ROLE OF INTERVENTIONAL RADIOLOGY IN ONCOLOGIC CARE: NOVEL TECHNIQUES

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HOW CAN THE INTERVENTIONAL RADIOLOGIST HELP?

- Image-guided procedures to assist diagnosis and facilitate oncologic treatment
  - Biopsies
  - Drainages
  - Catheter placements (ports, PICC, pheresis catheters)
  - Etc
  - Etc
  - Etc

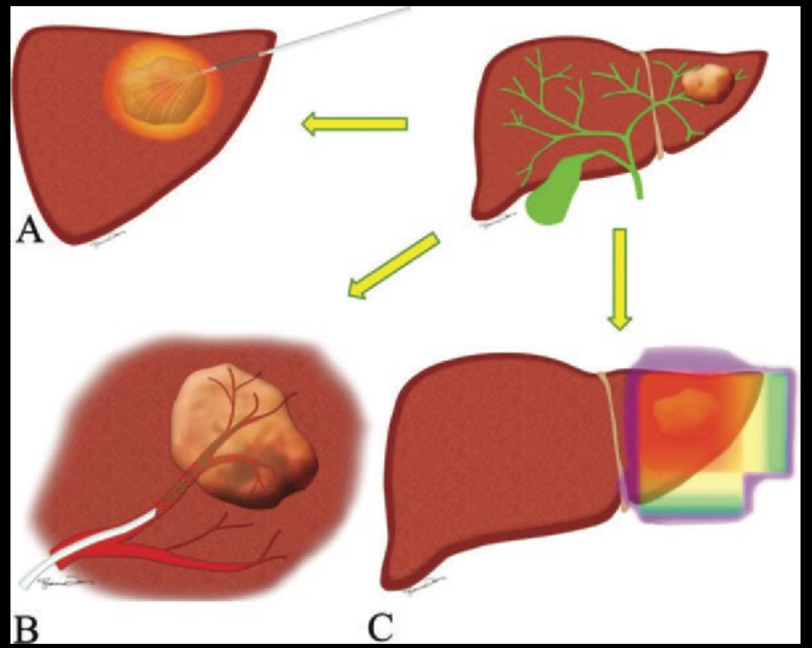
RELATIVELY NOVEL TECHNIQUES

Percutaneous modalities (ablations)

- Chemical
  - Percutaneous ethanol injection (PEI)
- Thermal Hot
  - Radiofrequency Ablation (RFA)
  - Microwave Ablation (MWA)
- Thermal Cold
  - Cryoablation
- Electric
  - Irreversible Electroporation (IRE)

Trans- arterial treatments

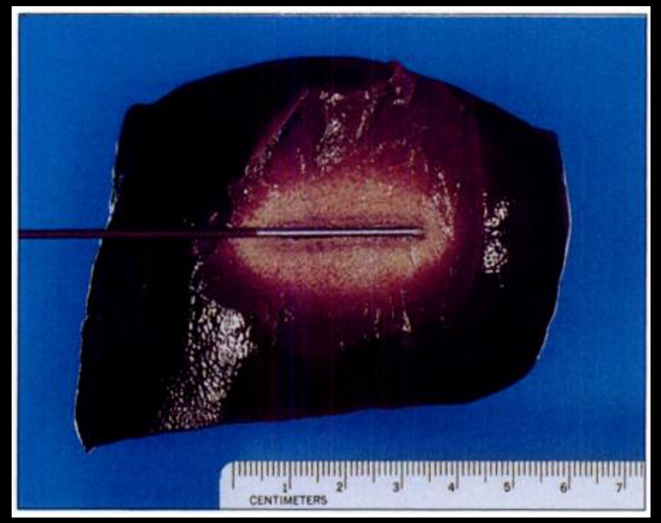
- Radioembolization (Y90)
- Chemoembolization (TACE)
  - DEB DOX
  - DEB IRI

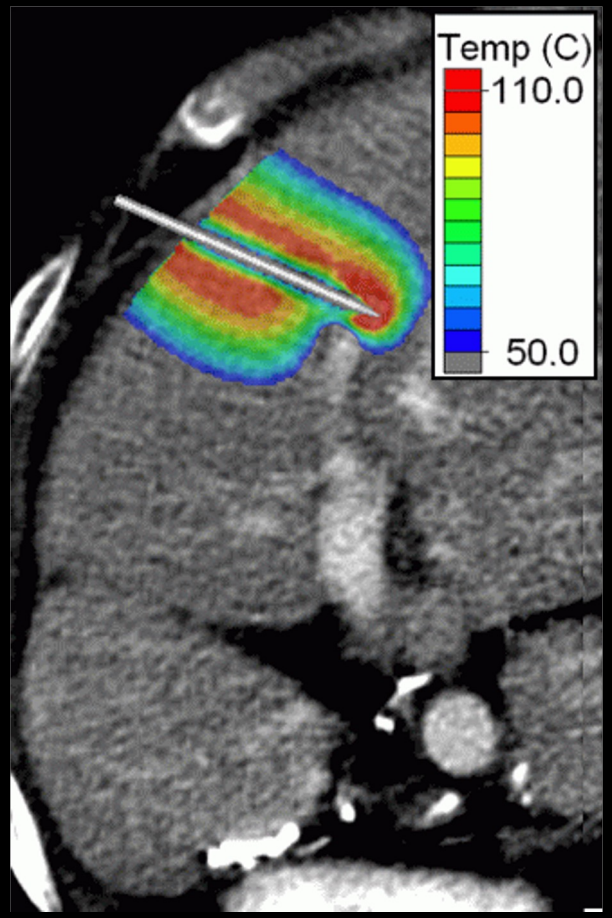


Baipai et al. Radiographics 2015; 35:1393-1418

THERMAL ABLATION

- Heat tissue up to:
  - 50-55° C for 4-6 min - irreversible cell damage
  - 60-100° C - immediate tissue coagulation
  - 100-110° C - tissue vaporization and carbonization





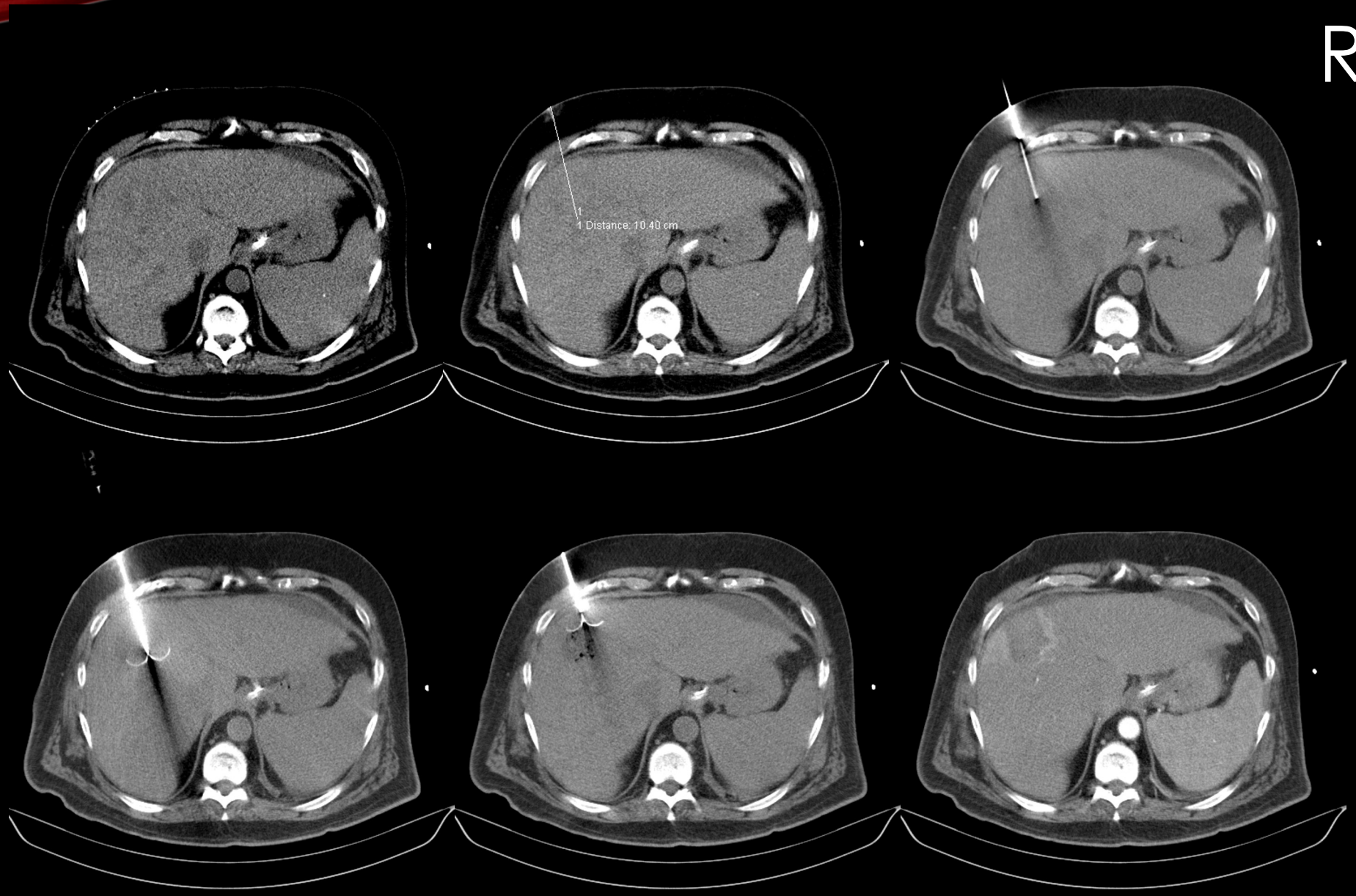
Goldberg S.N., AJR 174; 2000
Goldberg S.N., et al, AJR 170; 1998

