
*Trattamento non chirurgico delle oligometastasi: Fegato*

# ***Termoablazione percutanea***

Mariano Quartini

S.C. Epatologia e Gastroenterologia

A.O. “S.Maria” - Terni

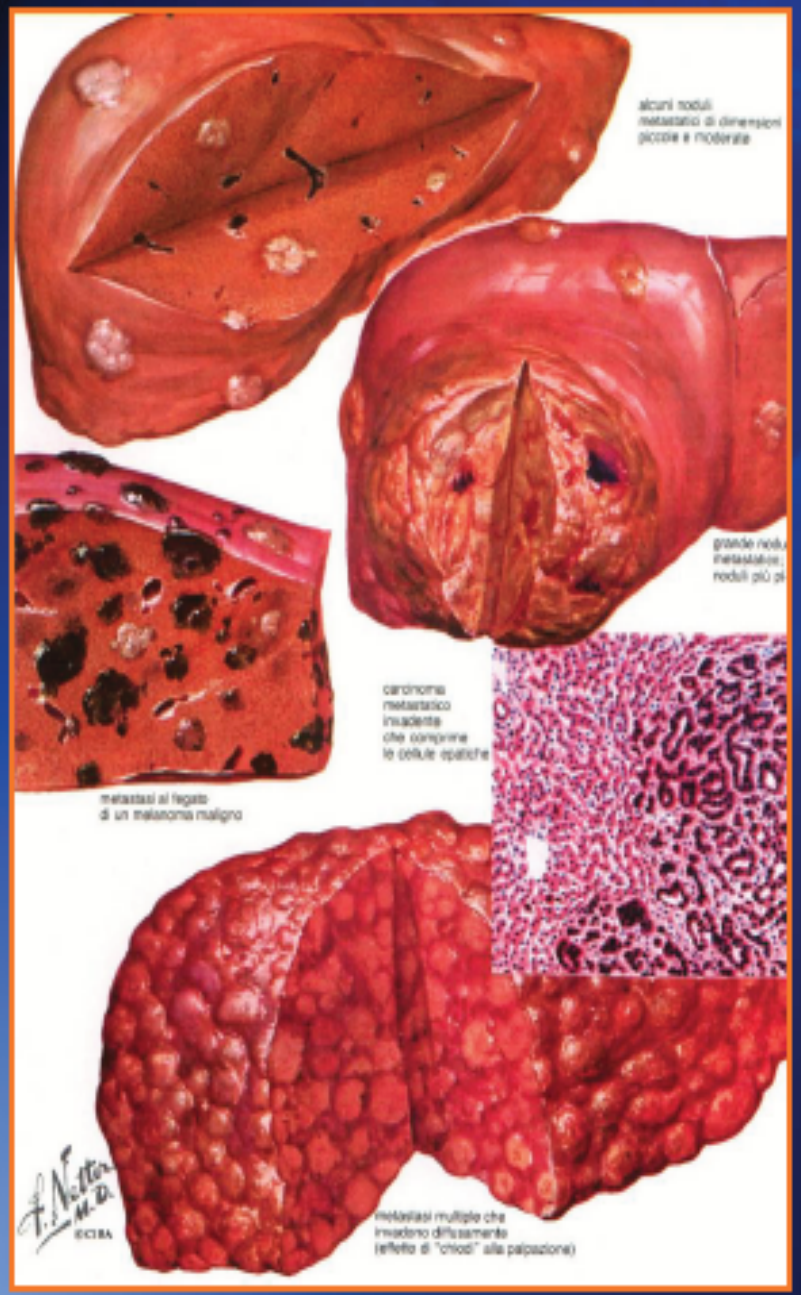
# P. Valdoni
# Manuale di Patologia Chirurgica
# III Edizione - 1961

"I tumori del fegato sono rari ed hanno essenzialmente interesse anatomo-patologico.."

# METASTASI EPATICHE

- La percentuale di resecabilità chirurgica è bassa (10-20%)
- Nelle forme sottoposte a resezione chirurgica, la sopravvivenza a 5 anni e' variabile dal 20% al 30%
- La mediana della sopravvivenza e' influenzata dalla radicalità della resezione con un rischio di morbilità e mortalità del 7%
- Nelle forme non resecabili, nessun pz. sopravvive a 5 anni
- Il trattamento standard delle forme non resecabili è la chemioterapia sistemica

# METASTASI EPATICHE




## Fattori che condizionano la terapia

NEOPLASIA PRIMARIA

MONOLOBARI BILOBARI

UNICHE MULTIPLE

SINCRONE METACRONE

DIAMETRO PROFONDITA'

# Rationale for Ablation

* Many patients ineligible for surgery
* Comorbidities
- ✓ Repeatability
- ✓ Low-risk
- ✓ High local efficacy for small mets
- ✓ Limited loss of non-neoplastic tissue
- ✓ Low cost

# EFFETTI delle TERAPIE INTERVENTISTICHE sui BERSAGLI NEOPLASTICI

* Devascolarizzazione (intravascolari e termiche)
* Aumento di consistenza (stiffness) (termiche)
* *Possibile riduzione di volume*
* Estensione del trattamento al tessuto peritumorale («safety halo») (termiche)

# Ablation

- Goal is to destroy abnormal tissue and a "surgical margin" of normal tissue 5 - 10 mm
- Minimal ablative margin minimizes damage to normal tissue
- Conservation of adjacent tissue vs resection
  - Cirrhotic liver

# History: Thermal Cancer Therapy

- Hot oil treatment of tumors described in 5000 y.o Egyptian papyrus

- "…… What is not cured by knife is cured by fire"

  Hippocrates

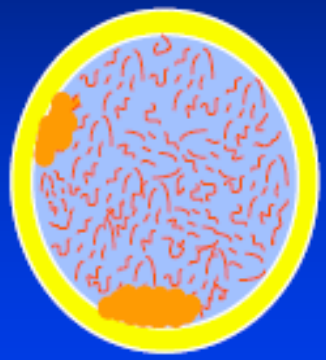
- Tumor´´ cautery´´ used for numerous cancer types over past 400 years
- Electrocautery destruction of superficial and endothelial malignancies over past 120 years
- More recently, cryoablation, laser photocoagulation, radiofrequency ablation and microwave coagulation

# Categories

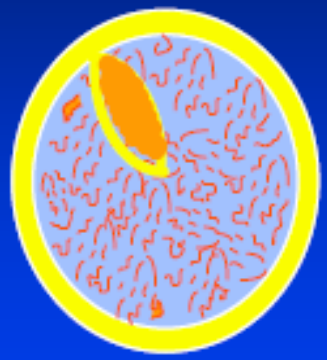
- Non Thermal
  - Injectable: chemical (alcohol-acetic acid)
  - Irreversible Electroporation, is emerging as option
- Thermal
  - Heat: RFA, is predominant

    Laser-Microwave-HIFU, are much less popular
  - Cold: Cryo, is much less popular

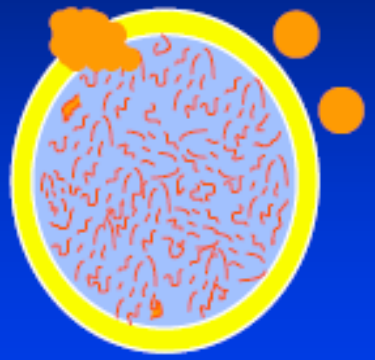
# Limitations of Ethanol Injection



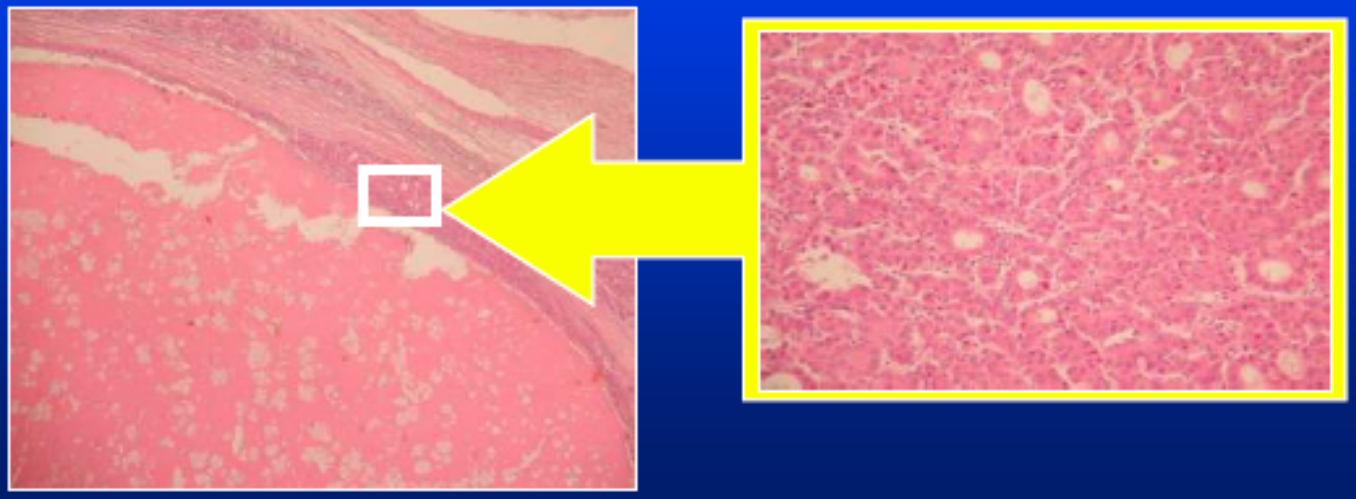
Inhomogeneous perfusion



Intratumoral septa

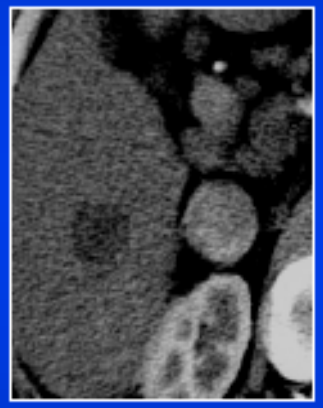


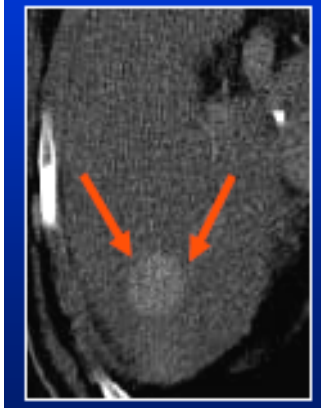
Extracapsular spread
Satellite nodules



# Limitations of Ethanol Injection

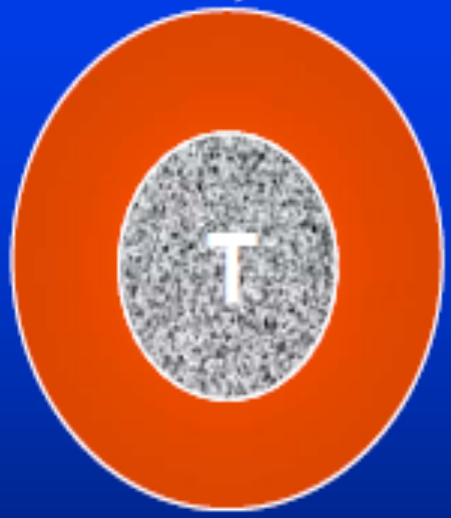
PEI





RFA

Safety margin



# Thermal Ablation

- Heat kills, cold kills, although slightly differently
- Heat
  - Radio-frequency Ablation
  - Laser Ablation
  - Microwave Ablation
  - High Intensity Focused Ultrasound
- Cold
  - Cryoablation

# Thermal Ablation Therapy:
## Temperature Tissue Interactions

- 35 - 40 ° C  Normothermia
- 42 - 46 ° C  Hyperthermia
- 46 - 48 ° C  Irreversible cellular damage 45 min
- 50 - 52 ° C  Coagulation necrosis, 4-6 min
- 60-100 ° C  Near instantaneous coag necrosis
- > 110 ° C  Tissue vaporization

# Mechanism of Cell Death

- Hyperthermia
  - alters structure of the cell membrane
  - drives intra & extra cellular water out of tissue resulting in coagulative necrosis
- Denature cytoskeleton and altering cellular architecture
- Impairment in DNA replication

# RFA

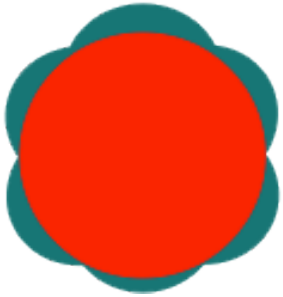
- Similar to Electrocautery
  - No heat flows directly from the device
- High frequency alternating current
- Ionic agitation
- Frictional heating
- Tissue near electrode

