

# Ultrasound Guided Ablation of Liver Tumors




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**Copenhagen University**

# Tumor Ablation

Focal tumor destruction

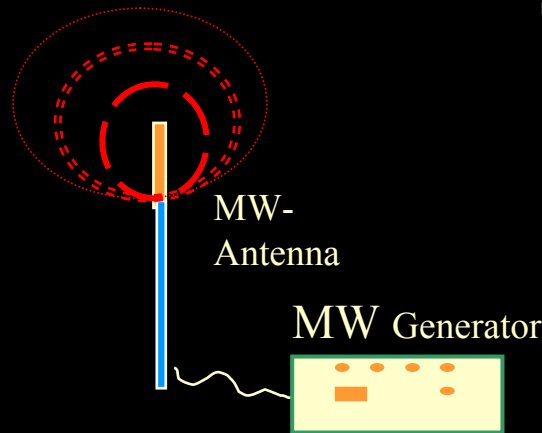
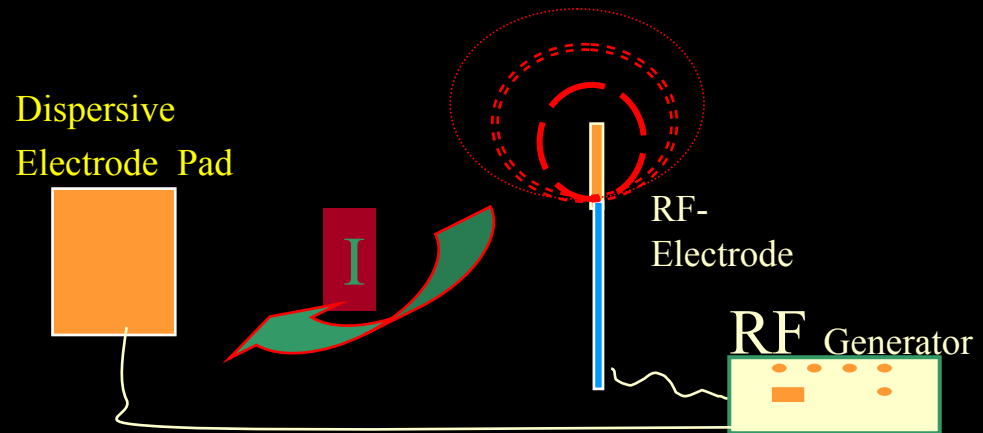


# Ablation modalities

- Resection
- **Ablation** 
- Resection and ablation
- Chemotherapy
  - Systemic
  - Regional
- Laser
- RF (400-450 KHz)
- MW (915 MHz 2,4 GHz)
- Cryo
- Injection (alcohol, etc)
- HIFU
- Electro - chemical

# Whats the difference?

Radio Frequency 430 KHz.  
High conductivity in the body



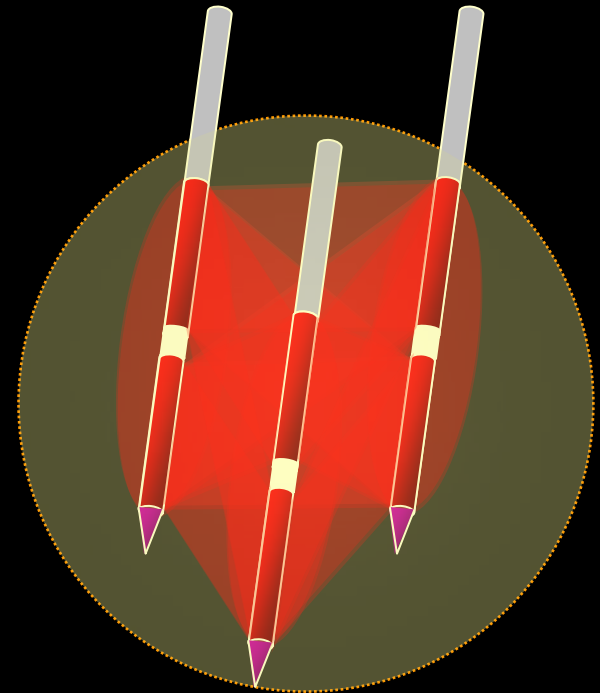
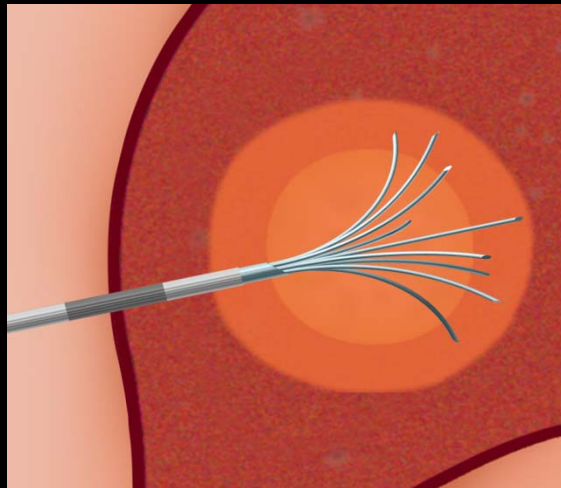
Micro Waves 915 MHz

High speed  
oscillation/movements of  
water molecules generates  
friction heat

