with diabetic foot syndrome and an increase in the number of surgical interventions. However, conservative therapy of osteomyelitis reduces the risk of impaired foot support function and high amputation of the lower limb.

Key words: diabetic foot syndrome, osteomyelitis, treatment, osteoarthropathy.

Р.А. Прихідько, О.Г. Краснов, М.О. Дудченко, М.І. Кравців, С.М. Заєць, Д.М. Іващенко, О.І. Краснова

СУЧАСНІ ПРИНЦИПИ ДІАГНОСТИКИ ТА ЛІКУВАННЯ КІСТКОВИХ УРАЖЕНЬ У ХВОРИХ З СИНДРОМОМ ДІАБЕТИЧНОЇ СТОПИ

Одним із найбільш невирішених питань у пацієнтів із синдромом діабетичної стопи є діагностика та лікування ураження кісткової тканини. Метою було порівняти результати лікування уражень кісткової тканини у хворих на синдром діабетичної стопи та висвітлити чинники профілактики ампутації кінцівки. Проведено лікування 658 хворих на синдром діабетичної стопи. Високі ампутації нижньої кінцівки в контрольній групі проводили частіше. Смертність була вищою в контрольній групі. При цьому опорна функція стопи у пацієнтів зберігалася частіше в основній групі. Радикальне хірургічне лікування остеомієліту призводить до скорочення термінів лікування хворих на синдром діабетичної стопи та збільшення кількості оперативних втручань. Проте консервативна терапія остеомієліту знижує ризик порушення опорної функції стопи та високої ампутації нижньої кінцівки.

Ключові слова: синдром діабетичної стопи, остеомієліт, лікування, остеоартропатія.

The work is a fragment of the research project "Development of modern scientifically based principles of stratification, monitoring and forecasting of the course of surgical diseases and injuries", state registration No. 0120U101176.

One of the most severe complications of diabetes mellitus (DM) is diabetic foot syndrome (DFS), which is a specific combination of foot lesions in diabetes, which is based on angiopathy, peripheral neuropathy and osteoarthropathy of the lower extremities with various purulent-necrotic complications [9, 11, 14]. According to statistics, DFS develops in more than 10 % of patients and requires surgical treatment in two thirds of them [1, 12]. Only a third of diabetic ulcers heal and in 28 % of cases they can lead to limb amputation [1, 4, 9].

In 10 to 50 % of patients with DFS, bone lesion (BL) is observed in the form of osteomyelitis (OM), diabetic osteoarthropathy (DO), which are one of the most difficult manifestations of DFS in diagnostic and treatment terms with a high risk of relapse [2, 6, 8]. Moreover, now the role of OM as a cause of high amputation of limbs has increased due to the reduction of vascular complications in DM due to the development of vascular reconstruction methods [12, 9, 14]. Early diagnosis of OM and DO, their differential diagnosis in patients with DFS is very difficult, and the presence of a pronounced pattern of OM in such patients leads to a high risk of limb amputation and disability [2, 3, 5].

For a long time, it was believed that the treatment of BL should involve mandatory radical removal of infected bone tissue [4, 7, 10]. However, certain parts of the foot play an important role in maintaining the supporting function of the foot, especially against the background of severe distal neuropathy and DO. Resection of an important area of the foot can lead to disruption of its supporting function and its further destruction [1, 5, 11].

Recently, there have been views about the possibility and effectiveness of a conservative approach to the treatment of BL [1, 2, 14]. Proponents of conservative treatment focus on prolonged antibacterial therapy, supplemented in some cases by staged necrectomies. The main goal of treatment for BL is not so much to preserve the integrity of the foot at any cost, but to improve the patient's quality of life, preserve

the support ability of the foot, wound healing and their prevention [4, 9, 14]. All this indicates the relevance of the problem of BL in patients with DFS and the need for its further study.

The purpose of the study was to compare the results of treatment of bone tissue lesions in patients with diabetic foot syndrome and to highlight the factors of preservation of the supporting function of the foot and prevention of high limb amputation.

Materials and methods. In the outpatient and surgical departments of the Second and Third City Hospitals of Poltava and the Medical Center "Medion", during 2013–2023, we conducted a comprehensive examination and treatment of 658 patients with grades IIB–IIIB of DFS according to Maggitt-Wagner.