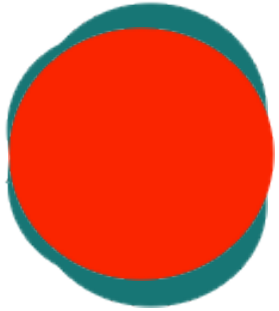
# Stages of RF Ablation

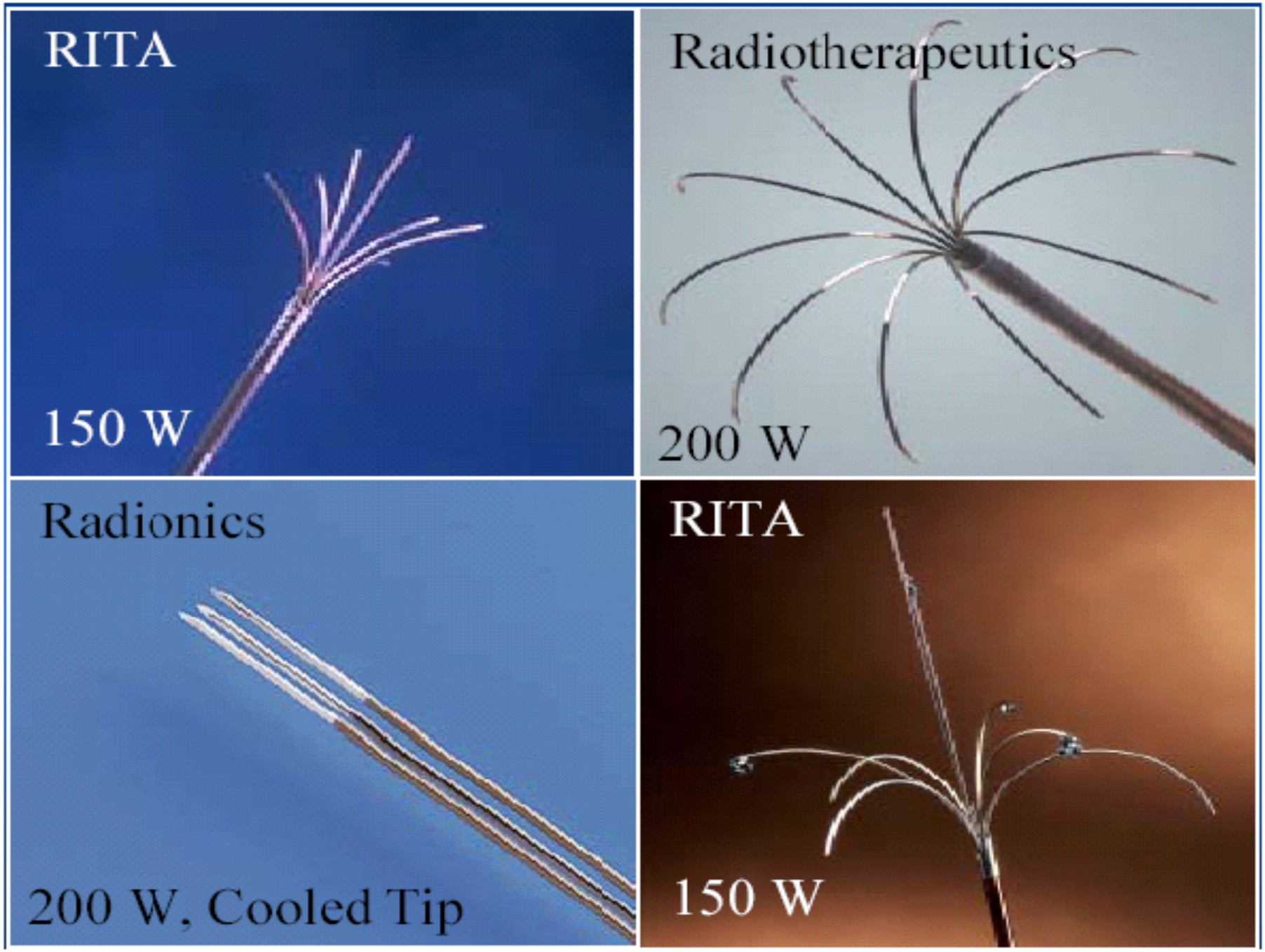
Frictional Heating

Conductive Heating

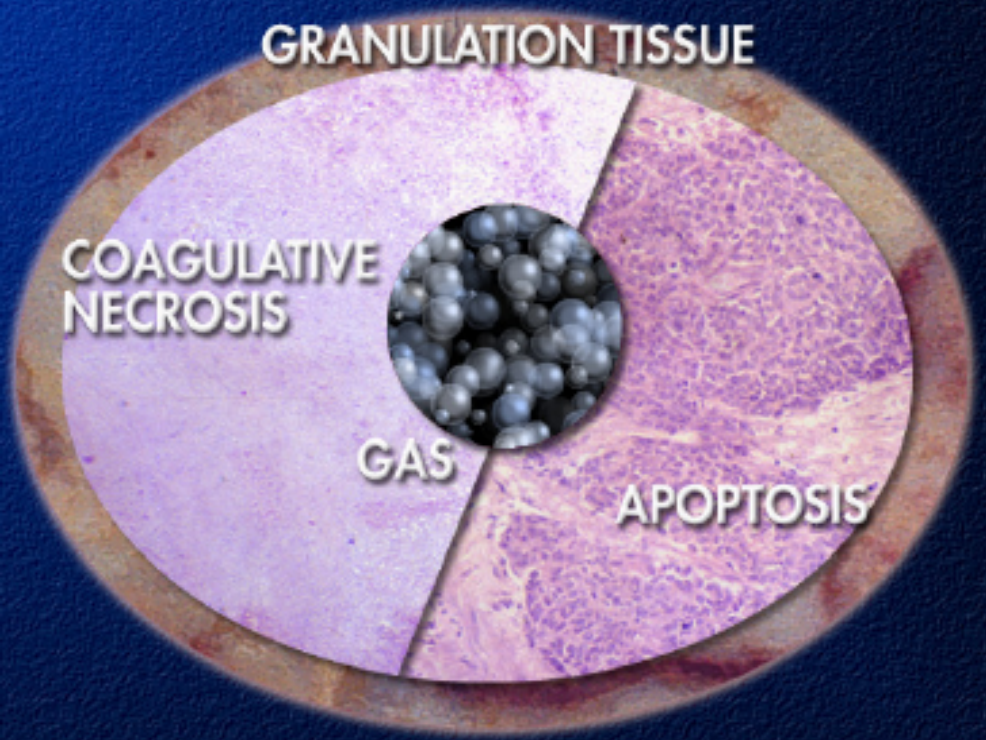
**Conduction Over Time . . .**

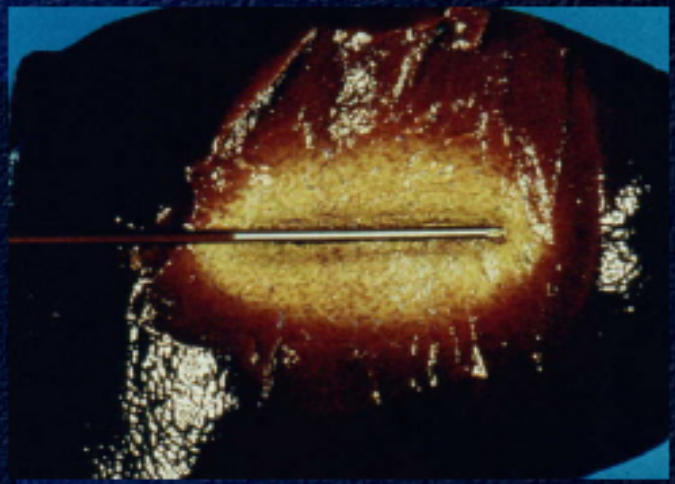





RITA
150 W
Radiotherapeutics
200 W
Radionics
200 W, Cooled Tip
RITA
150 W

## PATHOLOGIC CHANGES



DISRUPTION OF BLOOD VESSELS

# RFA

- Cytokines and stress response
  - Interleukins and TNF are increased
  - Heat shock protein expression
- Cellular immunity
  - Increased activated T cells/ circulating NK cells
- Trials of immunomodulators are underway
- Insufficient RFA promotes angiogenesis of residual HCC

# Percutaneous RFA - Advantages

- Least invasive approach
- Analgo-sedation in most cases
- Short treatment time: 10-30 minutes
- Early discharge after ablation procedure (1-2 days)
- Low morbidity and mortality
- Low cost (~ € 1500 for materials)

# Cost-effectiveness of RFA vs Hepatic Resection

| Treatment | FU testing and treatment (mo) | #Mets treated | Cost/pt |
|---|---|---|---|
| RFA | 12 | 6 | 24,800 |
| Resection | 12 | 6 | 61,000 |

State Transition Decision Model – Disease Extent, Post Treatment Imaging

Gazelle et al: radiology;2004:729

# RFA
# Complications

- Liver abscess
- Pleural effusions
- Pneumothorax
- Subcapsular hematomas
- Acute renal insufficiency
- Hemoperitoneum
- Needle tract seeding
- Post-ablation syndrome

# Complication Rates

Morbidity: 2.2 %

Mortality: 0.2 %

*(Sorensen, 2007 – Timmermann, 2009)*

# Ablation of CRC LIVER METASTASES

- Percutaneous imaging-guided
- Laparoscopic
- Intraoperative

- Only treatment
- With CTX (pre-, during, post-)
  - Systemic IV
  - Intra-arterial
  - IV liposomial

- With resection
  - Simultaneous
  - Two - stage
  - After PV embolization

- **Local control**
- Impact on cure (survival rates)

- Advantages and drawbacks
- Currently available literature data
- Developments and improvements

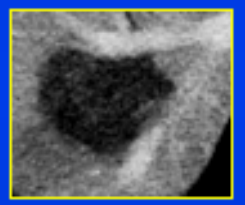
# **Local control**: critical issues

Lack of capsule
Infiltrative growth
Normal liver tissue around

→ NO "oven effect"

↓

Variable (unpredictable) size and shape of necrosis area
Heat sink effect of blood vessels **(with RFA)**



Occult (microscopic) invasion within 10 mm
from the edge of the tumor in 22% of lesion<4 cm, and in 85% of lesions >4 cm *(Shirabe et al, Brit J Surg, 1997)*

↓

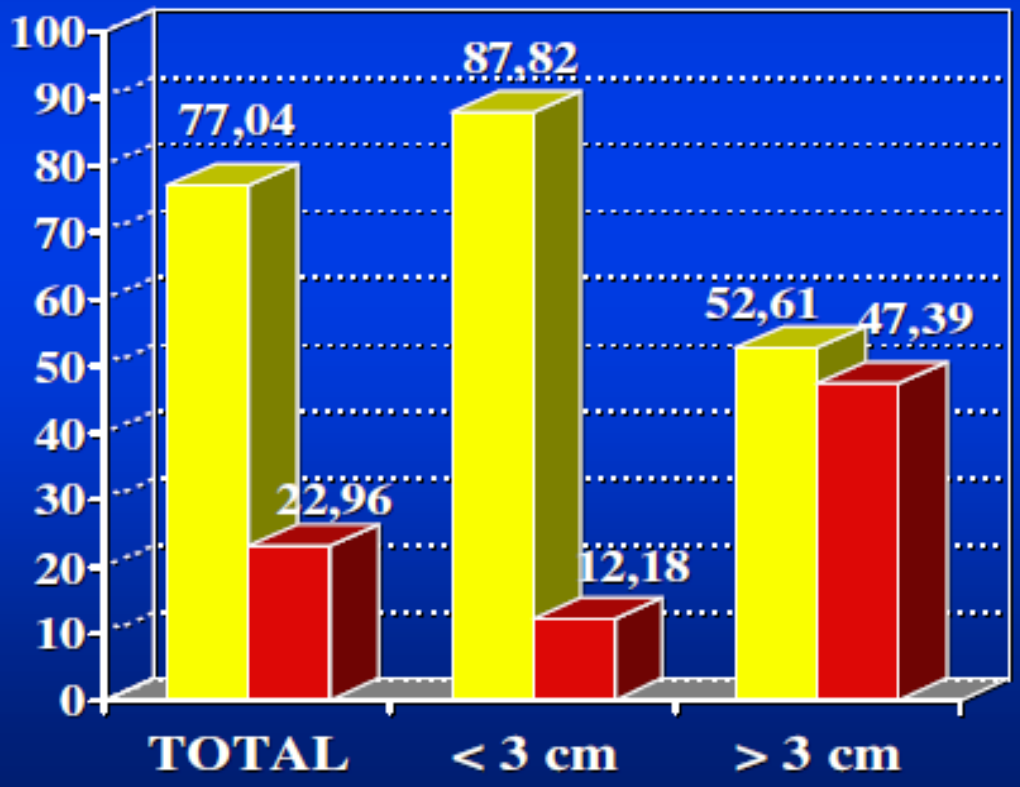
Need for large necrotic areas **(thick "safety halo")**

*(1 cm Ø → 2 cm Ø = volume x 8)*

Luigi Solbiati, MD
Tito Livraghi, MD
S. Nahum Goldberg, MD
Tiziana Ierace, MD
Franca Meloni, MD
Marina Dellanoce, MD
Luca Cova, MD
Elkan F. Halpern, PhD
G. Scott Gazelle, MD, MPH, PhD

**Percutaneous Radio-frequency Ablation of Hepatic Metastases from Colorectal Cancer: Long-term Results in 117 Patients**[1]

Radiology, Oct 2001


Local control

Local

## Overview of local control rates of liver metastases treated with RFA

| Size | Local control rate (A0) | # cases |
|---|---|---|
| **CRC > 5 cm** | **41.9%** | **31** |
| **CRC 3-5 cm** | **74.5%** | **106** |
| **CRC < 3 cm** | **85.9%** | **1680** |

Major issue of RFA

**LOW**

local control rate for lesions **> 3 cm**

*Mulier S, et al. Ann Surg 2005*

# Local control rate: improvements

Larger ablation volumes with thicker safety margins

Energy sources that minimize heat sink effect

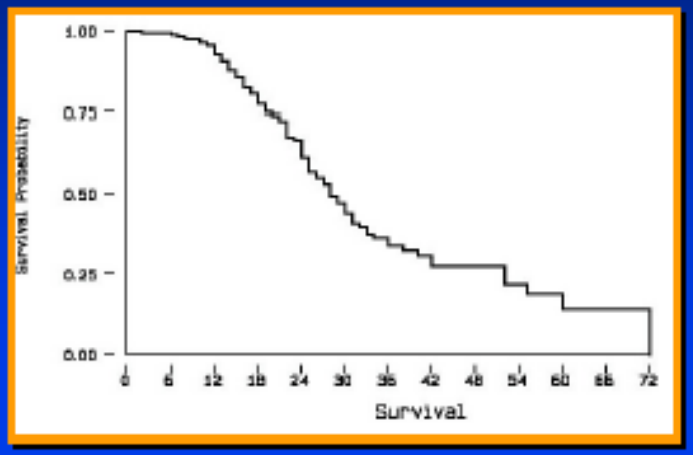
Precise treatments of small mets

# TOPICS

- Local control
- **Impact on cure (survival rates)**

- Advantages and drawbacks
- Currently available literature data
- Developments and improvements

# 1995 - 2000




Luigi Solbiati, MD
Tito Livraghi, MD
S. Nahum Goldberg, MD
Tiziana Ierace, MD
Franca Meloni, MD
Marina Dellanoce, MD
Luca Cova, MD
Elkan F. Halpern, PhD
G. Scott Gazelle, MD, MPH, PhD

**Percutaneous Radio-frequency Ablation of Hepatic Metastases from Colorectal Cancer: Long-term Results in 117 Patients[1]**

Radiology, Oct 2001

1-yr: 93 %

3-yr: 35 %

5-yr: 14 %

ESTIMATE MEDIAN SURVIVAL : 28 months

**LONG TERM SURVIVAL AFTER RFA FOR COLORECTAL CANCER LIVER METASTASES: LITERATURE REVIEW**

| Author | No pz | No. mets | Technique | Median Survival (mo) | 3- yr Survival (%) | 5-yr Survival (%) |
|---|---|---|---|---|---|---|
| Solbiati et al 2006 | 128 | 261 | Percutaneous | ng | 62 | 39.5 |
| Berber et al 2005 | 135 | 432 | Laparoscopic | 28.9 | 35 | ng |
| Veltri A, 2005 | 98 | 163 | Percutaneous laparotomic | ng | 48 | 30 |
| Tumor RFA Italian Network(Lencioni) 2005 | 423 | 543 | Percutaneous | ng | 47 | 24 |
| Jakobs et al 2006 | 68 | 183 | Percutaneous | ng | 68 | ng |
| Siperstein et al 2007 | 234 | 292 | Laparoscopic | 24 | 20.2 | 18.4 |
| Sorensen et al 2007 | 102 | 332 | Percutaneous | 52 | 64 | 44 |
| Gillams et al 2008 | 309 | 617 | Percutaneous | 27 | ng | 24-33 |

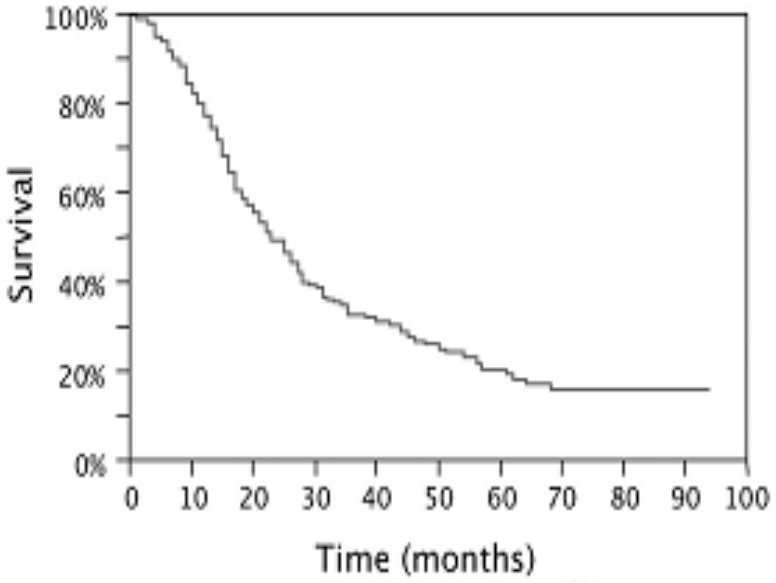



**FIGURE 1.** A Kaplan-Meier survival curve of 234 patients undergoing radiofrequency ablation, with a **median survival** of **24 months**.

