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## A multidisciplinary approach to performing endovascular operations and economical foot amputations against the background of chronic threatening ischemia of the lower extremities (CLTI)

**The aim of the work:** to determine the effectiveness of a multidisciplinary approach to the treatment of chronic threatening ischemia of the lower extremities associated with necrotic changes in the area of the foot.

**Materials and Methods.** The results of the use of endovascular operations in 39 patients with CLTI IV class were analyzed according to the Fontaine classification (category 6 according to the Rutherford classification), with open wounds after amputation of a part of the foot due to dry gangrene and PRP and PRF therapy using the PRGF®-ENDORET® technology, according to the examination and conclusions of the multidisciplinary team. The control group consisted of 41 patients with a similar pathology and stage of the necrotic process, in the treatment of which no relevant specialists were involved, and the treatment of open wounds after amputation of a part of the foot due to dry gangrene was carried out according to traditional methods. The average age of the patients was 56.7±9.3 years, all men. A multidisciplinary team consisting of vascular surgeons, ultrasound specialists and angiologists, an interventional physician, an orthopedic surgeon, and functional diagnosticians was created for the specific treatment tactics of the above-mentioned patients. In order to determine the indications for performing small amputations on the foot, we performed a comprehensive assessment of the limb's blood supply after endovascular operations and the use of platelet-rich plasma.

**Results and Discussion.** The use of endovascular operations in combination with PRP and PRF has a positive effect on the blood supply in the ischemic limb. This is evidenced by: improvement of indicators of microcirculation, speed of blood flow, increase of local skin temperature on the foot, indicators of the Ankle Brachial Index. As our studies have shown, the activity of the tyrosine kinase system, as well as the peculiarities of the cytokine relationship, which is a reflection of the processes of alteration and proliferation in the wound, can be an objective criterion for skin autotransplantation on the wound surface. After consultation with an orthopedist, we performed amputation of the foot: according to Garangeau – in 10 patients, according to Chopar – in 51 cases, according to Lisfranc or Lisfranc-Haye in 19 patients. Due to the lack of skin flaps, the wounds were treated by an open method followed by autodermoplasty, except for 39 patients (after endovascular surgery and PRP therapy), who were stimulated on the 5-6th day after foot amputation with the help of a plasma membrane (PRGF supernatant) ®-Endoret®), enriched with a growth factor, which covered the entire area of the wound surface.

**Keywords.** Chronic threatening ischemia of the lower extremities; multidisciplinary team; endovascular operations.

**Introduction.** Chronic limb threatening ischemia (CLTI) is the final stage of peripheral arterial disease and is associated with a high level of limb loss and mortality [1,2]. In this regard, the problem of preservation of the limb in the case of CLTI, against the background of which necrotic processes occur in the distal part of the foot, remains unsolved. In such cases, it is necessary to solve several tactical issues at the same time: the method of revascularization of the limb followed by economical amputation of the foot, stimulation of the regeneration process in the wound, determination of criteria for performing autodermal plastic surgery of its surface [3]. Based on this, the choice of surgical tactics in patients with CLTI is the biggest modern problem in angiosurgery [4,5,6,7].

The solution to this problem lies in the optimal approach to the treatment of CLTI, which are based on recommendations of the Global vascular guidelines on the management of chronic limb-threatening ischemia (2019), based on the paradigm of scientifically based limb revascularization – PLAN (Patient risk, Limb severity, and Anatomic complexity and WI-FI (wound, ischemia, foot infection) [1]. Numerous studies have demonstrated the high clinical effectiveness of this approach to the treatment of CLTI. In particular, a strong correlation was demonstrated between the WI-FI score, 1-year amputation-free survival, wound healing, and the need for limb revascularization [8,9,10,11]. Following these recommendations, it is possible not only to decide on the method and scope of the revascularization oper-

ation, but also on the indications for performing minor amputations involving the fingers or part of the foot. If enough attention is paid to the tactical and technical aspects of the surgical treatment of CLTI, then the issue of wound healing that occurs after amputation of the foot against the background of this pathology is not fully resolved. It is clear that the wound healing process in this category of patients depends on numerous factors, in particular: the degree of blood supply to the distal parts of the limb and foot, which will itself depend on the course of the wound process, local tissue resistance to microbial flora, etc. It is also important from a practical point of view to reduce the time it takes to prepare these wounds for autodermoplasty, which is necessary to resolve the issue of preserving the supporting function of the foot and further rehabilitation of the patient [12,13].

