CIO 2021 Session 4: Liver Therapy:
Maximizing Your Technique

Balloon-Occluded TACE
- My Top 5 Technical Pearls -

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National Cancer Center, Japan

Disclosures

- Royalties — Sumitomo Bakelite
- Speaker's Bureau — Merit Medical Systems, Fuji Pharma, Canon Medical Systems, Terumo International Systems, Bristol Meyer Squibb, Sumitomo Bakelite, Nippon Kayaku, Boston Scientific Japan, Bayer Pharmaceuticals, Japan Lifeline, Taiho Pharmaceutical, Guerbet Japan, Guerbet Asia Pacific, Kyorin Pharmacutical, AstraZeneca plc

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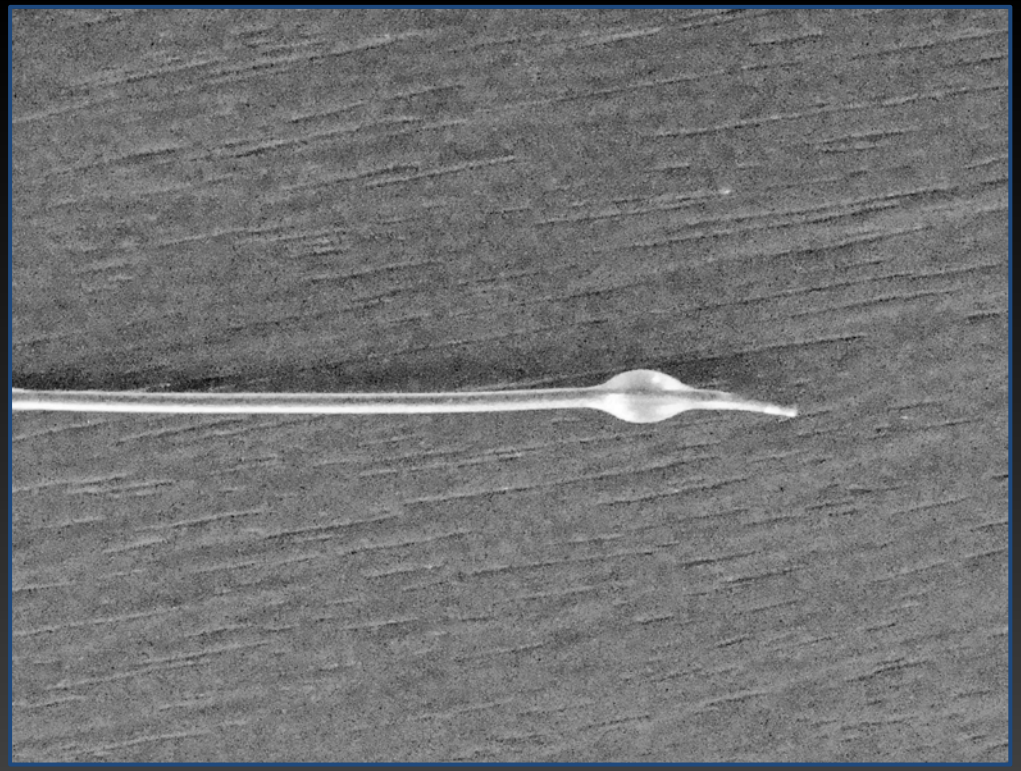
End-Holed Micro-Balloon Catheter



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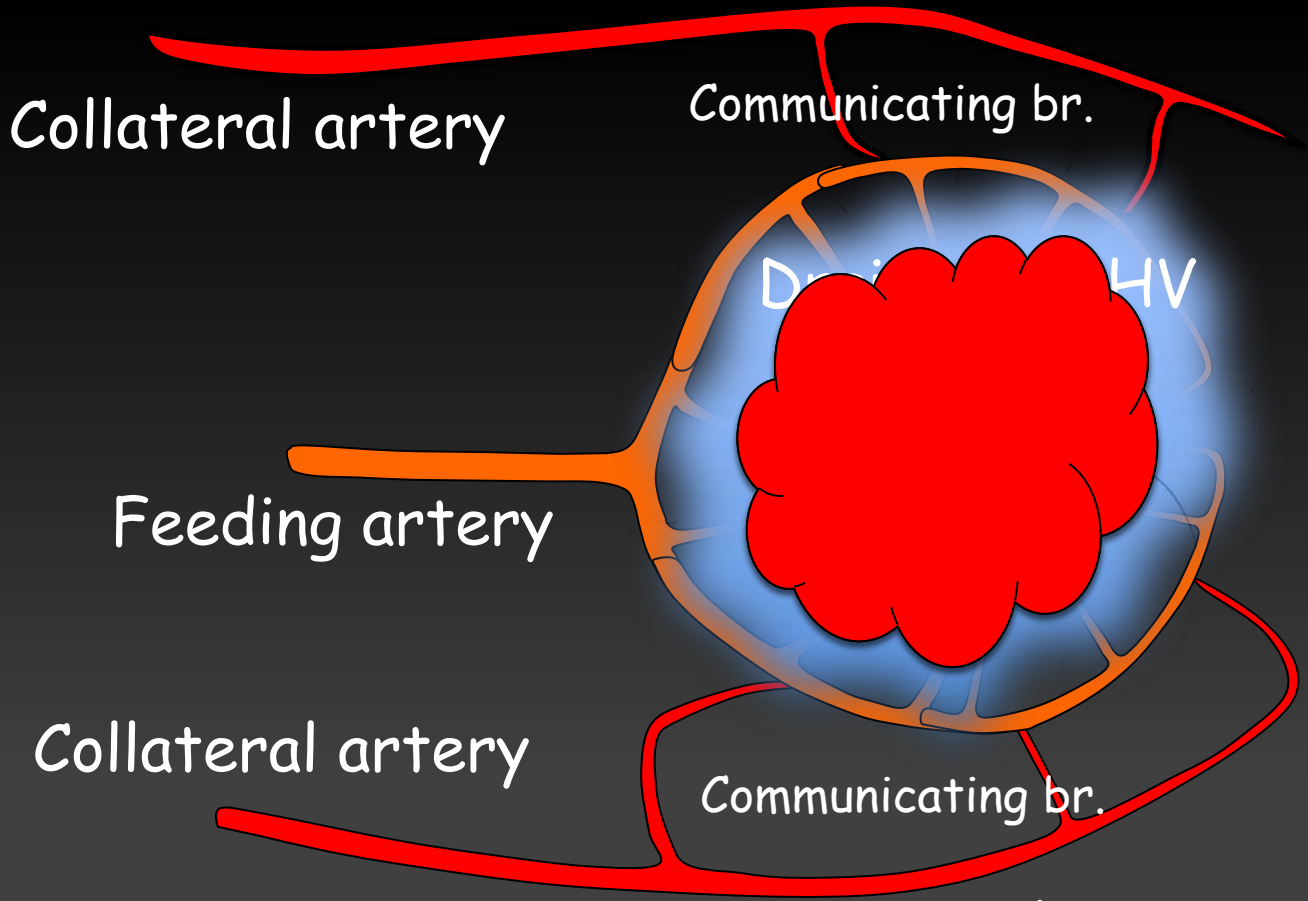
Anatomy and Hemodynamics of HCC



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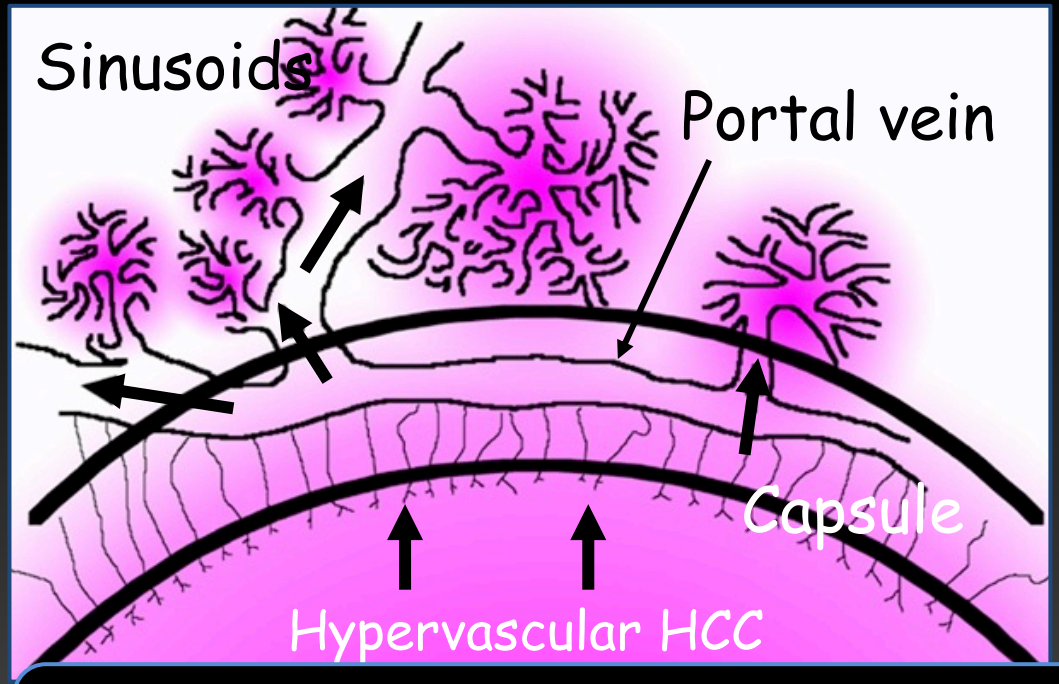
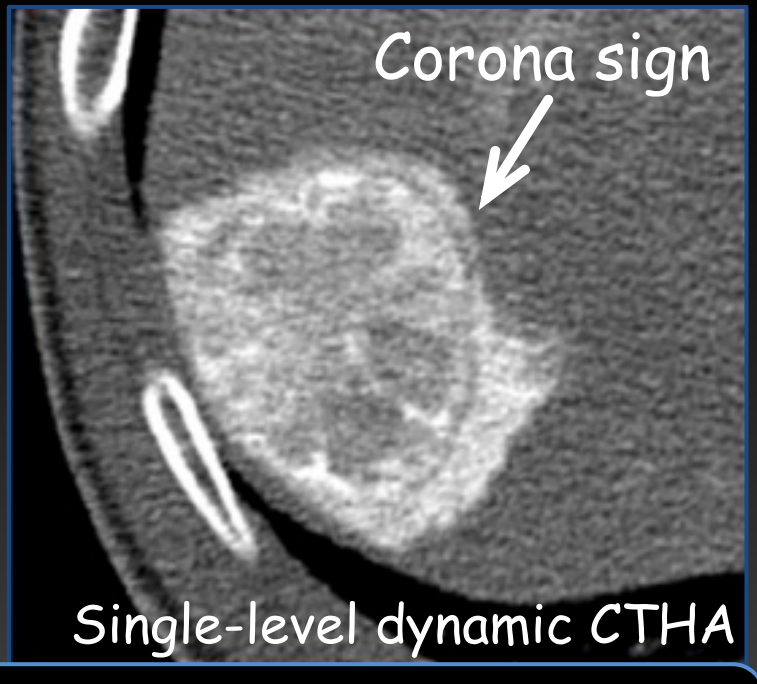
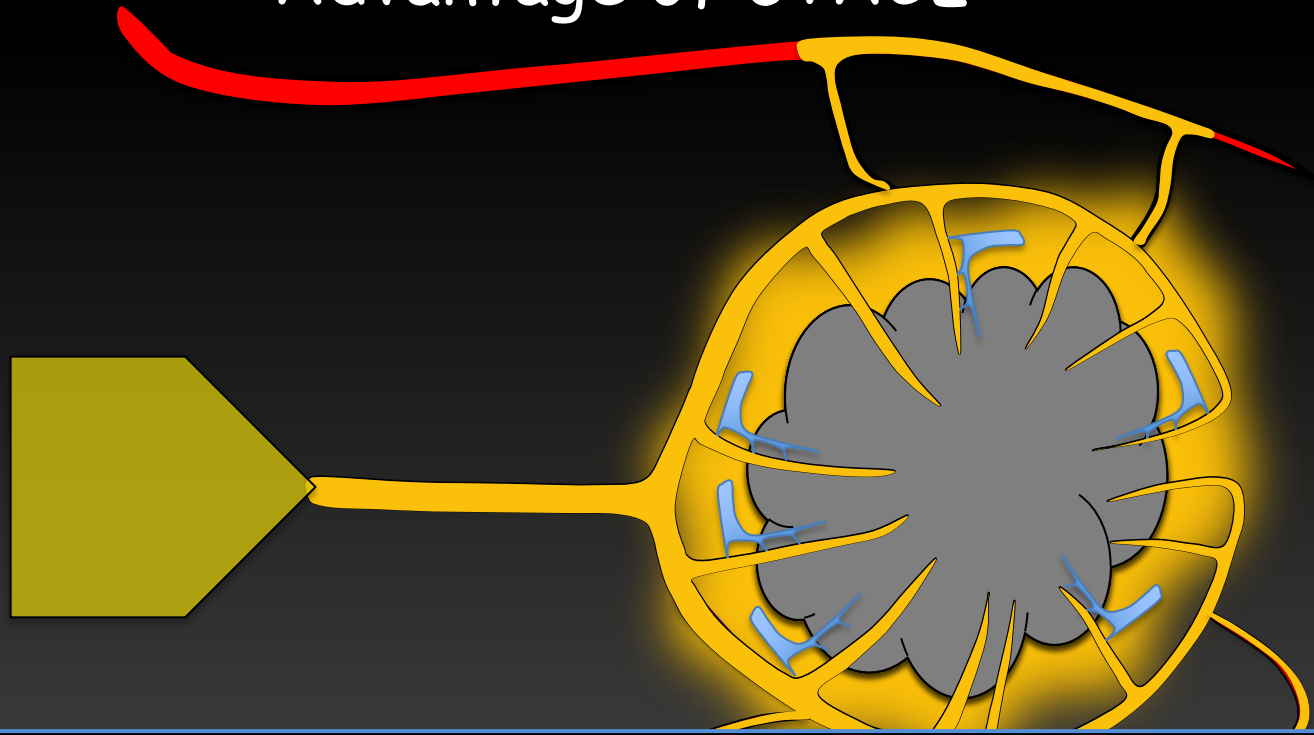
Anatomy and Hemodynamics of HCC





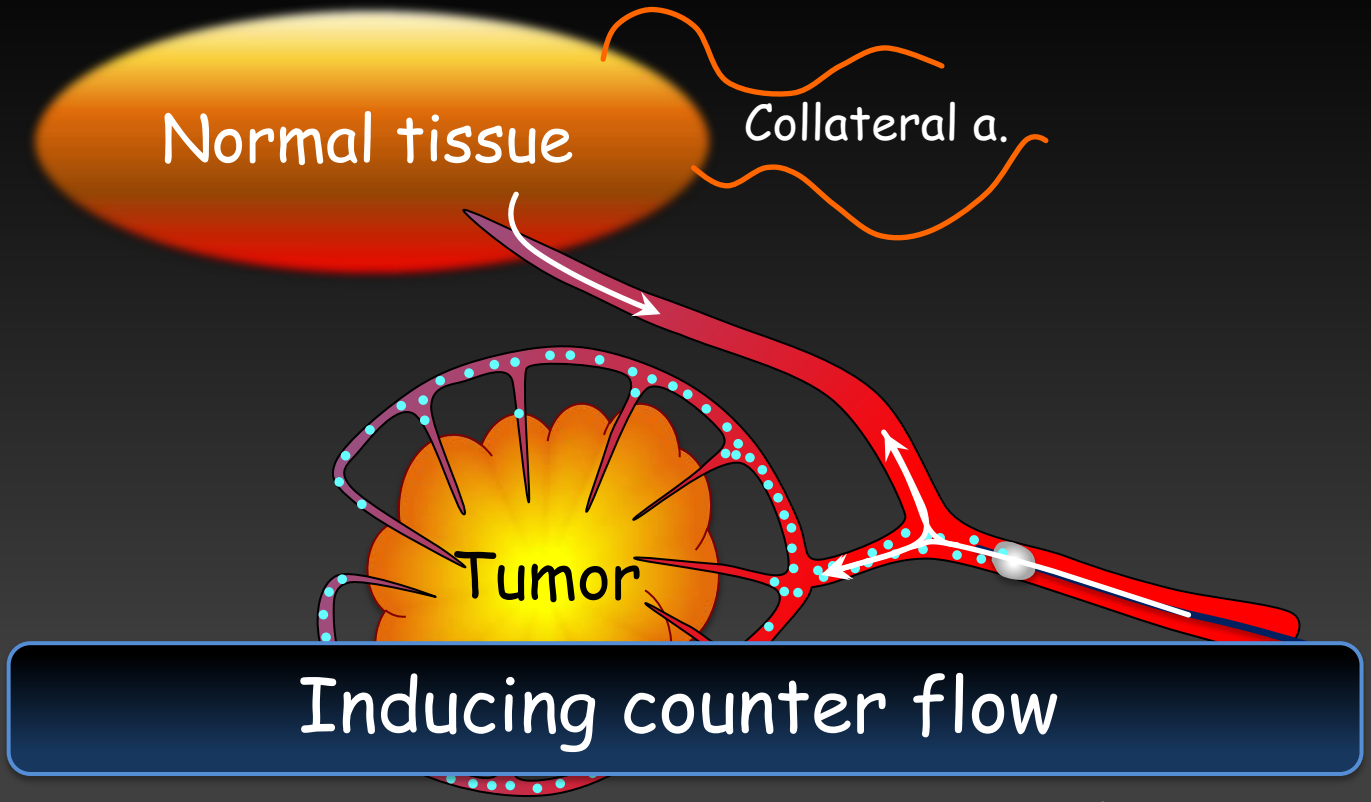
Not always, but sometimes PVs can supply blood to HCC, especially when HA embolized.

Advantage of cTACE



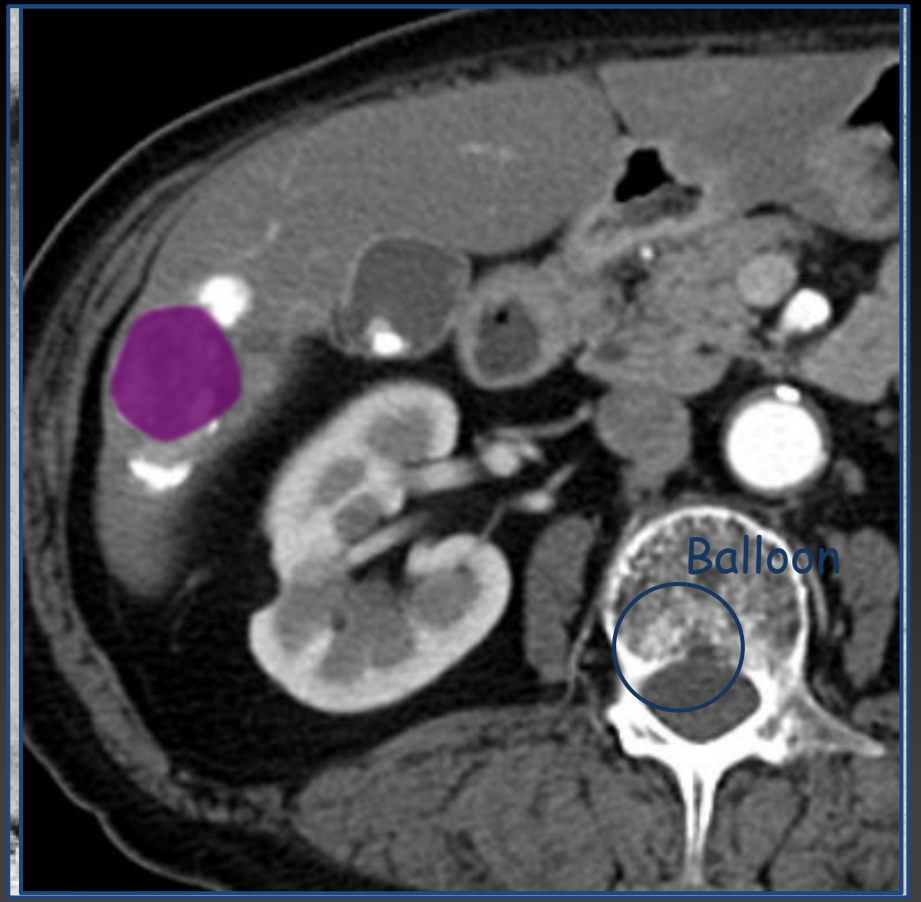
The advantage of cTACE is that lipiodol can also embolize PVs/sinusoids and leads complete shutdown of blood supply.