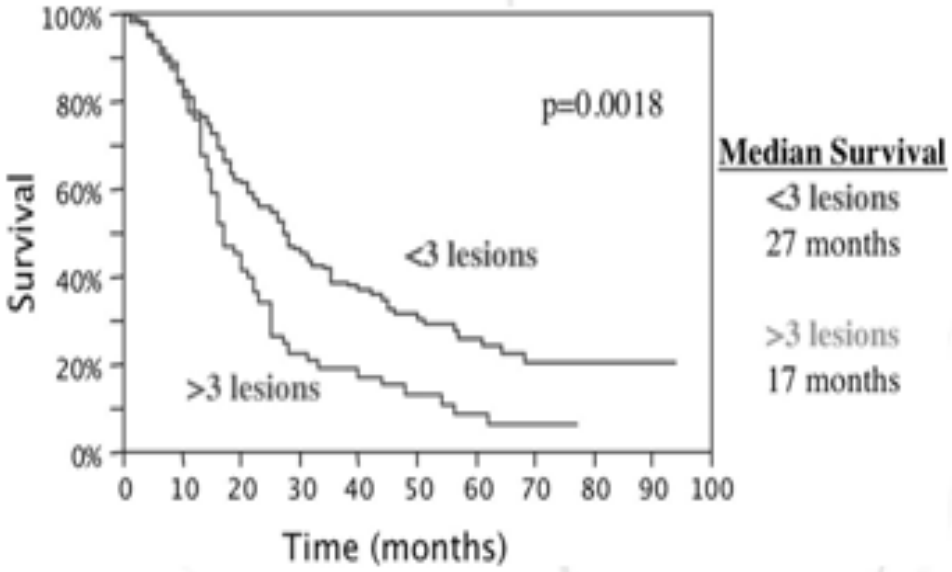



**FIGURE 2.** A significant survival difference based on the number of lesions presenting for ablation.
1, 2 and 3 lesions: **27 months median survival**
> 3 lesions: **17 months median survival**

*Allan E. Sipeerstein, MD, Eren Berber, MD, Naveen Baller, MD, and Rikesh T. Parikh, MD.* Survival After Radiofrequency Ablation of Colorectal Liver Metastases *10-Year Experience. Annals of Surgery* • Volume 246, Number 4, October 2007

# Long-Term Outcome of Radiofrequency Ablation for Unresectable Liver Metastases from Colorectal Cancer: Evaluation of Prognostic Factors and Effectiveness in First- and Second-Line Management

Junji Machi, MD, PhD,[1] Andrew J. Oishi, MD,[1] Kenneth Sumida, MD,[1] Kazuhiro Sakamoto, MD, PhD,[1] Nancy L. Furumoto, MD,[2] Robert H. Oishi, MD,[2] *Honolulu, Hawaii*, Jelle W. Kylstra, MD,[3] *Fremont, California*

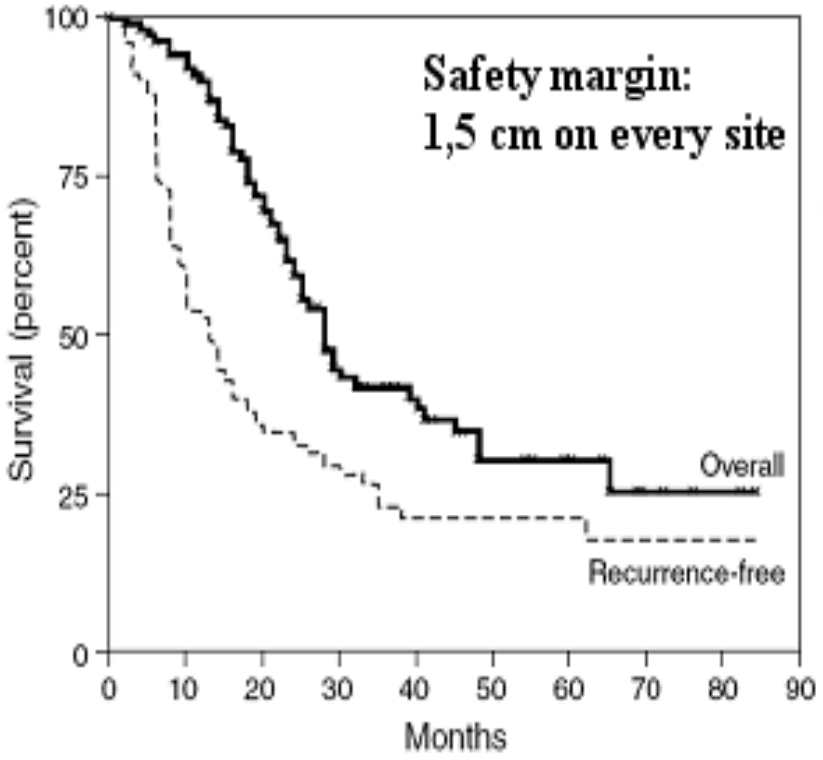



**Figure 1.** The **overall median survival** of the 100 patients was **28 months** and the **recurrece-free survival 13 months**.

# Patient Survival:

1 Year: **53.0%**

2 Year: **23.2%**

5 Year: **21.7%**

# Small Liver Colorectal Metastases Treated with Percutaneous Radiofrequency Ablation: Local Response Rate and Long-term Survival with Up to 10-year Follow-up[1]

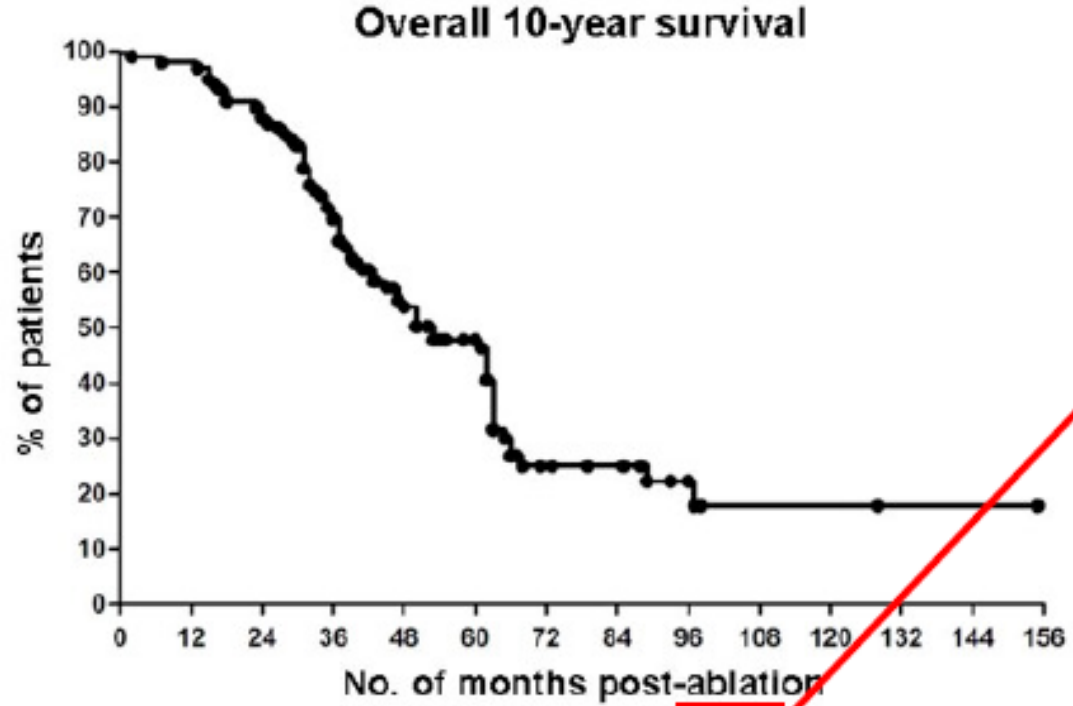
Luigi Solbiati, MD
Muneeb Ahmed, MD
Luca Cova, MD
Tiziana Ierace, MD
Michela Brioschi, MD
S. Nahum Goldberg, MD

Radiology

*radiology.rsna.org* ▪ ***Radiology:*** Volume 265: Number 3—December 2012

# July 1999 – June 2010:

- 99 patients with 202 mets at the time of 1st RFA




| Years | 1 | 3 | 5 | 7 | 10+ |
|---|---|---|---|---|---|
| % patients alive | 96.9 | 69.9 | 47.8 | 25.0 | 18.0 |

5-yr: 47.8%

# Long-term results of laser ablation of liver metastases of breast cancer.

- 279 patients (age range : 23-80 yrs, mean 54.8) with 671 mets
- indications to ablation : recurrences after surgery (7.7%), mets in both liver lobes (46.2%), refused surgery (25.6%), contraindications for surgery (2.2%), difficult location for surgery (18.3%)
- 41.8% of mets smaller than 2 cm, 10.4% larger than 4 cm
- mean survival : 4.5 yrs after the first LITT treatment (95% CI 4.5-5.5 yrs, median 3.4 yrs)
- 1-, 2-, 3- and 5-year survival after the first LITT treatment : 86%, 68%, 54% and 36%

*Mack MG, et al. Proceedings RSNA 2005: p 437*

# Radiofrequency ablation for the treatment of breast cancer liver metastases: long-term results in 88 patients.

- 88 patients with 180 metastases
- size range : 1.0 – 7.0 cm (mean 3.2 cm)
- indications to ablation : mets confined to the liver or associated with lung and/or bone mets stable after CTX
- f/u : 4-96 months (mean : 23.9) with CT, US and CEUS
- 1-, 3-, 5-, and 8-year survival rates : 72%, 55%, 49%, 16%
- survival related to the number of mets treated

*Meloni F, Livraghi T, Solbiati L, Cova L, Ierace T. Proceedings RSNA 2005: p 437*

## RF NET Mets

(Berber E. World J Surg 2002)

- 34 patients (palliative 28, curative 6)
  - 234 metastases, 1-16 / patient (m=5.6)
  - 0.5 -10 cm (m=2.3)
  - Symptomatic response (10.1±1.5 mois)
    - 63% complete response
    - 32% partial response
  - Local efficacy (1.6 ± 0.2 years of follow-up)
    - 3% incomplete ablation / tumor
    - 13% incomplete ablation / patients
      - Best results than for any other type of tumor ?
    - Mean diameter 4.2 ± 1.1 cm

# INDICATIONS

- **Size : < 4 cm  Number : < 5 ??**
- No extrahepatic tumor localization (exception : oligonodular lung metastases)
- Patient not eligible for surgery
- Mets potentially resectable but that would require large and/or difficult resections
- Patients who refuse surgery
- New met(s) or local progression after resection
- Partial response to CTX

- **« Test of time »**
- Ablation after successful CTX, before complete disappearance, to prevent from «rebound» after CTX

# RF ABLATION and "TEST of TIME" for CRC mets

Resection not beneficial if occult disease is present

Survival benefit from resection is determined by tumor biology rather than by early detection

*(Cady B, Semin Oncol,1991)*

"Test of Time" : 4-6 mos interval for re-evaluation of the natural course of disease with :

- statistically demonstrated advantages over immediate resection
- no survival impairment

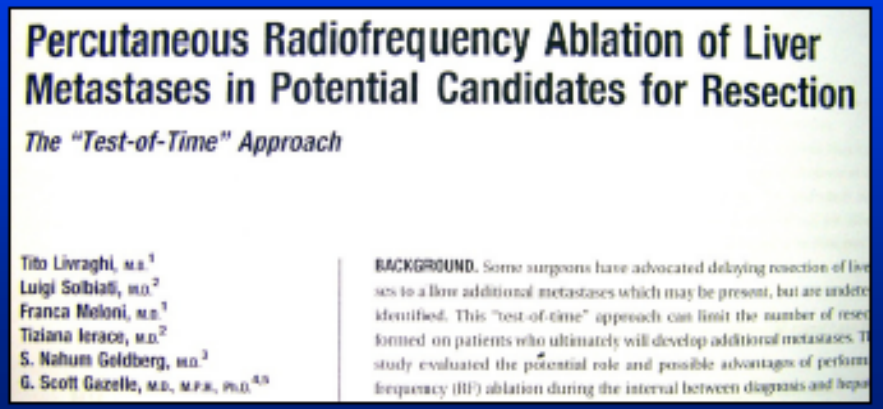
*(Lambert LA, Arch Surg,2000)*

+ Any role for RFA during test-of-time interval ?

