Relevance of research. Long-term and proper functioning of permanent vascular access in patients with terminal chronic kidney disease (CKD) is the basis of the effectiveness of renal replacement therapy (RRT), which directly affects the quality and life expectancy of patients. At the same time, hemodialysis (HD) remains the most common method of RRT in most countries of the world [1].

Today, the following types of permanent vascular access are distinguished for the performance of RRT by the HD method: arteriovenous fistula, arteriovenous prosthesis, and long-term central venous catheter. According to recently published data from the US Department of Health and Human Services, among all hemodialysis patients in 2020, 62.60% of patients used an arteriovenous fistula, 20.70% used a temporary or permanent central venous catheter, and 16.70% of patients used an arteriovenous prosthesis [2].

Due to the peculiarities of hemodynamics and the hemodialysis procedure, the most common vascular access lesions are thrombosis, stenoses, aneurysms, pseudoaneurysms, and infectious lesions. As a result of processing the data of more than 77 thousand sick residents of the USA with the terminal stage of CKD, who are on HD, among patients with arteriovenous fistula during the 3 years of its use, 69.11% required surgical intervention in order to restore the functioning of vascular access, on the other hand, the need for surgical correction of arteriovenous prostheses for the corresponding period was greater and amounted to 87.21% [3].

In Ukraine, as of February 1, 2023, there were treated 11,181 people with the help of the RRT method, of which 8,717 were treated by the HD method, that is, they needed permanent vascular access [4]. In the world, and in our country in particular, there is a tendency to increase the prevalence of CKD, therefore, the search for effective methods of preventing the development of hemodynamic lesions of arteriovenous accesses and increasing the duration of their use for RRT remains relevant.

Therefore, the aim of this study was a retrospective analysis of hemodynamic disorders and peculiarities of the use of arteriovenous prostheses as permanent vascular access in patients undergoing hemodialysis therapy.

Materials and methods of study
The study was performed on the basis of the intensive nephrology department of the CNPE “Regional Clinical Hospital of the Ivano-Frankivsk Regional Council.”

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PECULIARITIES OF ARTERIOVENOUS PROSTHESIS FUNCTIONING IN PATIENTS ON HEMODIALYSIS
V.A. Semchenko1, O.Ya. Popadyuk1, O.M. Lehun2
1Ivano-Frankivsk National Medical University;
2CNPE “Regional Clinical Hospital of the Ivano-Frankivsk Regional Council”
Semchenko_VI@ifnmu.edu.ua

Abstract. Long-term and proper functioning of vascular access is necessary for renal replacement therapy in patients with chronic kidney disease (CKD). If it is impossible to form an arteriovenous fistula due to a pathologically changed structure of the vascular wall of peripheral arteries and veins, an arteriovenous prosthesis of various locations is implanted to form a permanent vascular access. However, the problem of long-term use of arteriovenous prostheses remains relevant, in particular, due to the prevalence of hemodynamic disorders, such as thrombosis, stenoses, and pseudoaneurysms.

The aim of the study was a retrospective analysis of hemodynamic disorders and peculiarities of the use of arteriovenous prostheses as permanent vascular access in patients undergoing hemodialysis therapy.

There were analyzed 586 medical records of inpatients and 103 discharge epicsris of outpatients of the intensive nephrology department. Out of the 467 primary permanent vascular accesses formed for renal replacement therapy, 391 (83.72%) ones – were native arteriovenous fistulas (AVF) and 76 (16.27%) – were arteriovenous prostheses (AVP).

It was found that the increase in the frequency of initial uncorrected and corrected primary loss of vascular access for AVF is the greatest during the first year of use and amounts to 35.53% and 26.32% of cases, respectively. Instead, the greatest increase in secondary loss of patency is observed during the first six months of using prostheses, which corresponds to 10.53% of patients. It is worth paying attention to the problem of concomitant pathology, in particular diabetes mellitus, arterial hypertension, calcification disease, which directly affect the state of the vascular wall and the functioning effectiveness of the vascular access. The obtained results indicate the necessity to review and supplement the existing methods of prevention of hemodynamic disorders of AVF during the first 6-12 months of their use in order to improve the quality of patients’ lives.

