absence of maturation or impossibility or contraindication of another type of VA. The VAs in LE are used exceptionally in individualised cases. And finally, the clinical characteristics of each patient may affect the indication of the technique to be performed.

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**110.6**

**Vascular access for haemodialysis**

**Surgical Technique**

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## Introduction

The increase in life expectancy of the general population, the progress made in the treatment of Terminal Chronic Renal Insufficiency (CRI) and the greater survival rates of patients submitted to a regular haemodialysis (HD) programme, have led to an increase in demand for vascular access, as well as to the need for a greater functional duration of these accesses.

The ideal vascular access does not exist, so we must try to make the arteriovenous fistula (AVF) useful and long lasting. The AVF must provide sufficient flow for the HD to be efficient. It must also be simple to channel and permit multiple punctures distributed throughout its trajectory without having to concentrate them in a limited area. The AVF must be easy to monitor and also permit the necessary medicosurgical gestures or repairs to anticipate its failure and avoid its loss. As already mentioned, the AVF must have maximum duration and not be an impediment, when it fails, to carrying out another vascular access.

The arteries and veins that are involved in any AVF must satisfy a series of characteristics for them to be suitable for this function. There must be an absence of significant proximal pathology in the artery and the calibre of its lumen must be 2 mm or greater, to guarantee that the blood supply will permit high flows in the fistula. The vein must have a calibre of 2.5 mm or more at the point where the anastomosis is going to be carried out; it must be permeable along the entire trajectory, it must have a rectilinear segment that facilitates cannulation; it must be situated at a depth of less than 1 cm from the skin and maintain continuity with the proximal central venous system.

## Types of vascular access

We can classify the fistulae into two types, depending on the material used to construct them: **autologous** fistulae, when a vein from the actual patient is used as a conduit to carry out the fistula, and **prosthetic**, if material that is alien to the patient is used.

One of the disadvantages of the autologous arteriovenous fistulae is that they require at least four weeks maturation, and ideally it would be necessary to wait three to four months before using it. On the contrary, the prosthetic fistula only requires two weeks' maturation, although it is advisable to wait until the fourth week.

## Strategy

The recommended strategy to plan the execution of a AVF is as follows: the fistula must be prepared as distally as possible to reduce the risk of a medical condition of distal ischemia due to steal or of cardiac overload from developing, giving priority to the non-dominant extremity. An autologous fistula will always be carried out before a prosthetic one. The use of the lower extremity must be avoided and permanent catheters are reserved for those situations where all other AVF options have been exhausted.

## Types of anastomoses

Different types of anastomosis have been used to carry out the AVF, depending on the way the artery and the vein communicate. For its nomenclature, we take the first term of the donor artery and the second term of the receiver vein. These are basically reduced to four: side-to-side anastomosis (which was originally described by Cimino-Brescia), side to end (which is the most commonly one used today), end-to-side and end-to-end. To carry out end-to-side anastomoses, longitudinal arteriotomies are practised, which will measure approximately one and a half times the calibre of the vessel. Later the vein is bevelled with an approximate angle of 45°. The suture is carried out with 6/0 or 7/0 monofilament, non-absorbable material, generally polypropylene.

Sometimes, some type of visual magnifying system (magnifying lenses) can be useful to help make the suture, especially when the fistula is very distal, although in general, this is not necessary.

## Defects of anastomoses

The most common defects when performing an anastomosis of this type consist in carry out the suture by taking too much tissue into each stitch, either from the artery or from the vein, which gives rise to stenosis. Another defect is leaving a short segment of vein which causes traction of the artery and possible thrombosis. The venotomy may also be excessive, leaving a redundant anastomotic hood that will generate turbulences and favour thrombosis.

## Autologous vascular access in upper extremities

Arteriovenous fistulae can be carried out in the upper extremities in three areas: In the wrist, in the forearm and elbow, and in the arm. The disadvantage of arteriovenous fistulae of the wrist is that there is a higher rate of early failures and lack of maturation. But, on the other hand, if they work correctly they have the advantage of maintaining excellent permeability, with a low complication incidence. They also permit carrying out arteriovenous fistulae in proximal territories in the case of failure. For this reason, normally, this is the location of choice to carry out the first fistula. Three types of fistula can be carried out in the wrist: In the anatomical snuff box, the classic radiocephalic fistula described by Cimino-Brescia and the cubital-basilic fistula. Local anaesthesia is used to carry it out.

The venous and arterial segment is then dissected and the vein is sectioned as described above. After carrying out the local heparinisation and dilating the vein using saline solution, the side-to-end anastomosis is constructed. Fistulae in the anatomical snuff box are rarely used because the vessels in that area have limited calibre and it is in a flexion zone, so the possibilities of failure are greater. The cubital-basilic fistula is resorted to after the failure of the radiocephalic fistula. Before carrying it out, we must verify that the palmar arch and the radial artery are permeable to thus prevent distal ischemia from occurring. Another disadvantage of the latter is that it requires considerable skin detachment to mobilise the basilic vein.

The arteriovenous fistulae in the forearm and elbow may be: radiocephalic fistulae, venous transpositions and fistulae in the elbow flexure carried out with the perforator vein or with the median vein. The advantage of using the perforator vein is that it permits the flow through the cephalic and basilic veins of the arm, as well as from the veins of the palmar side of the forearm. They also have less risk of causing steal syndrome and distal ischemia.