# RF ABLATION and "TEST of TIME" for CRC mets

+ 88 potentially operable patients - 134 mets
  * max 3 lesions
  * less than 4 cm in size
  * less than 75 year-old

> F/U : 18-75 months



**Percutaneous Radiofrequency Ablation of Liver Metastases in Potential Candidates for Resection**

*The "Test-of-Time" Approach*

Tito Livraghi, M.D.[1]
Luigi Solbiati, M.D.[2]
Franca Meloni, M.D.[1]
Tiziana Ierace, M.D.[2]
S. Nahum Goldberg, M.D.[3]
G. Scott Gazelle, M.D., M.P.H., Ph.D.[4,5]

**BACKGROUND.** Some surgeons have advocated delaying resection of liv
ses to allow additional metastases which may be present, but are undete
identified. This "test-of-time" approach can limit the number of rese
formed on patients who ultimately will develop additional metastases. T
study evaluated the potential role and possible advantages of perform
frequency (RF) ablation during the interval between diagnosis and hepa

## RF ABLATION and "TEST of TIME" for CRC mets

* RFA successful in 53/88 (60.2%) pts :
  - 23/55 (43.4%) : currently disease-free
  - 29/55 (54.7%) : new intra- or extra- untreatable mets
  - 1/55 (1.8%) : resection
* RFA unsuccessful in 35/88 (39.8%) pts :
  - 20/35 (57.1%) : resection
  - 15/35 (42.9%) : untreatable mets

No patients became untreatable because of the growth of incompletely ablated lesions

+ Complications : bowel wall perforation (1)

# RF ABLATION and "TEST of TIME" for CRC mets

* 44/88 (50%) patients spared non-curative surgery (and post-operative morbidity)

* 23/88 (26.1%) additional patients avoided resection because of curative RFA

# Changes in Strategy

Strict follow-up after colorectal surgery

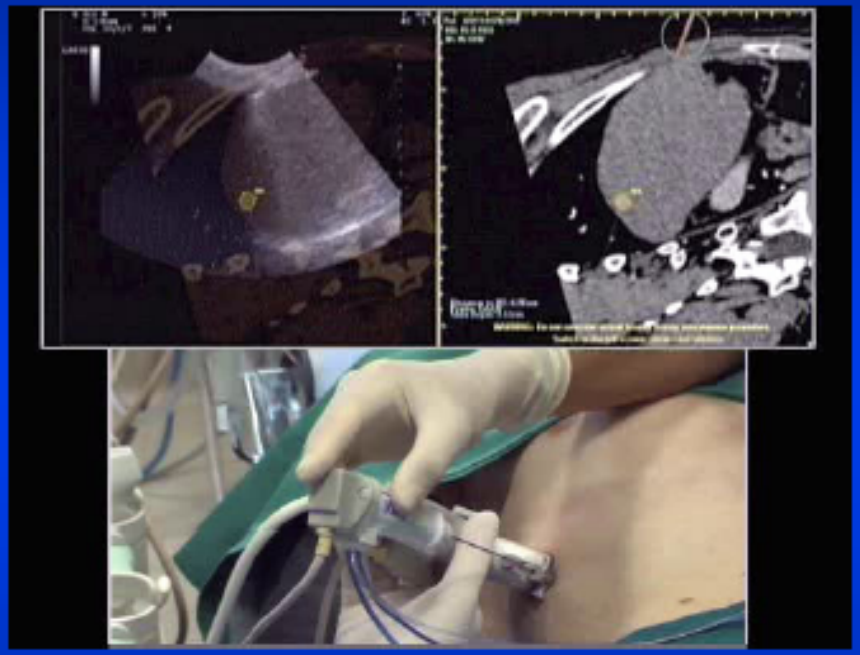
More accurate imaging methods for detection (CEUS, MSCT, MRI) and for targeting (Navigation systems)

Improved adjuvant / simultaneous chemotherapy

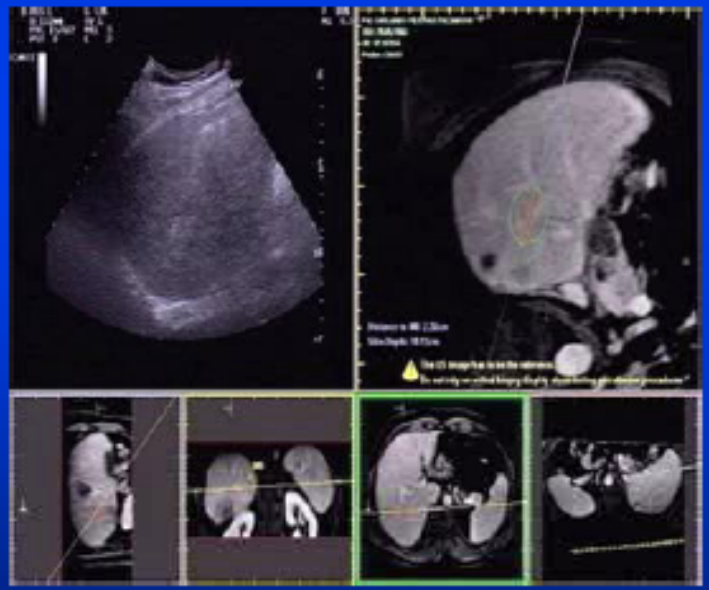
Larger areas of necrosis related to lesion size (hypervascular halo)

Immediate retreatment of initial local progression

2nd sensor coil applied to the needle handle

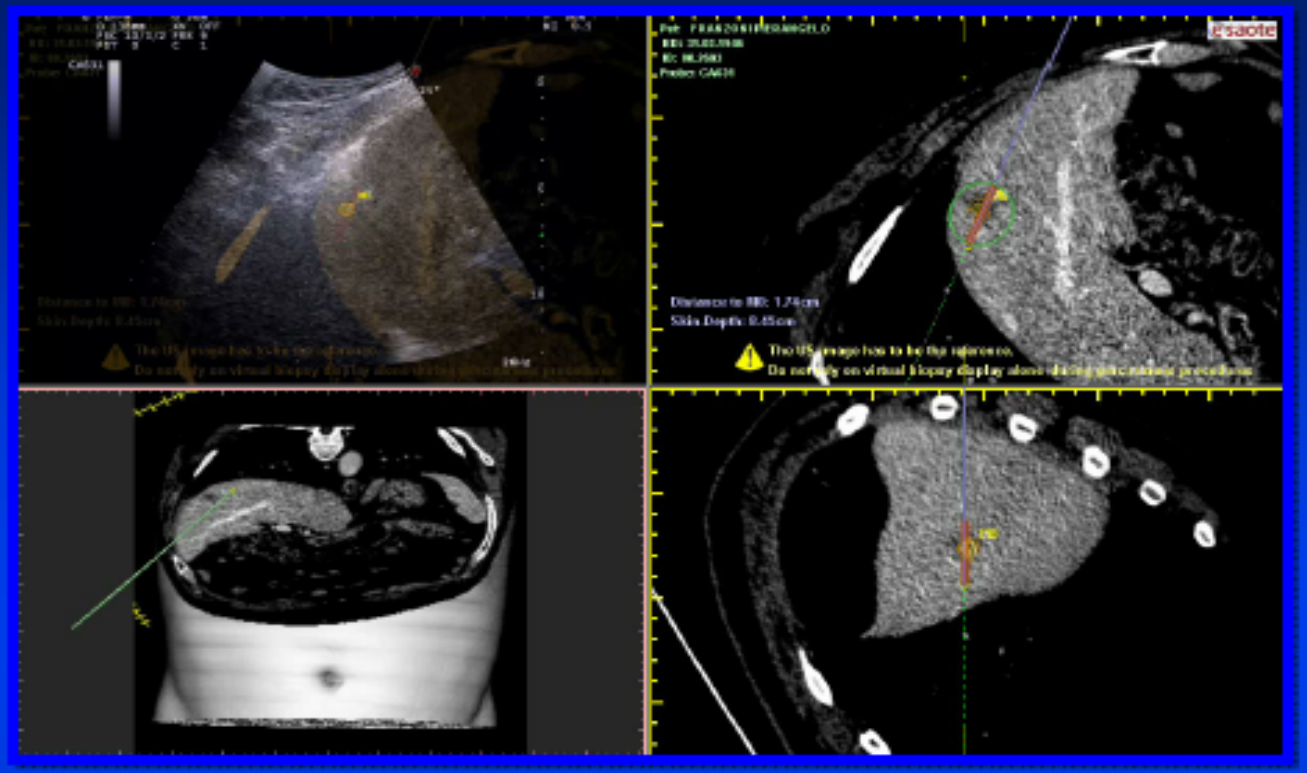


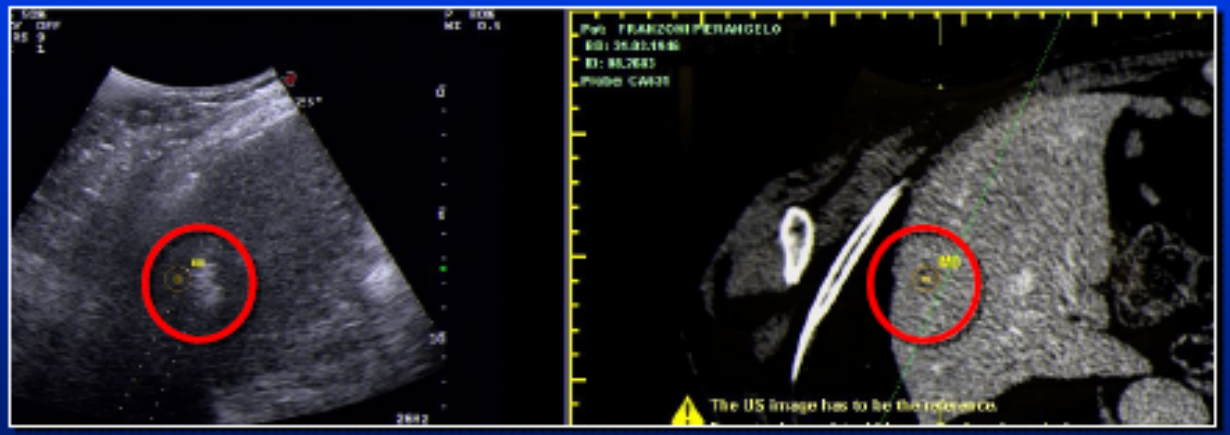
US – CT



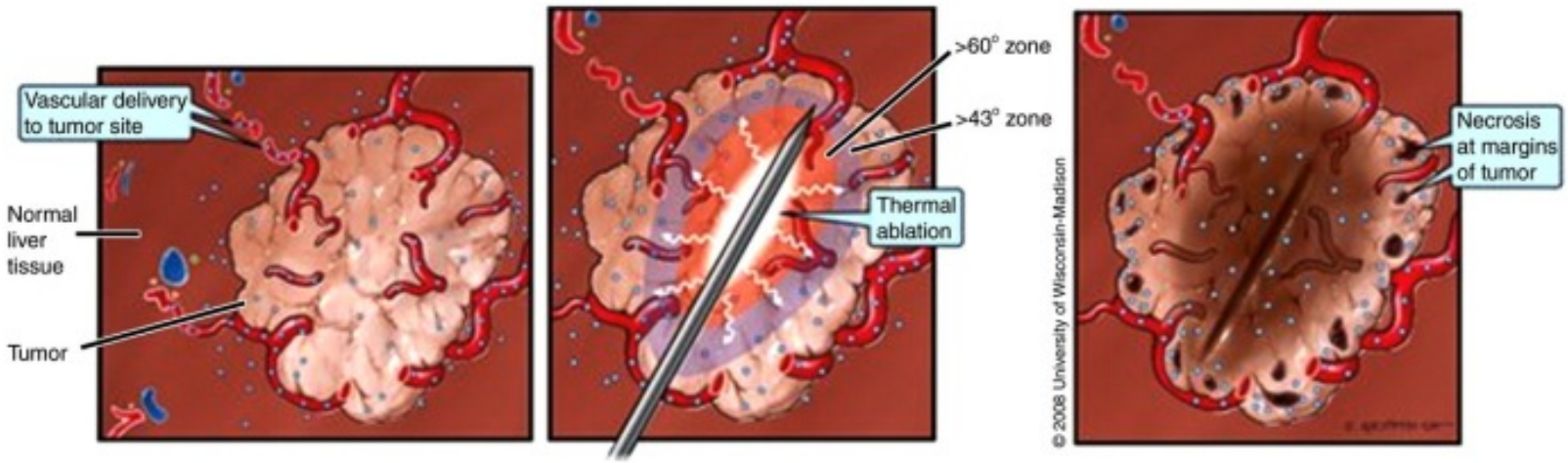
US – MRI

Virtual needle tracking


Esaote
Distance to RR: 1.74cm
Skin Depth: 0.65cm
The US image has to be the reference.


The US image has to be the reference.