In this regard, the involvement of multidisciplinary teams, which include vascular surgeons, interventional cardiologists, radiologists, orthopedists, endocrinologists, doctors of functional diagnostics, rehabilitation specialists, microbiologists, immunologists, provides an opportunity for joint decision-making in the choice of treatment tactics for this category of patients [14].

**The aim of the work.** To determine the effectiveness of a multidisciplinary approach to the treatment of CLTI of the lower extremities associated with necrotic changes in the area of the foot.

**Materials and Methods.** The results of the use of endovascular operations in 39 patients with CLTI IV class were analyzed according to the Fontaine classification (category 6 according to the Rutherford classification), with open wounds after amputation of a part of the foot due to dry gangrene and PRP and PRF therapy using the PRGF®-ENDORET® technology, according to the examination and conclusions of the multidisciplinary team. The control group consisted of 41 patients with a similar pathology and stage of the necrotic process, in whose treatment appropriate specialists were not involved. Treatment of open wounds after amputation of a part of the foot due to dry gangrene was carried out according to traditional methods. The average age of the patients was  $56.7 \pm 9.3$  years, all men.

The obtained results were analyzed using the STATISTISA 12.0 program package. The significance of the obtained differences between the results (minimum level of significance  $p < 0.05$ ) was evaluated using the Kruskal-Wallis and Newman-Keuls tests (BioStat program, AnalystSoft Inc.)

The following specialists were involved in the specific treatment tactics of the above-mentioned patients: **ultrasound specialists and angioradiologists.** Visualization of the arterial anatomy of the lower limb began with an ultrasound examination of arterial vessels on a Vivid 3 ("General Electric", USA) with a 5-10 MHz sensor and the corresponding standard

software package of the indicated company for examination of the arterial system. Further, to visualize the arteries of the thigh, the leg and foot, spiral computer angiography was used in 3D images on the angiographic complex of the company "Simens".

**Endovascular surgeons.** Antegrade access, access from the contralateral femoral artery, as well as puncture or open access from the popliteal artery were used to perform endovascular operations on the infrainguinal part of artery. For revascularization, vasoballoon dilatation of the occluded artery segment using the "sliding" or "drilling" technique was used, followed by its stenting with a self-expanding Terumo Misago stent (Japan) or a Palmas Cordis stent (USA). For prolonged occlusions, intraluminal balloon angioplasty techniques, subintimal angioplasty using the Re-Entry Outback device (Cordis, USA) were used. The SAFARI method (subintimal arterial flossing with antegrade-retrograde intervention) was performed: a) in cases of damage to the popliteal artery with a transition to the tibio-peroneal trunk and to the leg artery; b) with long-term occlusions of the lower leg arteries; c) with unsuccessful intraluminal passage of the tibial arteries. In these cases, an ipsilateral antegrade approach was used.

Three weeks before the restoration of blood supply in the limbs, 39 patients underwent "therapeutic" neoangiogenesis with plasma enriched with growth factors (PRGF®-ENDORET®), prepared according to the protocol of the Institute of Biotechnology (Spain).

Under ultrasound guidance (Fig. 1), 2 ml of plasma enriched with growth factors was administered



**Fig. 1.** Paravascular injection of growth factor-enriched plasma (PRGF®-ENDORET®).

paravascularly to the location of the main vessels of the leg affected by the atherosclerotic process (a.tibialis posterior and a.tibialis anterior).

