History and Science of CO_2 Digital Subtraction Angiography

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NCVH
New Cardiovascular Horizons

19th Annual Conference

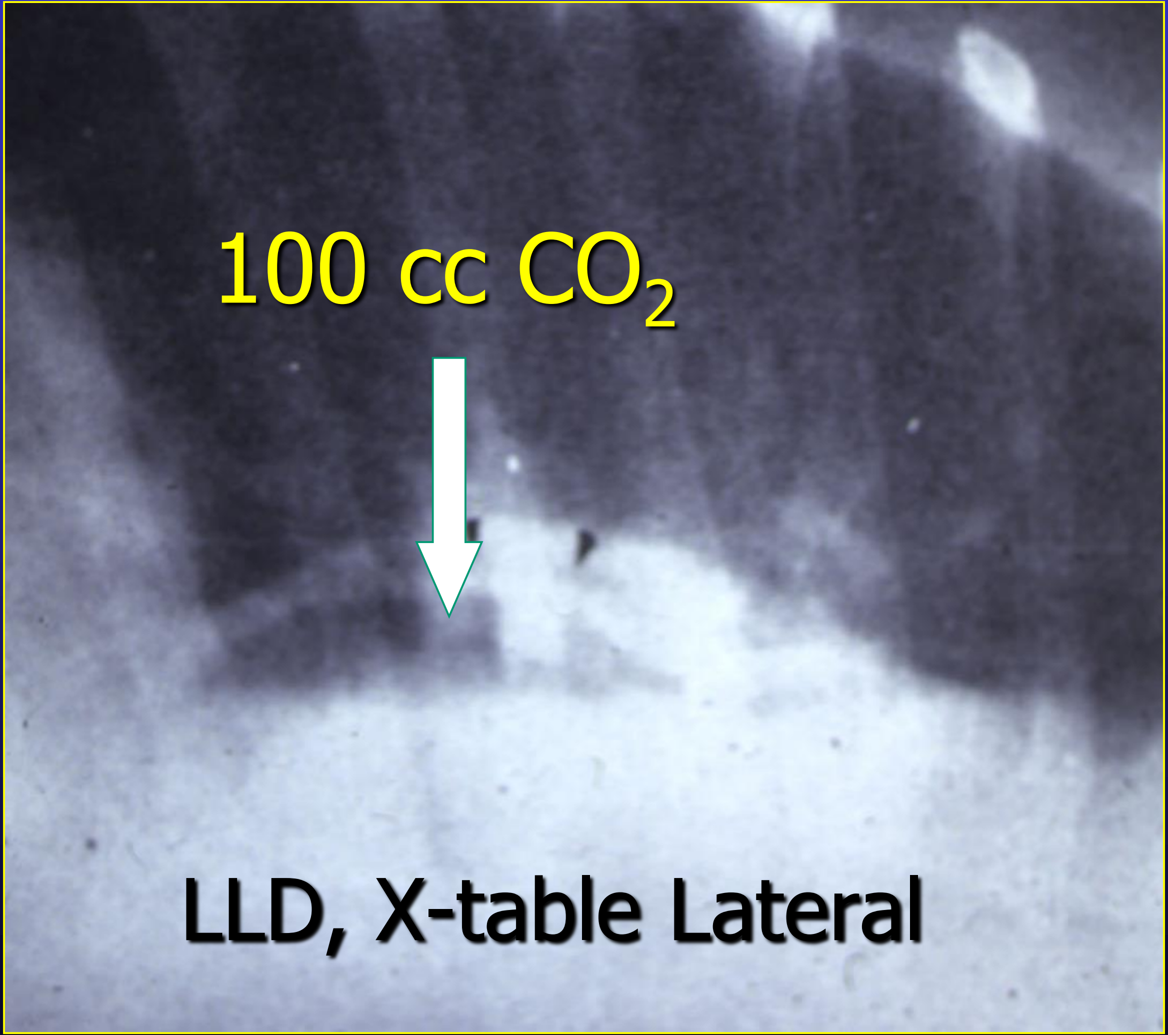
2018
May 30 - June 01
THE PERIPHERAL EVENT OF THE YEAR

History of CO_2 Angiography

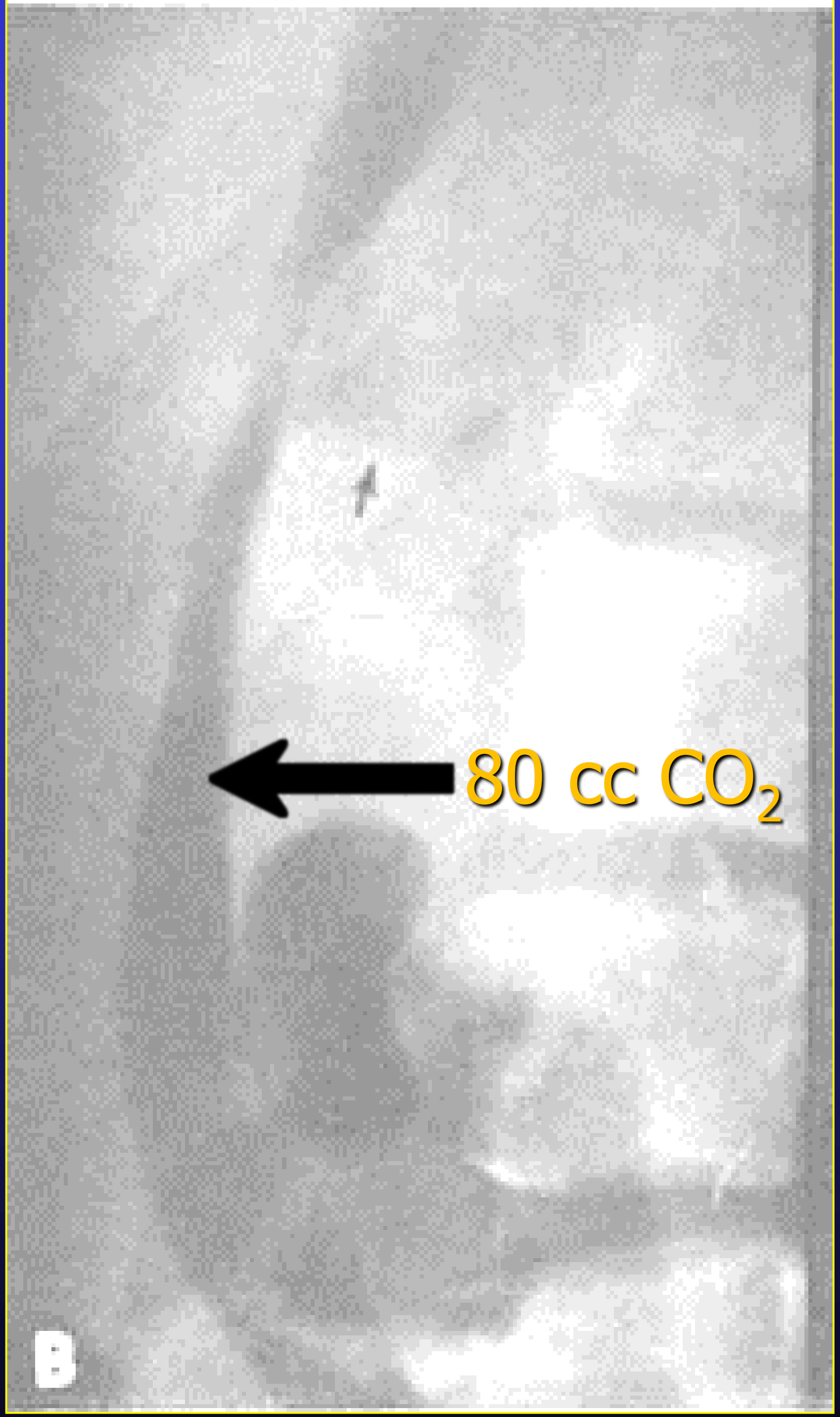
In 1920s, retroperitoneal pneumography with CO_2

Carelli HH and Sordelli E. Un Nuevo procedimento para explorar el ninon
Rev Assoc Med Argent 34:424-425, 1921

1950s - 1970s
CO_2 Angiocardiography



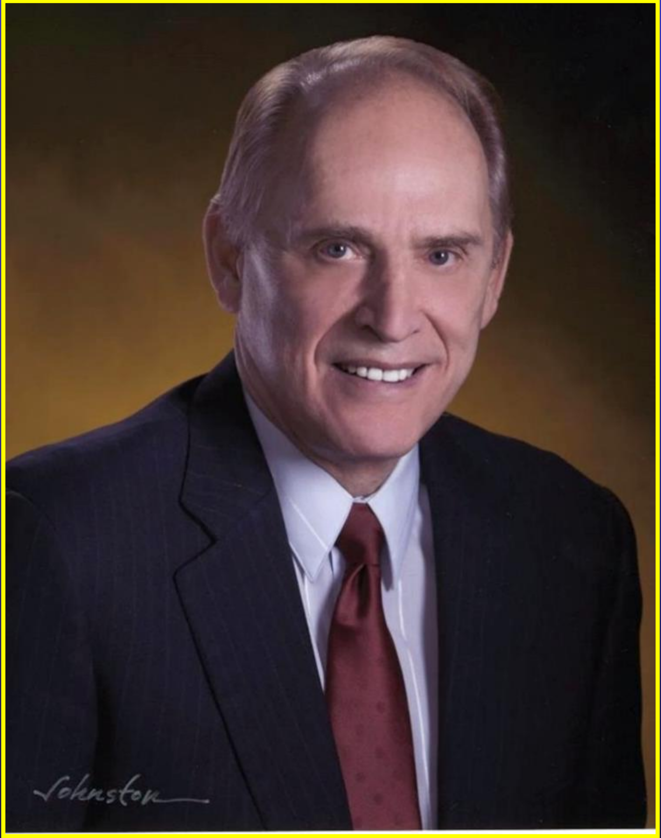
1969 Capnocavography:



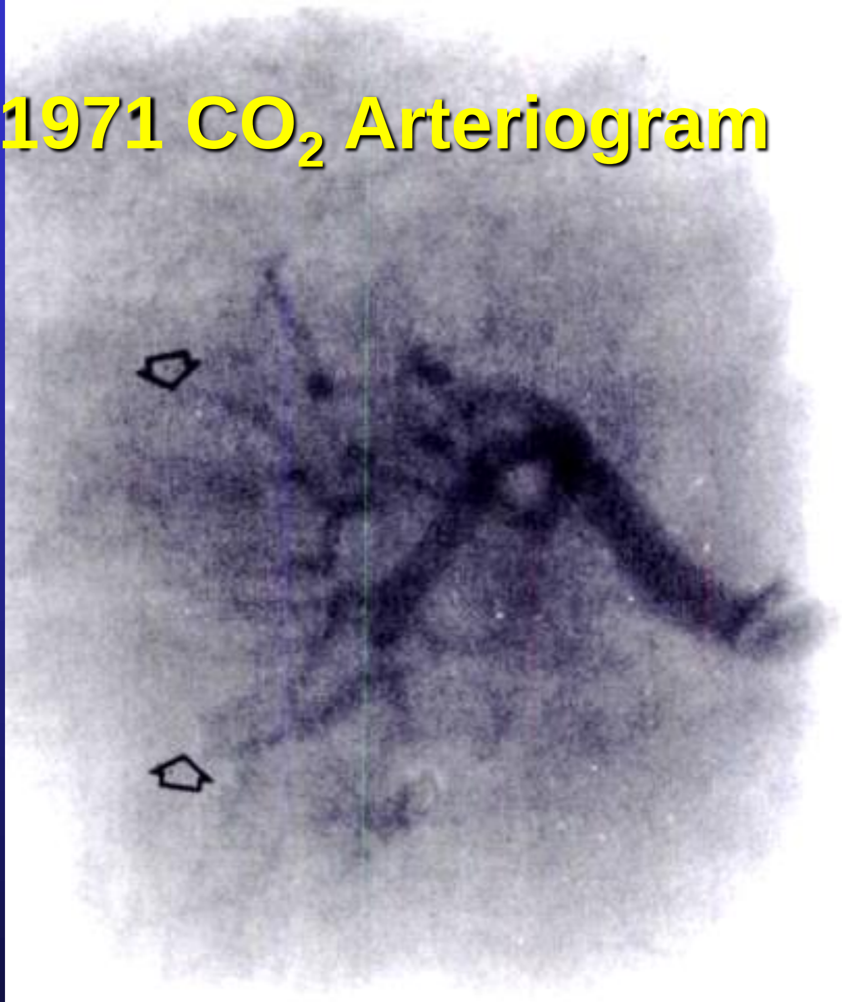
Hippona
Radiology 92:606,1969

Pioneer of CO_2 Angiography

Dick Hawkins, M.D.

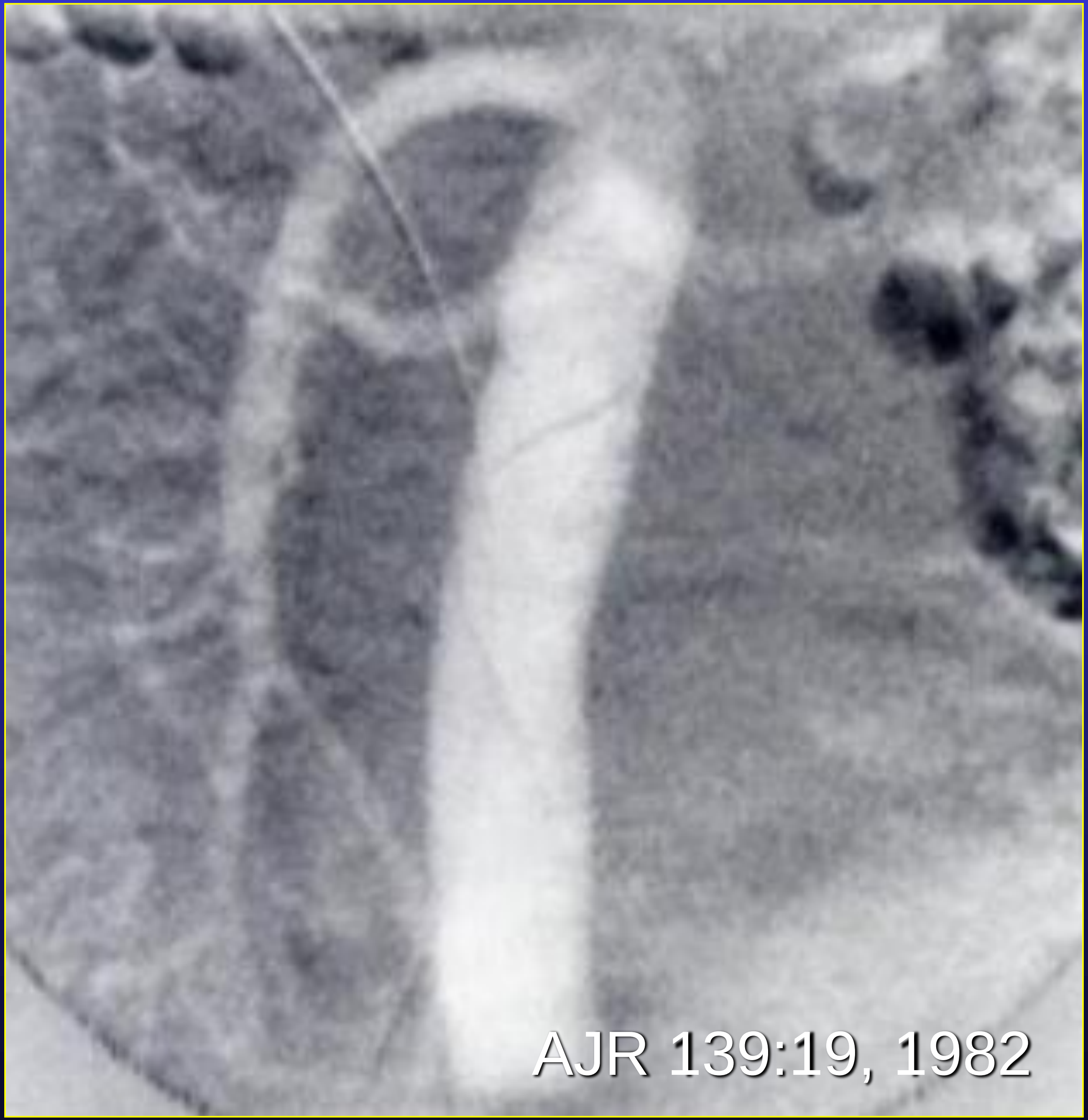


1936-2011



AJR139:19,1982

1980
DSA



NCVH
New Cardiovascular Horizons

CO_2 Angiography Society
Annual Conference

Science of CO_2 Angiography

CO_2 Unique Properties

- Negative contrast
- High solubility
- Low viscosity
- Buoyancy
- Compressibility