# RF: Monopolar vs Bipolar Needles

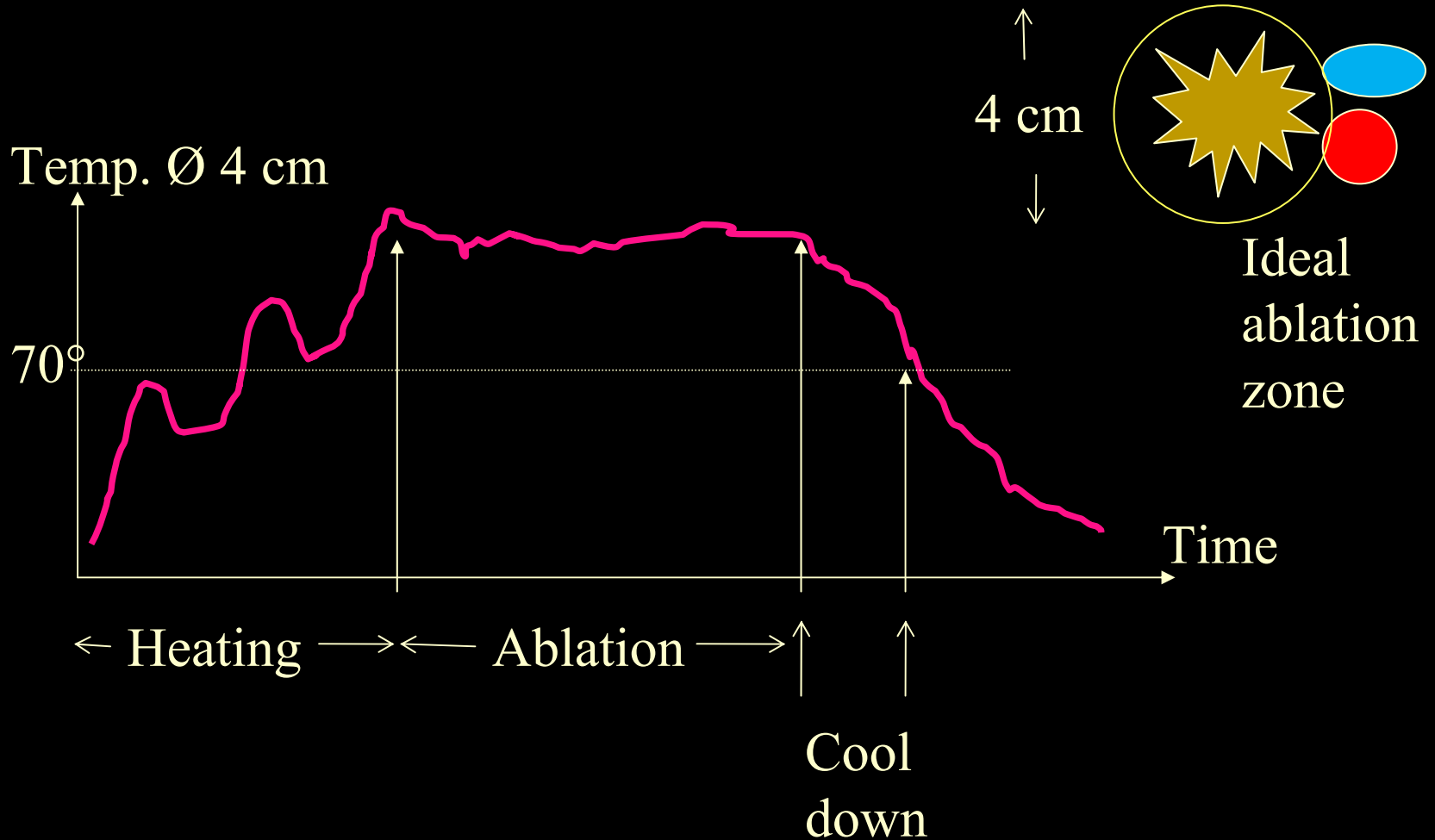


+ Ground pads



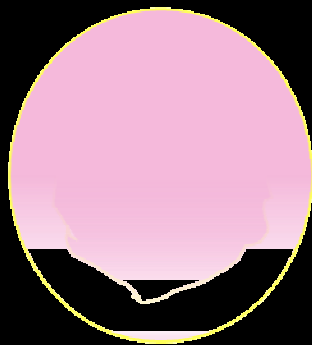
No Ground pads

# Hypertermal Ablation Procedure



# Hyper-Thermal Tumor Ablation

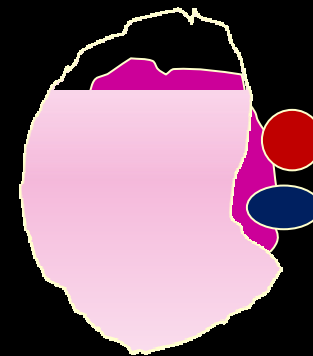
- Heat
  - Loss
  - Capacity
  - Distribution
- Controlled Heating
  - Avoid charring
  - maintain ablative temperatures
  - in a volume
  - covering the tumor



Ideal

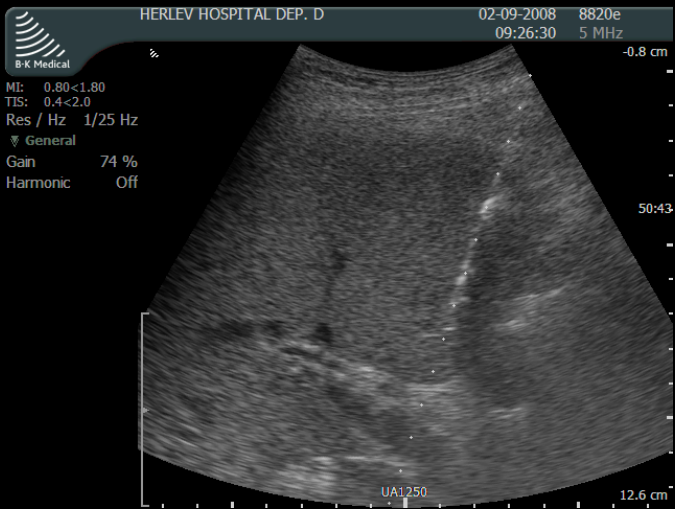
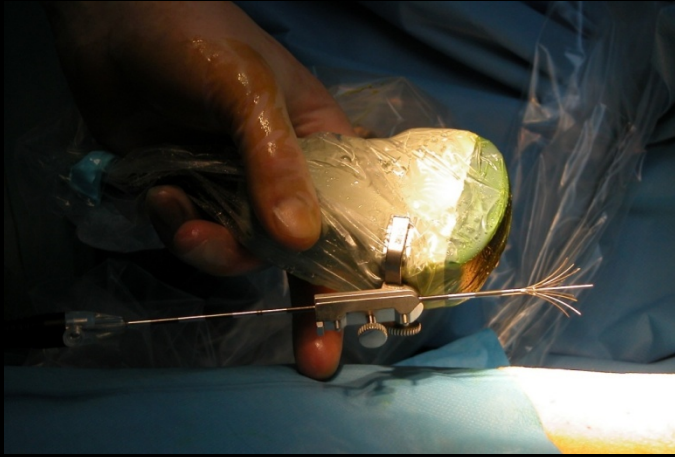


Off-center

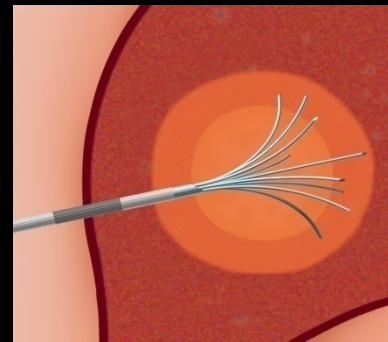
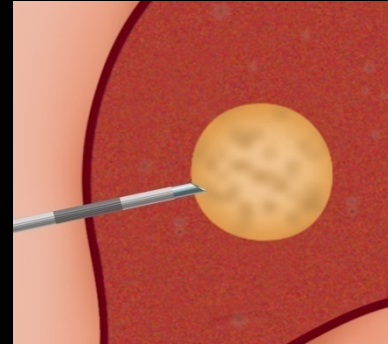


Irregular

# Hit it !



# Heat it !





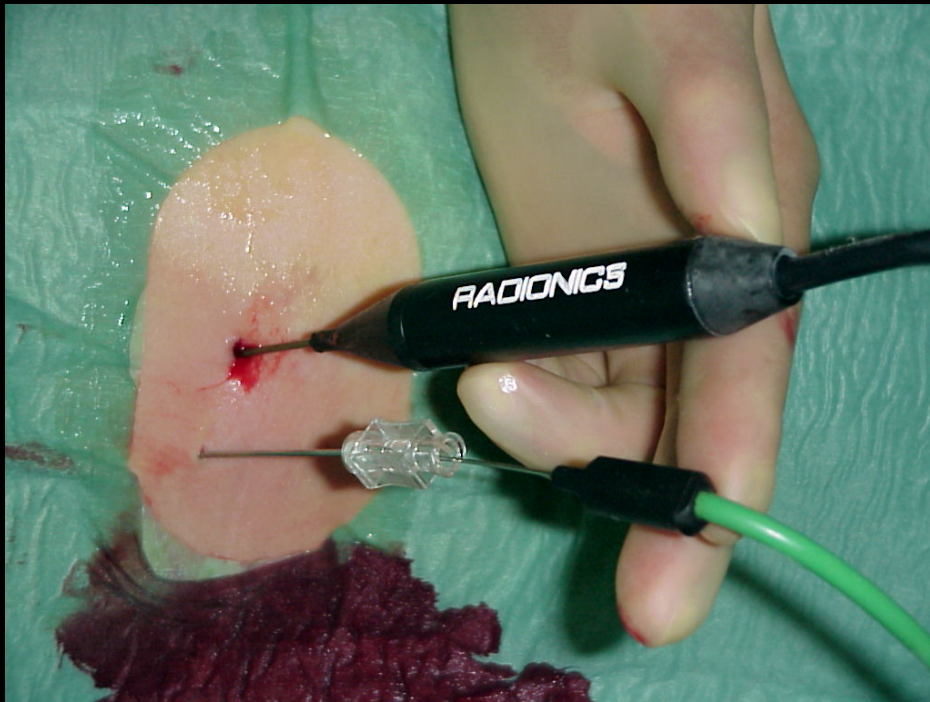
# Basic comparison scheme

*	Laser	UniAblate	Cool-Tip	Cluster	Micro W
Placement	2	3	3	1	3
Stability	1	1	1	3	1
Abl. Size	1	1	2	3	1
Abl. Border	3	2	2	1	3
Abl. Time	3	3	2	2	3
Control	1	1	2	3	1
Sum	11	11	12	13	12
Price	2	3	2	2	1