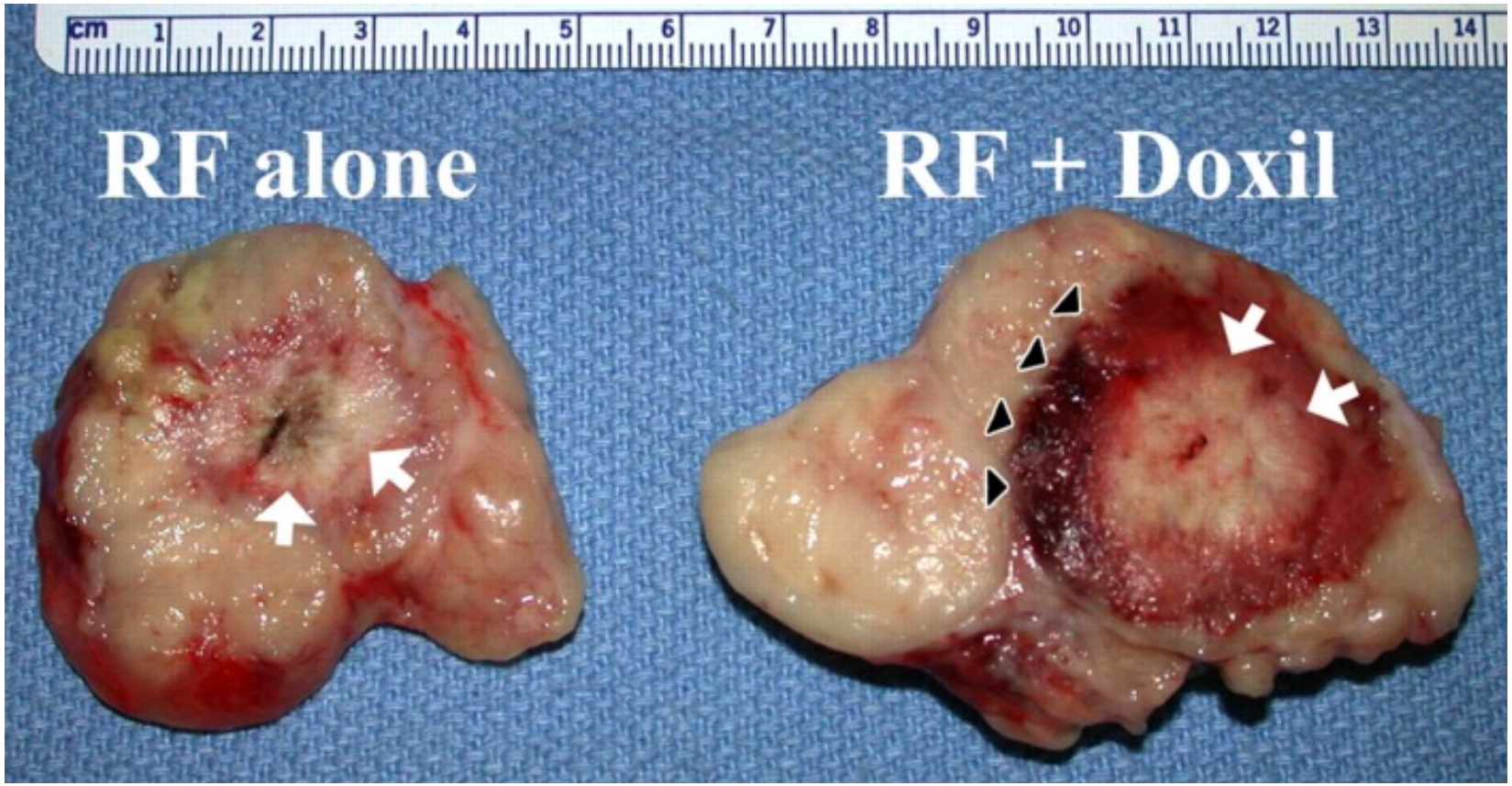
**Illustrations show method for combining thermal ablation with targeted drug delivery.**




**Ahmed M et al. Radiology 2011;258:351-369**

Radiology

**Images show results of combination RF ablation and intravenous liposomal doxorubicin.**




**Ahmed M et al. Radiology 2011;258:351-369**

Radiology

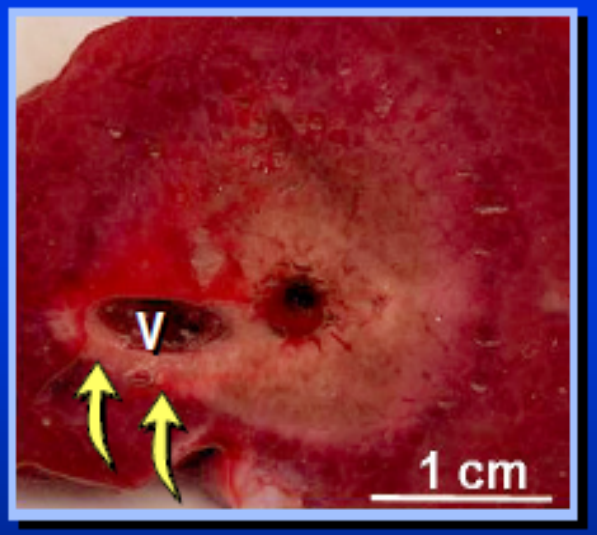
# Microwave - Advantages

- Waves move readily through tissues including low conductivity such as lung, bone, dehydrated or charred tissue
- Can produce extremely high temps >150 C
  - More efficient than RFA
  - No grounding pads

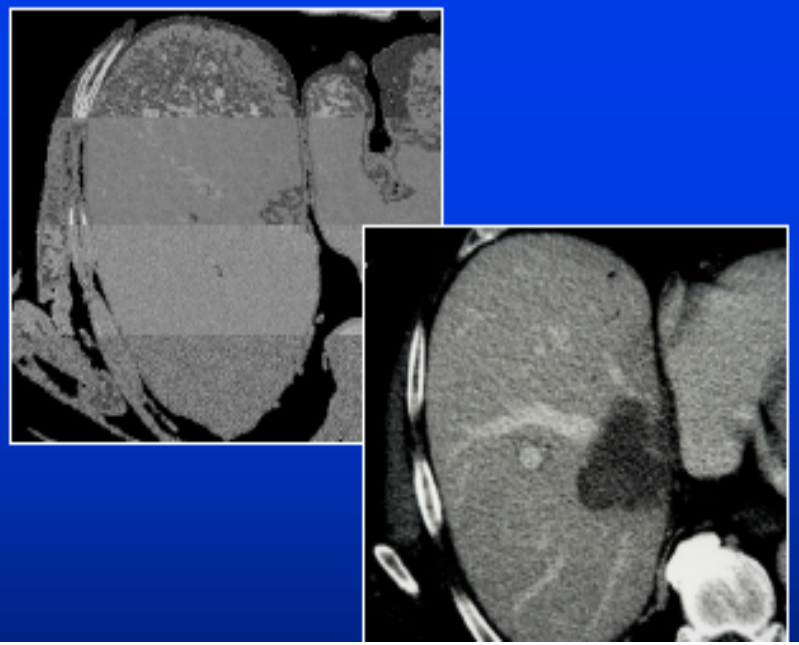
# ADJACENT TO BLOOD VESSELS

## ⇨ Microwaves

(faster, larger, no heat sink effect)




Perivascular ablation



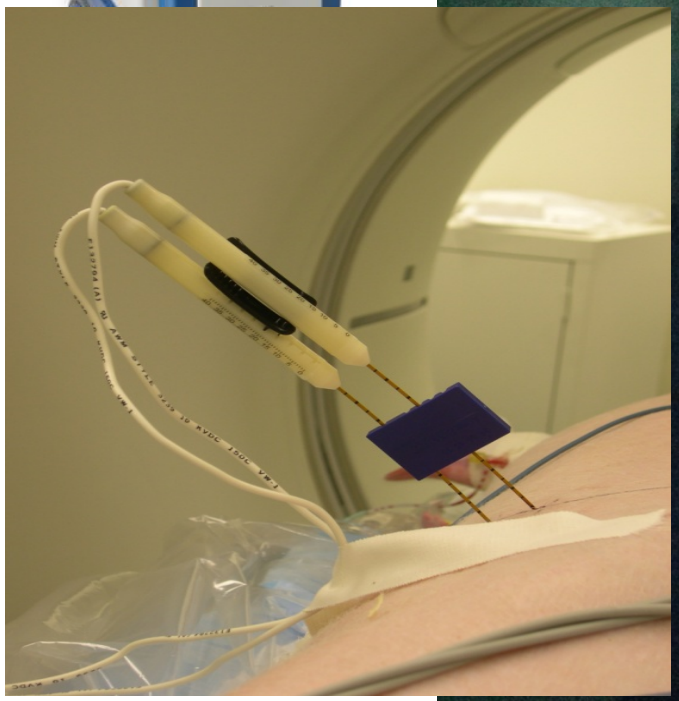
# Microwave - Disadvantages

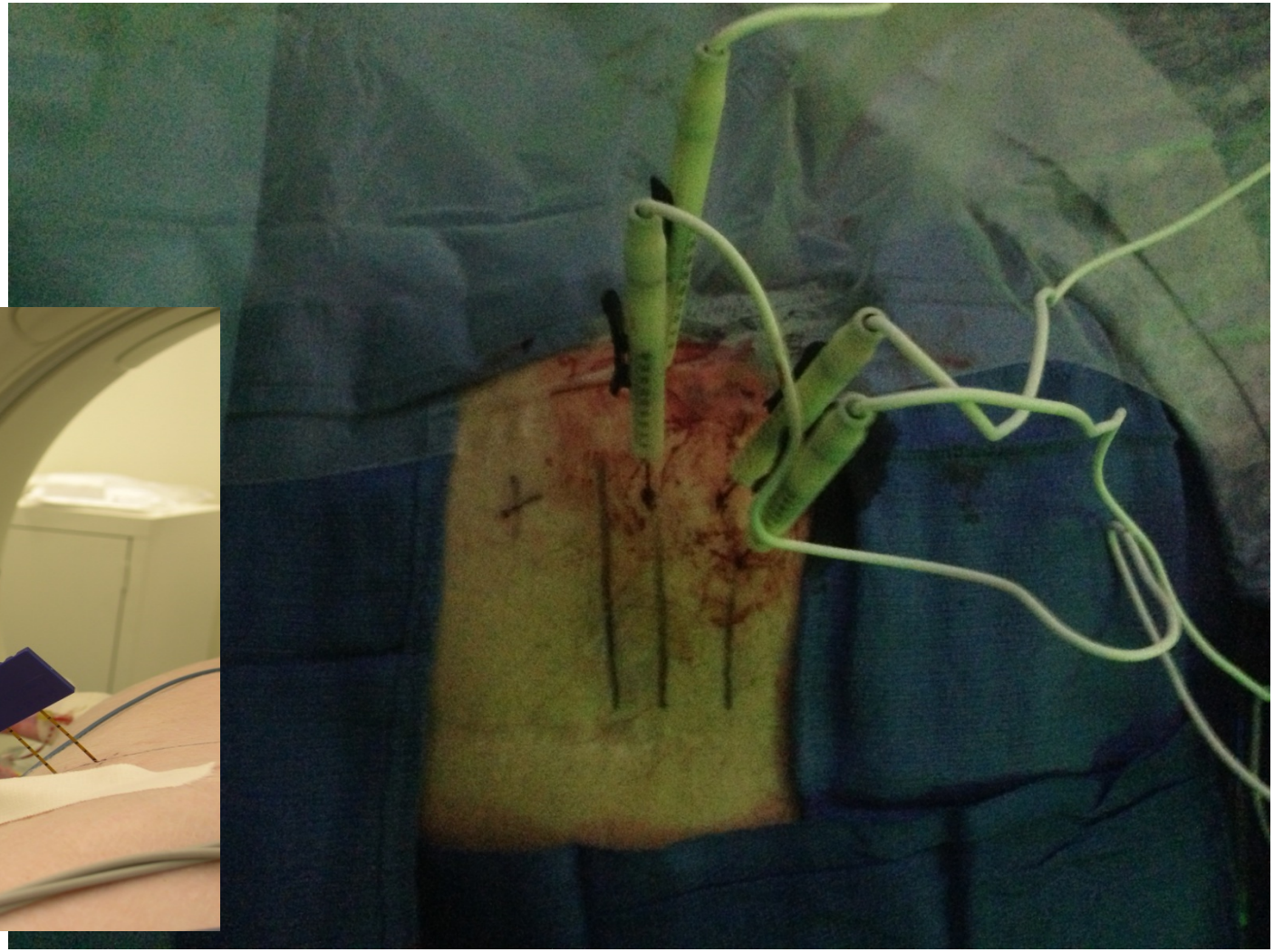
- Microwave energy is difficult to distribute
- Coaxial cables
- Wire heating is a problem
  - Skin injury
  - Cooling jackets to reduce cable heat
- Only one FDA approved system
  - Evident (Valleylab)

# Irreversible Electroporation

- Electroporation
  - Electric pulses create tiny holes in the cell
  - Temporary as long as the energy is low
    - 360 V/cm
  - Chemotherapy and Genetic therapy delivery
- "Irreversible"
  - Higher energy
    - 680 V/cm[1]
    - Create permanent holes in the cell
    - Cell loses essential molecules and internal signals tell the cell to die

Multiple IRE electrodes to treat larger lesions
minimum:
2 parallel electrodes spaced 1.5-2 cm





# IRE as an Ablation Tool: Potential Advantages

- *Non-Thermal:*

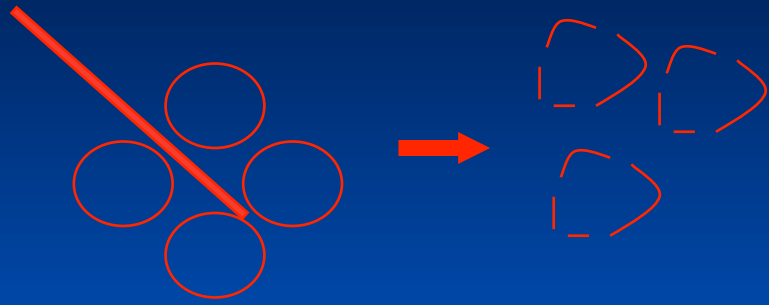
-Application in Locations non eligible for Thermal Ablation
-Limit recurrences near vessels by avoiding the "heat sink" effect

- *Cellular Kill Mechanism Avoids Damage to:*

- Extracellular Matrix. This may result in fewer complications: Near Bile Ducts, Intestines, Vital structures.

