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## Vascular access in diabetic patients. Are these patients “difficult”?

Dostęp naczyniowy u chorych na cukrzycę.  
Czy są to chorzy problematyczni?

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- A Study Design
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## Summary

### Background:

Diabetics with stage V chronic kidney disease (CKD) on hemodialysis (HD) are considered as “difficult patients”, because of problems with creation of the vascular access. There is controversy regarding the results and recommendations for preparation of the vascular access in these patients. The aim of this retrospective study was to evaluate the results of creating different types of arteriovenous fistula (AVFs) in consecutive series of patients starting dialysis treatment.

### Patients and methods:

The analysis was performed in 741 patients (385 females and 356 males), average age 61.4±7 years, who started dialysis treatment in our department between January 2005 and December 2012. Native AVFs were created in all patients. No patients received an AVF requiring synthetic graft material. The number of patients with diabetic nephropathy was 166 (22.4%). Among them, 30 (18%) had type 1 diabetes and 136 (82%) type 2. In this group the occurrence of calcification in the forearm artery was estimated on the basis of physical examination, Allan's test, Doppler ultrasound and forearm X-ray. In a subgroup of patients with atherosclerotic changes in the arterial system the frequency of failed AVFs was analyzed. These results were compared with the group without diabetes. The number of procedures necessary for successful AVF creation and type of access was counted in both groups. The assessment of the procedure frequency and AVF location in diabetic and in non-diabetic patients was made by  $\chi^2$  test with Yates correction.

### Results:

In the group of 166 patients with diabetes, in 100 cases (60%) atherosclerotic changes in forearm arteries were observed. In a subgroup of 30 patients with type 1 diabetes atherosclerosis was observed in 17 adults (57%). In this subgroup creation of a suitable forearm AVF in the first procedure in 9 patients was possible and in the other 8 cases the atherosclerotic changes necessitated repeated procedures and were an important obstacle to create the AVF. In the subgroup of 136 patients with type 2 diabetes, atherosclerosis in the forearm artery was observed in 83 cases (61%). In this subgroup the creation of a native AVF was possible in 40 patients during the first procedure and in 43 cases additional intervention was needed, but only in 8 cases was atherosclerosis the cause of fistula failure. Generally, among 166 patients only in 16 cases (10%) did atherosclerosis present an important obstacle for AVF creation, but the number of

<b>Conclusion:</b>	necessary procedures to create one functioning AVF was significantly greater in this population (2 v 2.7, p=0.0001). A functioning AVF in patients with diabetes was found significantly frequently in the arm localization in comparison to non-diabetic patients (4.3 v 2%, p=0.0478).  Atherosclerotic changes in forearm arteries in diabetic patients appear in 60% of hemodialysis patients and make it difficult to create an AVF only in 10% of diabetic patients, but it is possible to create a native AVF in 90% of diabetic patients, although this requires more procedures. In patients with diabetes, AVF in the wrist region should be preferred.
<b>Key words:</b>	<b>hemodialysis • ascular access • arteriovenous fistula • diabetes • atherosclerosis</b>
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## INTRODUCTION

The number of patients suffering from diabetes mellitus is steadily increasing [3]. In developed countries with a western life style almost 40% of patients have diabetes as a cause of CKD in stage 5 on hemodialysis [9]. Statistical evidence warns of an approaching epidemic of diabetes [8]. The probability of development of diabetic nephropathy by patients suffering from type 1 of diabetes is assessed at 20-30% with the peak of incidence 15 years after diagnosis [7] and by the group of patients with type 2 it is estimated at 10%, 10 years after diagnosis [1]. These two sets of patients are being considered as “difficult patients”, because of problems with creation of the vascular access. It seems that atherosclerotic changes and calcification of the forearm and brachial artery is the main cause of failure in creation of a native fistula. The pathologic changes of the vein are also important, because of the high frequency of hospitalization and damage to the venous system by blood sampling, drips and use of intravenous lines [4,5]. In the last few years there have appeared several reports dealing with the vascular access by diabetic patients starting hemodialysis treatment. There is controversy regarding results and recommendations concerning methods for preparation of the vascular access in this population. The aim of this study is to present a method for evaluating diabetic patients and our strategy for creation of the vascular access.