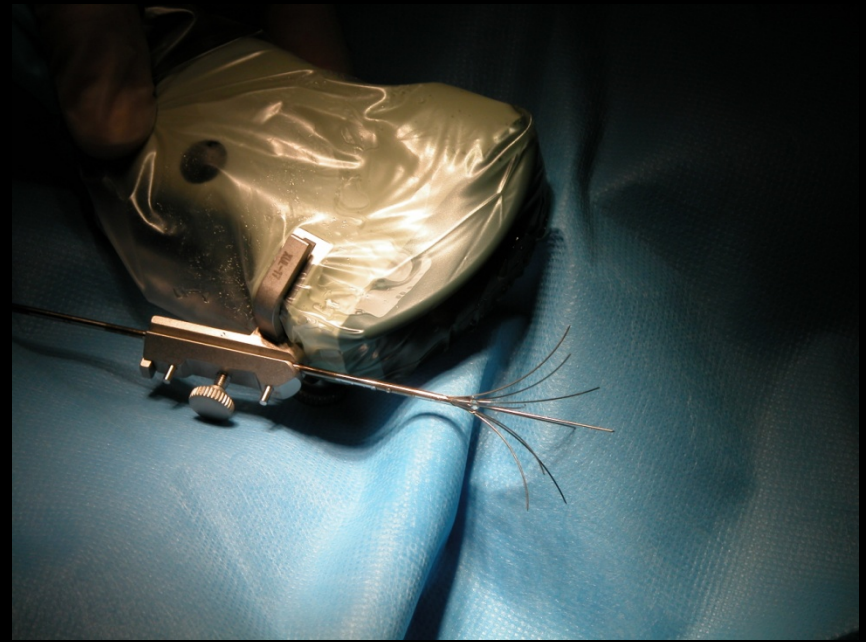
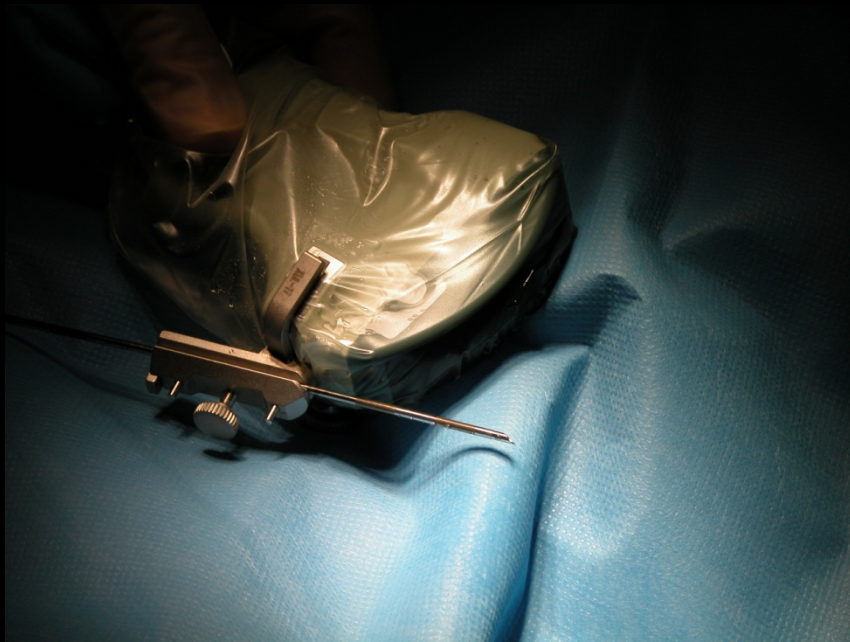
Single needle insetion, US-guided \*

Personal preference?

# *Cool-Tip needle and temperature sensor*



# Cluster Needle in Needle Steering Device



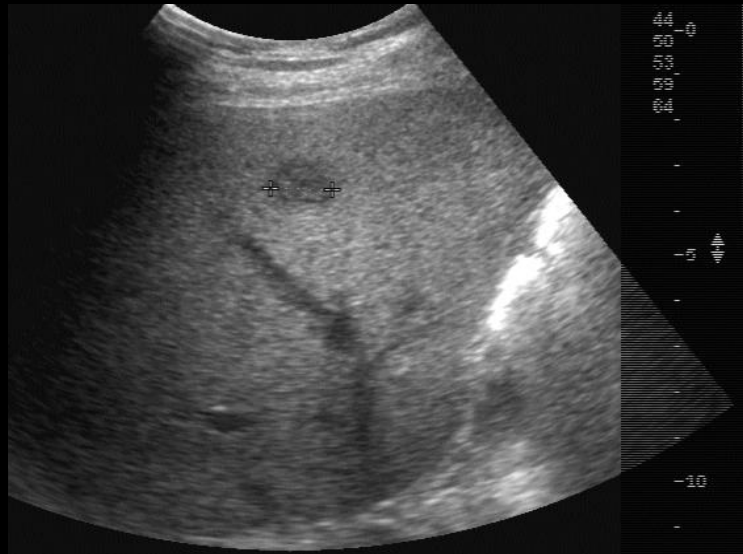
# Optimal Temperature Control



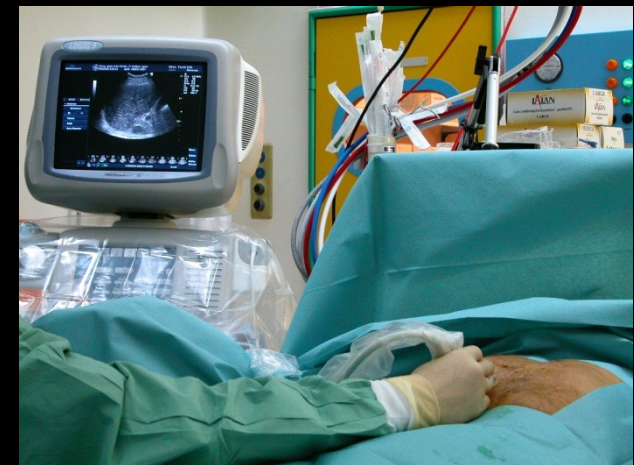
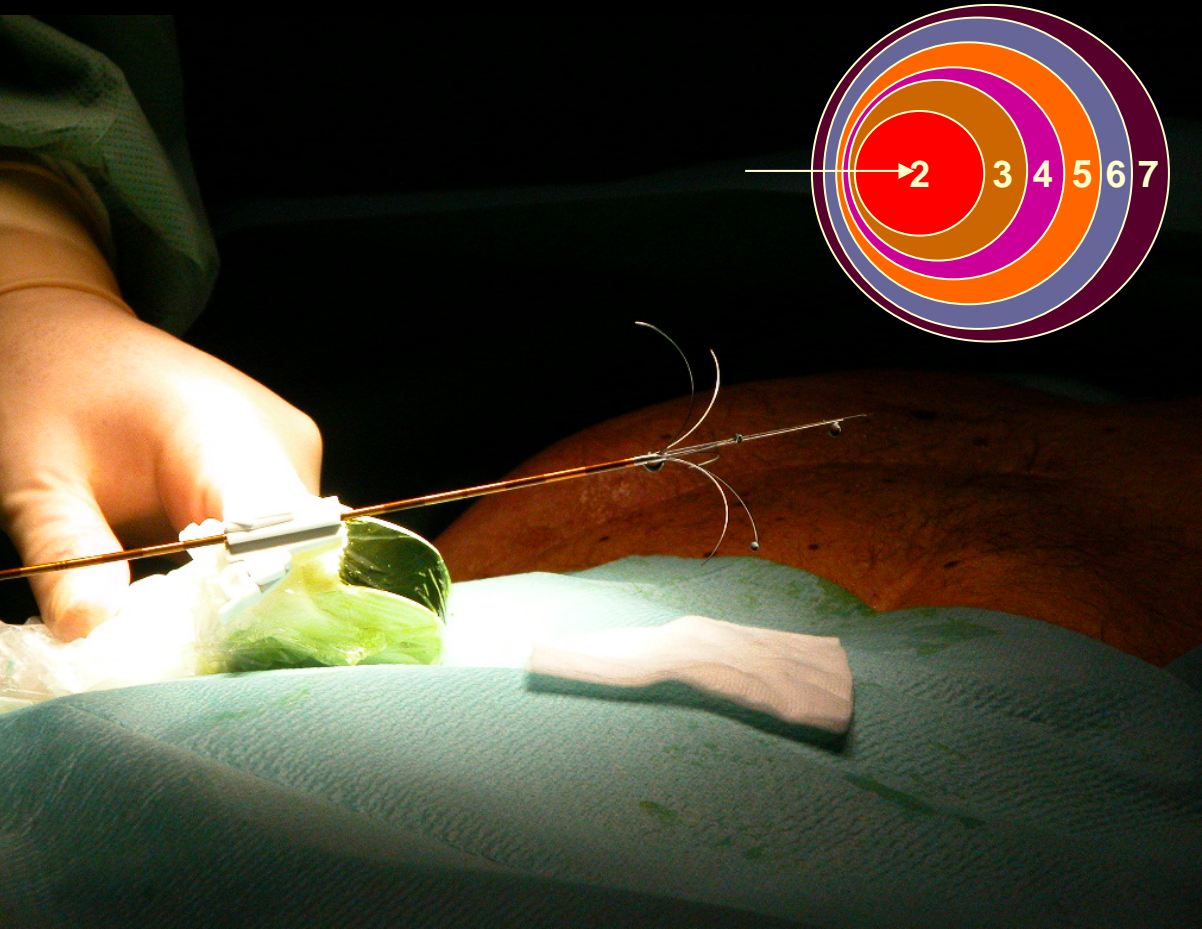
# Cluster diameter



