



Evaluating the Effectiveness of Arterio Venous Fistula Creation Strategy in Diabetics

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Abstract

Introduction: The Arterio Venous Fistula (AVF) approach is preferred to dialysis in patients with chronic renal insufficiency. Radio Cephalic Fistula (AVF RC) should first be created. A negative effect of diabetics on the remodelling and maturity of the AVF is described in diabetics. According to some literature, primary arteriovenous fistula creation at the elbow level should lead to better results.

Aim: To evaluate the effectiveness of creation and long-term patency of AVF in diabetics that was operated on at the II. Department of Surgery at the University Hospital in Olomouc from 2010-2017.

Results: During 1/2010 to 12/2017 265 vascular accesses for dialysis were created in diabetic patients. In 26 cases (12.7%), there was early failure in all arteriovenous fistulas. For early failure (30% of AVF RC creation), eighteen arteriovenous fistula at the elbow level were created in the second period. These AVFs were used for haemodialysis longer than 12 months in 82% of the cases. The primary patency of all vascular access created in diabetics was 78.5%, 70.4% and 64.1% after 12, 24 and 36 months. The primary assisted patency of all vascular access created was 82.5%, 74.4% and 66.1% after 12, 24 and 36 months. Secondary patency was 87.1%, 78.5% and 75.9% after 12, 24 and 36 months.

Conclusion: We have confirmed worse AVF RC results in diabetics. Consequent arteriovenous fistula creation at the elbow level has good long-term results. The strategy of primary creation of arteriovenous fistula at the elbow level seems beneficial in selected groups; it leads to decreasing the number of other reoperations.

Keywords: Hemodialysis; Arteriovenous fistula; Arterio venous graft; Diabetes mellitus

Introduction

Due to economic growth and dietary habits, the prevalence of diabetes has increased in recent decades. The prevalence of diabetes mellitus in the Czech Republic is increasing and the mortality of patients with diabetes is gradually decreasing. According to the UZIS data, there is an enormous growth in the number of patients with proven reduction renal function [1]. Some of these diabetics with nephropathy require the replacement of the function of the kidney, most frequently by haemodialysis. The Arterio Venous Fistula (AVF) approach is preferred to dialysis in patients with chronic renal insufficiency. Radio Cephalic Fistula (AVF RC) should first be created. A negative effect of diabetics on the remodelling and maturity of the AVF is described in diabetics. This decreases the probability of using AVF for dialysis [2]. The reason for frequent AVF failure in diabetics is not exactly known. A thorough pre-operation examination, using image methods and selecting a good place for AVF creation leads to improved results [3]. According to some literature, primary arteriovenous fistula creation at the elbow level should lead to better results. Despite routine use of preoperative vein mapping by duplex ultrasound, which is performed according to the recommendation of NFK-KDOQI, recent studies claim primary AVF failure in 26% to 50% cases and 1-year primary patency in 36% to 46% of the cases [4]. Most literature states diabetes as the negative factor, which worsens the maturity and function of the AVF. Independent evaluation of the patency of individual AVF in diabetic patients is missing; it is usually part of other results. The main aim was to evaluate the effectiveness of AVF creation in relation to the anatomic level in diabetic patients that was operated on at the II. Surgical Clinic at the University Hospital in Olomouc from 2010 to 2017.

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Materials and Methods

The retrospective study focused on AVF created in diabetic patients at the II. Department of Surgery at the University Hospital in Olomouc. During 1/2010 to 12/2017, the patients underwent pre-operation examinations that were conducted by an experienced vascular surgeon, the patients underwent preoperative vein mapping by duplex ultrasound, possibly a flebography. Six weeks after the operation, the patients were re-examined clinically and by ultrasound, where the flow of the AVF was measured. Furthermore, the course of the arterialized veins to cannulation was marked based on the results. The patients were sent for dialysis or if the AVF flow was unsatisfactory, another check-up was performed after six weeks. In the case of a stenosis finding, a fistulography with Percutaneous Angioplasty (PTA) was indicated. The course of the dialysis treatment was investigated at individual dialysis centres. In the case of early failure, creation of AVF more proximal or AVF on the other limb was indicated. Arterio Venous Graft (AVG) was indicated in patients with exhausted superficial veins. The strategy of these consequent operations was individualized according to the necessity of beginning regular dialysis treatment.