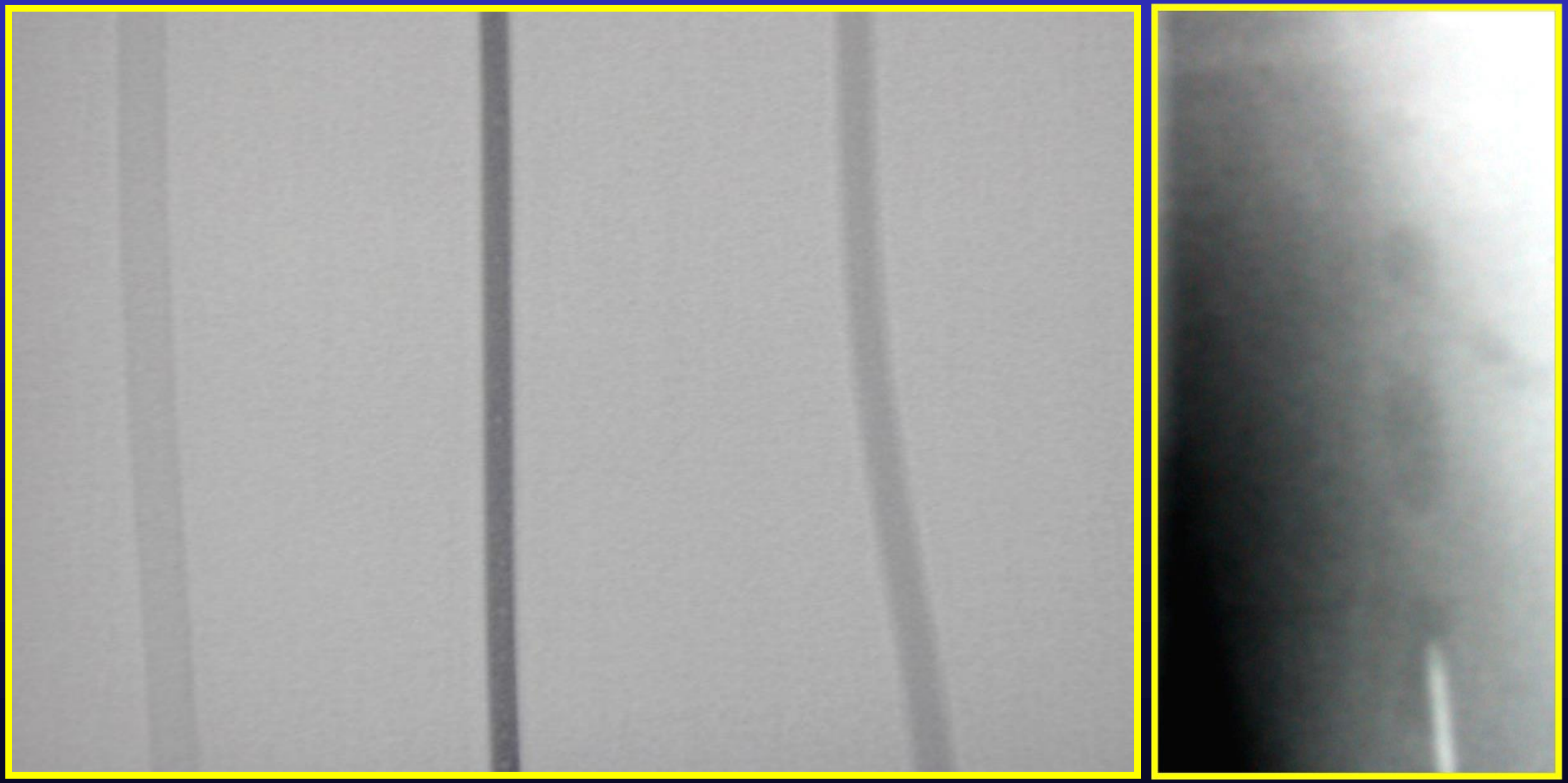
Properties of CO_2, O_2, N_2, Iodine and Gd

	CO2	O2	N2
Molecular wt	**44**	**32**	**28**
solubility	**0.87**	**0.03**	**0.016**

	Atomic Number
CO_2	C = 6, O =8
Iodine	53
Gd	64

Comparative Radiopacity of Saline, Iodine, Gd and CO_2

Saline Omnipaque 240 Gd CO_2 in arm vein



IVC thrombus in CO_2 vena cavogram

Comparison of MRA, CTA and CO_2 DSA of the Aorta

MRA

CO_2 DSA

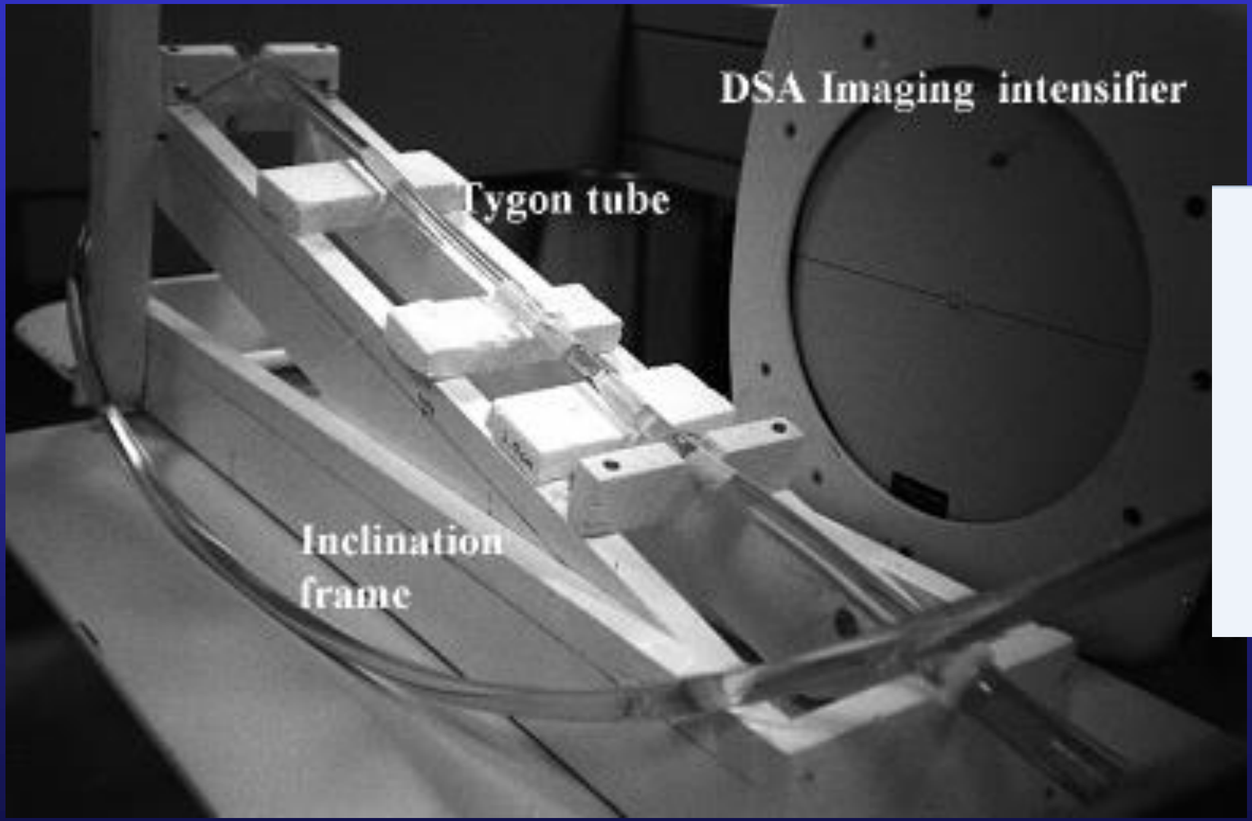
CTA

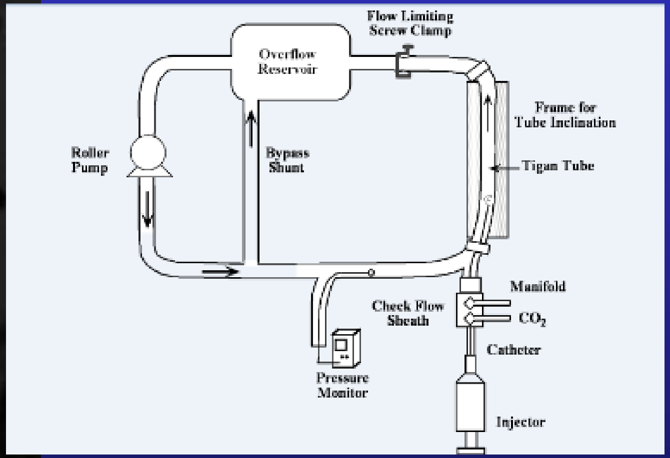
SFA DSA:
Comparison of Contrast and CO_2