# Percutaneous RFA

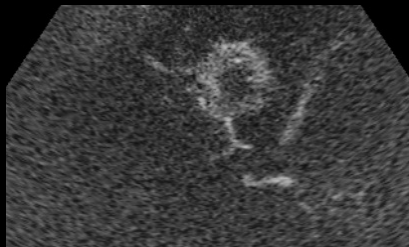


# US-Guided RFA with RITA XLi perfusion system



# Contrast enhanced US: CEUS

## Evaluation of vascular activity after RF



Arterial contrast phase prior to RF

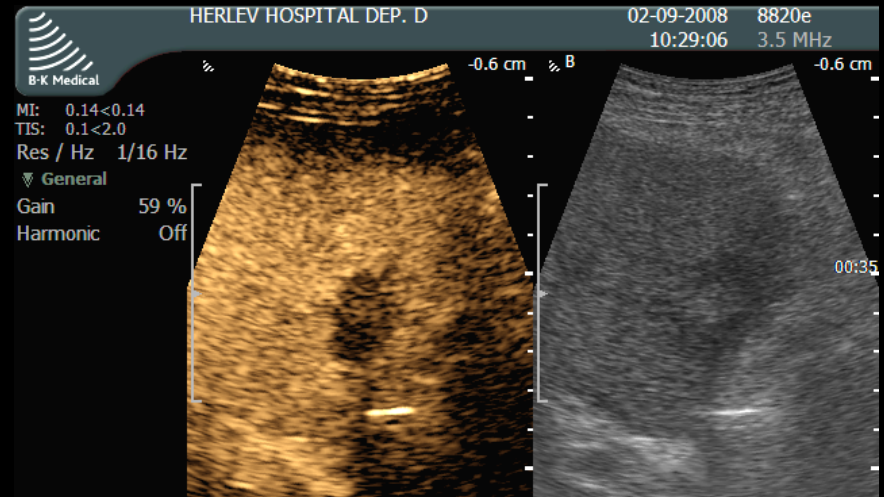
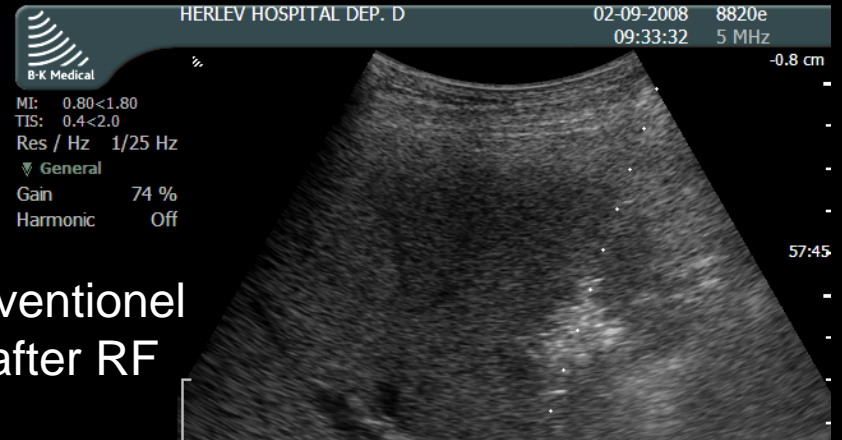


RF ablation



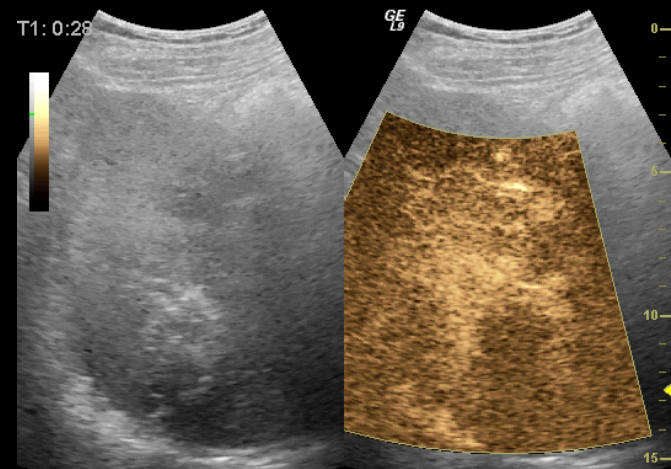
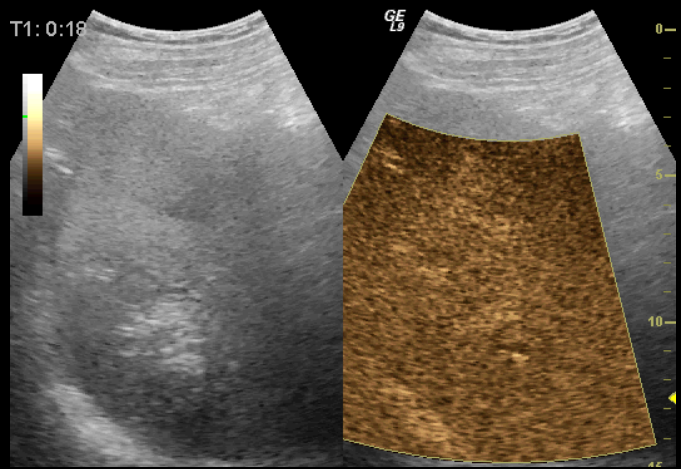
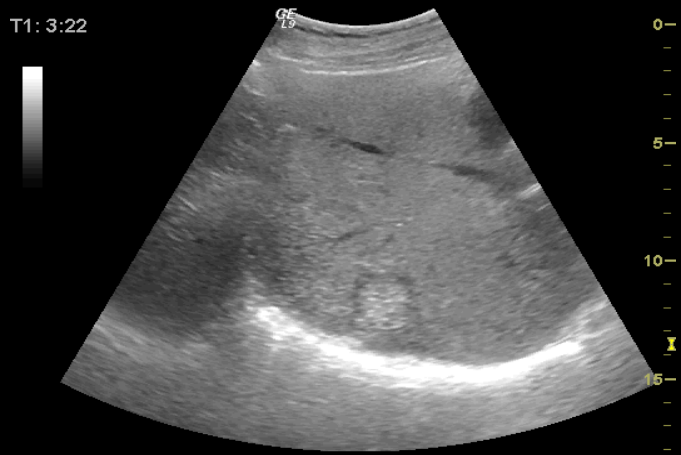
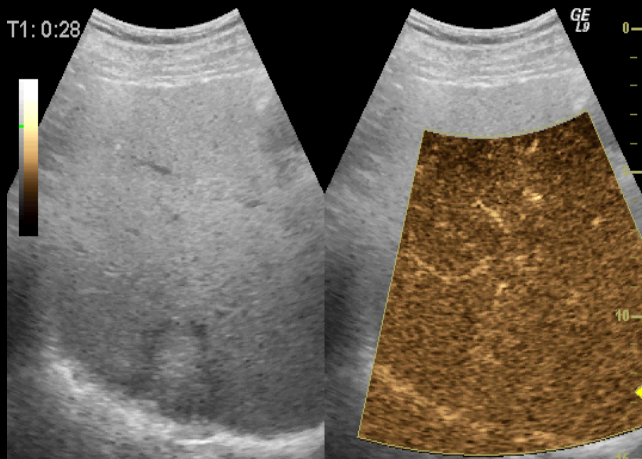
Late venous phase after RF

