# Detection of Bleeding in $CO_2$ DSA

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Transcatheter Arterial Embolization (TAE) is a good alternative to surgery in many patients with active hemorrhage if the bleeding point is identified. Conventional iodine contrast angiography, however, fails to detect arterial hemorrhage at a rate of 0.5 mL/minute or less. We have developed a new method of detecting minute arterial hemorrhage and eliminating angiographer's frustration in the field of emergency medicine.

Our materials include 64 consecutive patients with presumed abdominal and pelvic bleeding who underwent both conventional iodine contrast angiography and $CO_2$-IADSA at our hospital. There were 47 males and 17 females. Ages ranged from 15 to 80. Seventy-one angiographic procedures were performed for those patients, emergency in 58 procedures and elective in 13. The site of bleeding was gastrointestinal in 12 procedures, urinary tract in 16, peritoneal in 27, retroperitoneal in 17 and others in 2. Etiology of the lesion was benign in 6, malignant in 9, blunt trauma in 31, iatrogenic/postoperative in 13 and idiopathic in 12.

Conventional iodine contrast angiography was performed with the catheter tip placed near the suspected bleeding artery using nonionic iodinated contrast. $CO_2$-IADSA was performed by injecting 10 mL to 50 mL of medical grade $CO_2$ gas manually for 2 to 5 seconds, prior to or following conventional iodine contrast angiography. In unconscious patients or those with shortness of breath, IADSA was performed while patients breathed freely, with sufficient number of mask images obtained prior to the injection of the contrast medium.

Overall sensitivity in detecting extravasation was 20% in iodine contrast angiography and 52% in $CO_2$-IADSA. When we focus on the gastrointestinal bleeding, the sensitivity was 33% in iodine contrast angiography and 75% in $CO_2$-IADSA. Normal tissue never showed staining in $CO_2$-IADSA. Spatial resolution was better in iodine contrast angiography. Images of $CO_2$-IADSA generally had a poor contrast to noise ratio.

The most straightforward indicator of active bleeding is the extravasation of the contrast medium out of the vessel. It is not easy to detect extravasation if the bleeding is intermittent or below the threshold of the examination. It order to enhance the efficacy of angiography, one can employ pharmacoangiography with heparin, torazolin or even urokinase as Roesch indicated earlier. Another way to enhance the efficacy of angiography is to use carbon dioxide gas as a negative contrast material for IADSA.

$CO_2$ gas as a contrast medium has various features. $CO_2$ gas is compatible with about 37 mgI/mL of iodine contrast and thus $CO_2$-IADSA images have a poor contrast to noise ratio and are extremely susceptible to misregistration artifact. Buoyancy may play a significant role in $CO_2$-IADSA.

In the detection of bleeding, extremely low viscosity, high solubility in serum and the tendency to inflate by itself after extravasation play significant role in the detection of minute arterial hemorrhage. $CO_2$ has extremely lower viscosity than iodine contrast, and according to the Poiseille's equation, it passes through the tiny hole in the arterial wall much easier than iodine contrast does. Also, after $CO_2$ gas extravasates, it inflates by itself. This never happens when aqueous iodine contrast is used. And, $CO_2$ gas is highly soluble in serum, and not considered to reach capillary circulation. This explains the reason why no stain is obtained in $CO_2$-IADSA that can mask the extravasation. Those features are best suited for detecting minute arterial hemorrhage.

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## Materials

Patients with abdominal and pelvic bleeding who underwent both Iodinated contrast angiography and $CO_2$-IADSA from April, 1988 to December, 1996.

64 Patients; Male 47 Female 17
15y.o. - 80y.o. (42±19)
71 Angiographic Procedures
Emergency 58, Elective 13

## Materials

| Site of Hemorrhage | | Etiology | |
|---|---|---|---|
| G.I.Tract | 12 | Blunt Trauma | |
| Peritoneal | 27 | Benign | |
| Retroperitoneal | 17 | Malignant | |
| Urinary Tract | 16 | Iatrogenic/Postoperative | |
| Others | 2 | Idiopathic | |

## Results: Iodinated Contrast Media

| | |
|---|---|
| Sensitivity | |
| G. I. Tract | 33.3% (4/12) |
| Trauma | 13.0% (3/23) |
| Overall | 19.7% (14/71) |
| Image Quality | Fair/Exellent |
| Capillary Stain | Frequent |

## Results: Carbon Dioxide Gas

| | |
|---|---|
| Sensitivity | |
| G. I. Tract | 75.0% (9/12) |
| Trauma | 52.2% (12/23) |
| Overall | 52.1% (37/71) |
| Image Quality | Essentially Poo |
| Capillary Stain | Never |

77 y.o. male: Advanced gastric ca.
Left gastric Artery