Assessment of the state of blood supply in the distal parts of the lower leg and foot after performing revascularization operations and PRP therapy is a mandatory condition for determining the indications for performing "small" foot amputations. With the participation of functional diagnosticians, the temperature of the skin on the side of the lesion was measured (with an automatic thermometer "HEACO DT-8806S"), according to the angiosomal principle of blood supply to the lower extremities on the anteromedial, posteromedial and posterolateral surfaces of the leg, at the levels of its lower and middle third, on the medial and back surfaces feet before and after endovascular surgery. [15]. Also, they assessed the condition of the microcirculatory channel by studying the partial pressure of oxygen in the soft tissues of the lower limb (transcutaneous oximetry). A transcutaneous oximeter manufactured by RADIMETER (Denmark) was used to measure tcpO<sub>2</sub>. To obtain tcpO<sub>2</sub>, a Clark sensor was placed on the back of the foot and in the area of the heel. We used the following criteria to assess the degree of preservation of microcirculation [16] : *I degree of microcirculation disorders* (compensated tissue metabolism) – tcpO<sub>2</sub> > 30 mmHg; *II degree of microcirculation disorders* (subcompensated tissue metabolism) – tcpO<sub>2</sub> = 20-30 mmHg; *III degree of microcirculation disorders* (decompensated tissue metabolism) tcpO<sub>2</sub> < 20 mm Hg. The study of tissue perfusion was carried out in patients using a single-channel laser flowmeter BLF 21 of the company "Transonic Systems Inc" (USA). For this, sensors for measuring surface blood flow of the R type (right angle) with a diameter of 15 mm were used. The sensors were fixed with a sticky ring to the surface of the skin in two standard areas: on the sole of the foot and on the back of the foot.

In addition, the assessment of the effectiveness of revascularization of the limb was based on the patient's complaints, on the data of an objective examination and ultrasound dopplerography of the arteries with the measurement of the Ankle Brachial Index (ABI). Changes in clinical status were evaluated according to the Rutherford scale (1997) [17] : 0 – no changes (no changes in the degree of ischemia and no increase in ABI); +1 – minimal improvement (increase in ABI by more than 0.1, but no clinical improvement, or, conversely, clinical improvement without an increase in ABI by more than 0.1) +2 – moderate improvement (at least 1 degree of ischemia, ABI did not normalize, but increased by more than 0.1), +3 – significant improvement; – 1 – slight deterioration; – 2 – moderate deterioration; – 3 – significant deterioration.

To evaluate the effectiveness of means of stimulation of regeneration processes in the wound, 3 groups were formed: 1 group (comparison group) – 41 patients who underwent traditional wound treatment after foot amputation and 2 group (main group) – 39 patients (after endovascular surgery and PRP therapy), which, on the 5-6th day after amputation of the foot, stimulation of the reparative process in the wound was carried out with the help of a plasma membrane (PRGF®-Endoret® supernatant), enriched with a growth factor, which covered the entire area of the wound surface (Fig. 2). Groups 1 and 2 of patients were representative in terms of gender, age, level of occlusive process, concomitant pathology, and wound area.



**Fig. 2.** Closing the wound with a plasma membrane.

With the help of cytological studies, the dynamics of the wound process was determined with the help of cytological analysis of the cellular composition of the wound by the fingerprint method. The regenerative-degenerative index was used to assess the severity of degenerative and regenerative processes in the wound. Cytological indicators were studied at the time of admission of patients to the hospital and on days 5-6, 8-9, 12-14 during wound treatment.

With the help of biochemical and immunological studies, the peculiarities of the pathogenetic mechanisms of the healing process of wounds on the foot after amputations were evaluated, the reactivity of cells was evaluated by calculating the tyrosine kinase index (TKI – the ratio of tyrosine kinase activity to tyrosine phosphatase activity) at different times of treatment (6-10 and 15 days after amputation). The content of interleukins IL – 1 $\beta$ , IL – 4, tumor necrosis factor (TNF –  $\alpha$ ), interferon (IFN –  $\gamma$ ) in the blood plasma was determined by the radioimmunoassay method using a standard commercial set of reagents from the company "Amersham Pharmacia Biotech UK Limited", after which the intercytokine coefficient was calculated (ICC) – the ratio of the relative

increase (in %) of the level of cytokines of the damage phase (IL – 1 $\beta$  and TNF –  $\alpha$ ) to the increase of the level of cytokines of the proliferation and remodeling phase (IFN –  $\gamma$  and IL – 4), compared to the baseline before the operation according to the formula:

$$ICC = \frac{(\Delta IL - 1\beta + \Delta TNF - \alpha)}{(\Delta IF - \gamma + \Delta IL - 4)}$$

ICC can reflect the reactivity of systemic mechanisms that limit the phase of alteration in the wound and induce proliferative processes in the wound.