ABLATIONS

Modality	Mechanism	Pros	Cons
PEI	• Injection of absolute alcohol	• Reach difficult areas	• Uncontrolled dispersion of ethanol
RFA	• Electromagnetic energy deposition agitating molecules producing heat	• Most widely studied • Better local control • Better disease-free survival (vs PEI)	• Small lesions (up to 5 cm) • Heat sink effect • Painful – Needs GA
MWA	• Water molecule rotation generating heat	• Larger lesions (up to 6-7 cm) in single session • Better heat dispersion • No heat sink	• Less widely studied than RFA • Painful – Needs GA
Cryoablation	• Freezing and thawing cycles creating cell damage	• Iceball is visible • Can ablate close to heart and diaphragm • Painless	• Cryoshock • Iceball fracture
IRE	• Electric pulses creating irreversible cell damage	• Limited connective tissue injury, ECM preserved • No heat sink	• Arrhythmias and pacemakers

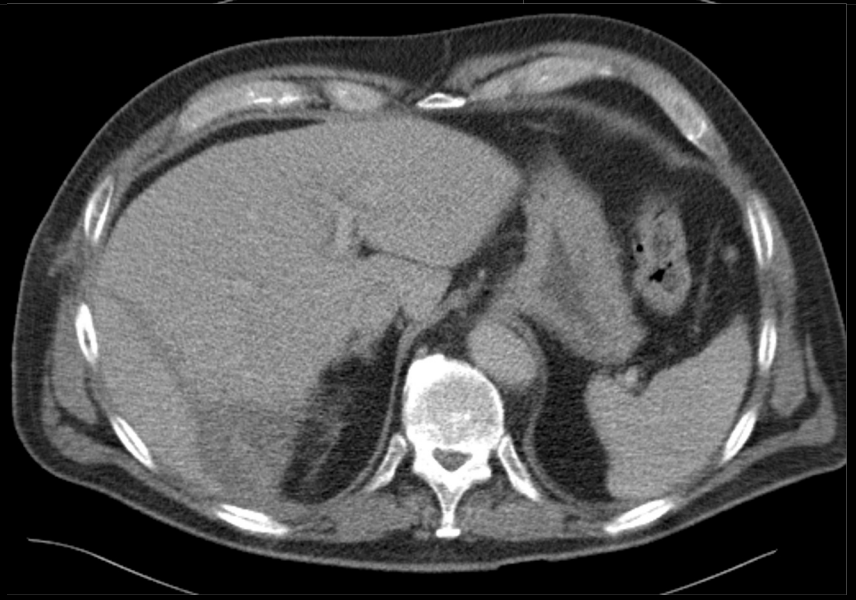
Sutter et al. Radiology; 284: 3
Baipai et al. Radiographics 2015; 35:1393-1418