Key words: vascular access, arteriovenous prosthesis, hemodynamic disorders, vascular surgery, hemodialysis, retrospective analysis.
Statistical processing of the results was performed on the basis of Excel of the Microsoft Office 365 ProPlus package.

**Results and discussion**

In the sampling studied by us, among the patients who were receiving an inpatient treatment in the intensive nephrology department of the CNPE “Regional Clinical Hospital of the Ivano-Frankivsk Regional Council” during the studied period, a total of 467 primary permanent vascular accesses for renal replacement therapy were formed; of them 391 (83.72%) – native arteriovenous fistulas (AVF) and 76 (16.27%) – arteriovenous prostheses (AVP).

In most cases, the upper extremity was used for the formation of AVP – 54 cases, which is 71.05%, whereas in 22 cases (28.95%) – surgical interventions were performed on the lower extremity. As a result of the analysis in this sampling of patients, it was found that on the upper limbs, the most common anatomical site for the formation of this type of vascular access is the shoulder, which was used for implantation in 43 patients (56.58% of the total number of AVP), instead, the area of the forearm – in 11 patients (14.47%). The reason for more frequent use of the proximal part of the upper extremity is the presence of pathologically changed areas of the skin of the forearm as a result of previous surgical interventions (formation, reconstruction and thrombectomy with AVF), venipunctures (during the HD sessions), damage to the walls of the distal parts of the arteries due to the concomitant diseases (diabetes mellitus, calcifying disease), which makes it impossible to form an arterio prosthetic anastomosis. At the same time, the better condition of the vascular wall and the larger size of the vascular lumen in the shoulder region provide higher indices of the speed and volume of blood flow, blood discharge into the venous channel, which in turn affects the duration and quality of the functioning of the vascular access and reduces the frequency of the occurrence of steal syndrome in the distal part of the limb.

In 44 patients (57.89%), AVP was implanted between the brachial artery (a. brachialis) and the major vein of the forearm (v. basilica), in 8 patients (10.53%) – between the brachial artery (a. brachialis) and the major forearm vein (v. cephalica), much less often – between the brachial artery (a. brachialis) and the median elbow vein (v. mediana cubiti) and between the ulnar artery (a. ulnaris) and the major forearm vein (v. cephalica) – 1 case each, respectively (1.32% each).

In the absence of conditions for the formation of a permanent vascular access on the upper limbs, the next step is the formation of AVP on the lower limbs, namely on the anterior-medial surface of the thigh. This anatomical site was used in 22 patients, which is 28.95% of all AVPs. In all cases, the common femoral artery (a. femoris communis) served as the vessel for prosthesis implantation, instead, the greater saphenous vein (v. saphena magna) was used for blood drainage in 16 (21.05%) and the femoral vein (v. femoralis) in 6 patients (7.89%).

In order to perform an effective RRT, the long-term functioning of permanent vascular access is necessary, which ensures a sufficient amount of speed and volume of the blood flow through the fistula. Undoubtedly, one of the most common hemodynamic problems of both AVF and AVP remains acute thrombosis, which requires surgical interventions to restore their patency. At the same time, the following types of vascular access dysfunction are distinguished: primary uncorrected loss of patency, primary corrected loss of patency, and secondary loss of patency. Primary uncorrected loss of patency includes the cases of the first surgical intervention since the beginning of the AVP or AVF functioning, in particular, angioplasty, thrombectomy or thrombolysis, aneurysm excision, formation of a new one and closure of the current vascular access. Primary corrected loss of patency includes all cases of repeated thrombectomies, formation of a new one, and closure of the current vascular access. And the secondary loss of patency includes only the formation of a new and closure of the current vascular access [5].