Definitions and Statistical Processing

Early failure was defined as the inability to use AVF/AVG successfully for dialysis due to its early thrombosis or failure to mature. Primary patency was defined as the patency of the AVF/AVG, which was confirmed clinically or by an ultrasound. Primary assisted patency was defined as the patency of the AVF/AVG, where it was necessary to perform PTA for stenosis, but closure did not occur here. Secondary patency was defined as the closure of the AVF/AVG with the consequent successful thrombectomy, which led to renewing the function of the AVF/AVG. The results were processed using Excel, Microsoft. The patency was processed using the Kaplan-Meier analysis and the log-rank test. The statistical significance of individual variable factors that could influence the patency was tested using Cox's regression. Since fistulas with primary failure had no useful life expectancy, their survival was considered "0" for the purpose of this analysis. The database was also used to quantify the number of access PTAs, thrombectomies and others access interventions.

Results

During 1/2010 to 12/2017, 960 vascular accesses for dialysis were created in patients with End-Stage Renal Disease (ESRD), of which 265 vascular accesses were created in 221 diabetic patients (32.03% of patients). Most of the group consisted of type II. Diabetics - 204 (92.3%). There were 117 (52.94%) of type II. Diabetics on insulin therapy, 56 (25.34%) diabetics on oral anti-diabetic treatment and 31 (14.03%) of diabetics on diets. There were 150 men and 71 women. The average age of the diabetic patients was 69.1 (median: 70 years old, ranging from 31 to 92 years of age). During follow-up, there were 16 deaths (13 AVFs were functional). Fifteen patients underwent kidney transplantations, all with function AVF/AVG. There was a total of 60 AVF RC (22.3%) created; 151 AVF at the elbow level (56.13%): 43 of which was a brachiocephalic fistula, 96 according to "Gracz", 12 brachio basilic fistula, 29 AVG (10.78%) and 14 patients (7.14%) had a permanent tunnelled catheter primarily inserted. The average time from the creation of the AVF to the beginning of the dialysis was 4.6 months (ranging from 1 to 33 months). In 62 patients (28.1%), AVF creation was already performed during the course of regular dialysis. For early failure of AVF RC (30% of AVF RC created), 18

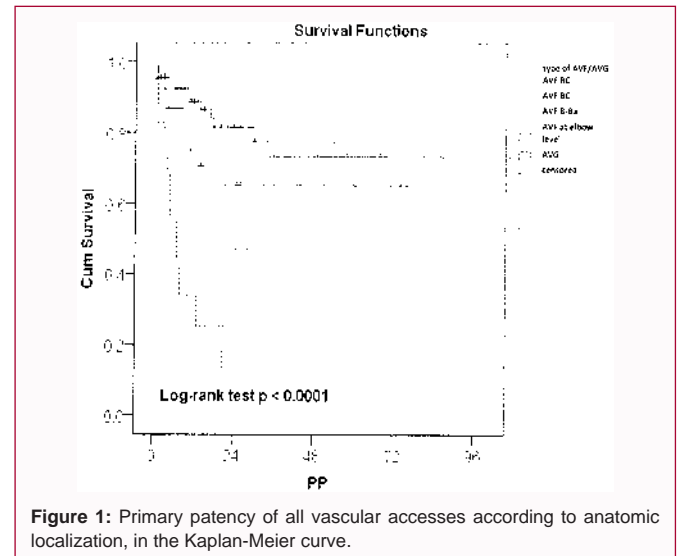


Figure 1: Primary patency of all vascular accesses according to anatomic localization, in the Kaplan-Meier curve.