Technical Pearl #1



Inducing counter flow

Using a Micro-Balloon Catheter-Induced Counter Flow



(Courtesy: Dr. Shiro Miyayama)

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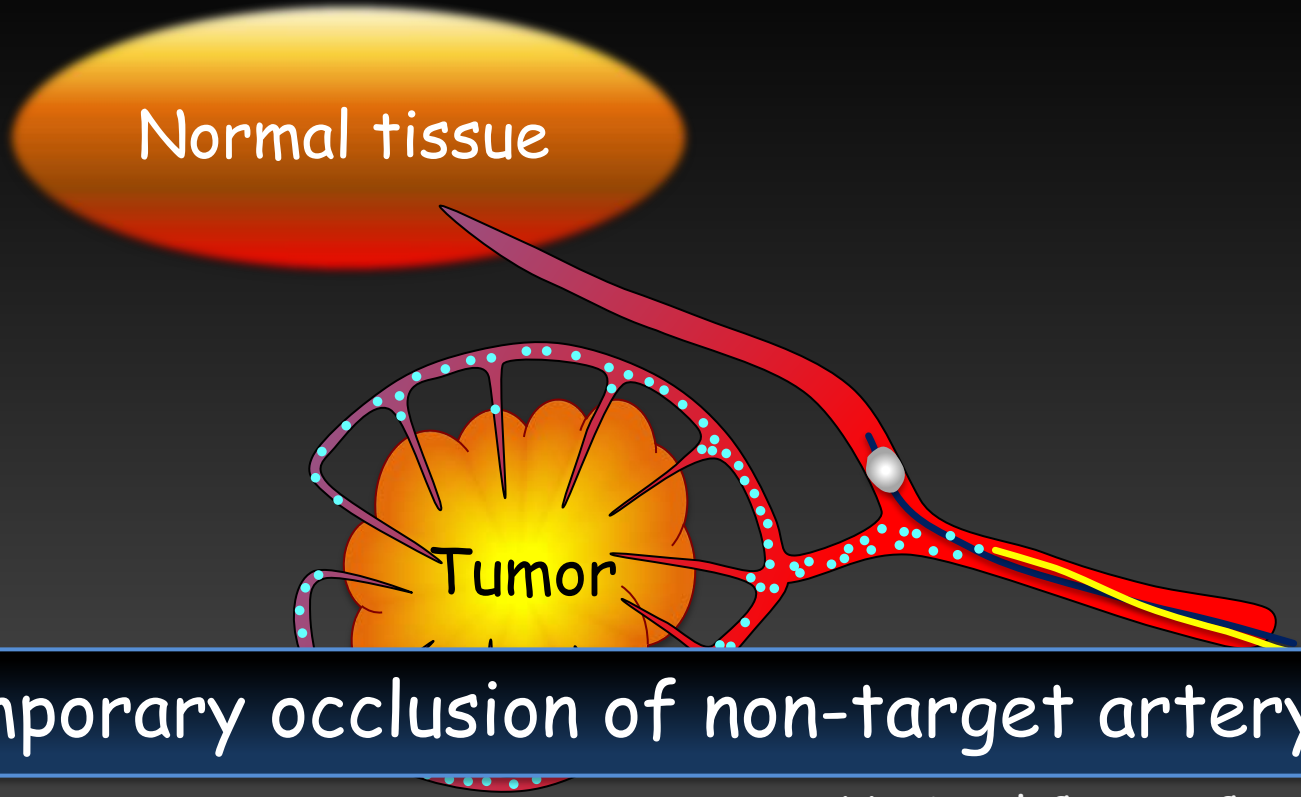
Technical Pearl #2



Temporary occlusion of non-target artery

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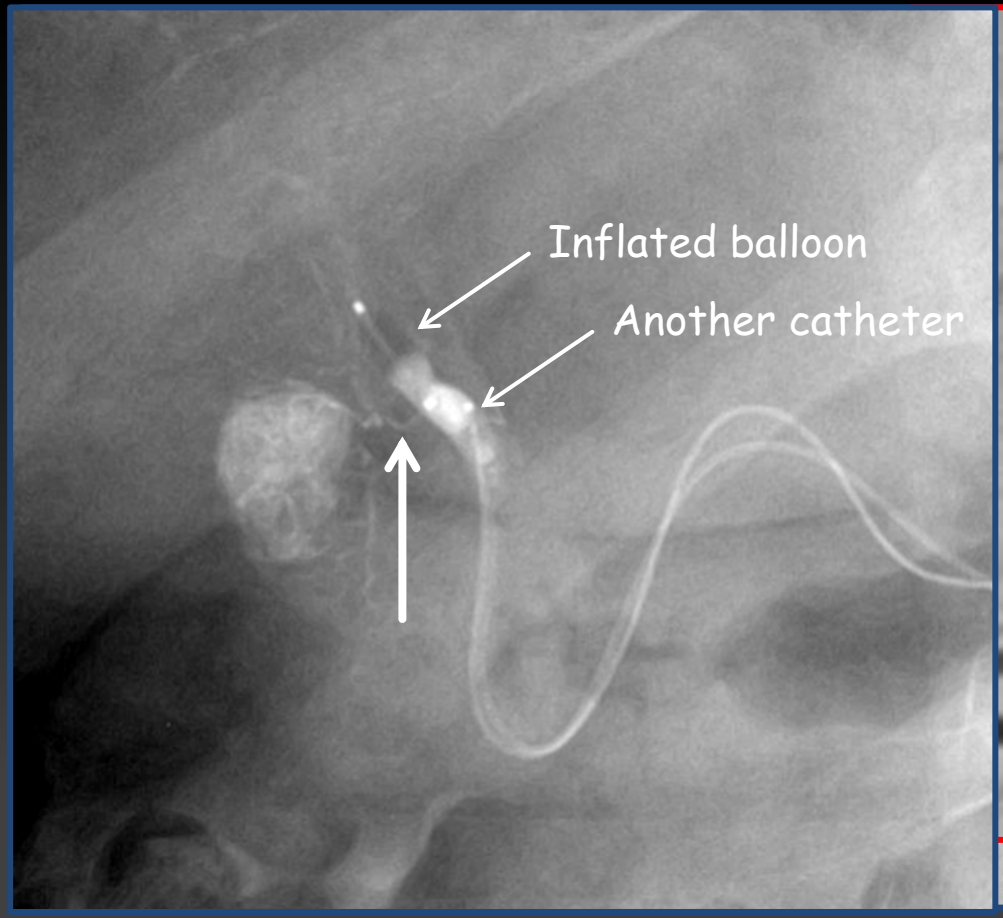
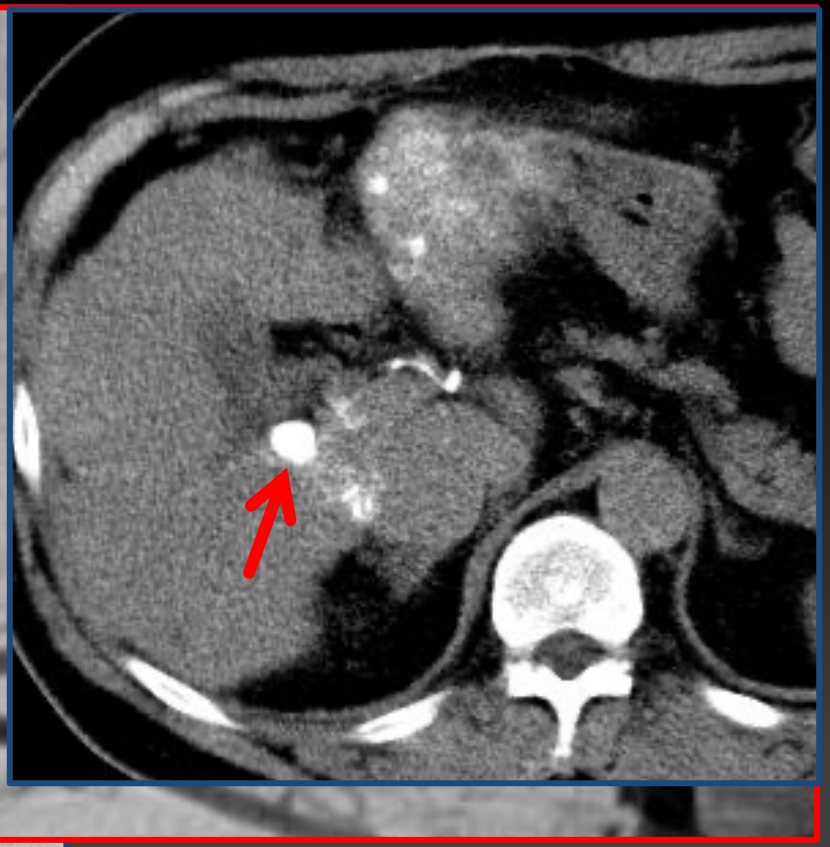
Temporary Occlusion of Non-Target Artery





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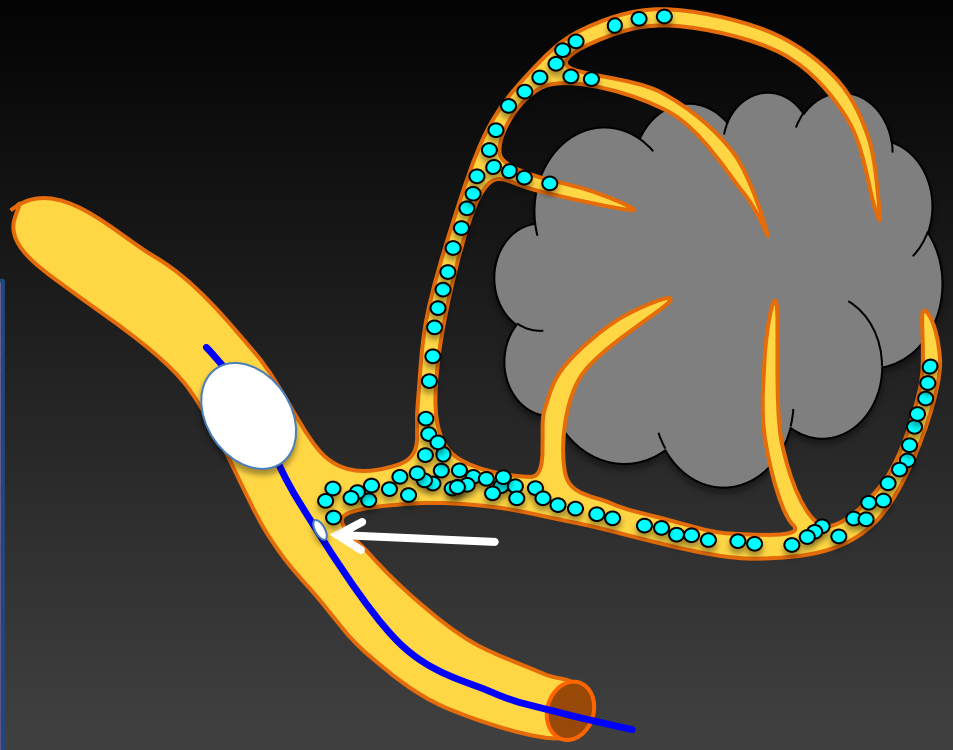
Side-Holed Micro-Balloon Catheter



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Temporary Occlusion of Non-Target Artery

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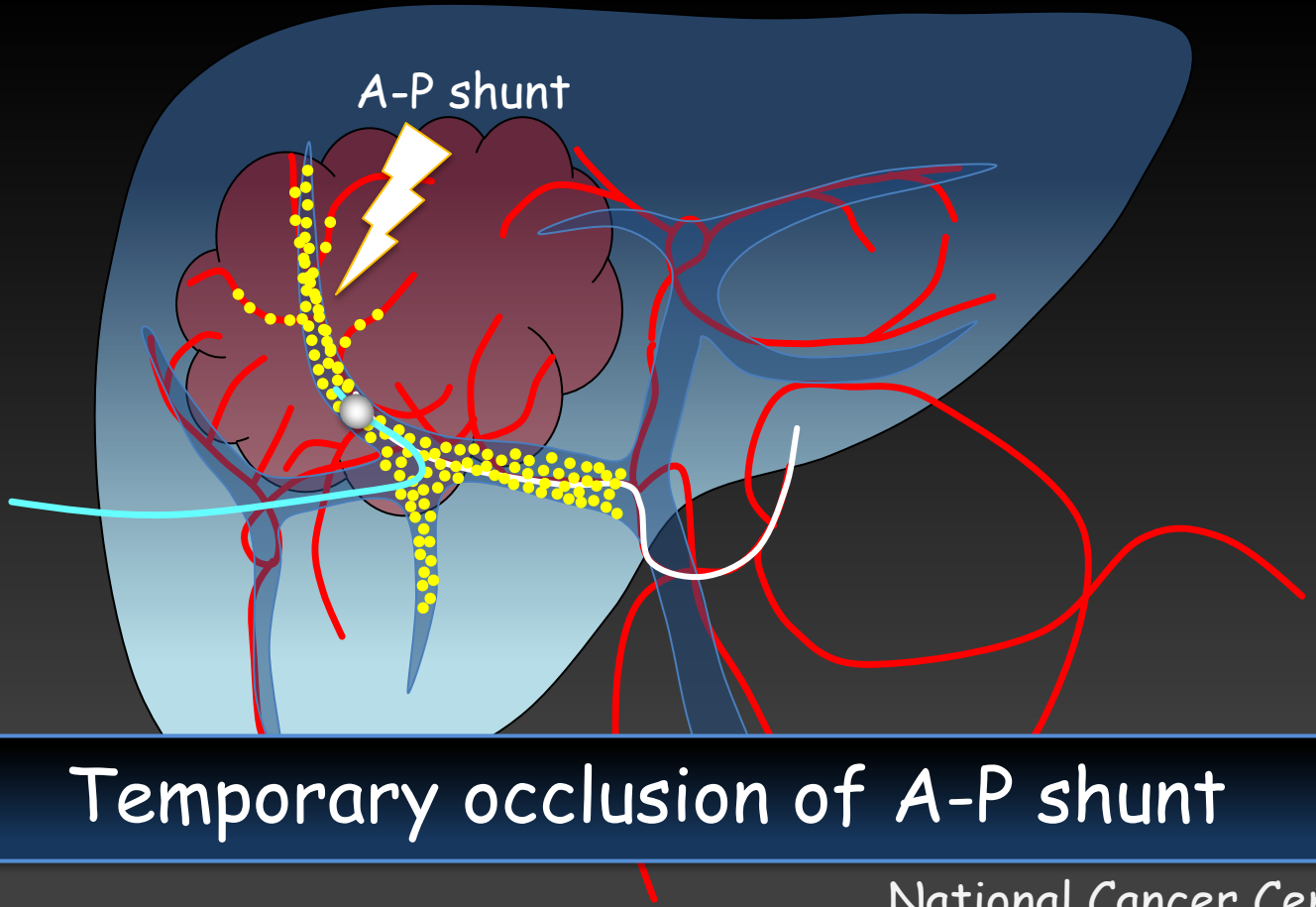
Technical Pearl #3



Temporary occlusion of A-P shunt

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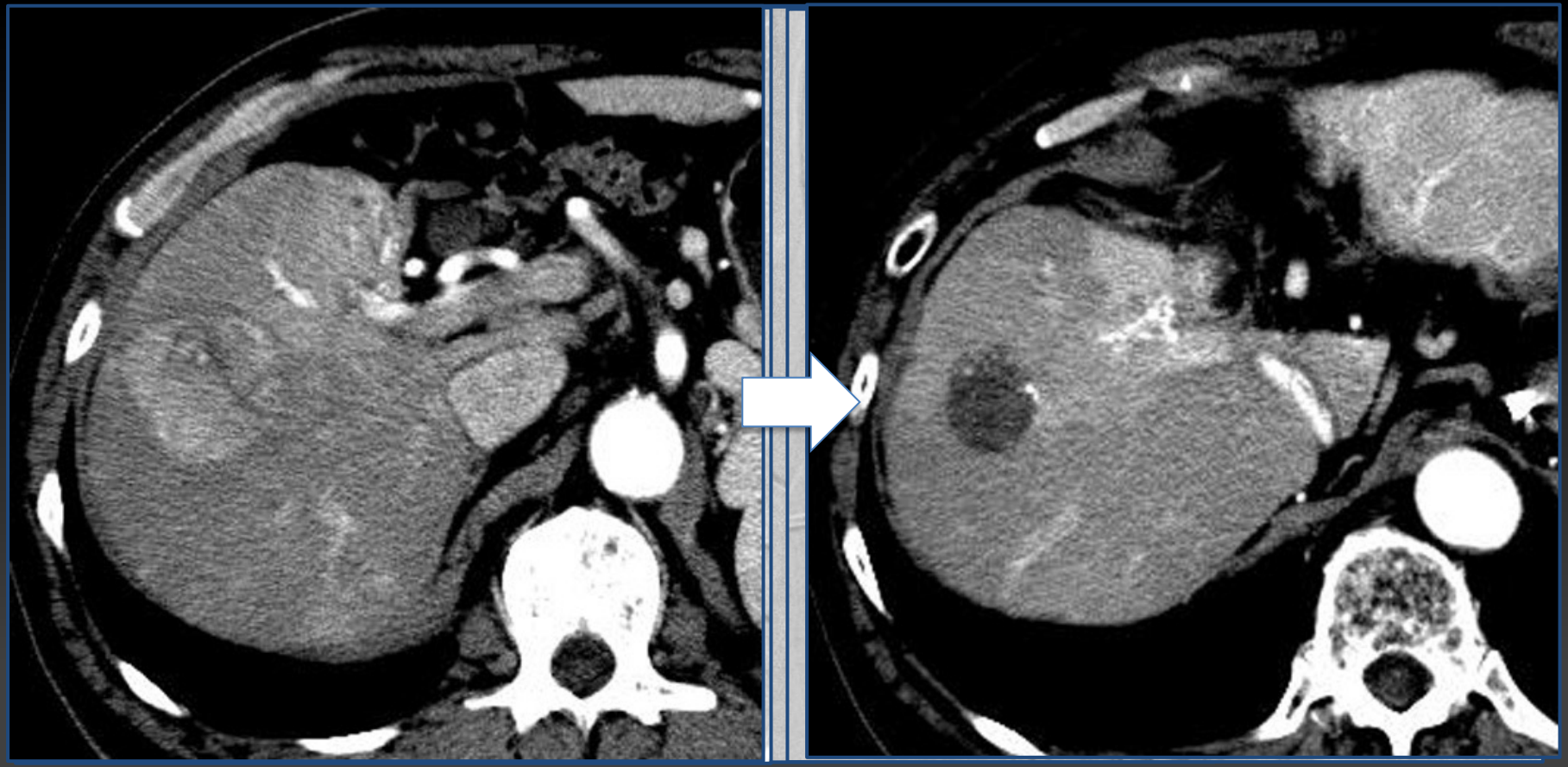
Temporary Occlusion of A-P Shunt



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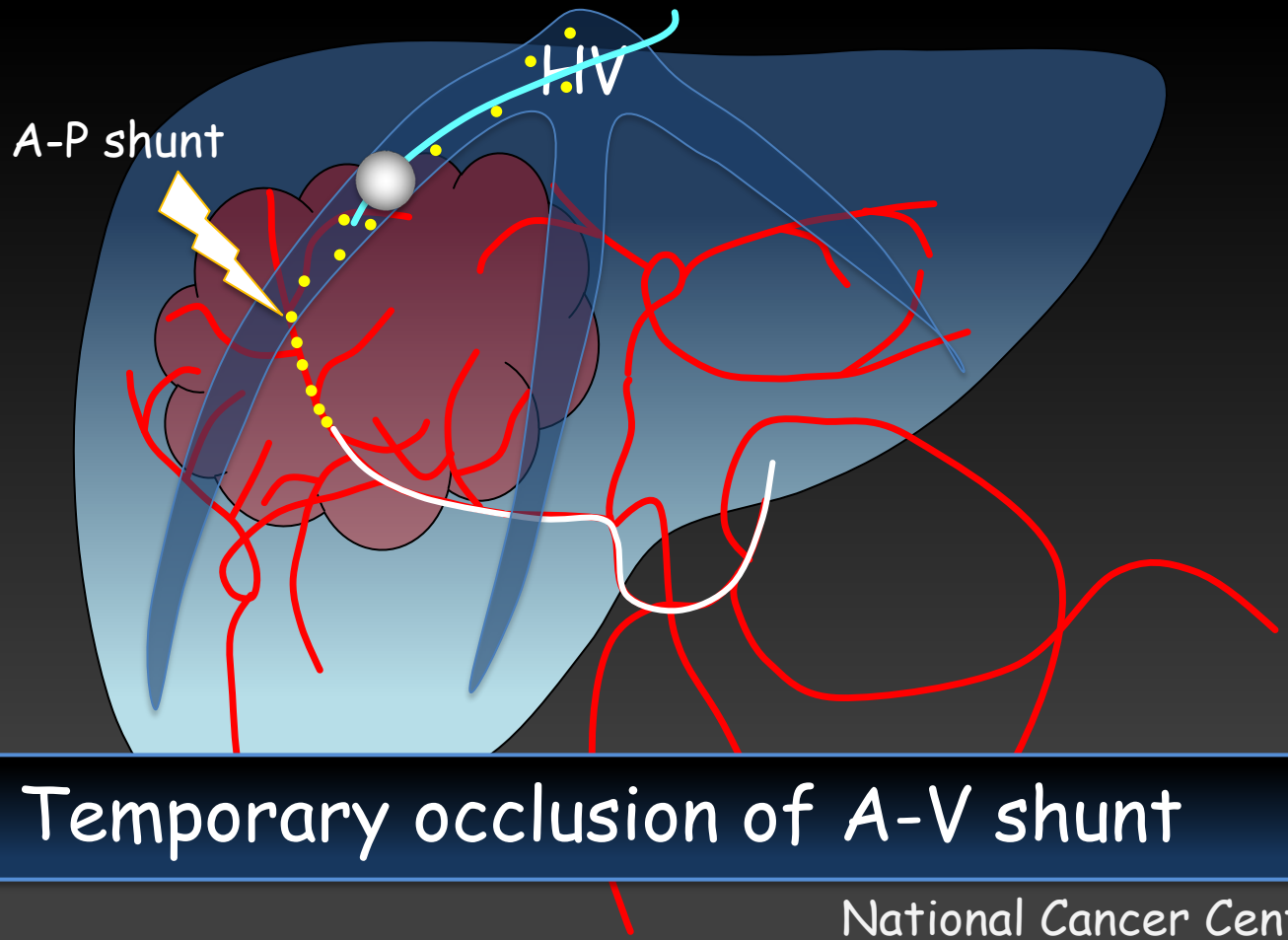
Technical Pearl #4



Temporary occlusion of A-V shunt

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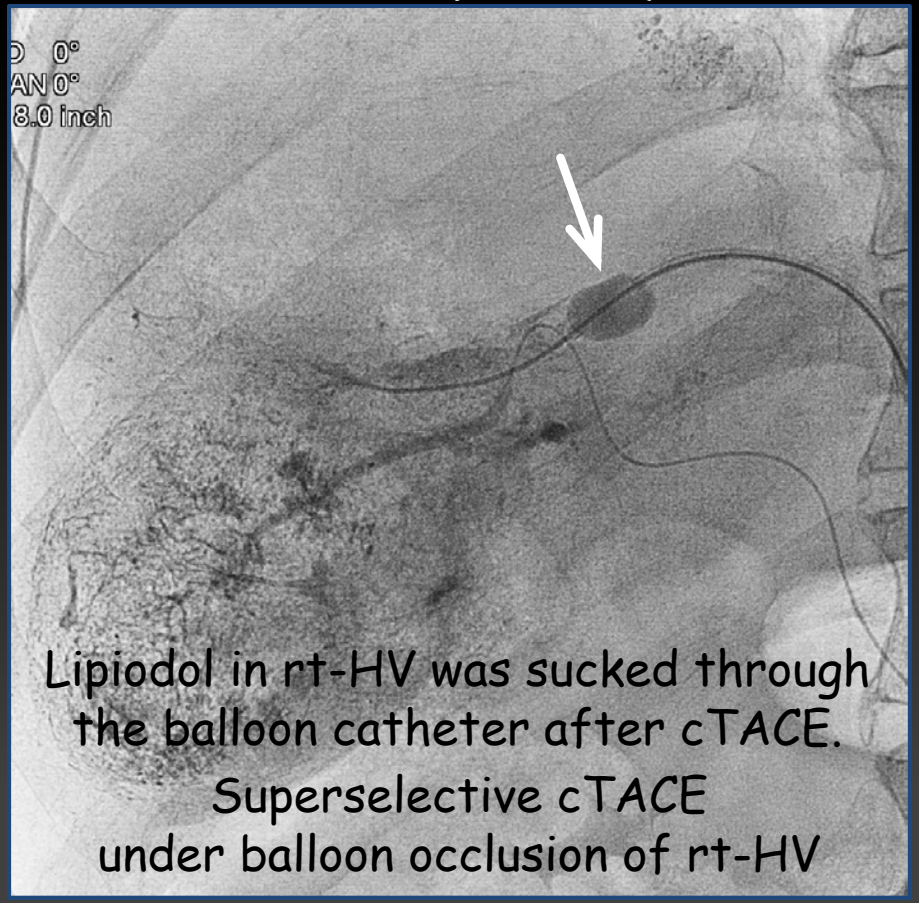
Temporary Occlusion of A-V Shunt



Lipiodol in rt-HV was sucked through the balloon catheter after cTACE.