RFA



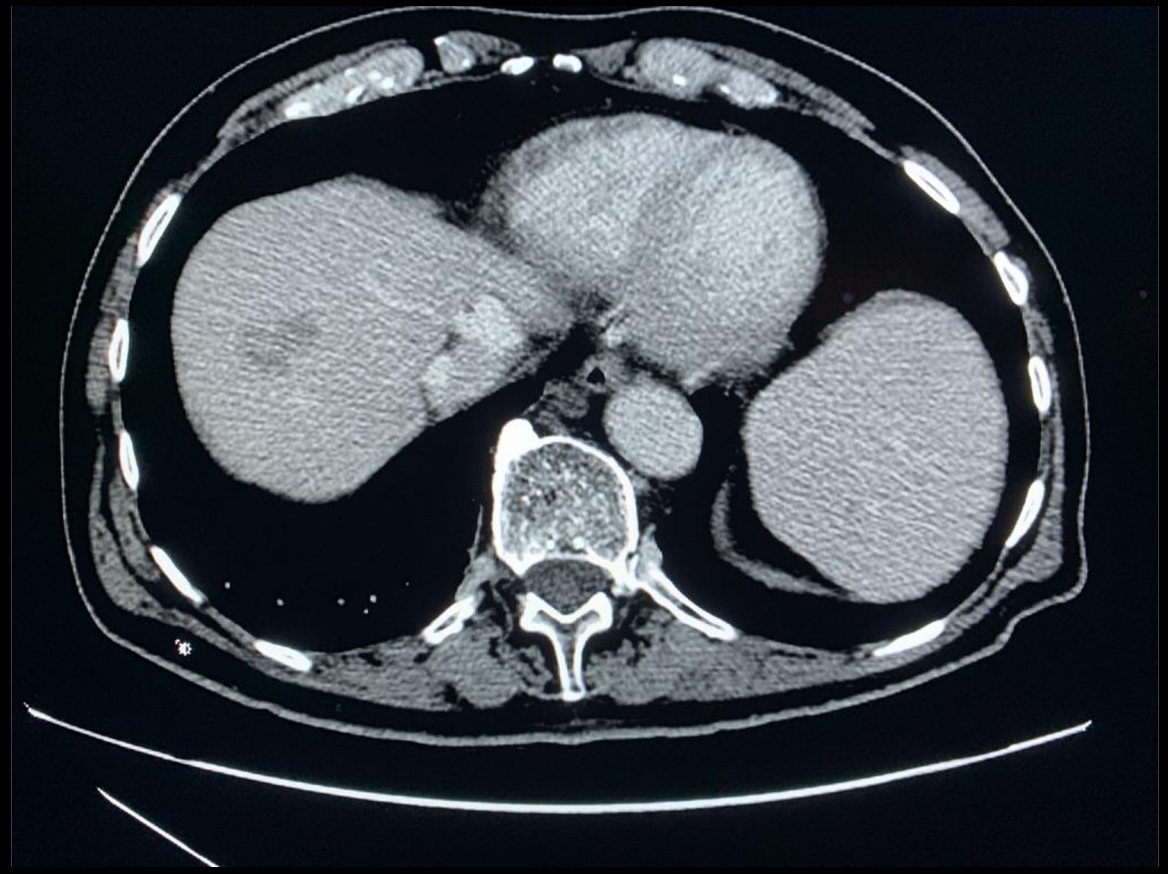
HCC
4.0 cm
lesion
RFA

MWA



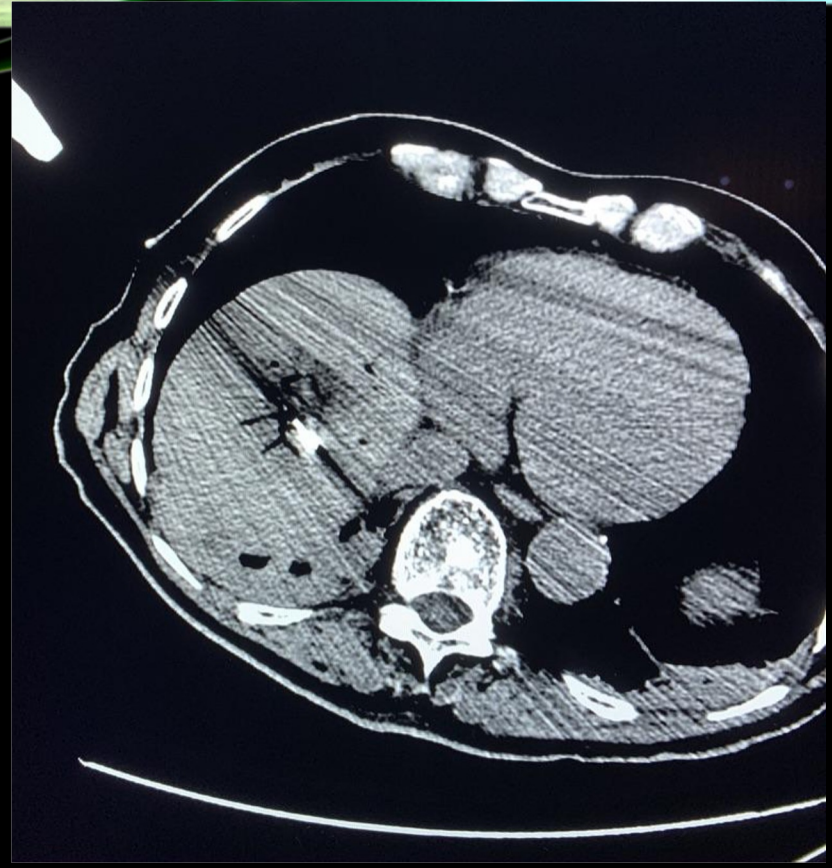
MWA
Lung Ca mets
Lesion size 7 x 5 x 6 cm

