CO$_2$ Digital Subtraction Angiography in Venous Diagnosis and Intervention

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Disclosures

- Consultant for Terumo
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- Teaching and training team for BTG
- Teaching and training team for BD
CO$_2$ in venous diagnosis and intervention

- CO$_2$ is excellent for venous work
- Particularly useful in selected cases
  - End stage renal disease patients who are not on dialysis
  - Dialysis patients who still make urine
  - Patients with severe contrast allergy, refractory to medication
  - Portal and mesenteric venous intervention
Basic rules for CO$_2$ in venous work

- **CO$_2$ does not behave like contrast**
  - Understand the behavior of the gas
  - Review images carefully
  - **CO$_2$ does not always follow flow**

- Gentle injection works much better
- Large volumes: not necessary (10-15 ml/injection)
- Always purge the catheter before injecting
- Use a reliable, low pressure CO$_2$ source
CO₂MMANDER- Reliable, low pressure CO₂ source
CO$_2$ in venous diagnosis and intervention

• Diagnostic venography
• Work-up for AV access creation
• Patients with end stage renal disease
• Not on dialysis
• History of previous catheterizations
• History of co-morbidities
Diagnostic venography-Technique

• May use a very small IV (20/22 gauge)
• Inner dilator of a micropuncture
• Very gentle injection of 10-15 ml of CO$_2$
• Multiple views can be obtained
• DSA works better
Diagnostic venography
Diagnostic venography
AV fistula rescue

• 30 - 60 % of native AV fistulae fail to mature
• **A good percentage of these patients are NOT on dialysis**
• Most patients will have hemodynamically significant stenoses
  • AV anastomosis
  • Outflow vein immediately central to anastomosis
• **AV fistula rescue is effective in approximately 85% of cases** *
• Minimizing the use of contrast is imperative in these cases
  • Avoid renal injury that may precipitate dialysis requirement
  • Avoid the urgent need for a tunneled catheter

* Clark T. Radiology. 2007;242:286
AV fistula rescue - Technique

• Careful ultrasound evaluation of the entire access
• AV anastomosis
• Entire course of the outflow vein
• Identify problem / stenotic areas
• Decide best access option
• May need to stage interventions
AV fistula rescue
AV fistula rescue
AV fistula rescue
AV fistula rescue

Before intervention

8 weeks after intervention
Contrast adverse reactions

- Adverse reactions to non-ionic contrast occur in 5-15% of patients *
- True allergic reactions are rare, in the order of less than 1%
- Most severe reactions occur within 20 minutes of administration
- Few patients have “delayed” reactions
- Most patients do well with premedication
  - Steroids and anti-histamines
- Small group of patients do not respond to premedication
  - Severe reactions
  - True contraindication to the administration of intravascular iodinated contrast

* ACR- Manual on contrast media , 2016
Contrast adverse reactions
Portal and mesenteric venous intervention

- CO$_2$ is useful for portal and mesenteric venography
- The buoyancy of the gas allows extensive distribution
- Applications:
  - Target of portal vein during TIPS procedures
  - "CO$_2$ target"
  - Evaluation of portal and mesenteric vein occlusions
TIPS procedures

• Portal vein catheterization is the limiting step of the procedure
• Several techniques for portal vein localization described
  • Intraportal “guiding wire”
  • Wedge contrast injection
  • CO$_2$ wedge injection
  • CO$_2$ intra-parenchymal injection
  • 3-D reconstructions from MRI or CT scans
  • IVUS
CO₂ wedge injection-technique

- AP and left anterior oblique views
- Wedge injection
  - Wedged catheter or balloon catheter
  - *Gentle* injection of 15-20 cc
  - *Careful in patients with ascites*
- Intraparenchymal injection
  - Puncture needle is advanced into the liver parenchyma (0.5-1 cm)
  - *Gentle* injection of 15-20 cc
CO$_2$ Portogram
CO$_2$ Portogram
Track measurement and final portogram
TIPS with CO$_2$
Mesenteric venous recanalization
Mesenteric venous recanalization
Mesenteric venous recanalization
Complications and Precautions

• Complications do occur
• Most (if not all) complications are related to operator error
  • Using a suboptimal CO$_2$ source
  • Breach in technique
  • Lack of understanding of the behavior of the gas
• Complications do not make CO$_2$ UNSAFE !!!!!
  • It is the operator who is dangerous, not the gas
TIPS complication
IR Safety Rounds

Transient Disorientation and Severe Bradycardia after Carbon Dioxide Angiography

Anil Kumar Pillai, MD, Amar Pravin Shah, MD, Hector Ferral, MD, Sreekumar Madassery, BS, Scott Asselmeier, MD, and Sudheer Paruchuri, MD
Discussion

• CO₂ is useful for endovascular intervention
• Practice expands indications
  • Patients with severe contrast allergy
  • Patients with borderline renal function
  • Patients with fluid overload
• Careful technique is imperative
• Use of a low pressure system is imperative
Thank you

Owl - Davide Salvadore
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