COMPLICATIONS OF VASCULAR ACCESS FOR HAEMODIALYSIS

SUMMARY:

- Any type of complication for either a centrally placed venous catheter or arterio-venous fistula/graft can place the patient at risk of sub-optimal haemodialysis treatment and clearances as well as longer term co-morbidity as a result of infection or blockages.

- Vascath infections can result in an exit site infection, a blood stream infection, or both. Centrally placed catheters are one of the major causes for blood stream infections.

- Complications for arteriovenous fistula are often related to stenoses preventing optimal blood flow along the inflow or outflow vein.

- Regular needling of a fistula does increase the risk of infection, particularly if optimal handwashing and non-touch sterile techniques are not followed when accessing the fistula.

- Any physical abnormalities for any type of access need to be identified early, assessed by competent clinicians, and appropriate treatment initiated as soon as possible in order to save the access and prevent the patient from any unnecessary suffering and co-morbidity.

- The following protocol outlines types of complications, causes and treatment for:
  1. Central Venous Catheters
  2. Infection in Central Venous Catheters
  3. Central Venous Obstruction
  4. Arteriovenous Access Failure
  5. Infections in Arteriovenous Access
  6. Aneurysm Formation
  7. Median Nerve Injury
  8. Seroma Formation
  9. Access Induced Ischemia

1. CENTRAL VENOUS HAEMODIALYSIS CATHETER DYSFUNCTION:

Central venous catheter dysfunction can be stated as failure to attain or maintain an extracorporeal blood flow rate of 300ml/min or greater with an arterial pressure of not more than 250mm mmHg (KDOQI, 2006). The preferred site is the right internal jugular vein due to a less complex anatomical pathway (Vachharajani, 2010).

Types of Central Venous Catheters:
- Non-Tunneled Internal Jugular

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- Non-Tunneled Subclavian – should be avoided in renal impaired patients
- Tunneled Internal Jugular - can be use for extended durations
- Femoral Catheter - for short term emergency use no longer than 1 week

**Types of dysfunction:**
- Mechanical
- Kinks (angulations in tunnel)
- Misplaced sutures
- Incorrect catheter size selection
- Catheter migration
- Drug precipitation
- Patient position
- Catheter integrity
- Holes
- Cracks
- Progressive occlusion of the catheter tip by thrombus or fibrin

**Types of thrombus/fibrin occlusion:**
- Intra-luminal thrombus (within the lumen causing partial or complete occlusion)
- Fibrin sheath or sleeve (fibrin adheres to external surface of catheter)
- Fibrin tail or flap (fibrin adheres to the tip creating a “ball valve” effect)

**Treatment and Prevention:**
- See the following protocols
  - ‘Poor flow via tunneled and non-tunneled catheters and decision tree’
  - ‘Instilling a Heparin/Antibiotic Lock into a Vascath Post Dialysis’ protocol
  - ‘Use of Actilyse in Vascaths’ protocol

**2. INFECTION IN CENTRAL VENOUS CATHETERS:**

a) Exit site infection (ESI): Inflammation confined to the area surrounding the catheter exit site, not extending superiorly beyond the cuff if the catheter is tunnelled, with exudate culture confirmed to be positive.

**Treatment and Prevention:**
- See ‘Vascath exit site care’ protocol
- See ‘Guideline for vascath suture removal’ protocol
- Patient education of catheter management
- Attend dressing each Haemodialysis treatment
- Culture to confirm bacterial infection and sensitivity

b) Tunnel Infection: The catheter tunnel superior to the cuff is inflamed, painful, and has drainage through the exit site that is cultured positive.

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Treatment and Prevention:
- See ‘Vascath exit site care’ protocol
- Removal of catheter

c) Catheter related Bacteraemia (CRB):
- Blood cultures are positive for the presence of bacteria with or without the accompanying symptom of fever.
- Definite bloodstream infection; the same organism from a culture of the catheter tip and from a peripheral or catheter blood sample.