Plastic Bag System for CO_2 delivery

CO_2mmander and AngiAssist Delivery system

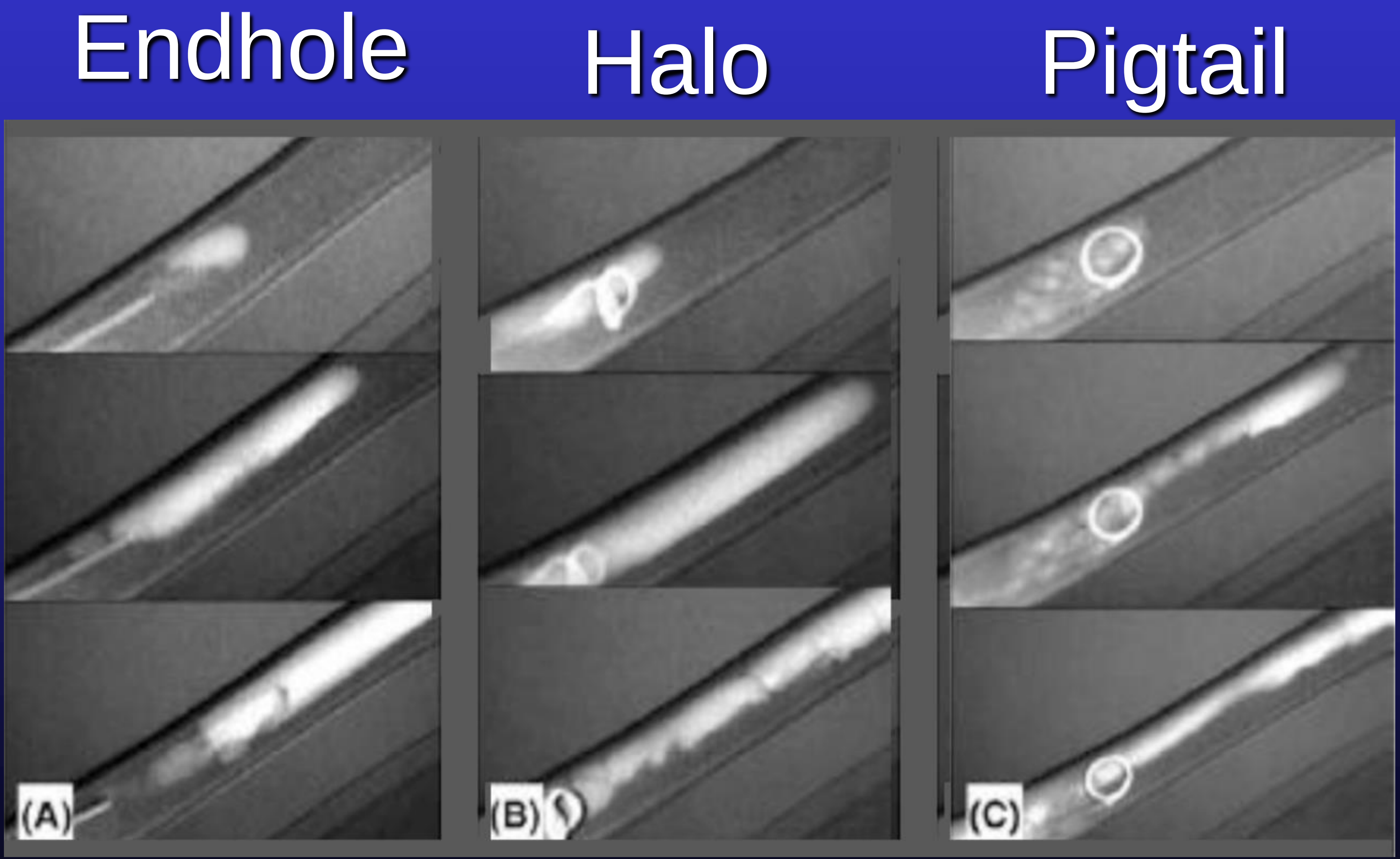
CO_2 Flow Dynamics in Vessel



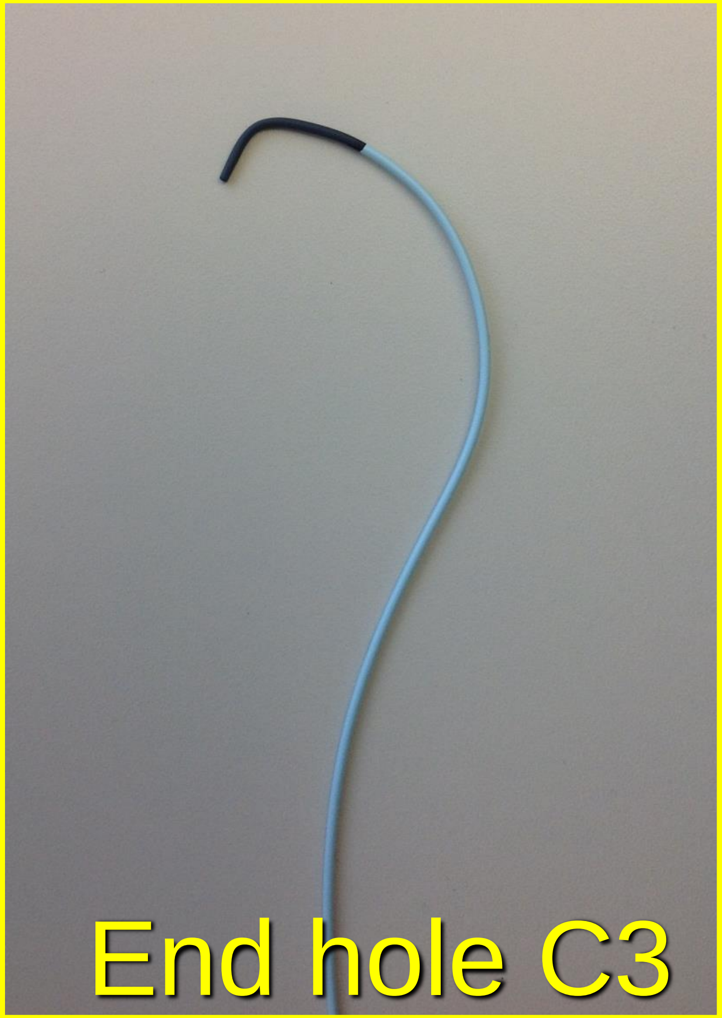


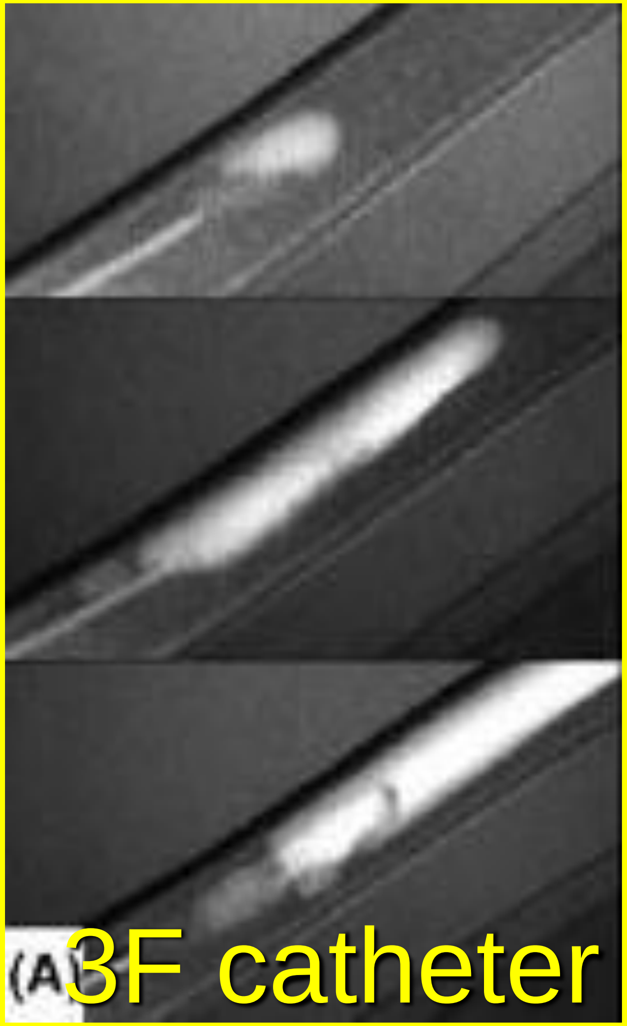
Pulsatile Flow Model

CO_2 Dispersal from Different Catheters

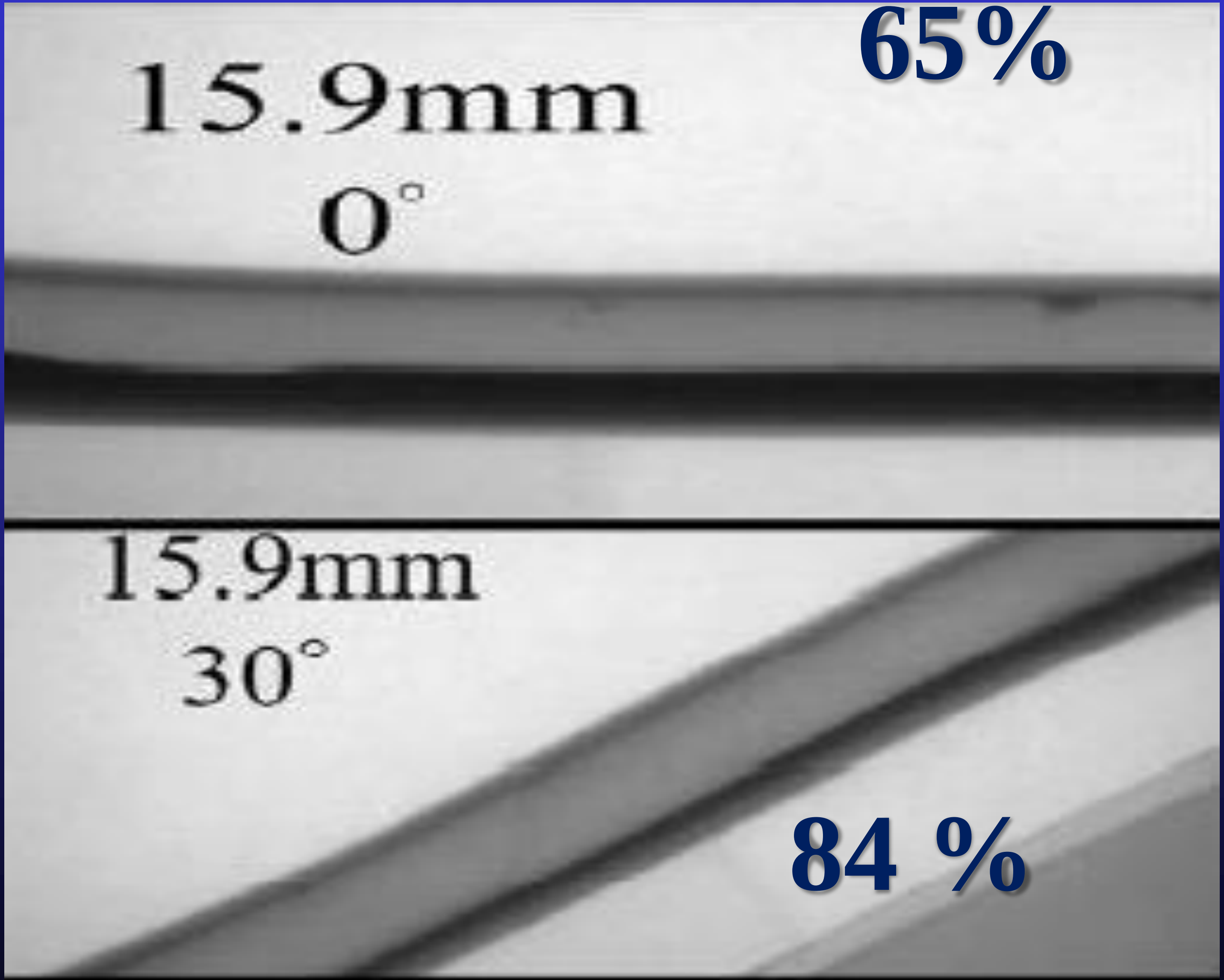


Endhole Catheter for CO_2 Angiography

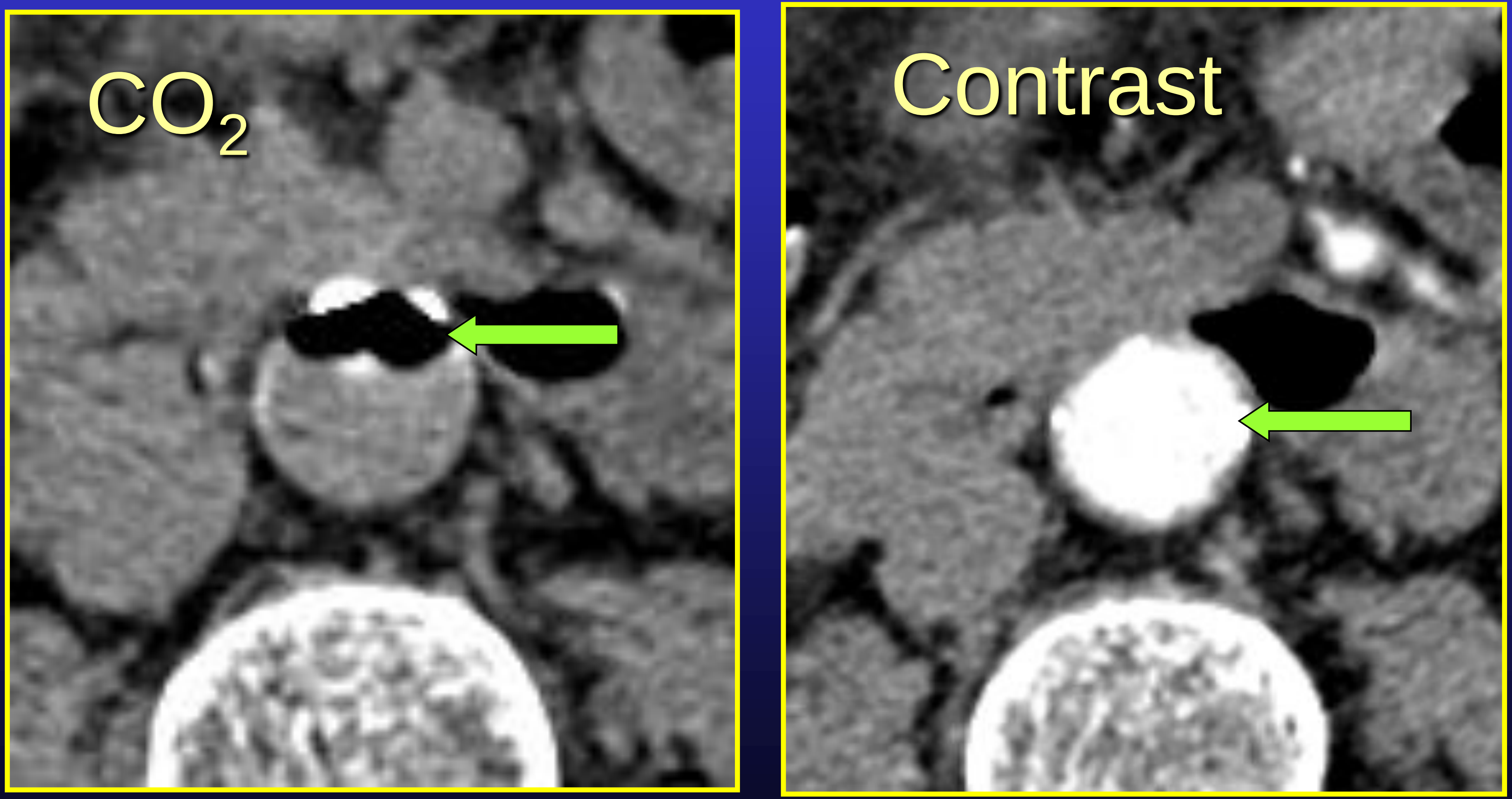

End hole C3


3F catheter

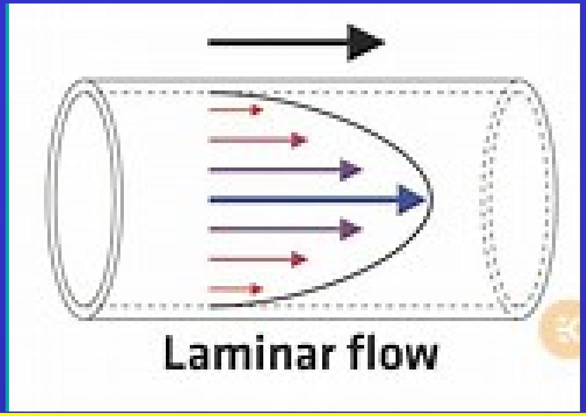
CO_2 Filling of 15.9 mm Tube in Supine vs 30^0 elevation



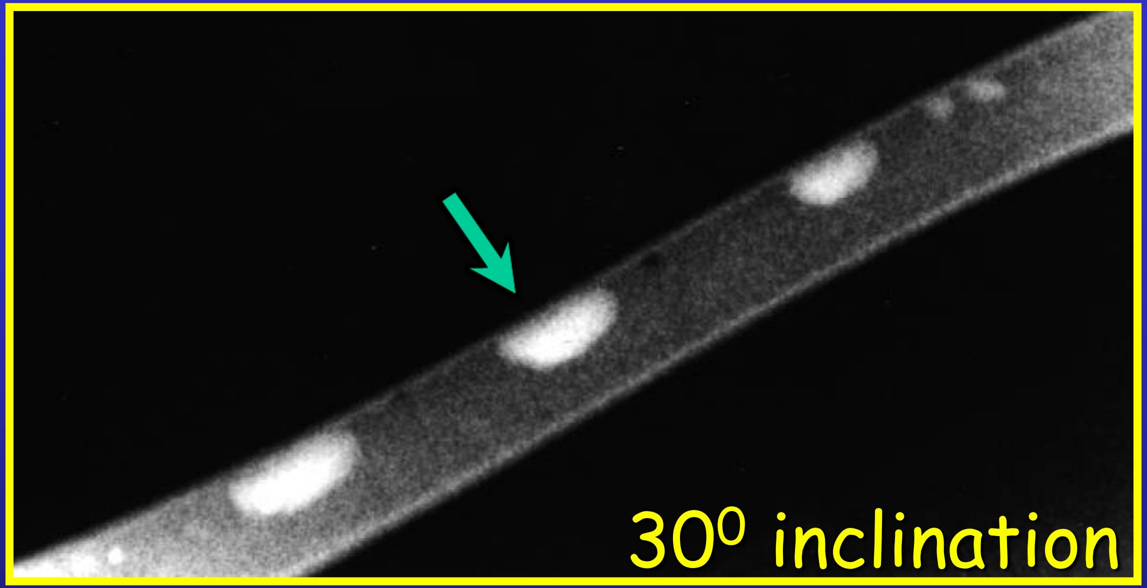
CT with intra-aortic injection of CO_2 and contrast medium: CO_2 displaces blood whereas contrast is mixed with blood