The first (main) group (315 patients) consisted of patients in whom modern approaches were used with a predominance of conservative treatment. The second (control) group (343 patients) consisted of patients in whom radical surgical treatment prevailed. Patients of both groups were divided into two subgroups: I – with neuropathic form of DFS, II – with neuroischemic form of DFS. The Maggitt-Wagner classification was used to determine the clinical form of DFS. In patients with osteoarthritis, we used the clinical classification of Rogers L., 2012.

Patients in both groups underwent a comprehensive examination: general clinical examination, foot radiography, doplerometry, ultrasound duplex scanning of the arteries of the lower extremities, bacteriological examination of the wound, measurement of the wound area according to indications, and consultation with an endocrinologist. If there was any doubt about the presence of OM, we performed a bone tissue biopsy in 13 patients of the main group. Special bone biopsy needles were used for the procedure [9, 14].

The obtained digital material of the study results was subjected to statistical processing using the Statistica 9.0 program and a comparison of the average indicators was carried out between patients with neuropathic and neuroischemic forms of DFS, as well as between patients of the main and control groups. The results were considered statistically significant at $p<0.05$.

Results of the study and their discussion. The duration of diabetes was less than 10 years in 133 (42.2 %) patients of the main group and 158 (46.1 %) patients of the control group. Insulin-dependent DM was observed in 53 (16.8 %) patients in the main group and in 42 (12.2 %) patients in the control group. Women aged 45 to 75 years predominated in both groups. Neuroischemic form of DM was revealed in 57 (18.1 %) patients in the main group and in 59 (17.2 %) in the control group. The remaining patients had neuropathic form of DM. Wounds and ulcers were localized in the zones of the greatest pressure during walking, their average area was 2.2±0.3 cm^2. In 295 (93.7 %) patients of the main group and in 317 (92.4 %) of the control group, the main blood flow in the femoral-popliteal segment was preserved. Tactile sensitivity was preserved in 207 (65.7 %) patients of the main group, temperature sensitivity was preserved in 51 (16.2 %) patients, pain sensitivity of the feet – in 205 (65.1 %) examined patients. Thus, manifestations of neuropathy of varying severity were characteristic of all patients with DFS.

Patients with DFS had different depths of foot lesions. Grade IIB according to Maggitt-Wagner was detected in 191 (60.7 %) patients of the main group and in 239 (69.7 %) patients of the control group, which corresponded to stage C according to the Rogers classification. Grade III according to Maggitt-Wagner was detected in 124 (39.3 %) patients of the main group and in 104 (30.3 %) patients of the control group, which corresponded to stage D according to Rogers' classification. Destructive changes in bones without skin lesions were observed in 11 (3.5 %) patients of the main group and in 9 (2.6 %) patients of the control group. A combination of bone destruction with soft tissue defects was present in 113 (35.8 %) patients of the main group and in 95 (27.7 %) patients of the control group; soft tissue defects were in the form of deep foot ulcers and fistulas. Bone tissue was rough upon palpation and had the appearance of "melting sugar".

Radiologically, changes in bone destruction were manifested by the disappearance of the bone contour, decreased bone density, and in the case of destruction of the joints of the foot – in the form of a violation of congruence and an increase in the joint space, ulceration of the joint contours. Destructive changes were not always detected by radiography, which we observed in 46 (37.1 %) patients of the main group and in 41 (39.4 %) patients of the control group with OM. Thus, the absence of radiological signs of bone destruction is not evidence of bone integrity [1, 13, 14]. Magnetic resonance imaging (MRI) and CT scans were used to diagnose OM in patients of the main group in the absence of its signs on the radiograph and the presence of a clinical picture of bone destruction [9, 13, 14]. The localization of the foot lesion was different, thus, the distal part of the foot (toes, metatarsal bones) was affected in 72 (58.1 %) patients in the main group and 76 (73.1 %) in the control group; the proximal part of the foot (arch, heel area) was affected

in 41.9 % and 26.9 % of patients, respectively. Neuropathic and neuroischemic ulcerative defects prevailed among the ulcerative defects of the foot. When studying the flora of wounds, streptococcal infection was observed more often in the control group than in the main group – in 110 (32.1 %) and 66 (20.9 %) patients, respectively. In addition, Pseudomonas aeruginosa was cultured more often in the main group – in 37 (11.7 %) and 24 (6.9 %) patients, respectively (Table 1).