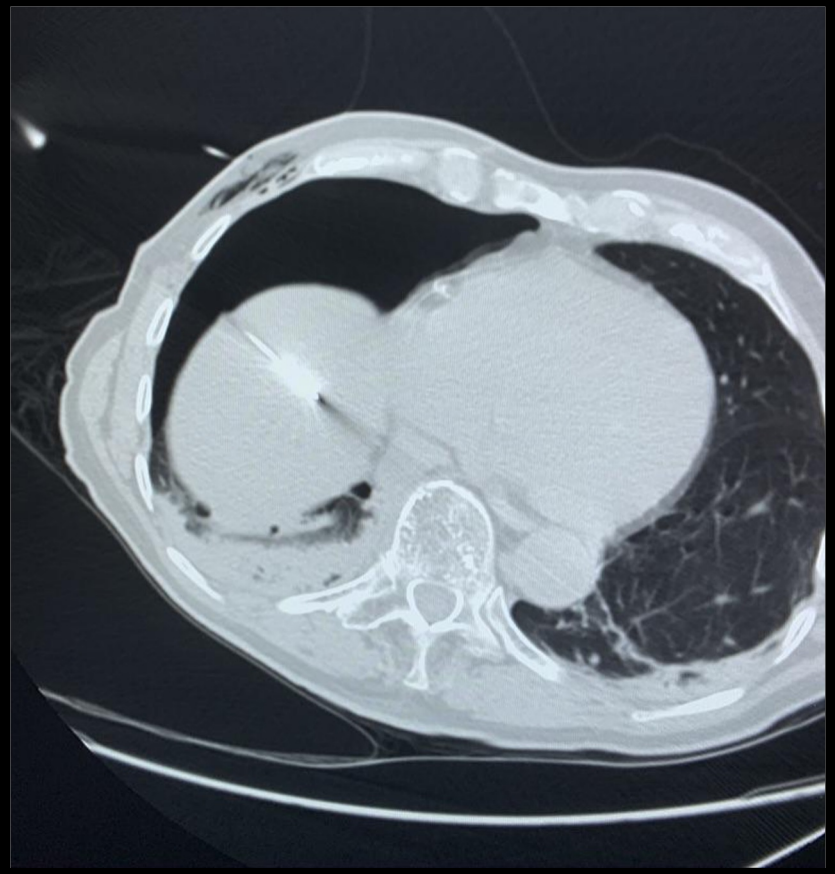
MWA



70 year old male with segment VII HCC typical imaging, elevated AFP

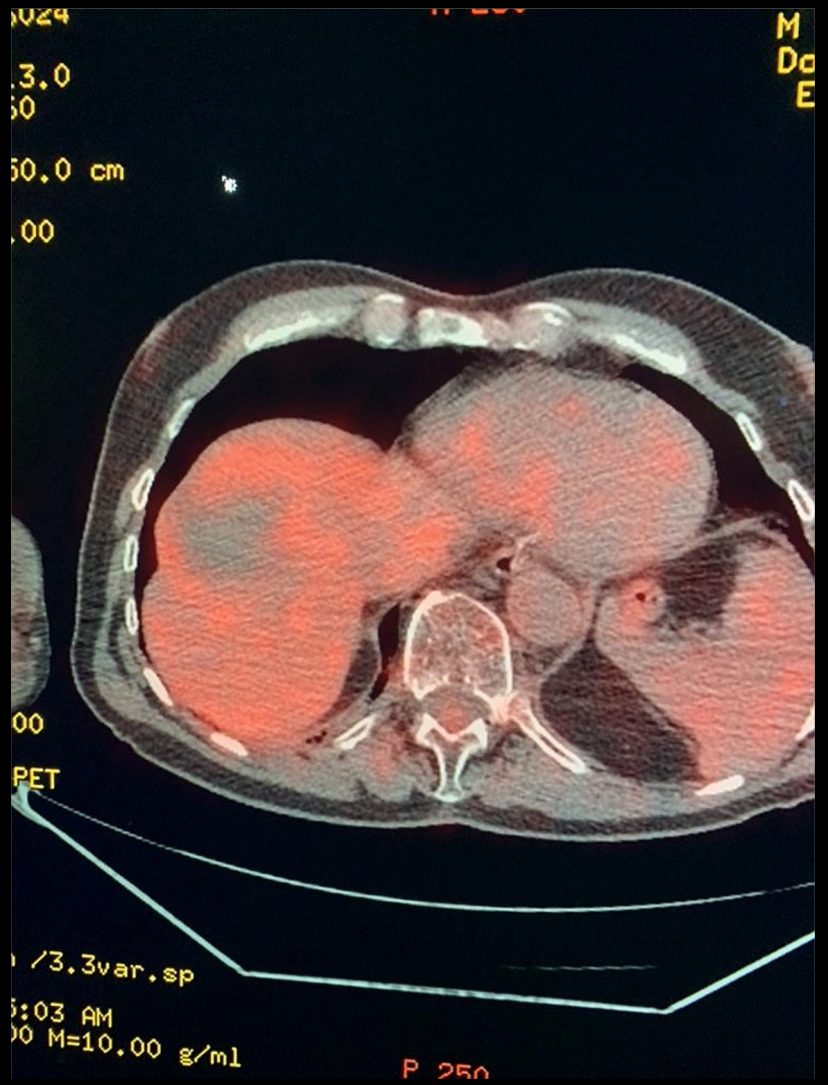
MWA



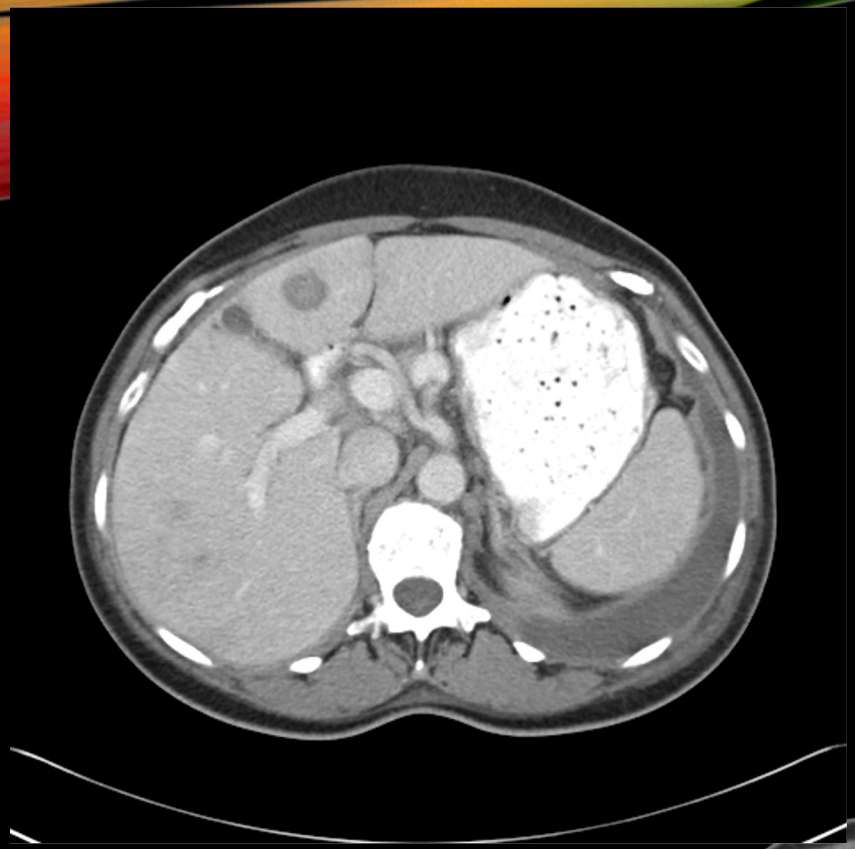


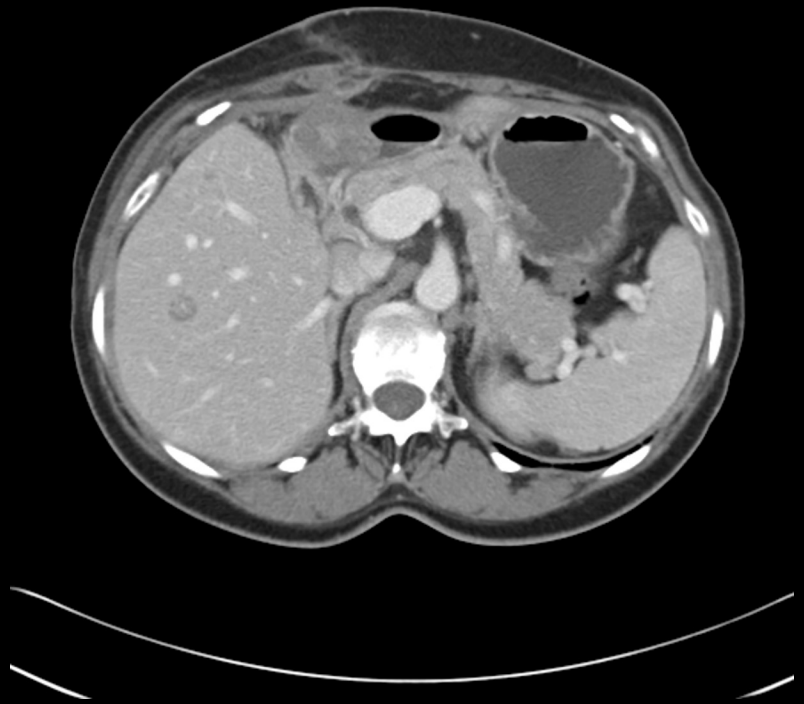
MWA with therapeutic pneumothorax

MWA



3 months follow-up

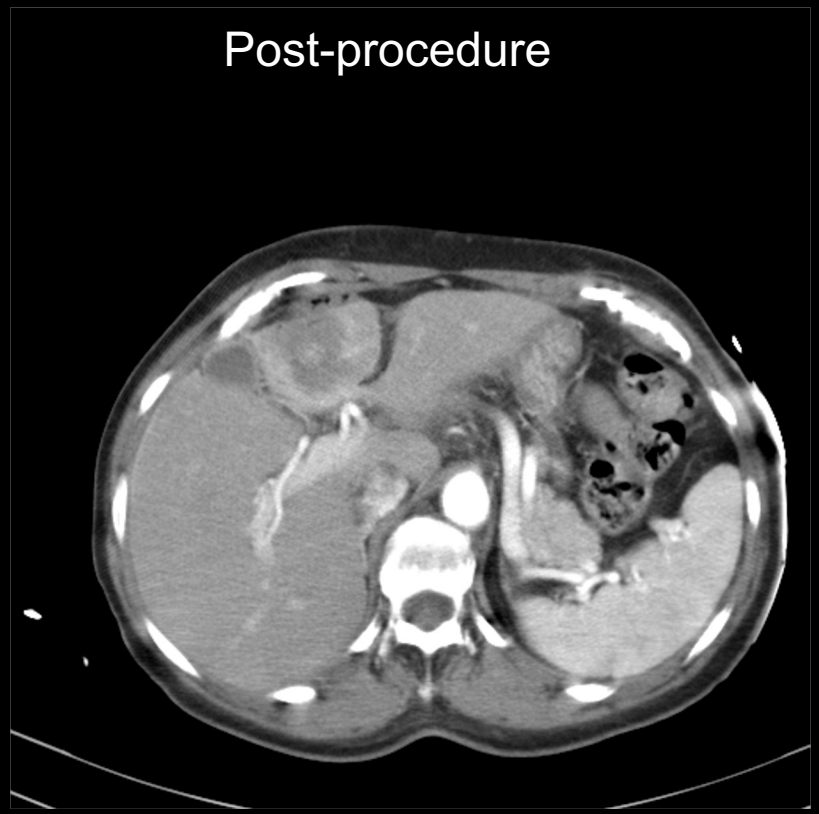




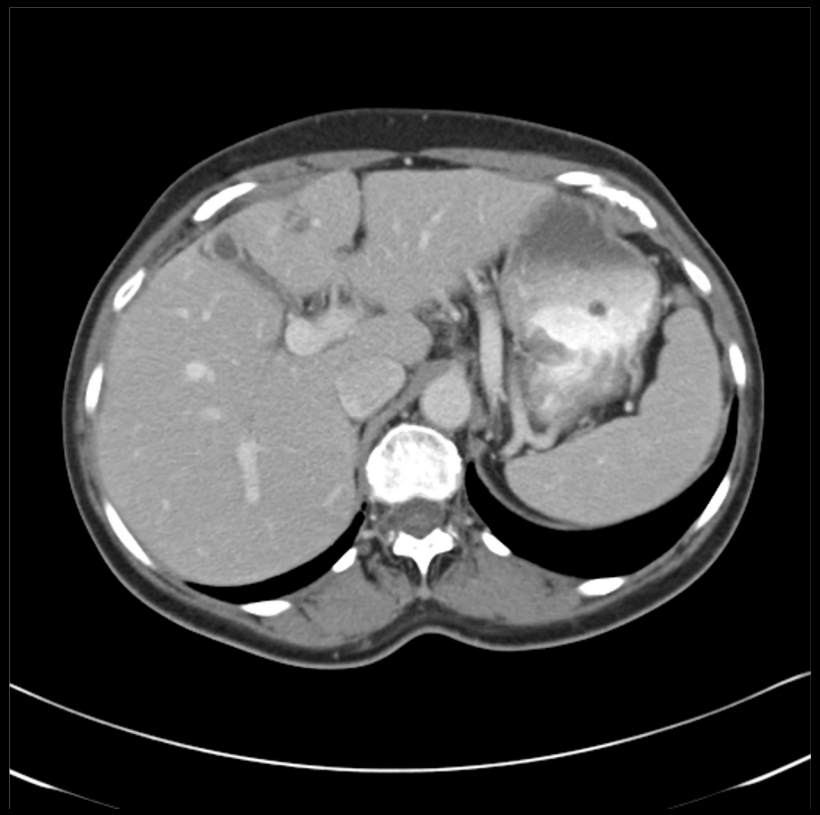
IRE

IRE

Post-procedure



3 month follow-up

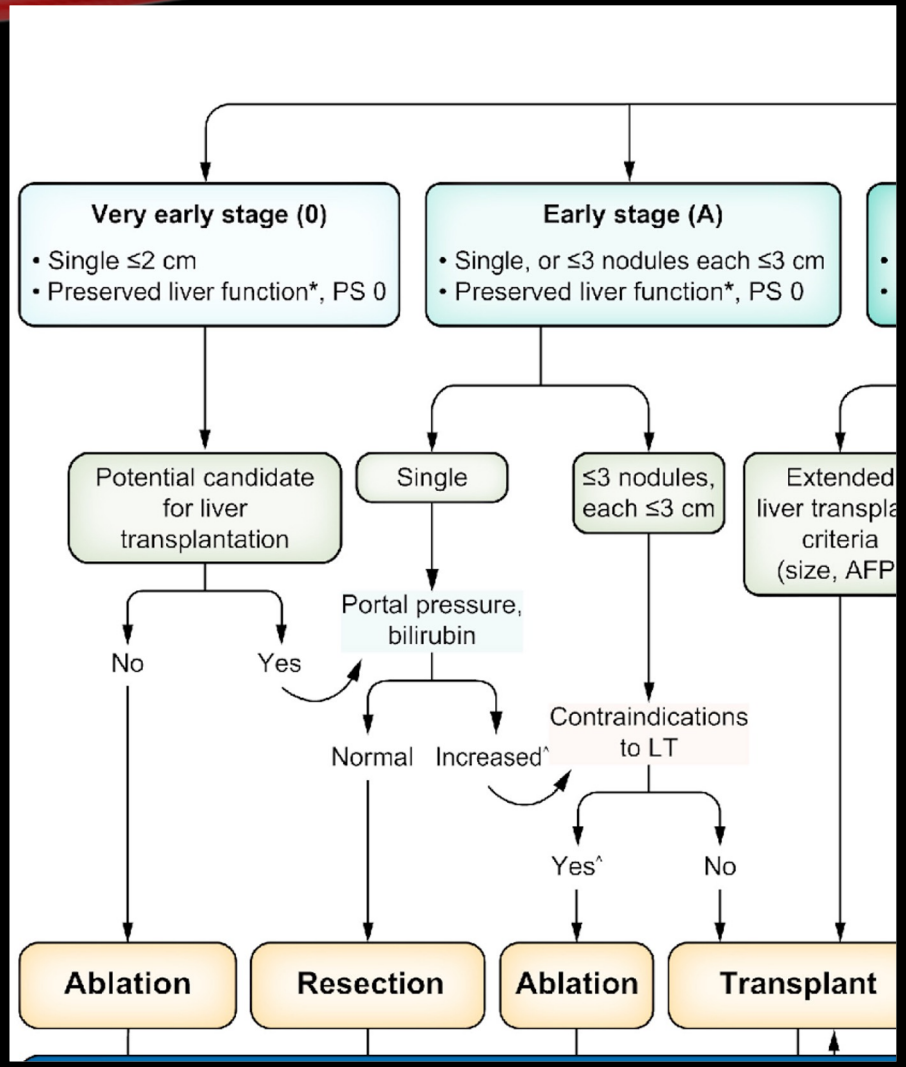


ABLATIONS

- Single day procedure (may need multiple sessions)
- Outpatient procedure, rarely admitted for 24-hour observation
- Minimally-invasive single or multiple percutaneous probes (needles)
- General anesthesia for heat thermal ablations and IRE
- Cryoablation under sedation

- Pre-procedure
  - MELD, Child-Pugh score
  - ECOG status
  - Routine labs (coagulation profile, liver function, etc)

WHEN TO USE ABLATIONS?



- Liver-HCC (BCLC 2022 update)
  - Very early stage (0)
    - Single ≤2 cm with preserved liver function AND contraindications to transplant
  - Early stage (A)
    - Single lesion ≤ 3 cm with increased portal pressure and bilirubin levels
    - ≤ 3 nodules ≤ 3 cm each with preserved liver function AND contraindications to transplant