Superselective cTACE
under balloon occlusion of rt-HV

(Courtesy: Dr. Shiro Miyayama)

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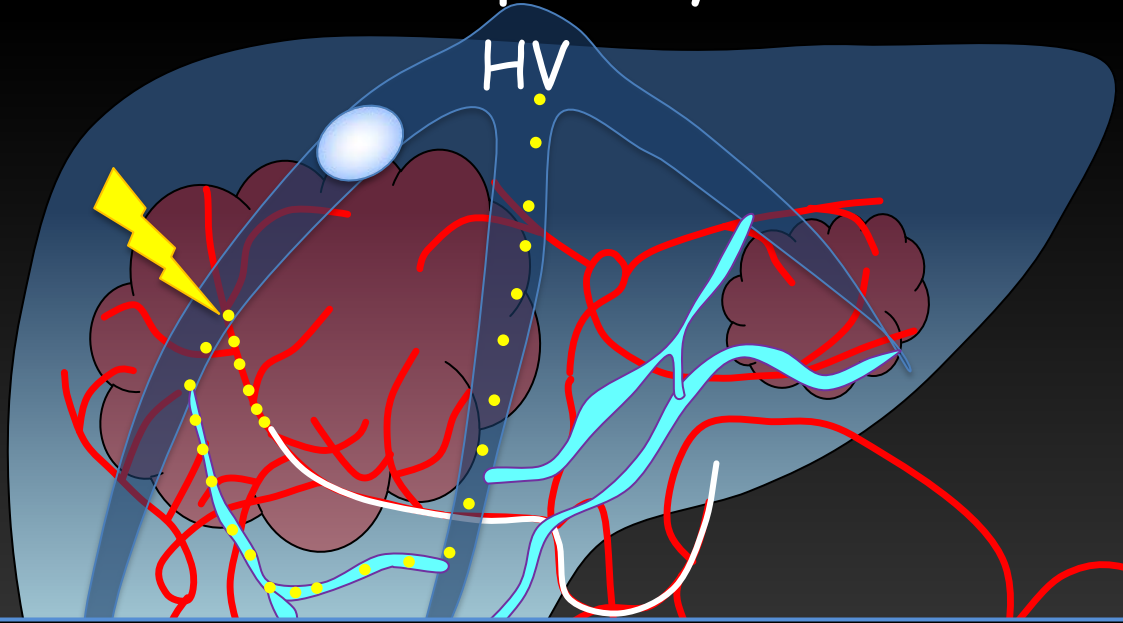
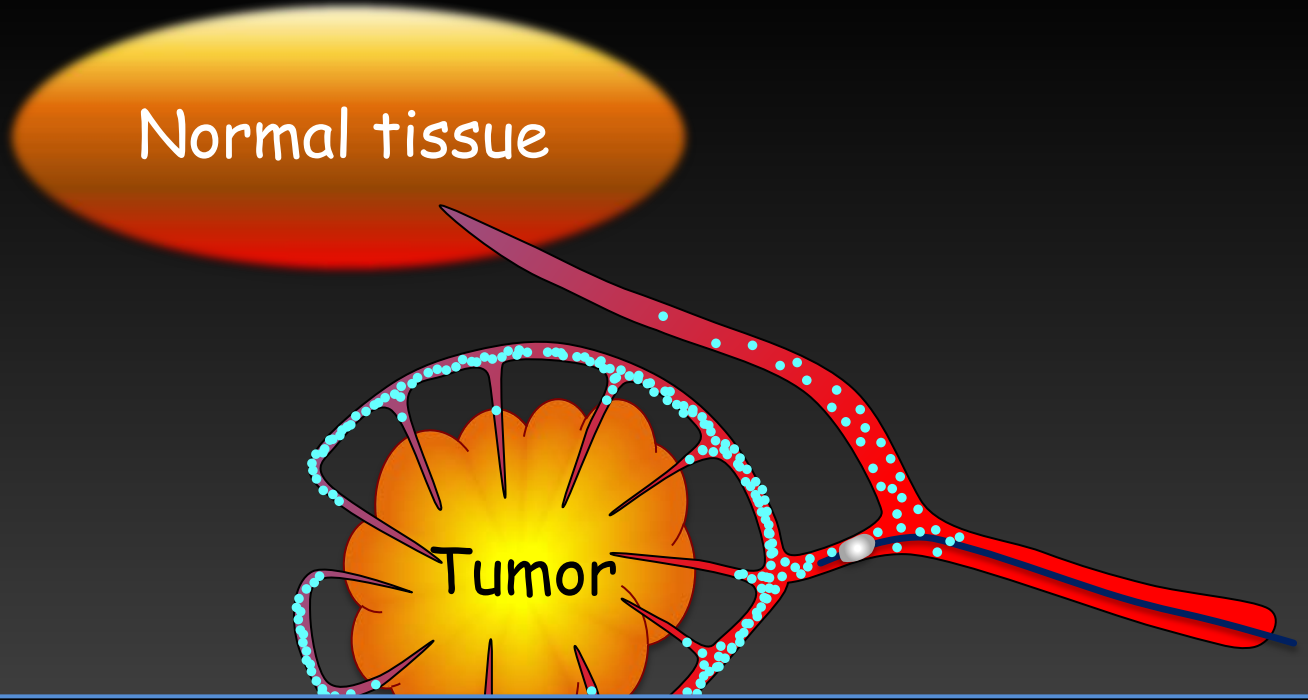
Pitfall in Temporary Occlusion of A-V Shunt



Caution !

HV occlusion cannot avoid completely the migration of embolic materials into the systemic circulation.

Technical Pearl #5



Forced injection without reflux

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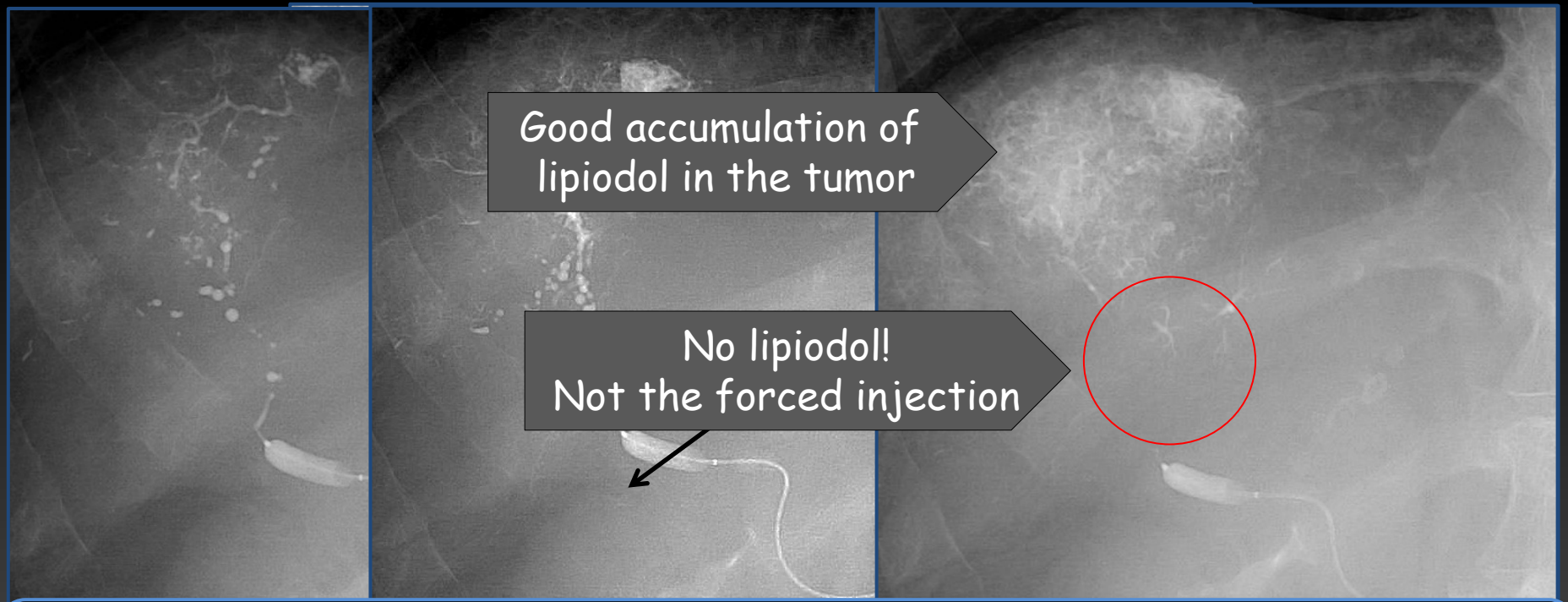
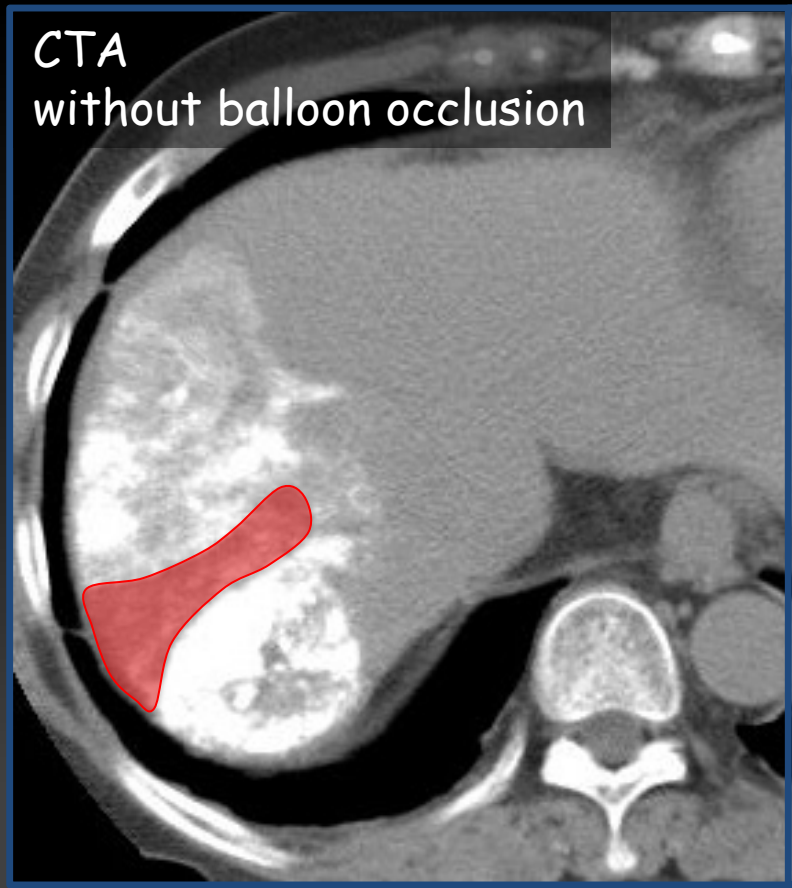
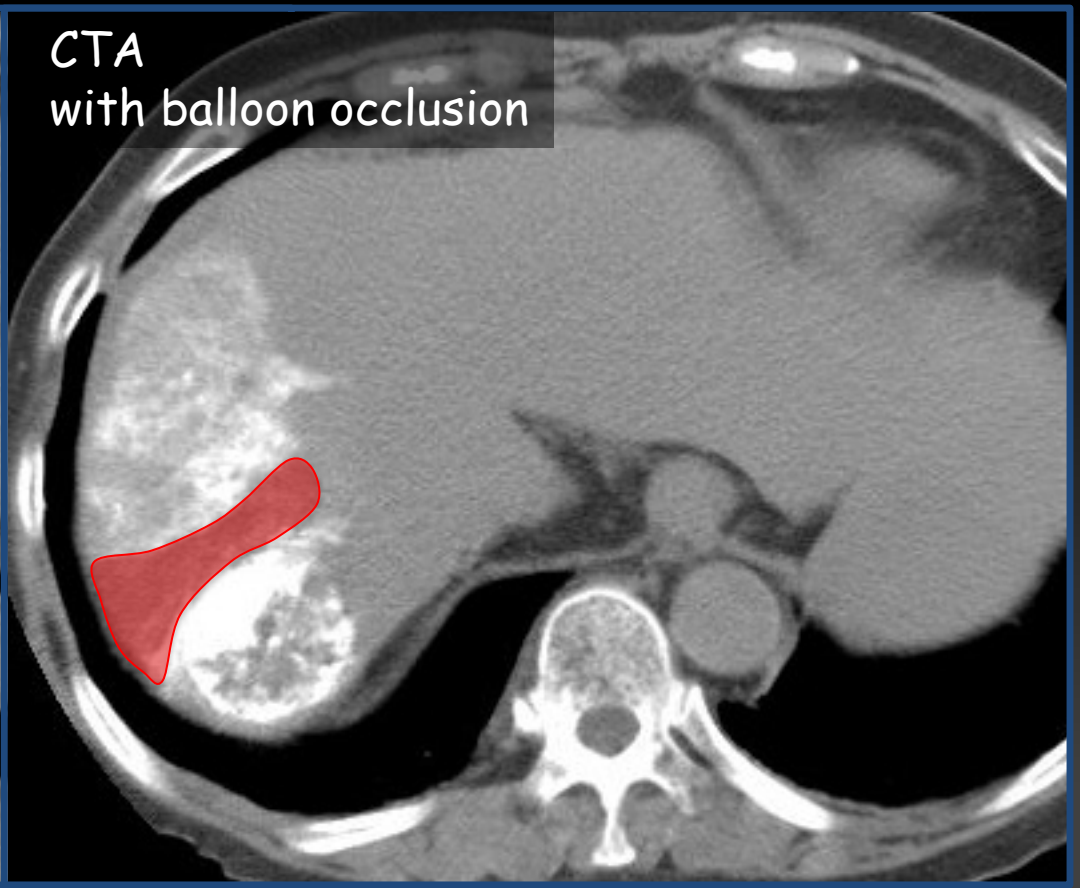
cTACE with Balloon Occlusion of the Feeding Artery



Lipiodol naturally flowed into the tumor.
Why ?

Why Flow Remains After Balloon Occlusion ?





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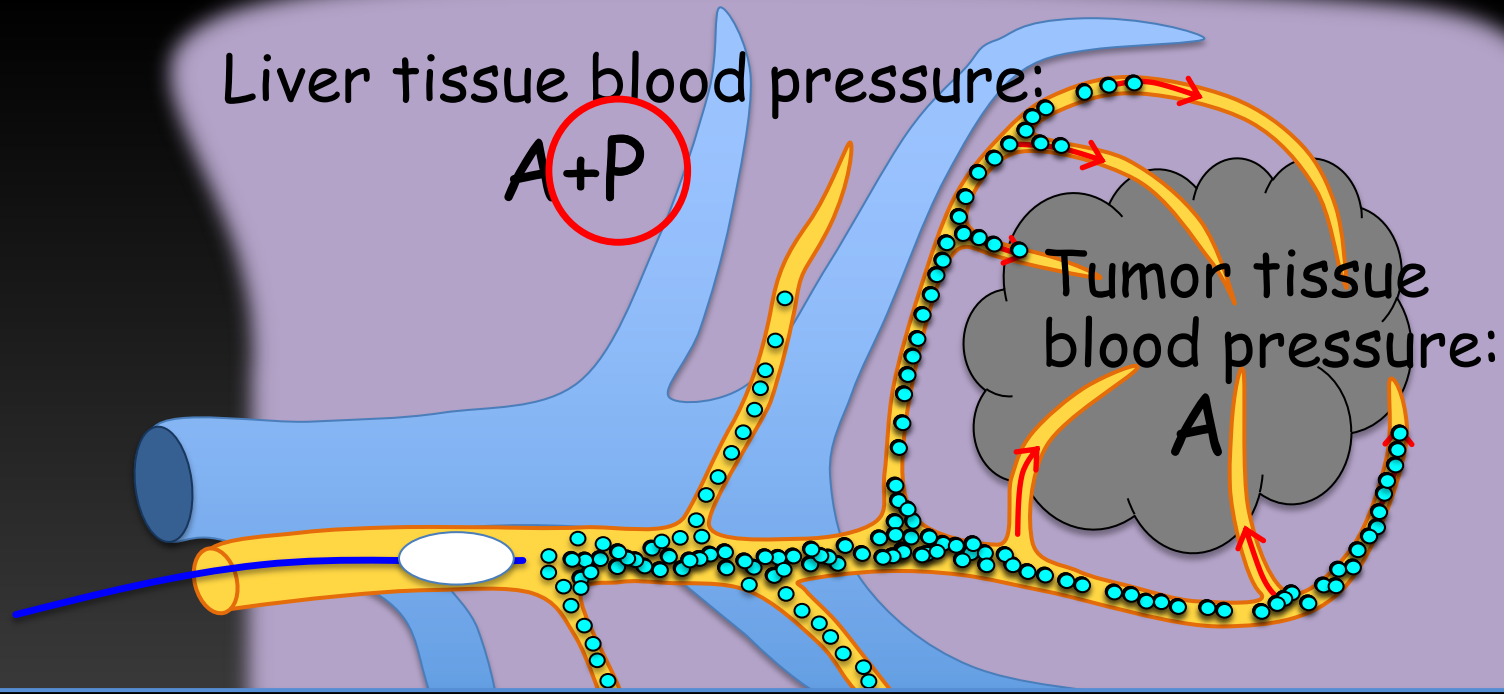
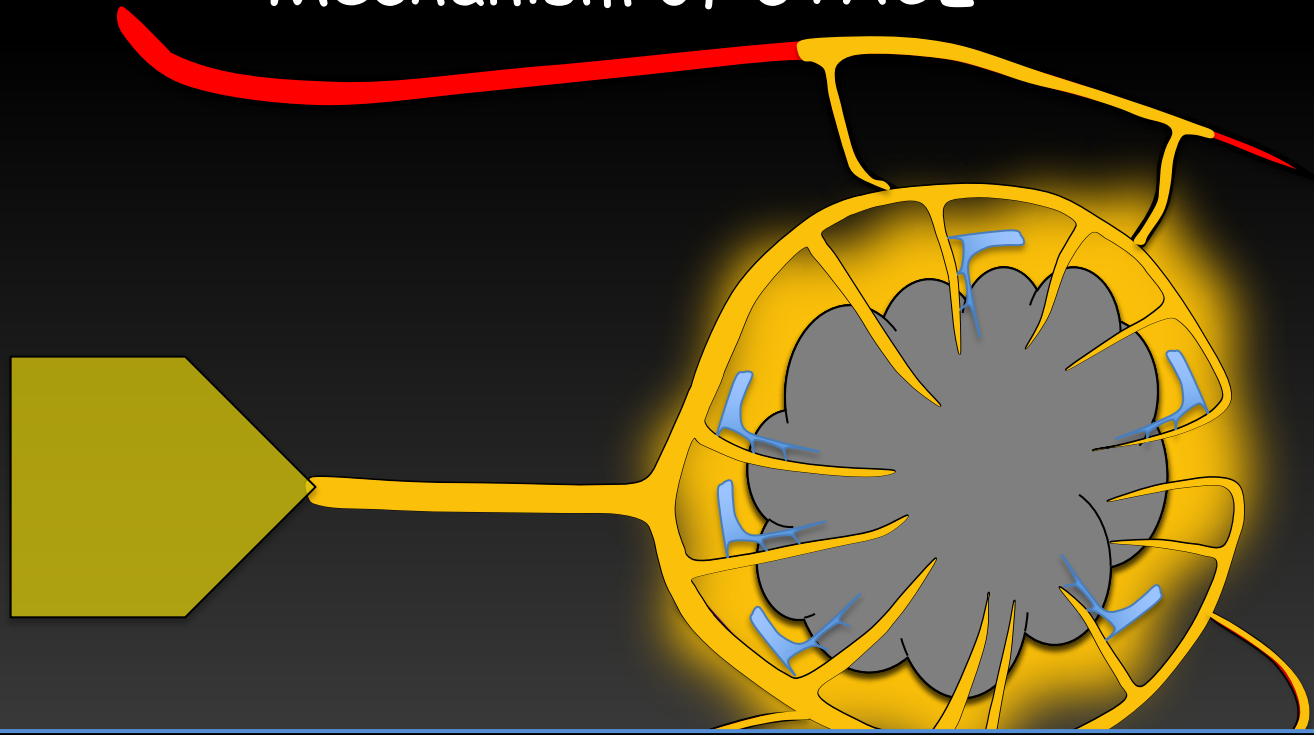
Why Flow Remains After Balloon Occlusion ?



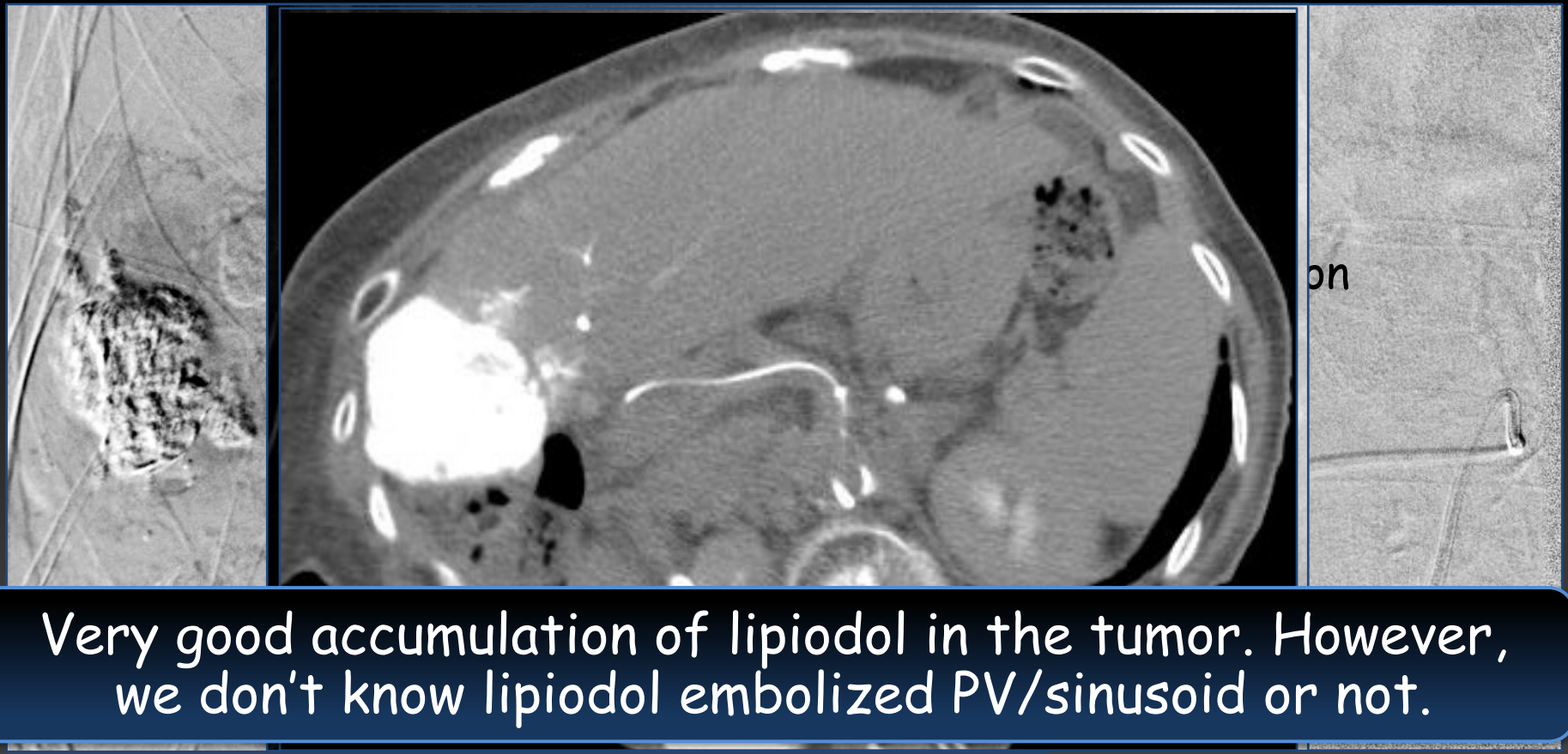
The mechanism of dense lipiodol accumulation in HCC under balloon occluded TACE has not been revealed yet

Mechanism of cTACE



The advantage of cTACE is that lipiodol can reach PVs/sinusoids. But, how is it under balloon-occluded TACE ?

