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Steal syndrome dialysis pdf

Skip hub destination In access-related stealing syndrome, four phases can be distinguished (Table 1, [1]). Steal syndrome phase I (retrograde flow of blood into access during diastole without complaints) is a frequent finding in arteriovenous (AV) fistula and grafts [2] and need no intervention. However, patients with pain during exercise or during dialysis (Phase II) require permanent attention for early detection of deterioration to phase III (resting pain) or phase IV (necrosis). Table 1.Classification of stealing syndrome (modified from [1]) Phase I Retrograd diastolic flow without complaints; steal phenomenon phase II Pain by exertion and/or during hemodialysis Phase III Resting pain Phase IV Ulceration/necrosis/gangrene Depending on the type and location of AV access to HD the risk of severe access-related peripheral ischemia (steal syndrome phase III or IV) varies between 1-2% (in distal radio-cephalic AV fistula) and 5-15% (in brachio-cephalic/basilic fistulae and grafts) [3-6]. After the creation of a femoral (autogenic or allograft) access, an even higher incidence of stealing syndrome (16 to 36%, [7.8]) has been reported. Women, diabetics and patients with known coronary or peripheral arterial occlusive disease have a higher risk than the remaining HD population [3,9-11]. The stealing syndrome will likely disappear once access is abandoned, but the creation of a new AV access on another extremity is burdened with a significant risk of recurrent peripheral ischemia. Therefore, correction of stealing syndrome should aim at the dual goal of maintaining access and at the same time, improving peripheral arterial turnover. Pathophysiology AV fistula in general is constructed in a side of artery-to-end of vein (or graft) mode. During rest conditions, the high resistance of muscle-feeding arteries in diastole causes a reglide flow in the artery distal to AV anastomosis and into AV access. This 'physiological' stealing phenomenon can be observed in 73% of AV fistele and in 91% of access grafts [2]. Approximately 75% of blood flow through distal radio-cephalic fistula is delivered by the proximal radial artery, but 25% comes from a patent ulnar artery via the distal radial artery and palmar arch [12]. In elbow fistula, periarticular arterial collateral has the same effect. When an AV fistula is created using healthy vessels, dilation of proximal and distal arteries, as well as dilation of collateral around anastomosis, compensates for increased systolic AV flow and also for diastolic retrograde influx in fistula. Any vascular pathology affecting one or more of these adaptive mechanisms can cause distal ischemia by a stealing mechanism. Arterial stenosis upstream of anastomosis prevents the necessary flow increase in feeding artery; severe peripheral arterial disease (PAOD) or vasculitis increases resistance in distal arteries while impairing the function of natural collateral [13]. In these circumstances, almost all blood coming from the collateral is drained under diastole access [14]. Instead of a stealing syndrome phase I (also named stealing phenomenon), the additional dreaded phases II to IV develop, with clinical signs of peripheral ischemia. The likelihood that a stealing syndrome develops depends more on the severity of arterial pathology and less on the amount of intra-access blood flow. Clinical findings Access-related peripheral ischemia is primarily diagnosed based on patient complaints and clinical outcomes. Like Fontaine's classification of PAOD, four phases can be distinguished (Table 1[1]). In critical ischemia Phase III or Phase IV, transcutaneous toilil content pressure (tcpO2) is lower than 30 mmHg, wrist or digital arterial pressure below 50 mmHg, and the digital(wrist)/brachial pressure index is below 0,6 [13]. With access compression, the respective values increase significantly, sometimes even to normal. These tests help distinguish stealing syndrome from other conditions that cause the constellation of dystrophy, pain and necrosis, such as carpal tunnel syndrome, Sudeck's dystrophy or calciphylaxis. A rare but potentially devastating complication of stealing is the so-called ischemic monomelic neuropathy (IMN) [15,16]. In uraemic diabetics with pre-existing neuropathy, a reduction of blood flow in vasa nervorum caused by stealing phenomenon can cause severe sensory dysfunction of ulnar, radial and median nerves without obvious tissue loss and with pressure index above critical values. Symptoms often occur immediately after the creation of access. When ischemia is not reversed immediately and adequately, irreversible neural damage and permanent impairment of the affected extremity may be the consequences. Diagnostic evaluation Access current measurements – either with color code duplex ultrasound or with one of the dilution methods – are of less relevance to the diagnosis of stealing syndrome because - depending on the severity of arterial disease - symptoms can occur at any rate of access flow. In a recent German series [17], two thirds of patients with av-fistula and access-related ischemia had access flows ≤250 