- Bridge to transplant
- Downstage to transplant

Reig et al. Journal of Hepatology 2022; 76: 681-693

WHEN TO USE ABLATIONS

- Metastatic disease
  - Palliative
  - Small lesions < 5 cm
  - Few lesions < 3-5

  - New data states its equivalent to surgical resection in small single lesions, <3 cm
  - For more than 3 lesions, intra-arterial therapies may be better

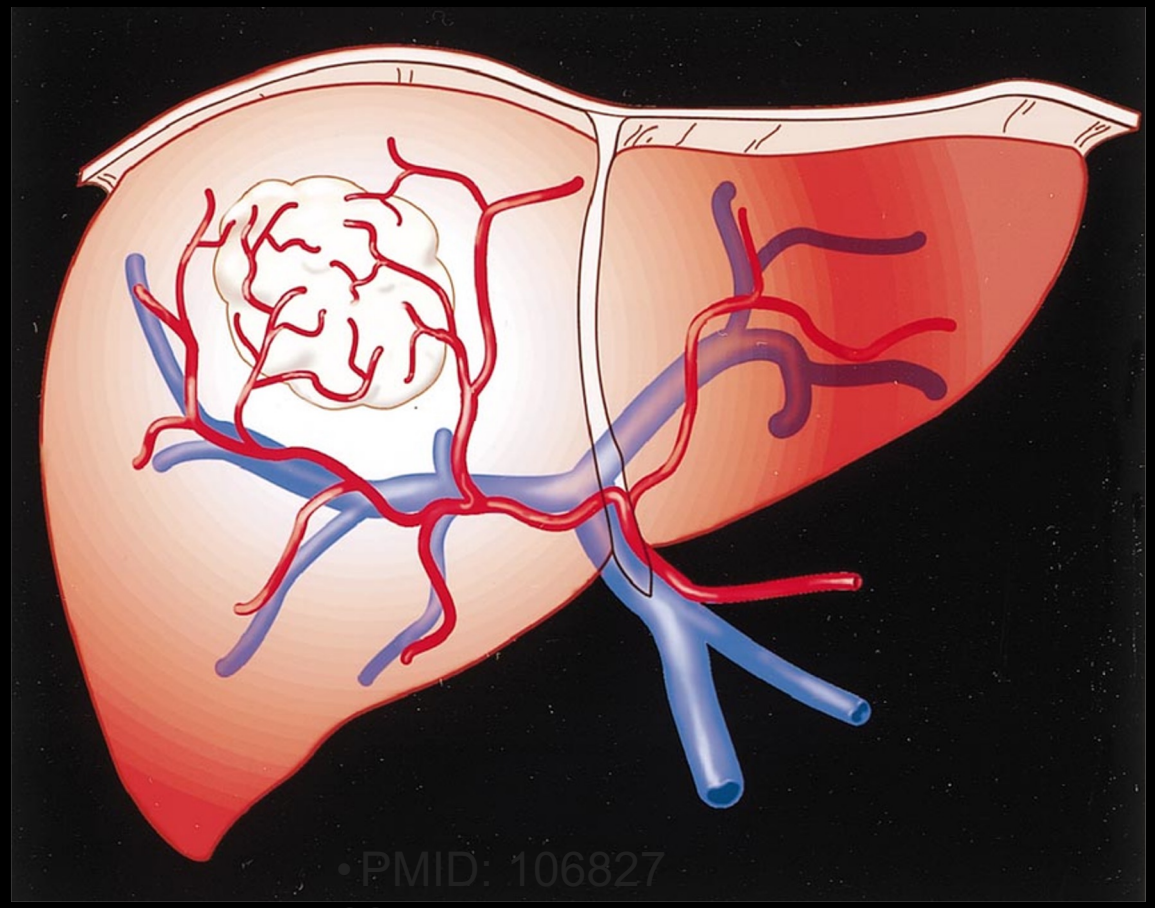
*We are treating visible disease, but there is usually occult or microscopic disease

Sutter et al. Radiology; 284: 3

INTRA-ARTERIAL THERAPIES

- TACE
- Y90 radioembolization

- Liver has dual blood supply
- Tumor fed by arterial system (also biliary system)
- Hepatocytes fed mainly by portal system



TACE

- Administer potent chemotherapeutic agent into the hepatic arteries supplying tumor followed by or with an embolic agent
  - Expose tumor to high local chemotherapy concentrations with minimal systemic bioavailability
  - Prevents washout of drug
  - Induces ischemic necrosis
    - Failure of transmembrane pumps in tumor cells creating greater absorption of chemotherapy
- Mainly selective due to embolization (could be done lobar but better to perform other modalities)
  - Tumor needs to be visible