Balloon-Occluded cTACE



Very good accumulation of lipiodol in the tumor. However, we don't know lipiodol embolized PV/sinusoid or not.

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Reported Clinical Outcomes of "Balloon-/Occluded TACE"

Report	N	Agent	Response	Survival
Hatanaka[1] (2018)	66	Miriplatin-Lip+GS	CR53%, RR63.6%	1y-76.8%, 2y-57.3%, 3y-46.7%
Kawamura[2] (2017)	30	Miriplatin-Lip+GS	TE4 51.0%, RR 59.6%	NA
Maruyama[3] (2016)	50	Epi-Lip+GS	BTACE>cTACE	NA
Irie[4] (2016)	28	Dox+MMC-Lip+GS	TE4 89.3%, RR 100%	1y-96.4%, 3y-60.3%, 5y-31.1%
Asayama[5] (2016)	29	Miriplatin-Lip+GS	TE4 8.6%, RR 57.1%	NA
Ogawa[6] (2015)	33	Miriplatin-Lip+GS	TE4 49.2%	NA
Minami[7] (2015)	27	Miriplatin-Lip+GS	TE4 43.8%, RR 56.3%	NA
Arai[8]	49	Miriplatin-Lip+GS	TE4 55.1%, RR 93.9%	NA

No robust positive data of balloon-occluded TACE.
B-TACE without deep consideration may lead to worse results.

1) Hepatol Res. 2018;48:165–175. 2) Hepatol Res. 2017;47:338–346. 3) Cardiovasc Intervent Radiol. 2016;39:359–366. 4) Hepatol Res. 2016 Feb; 46(2):209-14. 5) Springerplus. 2016;5:157. 6) Hepatol Res. 2016;46:E60–E69. 7) Oncology. 2015;89 Suppl 2:27–32. 8) Hepatol Res. 2015; 45(6):663-6.

Summary

Techniques using balloon occlusion are very useful in TACE, at least, inducing counter flow, temporary occlusion of non-target artery, A-P shunt, and A-V shunt.

On the other hand, though, so called "balloon-occluded TACE" shows the good accumulation of lipiodol in the tumor, the clinical advantage is uncertain.

We should use balloon catheter with deep consideration and learn more from further investigations.

Thank you !

National Cancer Center, Japan

Radiation Segmentectomy & Lobectomy

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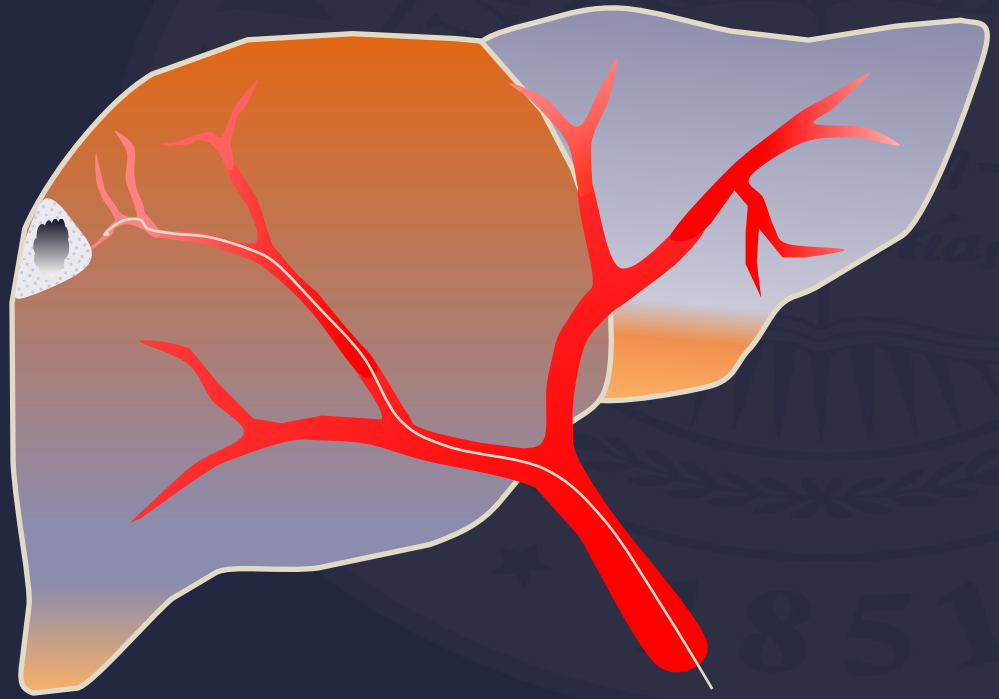
Professor of Radiology, Surgery, Medicine
Director of Interventional Oncology
Northwestern University (Chicago)

Disclosures

- Consultant: BSC, BD, Varian, ABK Medical, Alhambra Medical

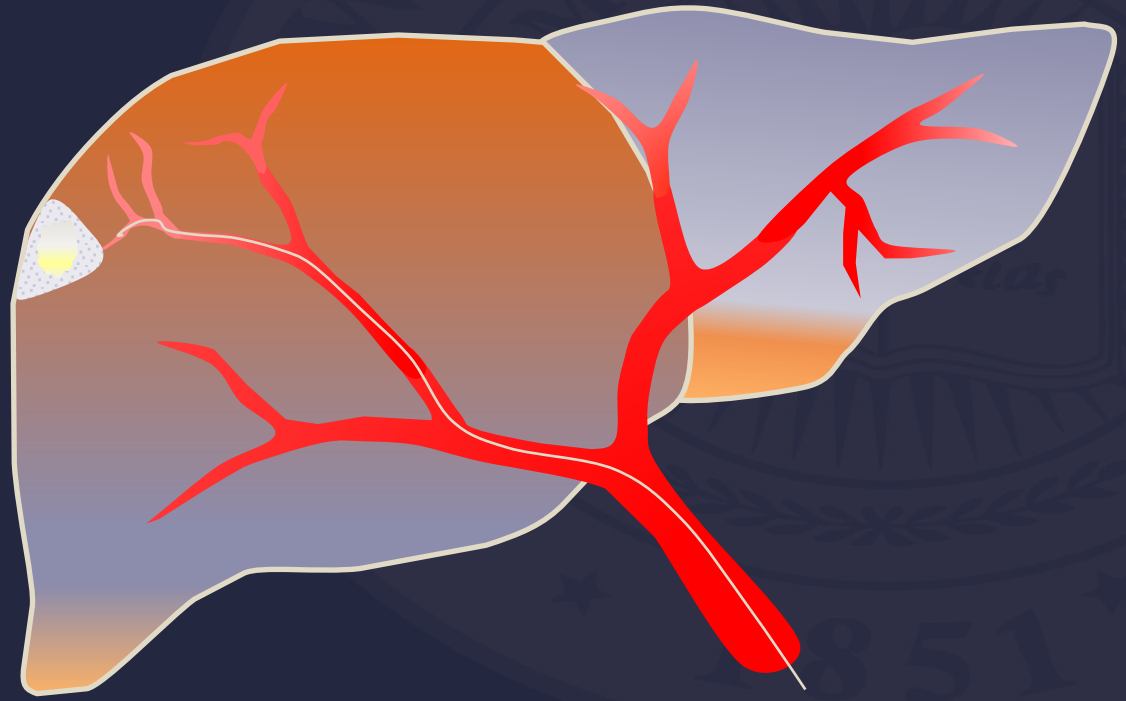
Radiation Segmentectomy

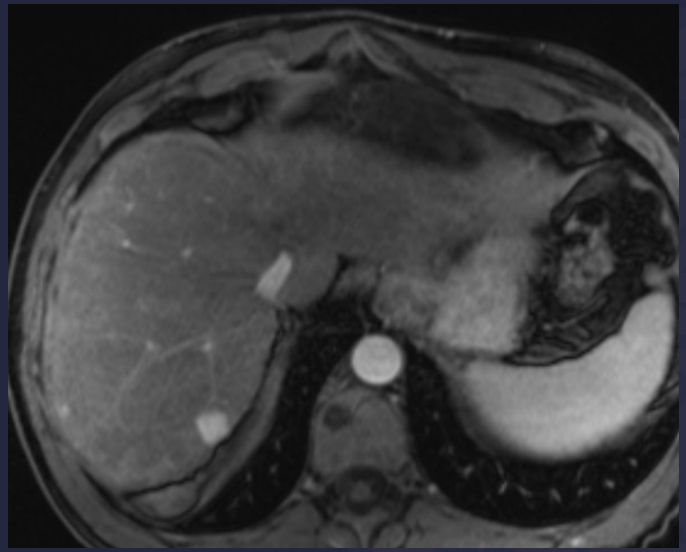
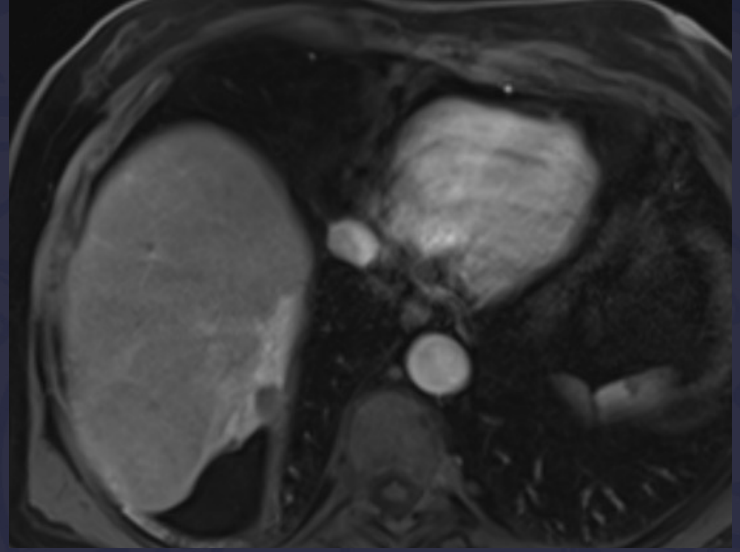
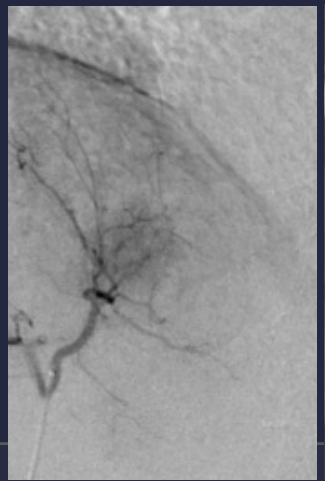
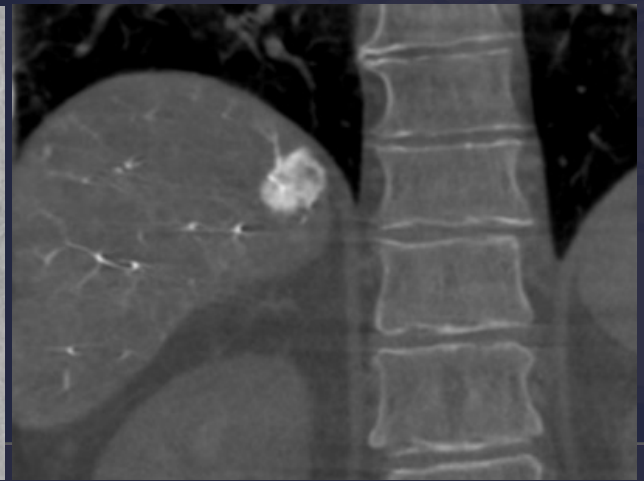
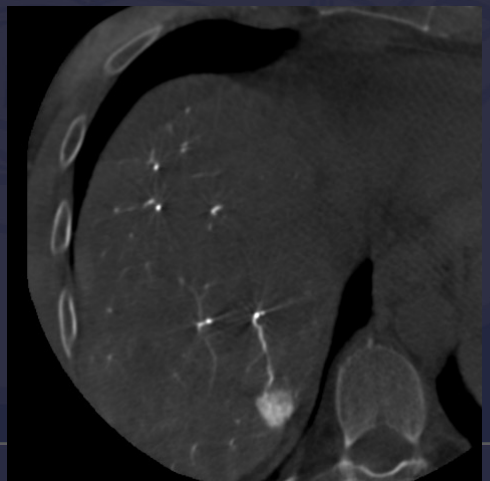