ml/min. However, preoperative access current measurements are indispensable in planning the optimal treatment of a stealing syndrome (see below). In order to detect proximal arterial stenosis, duplex ultrasound is of limited value in patients with an AV access, as the typical post-stenotic flow pattern (bi-phasic signal) is masked due to the high diastolic flow through access-feeding arteries. However, when duplex ultrasound is performed with access compressed, the post-stenotic flow pattern can and thus allows the localization of a potential stenosis that interferes with arterial influx. A pattern of minimal current in stenotic forearm arteries suggests serious disease of the peripheral artery as the cause of a stealing syndrome can be easily detected by ultrasound, while palmar arch and finger arteries are better visualized angiographically [18]. In selected cases, and when performed by an experienced investigator, color-coded duplex ultrasound alone may be sufficient to define the cause of stealing syndrome and to certainly plan the corrective procedure. Most authors, however, require angiographic visualization of the complete arterial and venous trees in the extremities. When an arterial stenosis proximal to AV anastomosis is excluded by duplex ultrasonography with access to compression or by MRI angiography, AV anastomosis and venous outflow are easily visualized by a transbrachial angiography. In cases with a severe stealing syndrome, forearm, hand and finger arteries can only be opacified when access is compressed during dye injection. As a less invasive alternative to arterial puncture, contrast media can be injected directly into access. With central compression of access, AV anastosis, the food segment of the artery and peripheral arterial wood can be visualized. Treatment Options Arterial Influx Obstruction Proximal arterial stenosiss cause access dysfunction in more than 10% of patients [19] and they have been shown to be present in 25 to 50% of patients with access-related ischemia [20.21]. Standard interventions result in immediate relief of symptoms [21]. Arterial influx obstruction should be addressed regardless of the severity of stealing-induced complaints; not only do they weaken the peripheral circulation, they also cause dysfunction of the vascular access, which reduces the effect of hemodialysis. 'Classic' stealing syndrome Only when influx stenoses have been excluded or successfully treated, one should classify symptoms of ischemia as a stealing syndrome in the narrow sense. In AV fistula without graft, blood flow tends to increase over time. Therefore, patients with fistula presents with phase II stealing syndrome require permanent attention by the nephrology team, in order to detect progression to phase III or phase IV in a timely manner. In patients with diabetic hemodialysis with significant neuropathy, early correction of Phase II stealing syndrome should be considered to prevent the development of IMN. Progressive stenosis of venous anastomosis of access grafts often causes flow reduction due to increased venous resistance. When stage II stealing syndrome occurs early after the creation of a vascular access using a graft, the wakeful waiting is warranted because the symptoms of a stealing syndrome will most likely disappear over time. If such a should be treated in a late stage, simultaneous prophylactic correction of stealing should be considered. The presence of a stealing syndrome causing critical limb ischemia (phase III or phase IV) or IMN is reason enough for acute imaging and treatment-regardless of the type of AV access. Since the early 1970s, banding access has been the preferred treatment for stealing syndrome. Meanwhile therapeutic decisions seem to have become somewhat more difficult with the advent of surgical procedures like DRIL and DRAL, PAVA, RUDI and MILLER. Although these techniques are widely cited, they are not necessarily well understood. The following algorithm will hopefully help find the most appropriate solution to the problem of the individual patient. Pre-therapeutic access flow measurements, but not necessary for diagnosing stealing syndrome, have become increasingly important for a differentiated approach. Depending on the measured flow values in) 'high current' (>800 ml/min. in ordinary fistula, >1200 ml/min in access transplants), (ii) 'normal flow' and (iii) 'low-current stalk' (<400 ml/min in native fistel, <600 ml/min in access grafts) can be distinguished from [22,23]. Ligation Access ligation will lead to an immediate improvement of stealing syndrome and also to loss of access with the need to create another, in turn runs the risk of provoking a stealing syndrome. Access ligation can be considered in severe ischemia or IMN to get time for a thorough diagnostic work up and preferably in a way that later reactivation of access with concomitant treatment of stealing syndrome is possible. However, after ligation, reactivation of fistula will not be possible in many cases due to thrombosis. Thus, a better alternative to ligation seems to be to quickly perform the studies necessary to plan treatment, and to treat the stealing syndrome immediately after with one of the procedures