Causes/predisposition:
- Diabetes
- Previous history of bacteremia
- Nasal carriage of Staphylococcus aureus or Methicillin-resistant S. aureus
- Catheter use of long duration
- Local infection

Treatment and Prevention:
- IV antibiotic therapy
- Follow up blood culture 1 week following the cessation of antibiotics
- Removal of catheter
- See ‘Decontamination’ protocol
- See ‘Instilling a Heparin/Antibiotic Lock into Vascath Post Dialysis’ protocol
- See ‘Insertion and Removal of the Tunneled Vascath’ protocol
- See ‘Insertion and Removal of a Non Tunneled Vascath’ protocol
- See ‘Taking isolated blood cultures from a Vascath’ protocol

Complications:
- Secondary tissue infections: i.e. Endocarditis, Osteomyelitis

3. CENTRAL VENOUS OBSTRUCTION:
Narrowing or occlusion of the central venous catheter lumens resulting in reduced and/or disruption of blood flow.

Causes:
- Thrombus and collagen occurrence in long term CVC
- Mechanical irritation and injury of the endothelium by CVC
- Hypercoagulopathy
- Indwelling permanent pacemakers
- Peripherally inserted central catheters
- Previous use of CVC
- Focal endothelial denudation on insertion of CVC

Clinical Manifestations:
- Ipsilateral arm oedema
- Pain and discomfort
- Dilated venous collaterals over the patient’s upper chest, neck, shoulders and upper arm

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Increased venous dialysis pressures
Difficulty with cannulation

Management:
- Observation if clinical symptoms are mild
- Percutaneous angioplasty with or without stenting
- Surgery
- Access occlusion

Prevention:
- Preservation of peripheral veins and non dominant limbs in chronic renal patients
- Early creation of permanent fistula assess prior to ESRD
- No PICC or subclavian catheterization on the chronic renal patient
- Patient evaluation prior to placement of a permanent access for previous CVC

4. ARTERIOVENOUS VASCULAR ACCESS FAILURE:

a) PRIMARY FAILURE:
An arteriovenous fistula/graft which fails within three months of creation.

Inflow Causes:
- Inadequate inflow is caused by a juxta-anastomotic stenosis (stenosis post anastamosis)
- Anastomosis stenosis
- Stenosis proximal to the anastomosis
- The use of an artery that is too small
- Arterial disease in the vessel used to create the AVF
- Hypovolaemia resulting in thrombosis of the new access

Outflow Causes:
- The use of veins that are too small
- Fibrotic or stenotic veins which may be due to previous trauma
- Existence of accessory veins preventing fistula maturity

Diagnostic:
- Physical examination - water hammer pulse will be felt at the anastomosis and a weaker pulse post stenosis
- The physical examination will also identify accessory veins and a non developed vessel.
- Ultrasound
- Fistulogram

Treatment:
- Percutaneous angioplasty (PTA)
- Surgical intervention

Prevention:
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- Vascular mapping before the AVF is created
- Physical examination
- Maintain an increased dry weight (wet) for 3 weeks post creation

b) SECONDARY FAILURE:
Failure of an AVF/AVG after three months of use for haemodialysis

Causes:
- Thrombosis
- Hypotension +/- hypovolaemia
- Compression of the fistula
- Stenosis of the fistula
- Elevated haemoglobin
- Infection of the fistula

Diagnosis:
- Physical examination see ‘Fistula assessment protocol’
- Discontinuous or high pitched bruit and thrill
- Persistent arm swelling
- Prolonged bleeding following the removal of the cannula
- Blood squirting when cannulating
- Increased venous pressures/decreased arterial pressures
- Ultrasound showing arterial or venous segment narrowing
- High recirculation studies
- Fistula/graft is hard when palpated

Treatment:
- Percutaneous angioplasty (PTA)
- Surgical intervention
- See ‘Flow chart for thrombosed fistula’

Prevention:
- Regular vascular access assessment by dialysis staff – see ‘Vascular access assessment tool’
- Early intervention when problems have been identified
- Patient education with regard to identifying any change to their AVF/AVG
- Avoiding hypovolaemia caused by haemodialysis
- Maintaining Hb between 110-120 mg/L

5. INFECTIONS OF THE ARTERIOVENOUS VASCULAR ACCESS:

Predisposing Factors:
- Peri fistula haematomas
- Pseudo aneurysms
- Severe pruritus over cannulation sites
- Fistula accessed for non haemodialysis purposes
- Surgical intervention