Images courtesy Pouya Entezari

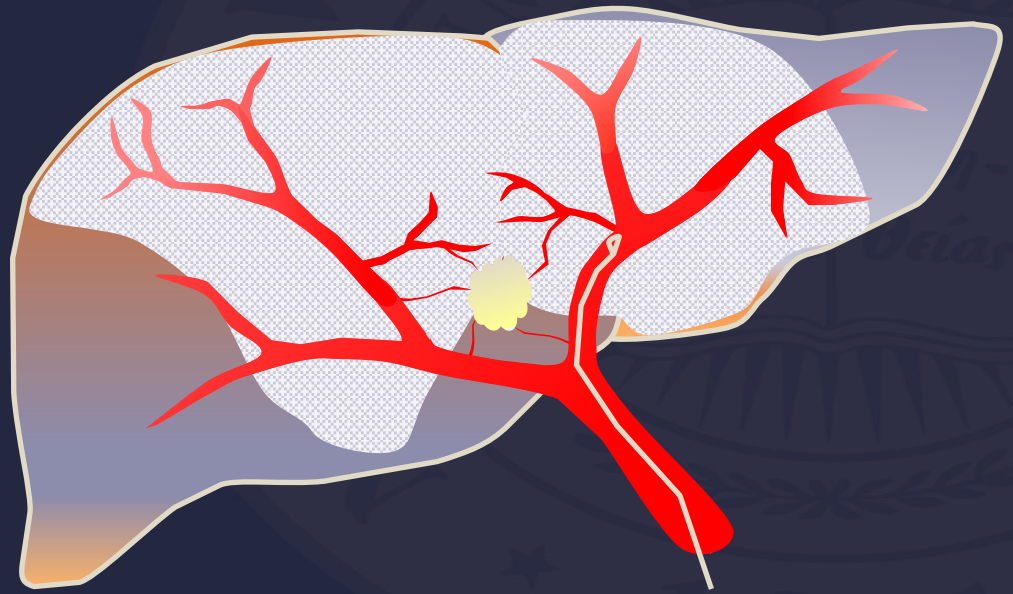
1. Tumor Location Is Important

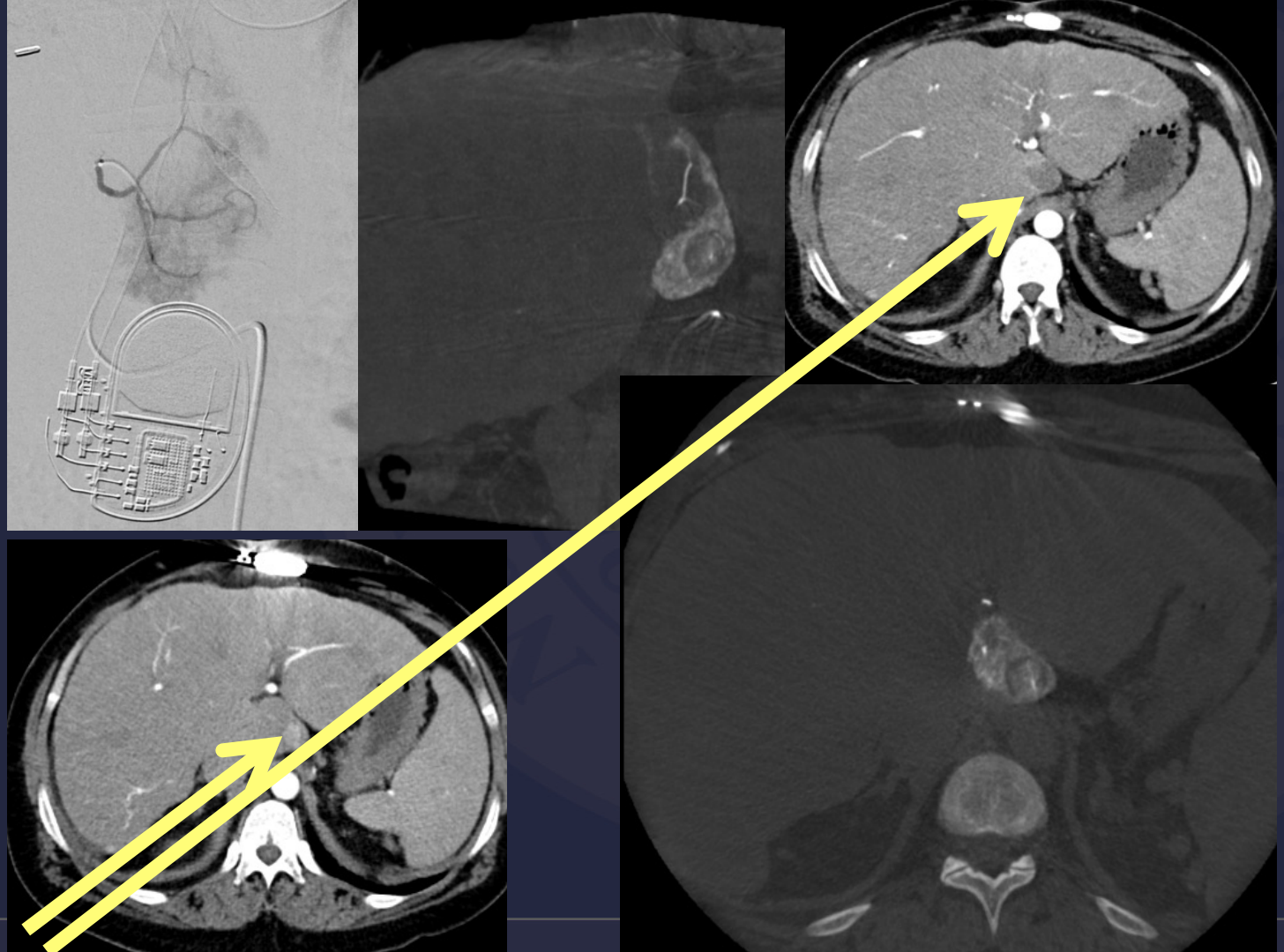
Peripheral Tumor



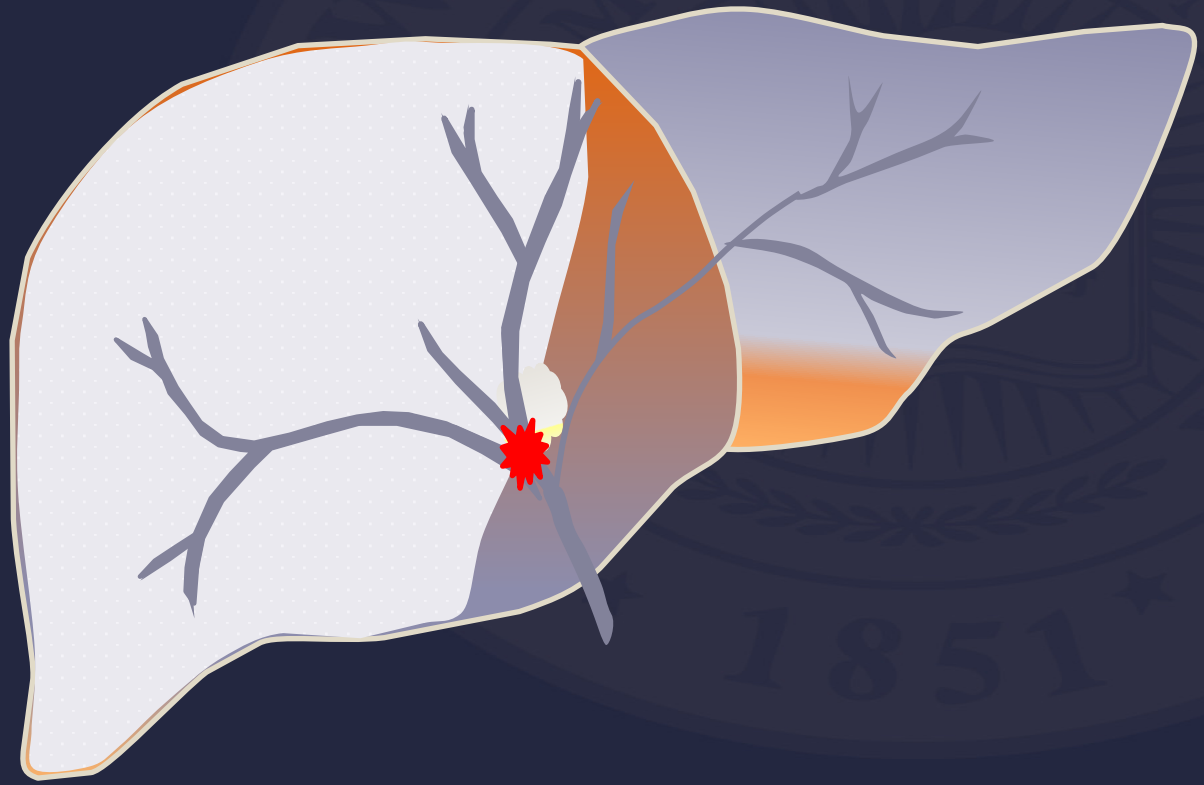






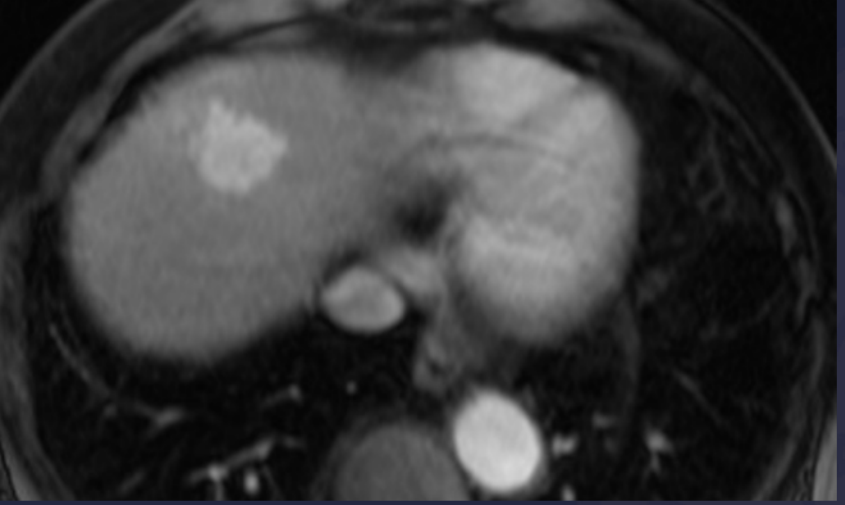
Central Tumor

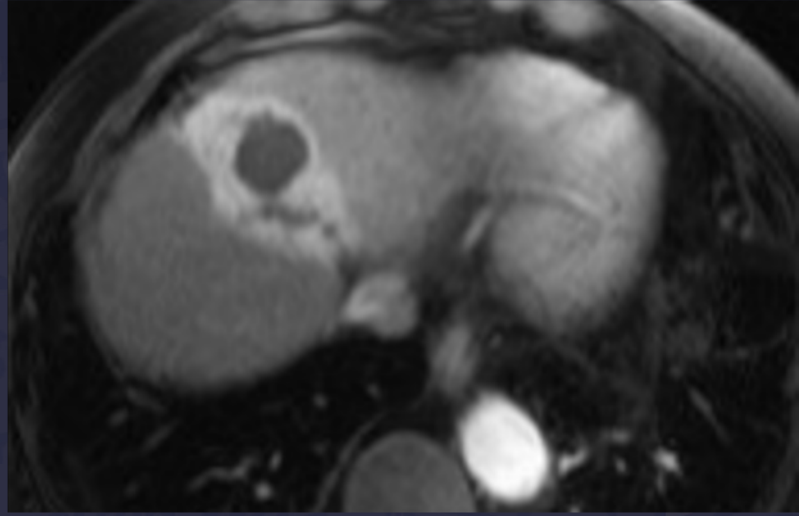


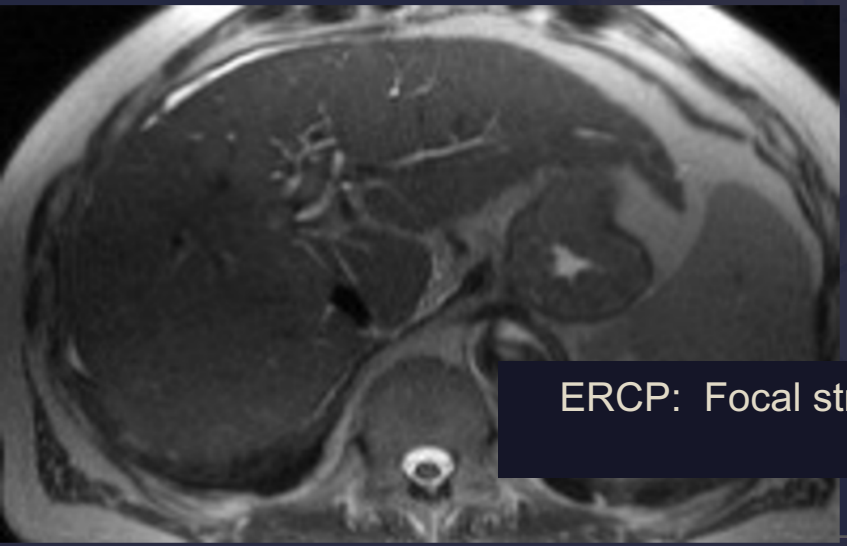


Central Tumor



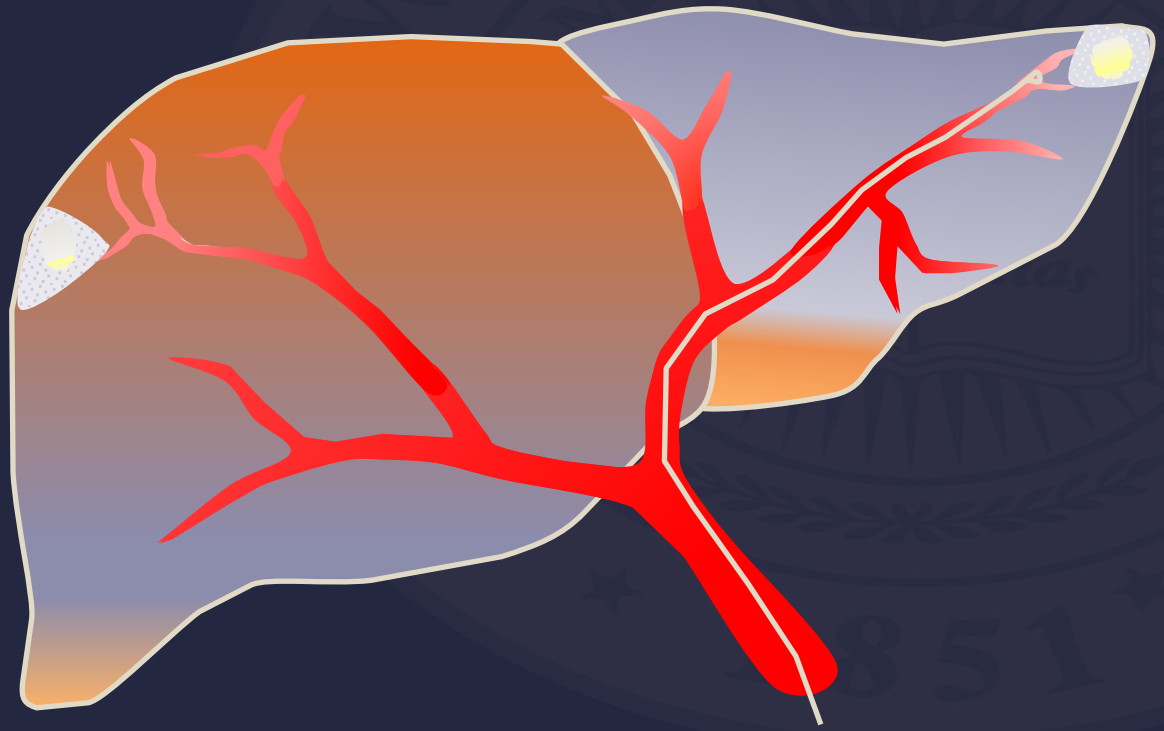






ERCP: Focal stricture origin left intra-hepatic duct

(Multiple) Peripheral Tumor(s)



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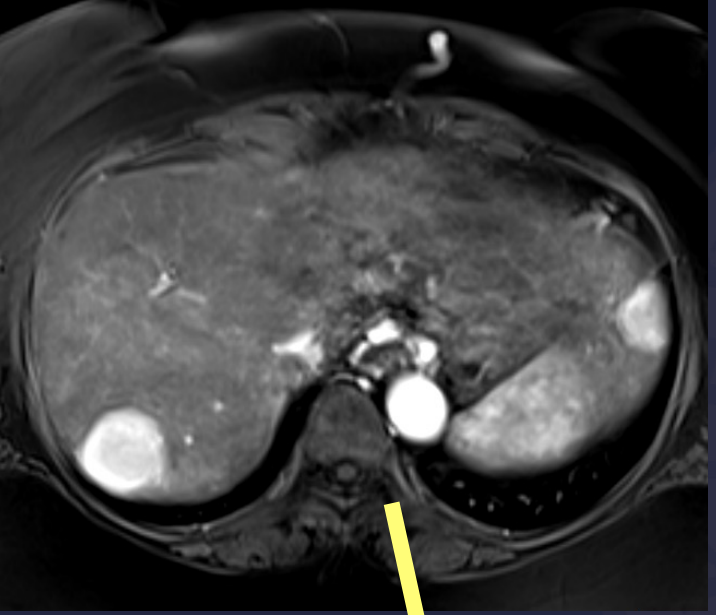
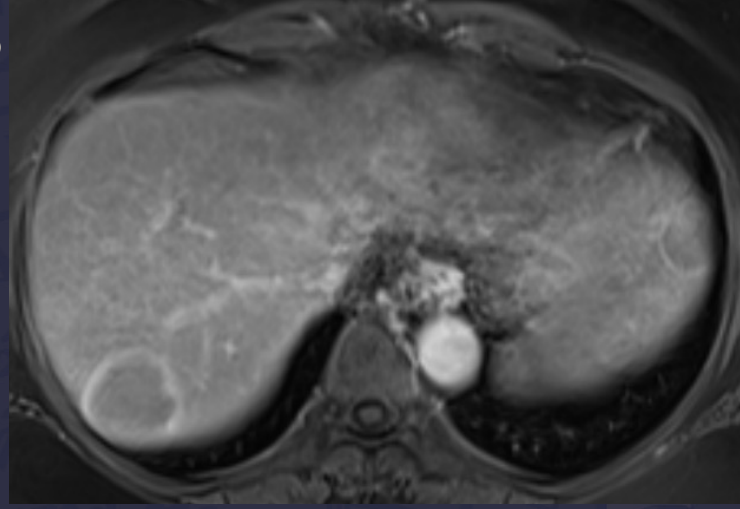
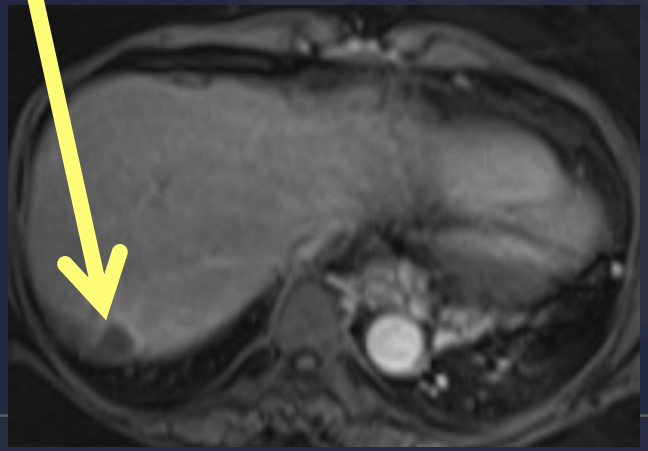
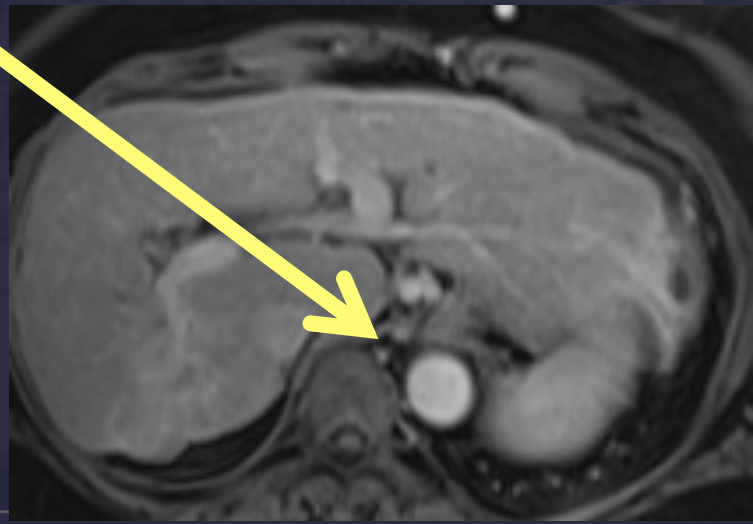
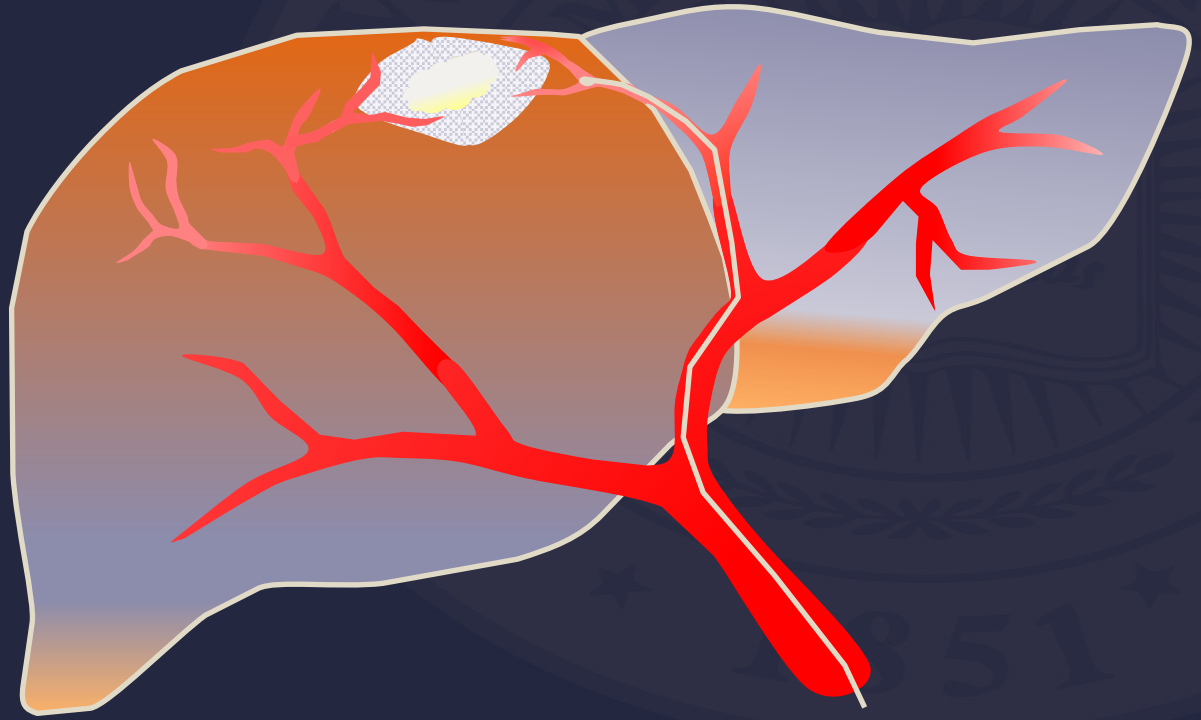