Lewandowski et al. Radiology; 259: 3: 2011

TACE

- Pros
  - Better for HCC and neuroendocrine tumors (arterial enhancement = visible tumors)
  - Less complications from non target embolization
  - Cheaper than Y90
- Cons
  - Small number of lesions (selective treatment)
  - Post-embolic syndrome (Pain, nausea, vomiting, fever)
  - Bilomas (depending on portal vein patency)

TACE

- Radial or femoral approach
- Single day procedure (may be multiple sessions)
- May need to admit for 24-hour observation (post embolic syndrome)
- Follow-up imaging at 4-8 weeks

- Pre-procedure
  - MELD, Child-Pugh score
  - ECOG status
  - Portal vein must be patent

TACE

- Indications
  - HCC
    - Doxorubicin - Miriplatin - Epirubicin
  - Metastatic disease
    - Colorectal
      - Irinotecan
    - Neuroendocrine
      - Doxorubicin
    - Breast
      - Mitomycin – Gemcitabine – Doxorubicin – 5FU

TACE

Y90

- Injection of micron-sized glass or resin microspheres loaded with Y90 radioisotope into hepatic arteries perfusing the tumor
- Y90 is pure beta emitter with mean tissue penetration of 2.5 mm
  - Allows for high radiation dose with less risk of radiation induced hepatic necrosis

Lewandowski et al. Radiology; 259: 3: 2011
Venkatanarasimha et al. Radiographics; 38: 1282-1283

Y90

- Lobar radioembolization
  - Multiple innumerable lesions
- Radiation segmentectomy
  - Lesions involving a single segment
  - High-dose radiation to single segment, treats tumor and atrophies segment
- Radiation lobectomy
  - Single lobe involvement
  - Analogous to portal vein embolization
  - Shrink diseased lobe and hypertrophy uninvolved lobe prior to surgical resection

Kishore et al. Curr Oncol Rep 2017; 19: 40

Y90

- Pros
  - Post-embolic syndrome unlikely
  - Single lesion (segmentecomy)
  - Lobar treatment
  - Lobectomy
- Cons
  - Non-target radioembolization at GI tract
  - Radiation pneumonitis
  - Radiation cholecystitis
  - Post-radiation syndrome
  - Expensive

Y90

- Two or three stage (outpatient) procedure
- Radial or femoral approach
    1. Mapping
        - Evaluate anatomy
        - Embolize branches that may cause potential non-target embolization
        - Evaluate lung shunt to calculate dose
    2. Y90 delivery
        - One lobe at a time separated by 30 day treatment free interval

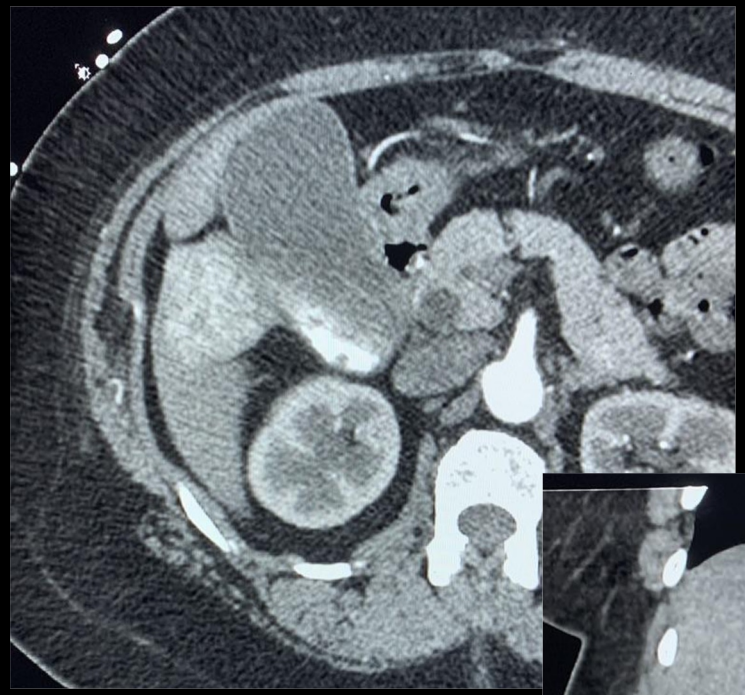
- Follow-up imaging at 3 months

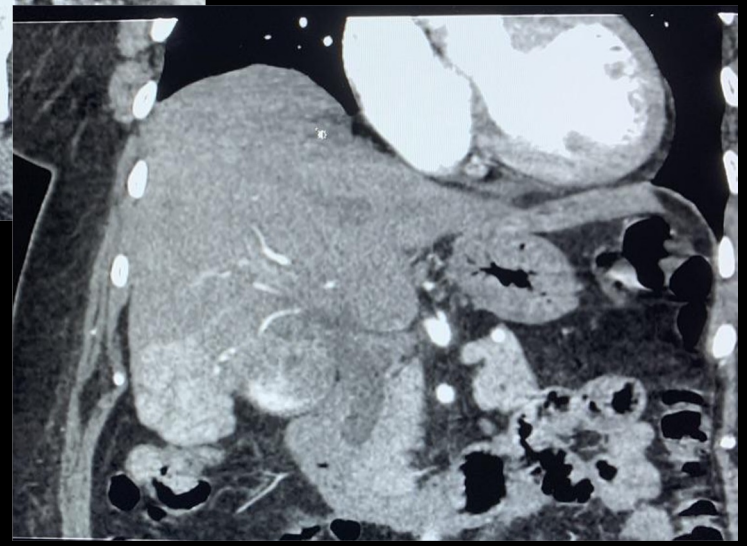
Y90

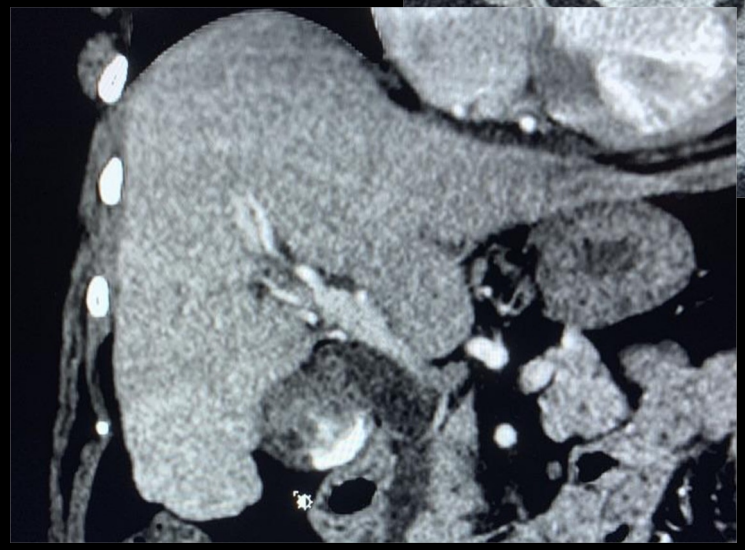
- Pre-procedure
  - MELD, Child-Pugh score
  - ECOG status
  - Routine labs (LFT's, coagulation profile, etc)
    - Total bilirubin < 2.0 mg/dL and not trending up