Conventional US after RF



Simultaneously contrast-US and conventional US after RF





# 2010 Guidelines

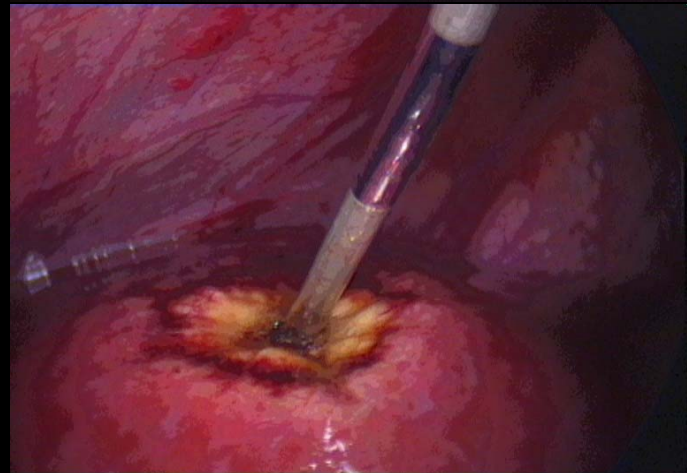
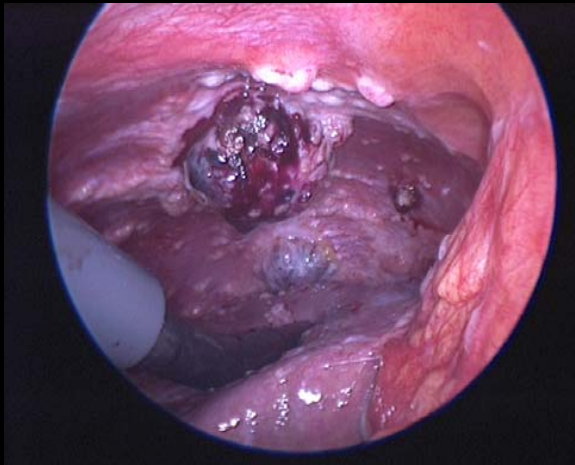
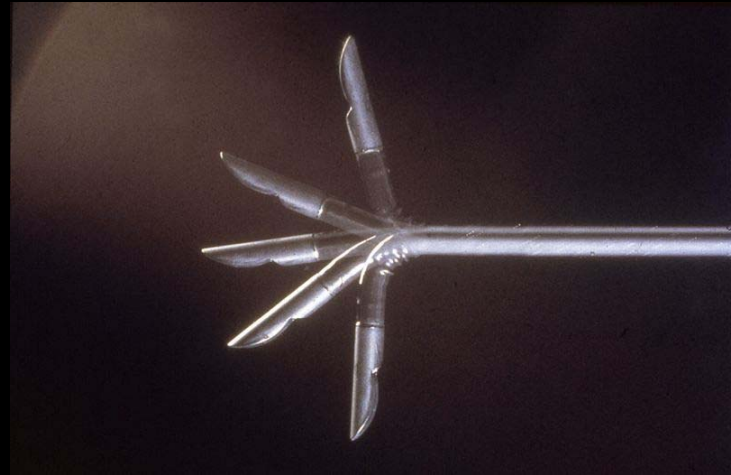
## Percutaneous Ablation

- Quality improvement guidelines for radiofrequency ablation of liver tumours
  - *Crocetti L, de Baere T, Lencioni R.*
  - Cardiovasc Intervent Radiol. 2010 Feb;33(1):11-7.

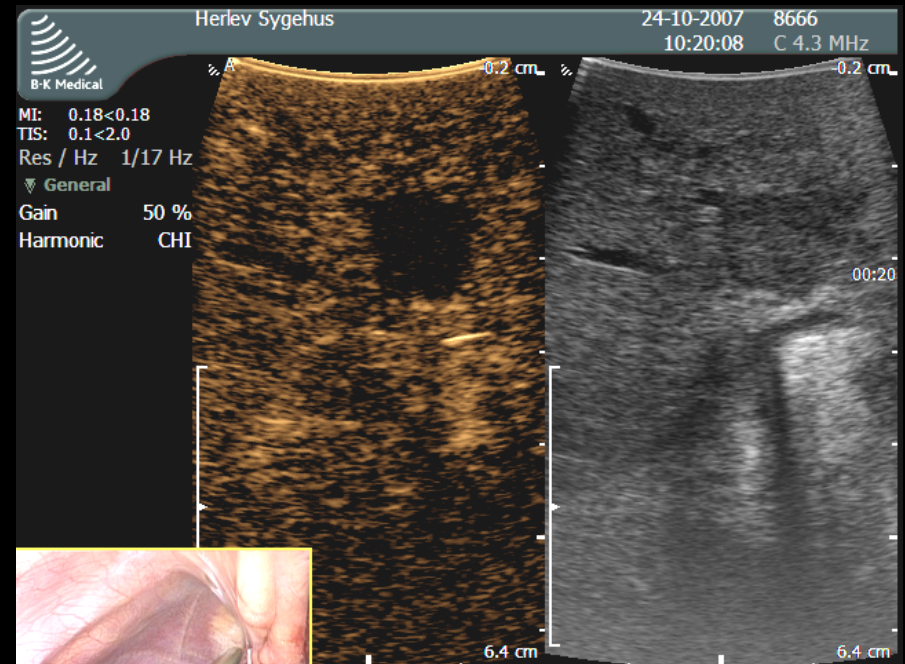
# How to approach

- Percutaneously
- US guided
- CT guided
- MR guided
- Intraoperatively
- OPEN/IUS
- LAP/LUS