**Results.** To determine the indications for foot amputation and the prognosis of wound healing, we performed an analysis of indicators that make it possible to objectively assess the condition of the blood supply of the distal part of the limb after its revascularization. Thus, the effectiveness of revascularization of the limb is evidenced by an increase in the temperature of the skin in the specified angiosomal areas of the lower limbs on the 7-14th day of the postoperative period (Table 1) and an improvement in the results of transcutaneous oximetry (Table 2).

The absolute tissue perfusion amount on foot soles and rear increased from 0.585  $\pm$  0.109 (ml/min/100g)

to 6.77  $\pm$  1.3 (ml/min/100g) and from 0.208  $\pm$  0.086 (ml/min/100g) to 6.77 $\pm$ 1.3 (ml/min/100g) (p<0,05) respectively.

A mild and significant improvement (on the Rutherford scale) occurred in 33 (66%) and 17 (34%) of patients regarding the condition of the lower limb (Table 2).

The obtained objective and subjective data, which indicated a significant improvement in the blood supply of the limb before the operative period, became indications for performing amputation of the foot. After consultation with an orthopedist, we performed amputation of the foot: according to Garangeau – in 10 patients, according to Chopar – in 51 cases, according to Lisfranc or Lisfranc-Haye in 19 patients. Due to the lack of skin flaps, the wounds were treated by an open method followed by autodermoplasty, except for 39 patients (after endovascular surgery and PRP therapy), who were stimulated on the 5-6th day after foot amputation with the help of a plasma membrane (PRGF supernatant) ®-Endoret®, enriched with a growth factor, which covered the entire area of the wound surface.

With the help of a number of biochemical and immunological studies, we also analyzed the effect

**Table 1. Skin temperature on angiosomic areas after revascularization**

Measuring areas	Preoperative	7th day after surgery	14th day after surgery
Mid-tibial level, anteromedial surface	33.4 $\pm$ 0.65	36.1 $\pm$ 0.26*	35.9 $\pm$ 0.33*
Lower tibial level, anteromedial surface	33.7 $\pm$ 0.49	35.9 $\pm$ 0.38*	35.3 $\pm$ 0.57*
Mid-tibial level, posteromedial surface	33.8 $\pm$ 0.56	36.0 $\pm$ 0.39*	35.8 $\pm$ 0.46*
Lower tibial level, posteromedial surface	33.6 $\pm$ 0.86	35.9 $\pm$ 0.32*	35.4 $\pm$ 0.81*
Mid-tibial level, posterolateral surface	33.7 $\pm$ 0.32	35.9 $\pm$ 0.44*	35.6 $\pm$ 0.41*
Lower tibial level, posterolateral surface	33.5 $\pm$ 0.38	35.1 $\pm$ 0.34*	35.1 $\pm$ 0.42*
Medial foot surface	33.3 $\pm$ 0.52	35.1 $\pm$ 0.17*	34.7 $\pm$ 0.44*
Rear foot surface	33.2 $\pm$ 0.76	34.9 $\pm$ 0.12*	34.5 $\pm$ 0.56*

Note: \* p<0.05 comparing to preoperative results.

**Table 2. Transcutaneous oximetry for surgery after the 7th and 14th day after transluminal surgery and PRP-therapy**

tcpO2 N	N=39		
	Pre surgery	7th day after surgery	14th day after surgery
I degree – (tcpO2 > 30 mmHg)	–	10	18
II degree – (tcpO2 20-30 mmHg)	15	22	21
III degree – (tcpO2 < 20 mmHg)	24	7	–



of the plasma membrane (PRGF®-Endoret® supernatant) on regeneration in the wound, as well as its readiness for skin autotransplantation.