arteriovenous fistula at the elbow level were created at the second period. For AVF RC failure, another 14 AVF were created at the elbow level during the period when the AVF RC was used to cannulation for dialysis and failed. In 26 patients, it was necessary to create AVF at the elbow level for closing the AVF RC or due to non-maturations and these AVF were used for haemodialysis longer than 12 months in 82% of the cases. A permanent tunnelled catheter was ensured for another 3 patients due to their overall worsening condition after AVF RC failure. The average time for the function of the AVF RC to its termination was 11.1 months. The AVF RC was used for dialysis on 20 patients (33.3%) without any problems. In 12 patients, it was necessary to perform PTA or thrombectomy, 6 AVF RC had extended maturity, 4 AVF were never used for dialysis. The average flow rate of the AVF was 891 ml/min. The average length of the AVF function at the elbow level for a diabetic patient with previously created AVF RC was 14.16 months (ranging from 1 to 68 months). The average length of the AVF function primary created at the elbow level was 29.7 months. The average flow rate of the AVF was 1091 ml/min. Early failure was recorded in 26 cases (12.7%) for all AVF. Two AVFRC were surgically closed due to signs of the steal syndrome gr. II and III and 8 AVF were modified at the elbow level proximalization of the arterial inflow anastomosis. Another 5 patients showed signs of the steal syndrome gr. I. The primary patency of all created vascular accesses in diabetic patients was 78.5%, 70.4% and 64.1% after 12, 24 and 36 months. The primary assisted patency of all created vascular accesses was 82.5%, 74.4% and 66.1% after 12, 24 and 36 months. Secondary patency was 87.1%, 78.5% and 75.9% after 12, 24 and 36 months. Primary patency of all vascular accesses according to anatomic localization, expressed using the Kaplan-Meier curve is illustrated in Figure 1. A significantly longer secondary patency time was detected in men than in women ($p=0.007$). In the case of primary patency, there was no significant dependence between the length and the gender ($p=0.053$). Age was a significant predictor of the length of primary patency ($p=0.024$), the cut off was set at 68 years of age. No significant dependence was proven between the length of the primary and secondary patency and the type of diabetes ($p=0.211$). AVG creation was evaluated as a predicatively negative factor ($p<0.0001$). When the primary failure AVFs were excluded, there was no significant dependence between the secondary patency and the anatomic level AVF creation ($p=0.524$). During the course of observation in relation to establishing a centre for vascular access and the transfer of ultrasound examinations into

the hands of a vascular surgeon from a radiologist, minor deviations from the AVF RC creation were recorded. When divided into groups according to monitored AVF RC creation period from 1/2010 to 12/2014, there were 12 failures and consequently 11 successful AVF creations at the elbow level. In the second monitored period, at the time of examination at the centre for vascular access, there were only 2 failures of AVF RC creation.

Discussion

According to a recent study in Korea, diabetics make up 50.2% of newly dialyzed patients, which is an increase of nearly 12% over 5 years. Here, diabetics have a lower percentage of AVF creation compared to the patients without DM. The overall survival of diabetics is significantly reduced [5,6]. In Central Europe, we can expect a similar increase in patients with DM, who require vascular access for dialysis. Currently, diabetics make up one third of our patients. The proportion of patients older than 60 is also increasing in this group. More than half the patients are older than 60 at the time their regular dialysis treatment begins [7]. According to the register of dialysis patients in the Czech Republic, the majority of patients are 61 to 70 years old and the second group of patients is older than 71 years old. In total numbers, 70% of Czech patients in the Czech Republic are older than 60 and more than 40% of the patients have diabetes. DM increases by percentage points and the mortality rate of diabetics is also on the rise [8]. In our group of patients, age was a negative predictive factor. In patients older than 65, a significantly higher risk of AVF RC failure compared to AVF at the elbow level was also proven. Therefore, there are authors, who, based on meta-analysis, recommend brachiocephalic fistula as the first choice in older patients with a shorter expected life span [6,9,10]. Diabetics can certainly also be included in this group.