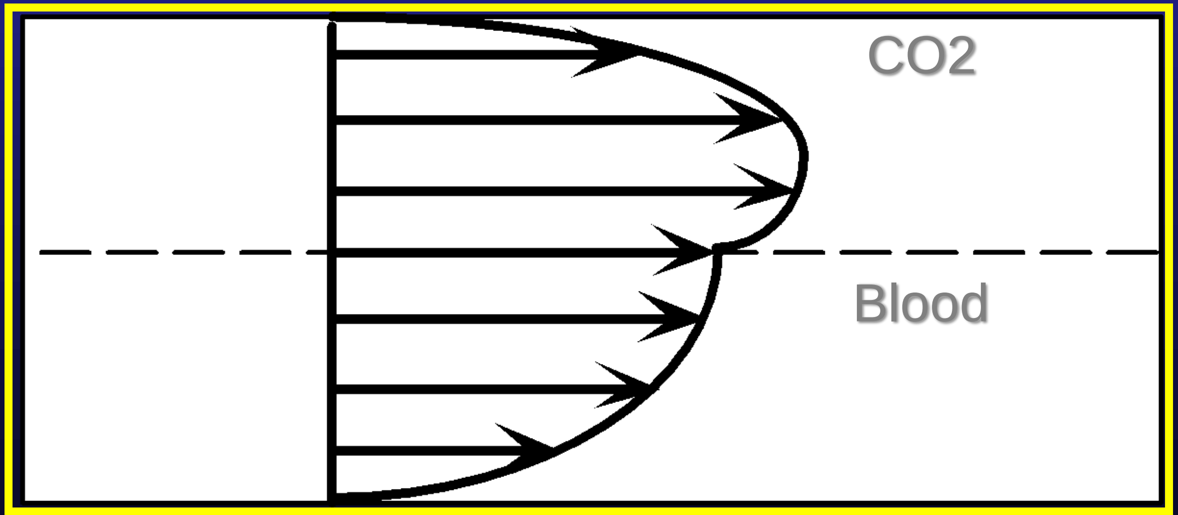


Laminar Flow of CO_2 in the Aorta



CO_2 Bubble Flow in a 9.5 mm Tube in Pulsatile Flow Model



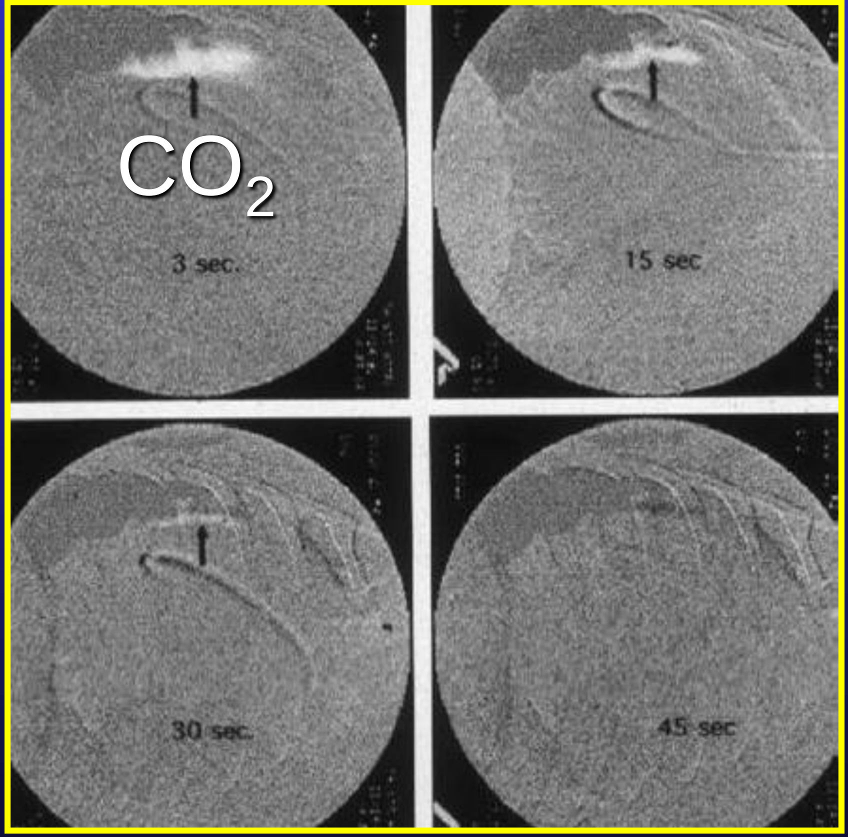


CO_2 Solubility

5 cc of CO_2 injected into IVC in L lateral decubitus

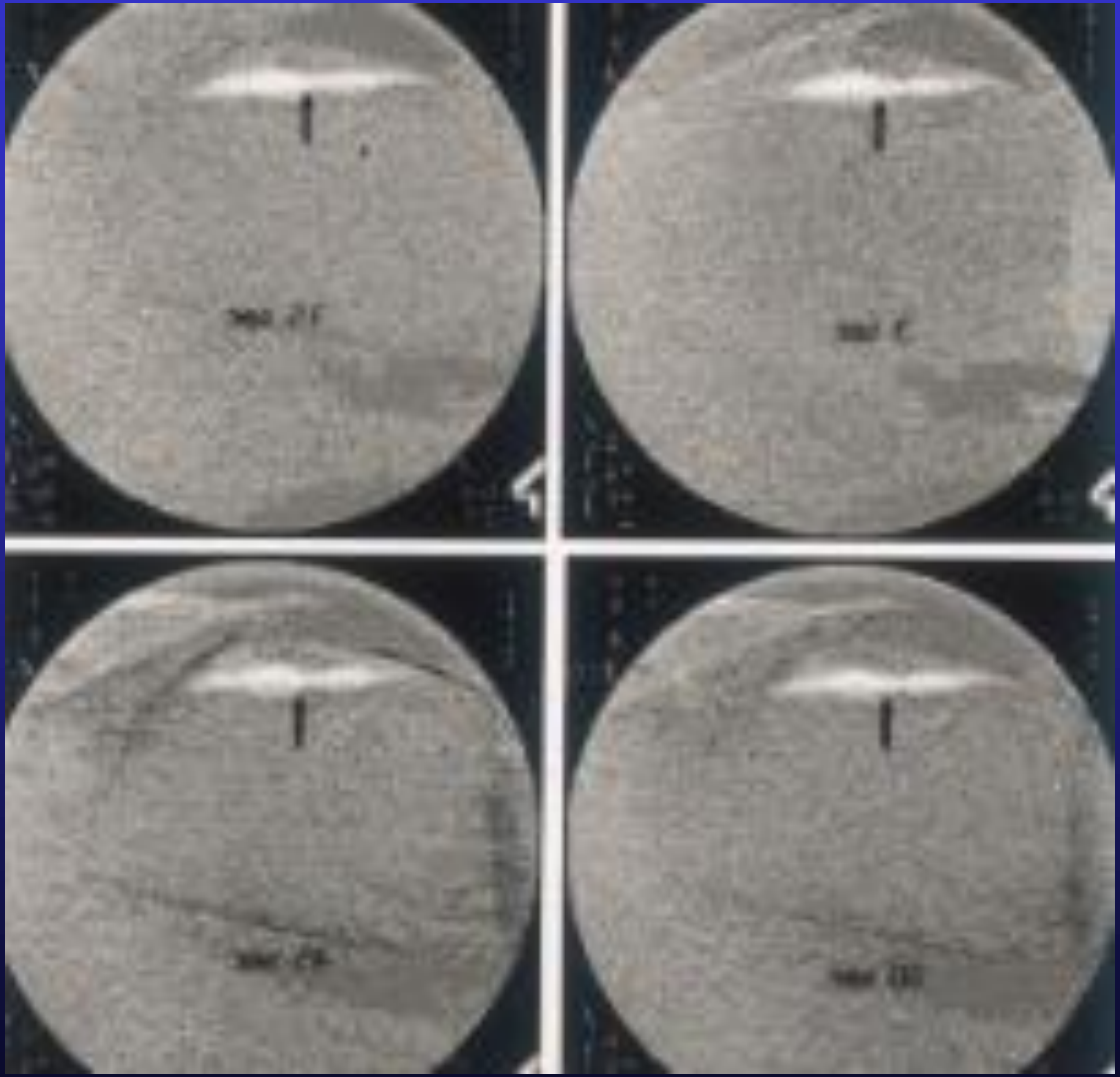
Cross-table lateral DSA of CO_2 trapped in right atrium

Complete gas absorption in 45 sec



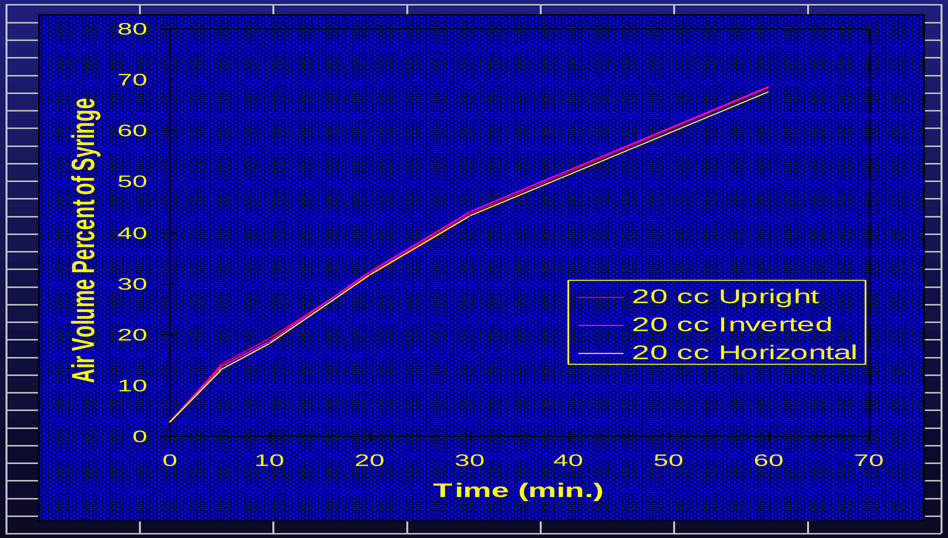
Air Insolubility

5cc air
into
IVC



Air contamination of open-ended syringes in 3 different positions

GC

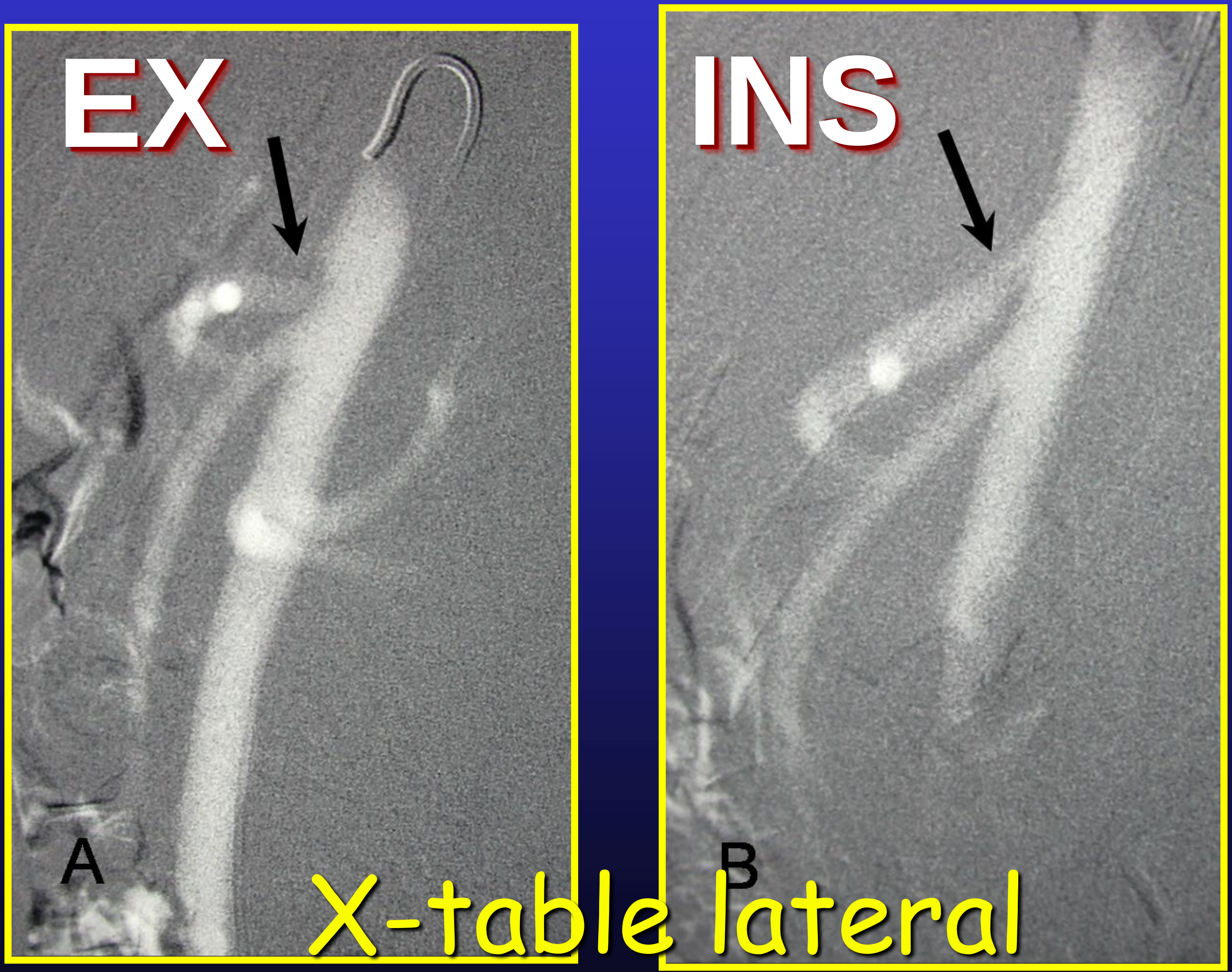


Air replacement

Buoyancy

CO_2 Aortogram

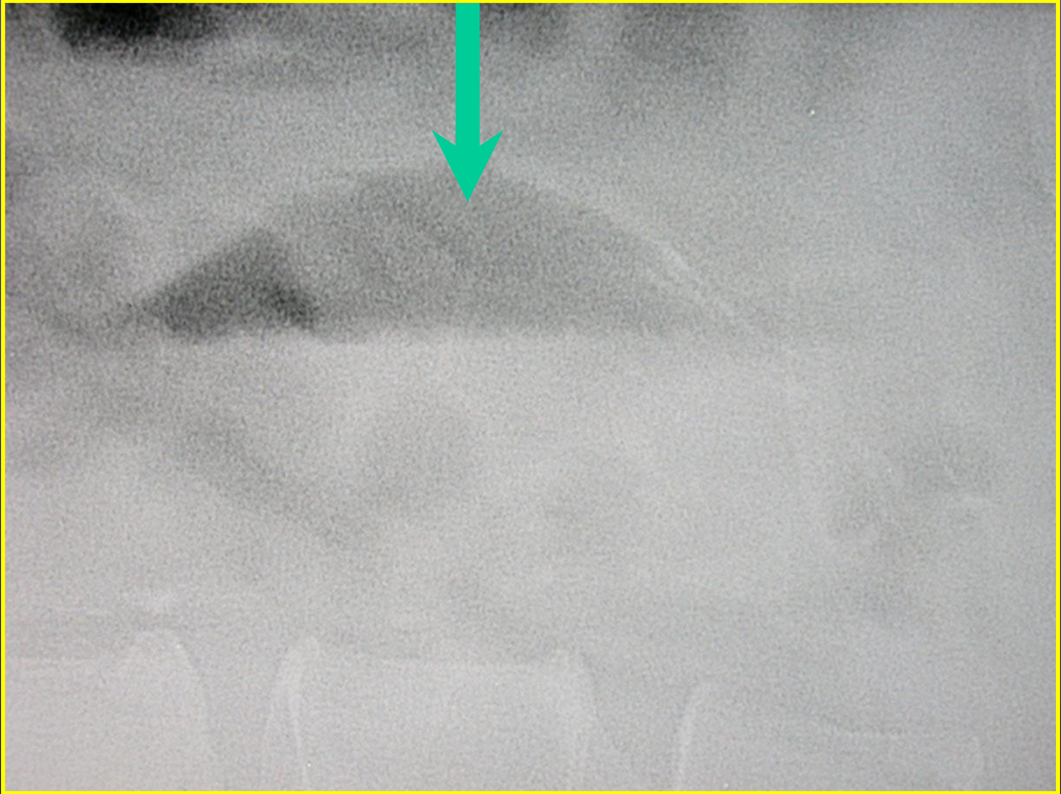
Lateral CO_2 Aortogram: Median Arcuate Ligament Compression