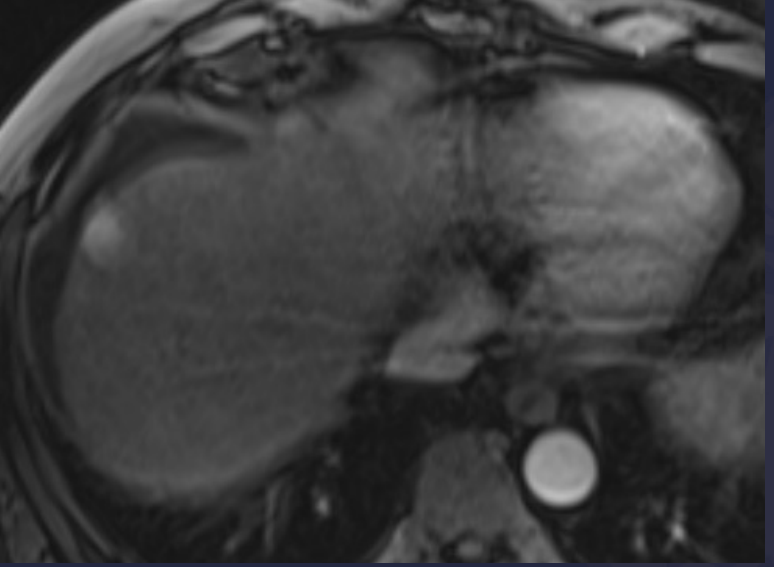




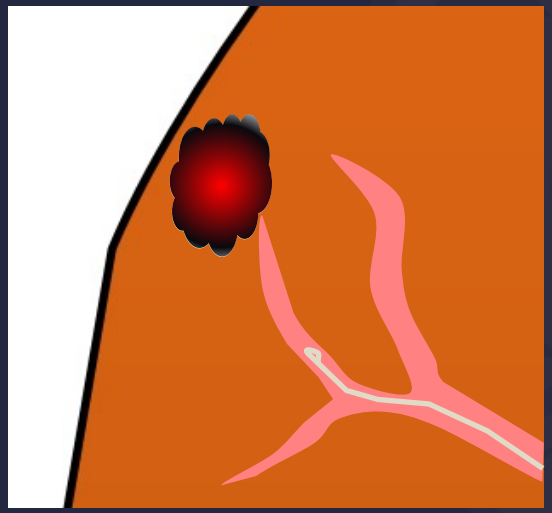


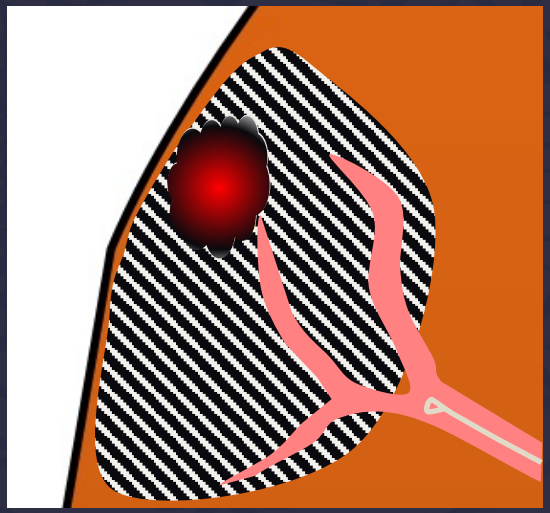
Watershed Tumor



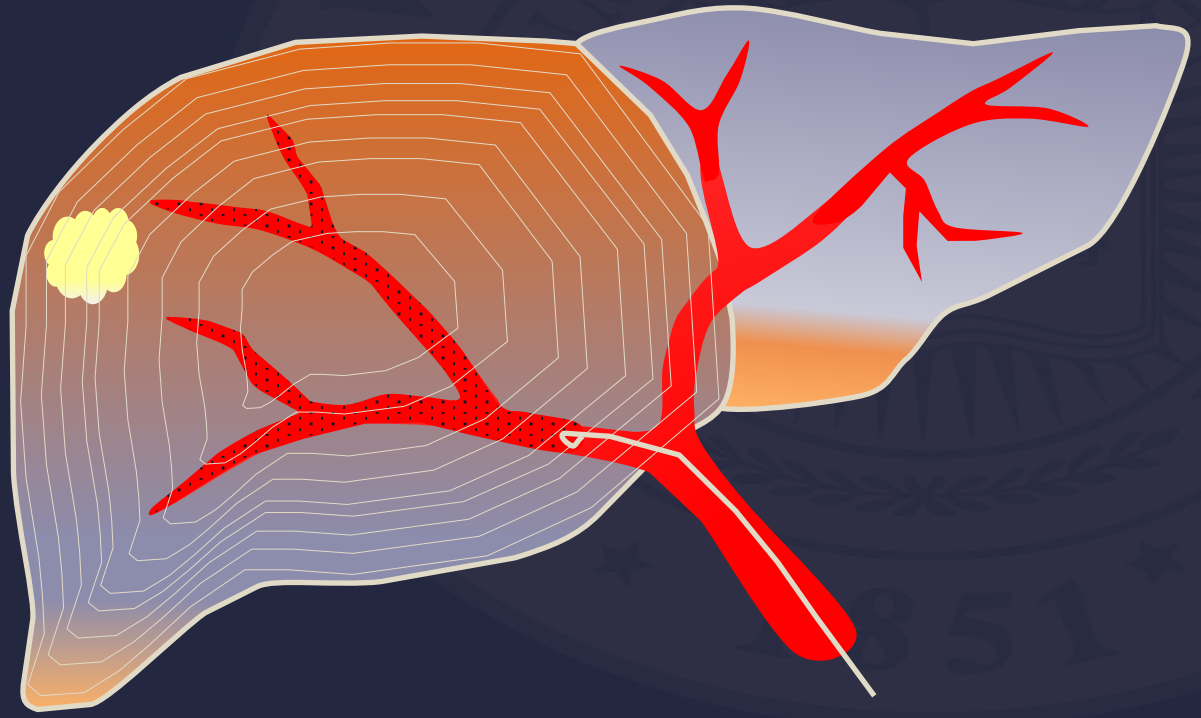


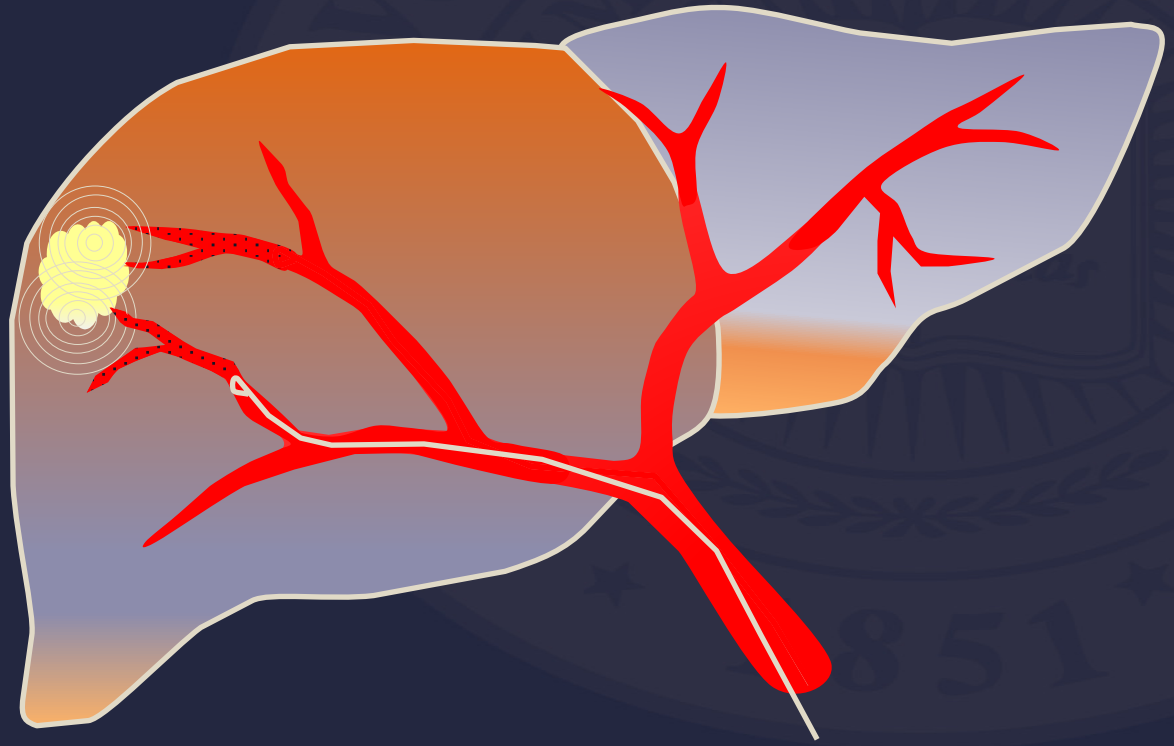
2. Margin Important

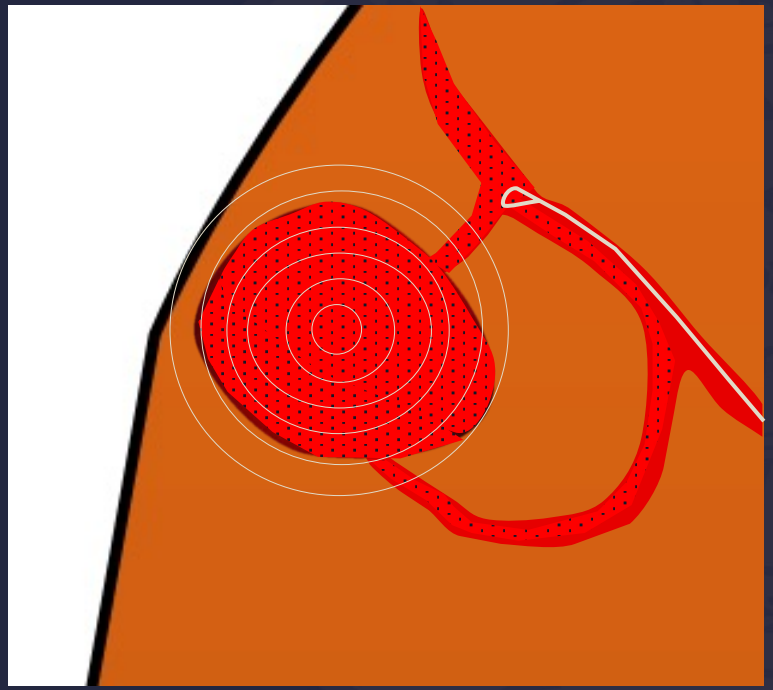




3. Cone-Beam CT







4. Dose Matters

RADIATION SEGMENTECTOMY: A NOVEL APPROACH TO INCREASE SAFETY AND EFFICACY OF RADIOEMBOLIZATION

AHSUN RIAZ, M.D.,* VANESSA L. GATES, M.S.,* BASSEL ATASSI, M.D.,*
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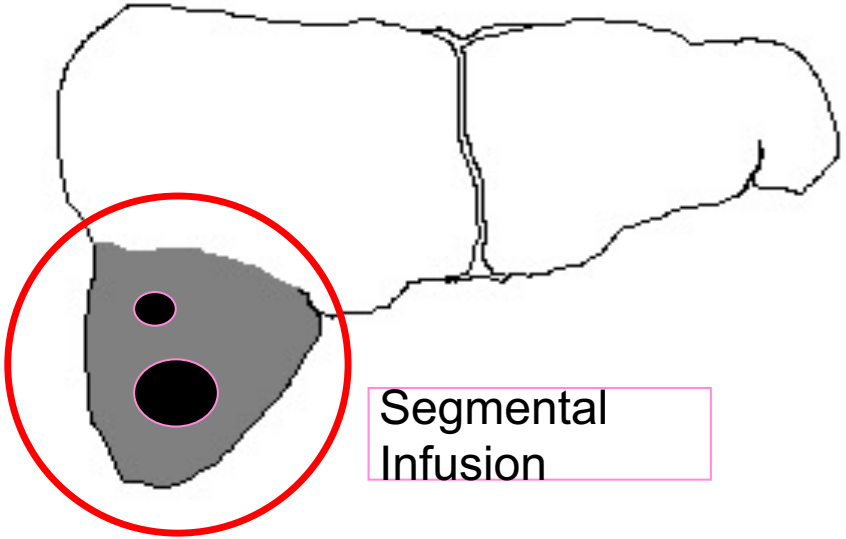
ANDREW KENNEDY, M.D.,‖ AND RIAD SALEM, M.D.*‡

SEGMENTECTOMY



Radiology-Pathology Correlation

Unresectable Solitary Hepatocellular Carcinoma Not Amenable to Radiofrequency Ablation: Multicenter Radiology-Pathology Correlation and Survival of Radiation Segmentectomy

Michael Vouche,[1] Ali Habib,[1] Thomas J. Ward,[2] Edward Kim,[2] Laura Kulik,[3] Daniel Ganger,[3] Mary Mulcahy,[4] Talia Baker,[5] Michael Abecassis,[5] Kent T. Sato,[1] Juan-Carlos Caicedo,[5] Jonathan Fryer,[5] Ryan Hickey,[1] Elias Hohlastos,[1] Robert J. Lewandowski,[1,4] and Riad Salem[1,4,5]

JHEP 2014

- All 33 Patients with > 90% pathologic necrosis
  - Threshold dose 190 Gray to achieve CPN

Angiosomal radiopathologic analysis of transarterial radioembolization for the treatment of hepatocellular carcinoma

Altan F. Ahmed,[1] Naziya Samreen,[1,2] Joseph R. Grajo,[1] Ivan Zendejas,[3] Chris L. Sistrom,[1] Amy Collinsworth,[4] Ashwini Esnakula,[4] Jehan L. Shah,[1] Roniel Cabrera,[5] Brian S. Geller,[1] Beau B. Toskich[1,6]

Abdominal Radiol 2017

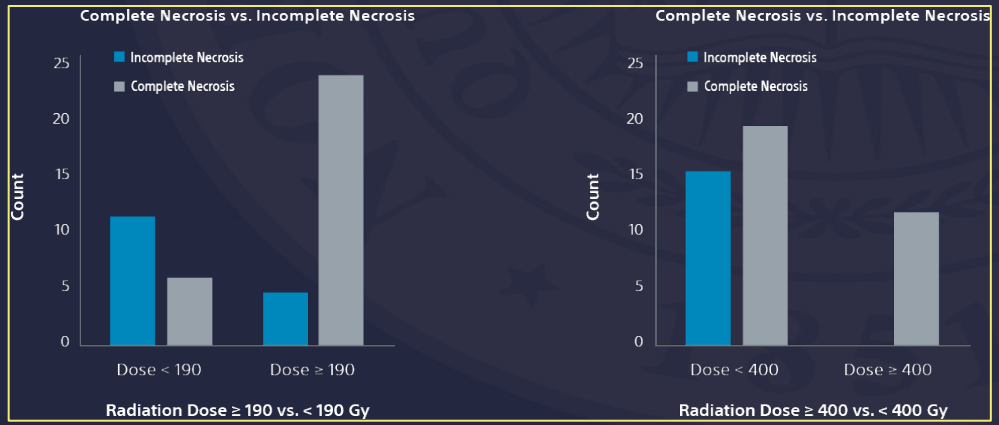
- Complete pathologic necrosis observed in 7/12 tumors
  - Ablative 5/6 (83%) vs. Non-ablative 2/6 (33%)

SHORT COMMUNICATION

Correlation of Y90-absorbed radiation dose to pathological necrosis in hepatocellular carcinoma: confirmatory multicenter analysis in 45 explants

Ahmed Gabr[1] · Ahsun Riaz[1] · Guy E. Johnson[2] · Edward Kim[3] · Siddharth Padia[4] · Robert J. Lewandowski[1] · Riad Salem[1]

- Retrospective, multicenter: 45 HCC patients (CPA)
- Radiation segmentectomy: Solitary HCC ≤ 8 cm
  - Dose > 190 Gray*: 86% had CPN
  - Dose > 400 Gray*: 100% had CPN

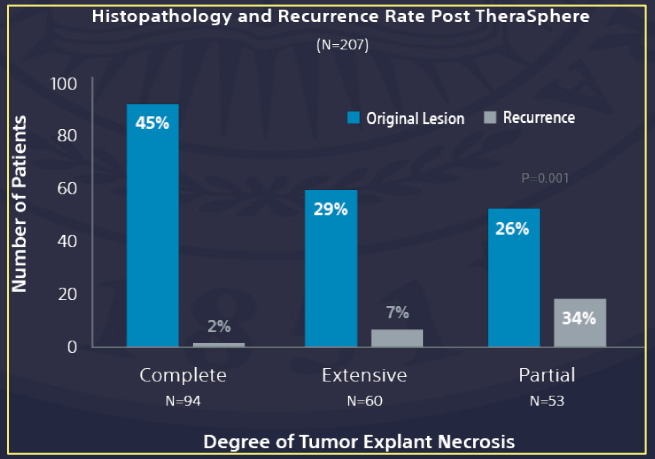


*Absorbed perfused liver doses were estimated using MIRD calculations

EJNNMI 2020

Correlating Histopathology with Outcomes

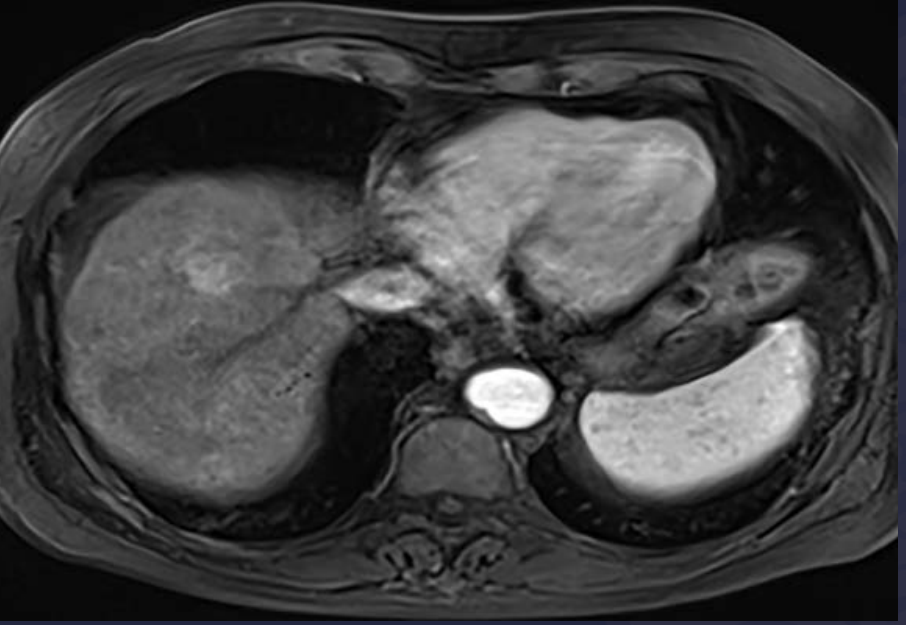
- Post-explant tumors examined from 207 patients who underwent liver transplant post Y90
- Tumors with CPN had lower HCC recurrence rate than tumors with incomplete necrosis
- Complete/extensive tumor necrosis was strongly associated with lower HCC-related mortality rate (p=0.0009); longer recurrence free survival (p=0.0056) and longer time to recurrence (p<0.0001)

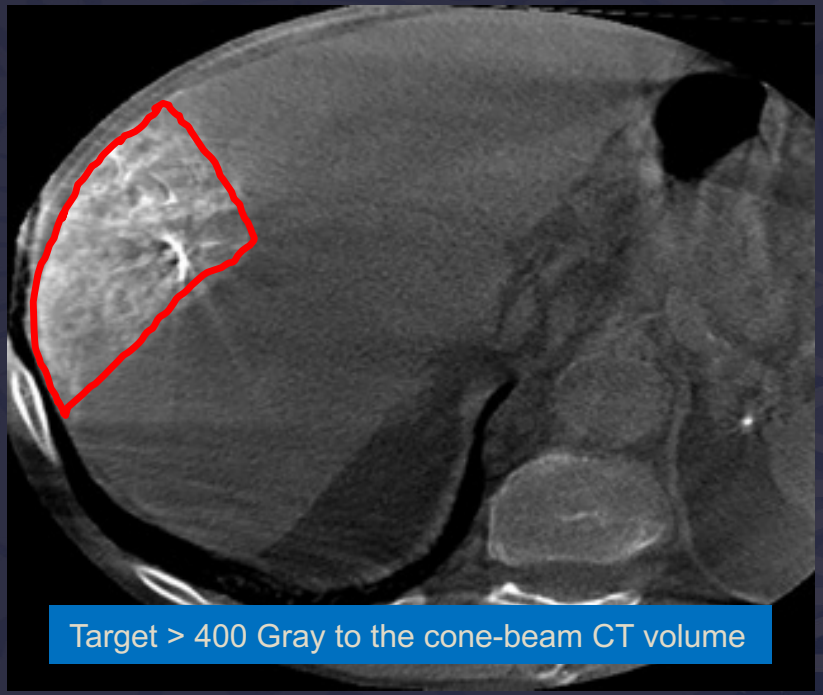


Necrosis defined as:

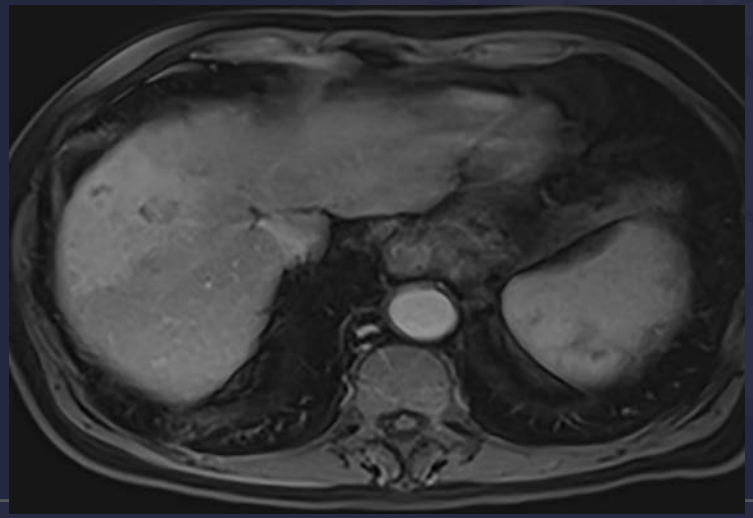
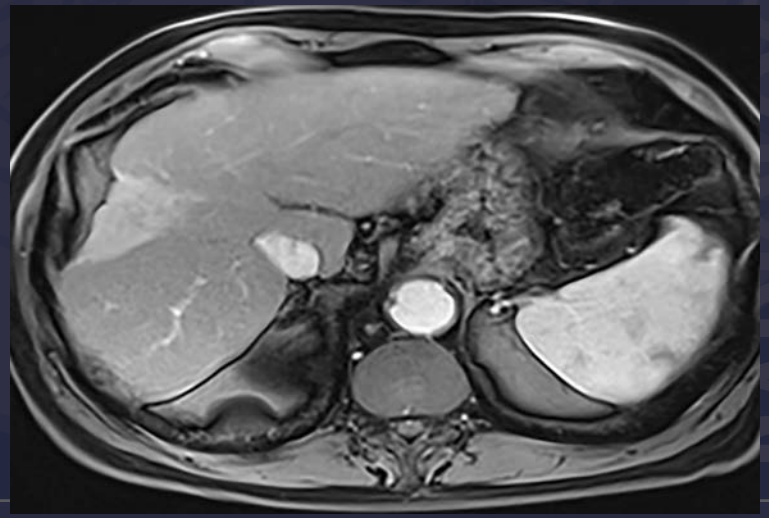
- Complete: no viable HCC
- Extensive: 50-99% necrosis
- Partial necrosis: <50% necrosis

Gabr et al. Hepatology 2020 doi.10.1002/hep.31318




Target > 400 Gray to the cone-beam CT volume

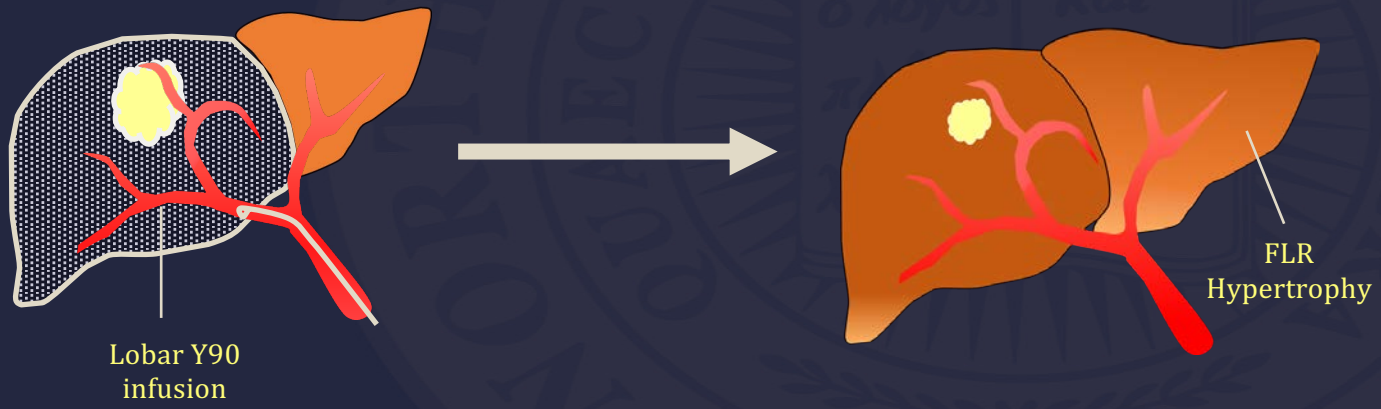


Radiation Segmentectomy

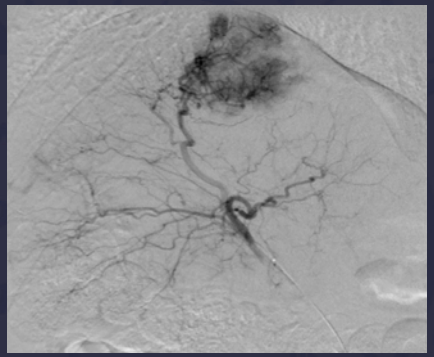
1. Patient Selection
   a) Peripheral tumors, Solitary or Multi-Focal
   b) Bridging/Down-staging/Definitive
2. Technique
   a) Selective catheterization/Cone-beam CT
   b) Dosimetry based on volume of perfusion
   c) Glass: > 190 Gray (> 400 Gray)
   d) Resin: possibly > 150 Gray (multi-discipline panel 2021)
3. Results
   a) Long TTP (and Duration of Response)
   b) High rates of CPN
   c) Curative Intent

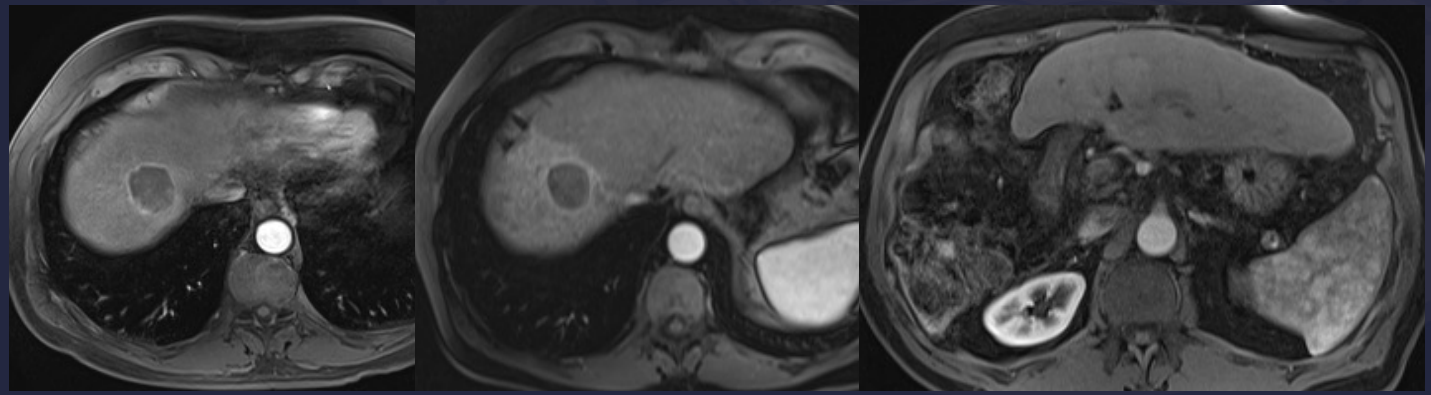
Radiation Lobectomy



(Same Day) Radiation Lobectomy

- Procedure Started at 9:15 AM
  - Planning angiography
  - Tc99m MAA scan ➔ Nuclear Medicine Department
  - Radioembolization
- Patient left angiography suite at 11:30 AM