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Treatment:
- Intravenous antibiotic therapy of 6 weeks duration for episodes of bacteraemia (K/DOQI, 2006)
- Surgical drainage and excision should be considered for grafts if blood cultures remain positive after antibiotic therapy - see ‘Protocol for Infected AVF/AVG’
- Persistent fevers or bacteraemia following a vascular access infection should be investigated for the tissue source - possibility of endocarditis or osteomyelitis must be considered
- See ‘Infection AVF and AVG management flowchart’

Prevention:
- Nasal mupirocin for patients with repetitive infections positive for staph aureus
- Prophylactic antibiotics prior to access surgery and/or thrombectomy
- Aseptic technique used when accessing AVF/AVG - see ‘Renal vascular access cannulation policy’ protocol and ‘Buttonhole cannulation’ protocol
- Hygiene education for patient

6. ANEURYSM FORMATION IN ARTERIOVENOUS FISTULAS/GRAFTS:

An aneurysm is an abnormally dilated focal region of a blood vessel which is at risk of rupture or infection.

A pseudoaneurysm is the disruption of a vessel/graft wall resulting in a collection of blood outside the vessel wall, which is in communication with the vessel and is contained by the surrounding fibrous tissue.

Causes:
- Repeated cannulation in the same area of the vascular access

Signs of increased risk of aneurysm rupture:
- Skin over the fistula is compromised – appears thin and shiny
- Poor scab (eschar) formation post cannulation, scabs not healing
- Episodes of spontaneous bleeding
- Aneurysm size increases quickly
- Graft material shows signs of severe degenerative changes
- Evidence of infection

Treatment:
- Surgical revision
- Surgical occlusion and/or removal of graft
- Observe for risk of infection

Prevention:
- Rotation of cannulation sites (rope ladder technique)
- Cannulation through an aneurysm must be avoided

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7. MEDIAN NERVE INJURY:

**Causes:**
- Long term haemodialysis
- Localized amyloidosis deposits to the median nerve can cause Carpel Tunnel Syndrome
- The compression of the median nerve due to extra vascular fluid from the vascular access
- Ischemic injury to the median nerve as a result of vascular steal effect

**Diagnosis:**
- Physical assessment
- Nerve conduction studies

**Treatment:**
- Referral to the Hand Clinic
- Referral to Vascular Surgeon for surgical repair

8. SEROMA FORMATION NEAR AN AVG:

The formation of a pocket of serous fluid next to an AVG which may become firm over time

**Causes:**
- High intraluminal pressures at the arterial end of the AVG
- Central venous stenosis

**Treatment:**
- Percutaneous angioplasty (PTA) of identified stenosis
- Surgical revision

9. ACCESS INDUCED ISCHAEMIA (STEAL SYNDROME):

The reduction of arterial blood flow to a distal limb caused by the creation of an AVF/AVG.

**Causes:**
- Diversion of blood by an AVF/AVG from the distal limb
- Patients at risk are the elderly, diabetic and those with peripheral and/or coronary artery disease

**Diagnosis:**
- Physical examination
- Transcutaneous O2 determination
- Ultrasound of arteries
- Access flow measurements

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Angiography with visualization of upper and lower extremity arterial tree
AVG induced ischaemia may develop after only two days while AVF induced ischaemia may take up to six weeks

Classifications:
- Grade 1- Pale/blue hands without pain
- Grade 2- Pale/blue hands pain during exercise or while on haemodialysis
- Grade 3- Ischaemic pain at rest
- Grade 4- Ulceration, necrosis and/or gangrene of the ischaemic area

Treatment:
- Grades 1-2 - conservative management
- Grades 3-4 - intervention is indicated
- Surgical interventions include revision, distal revascularization and/or ligation
- Change in the renal replacement therapy modality
- Use of a central venous catheter

Prevention:
- Pre-operative physical examination of peripheral pulses, bruits, and bilateral BP measurement
- Pre-operative ultrasound assessment, angiogram or MRI
- Pre-operative digital pressure measurement (DBI < 1.0 increased risk of steal syndrome)
- Steal syndrome is more common in AVF/AVG of brachial-cephalic origin

REFERENCES:

Beathard, G. A. (2010). Early and late hemodialysis arteriovenous fistula failure. *UpToDate, January 21, 2010* x, pp. x-x