Table 1

Characteristics of microbial flora isolated from wounds of patients

Microorganism	Main group (315 patients)		Control group (343 patients)	
	Neuropathic form (258 patients)	Neuroischemic form (57 patients)	Neuropathic form (284 patients)	Neuroischemic form (59 patients)
Staphylococcus	66 (25.6 %)	12 (21.1 %)	37 (13.1 %)	4 (6.8 %)
Streptococcus	61 (23.6 %)	5 (8.8 %)	98 (34.5 %)	12 (20.3 %)
Enterococcus	41(15.9 %)	10 (17.5 %)	36 (12.7 %)	8 (13.6 %)
Proteus	38 (14.7 %)	6 (10.5 %)	26 (9.2 %)	3 (5.1 %)
Escherichia coli	7 (2.7 %)	3 (5.3 %)	5 (1.8 %)	2 (3.4 %)
Klebsiela	8 (3.1 %)	3 (5.3 %)	4 (1.4 %)	0
Pseudomonas aeruginosa	26 (10.1 %)	11 (19.3 %)	17 (5.9 %)	7 (11.9 %)
Citrobacter	16 (6.2 %)	2 (3.5 %)	9 (3.2 %)	1 (1.6 %)
Other microorganisms	9 (3.5 %)	2 (3.5 %)	6 (2.1 %)	2 (3.4 %)

In 65.7 % of patients in the main group, a mixed infection was cultured. A combination of 2–3 types of microorganisms was observed in 148 (46.9 %) patients in the main group and in 120 (34.9 %) in the control group, and the presence of 4–8 microorganisms was observed in 59 (18.7 %) patients in the main group and in 41 (11.9 %) – control group. Thus, in the main group, associations of several microorganisms were detected more often than in the control group.

The microbial composition of superficial and deep ulcers did not differ. There were also no differences in the composition of the microflora in patients with bone tissue destruction. Associations of 2–3 microorganisms and monoinfections were more common in the neuroischemic form, and with 4–8 microorganisms – in the neuropathic form. In case of superficial lesions of foot tissues, gram-positive microorganisms were isolated from wounds. With deep lesions in the wounds, gram-negative and anaerobic microorganisms were detected.

For bacteriological and histological examination, 2–3 samples were taken from 13 patients of the main group if the presence of OM was doubtful. The biopsy is performed through uninfected skin. Based on the results of pathohistological examination of punctures, we found a picture of acute OM in 2 (15.4 %) patients, chronic OM in 7 (53.8 %) patients, and DO without OM in 4 (30.8 %) patients. In acute OM, foci of degeneration, a cellular resorption and sequestra of various shapes were detected in the bone tissue. In the bone marrow spaces, neutrophilic foci and polymorphic cell infiltration of the vessel walls were noted. In chronic OM, bone beams of different thicknesses, blurred contours, and foci of bone resorption were identified. In the bone marrow spaces there were areas of granulation and fibrous tissue; infiltration by lymphocytes, macrophages, fibroblasts, and areas of fibrosis were observed in the surrounding soft tissues. The morphological substrates of DO were dystrophy and the regenerative process, foci of acellular and cellular resorption of bone tissue and foci of osteogenesis.

Conservative therapy for BL in patients with DFS was possible with positive dynamics of the wound process, absence of infection progression, and in the presence of soft tissue ischemia and with damage to the proximal part and arch of the foot.

In the presence of destructive changes, in the presence of ischemia, the question of the need and possibility of vascular reconstruction was decided. In the absence of critical ischemia of the limb, the patient with grades II, III B according to Wagner was treated on an outpatient basis; in the case of an active purulent-necrotic process, the patient was referred to the second level of medical care in the hospital. Complicated cases of DFS required hospitalization in 136 (43.2 %) patients of the main group and in 158 (46.1 %) patients in the control group.

In both groups, patients received drug therapy, which included compensation of carbohydrate metabolism; elimination of manifestations of critical foot ischemia in the neuroischemic form of DFS; antibacterial therapy taking into account the sensitivity of microflora; metabolic therapy was prescribed for the neuropathic form of DFS; symptomatic therapy. We sought to begin antibacterial therapy in such patients as early as possible. In this case, the following factors were taken into account: results of

microbiological testing, severity, risk of complications, previous use of antibiotics. The duration of the course was at least seven days for standard antibacterial therapy and was based on a clinical assessment of the course of the wound process. If resection of bones altered due to OM was performed, antibacterial therapy was prescribed for a short course of one to two weeks. In cases where conservative therapy was carried out for OM, a prolonged course of antibacterial therapy was prescribed for several weeks. In the presence of OM, we prescribed antibiotics for up to six weeks, using parenteral or oral forms of antibiotics. To correct DO, we used foot unloading: immobilizing unloading bandages, bed rest, wearing orthopedic shoes that reduce the load on the foot, crutches.