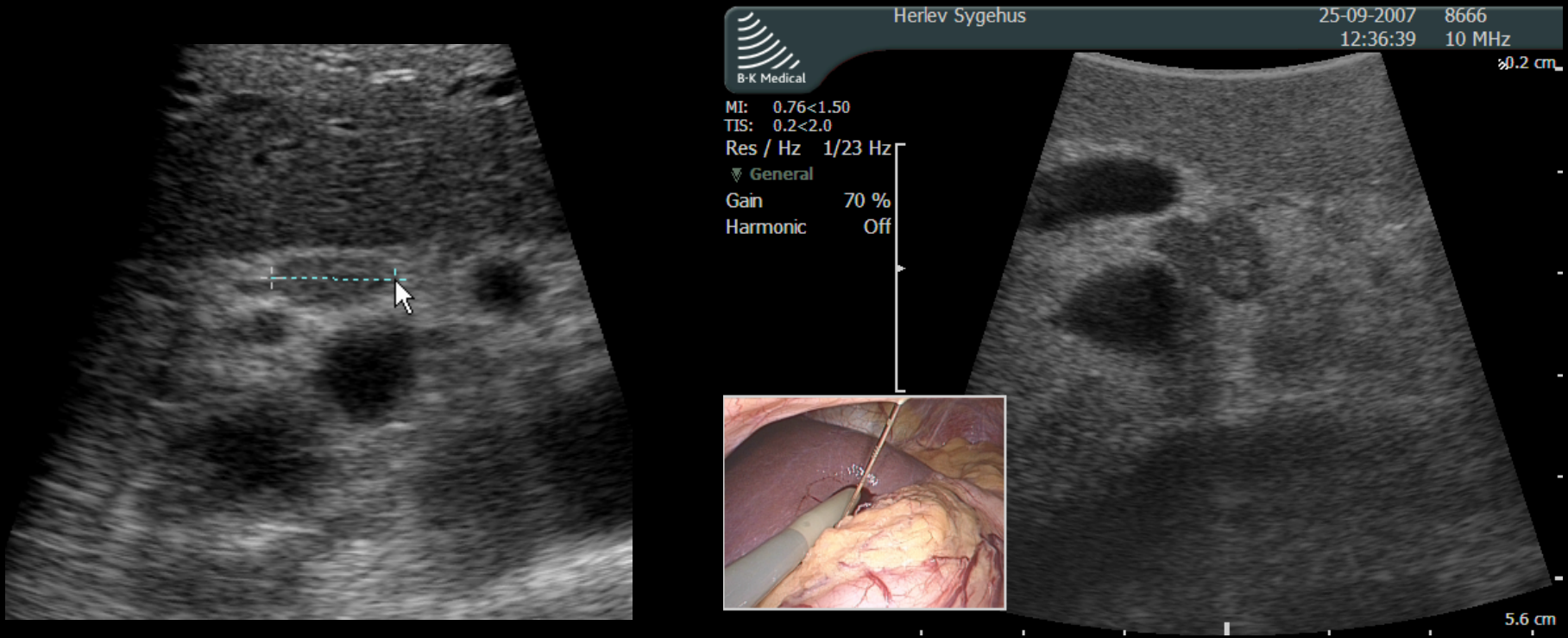
# Laparoscopic guided RFA



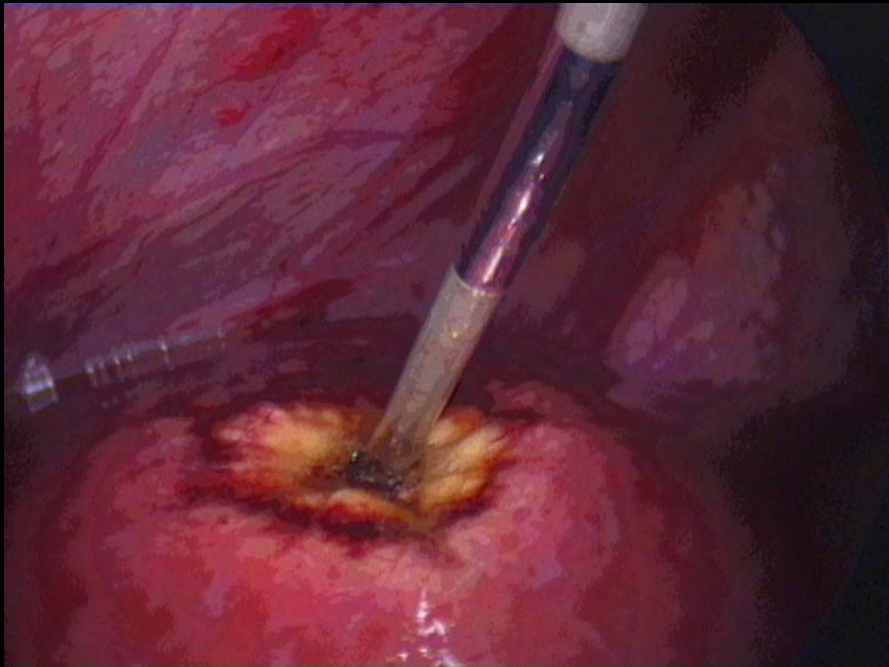
# CE-LUS: Liver metastasis



# Retroperitoneal lymph node Biopsy



# Laparoscopic guided RFA Superficial lesions



# Intra operative US (IUS)

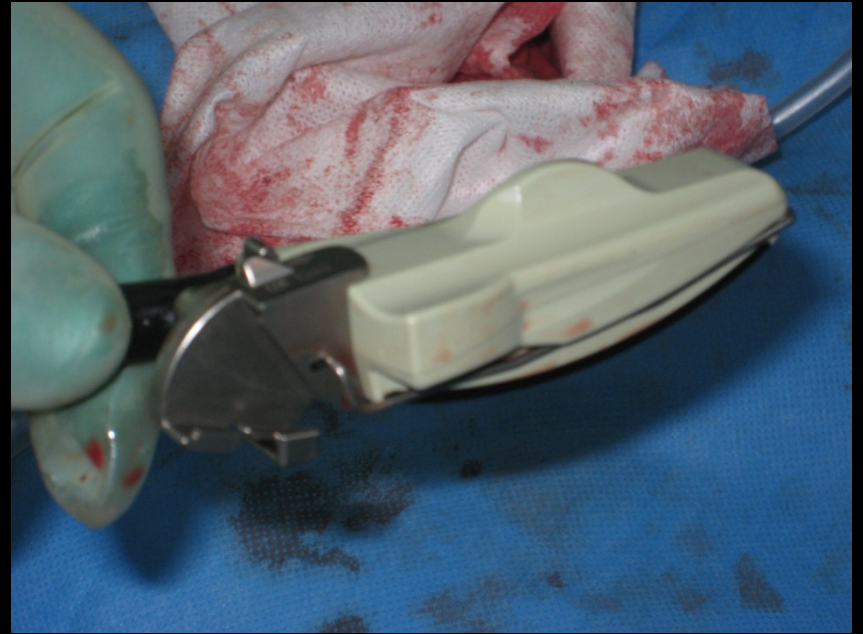
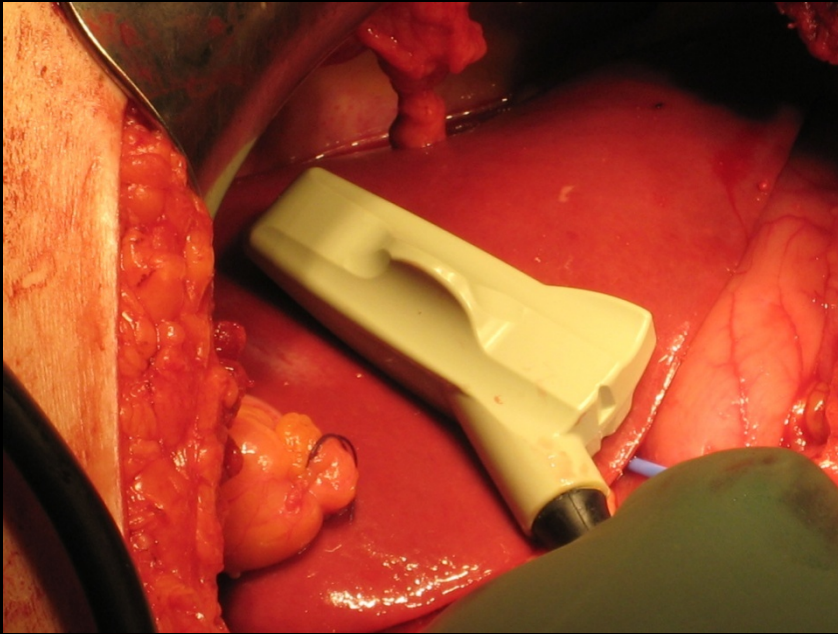


Sensitivity in detection of liver lesions:

IUS / CE-IUS > 98 %

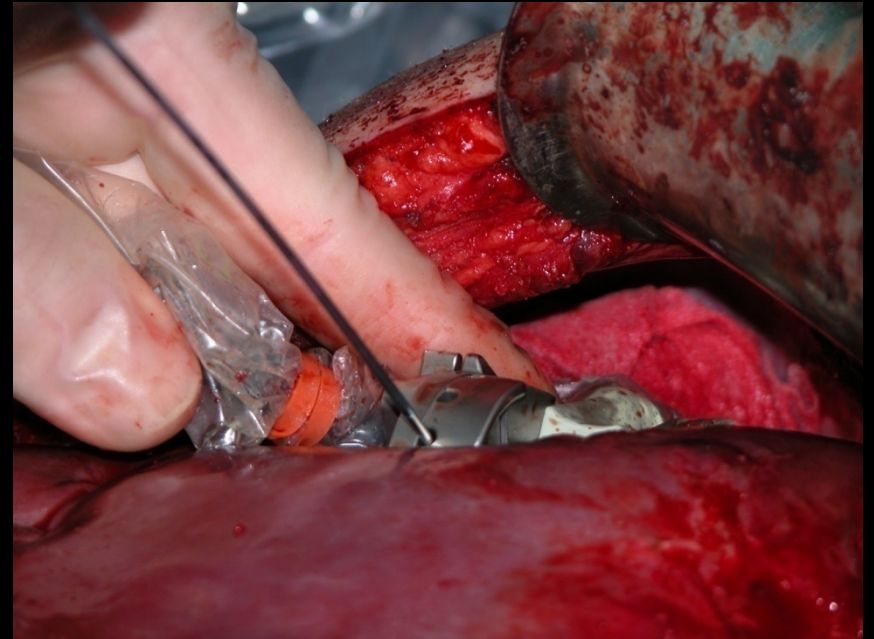
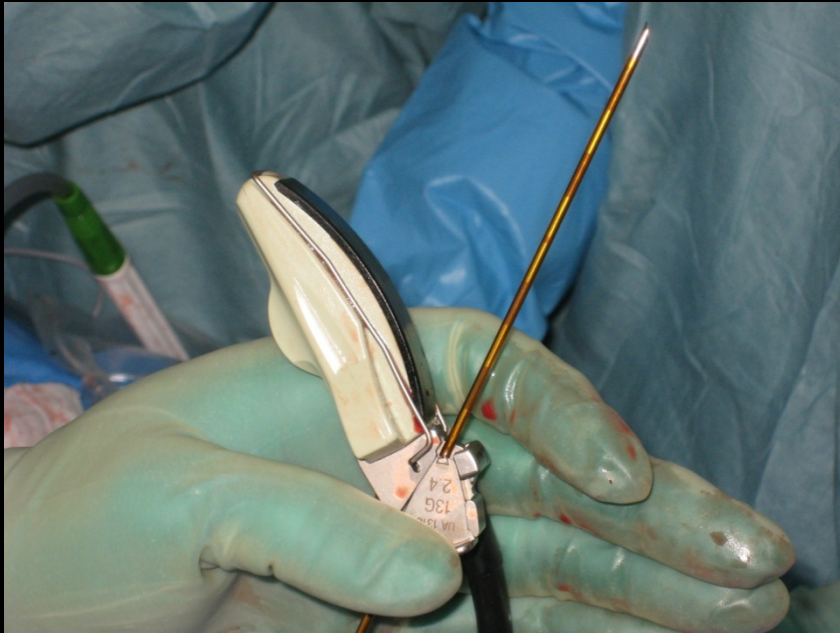