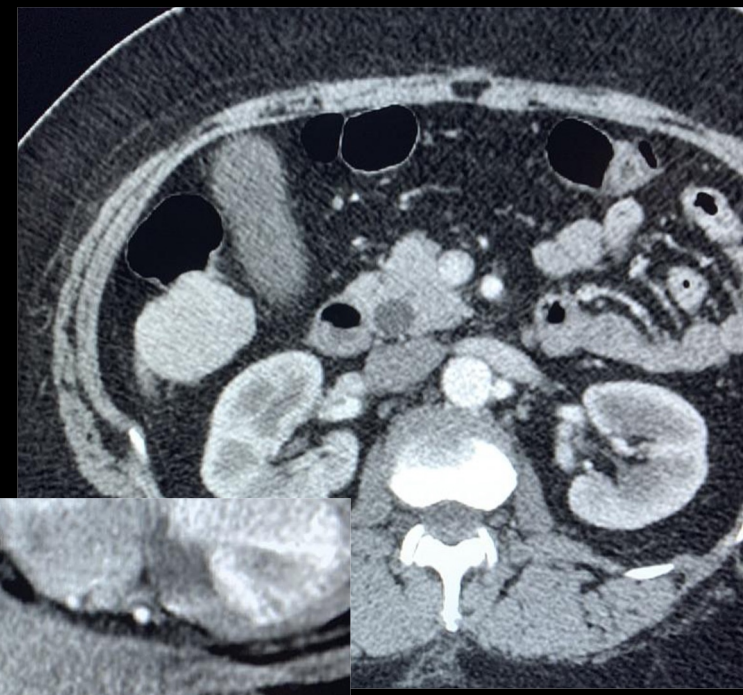
Y90

65 year old
Biopsy proven segment VI HCC 5 cm
Elevated AFP





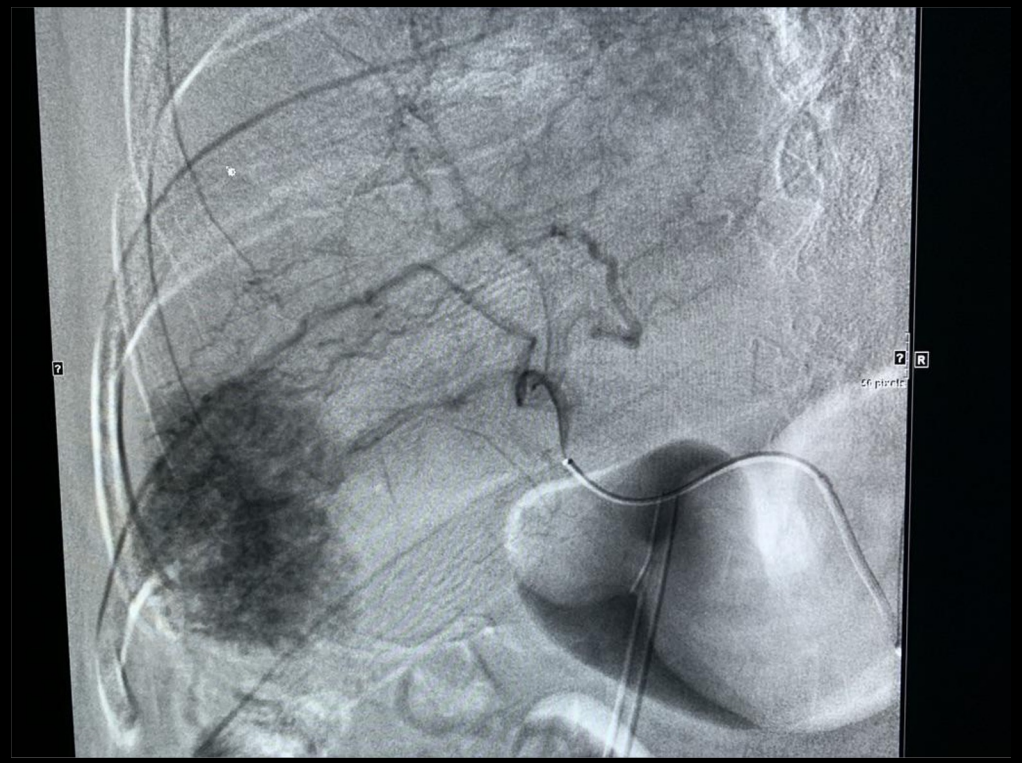


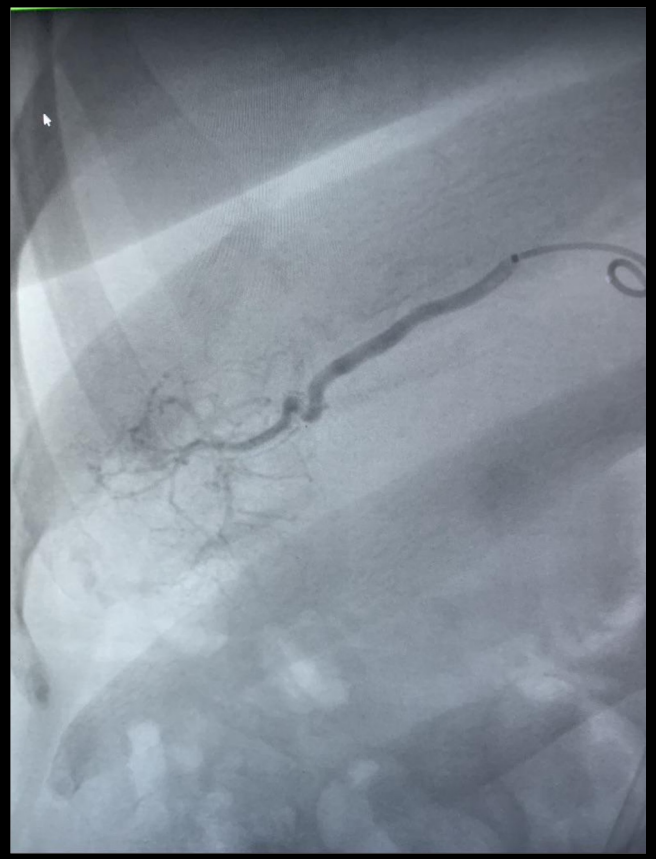


Y90

Mapping

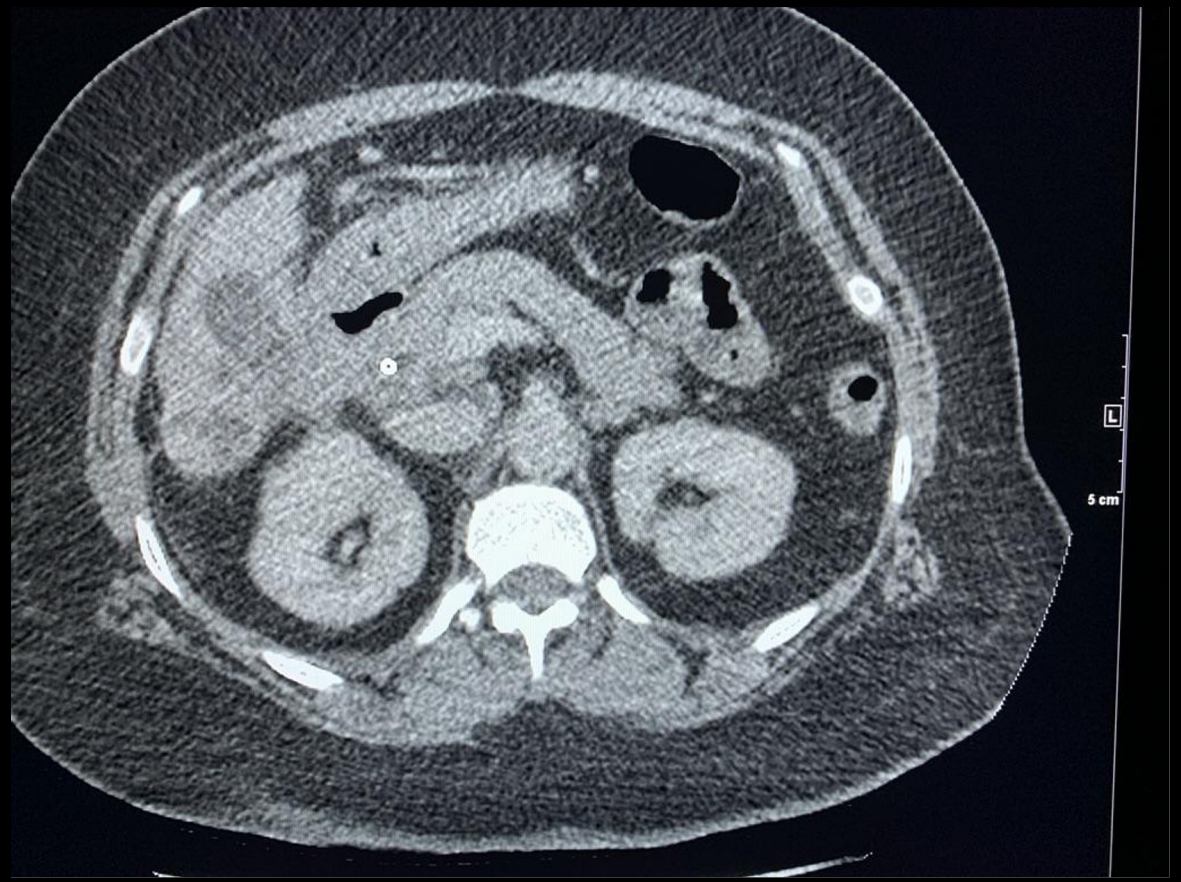
Y90





Segmentectomy

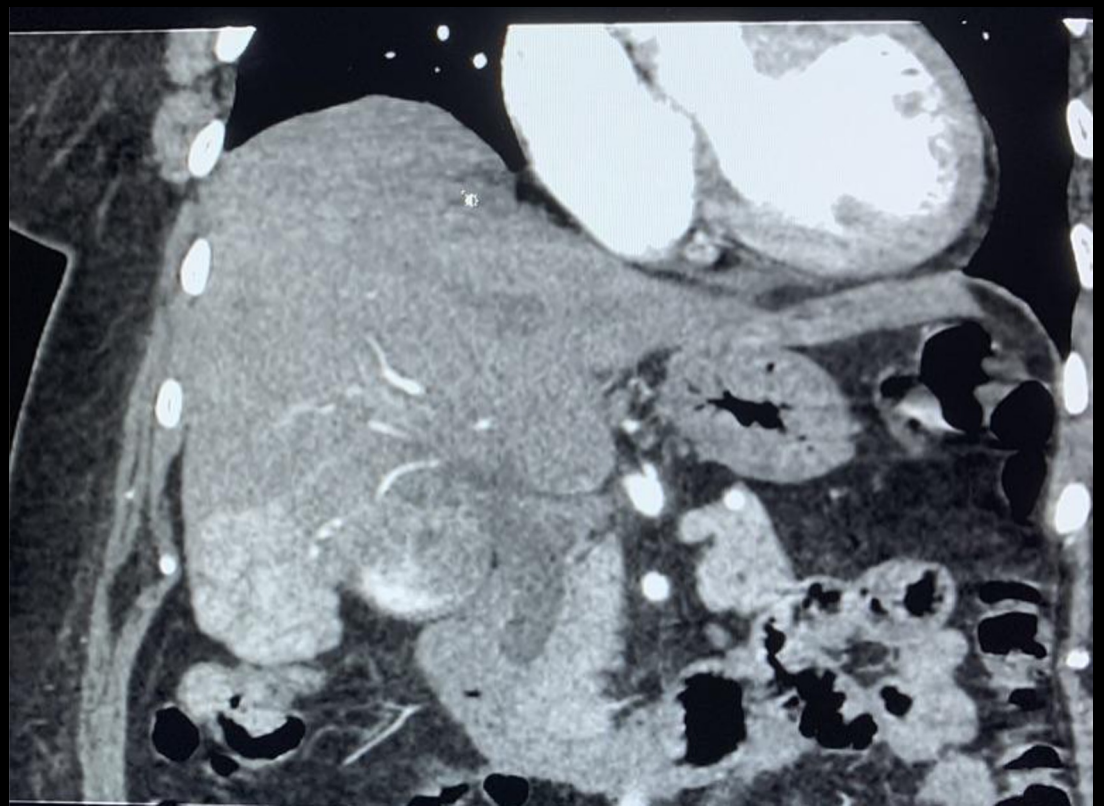
Y90



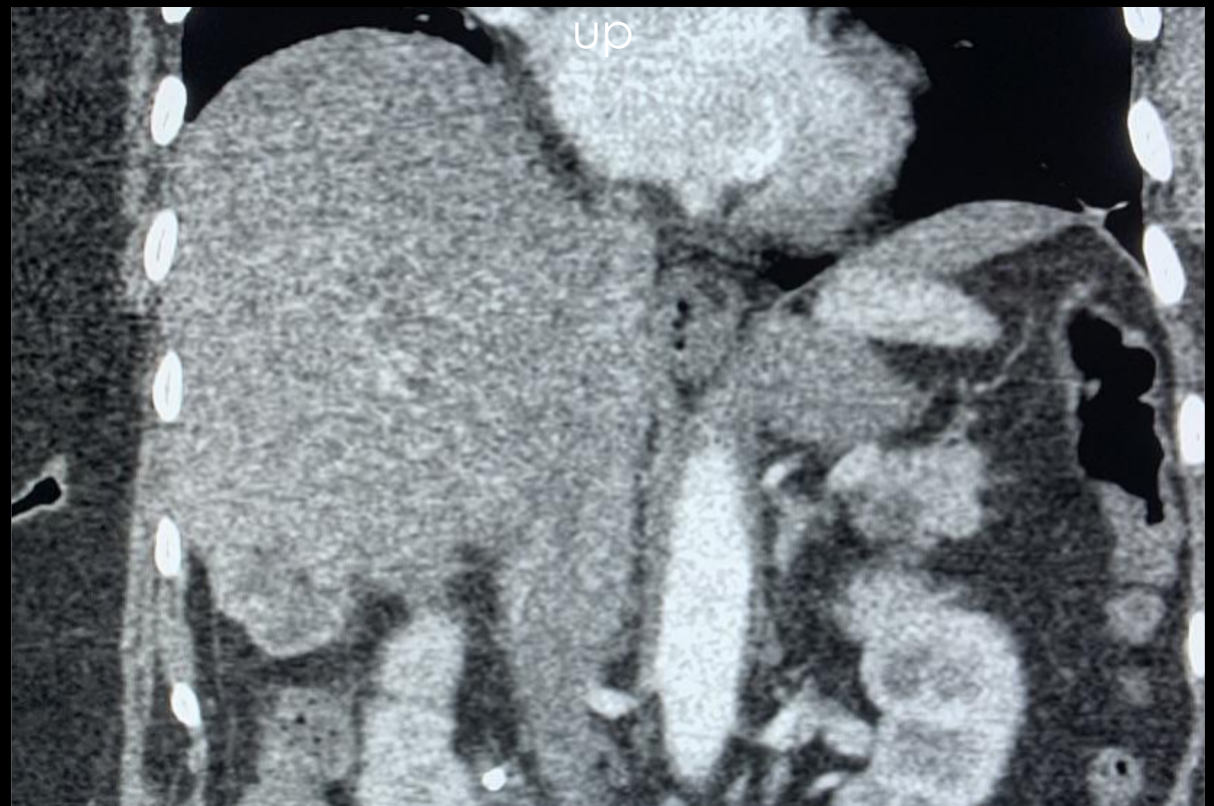
3 month follow-up

Y90

Initial



Follow-up



WILL IT INTERFERE WITH SYSTEMIC THERAPIES?

Table 1 Systemic therapies and their potential toxicities when combined with SIRT

Drug name	Potential effects when combined with SIRT		References/ongoing studies, NCT[a] ID	Recommendation
	Synergy	Toxicity		
Chemotherapy agents				
5FU	Radiosensitization	Liver toxicity	Hendlisz *et al.* 2010 (14)/–	No safety concerns
Capecitabine	Radiosensitization	Liver toxicity	Cohen *et al.* 2014 (26)/–	Capecitabine 1,000 mg/m^2 bid is recommended for phase II study