When performing local treatment, we took into account the phase of the wound process. In the first phase of the wound process, we used hydrophilic preparations, dressings with aqueous solutions of antiseptics and antibiotics. In the cleansing phase, ointments on a hydrophilic basis were used. In the regeneration phase, preparations aimed at accelerating wound healing and epithelialization were used. We used modern wound dressings taking into account the phase of the wound process to comply with the principle of "moist wound healing". Local treatment of wounds also included removal of areas of hyperkeratosis and primary treatment of the ulcer.

The decision to surgically treat BL in DFS was made in cases of infection spreading to soft tissues, progressive bone destruction according to X-ray examination, MRI and CT scans, as well as in the presence of bone in the wound. In the case of the destructive process of foot tissue, various types of necrectomies were performed. Necrectomies were carried out by a mechanical, chemical method, with the help of applying a wound dressing.

Opening of the abscess and phlegmon of the foot was carried out in 54 (17.1 %) patients of the main group, amputation and disarticulation of the fingers – in 78 (24.8 %), resection or amputation of the foot – in 14 (4.4 %) patients, necrectomy, including and multiple (staged) were performed 152 times in patients of the main group.

In the control group, opening of the abscess and phlegmon of the foot was performed in 38 (11.1 %) patients, amputation and disarticulation of the fingers – in 157 (45.8 %), resection or amputation of the foot – in 37(10.8 %), necrectomy, including reusable ones were executed 127 times.

In 4 (1.3 %) patients of the main group, amputations were performed at the level of the shin and in 6 (1.9 %) – at the level of the thigh. In 8 (2.3 %) patients of the control group, amputations were performed at the level of the shin and in 13 (3.8 %) – at the level of the thigh. 3 (1.0 %) patients of the main group and 6 (1.8 %) patients of the control group died against the background of the treatment. The average terms of wound healing were 37.4±1.5 days in the main group and 24.3±1.6 days in the control group. At the same time, the supporting function of the foot was preserved in 253 (80.3 %) patients in the main group and in 141 (41.1 %) in the control group (Table 2).

Table 2

Operative interventions were performed in the main and control groups in patients with DFS and the results of treatment

	Amputations at the level of the lower leg	Amputations at the level of the thigh	Died	Preservation of the supporting function of the foot	Mean wound healing times, days
	abs. (%)	abs. (%)	abs. (%)	abs. (%)	
Main group (n=315)	4 (1.3 %)	6 (1.9 %)	3 (1.0 %)	253 (80.3 %)	37.4±1.5
Control group (n=343)	8 (2.3 %)	13 (3.8 %)	6 (1.8 %)	141 (41.1 %)	24.3±1.6

Therefore, amputations at the level of the leg and thigh in the control group were performed more often than in the main group. Mortality was higher in the control group than in the main group. Mean wound healing times were longer in the main group than in the control group. At the same time, the supporting function of the foot in patients was preserved more often in the main group than in the control group.

The ineffectiveness of the treatment of OM in our patients was observed in cases when the spectrum of action of antibacterial drugs did not overlap the action of microorganisms, the therapy did not last long enough time, the drugs did not penetrate the bone, or areas of infected bone tissue remained after surgery.

The main risk factor for the development of DFS is neuropathy [5, 11, 14]. D. Armstrong identifies the most important risk factors for the development of DFS, most of which are associated with neuropathy [3]. Neurological disorders are an extremely early sign of the disease. According to our data, a clinical study of the state of peripheral somatic innervation showed that manifestations of neuropathy

are characteristic of all patients. In this regard, we agree with the statement [1, 3, 14] that damage to the nervous system is the main pathogenetic factor in the development of destruction of soft tissues and bones in DFS.

Thus, trophic changes in the soft tissues and bones of the lower extremities against the background of neuropathy create conditions for the development of purulent-necrotic processes in the soft tissues and bones of the foot. In addition, these factors significantly reduce the healing processes in tissues and bones, which has a negative impact on the results of treatment [1, 3, 4]. Neuropathy in combination with foot deformation when walking leads to an increase in local pressure in certain areas of the foot, to damage to soft tissues and bones [5, 14, 15].