# Dedicated IUS transducer with interventional attachment

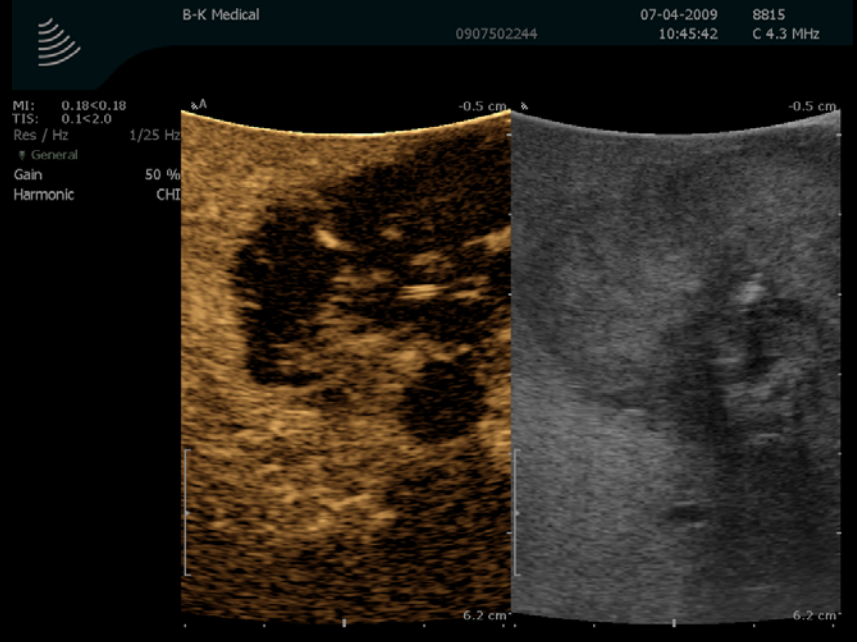
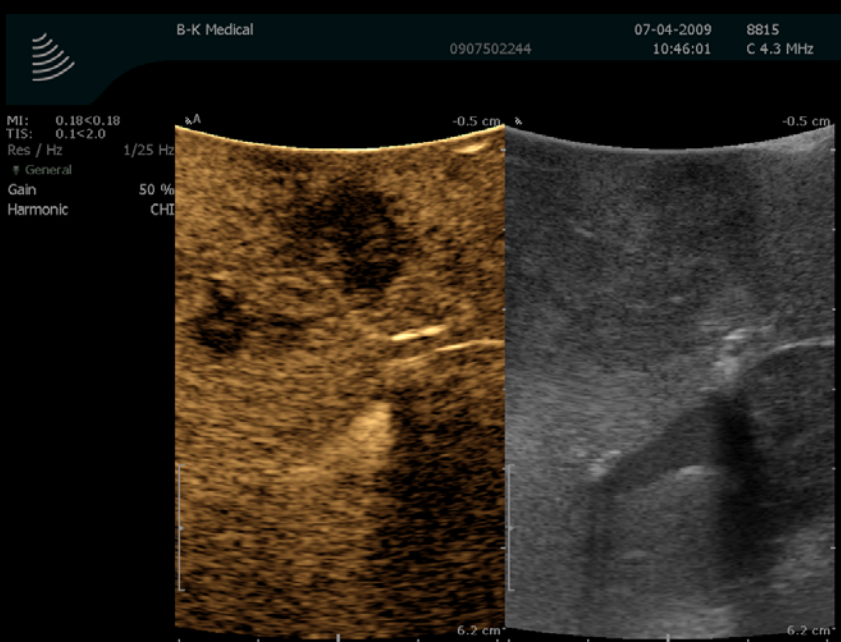