According to our data, the tyrosine kinase index (TKI) reflects the sensitivity of cells to factors that stimulate the processes of proliferation, migration and intercellular interactions in damaged tissues and can be an informative criterion for the prognosis of wound healing. However, a clearer answer to the presence of other factors affecting reparative processes in the wound can be determined by cytokines, because they regulate intercellular interactions that are specific for each phase of the wound process [18,19]. Our studies

established that the cytokine levels in the blood plasma before foot amputation were almost identical to those in the first and second groups of patients compared to the control group (13 patients with obliterating atherosclerosis of the lower extremities from CLTI). Thus, in these groups before the amputation of the foot, low values of IL-1 $\beta$ , IL-4 and IFN- $\gamma$  were characteristic, while the level of TNF- $\alpha$  was significantly higher compared to the control group of patients by 298, 36% ( $p < 0.001$ ). It was noted (Table 3) that the content of IL-1 $\beta$  is lower than control values by 31.4%, IL-4 by 53.72%, and IFN- $\gamma$  by 71.12% ( $p < 0.01$ ).

**Table 3. The initial content of cytokines (mg/ml) in the blood plasma of patients ( $M \pm m$ ) of the experimental groups**

A group of patients	IL – 1 $\beta$	IL- 4	TNF – $\alpha$	IF– $\gamma$
Control	807.72 $\pm$ 20.59	8.54 $\pm$ 0.73	23.46 $\pm$ 2.29	45.27 $\pm$ 4.15
1st	526.60 $\pm$ 18.95**	3.77 $\pm$ 0.19***	96.87 $\pm$ 5.06***	10.41 $\pm$ 0.89***
2nd	554.32 $\pm$ 39.81*	3.56 $\pm$ 0.42***	118.80 $\pm$ 8.93***	9.76 $\pm$ 1.01***

Note: \* –  $p < 0.05$ . \*\* –  $p < 0.01$ . \*\*\* –  $p < 0.001$  comparing to the control group.

At the same time, in the 1st and 2nd groups of patients, we found a significant increase in the level of TNF- $\alpha$  (compared to other groups of patients, by 5.1 and 1.2 times, respectively). The content of other cytokines in the first and second groups practically did not differ. ICC in these groups of patients with necrotic lesions of the foot was lower than the control by 57.8%, respectively. This may indicate metabolic changes in the production of cytokines associated with necrotic processes in the foot. We analyzed the dynamics of ICC in patients whose wounds were treated according to the standard method and according to the method of PRF therapy. It is interesting that in the patients of the first group of patients, ICC increased by an average of 3.9 times compared to the foot amputation, mainly due to IL-1 $\beta$  and TNF- $\alpha$ . This may be evidence of the deterioration of alternative processes and the spread of destructive changes in the wound. At the same time, low levels of IL-4 and IFN- $\gamma$  are evidence of a decrease in the reserve capacity of pro-inflammatory factors. Such a situation can be explained by insufficient blood supply to the foot and its ischemia. In patients whose limb amputations underwent endovascular angioplasty and PRP therapy and the wound was closed with a plasma membrane, ICC decreased below baseline. Such dynamics can be explained by a significant increase in the level of an-

ti-inflammatory cytokines against the background of a stable amount of pro-inflammatory factors. Thus, the reaction of IL-4 and IFN- $\gamma$  can be regarded as preparation for the transition of the wound process to the proliferation stage, and the decrease in the levels of IL-1 $\beta$  and TNF- $\alpha$  reflects a decrease in the manifestations of the inflammatory reaction in the wound. Thus, the activity of the tyrosine kinase system, as well as the peculiarities of the cytokine relationship, which is a reflection of the processes of alteration and proliferation in the wound, can be an objective criterion for autotransplantation of skin on the wound surface.

The results of cytological studies showed that the use of the above-mentioned technology led to a decrease in the number of cells that determine the acute phase of inflammation (neutrophils, lymphocytes, monocytes) and an increase in the number of cells responsible for reparative processes (macrophages, fibroblasts) in smears-prints of wounds. For example, in patients already on the 2nd-3rd day, a decrease in the content of neutrophils and lymphocytes was noted, on the 4th-5th day – in all inflammatory cells. This corresponds to the transition from the degenerative-inflammatory type of cytograms to the inflammatory-regenerative type. By the 8th day, a change in the nature of the cytograms to the regenerative-inflammatory type is noted in most patients. At the same time, in patients

whose wounds were treated according to traditional methods, the change in the character of cytograms to the regenerative-inflammatory type occurs much later, on 18-21 days. The above is an additional criterion for performing autodermal plastic surgery of a foot wound.

