AUTOGENOUS ARTERIOVENOUS ELBOW FISTULA FOR HAEMODIALYSIS AND UPPER EXTREMITY ISCHEMIA

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Background: The autogenous brachiocephalic or brachio basilic arteriovenous elbow fistula is not considered to be only the secondary haemodialysis access. In patients with an unsuitable forearm vessel bundle, it is indicated as primary access and it is the method preferred to the fistula creation using a vascular prosthesis. Its rather rare complication is the development of upper extremity ischemia.

Aim: To summarise current knowledge of this fistula type and its associated complications

Methods: Review of the literature.

Results: The creation and maturation of the fistula and occurrence of the steal syndrome is influenced by a number of factors. The analysis and awareness of such factors will provide for creation of a suitable fistula as well as for timely complication diagnostics and treatment.

Conclusions: The autogenous elbow fistula utilising the brachial artery and the cephalic or basilic vein in the upper extremity represents a high-quality haemodialysis access. Its potential complication is the occurrence of the steal syndrome. Its occurrence and manifestations do not constitute indications for ligation of the access. The gathered information shows that a suitable surgical procedure can help meet the basic rule for haemodialysis access – resolving the ischemia and maintaining the access.

INTRODUCTION

The creation of a quality arteriovenous (AV) fistula for haemodialysis is dependent on a relatively healthy and undamaged arterial and subcutaneous venous bed. The standard primary AV fistula in Europe is the Brescia-Cimino fistula¹ or a modification thereof.

The autogenous AV fistula in elbow, which utilises the rich subcutaneous venous bed, is mainly considered the “secondary” access after having exhausted all the possibilities of fistula creation at the more distal level². Today older, polymorbid patients are dialysed with lower quality distal forearm vascular bundle, unsuitable for AV fistula creation, and elbow fistula becomes the primary access. The cephalic or basilic veins are arterialised via the brachial artery.

In 1970 Cascardo et al.³ published their experience in creating elbow AV fistulas for low-quality forearm arterial bed. The use of the basilic vein is described by Dagher⁴. Use of the perforating vein for anastomosis was published by Gracz⁵. 10–25 % of cases of the brachiocephalic and brachio basilic AV fistulas show steal syndrome presentations.

METHODS

Using the Pubmed database, relevant publications were found on creation of the autogenous arteriovenous fistulas for haemodialysis in the elbow with a focus on the occurrence of the steal syndrome and upper extremity ischemia.

RESULTS

The method of primary arteriovenous fistula creation is different in Europe and in the U.S.A. Primary autogenous fistula is created in 80 % of patients in Europe compared to 24 % in the U.S.⁶. In the early 1990s, the method of choice in the U.S. was the AV fistula using an ePTFE graft, which ensured high blood flow rates of the fistula⁷. The complications associated with these fistulas are well-known and are predominantly of stenotic and thrombotic nature^{8–10}. In the mid-1990s, the situation was reviewed in the U.S., following the DOQI recommendation, and revival of the autogenous fistulas took place due to less proneness to stenoses, thromboses and infectious complications in comparison with the grafts. It was recommended that

at least 50 % of the fistulas created was autogenous^{2,11}. A summary of the observations of both access types in the U.S. shows that both fistula types have a comparable operating duration, with the advantage of autogenous fistulas being the lower number of post-maturity complications and fistula interventions. Maintaining the graft operable requires a higher number of procedures such as angioplasty, thrombectomy and surgical revision. Grafts also demonstrate a higher occurrence rate of infectious complications. The creation of the autogenous AV fistula is associated with early post-insertion complications and the necessary maturation of the fistula. Its subsequent operation is typically of a long-term nature with a low complication rate^{8,12,13}. This opinion can be agreed with. It should be mentioned that the autogenous fistula has always been considered the gold standard in Europe.

The age of patient included in the chronic dialysis programme is increasing and so is mainly the number of patients with atherosclerotic and diabetic complications. The creation of the AV fistula at the wrist level is often impossible in such patients. This is due to the sclerotic arterial bed of the forearm, often combined with a poor subcutaneous venous bed. The method of choice in the creation of the autogenous arteriovenous fistula is the elbow fistula, which involves arterialisation of the subcutaneous venous bed of the basilic or cephalic veins in the arm by means of anastomosis to the brachial artery. The autogenous elbow fistula is currently the access used for the creation of up to 45 % of primary autogenous fistulas for haemodialysis in Europe. Its creation is technically easy but it is necessary to consider all possible complications which make it difficult or prevent its application and which require further surgical procedures. In terms of utility and complication occurrence, the results are very good¹³⁻¹⁷. This fistula type involves well-known disadvantages and complications. Arterialisation of the basilic vein is often accompanied by concurrent or subsequent basilic vein ante-position because, in its physiological course, it is placed subfascially in the proximal 2/3 of the arm^{16,18}. The adverse complication of these fistula types is the possible gradual development of the steal syndrome with upper extremity ischemia.

Despite great care in the creation of arteriovenous anastomosis of the fistula within the diameter of 7 mm, there is always the risk of development of a hyperfunctional fistula with steal syndrome and hand ischemia¹⁹. Under suitable anatomical conditions, the prevention can involve performance of elbow fistula more distally on the radial or ulnar artery just under the brachial artery branching using the v. mediana antebrachii²⁰. U.S. literature recognises the steal syndrome and deals with it mainly in fistulas performed using the ePTFE graft^{21,22}. The steal syndrome shows early manifestations in fistulas performed with a graft as opposed to their later manifestation in autogenous fistulas in connection with fistula development²³.