X-table lateral

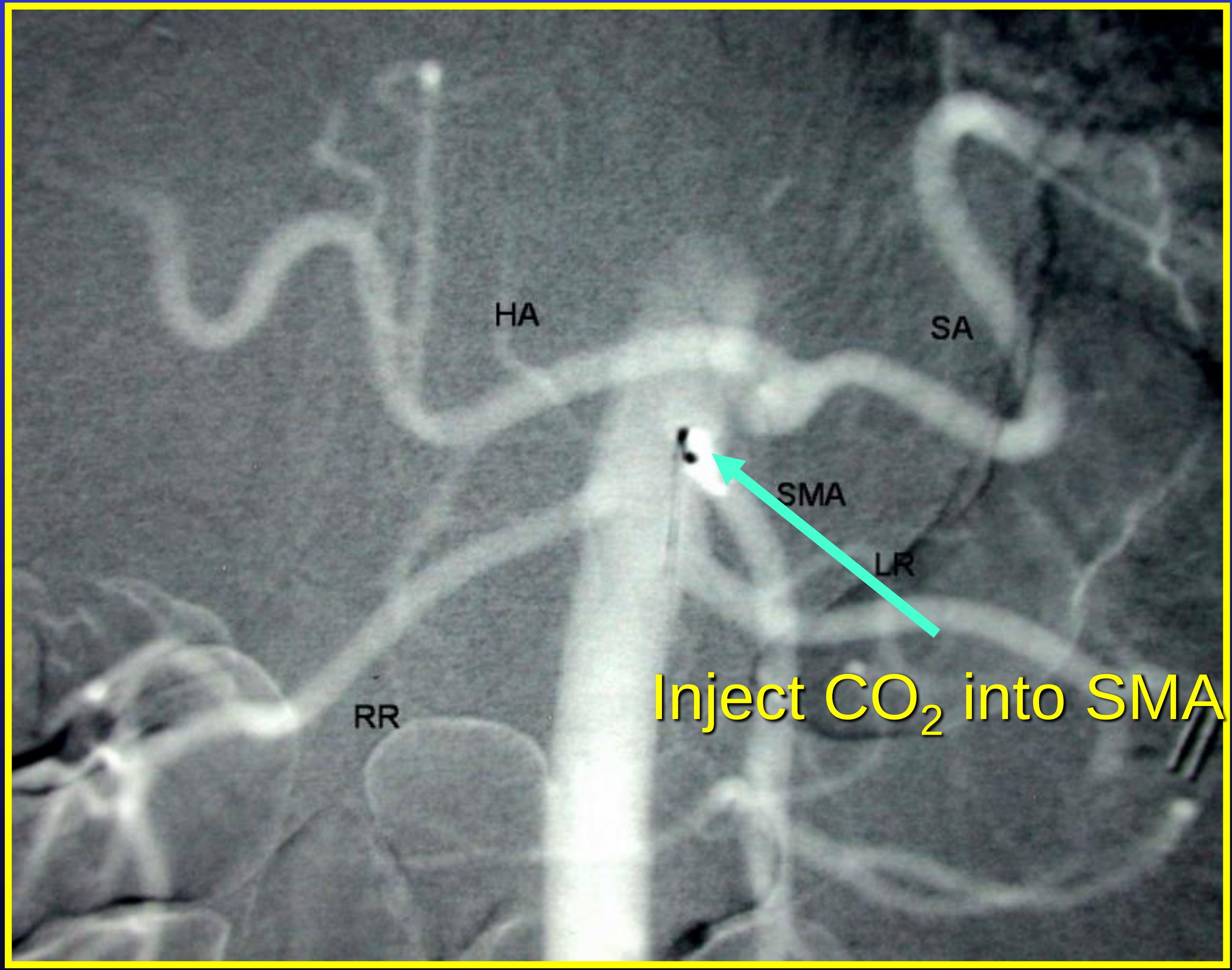
Buoyant CO_2 is trapped in AAA

CO_2 aortogram

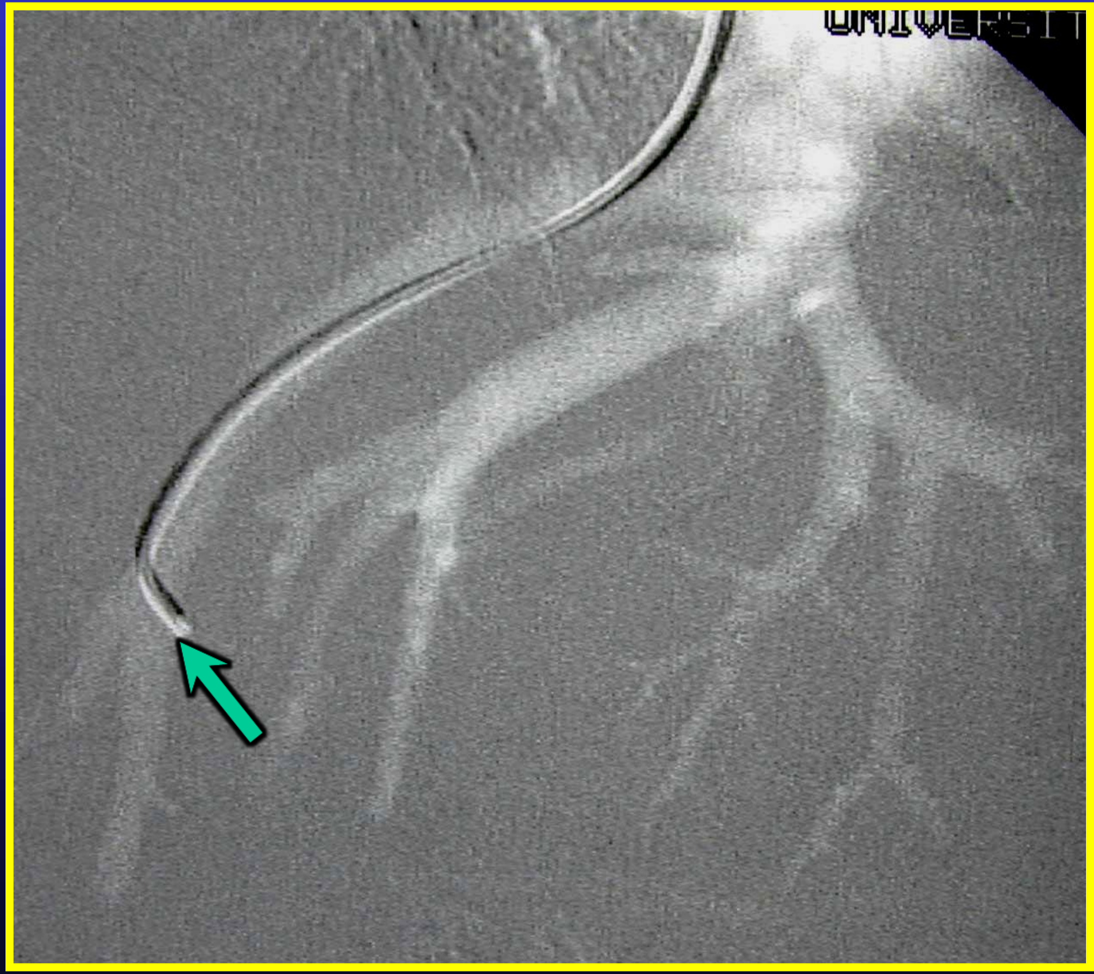


X-table Lat

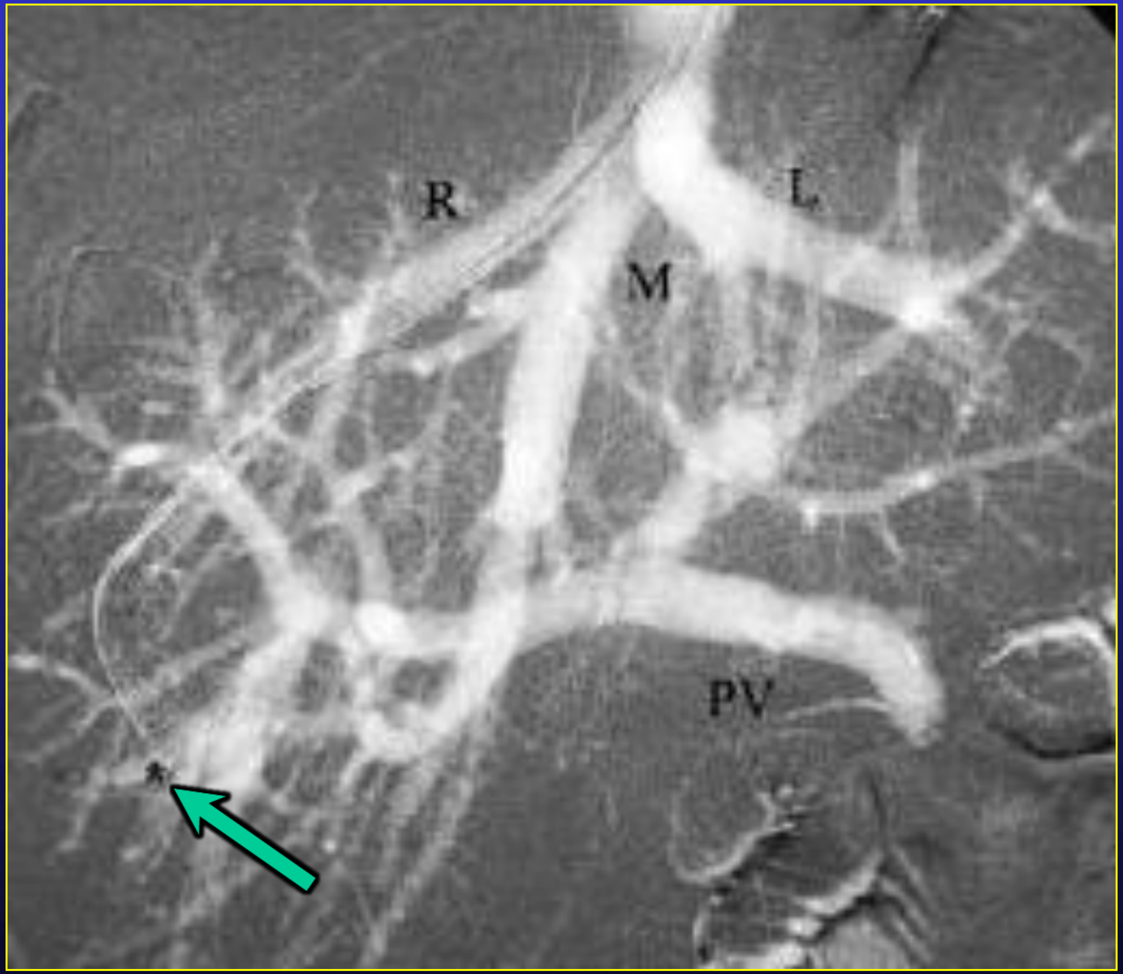
Explosive, Buoyant



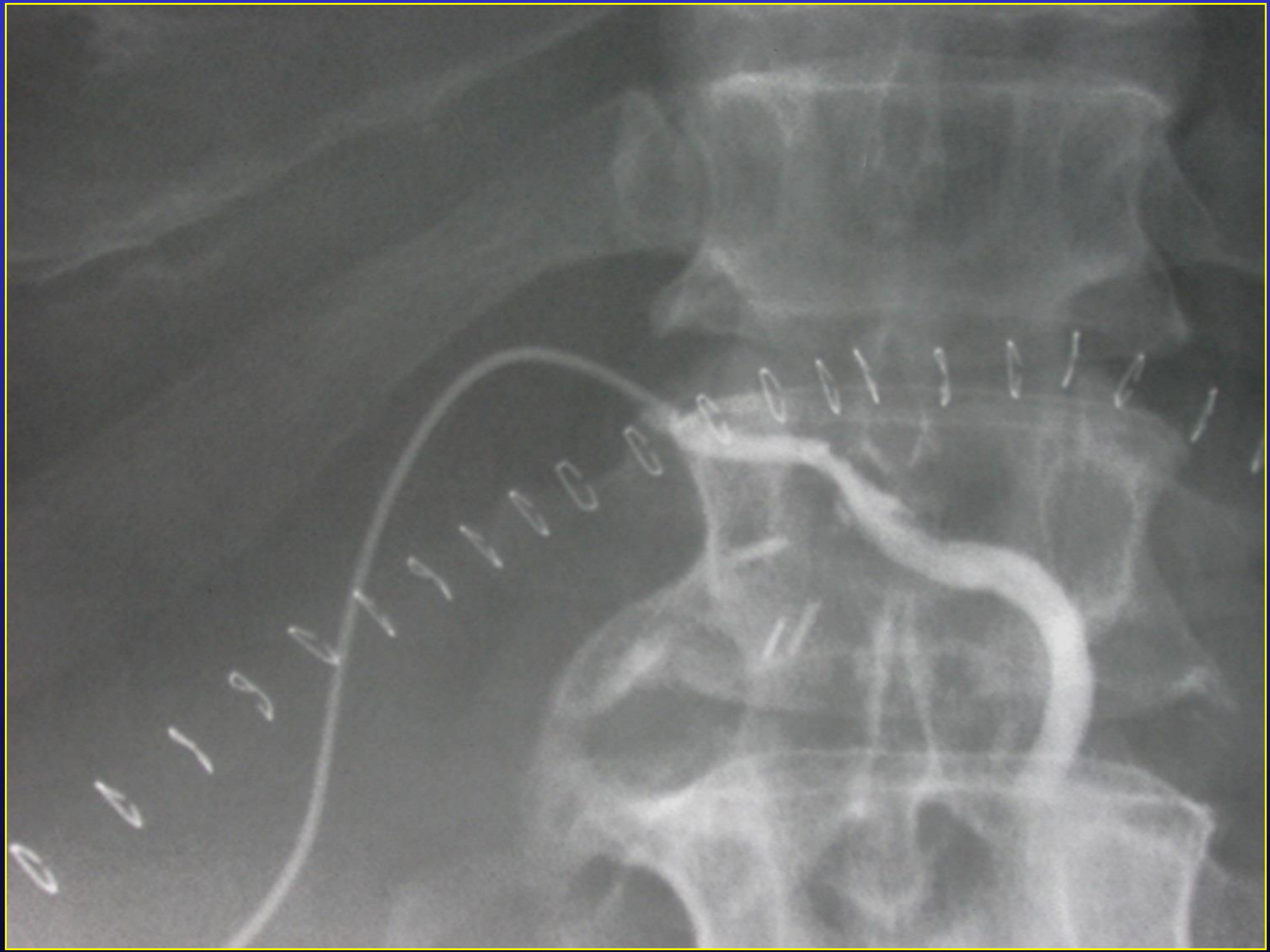
Buoyant CO_2 injected into right hepatic vein filling anterior, middle and left hepatic veins



Buoyant, less viscous CO_2 injected into wedged right hepatic vein fills the portal, right, middle and left hepatic veins