**Discussion.** When choosing the tactics of treatment of patients with CLTI, not all patients are suitable for limb revascularization, therefore, the key strategy should be the stratification of patients unsuitable for this operation by taking into account both clinical and non-clinical risk factors according to the concept of individual residual risk for each patient. In this regard, we are guided by global recommendations (Global vascular guidelines on the management of chronic limb-threatening ischemia 2019), which offer a three-stage integrated approach based on the assessment of the patient's risk, the stage of limb ischemia, and the anatomical structure of the disease (PLAN). The first item contains the patient's assessment of limb replacement candidates, periprocedural risk, and life expectancy. It should be performed using several risk stratification tools that provide objective criteria. The second point can be assessed using the SVS Threatened Limb Classification System (WIFI), which determines the clinical severity of ischemia. In addition, to determine the general picture and severity of limb disease, the Global Limb Anatomical Staging System (GLASS) should be used [1]. Using these recommendations, we determined the indications for performing revascularization operations, based on the presence of full-fledged inflow and outflow pathways, the possibility of using the target auto vein as a shunt, in its absence, the use of various methods of endovascular operations. It should be noted that vascular surgeons do not have all the necessary skills to manage complex patients with multiple comorbidities. Therefore, there is a need to involve other specialists with the necessary skills in the consultation and treatment of this category of patients, that is, to create multidisciplinary groups. In our opinion, the intermediate model of the multidisciplinary team, which is engaged in the treatment of patients with CLTI, should include, in addition to a vascular surgeon, an endocrinologist, an interventional physician, an orthopedic surgeon, and a podiatric surgeon. The effectiveness of the work of such a team is confirmed by the conclusions of a number of authors [14,20,21,22,23,24]. Taking into account the accompanying pathology, advanced and senile age of the patients, we included a cardiologist and a neurologist in the multidisciplinary group. However, the role of the vascular surgeon in saving limbs due to the performance of small amputations of the foot (amputation of the toes and the front part of the foot) is decisive. However, without an objective

assessment of the blood supply to the foot, it is not possible to determine the indications for performing "small" amputations of the foot. In this matter, the assessment of the state of the microcirculatory channel by determining the partial pressure of oxygen in the soft tissues of the lower limb (transcutaneous oximetry), as well as the determination of tissue perfusion and ultrasound dopplerography of the arteries with the measurement of the Ankle Brachial Index is of crucial importance. Taking into account the possibility of performing small foot amputations, the consultation of an orthopedist is necessary to determine the level of these amputations. The obtained results of our research confirm the need for a multidisciplinary approach to the treatment of this category of patients, which makes it possible to save the patient's limb and accelerate his rehabilitation.

Another issue that can finally resolve the patient's rehabilitation process is accelerating the healing of a wound on the foot or preparing it for autodermotransplantation by using the "neoangiogenesis" technique. Among the numerous methods of "therapeutic angiogenesis", as shown by the results of our research, the use of PRP and PRF is a new promising biotechnological direction in the treatment of CLTI. This technology, in combination with endovascular operations, is currently the most effective in preserving the functional capacity of the limb. Also, the advantage of this technology is its low material costs, its availability, and the absence of risk of parenteral transmission of HIV – infection, viral hepatitis, and immune reactions. In our opinion, it is necessary to continue further in-depth study of the effect of platelet-rich plasma on the regeneration process in the wound, and thus create a theoretical and practical basis for a new direction of wound treatment.

**Conclusion.** 1. Involvement of a multidisciplinary team in the treatment of patients with chronic threatening ischemia of the limb with necrotic lesions of the tissues of the foot contributes to the preservation of the limb and acceleration of their rehabilitation.