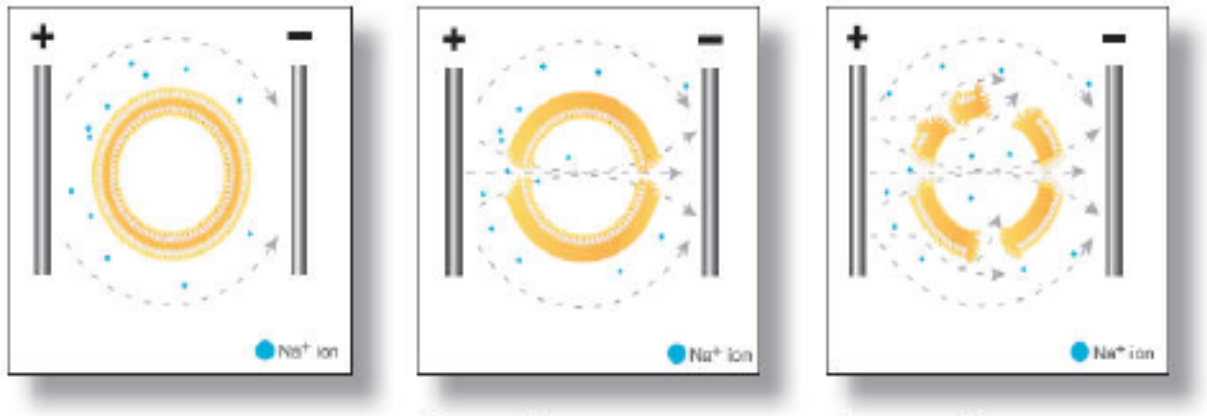
# Electroporation

- Reversible electroporation is used to allow genes and drugs to enter cells (300-600 V/cm)
- Direct current pulse leads to elevation of transmembrane potentials creating permanent cell membrane pores: ~1,500 V/cm

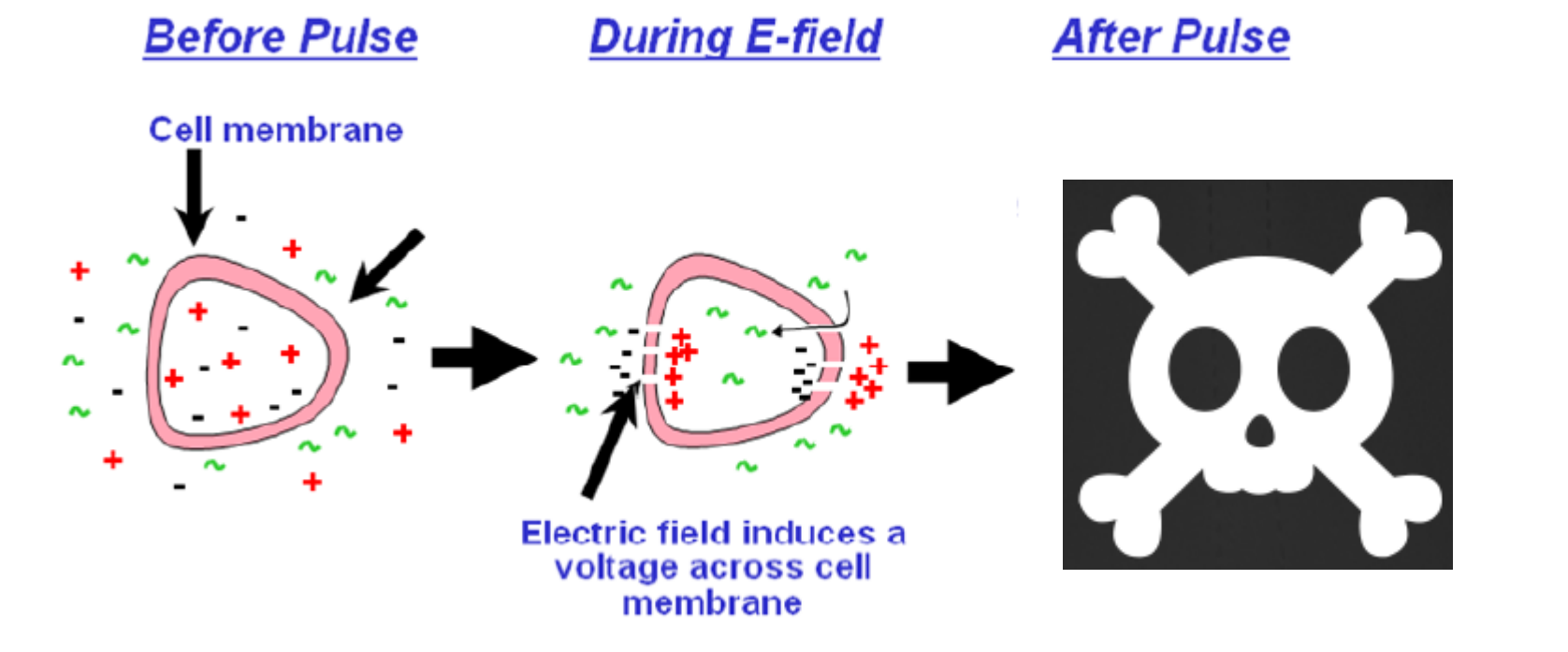


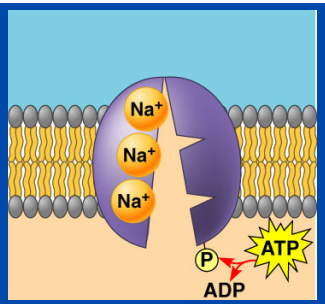
- Strong electric fields applied across a cell can cause:

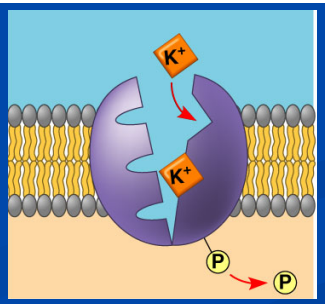
Irreversible permeabilization of the cell membrane: "*IRE*"



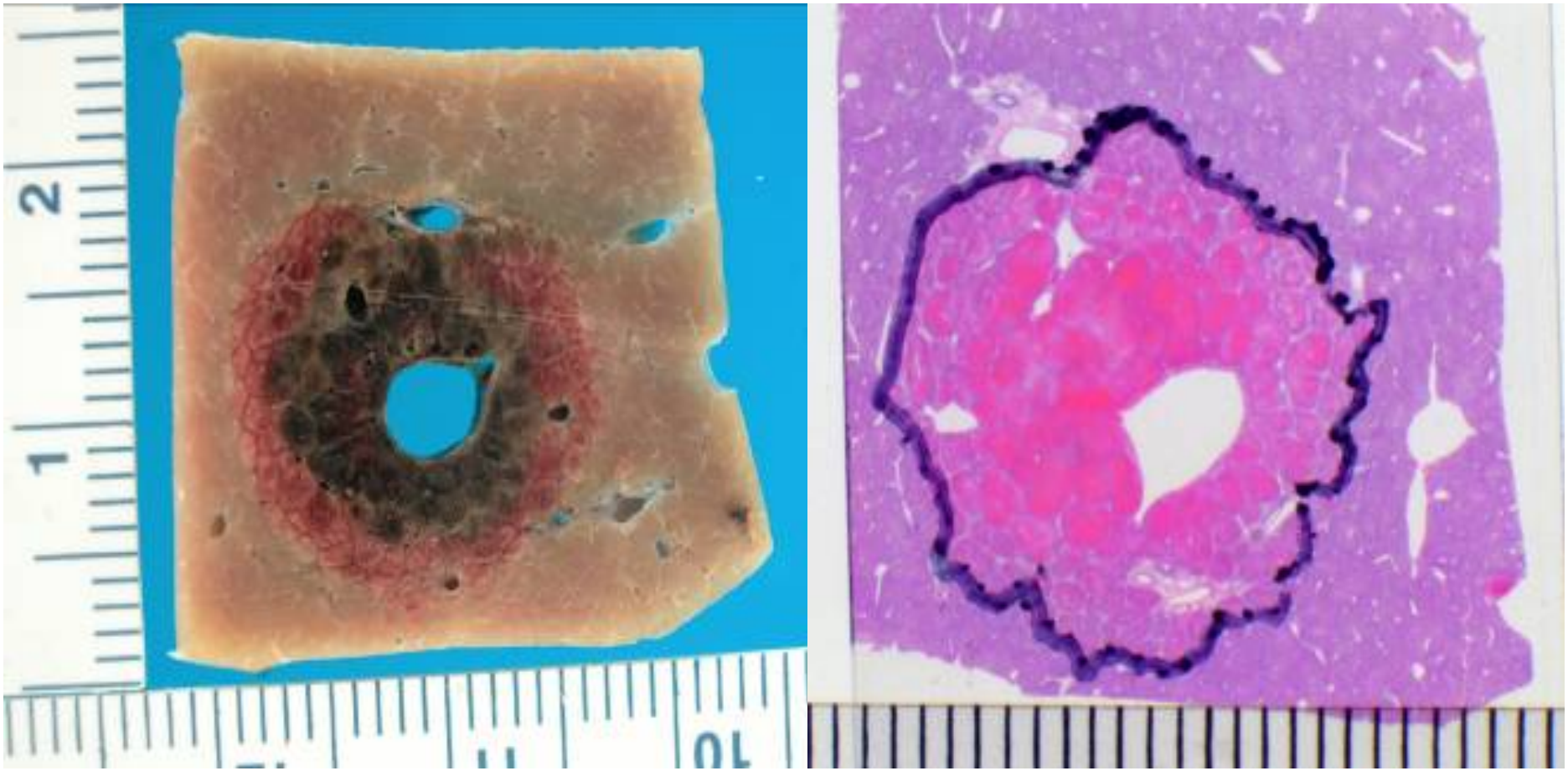
# How IRE kills cells



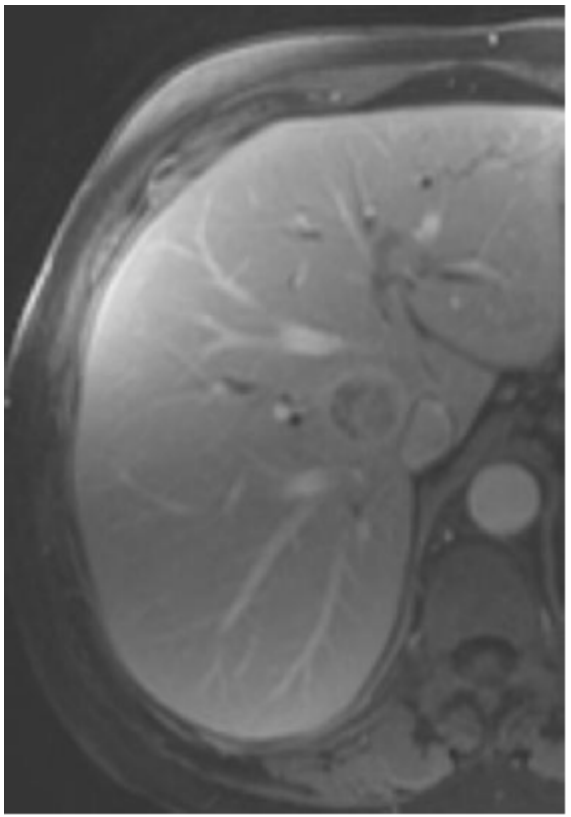



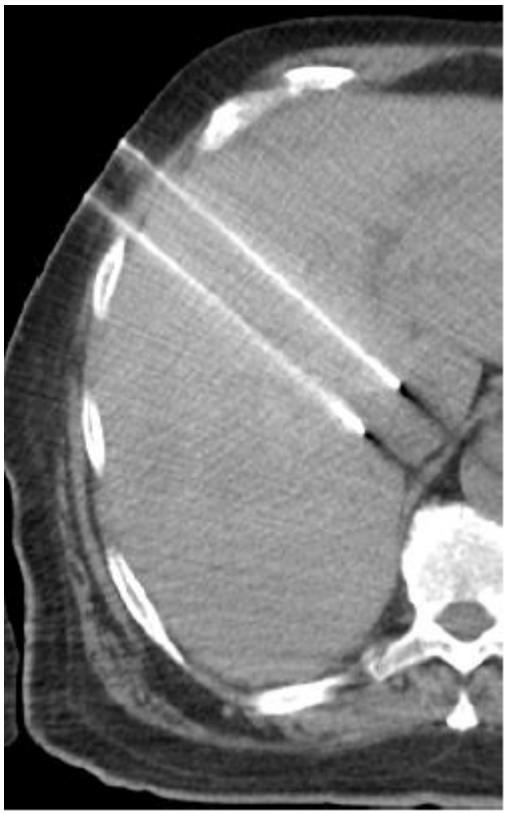
# NO Heat Sink Effect

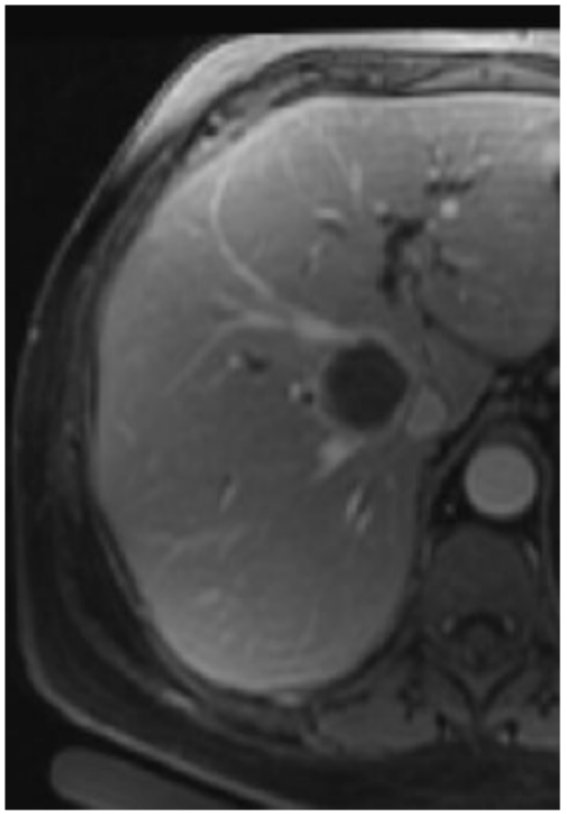


# Case close to bile duct and major vein

- Pre-Tx
- Tx

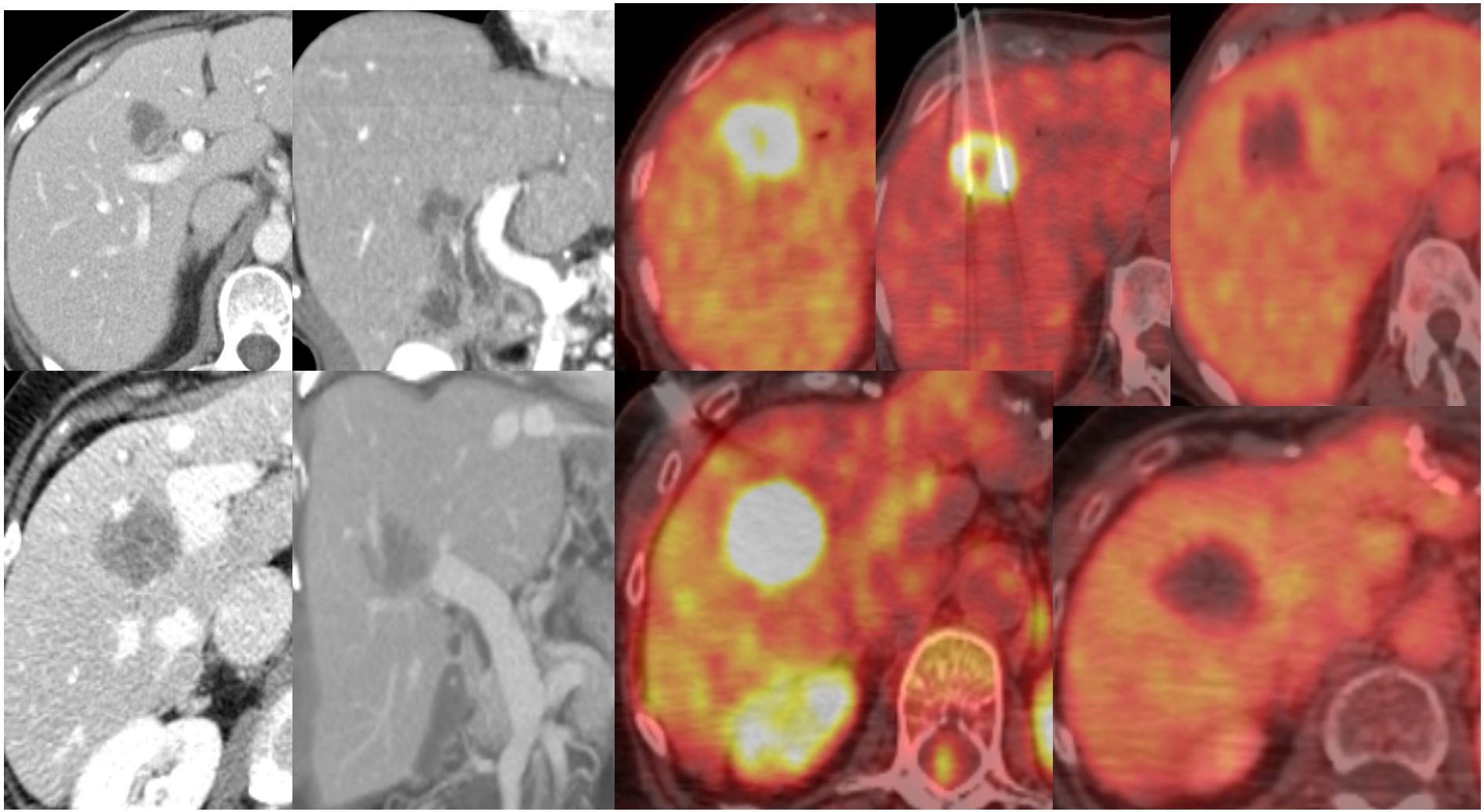






# *Perivascular/periductal Liver*

6 months: 92% Complete Ablation



Kingham P et al: IRE for Perivascular Hepatic Malignant Tumors. J Am Coll Surg 2012; 215(3): 379-87