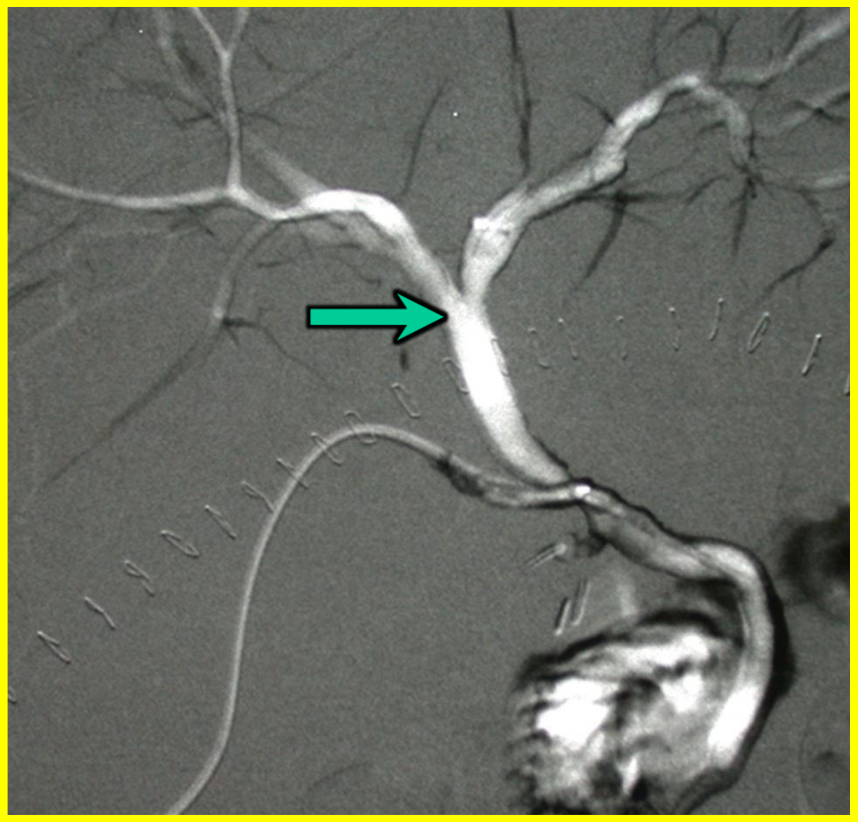


T-tube cholangiogram using contrast medium



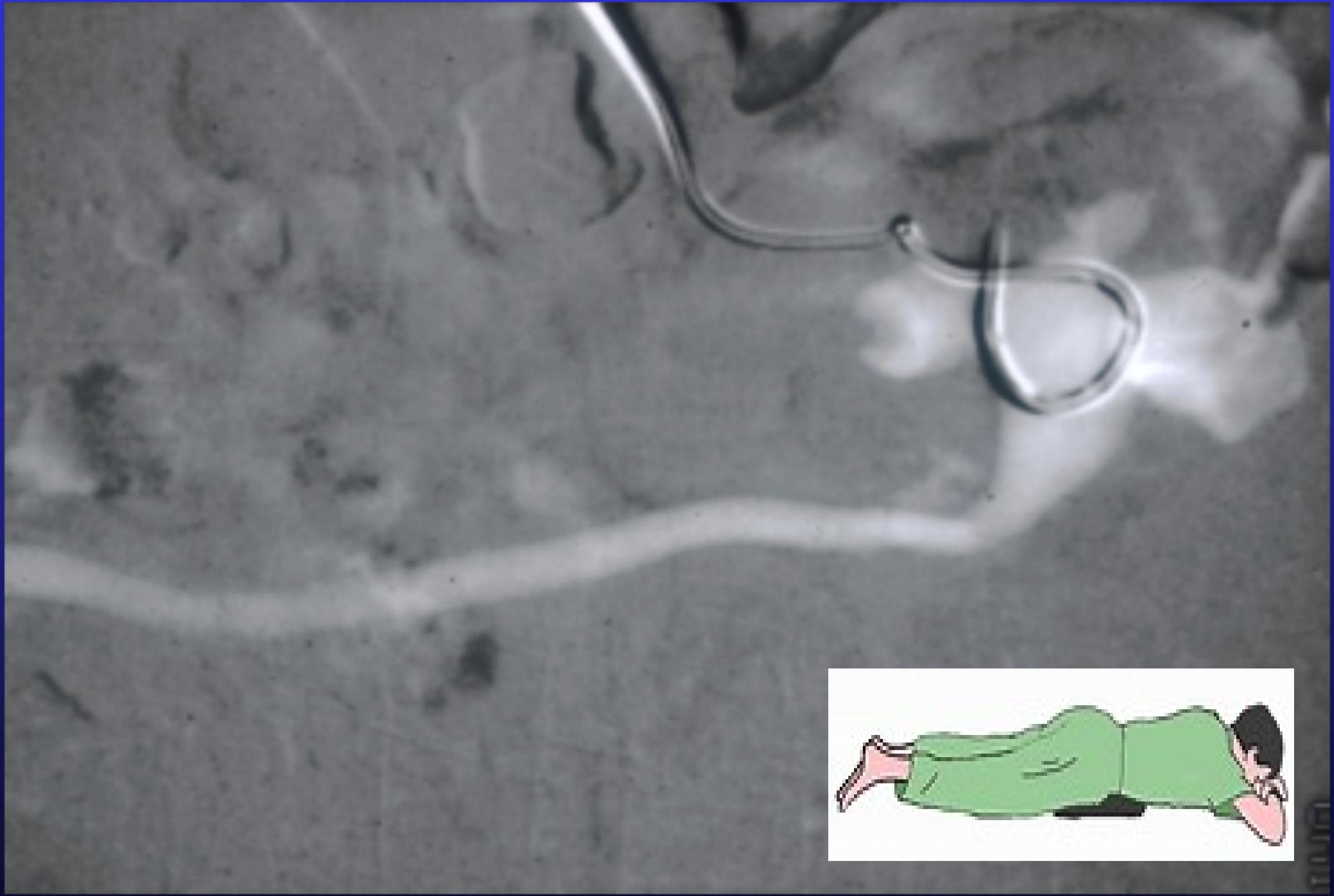
CO_2 Cholangiogram

CO_2 injection into bile duct fills intra-and extrahepatic ducts

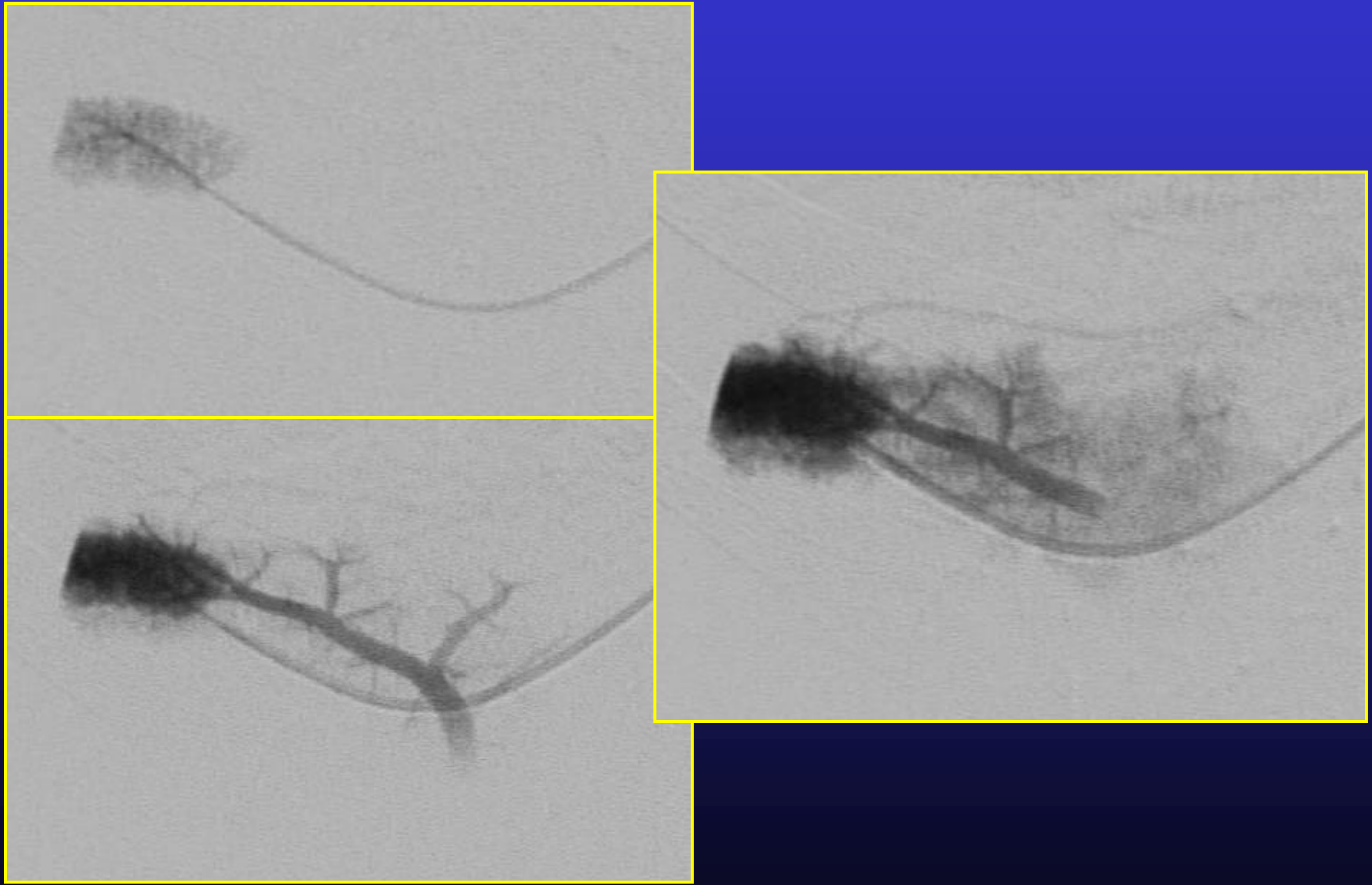


CO_2 is buoyant, displaces bile and contrast, and explosive

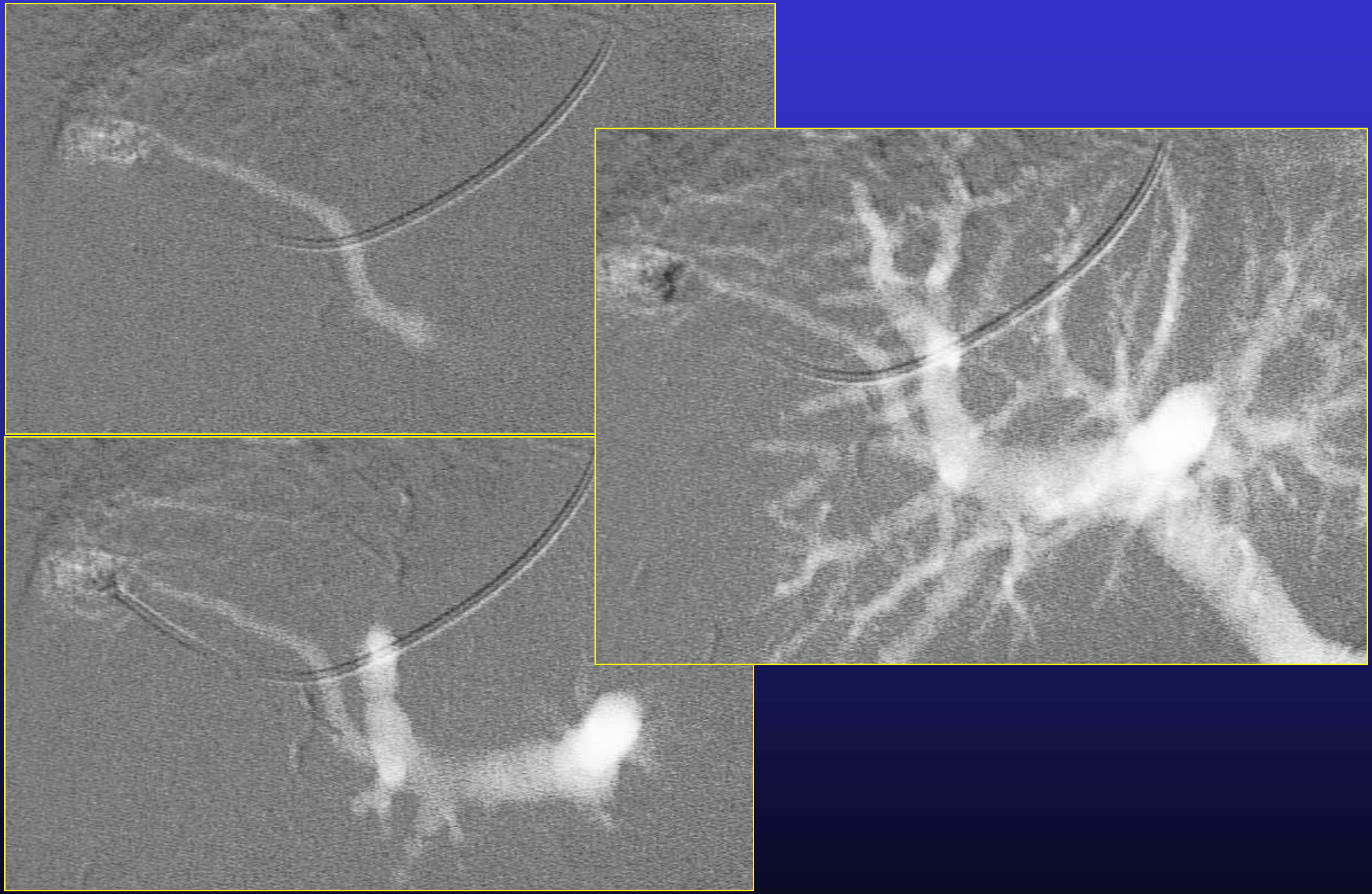
CO_2 Nephrostogram



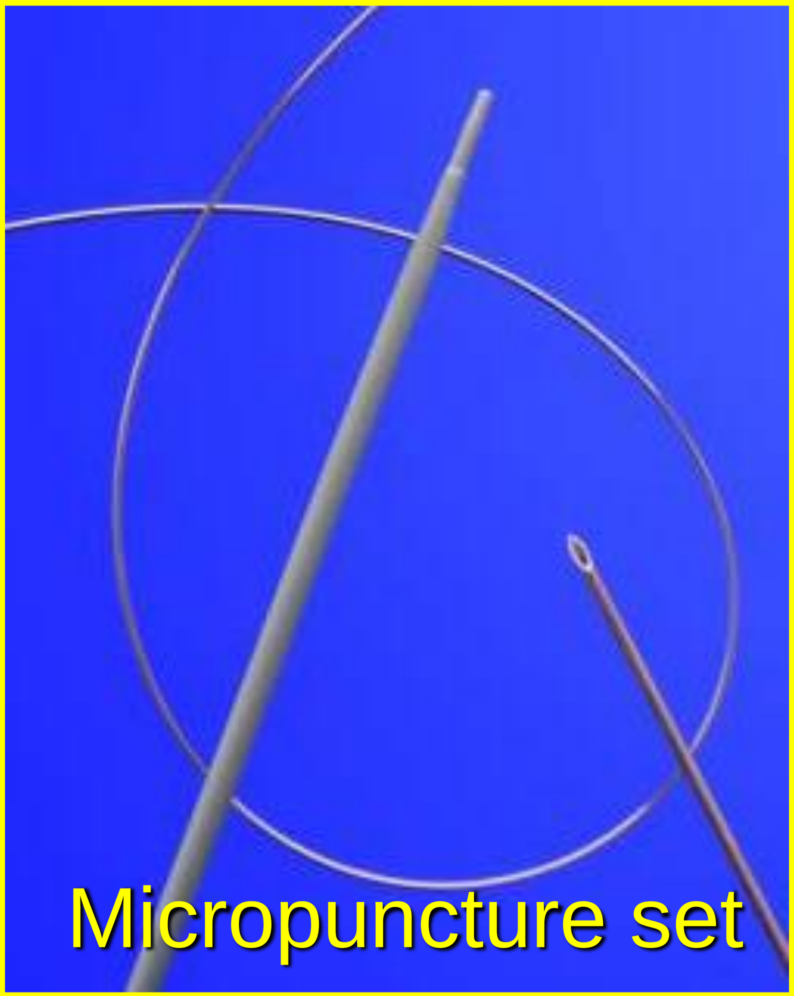
Wedged Hepatic Venogram with Contrast medium