2. The use of endovascular operations in combination with PRP therapy in a short time improves the blood supply of the distal part of the limb in patients with critical ischemia, which is a good prognostic criterion for wound healing after foot amputation.

3. The use of a plasma membrane enriched with platelets creates optimal conditions for the regeneration of tissues in the wound and, thus, shortens the time for its closure with an autodermal flap.

**Financing.** The article is a fragment of the planned research work of the Department of Surgery of the Faculty of Postgraduate Education of the I.Ya. Gorbachev of the Ministry of Health of Ukraine, external sources of funding were not involved.

**Conflict of interest.** The authors declare no conflict of interest.

**Contribution of the authors.** Goshchynsky V.B. – conceptualization, methodology, writing – review-

ing and editing; Migenko B.O. – collection and statistical processing of material, writing the text of the article; Svistun R.V. – collection and statistical processing of material, analysis and discussion/

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Received 20.05.2024

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### МУЛЬТИДИСЦИПЛІНАРНИЙ ПІДХІД ДО ВИКОНАННЯ ЕНДОВАСКУЛЯРНИХ ОПЕРАЦІЙ ТА ЕКОНОМНИХ АМПУТАЦІЙ СТОПИ НА ТЛІ ХРОНІЧНОЇ ЗАГРОЗЛИВОЇ ІШЕМІЇ НИЖНІХ КІНЦІВОК

**Мета:** визначити ефективність мультидисциплінарного підходу до лікування хронічної загрозливої ішемії нижніх кінцівок, асоційованої з некротичними змінами в ділянці стопи.

**Матеріали і методи.** Проаналізовані результати застосування ендovasкулярних операцій у 39 хворих із ХЗІНК IV ст. за класифікацією Fontaine (6 категорія за класифікацією Rutherford), із відкритими ранами після ампутації частини стопи з приводу сухої гангренни та PRP і PRF-терапії за технологією PRGF®-ENDORET®, згідно з обстеженнями та висновками мультидисциплінарної команди. Контрольну групу склав 41 пацієнт із аналогічною патологією та стадією некротичного процесу, до лікування яких не були залучені відповідні спеціалісти, а лікування відкритих ран після ампутації частини стопи з приводу сухої гангренни проводилося за традиційною методикою. Середній вік пацієнтів складав (56,7±9,3) роки, всі чоловіки. Для визначення тактики лікування вищезначених хворих була створена мультидисциплінарна команда в складі: судинних хірургів, УЗД-спеціалістів та ангіорентгенологів, лікаря-інтервенціоніста, хірурга-ортопеда, функціональних діагностів. З метою визначення показань до виконання малих ампутацій на стопі ми здійснили комплексну оцінку кровопостачання кінцівки після виконання ендovasкулярних операцій та застосування плазми, збагаченої тромбоцитами.

**Результати.** Застосування ендovasкулярних операцій в поєднанні з PRP та PRF позитивно впливає на кровопостачання в ішемізованій кінцівці. Про це свідчить покращення показників мікроциркуляції, швидкості кровотоку, підвищення локальної шкірної температури на стопі, показників плечо-кісточкового індексу. Як показали наші дослідження, активність тирозинкіназної системи, а також особливості взаємовідношення цитокінів, є відображенням процесів альтерації та проліферації в рані можуть бути об'єктивним критерієм для автотрансплантації шкіри на ранову поверхню. Після консультації ортопеда ми виконували ампутацію стопи: за Гаранжо – у 10 пацієнтів, за Шопаром – у 51 випадку, за Лісфранком або Лісфранком-Хею – у 19 хворих. У зв'язку із дефіцитом шкірних клаптів рани лікували відкритим методом з наступною автодермопластиком, окрім 39 хворих (після ендovasкулярної операції та PRP терапії), яким на 5–6 день після ампутації стопи здійснювали стимуляцію репаративного процесу в рані за допомогою плазматичної мембрани (супернатант PRGF®-Endoret®), збагаченої фактором росту, якою вкривали всю площу ранової поверхні.

**Ключові слова:** хронічна загрозлива ішемія нижніх кінцівок; мультидисциплінарна команда; ендovasкулярні операції.