# IRE - Disadvantages

- Electrodes 19 gauge must be placed 1-3 cm apart.
- Single needle option for very small lesions
- Generates dangerous electrical harmonics
- Stimulates muscle contraction and dangerous cardiac arrhythmia
  - General anesthesia paralysis and cardiac gating
- High cost

VOLUME 28 · NUMBER 3 · JANUARY 20 2010

JOURNAL OF CLINICAL ONCOLOGY

ASCO SPECIAL ARTICLE

# American Society of Clinical Oncology 2009 Clinical Evidence Review on Radiofrequency Ablation of Hepatic Metastases From Colorectal Cancer

*Sandra L. Wong, Pamela B. Mangu, Michael A. Choti, Todd S. Crocenzi, Gerald D. Dodd III, Gary S. Dorfman, Cathy Eng, Yuman Fong, Andrew F. Gusti, David Lu, Thomas A. Marsland, Rob Michelson,† Graeme J. Poston, Deborah Schrag, Jerome Seidenfeld, and Al B. Benson III*

emphasizes that definitive conclusions concerning effects of RFA on treatment outcomes for CRHM require RCT evidence.

Multiple factors contribute to the paucity of RCT evidence on outcomes of RFA for CRHM. The reluctance of patients to be randomly assigned may be one factor. Another is that many clinicians are reluctant to enroll patients onto trials because they are convinced that currently available data from highly selected patient series is sufficient evidence and discount patient selection bias and other threats to validity of conclusions based on such data.

***Two attempts of randomized clinical trials failed due to poor recruitment*** *(Stangl, Eur J Cancer, 2009)*

# ESMO Guidelines 2009

RFA, in combination with systemic treatment, is under investigation as an alternative or a complement to surgical resection of liver metastases in cases where this is not possible or complete.

?

# CONCLUSIONS

- Local tumor progression is still a challenge, but new ablation methods (MW, cryo, etc..) may significantly improve local control rates
- Ablation is a well-established treatment modality, mostly for some indications (old patients, contraindications to resection, refusal of surgery, new mets after surgery, "test of time" before resection)
- For CRC mets $\leq$ 2 cm local control rate of ablation is approximating 100% : **ablation may replace resection**
- Guidelines which include ablation as a definite treatment option ?
- Strict multidisciplinary collaboration with oncologists and surgeons


cimitero
VIVENTE
STOP
STOP
www.marok.org

# Treatment for Colon Cancer Liver Metastases


- *Surgery (10-25%)*
- *Chemotherapy:*

  *systemic / Local*

**-Ablation**

-RFA, Cryo, other

- Radioembolization
- Chemoembolization

sofoclec@mskcc.org

# Facts about Colon Cancer

- Second leading cause of cancer-related death in the United States.
- 150,000 new patients diagnosed each year.
- Half of these patients will have cancer spread to their liver (liver metastases) at some point during the course of their disease.
- Surgery is considered the best treatment for liver metastases  but the majority of the patients are not candidates for surgery.
- “In those (<25%) who undergo surgery, recurrence (a new spot of cancer coming back) is a serious problem.

# Ethanol

- First used in the 1980s
- Three to six injection sessions
  - Twice weekly
  - Multi side hole needle 21 gauge
- Inexpensive
- Can be used safely around bile ducts, gallbladder and diaphragm compared to thermal techniques

# Ethanol

Two mechanisms of tissue destruction:

- Dehydration of the cytoplasm, protein denaturation > coagulative necrosis
- Ethanol enters microcirculation > necrosis of the vascular endothelium, platelet aggregation, vascular thrombosis > tissue ischemic necrosis

# Ethanol

- Diffuses through soft tumors such as HCC more easily than cirrhotic liver
- Is constrained by tissue planes
- Concentrated inside of fibrotic capsules / pseudo-capsules
- Less likely to diffuse through fibrotic metastatic tumors

# Ethanol - Disadvantages

- Pyrexia
- Pain
- In liver, rise in liver enzymes
- Systemic intoxication

- Randomized controlled trials demonstrate inferiority compared to RFA

# Laser

- Interstitial laser photocoagulation
- Percutaneous use 1989* vs mets to liver
- Optical fibers are used to carry energy
  - MRI compatibility…
- Photon energy conduction induced heating to just over 50 Degrees C
- Tissue penetration of the laser light is only 0.4mm

* Br Med J 1989; 299:362-365

# Laser - Disadvantages

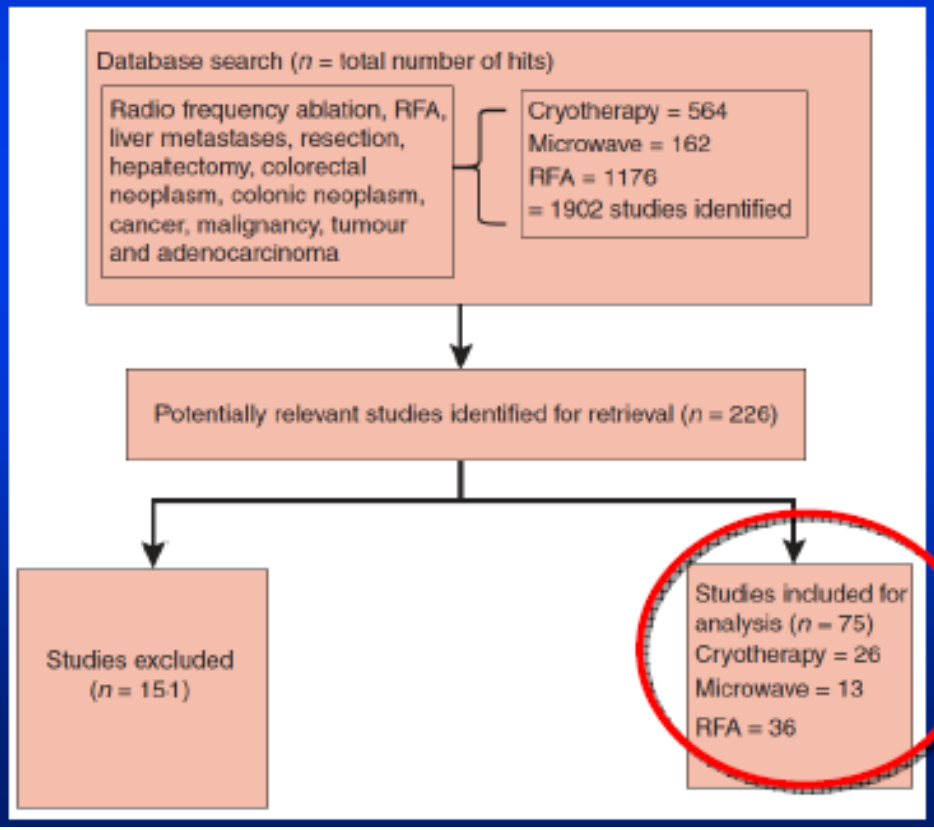
- No FDA approved systems
- Light does not penetrate charred or desiccated tissues
- Requires multiple optical fibers
- Fiber bundle must be cooled to avoid skin injury

# Ablative therapies for colorectal liver metastases: a systematic review

**S. Pathak*, R. Jones*†, J. M. F. Tang†, C. Parmar*, S. Fenwick*, H. Malik* and G. Poston***

*Department of Hepatobiliary Surgery, Aintree University NHS Foundation Trust, Liverpool, UK and †School of Cancer Studies, University of Liverpool, Liverpool, UK

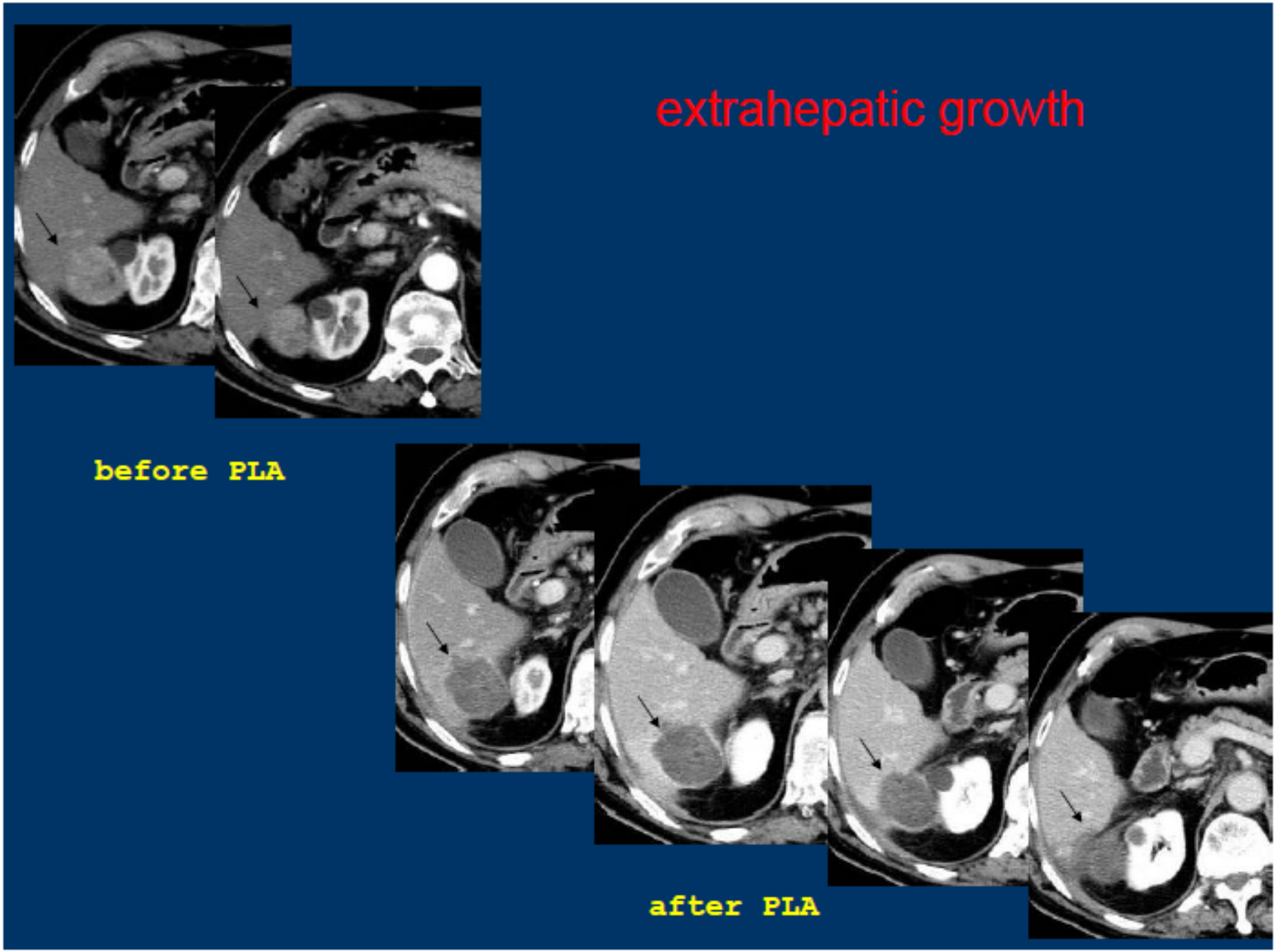
Colorectal Disease © 2011 The Association of Coloproctology of Great Britain and Ireland. **13,** e252–e265




Use of ablation as adjunct or definitive treatment of CLRM

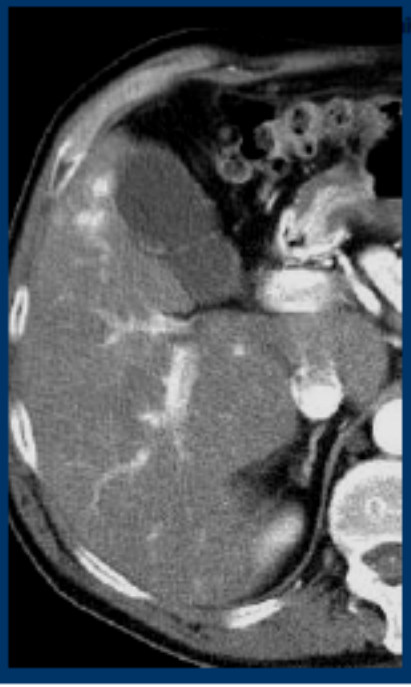
At least 1-yr f/u

Minimum of 10 patients


extrahepatic growth
before PLA
after PLA



lesions close to gallbladder



# Small Liver Colorectal Metastases Treated with Percutaneous Radiofrequency Ablation: Local Response Rate and Long-term Survival with Up to 10-year Follow-up[1]

Radiology

Luigi Solbiati, MD
Muneeb Ahmed, MD
Luca Cova, MD
Tiziana Ierace, MD
Michela Brioschi, MD
S. Nahum Goldberg, MD