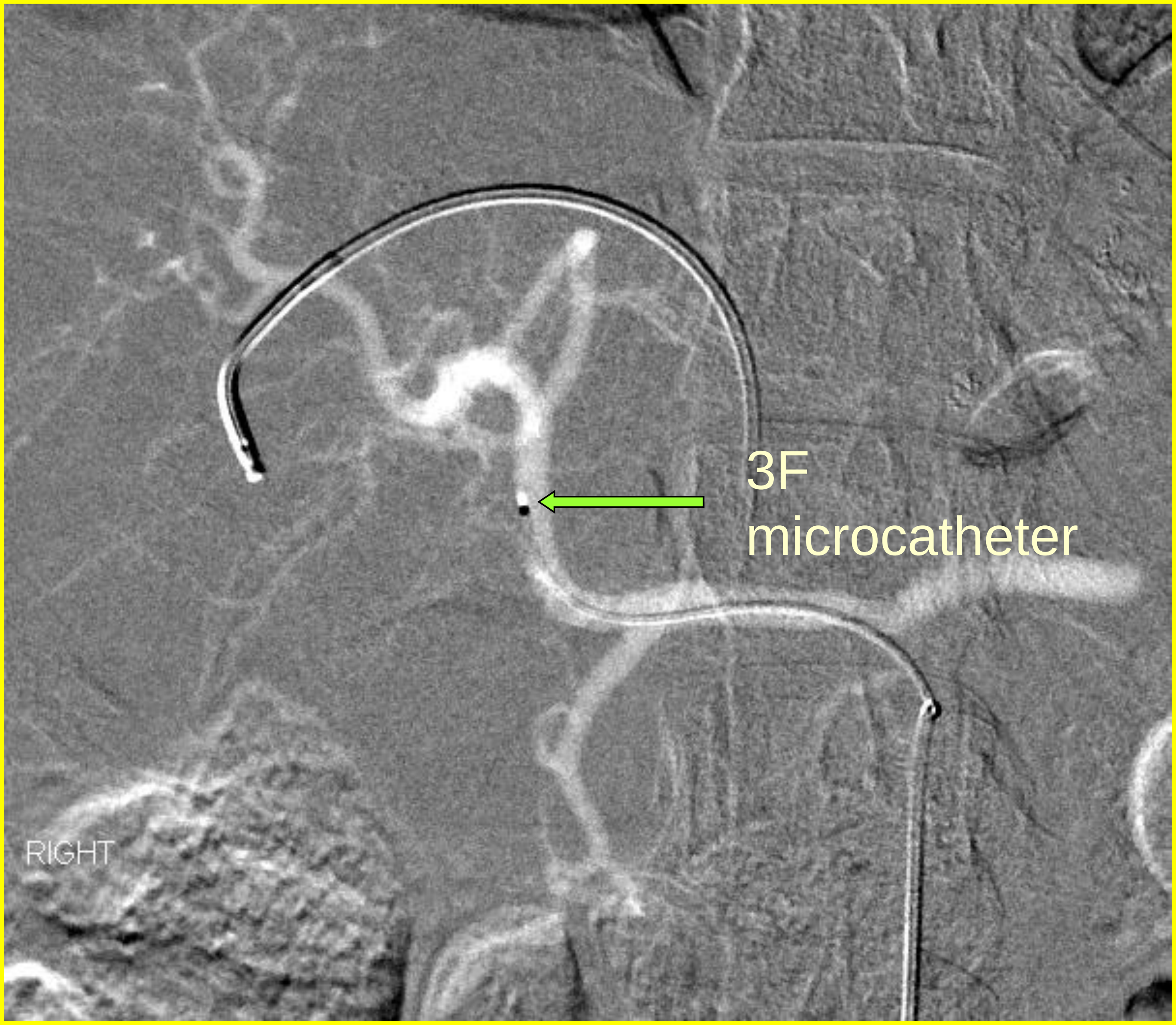
Wedged Hepatic Venogram with CO2



CO_2 flows through collateral into proximal and distal vessels

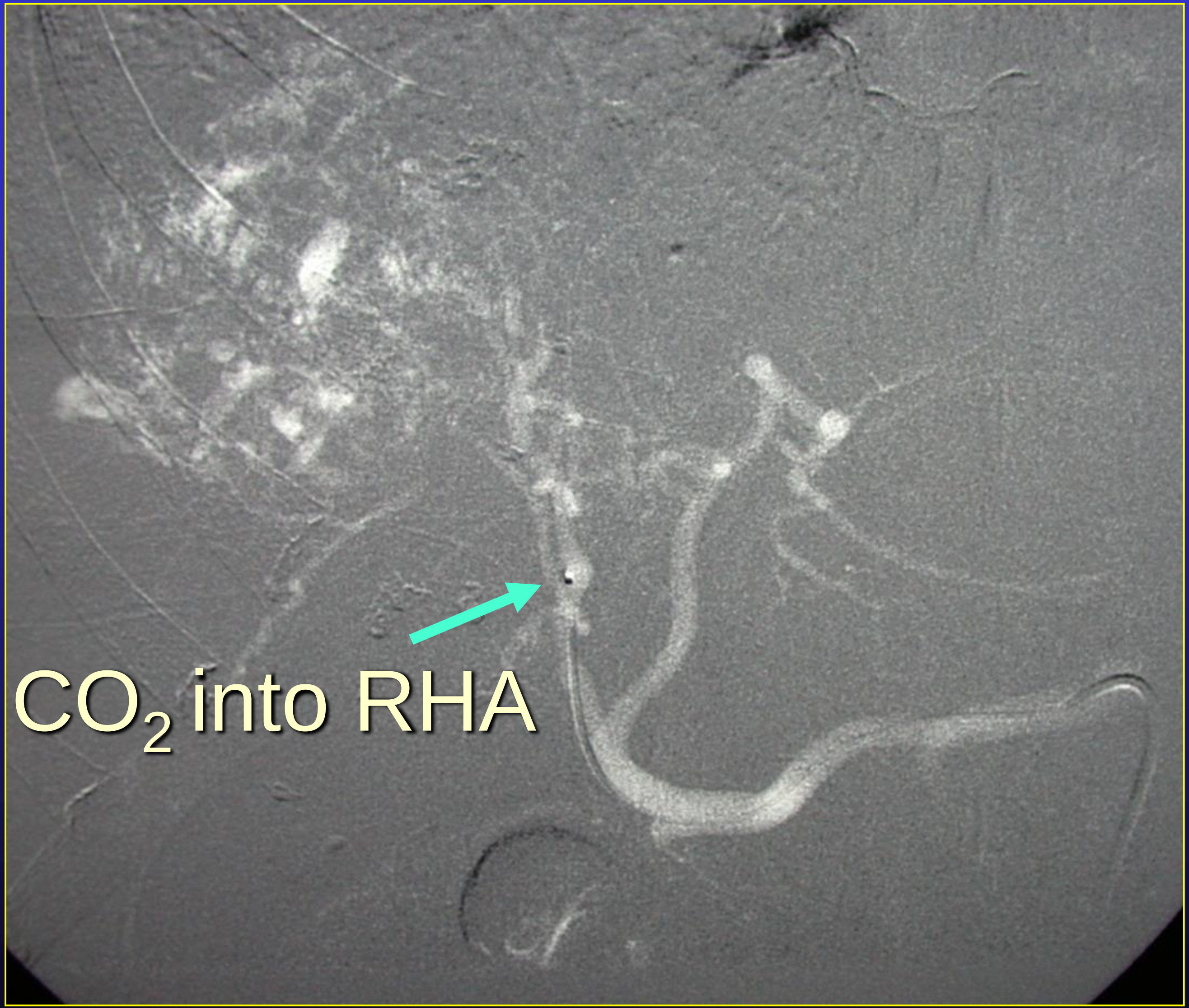


CO_2 Hepatic DSA using Microcatheter

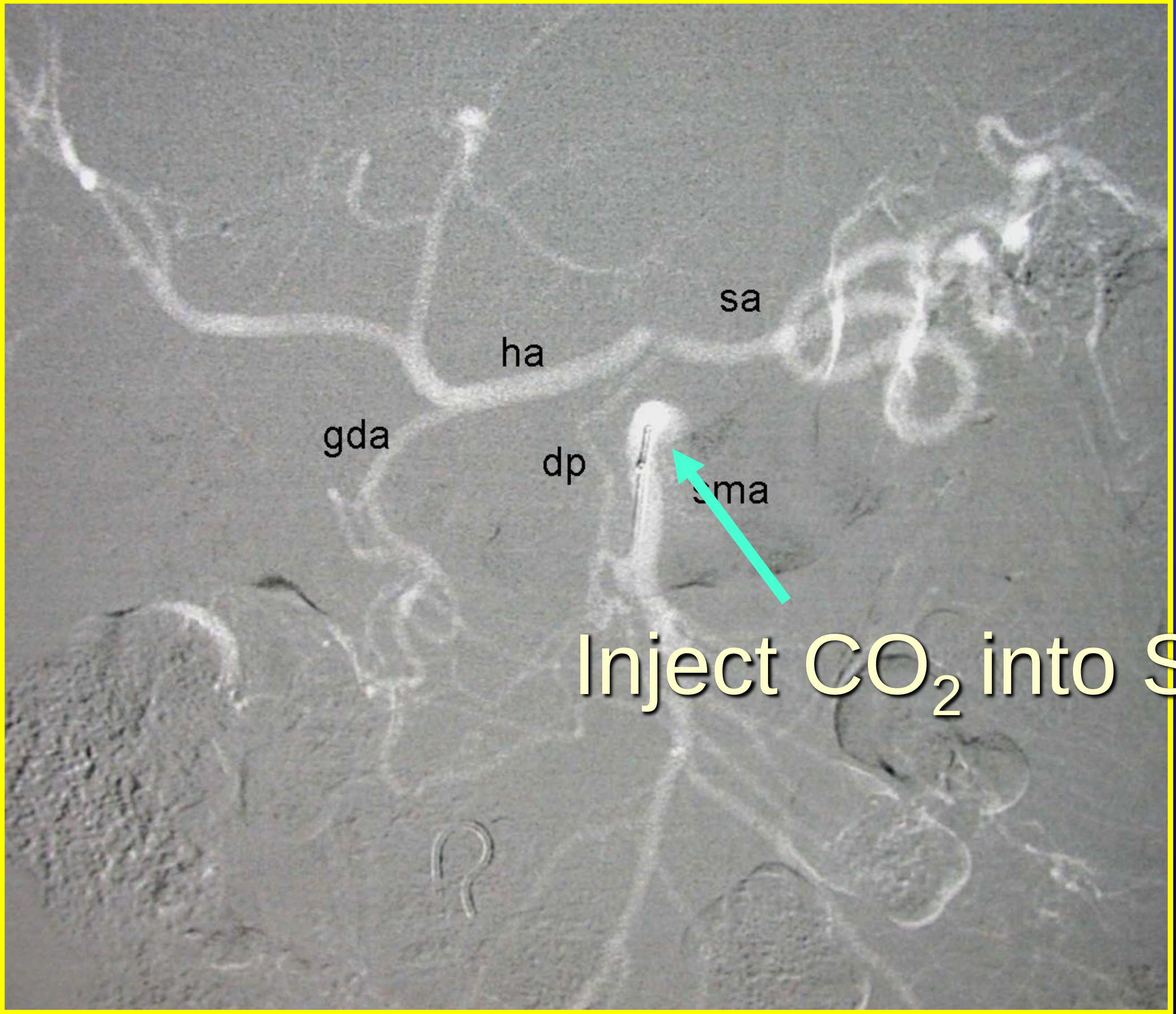


3F
microcatheter

HCC and TACE

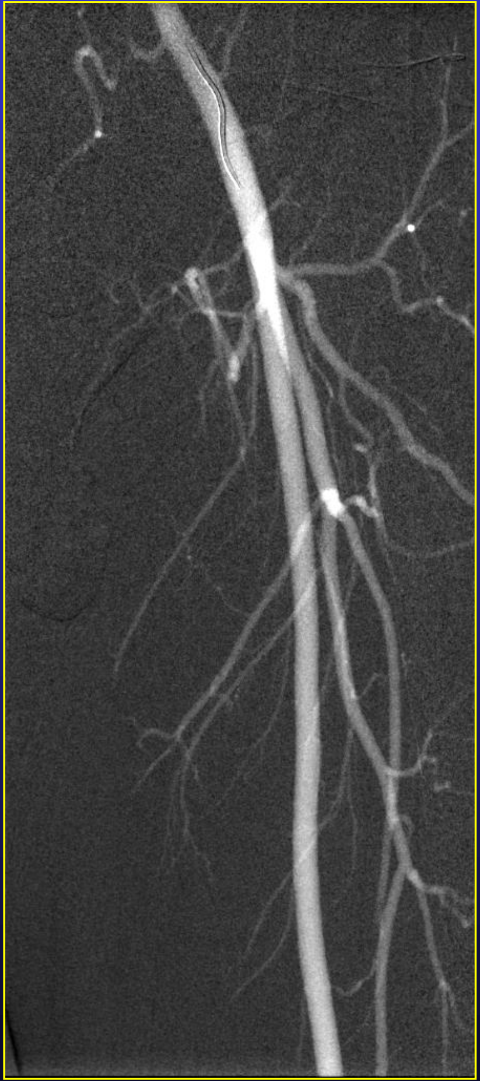


Celiac Occlusion

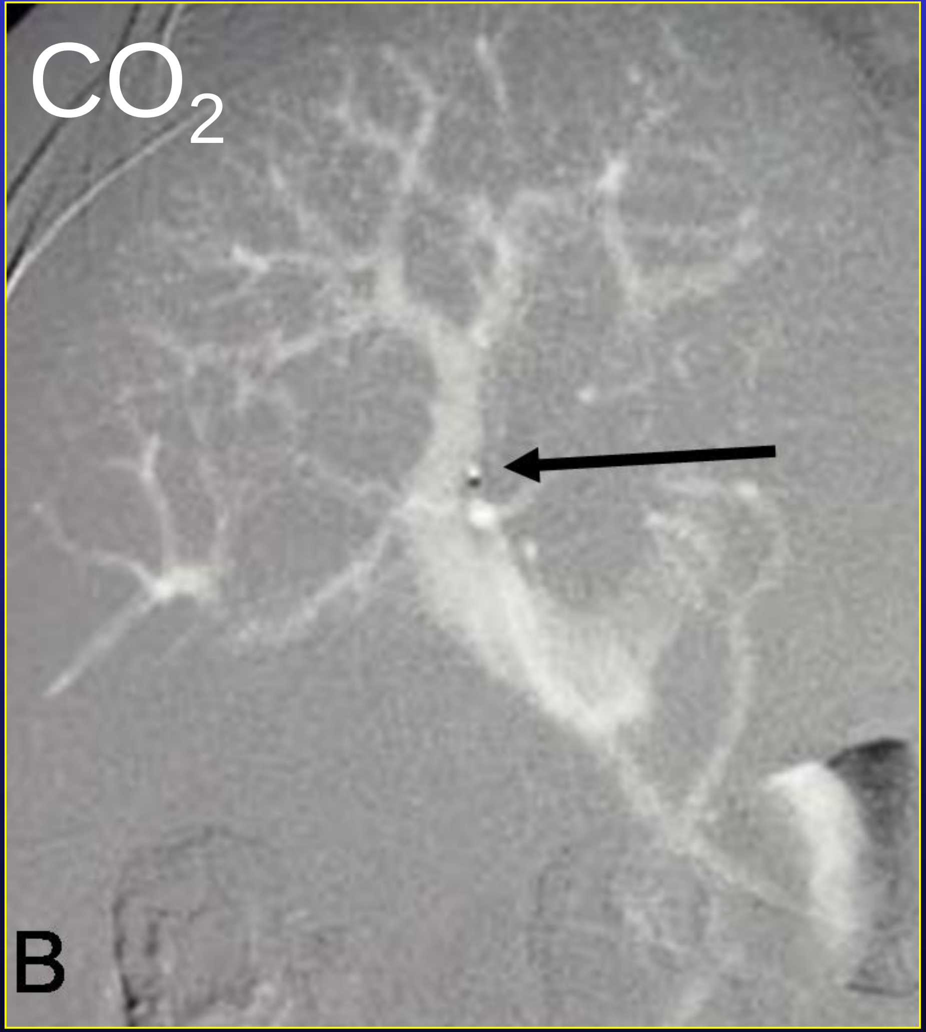


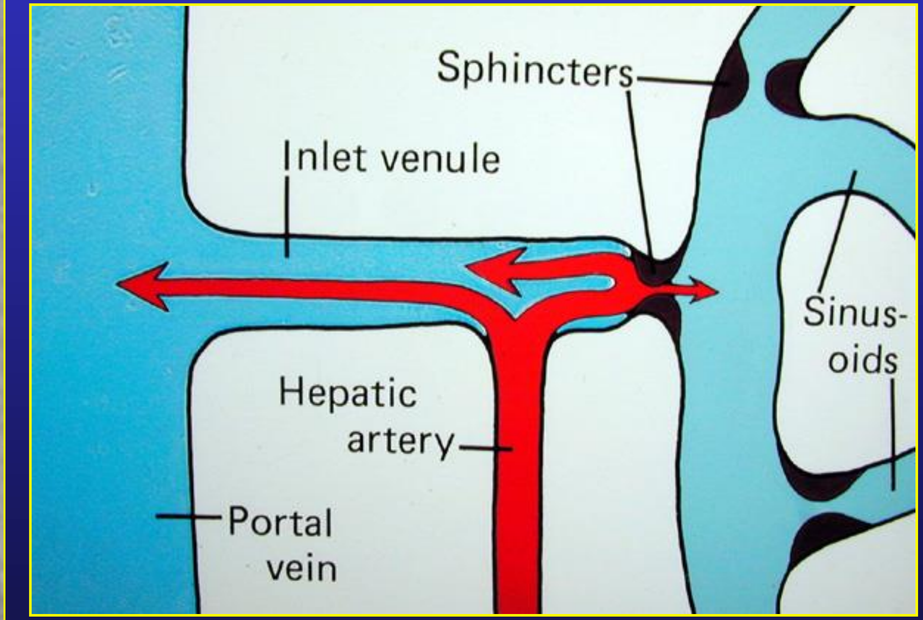
Inject CO_2 into SMA

Outflow via 3F Catheter

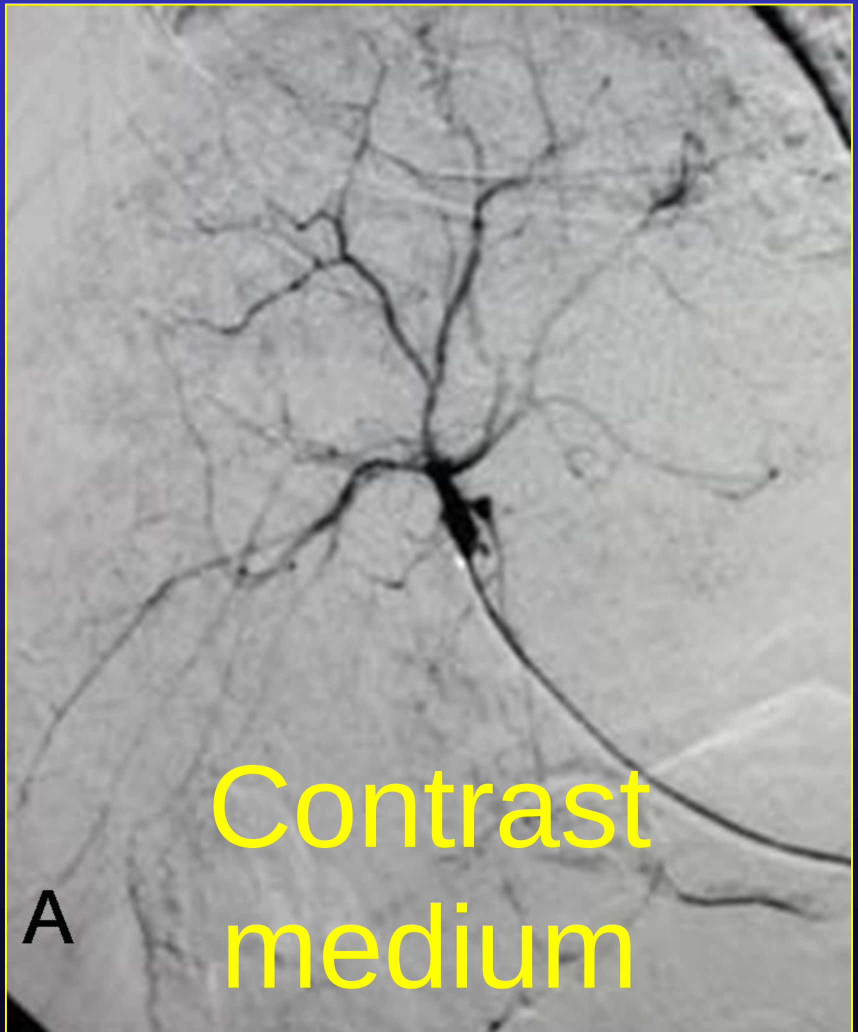


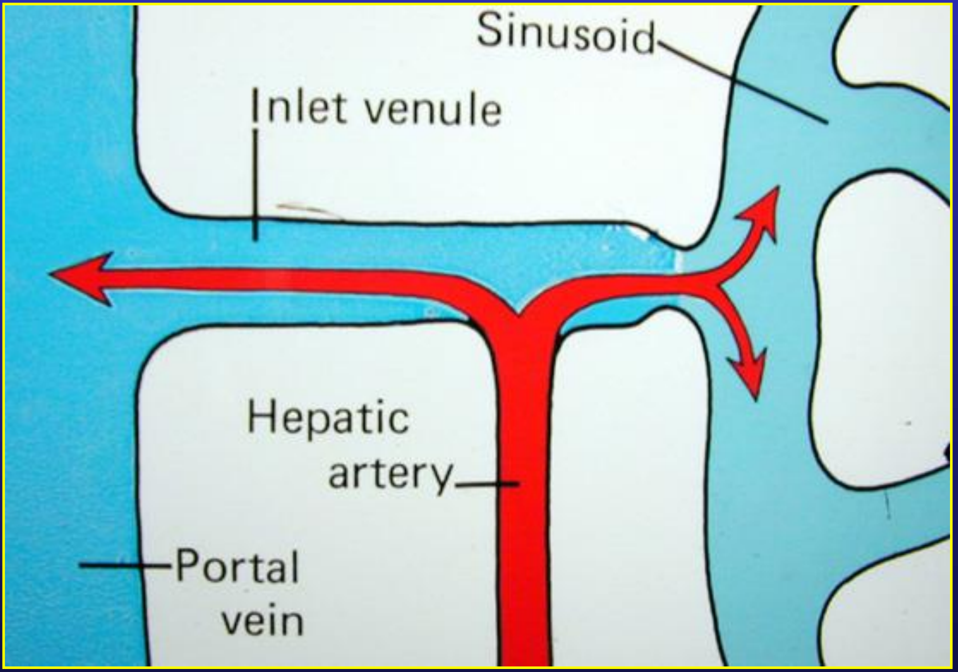
Hepatic Arteriogram with CO_2





Hepatic Arteriogram with Contrast Medium



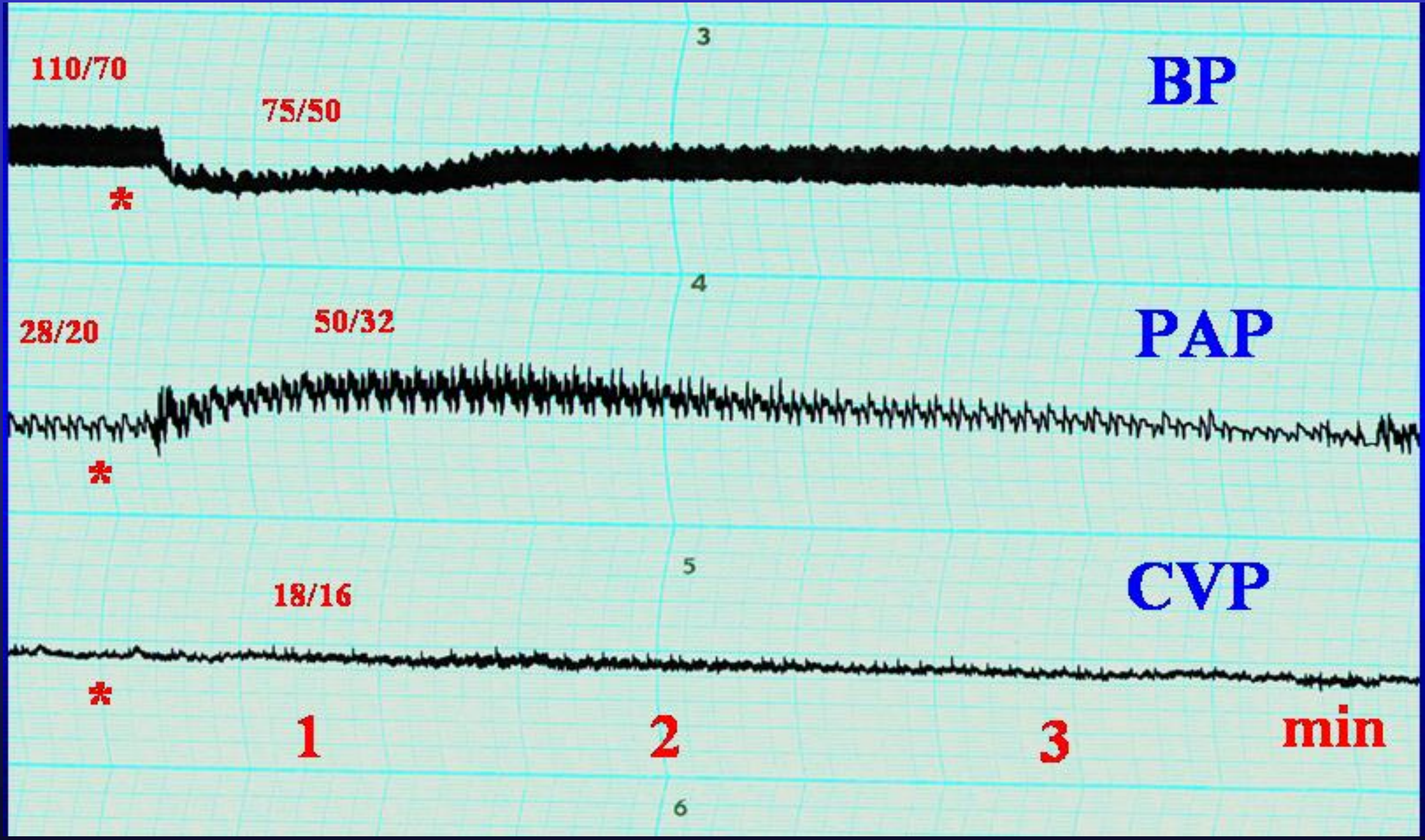


CO_2 Flow in Liver

Safety and Tolerance Study of CO_2 as a Venous Contrast Agent in Swine

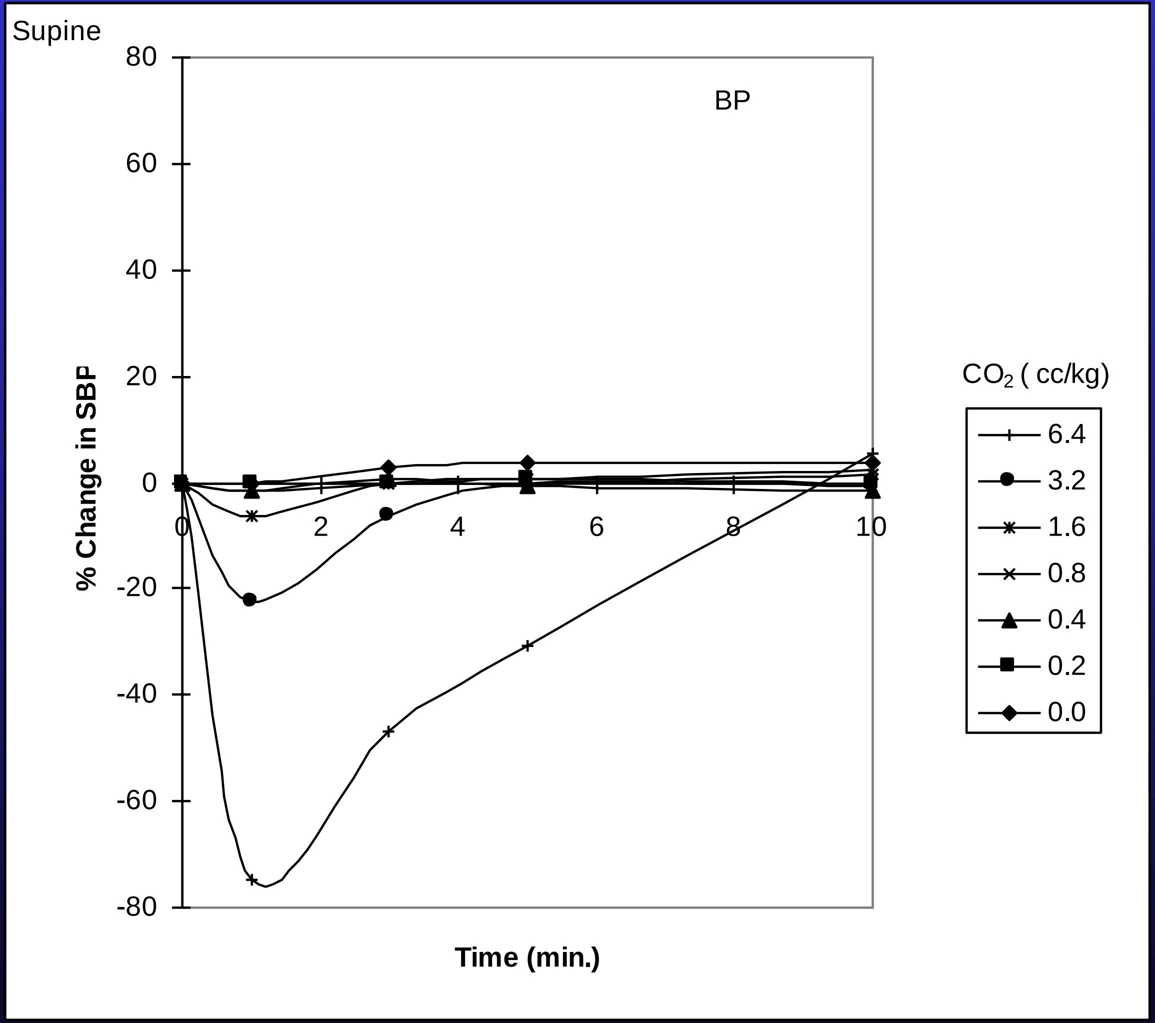
The hemodynamic and ventilatory responses to intracaval injections of ascending doses of CO_2

Polygraph tracing of blood pressure, pulmonary artery pressure and CVP following intracaval injection of CO_2 at 3.2 cc/kg in swine



CO_2 3.2 cc/kg, supine

Average percent changes in systemic blood pressure following intracaval injections of ascending doses of CO_2 in swine



Conclusions

- CO_2 has been used as a contrast agent in the nonvascular system since 1920s, in the venous system since 1950s and in the arterial system since 1970s.

- Intravenous CO_2 in doses of 0.2-1.6 cc/kg caused no cardiopulmonary effects in swine.

- Knowledge of CO_2 properties, and facile catheterization and imaging techniques are essential in obtaining a successful CO_2 angiogram for the vascular diagnosis and intervention.

- Blood pressure monitoring and capnography provide the earliest sign of “vapor lock” in the pulmonary artery from the inadvertent injection of large volume of CO_2 or air.

Thank You

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