6. Diagnosis of stenoses in AV fistulae and AV grafts

Guideline 6.1. If a haemodynamically significant stenosis is suspected by physical examination and/or flow measurement, imaging should be performed as soon as possible (Evidence level III).

Guideline 6.2. Pre-emptive intervention should be performed percutaneously or surgically without further delay and imaging should be performed immediately before the intervention (Evidence level II).

Guideline 6.3. If the complete arterial inflow and venous outflow vessels need to be visualized, magnetic resonance angiography (MRA) should be performed (Evidence level III).

Rationale

Clinical examination should remain the key method for the diagnosis of stenosis in autogenous arteriovenous fistulae and AV grafts [1]. However, the decision on whether clinical examination alone is sufficient or additional imaging examination must be performed before treatment, depends on local customs and practice. In cases of percutaneous treatment of stenoses, pre-, intra- and post-operative angiography must be conducted. When surgical revision is carried out, on-table angiography after completion should also be conducted when available. Angiography entirely for diagnostic purposes, without concommitant treatment should be avoided. Once thrombosis has occurred, surgical or interventional radiological clot removal is necessary to allow haemodialysis through the vascular access without the need for central venous catheter insertion. Correction of the underlying stenosis is an integral part of any declotting procedure.

Diagnosis of stenosis

Duplex ultrasonography

Whenever stenosis is suspected, duplex ultrasonography can be performed to locate and to quantify the degree of diameter reduction due to the stenosis [2–5]. Duplex ultrasonography in the hand of an experienced clinician or vascular technician is an adequate diagnostic tool except for hand arteries and central veins [6] and can be helpful in defining thrombus extent. Angiography is not necessary if duplex indicates a stenosis at the arteriovenous anastomosis in forearm fistulae, which usually are only amenable to surgical revision by proximal re-anastomosis. Duplex examination is especially valuable in detecting stenoses and to perform flow measurements in non-maturing AV fistulae in which iodine injection should be avoided, because of the risk of renal function deterioration. Recently, duplex was suggested as the initial imaging modality of dysfunctional fistulae, but complete access should be depicted at DSA and angioplasty to detect all significant stenoses eligible for intervention. Magnetic resonance angiography (MRA) should be considered only if DSA is inconclusive [7].

Angiography

Diagnostic angiography with iodinated contrast agents without subsequent dilatation or surgical revision is not advised. However, angiography is typically performed before, during and after dilatation or percutaneous thrombolysis and after surgical thrombectomy in order to guide the treatment and depict inflow as well as residual stenoses and/or clots or central venous obstruction [8]. To avoid impairment of residual renal function, gadolinium-enhanced digital subtraction angiography may be an alternative. Le Blanche et al. [9] found no impairment of renal function using gadolinium in their patient collective. They concluded, that gadolinium-enhanced digital subtraction angiography is an effective and safe method to assess the cause for malfunctioning AVFs. It can also be used to plan and perform percutaneous transluminal angioplasty. As an alternative, diluted iodine may be used, with a low risk of further renal function detoriation. Arterial inflow stenosis may be missed by diagnostic angiography. By introduction of a catheter through the access up into the arterial tree, also the subclavian and brachial arteries can be imaged [10].

Magnetic resonance angiography

MRA has been reported to be an useful, safe and practical imaging modality in complex fistulae with fewer complications and side-effects compared with fistulography [11]. It allows non-invasive evaluation of the arterial and venous system in one examination [12]. If MRA is performed as an alternative, it should be employed with contrast-enhanced (Gadolinium) technique (CE-MRA), since the latter shows a good visualization of arm veins with diameter measurements closely correlating with conventional venography [9]. In one study, MRA depicted all 13 stenoses and two false-positive findings, resulting in a sensitivity of 100% and a specificity of 94% for the arterial and venous tree [13]. Froger et al. found a sensitivity, specificity and positive and negative predictive value of MRA in the detection of stenosed vessel segments of 97, 99, 96 and 99%, respectively [14]. When central

venous obstruction is suspected, angiography of the complete venous outflow system up to the right atrium is mandatory. MRA of the central veins is accurate and even superior to contrast venography, which may fail to show all patent thoracic vessels [15,16]. However, it is an elaborate procedure, and therefore not possible in every hospital. Also, an additional intervention is not possible at the same time [17].

Recommendations for further research

New imaging modalities may be applied for a more accurate diagnosis of access stenosis.

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