described below. Access ligation can of course be performed when a stealing syndrome develops after a successful kidney transplant. It is imperative that other corrective procedures are not suitable or have failed. Banding Access banding aims to create a narrow vessel segment within access, close to or on av anastomosis. Native fistula can be banded by non-absorbable sutures, small caliber interposition grafts or by narrowing the vein with a tight Dacron or polytetrafluoroethylene (PTFE) cuff. In prosthetic entries, interposition of a short tapered graft segment has been proposed [5,6,17,20,22,24]. Banding aims to reduce the flow of access. Thus, it can be successfully performed only in patients with a high flow associated stealing syndrome. Banding a low flow access to a degree where stealing syndrome disappears will result in ineffective dialysis or even access to thrombosis. In some previous series, banding was only tcpO2 measurements. Steal was cured in 90 to 100% of patients, but only 10 to 40% of the damned accesses remained patented (Table 2, [5,6,20]). When the use of banding is limited to high flow associated stealing syndromes, and when the degree of banding is controlled by intraoperative flow measurements (aiming for ∼ 400 ml/min in native fistula and ∼600 ml/min in access grafts), postoperative access patency rates are obviously much better (Table 2, [22.25]). Table 2.Treatment results of stealing syndrome. Author, year [ref.] . Number of patients. Free of symptoms (%) . Access patent (%) . Banding Odland et al., 1991 [6] 16 100 40 DeCaprio et al., 1997 [20] 11 91 10 Morsy et al., 1998 [5] 6 100 33 Aschwanden et al., 2003 [25] 3 100 100 Zanow et al., 2006 [22] 77 86 91a 58b DRIL Schanzer et al., 1992 [11] 14 93 82 Haimov et al., 1996 [14] 23 96 73 Katz et al., 1996 [28] 6 83 100 Berman et al., 1997 [9] 21 100 94 Lazarides et al., 1998 [4] 7 94 – Stierli et al., 1998 [31] 6 100 100 Knox et al., 2002 [2002 52 90 83 Korzetz et al., 2003 [29] 9 89 100 Sessa et al., 2004 [30] 18 100 94 PAVA Zanow et al., 2006 [23] 30 84 87 DRIL and DRAL I 1988 , Schanzer et al. introduced the distal revascularization-interval ligation (DRIL) procedure [26] to treat access-associated stealing syndrome. The artery distal to access anastomosis is ligted. Thereby retrograde the diastolic approach into the fistula-the pathophysiological principle of stealing-is stopped. This first part of the DRIL procedure is quite sufficient for the treatment of stealing syndrome in the distal radio-cephalic fistula (distal radial artery ligation, DRAL), as long as the ulnar artery and palmar arch are patented, providing adequate blood flow to the hand [27]. In brachialis AV fistula and grafts, a (vein) bypass is also implanted, connecting the brachialis artery over anastomosis with antecubital artery (or one of the forearm arteries) distal to the ligation, which is now located in the 'interval' between access anastomosis and distal bypass anastoosis. Functioning vein valves in the graft and a reasonable distance (>5 cm) between the proximal bypass anastomosis and access anastomosis prevent retrograde diastolic flow in the graft. The DRIL procedure has been shown to result in immediate relief of the signs and symptoms of stealing syndrome in the vast majority of patients, and provides excellent long-term patency rates for both vein bypasses and accesses (Table 2, [4,9-11,14,28-31]). From a pathophysiological point of view, DRIL seems to be the ideal treatment for stealing syndrome. However, there are several drawbacks. DRIL is a rather complex and time-consuming procedure, is only possible when an appropriate vein can be harvested. Blocking backflow in access and bypassing the blood around it can reduce the flow of access by 25% or even more. This makes the DRIL procedure a valuable option only for patients with high flow and normal flow associated stealing syndrome. In low flow associated stealing syndrome, it has been suggested to perform bypass without interval ligation [32]. However, clinical results have not yet been published. PAVA Another method of treating stealing syndrome is to create a new, significantly more proximal arteriovenous anastomosis (PAVA). The original AV anastomosis is lyed and an interposition graft is used to connect the access vein or graft with the feeding artery far central, the distal brachial artery in the case of a wrist fistula, the proximal brachialis or even the axillary artery in the event of an upper arm access. Thus greater collateral from the upper arm is recruited increase peripheral blood supply. Although the PAVA procedure has been widely used to treat stealing syndrome, systematic studies have rarely been published. In their excellent prospective series of 30 patients, Zanow et al. [23] reported a complete relief of ischemic symptoms in 84% of their patients with excellent access salts (Table 2). The PAVA procedure has several advantages over DRIL. There is no need for ven harvesting because a PTFE graft can be used for proximal feeding of access. The graft's anastomosis to the larger vessels is easier to suture than those in the vein bypass to tiny and often calcified forearm vessels in DRIL. Thus, PAVA is a valuable