A bubble-mixture method to improve dynamic image of carbon dioxide angiography

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Carbon Dioxide Angiography

- First reported by Hawkins (1982)
  - Inadvertent injection

- CO2
  - Odorless and colorless gas
  - Soluble $20 \times$ than O2
Benefits of CO2 Angiography

- Non-nephrotoxic
- Non-hepatotoxic
- No allergy
- Unlimited dosage
- Cheap
Characters of CO\text{2} angiography

- Rely on **digital subtraction angiography (DSA)** for better resolution
  - "Negative" opacification image
  - Caution of air emboli and **air contamination**

- **Buoyancy** of the gas
  - Lower image quality
  - Higher radiation exposure
CO2 Angiography Indication

- Advantageous indication
  - Renal impairment
  - Iodine contrast allergy
  - Anticipated high contrast load
Classic CO2 angiography setup

- CO2 Tank
- Flowmeter
- Air filter
- Tube
- 3-Way stopcock
- Single way valve
- Syringe
- Basin for waterseal
CO$_2$ (Stacking) Software

Un-Stacked

Stacked

Courtesy of ANGIODYNAMICS®
Buoyancy of CO2

Leg elevation by means of a radiotransparent table may sometimes improve gas delivery to the distal vessels.
Problems of CO2 Angiography

- CO2 → filling non-dependent vessels (antigravity)
- If force of CO2 buoyancy > kinetic force of blood flow, it causes transient air trapping and poor visualization of distal vessels. (Vapor-lock phenomenon)
A novel way of preparing carbon dioxide (CO2) used for angiography by bubble-mixture of blood and CO2 gas before injection.

It solves uneven distribution of CO2 toward antigravity side of vessels and provides a more smooth “contrast-like” dynamic images of CO2 angiography.
How to do it

Patient

Angio-catheter → 20ml Syringe → 3-Way Stopcock → CO2 Reservoir

CO2 → Filter

3-Way Stopcock
Bubble-mixing procedure

A. Withdraw CO2

B. Withdraw blood

C. Bubble mixture

D. Ready for injection
Pure CO2

Higher contrast
Fragmentation
Fast dissemination

Bubble mixed CO2

Lower contrast
Even distribution
Sustainable motion
More alike iondinated contrast dynamic motion
Conclusion: Bubble-mixture method

- Pre-mixture of blood and CO2 gas outside the patient with bubble creating technique
- Single CO2 gas dispersing into multiple tiny bubbles
  - Vapor-lock can be reduced
  - Distribution is more even.
- More “contrast-like” dynamic image
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