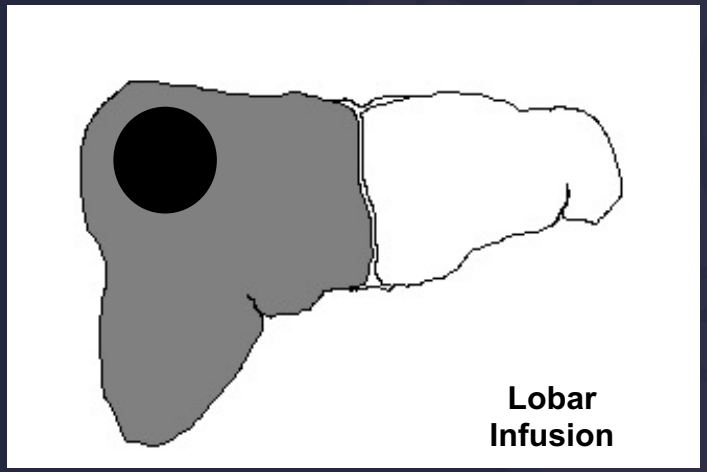


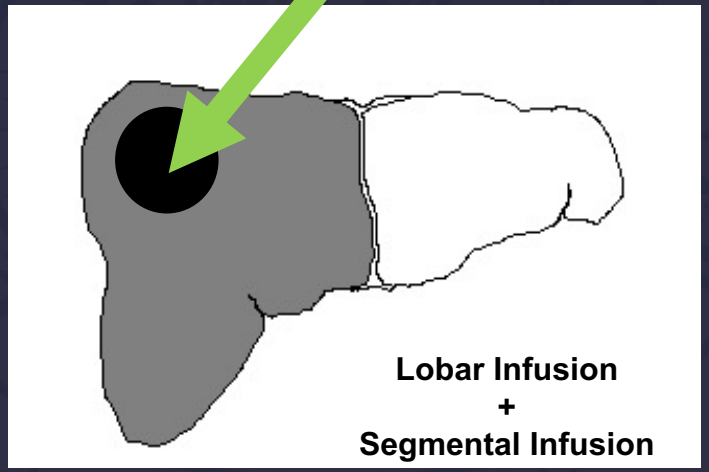


FLR increased 32-48%

Trisegmentectomy 3-months post Y90

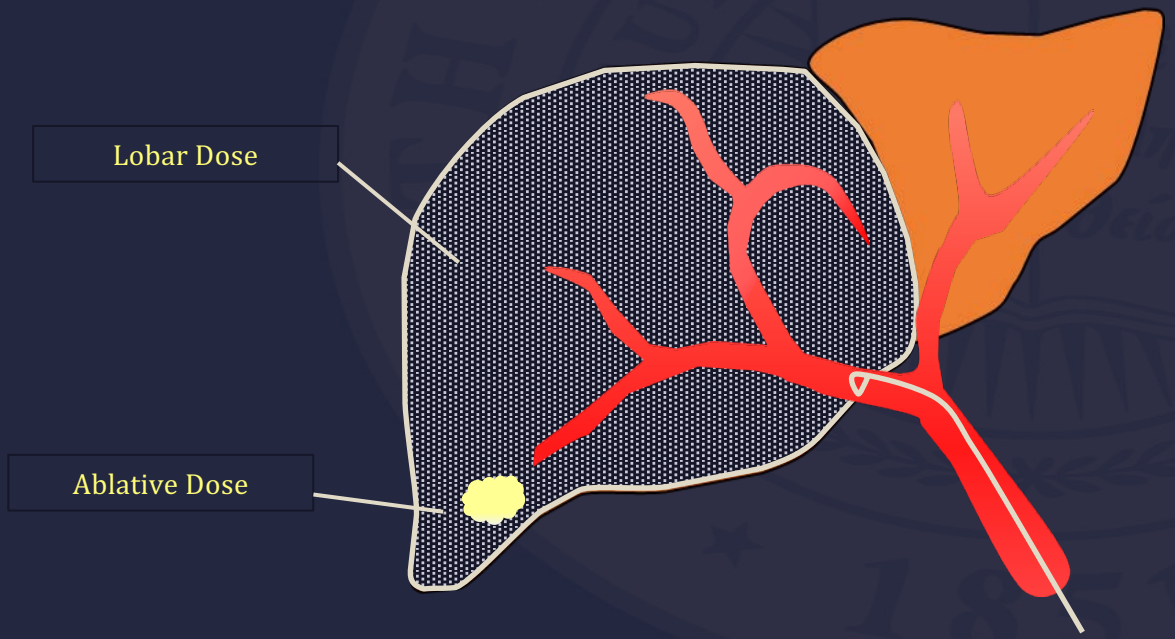
LOBECTOMY

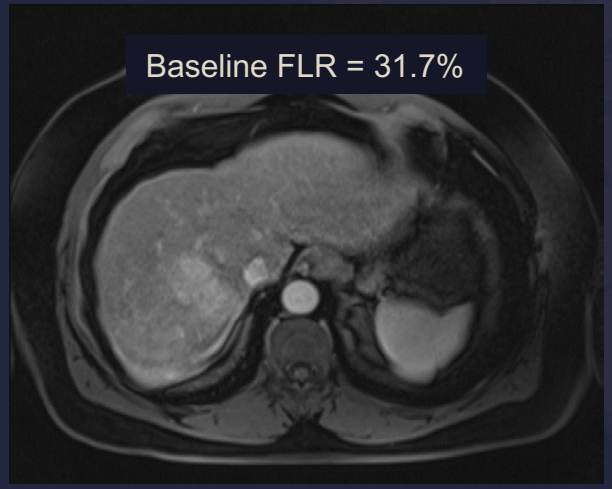


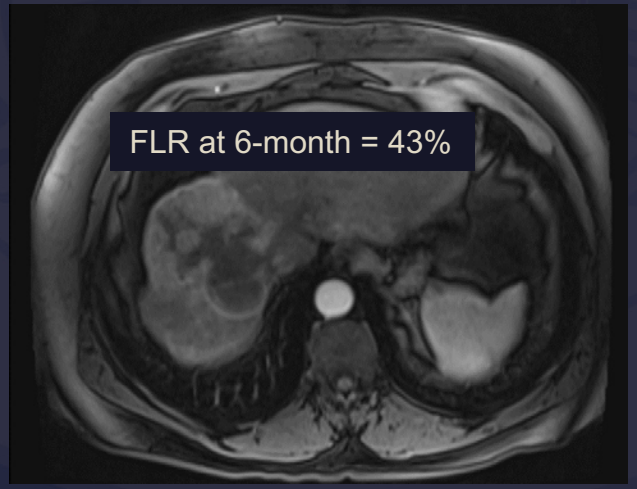


Grant number: R01CA2338878
Y-90 radiation lobectomy: Dose optimization and prediction of FLR hypertrophy to enable resection of HCC

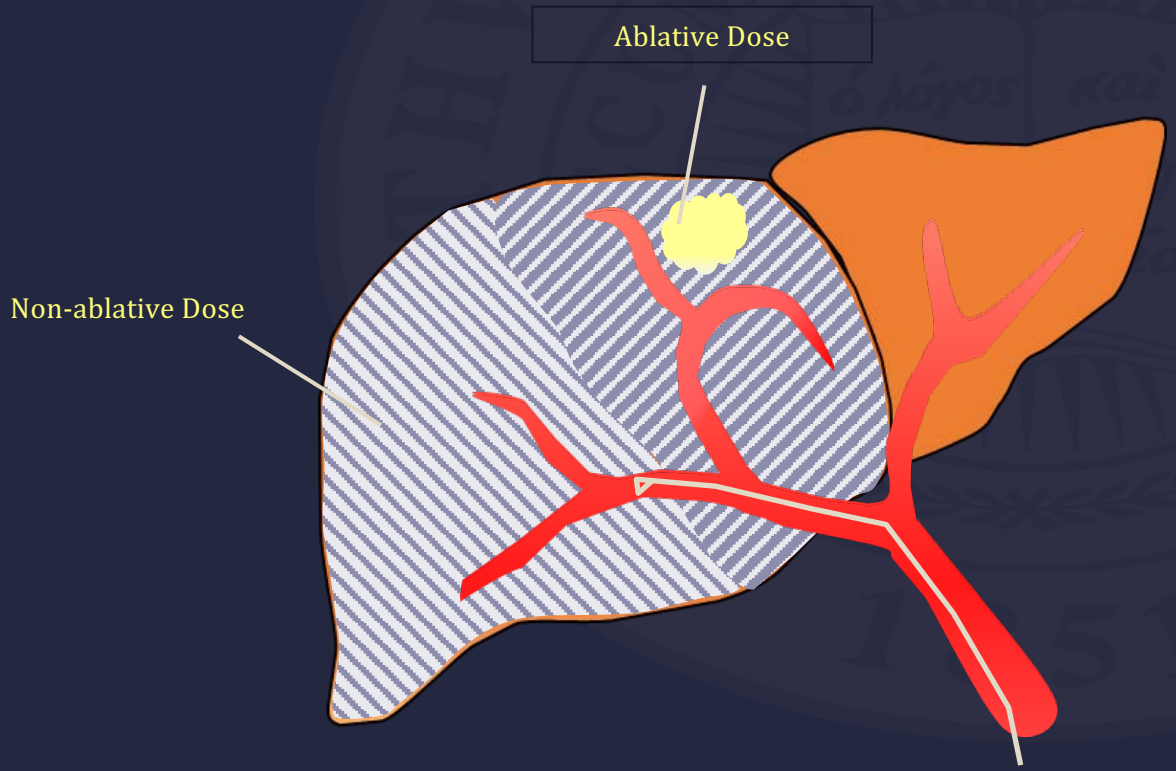
Segmental + Lobar Approach



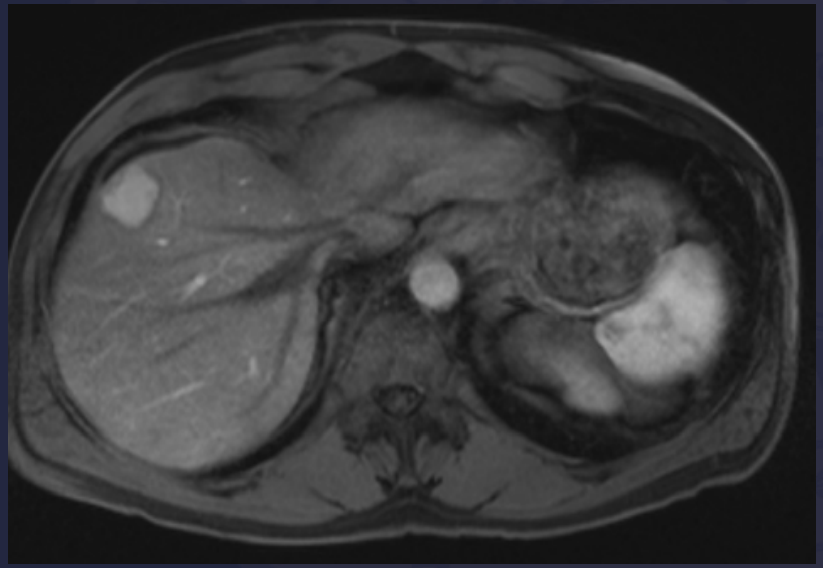




Double Segmental Approach



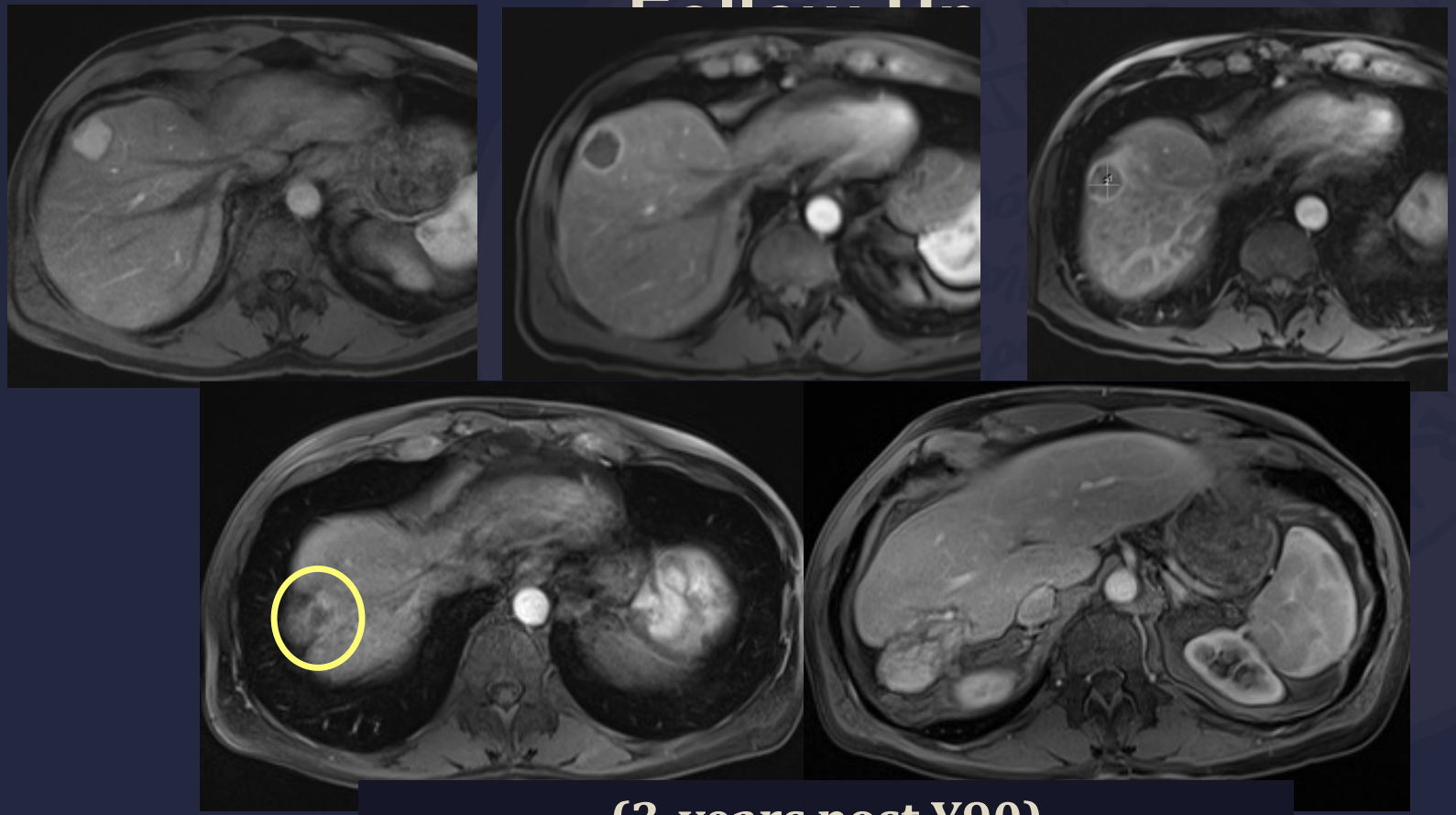
65 y/o Male with Hep C



FLR 30%

Differential Dosing

Follow-Up



(3-years post Y90)

Robert J Lewandowski

r-lewandowski@northwestern.edu

Portal Vein Embolization: My Top 5 Technical Pearls

Alban Denys

Chairman of Radiology

CHUV University of Lausanne

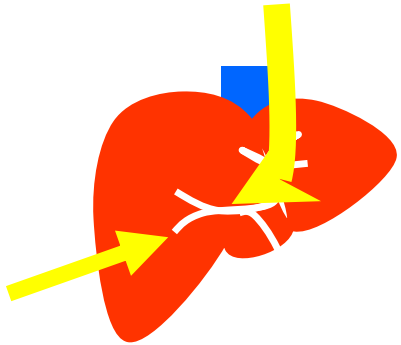
Disclosure

Consultant for: Terumo, Cook, Neuwave

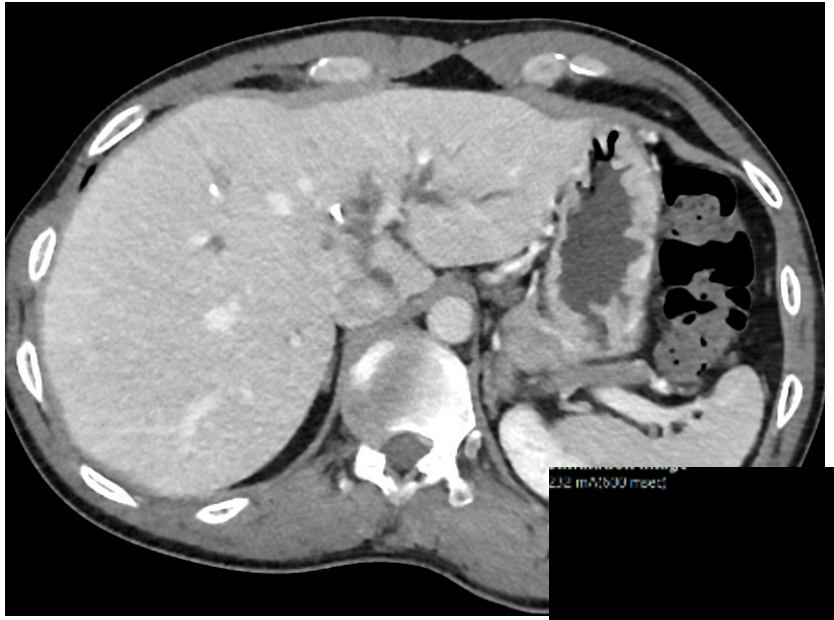
Brand names are included in this presentation for participant clarification purposes only. No product promotion should be inferred.

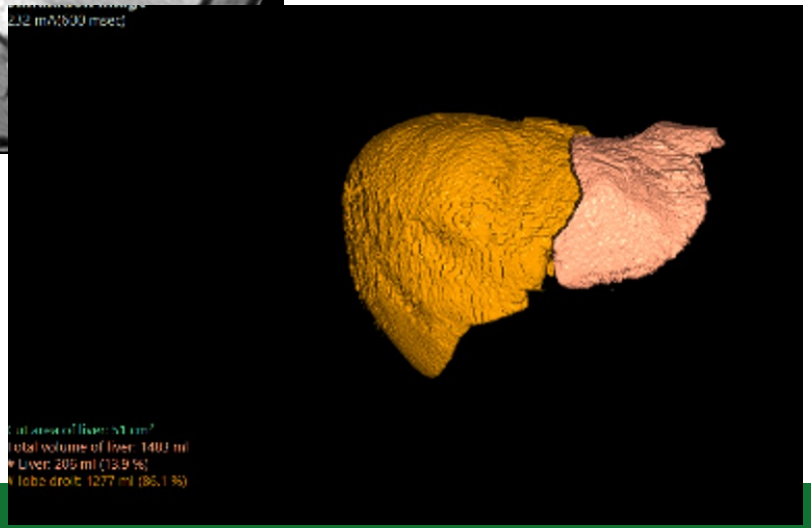
Pearl 1 :access route tips and tricks….

- Indications for both exists
  - Contralat mandatory in case of Klatskin tumors
  - Ipsi depending on the embolic material

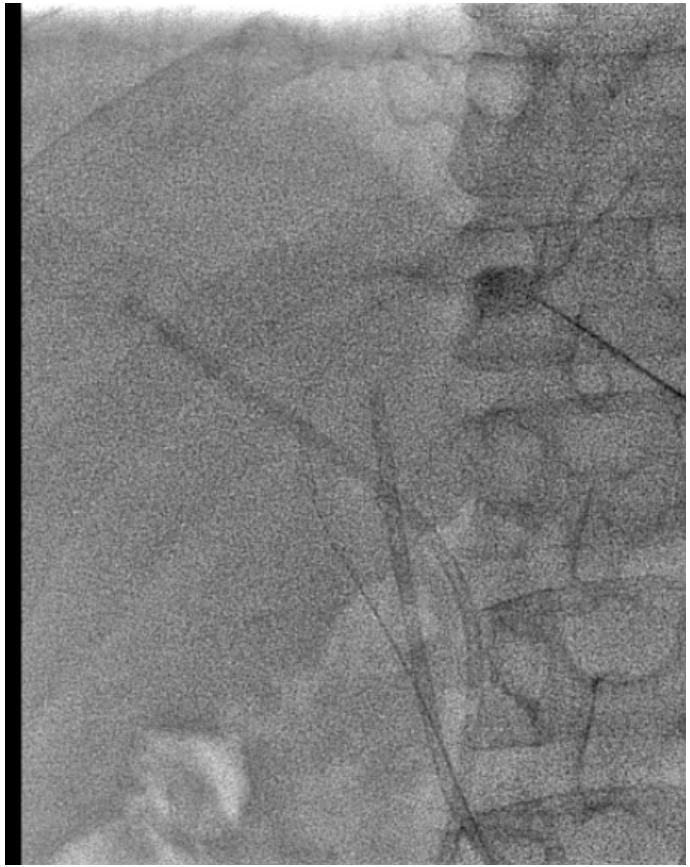


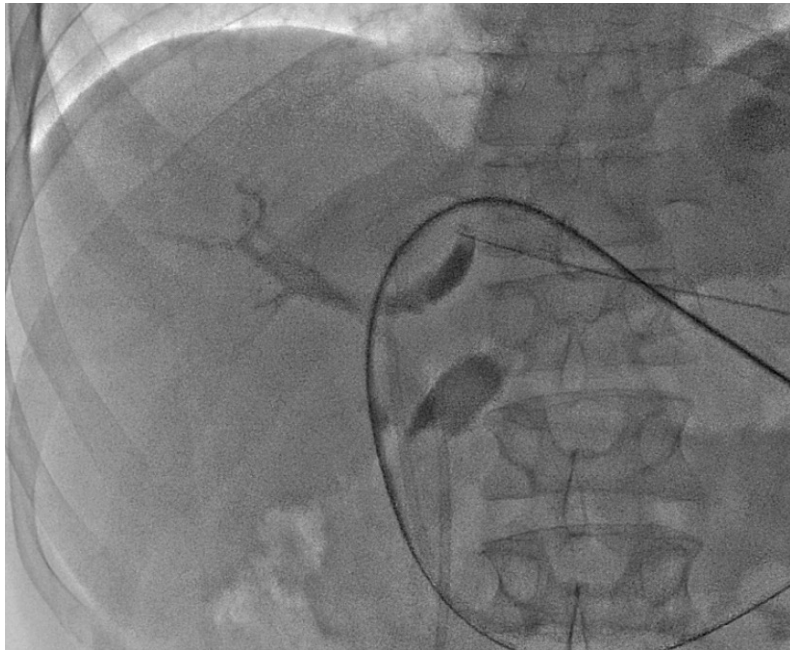
	Controlateral route	Ispsiateral route
pros	Catheterism easier Final control easier Dose reduction ? Use of glue	No risk for FRL Easy puncture Access to segt 4 branches
Cons	Risk of complications of FRL (increased by PH)	Catherism more complex Use of glue more tricky Final control hard to achieve

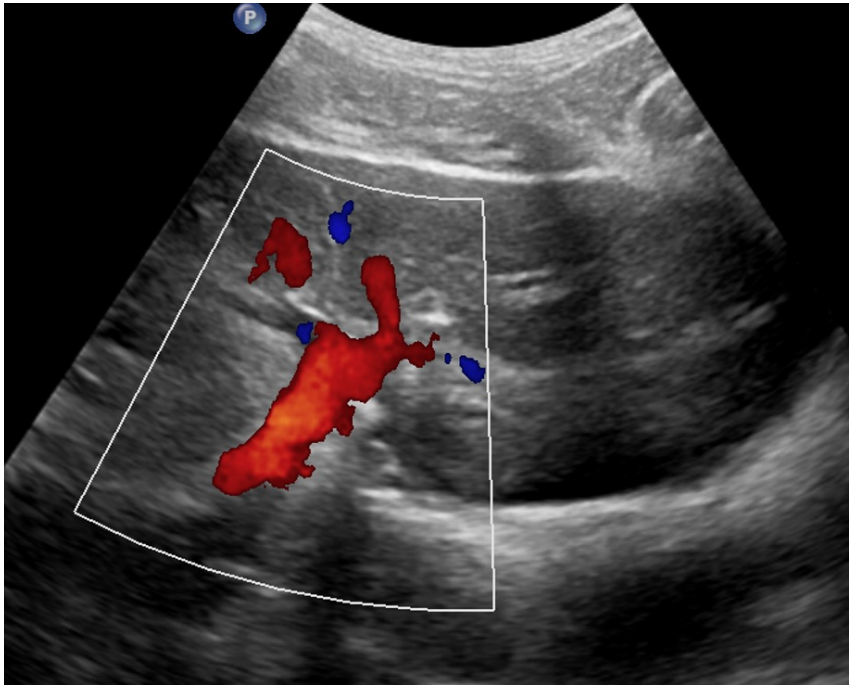




Klatskin IIIA
Left lobe volumetry: FRL 18%
Need for left lobe drainage, right PVE +LVD



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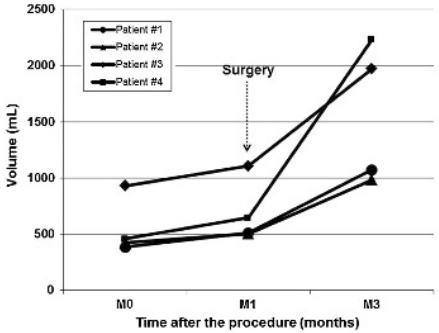
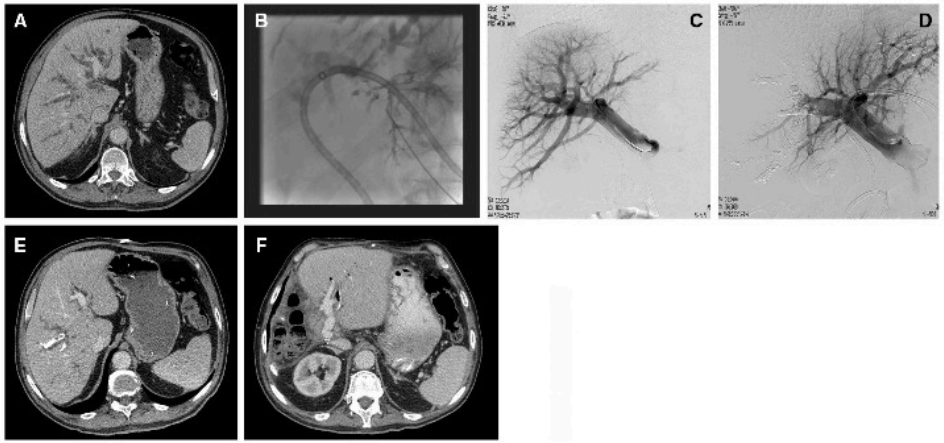
Pearl 2 combine PVE and PCBD in the same procedure

Perform PVE and biliary drainage in the same procedure





Cardiovasc Intervent Radiol (2014) 37:698–704
DOI 10.1007/s00270-013-0699-7

CIRSE

CLINICAL INVESTIGATION INTERVENTIONAL ONCOLOGY

Simultaneous Biliary Drainage and Portal Vein Embolization Before Extended Hepatectomy for Hilar Cholangiocarcinoma: Preliminary Experience

Boris Guiu · Pierre Bize · Nicolas Demartines · Mickaël Lesurtel · Alban Denys

Klatskin tumor: why should liver preparation be faster?