*radiology.rsna.org* ▪ ***Radiology:*** Volume 265: Number 3—December 2012

J Gastrointest Surg (2009) 13:890–895
DOI 10.1007/s11605-008-0794-2

ORIGINAL ARTICLE

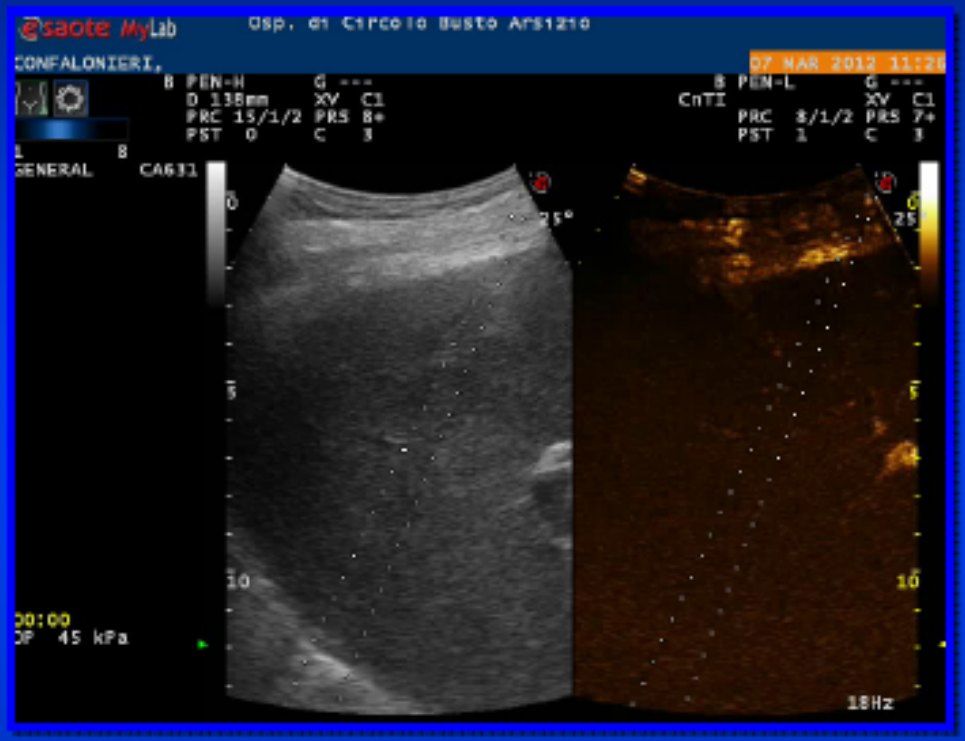
# Local Treatment for Recurrent Colorectal Hepatic Metastases after Partial Hepatectomy

Anne E. M. van der Pool · Z. S. Lalmahomed · Johannes H. W. de Wilt · Alexander M. M. Eggermont · Jan M. N. IJzermans · Cornelis Verhoef

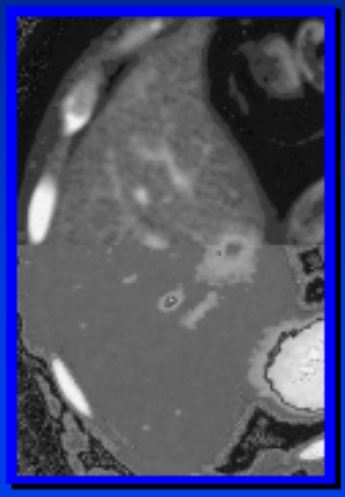
1-yr f/u

*Conclusions* Resection, RFA, and SRx can be performed safely in patients with recurrent colorectal liver metastases and offer a survival that seems comparable to primary liver resections of colorectal liver metastases.

# Speed



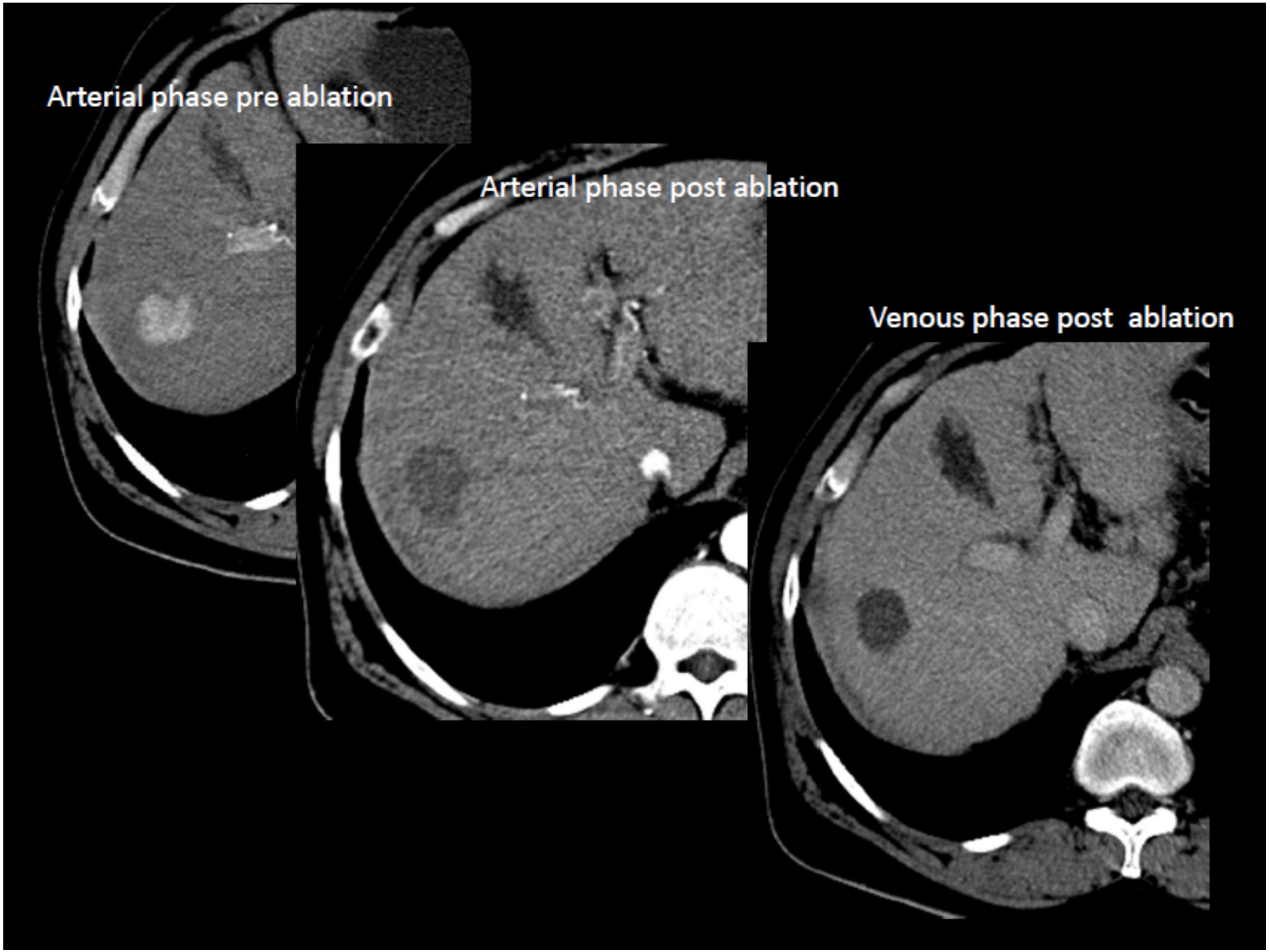

# Low cost



C.R., 77-yr old
RF ABLATION
2-day hospitalization

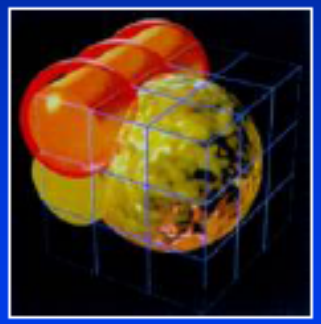
Cost : 3,500 E

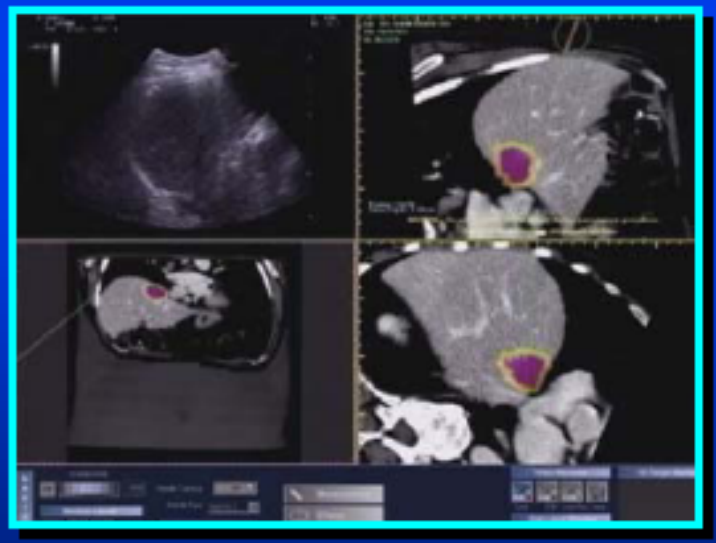
➡ 24-month follow-up (+ CTX): NO recurrence, NO new mets


Arterial phase pre ablation
Arterial phase post ablation
Venous phase post ablation

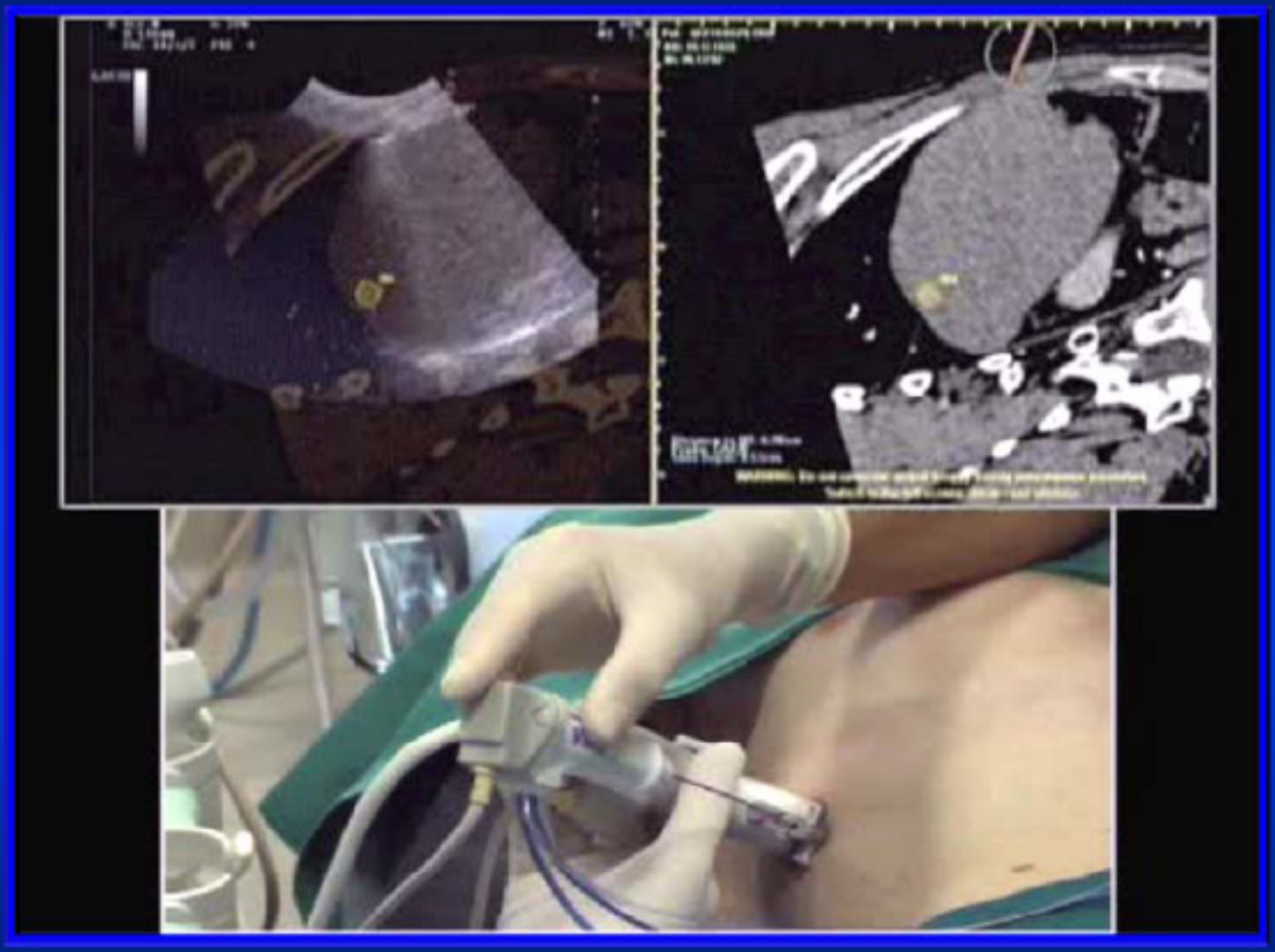
# New improvements for reducing local recurrence rate

Intraprocedural US contrast agents





Real-time CT/US image fusion



# INDICATIONS

- Size : < 4 cm  Number : < 5 (??)
- No extrahepatic tumor localization
- Patient not eligible for surgery
- Mets potentially resectable but that would require large and/or difficult resections
- Patients who refuse surgery
- New met(s) or local progression after resection
- Partial response to CTX
- «Test of time»
- **Ablation after successful CTX, before complete disappearance, to prevent from «rebound» after CTX**

"Rebound" Research Could Aid Tumor Treatment

# STRICT COLLABORATION with ONCOLOGISTS

## ABSOLUTELY MANDATORY

e.g. :

patient unresectable with 3 mets < 3cm

→ Oncologist : efficacy of CHT ?

(if mets do not respond and increase their size :

ablation becomes unfeasible)

→ start of CHT → very early (after 1st cycle) imaging control of lesion vascularity and size → if poor signs of response → Ablation + CHT

# IRE - Advantages

- IRE is non-thermal
  - Little to no scar tissue formation
  - Structural Protein Sparing
    - Nerves and bile ducts in the area of ablation have the potential to heal after treatment
  - No heat sink effect
    - Compared to thermal techniques where blood flow dissipates heat. Electric pulses are not effected by blow flow.

# Irreversible Electroporation

- Non thermal
- Micro to milli second pulses of electrical current
- Generate electrical fields up to 3 kV/cm
- Irreversible damage to cell membranes
- Induces apoptosis
- No heat sink effect: large vessels have limited effect on ablation
- Does not effect nerves
- Does not effect collagenous tissues