alternative to DRIL in normal flow associated stealing syndrome, especially in patients without an appropriate bypass vein and in patients with a graft access. One potential drawback of the method is that when applied to an autogenic fistula, fistula is turned into a semi-prosthetic access with the consecutive risk of stenosis on graft-to-vein anastomosis. On the other hand, there should also be a significant risk of stenosis by the distal anastomosis in the vein bypass of the DRIL. Comparative studies are lacking. Hemodynamic, PAVA is very similar to DRIL, because as in DRIL, a proximal diversion of flow is created. However, when the central anastomosis of interposition graft in PAVA is created on the central brachialis or axillary artery, and when the graft used for feeding access has a diameter of 5 or 6 mm, PAVA improves access flow [23,32]. Therefore, in low flow associated stealing syndrome, PAVA seems to be the best, if not the only option to preserve both access and extremity. RUDI In case of high flow induced heart failure due to a brachialis AV access, closing anastomosis in antecubital fossa and interposing a graft between the forearm ulnar or radial artery has been shown to effectively reduce by more than 50 % [33]. Minion et al. [34] recently published a small series of four patients with brachiaal AV access-induced stealing syndrome, in whom they successfully used the same technique, which they called 'revision using the distal influx' (RUDI). Unfortunately, no pre- and post-operative flow rates were reported. The RUDI procedure may be an alternative to banding in high flow associated stealing syndrome, but it should only be used if the forearm artery is not used for distal influx is patent; otherwise there would be a high risk of persistent stealing. RUDI is somewhat more invasive than most banding procedures, and flow reduction cannot be tailored to each patient's needs, but it prolongs the needling area of access. MILLER Minimally invasive limited ligation endoluminal-assisted revision (MILLER) to treat access-induced stealing syndrome was recently described by a group of U.S. interventional nephroloists [35]. In 16 patients with brachialis AV access, they exposed access vein or graft proximal to its anatoosis to the artery and performed banding by tying a non-resorbable suture around access over an inflated 4 or 5 mm dilation balloon during fluoroscopy control to get a defined reduction in the vessel's diameter. Pre- and post-operative flows were not measured. The MILLER procedure is no more than a simplified banding procedure and should therefore (if at all) only be used in high flow associated stealing. It can be performed quickly and easily in the radiology unit immediately after diagnostic angiography for evaluation of stealing. Banding an access to a defined diameter, however, carries the risk of insufficient post-interventional access flow or inadequate treatment of stealing symptoms. As already mentioned above, measurements of pre- and interventional flow will increase therapeutic safety. Conclusion Due to the increase in average relationships to the event and widespread hemodialysis patients and due to the increasing percentage of diabetics among them, access-related ischemia has become a growing problem. While arterial influx obstacles causing ischemia and access failure can often be treated interventionally, the classic stealing syndrome mostly requires surgery. Access-associated stealing syndrome in this strict sense is basically caused by a significant increase in peripheral arterial resistance. Pre- and intraoperative flow measurements are essential for differentiated and successful treatment in order to maintain access and extremity. Banding access is only indicated in high flow associated stealing syndrome. The DRIL procedure is very effective for treating high flow and normal flow associated ischemia, but is rather complex and time consuming. PAVA is just as effective and at the same time less invasive and easier to perform than DRIL. PAVA is the only way to optimise both in low flow associated stealing syndrome, which is becoming more and more frequent among our hemodialysis population due to the increasing proportion of elderly and diabetic patients. One potential drawback of the method is that when applied to an autogenic fistula, fistula is turned into a semi-prosthetic access, with the consecutive risk of stenosis on graft-to-vein anastomosis. RUDI and MILLER are changes to the typical banding procedures. Their relative importance in the treatment of stealing syndrome is not yet defined. Declaration of conflict of interest. No one to declare. References 6, et al. Handling dialysis-associated stealing syndrome complicates upper end arteriovenous fistulas: use of intraoperative digital photoplethysmography, vol. (pg. -)7, . Femoral vein implementation for arteriovenous hemodialysis access: improved patient selection and intraoperative measures reduce postoperative ischemia, vol. (pg. -)9, , et al. Distal revascularization-interval ligation for limb salvage and maintenance of dialysis access in ischemic stealing syndrome, vol. (pg. -)10, et al. 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