## PATIENTS AND METHODS

The study included 741 patients with CKD stage 5 (385 females and 356 males), aged 61.4 ±7 years, who were treated in our center and other cooperating dialysis units

(including Fresenius Medical Care) during the period from 2005 to 2012. No patients received an AVF using synthetic graft material. Before each procedure the assessment of the vascular system was done. Information regarding previous catheterization of the central and of the forearm veins was collected. The axillary, brachial, radial and ulnar artery pulses were carefully palpated. The Allan test was performed to assess the efficiency of the palmar arch. The status of the superficial veins was assessed before and after tightening a tourniquet on both arms. Patients with diabetic nephropathy (166 cases) were selected from all HD patients. These patients were analyzed according to type 1 and 2 diabetes. In this group the occurrence of calcification in the forearm artery was estimated on the basis of physical examination, Allan’s test, Doppler ultrasound and forearm two-dimensional radiography. The patients were included in this group in the following conditions: There was observed an asymmetry of the pulse in physical examination and/or positive Allan’s test and/or presence of macrocalcification of the radial artery in the form of a linear railroad track in X-ray of the forearm measured at least 6 cm, and/or presence of linear or irregular calcification with wall thickening or narrowing of the artery lumens in ultrasound assessment. In the subgroup of patients with atherosclerotic changes in the arterial system the frequency of failed AVF was analyzed. Those results were compared with the group without diabetes. The number of necessary procedures for successful AVF creation and type of access were recorded for both groups. The placement of the fistula was attempted as distally in the wrist region as possible. The procedures were done under local anesthesia with 1% lignocaine. In the case of primary fistula failure, a further attempt was performed a few centimeters higher. In obese patients with deep fore-



arm vein location, our own method – superficialization of the venous part of the AVF – was performed [10]. This procedure was performed at the time when the vein was sufficiently wide and mature, approximately two weeks after creating the AVF. A 10–15 cm longitudinal incision, slightly laterally to the arterialized vein and 3–4 cm above the fistula, was made. The arterialized vein was prepared and the bed of the venous part of the fistula was closed in layers using absorbable sutures. The vein was mobilized, repositioned superficially above the subcutaneous fat and placed into a previously prepared subcutaneous pocket. Subsequently, the skin was typically closed. The skin suture was located laterally to the vein.

## RESULTS

The total number of HD patients included in the study was 741. Patients suffering from diabetes mellitus constituted 22.4% (n=166). Type 1 diabetes was represented by 30 patients (18%) and type 2 by 136 patients (82%). Atherosclerotic changes in arterial vessels were observed in 100 cases (60%) among patients with diabetes (n=166). In a subgroup of 30 patients with type 1 diabetes atherosclerosis was observed in 17 adults (57%) and in a subgroup of 136 patients with type 2 diabetes in 83 (61%). Atherosclerotic changes in type 1 diabetes were more advanced than in type 2. They were characterized by lack of pulse or slight pulse examined on the radial artery in the wrist region and distinct visible calcification changes in forearm X-ray. In the type 2 diabetes subgroup changes were less expressed and were characterized by pulse impairment, and the signs of calcification were less advanced in the forearm/arm arteries X-ray.

In the subgroup of 17 patients with type 1 diabetes and atherosclerotic changes successful creation of the suitable forearm AVF in the first procedure was possible in 9 patients and in the 8 other cases the atherosclerotic changes were an important obstacle to create the AVF and necessitated repeated procedures. In the subgroup of 83 patients with type 2 diabetes and atherosclerotic changes in the forearm/arm arteries the creation of a native AVF was possible in 40 patients during the first procedure and in 43 cases another intervention was needed, but only in 8 cases was atherosclerosis the cause of fistula failure. In the rest of the patients with diabetes the changes in the venous system were the cause of failure in AVF creation. These were caused by vein destruction due to multiple blood samplings and infusions in the predialysis period.

In only 16 cases (10%) from the set of 166 patients with diabetes were atherosclerotic changes in forearm/arm arteries an obstacle for AVF creation. Additionally, the function of fistulae created using changed, stiff arteries was proper and allowed adequate hemodialysis to be performed. In 86 (52%) of 166 diabetic patients the success in AVF creation was obtained at the first procedure. In diabetic patients significantly more procedures were required compared to non-diabetic patients for a suitable fistula (2 v. 1.7, p=0.0001). There were also fewer AVFs in

the forearm location in diabetic compared to non-diabetic patients (90% v. 96%, p=0.0478).

