CO2 Venography in Dialysis Access & Treatment

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Background

Never low-molecular contrast agents have been developed but even with premedication, are still associated with side [1] [2] [5]. CO2 angiography [5] has been used in the early nineties but has scarcely been mentioned in recent literature. Misses points relating to difficulty of use, complications (Needing capnography as a process of following) [6] [7].

We conducted a systematic electronic database search & citation search to find the evidence on the use of CO2 venography in dialysis access diagnosis, to advantage or disadvantage recommendations to its use in published Vascular society guidelines.

Even after Chalmers et al. published their comparison of CO2 to digital subtraction angiography (DSA) with intravenous contrast in upper limb AVF[8]. Follow up of 47% [5], there may have been a beneficial impact in detecting AVF use AVF.

Ehrman et al. presented the use of CO2 venography on nasopharyngeal angiography in a central venous, for parent-NSV angiography used based 7 patients (Mean 51 yrs) at the 1st attempt & treatment of malposition and unsuccessful initial [9].

Kariya et al. presented a clinical cohort of CO2 venography including AVF imaging and found no significant difference in screening time as compared to using intravenous contrast media (ICM) [10].

Kariya et al. compared CO2 to ICM in 22 patients, found 90% sensitivity, 65% specificity and 82% overall accuracy of the CO2 to ICM. In 2010, no mention of ICM allergy. It has a clear advantage over Ultrasound (adequate imaging) and a significant difference in screening time as compared to using intravenous contrast media (ICM) [10].

Advantages

CO2 is a colourless, odourless, non-combustible, &compressible. Compared to O2, it is 20 times more soluble and compared to intravenous iodine based contrast, it is 400 times less viscous.

Carboxic anhydrase action diffuses CO2 and is cleared via the lungs - little effect on PET or pH [12] & is safe to use in HD patients [5] [6] [13].

Unlike ICM which mixes with and is carried by blood flow, CO2 being exceedingly buoyant, will dissolve at areas of congestion [6].

Unlimited volumes of CO2 can be utilised safely, as long as sufficient time is allowed for it to be cleared between injections [6]. It can be used in ICM allergic patients on its own or with diluted ICM in general contrast based contrast & thus reduce overall cost and load.

As low viscosity allows for detection of subtle bleeding and small collaterals, where as ICM can give false-diagnostic images [6].

With adequate injection technique & volume, vessel diameters have been accurately measured. It travels faster in comparison to ICM & may reduce movement artefact.

Successful intervention has been reported [6] [8] and its cost benefits are well documented when compared to ICM.

Disadvantages

There have been reports of light-headedness/transient loss of consciousness, bradycardia, hypotension, seizures [11] [7] with arterial reflux resulting in entering the cerebral circulation, & should be avoided [14].

Patients with sepsis defect (pseudomembranous) and occluded AVF’s should not undergo CO2 angiography.

Vapour lock (trapping) is a risk if there is air contamination[9] or excessive volume injection, resulting in arterial or venous dissolution. This can potentially impede flow, especially in non-dependent sites (ipsilateral ischemia, head, brachial, hypotension & ST elevation) [13]. Direct aspiration or patient position change [6] can allow relocation & dissolution. Areas at risk should have undergone ultrasound [15]. Simultaneous injected nitrous oxide is not recommended [16] and as results in longer dissolution.

Under or over estimation of vessel wall diameter, has been reported[15] [6]. Being Insensitive, small volume injection can give a false impression of smaller diameter, especially in large diameter central veins; similarly excessive injection could give the inverse over estimated result.

Pain at injection site has been associated with rapid or large volume injection [18]. Controlled volume injection (injector systems) reduces risk of pain as well as bolus fragmentation & non-diagnostic imaging.

What do The Guidelines say?

❖ The 2006 update KDOQI, 2007 ERPG and 2008 American Society of Vascular surgery guidelines mention very little in terms of clear recommendations on its use. The 2011 ACR SHR and UK Renal Association does not mention CO2 angiography.

❖ The Canadian Society of Nephrology mention CO2 as an appropriate diagnostic technique when contrast studies are unreliable but no further recommendations are made and the American CARI guidelines while quoting this, themselves make no recommendations on timing & selection of its use.

Discussion

❖ CO2 angiography remains widely under used despite clear advantages for central venous imaging [11].

❖ Adequate time should be left between injections to allow for dissolution. Use of an injector system reduces risks - avoid air contamination & concomitant non-air osteus anaesthesia use.

❖ Care should be taken when injecting near the swing segment - avoid arterial reflux to cerebral circulation.

❖ There is no significant increase in screening time when used. Cost benefits are clear.

❖ Good diagnostic imaging can be obtained - 97% sensitivity when compared to ICM [10] [22].

❖ It is advisable to have access to on table monitoring - ECG & perhaps capnography.

❖ At present it is the best alternative to reducing contrast load, & safer imaging alternative for patients & providers. ICM should be the second choice when CO2 angiography is not feasible (Localised arterial central segment imaging) and possibility to proceed with intervention in cases of pre-PTA intervention in cases of pre-PTA intervention in cases of pre-PTA intervention with suspected central stenosis.

❖ As Magnetic resonance imaging (MRI) becomes more readily available with newer and safer contrast media & non-contrast enhanced (NGE-SHR techniques), it may again become a valid option for vessel mapping/surveillance.

❖ Contra indications to MRI can also exclude a large cohorts of patients. Although the use of gadolinium contrast has declined rapidly since approval of MRI by the JEU and we have not encountered any cases. Limited recent advance in contrast media may have shown a 90.7% decrease in concentration after 24 hours, as compared to good results [20].