Diabetes mellitus is considered a risk factor for the occurrence of this complication^{11,16,24-28}. However, some authors do not agree²⁹. Other risk factors include the use

of brachial artery^{30,31}, age over 60³⁰, female gender^{26,31} and lupus²⁶. In terms of the steal syndrome occurrence, the brachiocephalic fistula is a risk factor as opposed to the radiocephalic fistula or to the application of the loop using a vascular prosthesis²⁴. In advanced ischemic symptoms with finger gangrene, the basic factor is the atherosclerosis^{26,27}. Since providing access for haemodialysis is a priority, the performance of the fistula in the elbow is preferred in diabetic patients to the radiocephalic forearm fistula, which is patent yet unsuitable for cannulation¹⁷.

The actual occurrence of the steal syndrome demonstrations after elbow fistula performance between the brachial artery and the cephalic or basilic veins is difficult to assess because published reports usually do not specify the performance type with regard to fistula complications^{14,32,33}. The steal syndrome fistula has an asymptomatic form, the so-called "physiological steal" which occurs in 80 % of the patients, and a symptomatic form. The physiological steal is a demonstrable drop in blood pressure at the periphery and is compensated by the arterial collateral circulation and vasodilation. If these mechanisms fail, the symptomatic form occurs in 3.7-8 % of the fistulas^{14,19,25,30,34}. In the brachiocephalic and brachio-basilic fistulas it even appears in as much as 10-25 %¹⁹. Its manifestations include cold sensation and pallor of the limb, pain while working or during dialysis, sensitivity loss, cramps and pain while resting, the development of ulcers, necrosis to tissue loss^{19,23}. In certain cases, the problems are not caused by the steal syndrome but rather by ischemic monomelic neuropathy^{35,36}.

It is a question how to examine a patient with a sclerotic arterial bed and diabetes prior to the autogenous fistula performance in order to correctly indicate elbow fistula and how to prevent the development of a hyperfunctional fistula with the steal syndrome. There is probably no imaging method to indicate the fistula type. There is also no demonstrable method to clearly determine, before or after the fistula performance, that the fistula will be hyperfunctional with steal demonstrations^{34,37}. However, imaging can determine where the fistula should not to be attempted because the arterial or venous bed does not provide a solid basis for a satisfactory result. After creation of the fistula in elbow, it is necessary to monitor the patient and the fistula as well as any steal syndrome symptoms development.

It is not difficult to recognise the developed clinical manifestations of the steal syndrome after the AV fistula creation. Effort should mainly be made to recognise the early manifestations in order to treat the fistula in time. A number of methods are recommended: physical examination of the site²⁴, digital plethysmography of the arm periphery^{24,25,33}, skin temperature monitoring²⁴, periphery oxygenation measurement²⁴, digital pressure measurements³⁷, vessel bundle flow rate assessment by colour duplex sonography³³ or arteriography of the entire fistula bed with or without fistula compression^{25,33}. The fistula flow rate, however, does not typically influence steal development. Its occurrence rather depends on the peripheral arterial bed and collateral circulation^{24,40}.

The main therapy principle is resolving the ischemia and maintaining the access. However, this principle may be difficult to fulfil, mainly in risk groups of patients. A number of methods have been described and evaluated regarding modification of the autogenous elbow fistula between the brachial artery and the subcutaneous upper extremity (arm) venous bed with steal manifestations and regarding the maintained functionality thereof.

Primarily, it is the procedure of distal revascularization-interval ligation (DRIL). In principle, this is a venous bypass from the brachial artery above the AV fistula anastomosis to the radial or ulnar artery with the subsequent ligation of the brachial artery below the AV anastomosis. The method was described by Schanzer³⁹ and applied by other authors who describe positive results, i.e. the ischemic symptoms improved in 90–100 % while maintaining fistula patency in 80–100 %^{22,25,33}. In patients with a poor arterial bed in the elbow, the anastomosis on radial or ulnar artery may be technically impossible.

Another technique is the proximalisation of the arterial inflow. The principle of this method is to interrupt the AV fistula anastomosis, treat the venous stump and then insert the ePTFE graft subcutaneously between the axillary artery and the original vein over the elbow. A 4–5mm gauge prosthesis is used. Larger-lumen prostheses can be later used for cannulation. Compared with the DRIL procedure, the stem artery is not ligated. The problems receded 90 % of cases, and the fistula operability at 1 year was 90 % (ref.³²).

In line with the contemporary literature, other methods can be considered obsolete. These include reducing the flow through the fistula by stitches, banding or clip^{33,41}. The disadvantage of such methods is either an insufficient reduction of the flow and thus failure to remove steal or such a reduction of the flow as to cause thrombosis of the fistula. Another option is the insertion of a graft after the AV anastomosis disconnecting between the brachial artery and efferent vein in the forearm subcutis³⁸.

In a number of instances, mainly in diabetic patients with severe ischemic changes in the extremity peripheries, the request for saving the fistula cannot be met, and the only possibility is ligation of the arteriovenous access. In such cases, it must be determined whether to attempt another fistula or to apt for placing long-term central vein catheters or ports.

CONCLUSIONS

It can be summarised that the autogenous fistula in the elbow between the brachial artery and the cephalic or basilic vein currently holds an irreplaceable position in providing access for haemodialysis and that it needs to be preferred to using a graft. Mainly in risk groups of patients (diabetes mellitus, advanced stages of atherosclerosis), the condition of the patients needs to be monitored, as well as the flow through the fistula due to the possible steal syndrome occurrence. Further fistula treatment must be provided in the event of steal syndrome manifestations.

Proximalisation of the arterial inflow appears to be the most suitable method. Another method is the DRIL procedure. Certain cases cannot be repaired, the fistula cannot be saved and has to be surgically closed.

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