**Table 1.** Number of AVFs created in separate patient groups

	Number	Number of procedures	Number of procedures to create one functioning fistula
Patients	741	1248	1.7
Diabetes	166	326	2
Type 1	30	82	2.7
Type 2	136	245	1.8
No diabetes	575	922	1.6

**Table 2.** Type and location of access

	Number of patients	Forearm AVF	Elbow fistula	Permanent catheter
Patients	741	700 (94.6%)	19 (2.5%)	22 (2.9%)
Diabetes	166	150 (90%)	7 (4.3%)	9 (5.4%)
Type 1	30	24 (80%)	3 (10%)	3 (10%)
Type 2	136	126 (93%)	4 (3%)	6 (4%)
No diabetes	575	552 (96%)	12 (2%)	11 (2%)

## DISCUSSION

Our study of haemodialysis patients suffering from diabetic nephropathy allows one to answer the title question, whether all diabetic patients are “difficult” with regard to creation of a suitable vascular access. Atherosclerosis in arteries is thought to be the main cause of complication in AVF creation. Such changes were present in 100 (60%) patients from the group of 166 diabetic patients. Only in 16 (10%) cases were they an obstacle for AVF creation. In 7 (4.3%) diabetic patients the fistula had to be created in the arm and in 9 (5.4%) patients it required a central catheter. In 150 (90%) patients it was possible to create a forearm AVF, which is the best type of vascular access. The advantage of the forearm AVF is connected with a low rate of various complications (infection, steal syndrome, heart insufficiency by high-flow fistula). Although the frequency of forearm AVF in non-diabetic patients was higher than diabetic (96 v 90%), these results are encouraging. It should be stressed that all fistulas allow effective hemodialysis to be conducted after maturation time. The atherosclerotic changes and stiff

artery, particularly in type II diabetes, did not constitute a significant obstacle in effective AVF creation. It only necessitated performance of more surgical procedures. The total number of AVF creation procedures in diabetic patients was significantly higher than in non-diabetic patients. It is usually thought that the problem is connected with atherosclerotic changes and low blood flow in a narrowed artery. In our present analysis and earlier experiences [11] the main problem with AVF creation was related to vein damage caused by frequent blood sampling and infusion in the predialysis period.

Because of the generally poor outcome of wrist AVFs in patients with diabetes, there appeared a few studies promoting placement of a prosthetic graft fistula as the primary vascular access [12,13] or insertion of permanent indwelling venous catheters, especially in elderly diabetics [6]. Those initial reports were based on observations of pathological changes in the feeding artery, especially the inability of the artery to dilate due to presence of calcification. In this respect Konner [5] proposed a new strategy using an artery in the elbow region for primary access, because it usually provides the best quality of the artery in such a set of patients, assuring the highest success rate for creating a native AVF. He advised careful examination of the vascular system – especially assessment of diameter and occurrence of calcification in the feeding artery before creating the AVF. On this basis the localization of the primary AVF was done. In the group of diabetic patients, the number of primary fistulas created in the location of the wrist/forearm was low and was only 25.6%. The elbow region was chosen in 74% of cases [5]. A comparable structure of AVF localization was presented in a study by Grochowicki et al., who reported forearm fistulas in 37.5% of diabetics [2]. Our distinct view on this issue results from the fact that causes of primary AVF failure are not accurately understood. From our praxis, in many “difficult” cases creation of a well-functioning fistula was successful in the region of the forearm without using

the second choice – an arm fistula. The outcome of 90% successful primary forearm AVF creation in diabetic patients was achieved probably by our own approach to the vascular access for haemodialysis in so-called “difficult patients”. The outlook was associated with the preference for AVF creation in the wrist region as the first and then in the case of primary fistula failure, another attempt was performed a few centimeters higher, using all possibilities on the forearm. The most important aspect of this strategy is a repeated attempt to create a new fistula above the previous unsuccessful one. The other approach was used by obese patients who are frequent patients among diabetics. The two-step procedure was practiced in such patients. In the first stage under local anesthesia with 1% lignocaine the standard radiocephalic fistula was created in the wrist region. In the second stage the arterialized vein was relocated subcutaneously to enable safe puncture. Superficialization of the venous part of the fistula was performed after 2 weeks. A 10-15 cm longitudinal incision, slightly laterally to the arterialized vein and 3-4 cm above the fistula, was made. The arterialized vein was prepared, and the bed of the venous part of the fistula was closed in layers using absorbable sutures (2.0). The vein was mobilized, repositioned superficially above the subcutaneous tissue and placed into a previously prepared subcutaneous pocket. Subsequently, the skin was typically closed. The skin suture was located laterally to the vein course [10].