It is necessary to carry out a differential diagnosis of OM with DO – non-infectious bone destruction due to neuropathy [2, 9, 15]. Its acute phase with swelling of the foot, local hyperthermia, and induration is replaced by a chronic course, when pathological dislocations and fractures, bone deformations with the formation of ulcers are observed [2, 6]. Unlike OM, diabetic osteoartopathy often requires conservative therapy, which is aimed at slowing osteoporosis, unloading the foot, and relieving inflammation [6, 9, 14]. Bone changes in DO may mimic infectious bone destruction.

The diagnosis of OM should be considered in those cases when the ulcer does not heal for more than six weeks and has a great depth, bone is visible in the wound or a probe detects it during revision. According to many researchers, the most reliable method for detecting OM is MRI and CT scans, which we used widely in patients of the main group [9, 14, 15]. However, the standard for diagnosing OM remains a bone biopsy with microbiological examination [2, 9, 13]. The availability of bone tissue research data allows choosing the right treatment tactics and strategy.

Neuropathy and subtle manifestations of OM lead to the fact that the patient often feels satisfactory and is treated conservatively for a long time. This has led many surgeons to treat these patients with minimal surgical activity [1, 5, 14]. According to our observations, conservative treatment of OM with long-term use of antibiotics is possible when radical treatment of OM can lead to loss of limb function, if there is limb ischemia and it is impossible to perform vascular reconstruction, and the tissue defect is minimal, or in cases where radical treatment carries a high risk for the patient's life.

The decision to surgically treat BL in DFS should be made when the bone prolapses into the wound, increasing bone destruction and when infection spreads to soft tissues with the formation of phlegmons and abscesses [1, 9, 14]. Traditionally, resection of the affected bone is performed within the intact tissue. At the same time, the most common amputations of the first toe with part of the first metatarsal bone and transmetatarsal amputations of the foot lead to anatomical and functional changes and redistribution of areas of increased plantar pressure, with the emergence of new trophic ulcers and areas of bone destruction [1, 3, 8]. In many cases, resection of the metatarsal bones leads to faster healing of wounds, a decrease in the frequency of relapses and the duration of hospitalization compared to conservative treatment [7, 9, 10].

As our research showed, in the control group with radical treatment of the focus of BL, the number of operations in the presence of BL was almost twice as high as in the main group. In addition, the average duration of treatment was 1.5 times less in the control group. However, the supporting function of the foot was preserved in the main group 1.8 times more often than in the control group. At the same time, the number of high amputations of the lower limb in the control group was 1.9 times higher, and the mortality rate was 1.75 times higher than in the main group, where organ-preserving therapy prevailed.

Therefore, a differentiated approach to the treatment of chronic osteomyelitis, including taking into account the etiology, helps to reduce the probability of an unsuccessful treatment outcome and high limb amputation.

Conclusions

1. Radical surgical treatment of OM leads to a reduction in the treatment time of patients with SDS and an increase in the number of surgical interventions. However, conservative therapy of OM with long-term antibacterial therapy against the background of economical surgical interventions reduces the risk of impairment of the supporting function of the foot and high amputation of the lower limb, which is especially significant in case of damage to the proximal part and arch of the foot.

2. The correct ratio between radical resection of the affected bone tissue and preservation of the anatomy of the foot with long-term antibacterial therapy should be based on the characteristics of the patient's condition, the course of the wound process, the structure and biomechanics of the foot.

3. Control of DO, early diagnostics of OM of the foot and an individual approach to surgical treatment and antibacterial therapy of OM can improve the quality of life of patients with diabetes and prevent the loss of the lower limb.