Oxaliplatin, platinum	Radiosensitization	Liver toxicity	Sharma *et al.* 2007 (18)/ NCT02807181	Reduced dose as used in SIRFLOX
Irinotecan	Radiosensitization	Liver toxicity	Gulec *et al.* 2014 (27), van Hazel *et al.* 2009 (16)/–	Irinotecan 100 mg/m^2 on days 1 and 8 of a 3-week cycle is recommended
TAS 102	Radiosensitization	Liver toxicity	–/NCT02602327	SCT[b]
Taxanes	Radiosensitization	Unknown	Unknown	Unknown
Gemcitabine	Radiosensitization	Unknown	Iñarrairaegui *et al.* 2015 (28)/NCT02807181	SCT
Octreotide	Radiosensitization	None	Kennedy *et al.* 2015 (29)/–	No safety concerns
Lanreotide	Radiosensitization	None	–/NCT02859064	SCT
Temozolomide	Radiosensitization	Unknown	Unknown	Unknown

J Gastrointest Oncol 2017;8(6):1079-1099

SUMMARY

- Ablations
  - Small lesions < 3 lesions
- TACE
  - Small number of larger lesions (selective intra-arterial procedure)
- Y90
  - Multiple lesions (lobar procedure)
  - Segmentectomy for large single segment lesions
  - Radiation lobectomy to assist surgical lobectomy

THANK YOU!