## CONCLUSIONS

Atherosclerotic changes in forearm arteries in diabetic patients appear in 60% of hemodialysis patients, but only in 10% do they make it difficult to create an arteriovenous fistula. It is possible to create a primary arteriovenous fistula in the forearm region in 90% of diabetic patients, but it requires more procedures. In patients with diabetes, an arteriovenous fistula in the wrist region should be preferred. Each diabetic patient should be treated as individual, not as “difficult”.

## REFERENCES

- [1] Adler A.I., Stevens R.J., Manley S.E., Bilous R.W., Cull C.A., Holman R.R., UKPDS GROUP: Development and progression of nephropathy in type 2 diabetes: the United Kingdom Prospective Diabetes Study (UKPDS 64). *Kidney Int.*, 2003; 63:225-232
- [2] Grochowicki T., Jakimowicz T., Gałazka Z.: Wpływ cukrzycy na czynność przetok tętniczo-żylnych do dializ wytworzonych na naczyniach przedramienia. *Pol. Przegl. Chir.*, 2002; 6: 536-541
- [3] Kidney Disease Outcomes Quality Initiative (KDOQI) Clinical Practice Guideline for Diabetes and Chronic Kidney Disease (CKD) <https://www.kidney.org/sites/default/files/docs/diabetes-ckd-update-2012.pdf>
- [4] Konner K.: Increasing the proportion of diabetics with AV fistulas. *Semin. Dial.*, 2001; 14: 1-4
- [5] Konner K.: Primary vascular access in diabetic patients: an audit. *Nephrol. Dial. Transplant.*, 2000; 15: 1317-1325
- [6] Leapman S.B., Boyle M., Pescovitz M.D., Milgrom M.L., Jindal R.M., Filo R.S.: The arteriovenous fistula for hemodialysis access: gold standard or archaic relic? *Am. Surg.*, 1996; 62: 652-656
- [7] Orchard T.J., Dorman J.S., Maser R.E., Becker D.J., Drash A.L., Ellis D., LaPorte R.E., Kuller L.H.: Prevalence of complications in IDDM by sex and duration. Pittsburgh Epidemiology of Diabetes Complications Study II. *Diabetes*, 1990; 39: 1116-1124
- [8] Tuttle K.R., Bakris G.L., Bilous R.W., Chiang J.L., de Boer I.H., Goldstein-Fuchs J., Hirsch I.B., Kalantar-Zadeh K., Narva A.S., Navaneethan S.D., Neumiller J.J., Patel U.D., Ratner R.E., Whalley-Connell A.T., Molitch M.E.: Diabetic kidney disease: a report from an ADA Consensus Conference. *Am. J. Kidney Dis.*, 2014; 64: 510-533
- [9] U.S. Renal Data System: USRDS 2013 Annual Data Report: Atlas of Chronic Kidney Disease and End-Stage Renal Disease in the United



States. Bethesda, MD: National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases; 2013. <http://www.usrds.org/atlas.aspx>

[10] Weyde W., Krajewska M., Letachowicz W., Klinger M.: Superficialization of the wrist native arteriovenous fistula for effective hemodialysis vascular access construction. *Kidney Int.*, 2002; 61: 1170-1173

[11] Weyde W., Porazko T., Kuształ M., Krajewska M., Trafidło E., Bartosik H., Madziarska K., Krawczyk R., Klinger M.: Vascular access in the diabetic haemodialyzed patients. Are they always difficult patients? *Nephrol. Dial. Transplant.*, 2005; 20, suppl. Poz. SP 388

[12] Windus D.W.: Permanent vascular access: a nephrologist's view. *Am. J. Kidney Dis.*, 1993; 21: 457-471

[13] Windus D.W., Jendrisak M.D., Delmez J.A.: Prosthetic fistula survival and complications in hemodialysis patients: effects of diabetes and age. *Am. J. Kidney Dis.*, 1992; 19: 448-452

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