As a result of the analysis of the studied sampling indices, the following indices of primary uncorrected loss of patency of the vascular access were found: 3 months after the beginning of AVP use in 15.79% of patients, after 6 months – in 26.32% of patients, after 1 year – in 35.53% of patients and after 3 years – in 44.74% of patients. Instead of this, primary corrected patency loss was diagnosed in 10.53% of AVPs after 3 months, in 14.47% – after 6 months, in 26.32% – after 1 year, and in 30.26% – after 3 years. Secondary loss of patency of the vascular access, that is, closure of the AVP, was detected after 3 months in 9.21% of patients, after 6 months – in 10.53% of patients, after 1 year – in 13.16% of patients, and after 3 years – in 21.05% of patients with this type of vascular access. After analyzing the results obtained, it can be concluded that the greatest risk of both primary and repeated hemodynamic complications of AVP is observed during the first year of operation of the vascular access. In order to prevent thrombotic complications, the majority of patients in the studied sampling received double antiplatelet therapy, namely a combination of acetylsalicylic acid and clopidogrel.

According to the latest published report of the US Department of Health and Human Services, among all patients with the terminal stage of CKD who were on RRT by the HD method through the AVP during the period of 2017-2019, the primary uncorrected loss of vascular access patency was diagnosed after 3 months in 26.90% of patients, after 6 months – in 40.10% of patients, after 1 year – in 50.90% of patients, and after 2 years – in 58.20% of patients. Such indices of primary hemodynamic lesions are almost twice as large, when compared with the results of the sampling studied by us for the corresponding time periods. At the same time, the use of antiplatelet or anti-
coagulant therapy by patients to prevent thrombotic complications is also not indicated. It is interesting to compare indices of secondary loss of vascular access patency. The following results were published: in 4.51% of patients after 3 months, in 5.50% of patients after 6 months, in 6.72% of patients after 1 year, and in 7.82% of patients after 2 years [2]. It should be noted that the cessation of functioning and use of AVFs for the corresponding periods of time was observed with a lower frequency, compared to the results we’ve obtained.

In January 2023, one of the largest cohort studies concerning functioning of permanent vascular access for CKD patients on RRT was published. The study cohort included 60,329 patients using AVF for HD sessions and 17,763 patients with AVP. At the same time, the exclusion criterion concerned patients taking oral anticoagulants. As a result of the study, it was found that patients with AVF after 3 years of observation have a higher frequency of primary uncorrected patency loss (87.12% vs. 69.23% in patients with AVP). The difference in the indices of the primary corrected loss of patency after 3 years is quite significant, which is 69.05% and 25.18% for users of AVP and AVF, respectively. The difference in the secondary loss of patency for the corresponding period remains significant – 22.15% for AVP and 10.04% – for AVF [3]. Such data reflect the necessity to create new methods of prevention of hemodynamic lesions of vascular access to increase the duration of its functioning and reduce the necessity for invasive surgical interventions.

When examining, it is worth paying attention to the presence of concomitant pathology that affects the morphological structure of the vascular wall. It is the condition of the arterial and venous walls, the size of their lumen, and the blood flow velocities that is key to and depend on the functional capacity of the AVP and the duration of its use as a vascular access for RRT. One of the most common comorbidities among people with CKD remains diabetes mellitus (DM). According to the International Diabetes Federation (IDF), as of 2021, more than 530 million inhabitants of our planet have DM. It was estimated that 40% of patients will develop one or another stage of CKD, including a significant number of people with a terminal stage that requires RRT [6]. This disease equally affects both elastic type arteries (aorta) and muscular type arteries of large and medium caliber (brachial, radial arteries) and is characterized by the damage to the intima and subintimal layer of the vascular wall, which leads to the vascular lumen narrowing and to the disorders of hemodynamics (decrease in speed and volume of blood flow). In our studied sampling of patients with AVP, 28.0% of patients were diagnosed with DM in general (13.33% of them had type I diabetes mellitus and 14.76% of patients had type II DM). At the same time, in most cases, due to the condition of the vascular wall of the peripheral arteries, the patients lacked conditions for the formation of AVF.

Conclusions
The problem of hemodynamic disorders of arterio-venous prostheses in patients who are on RRT remains relevant and not fully studied. It is important that the most intensive growth of the primary uncorrected and corrected loss of patency of AVP is observed during the first year of vascular access use, while secondary loss of patency prevails in the first 6 months. Therefore, it is necessary to improve the existing or to develop new methods of prevention of hemodynamic disorders in order to increase the duration of the AVP functioning and improvement of the quality of patients’ life.

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