The mechanism of negative effects of diabetes on AVF failure is not exactly known. DM causes a higher risk of aggregation platelets and an increased release of the von Willebrand factor, which ultimately leads to destruction of the endothelium [11]. Vascular intima damage and angio-sclerosis exists simultaneously and are more susceptible to the occurrence of thrombosis. Atherosclerosis alone is more common and more developed in diabetics. Some studies have found that atherosclerosis changes on the veins of the forearm in 60% of dialyzed diabetics. On the other hand, some authors claim that native AVF may be created in up to 90% of the patients but at the expense of the following procedures, such as PTA [12]. Asian authors describe a lower percentage of AVF creation in the forearm (41%) [2,6]. In our group of patients, the number of AVF creation on the forearm was even lower. A deviation from the indication of such distal AVF during the course of monitoring in relation to capturing poor results was recorded. On the other hand, indications of arteriovenous fistula creation at the elbow level and the monitoring of post-operative course achieved very good primary and secondary patency results even after 36 months. Arteriovenous fistula creation at the elbow level has a lower level of risk of primary failure [10,13]. Transposed brachiocephalic fistula has lower primary failure and the necessity of intervention compared to the brachiocephalic fistula. Primary failure for brachiocephalic fistula is described in a range from 0 to 21% [14]. At our worksite, we use the technique according to Konner during arteriovenous fistula creation at the elbow level, using the perforating vein. According to authors, this technique has similar results in diabetics as in non-diabetics, but with a higher risk of the steal syndrome [15,16]. At our worksite, the steal syndrome was lower than we had expected. In spite of the reported 5 to 10% incidence with

a higher risk in older diabetics, with the Arteriovenous fistula creation at the elbow level, we recorded 10 patients (3.9%) [17]. Apart from DM, other risk factors involved in early failure include the female gender and the radial artery as the inlet artery [5,9]. In our group, we confirmed the female gender as a risk factor. Not all literature claims diabetes as a risk factor for arteriovenous fistula. Paradoxically, studies focused on the maturity of arteriovenous fistula in over 600 patients, reported that the risk of early thrombosis is significantly lower in diabetics ($p=0.004$) [18]. Another author did not find a difference in the function of the arteriovenous fistula in diabetics and non-diabetic patients [19]. Following America's initiative, Fistula First, the results of the increasing number of arteriovenous fistula creation was evaluated in 371 patients at the Mayo Clinic. It was found that up to 50% of AVF creation was never used for dialysis and the AVF that were functional failed in 25% of the cases after 2 years. Primary failure was 37.1%. There were 34.8% diabetics. The most common AVF was brachiocephalic (68.2%). More than half the patients underwent AVF creation after initiating regular HD treatment. The average beginning of AVF cannulation was one month from creation. Forty-nine percent of the AVF was not used for HD. One-year primary patency was 41% and secondary patency was in 77%. The steal syndrome occurred in 18.3% cases. Here, diabetes was evaluated as the only risk factor [20]. Despite similar representation in diabetics, we have better results in long-term monitoring for all the monitored parameters. In comparison with the AVF, the results of the AVG are worse. This is also attributed to the far greater risk of infection decreasing patency. We have confirmed this well-known data. Despite standardized protocol monitoring, thrombosis and infections occurred and in most of these cases, it was necessary to remove the functional AVG. We have also confirmed diabetes to be a negative factor for the function of the AVG in our previous work as well [21,22]. During standard implementation of examination by a vascular surgeon, AVF before and after creation by ultrasound led to a natural decrease in the amount of indicated AVF RC. On the other hand, there were fewer patients with type I. diabetes during this period. Patients with type I. diabetes are indicated for AVF creation at a younger age and there is a greater probability of AVF creation distally. We regard ultrasound vein mapping provided by a vascular surgeon as more beneficial than the radiologist due to more complex consequences. The disadvantage of our work is that it is retrospective. However, the length of monitoring the supporting data from dialyses and post-operative monitoring of all patients significantly contributes to the indications of AVF.

Conclusion

We have confirmed worse AVF RC results in diabetics. Consequent arteriovenous fistula creation at the elbow level has good long-term results. The strategy of primary i arteriovenous fistula creation at the elbow level seems beneficial in selected group; it leads to decreasing the number of other reoperations.

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