References

1. Krasnov OH, Liakhovskyi VI, Liulka OM, Kravtsiv MI, Al-masri AM, Kyzymenko OO. Udoskonalennia orhanozberihaiuchoho likuvannia syndromu diabetychnoi stopy z urakhuvanniam osoblyvostei perebihu ranovoho protsesu. Klinichna khirurhiia. 2015; 11.2 (880): 72–74 [in Ukrainian].
2. Aragon-Sanchez J, Lipsky BA. Modern management of diabetic foot osteomyelitis. The when, how and why of conservative approaches. Expert Rev Anti Infect Ther. 2018; 16: 35–50. doi:10.1080/14787210.2018.1417037.
3. Armstrong DG, Boulton AJM, Bus SA. Diabetic Foot Ulcers and Their Recurrence. N Engl J Med. 2017; 376(24): 2367–75. doi:10.1056/NEJMra1615439.
4. Brownrigg JR, Hinchliffe RJ, Apelqvist J, Boyko EJ, Fitridge R, Mills JL, et al. Performance of prognostic markers in the prediction of wound healing or amputation among patients with foot ulcers in diabetes: a systematic review. Diabetes Metab Res Rev. 2016; 32 Suppl 1:128–35. doi: 10.1002/dmrr.2704.
5. Crawford F, Cezard G, Chappell FM, Murray GD, Price JF, Sheikh A, et al. A systematic review and individual patient data meta-analysis of prognostic factors for foot ulceration in people with diabetes: the international research collaboration for the prediction of diabetic foot ulcerations (PODUS). Health Technol Assess 2015 Jul; 19(57):1–210. doi: 10.3310/hta19570.
6. Elmarsafi T, Kumar A, Cooper PS, Steinberg JS, Evans KK, Attinger ChE, et al. Concordance Between Bone Pathology and Bone Culture for the Diagnosis of Osteomyelitis in the Presence of Charcot Neuro-Osteoarthropathy. J Foot Ankle Surg. 2018; 57(5):919–923. doi: 10.1053/j.jfas.2018.03.016.
7. Game FL, Apelqvist J, Attinger C, Hartemann A, Hinchliffe RJ, Löndahl M et al. Effectiveness of interventions to enhance healing of chronic ulcers of the foot in diabetes: a systematic review. Diabetes Metab Res Rev. 2016; 32 (Suppl 1):154–168. doi: 10.1002/dmrr.2707.
8. Jupiter DC, Thorud JC, Buckley CJ, Shibuya N. The impact of foot ulceration and amputation on mortality in diabetic patients. I: From ulceration to death, a systematic review. Int Wound J. 2016 Oct; 13(5):892–903. doi: 10.1111/iwj.12404.
9. Lipsky BA, Senneville É, Abbas ZG, Aragón-Sánchez J, Diggle M, Embil JM, et al. Guidelines on the diagnosis and treatment of foot infection in persons with diabetes (IWGDF 2019 update). Diabetes Metab Res Rev. 2020; 36(S1): e3280. doi: 10.1002/dmrr.3280.
10. Peters EJG, Lipsky BA, Senneville É, Abbas ZG, Aragón-Sánchez J, Diggle M, et al. Interventions in the management of infection in the foot in diabetes: a systematic review. Diabetes Metab Res Rev. 2020 Mar; 36 Suppl 1: e3282. doi: 10.1002/dmrr.3282.
11. Pickwell K, Siersma V, Kars M, Apelqvist J, Bakker K, Edmonds M et al. Predictors of lower-extremity amputation in patients with an infected diabetic foot ulcer. Diabetes Care. 2015; 38:852–857. doi: 10.2337/dc14– 1598.
12. Puzyrov GS, Lyakhovskyi VI, Shepitko VI, Sydorenko AV. Morphological justification of the stepwise dosed balloon angioplasty application compared to standard methods in patients with diabetic foot. World of medicine and biology. 2020; 3 (73): 87–91. doi:10.26724/2079-8334-2020-3-73-87-91.
13. Ramanujam CL, Han D, Zgonis T. Medical Imaging and Laboratory Analysis of Diagnostic Accuracy in 107 Consecutive Hospitalized Patients With Diabetic Foot Osteomyelitis and Partial Foot Amputations. Foot Ankle Spec 2018; 11:433–43. doi: 10.1177/1938640017750255.
14. Schaper NC, van Netten JJ, Apelqvist J, Bus SA, Hinchliffe RJ, Lipsky BA. IWGDF practical guidelines on the prevention and management of diabetic foot disease (2019), https://iwgdfguidelines.org/wp–content/uploads/ 2021/03/IWGDF–2019–final.pdf [Access January 2024]. doi: 10.1002/dmrr.3266.
15. Senneville É, Lipsky BA, Abbas ZG, Aragón-Sánchez J, Diggle M, Embil JM, et al. Diagnosis of infection in the foot in diabetes: a systematic review. Diabetes Metab Res Rev. 2020; 36(S1):e3281. doi: 10.1002/dmrr.3281.

Стаття надійшла 8.01.2024 р.