- 494 pats treated for biliary cancer received PVE
  - Mean delay diagnosis and surgery unknown
  - But 2 steps strategy biliary then PVE
  - 24.7% did not receive resection due to tumor progression…..
    - More frequent in gallbladder cancer than with klatskin tumor

Dig Surg. 2012;29(1):23-9. doi: 10.1159/000335718. Epub 2012 Mar 15.

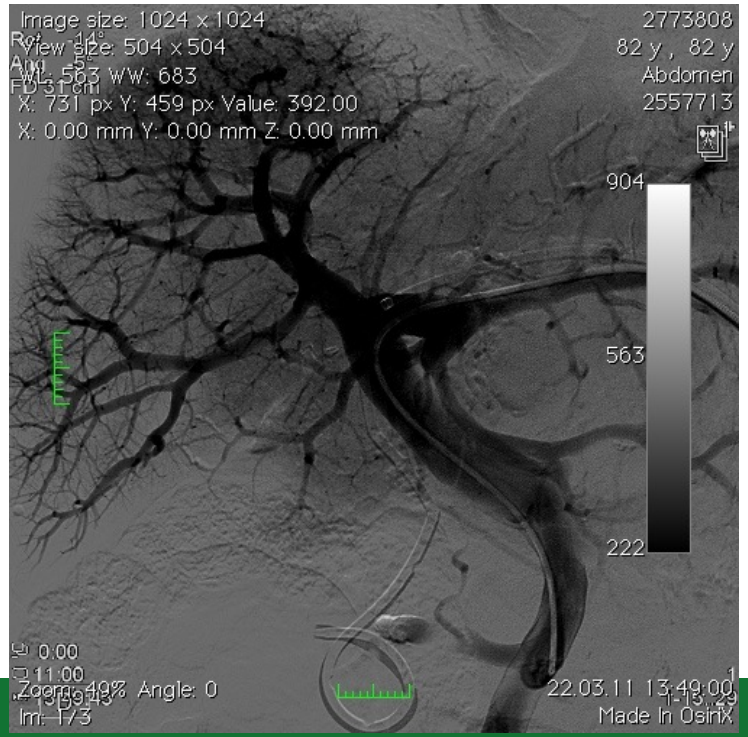
Portal vein embolization before extended hepatectomy for biliary cancer: current technique and review of 494 consecutive embolizations.

Ebata T[1], Yokoyama Y, Igami T, Sugawara G, Takahashi Y, Nagino M.

Delay between tertiary center consultation and treatment is 74 days in amsterdam series (Rhuys AT HPB 2014)
Delay from biliary decompression to PVE in US series between 55 to 61 days followed (Walter T JVIR 2013)

Pearl 3 Use a mixture of Glue and Lipiodol

- Try first the most tricky portal branches close to the portal bifurcation and move to the easy ones
- Dilute one to 2 in the first injections to embolize distally and then 1 to 1 finally

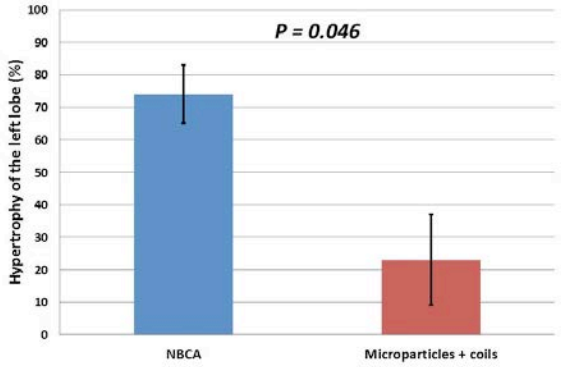


Why Glue?

	NBCA	Microparticles+coils	*P value*
Age	68±12	67±9	>.05
Sex ratio (W/M)	5/9	4/10	>.05
Cirrhosis/metastases	5/9	5/8	>.05
Total liver volume	1978±1352	1692±391	>.05
Left lobe volume	470±210	495±191	>.05
FRL ratio	0.027±0.11	0.29±0.06	>.05

Much less contrast for Glue than coils and particles (164 vs 262)
Similar rate of complications
Lower cost (Europe)

Guiu, Denys et al CVIR 2013



Pearl 4 : Prepare your table with G5% NO SALINE…..

Pearl 5: embolize the hepatic veins as well….

Eur Radiol. 2017 Aug;27(8):3343-3352. doi: 10.1007/s00330-017-4744-9. Epub 2017 Jan 18.

Extended liver venous deprivation before major hepatectomy induces marked and very rapid increase in future liver remnant function.

Guiu B[1,2,3], Quenet F[4], Escal L[5], Bibeau F[6], Piron L[5], Rouanet P[4], Fabre JM[7], Jacquet E[8], Denys A[9], Kotzki PO[10,11], Verzilli D[12], Deshayes E[10,11].

Initial experience with patients candidate to resection with FRL <25% or FRL function <2.69%/min/m2 at mebubronin scintigraphy (VanGulik criteria)
PVE + Right AND middle hepatic vein simultaneous embolization
Etiology: 8 liver mets CRC (, Klatskin 1, GB carcinoma 1)

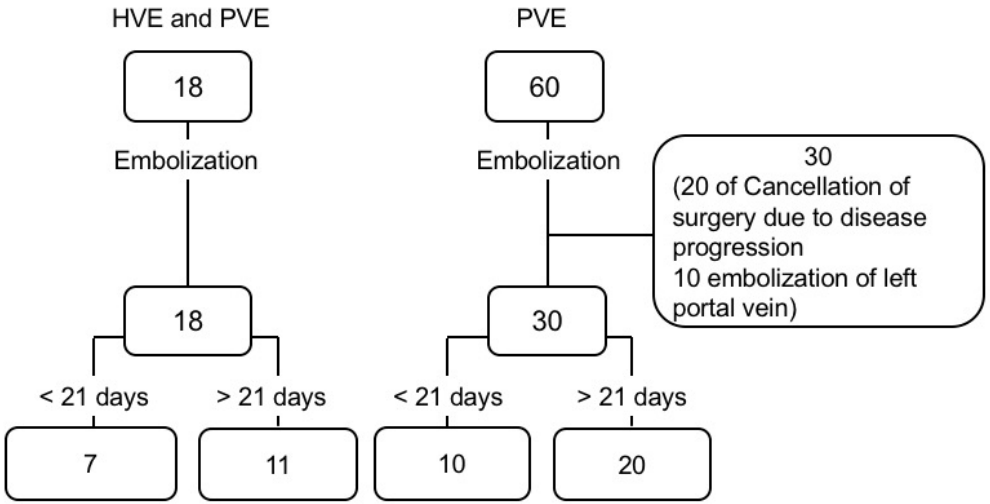
Results:

FRL function increased by 64% (range 28-107%) at day 21
Maximal liver function gain was at day 7 (+65+/-16%)
Maximal FRL volume increased by 53% at 7 days (25+/-8 days a week)

Opens the gate for earlier resection between 1 and 2 week

Comparison to PVE

- 1 randomized trial starting in France in 2019
- Lausanne experience 6 years



Surgery 167 (2020) 917–923

Contents lists available at ScienceDirect

Surgery

journal homepage: www.elsevier.com/locate/surg

Liver venous deprivation compared to portal vein embolization to induce hypertrophy of the future liver remnant before major hepatectomy: A single center experience

Kosuke Kobayashi, MD[a], Takamune Yamaguchi, MD[a], Alban Denys, MD[b], Lindsay Perron, MD[b], Nermin Halkic, MD[a], Nicolas Demartines, MD[a,*], Emmanuel Melloul, MD[a]

[a] Department of Visceral Surgery, Lausanne University Hospital and University of Lausanne, Switzerland
[b] Interventional Radiology, Lausanne University Hospital and University of Lausanne, Switzerland

Table 1. Patients' characteristics

Variables	HVE and PVE (n=18)	PVE (n=30)	p value
Age, year	66 (31-85)	64 (41-75)	0.975
Sex, male : female	10 : 8	19 : 11	0.594
BMI, kg/m²	23.4 (18.9-35.6)	23.8 (17.1-32.5)	0.624
Total bilirubin, µmol/dl	6.5 (3-348)	10 (3-62)	0.499
PT, %	100 (65-150)	100 (60-120)	0.081
AST, U/l	36 (18-189)	46 (14-217)	0.390
ALT, U/l	41 (15-241)	45 (12-522)	0.644
Preoperative drainage of bile duct	6 (33.3%)	2 (6.7%)	0.016
ERCP / percutaneous	2 / 4	1 / 1	
Embolization			
RPV + P4/ RPV	1 / 17	3 / 27	
RHV / RHV and MHV	13 / 2	-	-
Diagnosis			
Colorectal metastasis	9 (50.0%)	26 (86.7%)	0.006
Hepatocellular carcinoma	2 (11.1%)	2 (6.7%)	0.590
Cholangiocarcinoma (K IIIa)	7 (38.9%)	2 (6.7%)	0.006

Table 3. Volumetric analysis and outcome

Variables	HVE and PVE n=18	PVE n=30	p value
Volumetric analysis of pre-operation			
TLV, ml	1592 (1203-2328)	1650 (959-2605)	0.831
SLV, ml	1278 (1007-1520)	1281 (1071-1557)	0.865
FRL volume, ml	530 (334-989)	523 (288-1032)	0.774
FRL / TLV, %	34.3 (24.4-44.6)	32.9 (17.4-58.3)	0.749
FRL / SLV, %	39.4 (25.5-65.1)	38.9 (24.9-96.3)	0.949
Spleen volume	206 (82-401)	211 (70-451)	0.932
Volumetric outcome of post-embolization			
Days between embolization and CT, days	23 (13-35)	26 (15-72)	0.277
TLV, ml	1859 (1373-2424)	1620 (1014-2314)	0.045
FRL volume, ml	721 (555-1186)	696 (317-1086)	0.360
FRL / TLV, %	42.7 (30.1-55.8)	43.0 (30.4-71.4)	0.733
FRL / SLV, %	58.1 (42.0-78.0)	51.3 (29.1-101.4)	0.131
Spleen volume, ml	257 (89-449)	207 (78-521)	0.418
Post-TLV – Pre-TLV, ml	**128 (-92-585)**	**12 (-337-439)**	**0.002**
Post-FRL volume – Pre-FRL volume, ml	**195 (80-442)**	**109 (11-463)**	**0.009**
Post-FRL% / Pre-FRL% of TLV, %	121.0 (108.3-216.3)	122.9 (97.6-202.8)	0.966
Post-FRL% / Pre-FRL% of SLV, %	**134.7 (112.0-232.3)**	**124.3 (98.4-203.4)**	**0.039**
Post-Spleen / Pre-Spleen, %	**123.1 (96.2-173.3)**	**110.3 (45.0-181.0)**	**0.048**

Data are presented as median (range) or n (%).
Abbreviations: TLV, total liver volume; SLV, standard liver volume; FRL, future remnant liver

Doubling of the FLR vs PVE
Increase in spleen size

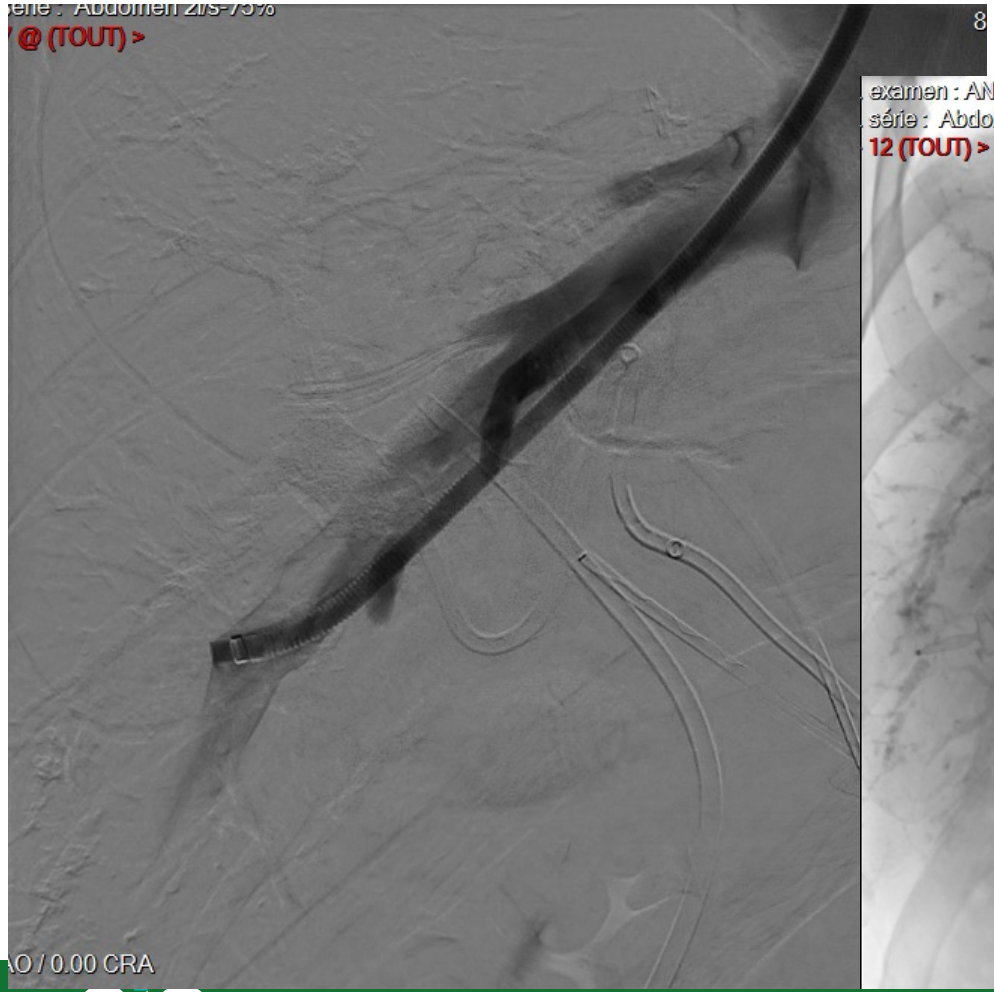
CIO

Variables	HVE and PVE (n=18)	PVE (n=30)	p value
Intraoperative outcomes			
Days between embolization and operation, days	36 (23-109)	35 (20-181)	0.924
Right Hepatectomy	8 (44.4%)	19 (63.3%)	0.202
Extended Right Hepatectomy	10 (55.6%)	11 (36.7%)	0.202
Operative time, min	363 (274-577)	344 (210-554)	0.198
Estimated blood loss, ml	850 (600-2500)	1000 (200-2600)	0.716
Pringle maneuver	18 (100%)	29 (97.0%)	0.434
Postoperative morbidity			
Morbidity	11 (61.1%)	15 (50.0%)	0.455
Clavien-Dindo classification I or II	4 (22.2%)	6 (20.0%)	0.854
Clavien-Dindo classification > III	7 (38.9%)	11 (30.0%)	0.527
Comprehensive Complication Index	16.6 (0-100)	4.4 (0-57)	0.364
Mortality	0	0	
Postoperative length of stay, days	14 (6-57)	11 (5-69)	0.086

Data are presented as median (range) or n (%).

Abbreviations: BMI, body mass index; PT, prothrombin time; AST, aspartate aminotransferase; ALT, alanine aminotransferase

No difference in blood loss despite the »Budd-Chiari « effect
No difference in operative outcome despite more extended right hepatectomies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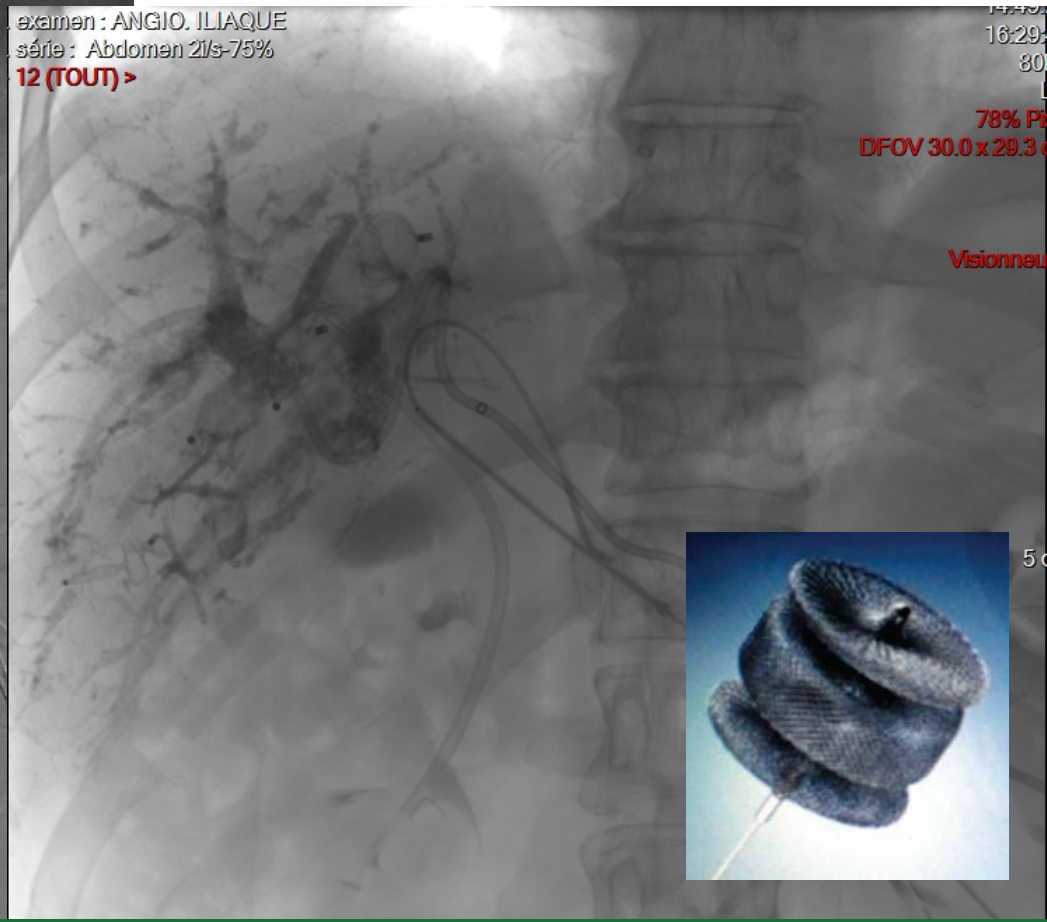
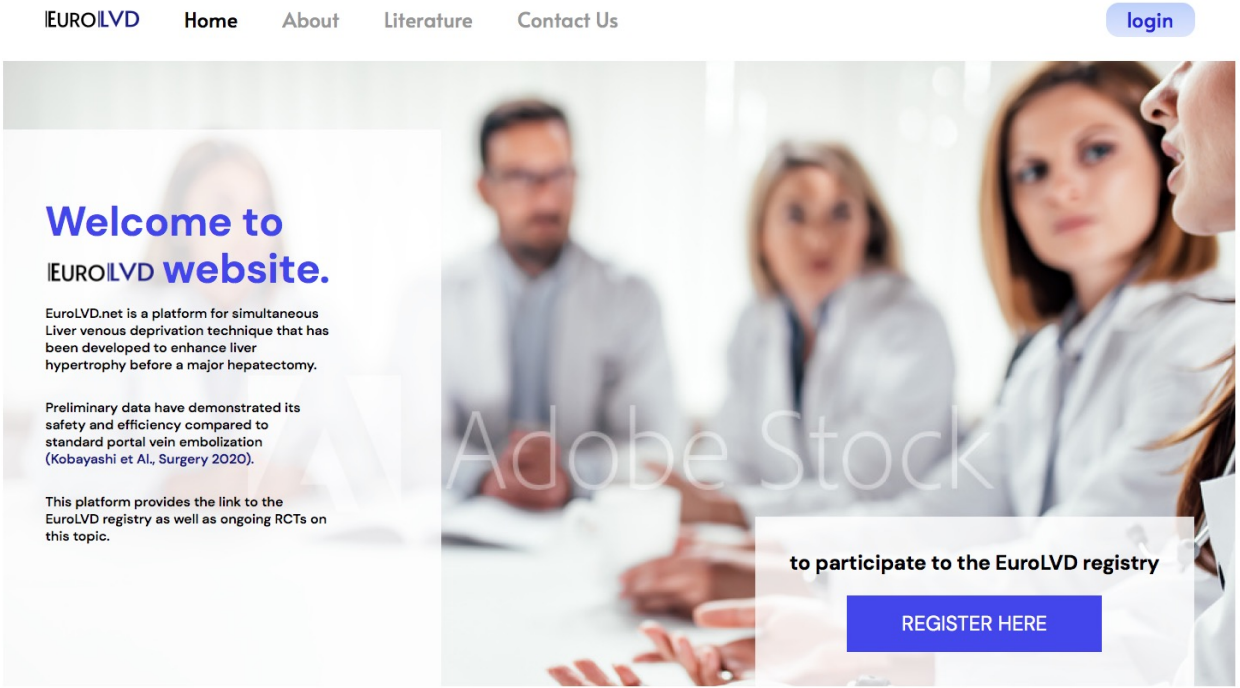

examen : ANGIO. ILIAQUE
série : Abdomen 2i/s-75%
12 (TOUT) >

Embark in EuroLVD adventure



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