The arteriovenous fistulae of the arm are humeral-cephalic and humeral-basilic fistulae. The latter may be carried out by transposition of the vein or superficialisation of the vein.

## Autologous vascular access in lower extremities

The autologous vascular accesses of the lower extremities are carried out using the internal saphenous vein. The vein can be placed in a rectilinear assembly or in a U-shaped assembly. In the rectilinear assembly the arterial anastomosis is carried out in the first popliteal portion, the vein is tunnelled subcutaneously on the antero-internal side of the thigh, and the venous anastomosis is carried out in the femoral vein distal to the crook of the internal saphenous vein.

For the U-shaped assembly the vein is extracted and is placed by anastomosing the arterial end in the superficial femoral artery and the venous end in the same way as in the rectilinear assembly after having tunnelled the vein subcutaneously in the anterior side of the thigh.

### Prosthetic vascular access

The prosthetic vascular accesses will always be carried out after having exhausted all the possibilities of executing autologous accesses. They have the advantage of having a relatively simple technique, not requiring a prolonged maturation period and being easy to puncture as the most convenient area to tunnel them can be freely chosen. However, they also have the highest complication rate and require a greater number of revisions, with the subsequent economic cost and impairment of the patient's quality of life.

Different prosthetic materials have been used for vascular accesses. The most commonly used material is ePTFE (expanded polytetrafluoroethylene), although other materials such as polyurethane are also used. Xenografts derived from bovine mesenteric vein or alografts with femoral vein or internal saphenous vein have also been used. The ideal calibre for these channels is not clear, but what nobody questions is that with a lumen of less than 6 mm, there are considerable probabilities of occlusion, and if it is greater than 6 mm, the possibilities increase of developing an arterial steal syndrome or cardiac volume overload. To avoid these situations, tapered prostheses with a greater calibre at entry and smaller calibre at exit have been used. The length of the prosthesis varies between 20 and 40 cm in order to provide a minimum of 15 cm trajectory to carry out the punctures. They can be implanted in a straight or U-shaped position. Whenever a prosthesis is implanted, carrying out an antibiotic prophylaxis is inexcusable given that the prosthetic materials are especially susceptible to infection during implantation and they do not possess the defence mechanisms that protect the autologous fistulae.

### Alternative vascular access

This group includes those vascular accesses that are not carried out on a routine basis, and those that must be resorted to when the normal autologous or prosthetic vascular access possibilities have been exhausted. This type of access can be carried out on the anterior side of the thorax taking the axillary or subclavian artery as the donor artery and the axillary or jugular vein as the receiving vein. The position of the prosthesis may be U-shaped, tunnelling the prosthesis subcutaneously on the pectoralis major muscle or crossing over the anterior side of the sternum from one axillary vessel to another contralateral one.

The abdominal vessels can also be resorted to, where the external iliac artery or the common femoral artery is the donor artery and the iliac vein or inferior cava is the receiving vein. In both cases an attempt must be made to carry out the anastomoses as distal as possible to minimise the risk of steal syndrome. The prosthesis can be tunnelled subcutaneously in the iliac fossa or on the antero-external side of the thigh.

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**110.7**

**Surgical treatment of complications in vascular accesses for haemodialysis**

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Stenosis and acute thrombosis of vascular accesses are the most frequent causes of the latter's dysfunction. Other complications, which might endanger not only the feasibility of the access but also the patient's life, include: the formation of aneurysms and pseudoaneurysms, haemorrhage and breakage of the access, infections of the access and other complications such as distal ischemia, high venous pressure and thrombosis of central veins.

## Dysfunction due to vascular access stenosis

When the dysfunction of a vascular access is detected early on, the stenosis can be identified and corrected, reducing the risk of thrombosis and increasing the survival of the vascular access.

The routine physical examination before and after each haemodialysis session may be useful in detecting access stenosis. The existence of stenosis can be suspected by observation, palpation (thrill) and auscultation (murmur) of the trajectory of an arteriovenous access. In an autologous fistula, stenosis can be appreciated as a depressed trajectory of the vein. The venous trajectory between the anastomosis and the stenotic area will have a greater pulse, whilst the venous trajectory after the stenosis will have less pressure and will even have lost the thrill or will have collapsed. A discontinuous and sharp murmur may be auscultated in the stenosis area, which may indicate critical stenosis. The venous segment proximal to the stenosis may develop a venous aneurysm. These stenoses in the venous trajectories of autologous fistulae may be due to fibrosis of the venous wall, caused by repeated punctures at the same point during the haemodialysis sessions. The existence of a severe and progressive oedema, with cutaneous cyanosis and collateral circulation, in an extremity that bears an arteriovenous access, may mean the existence of high venous pressure due to stenosis or venous occlusion proximal to the access. Furthermore, depending on the location of the oedema, it will be possible to infer which access drainage vein contains the obstruction.

Likewise, during the haemodialysis sessions, attention must be paid to certain situations that may be indicative of access dysfunction. Difficulty in the cannulation of the access may indicate a lack of maturation of the access. Changes in pre-pump blood pressure with respect to previous sessions, as well as the impossibility of maintaining normal blood flows in three consecutive sessions, may indicate a reduction of the access flow. An increase in venous pressure during the haemodialysis at normal flows may be indicative of venous stenosis at proximal level. Increased bleeding time after removing the needles, and after ruling out coagulation alterations, may be caused by an increase