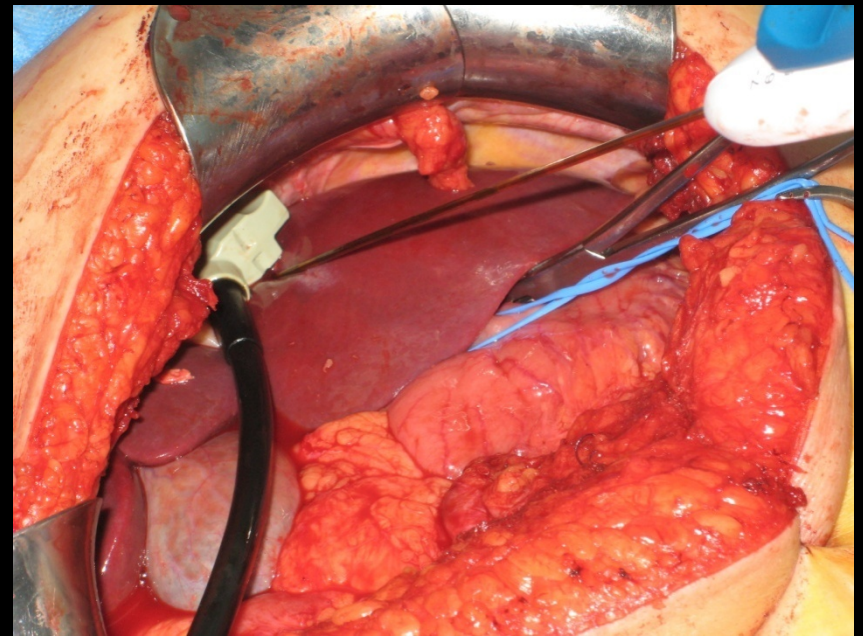
# IUS Guided Ablation



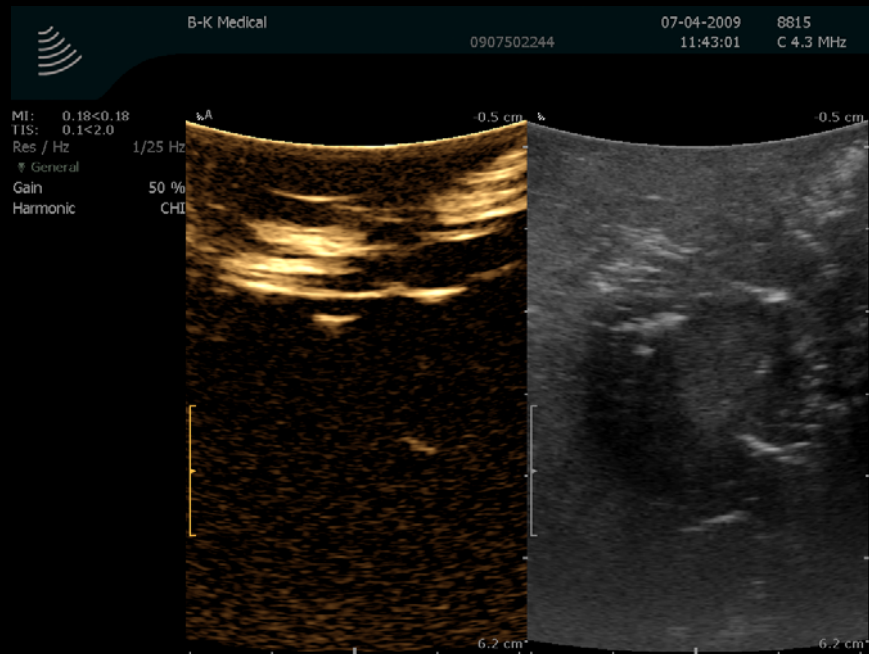
# CE-IUS before ablaion



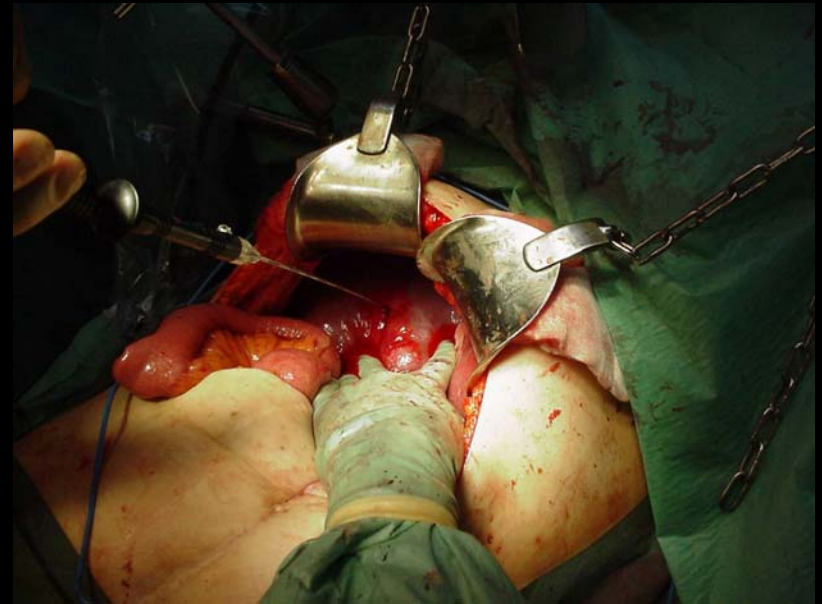
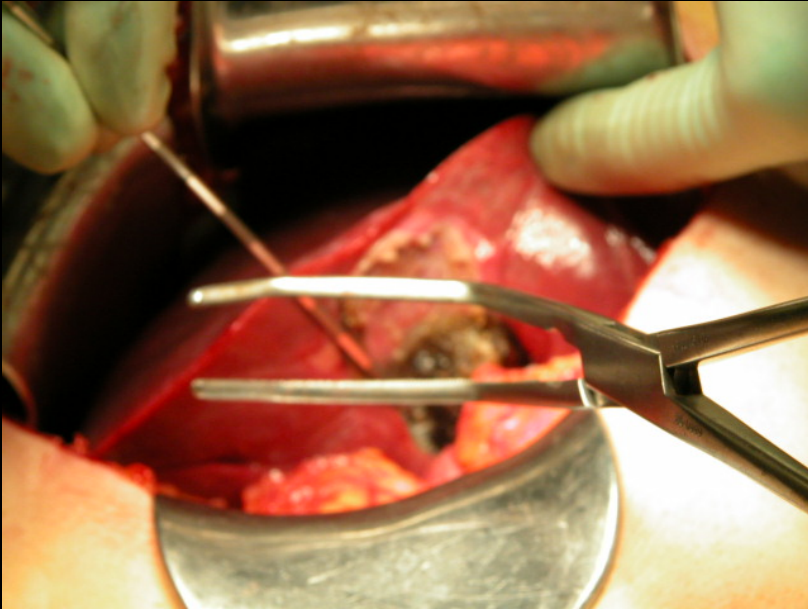
# ”Open” RF: Cluster needle with perfusion



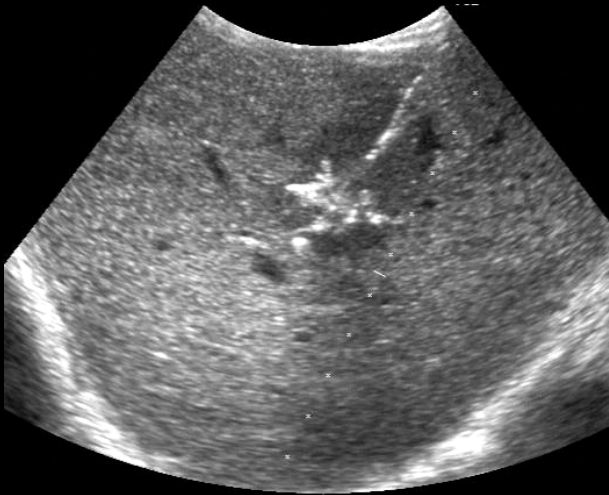
# CE-IUS after ablation



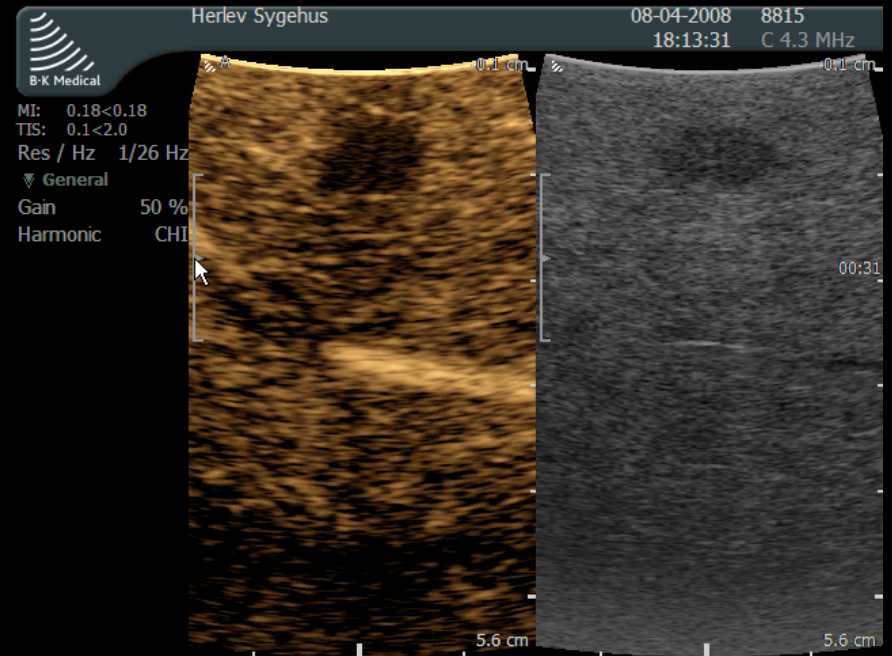
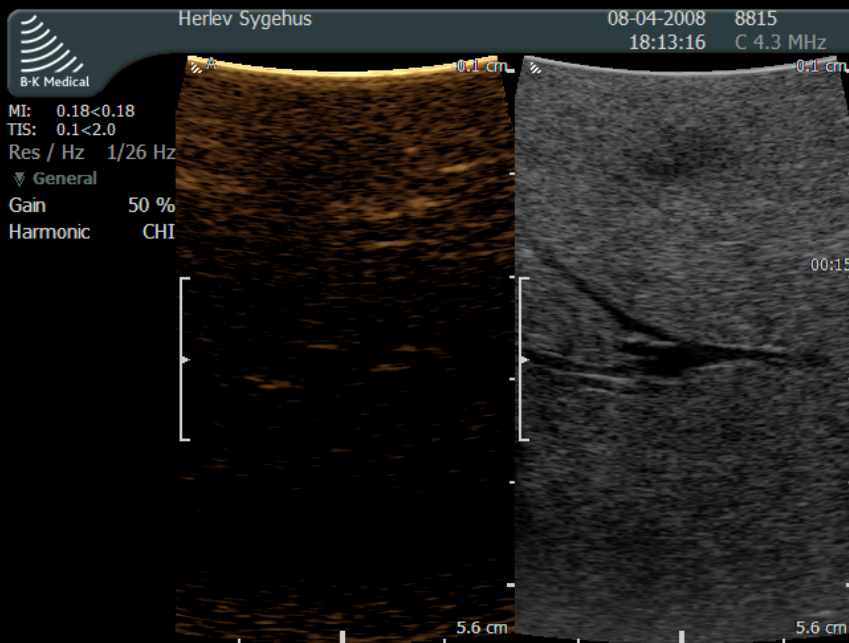
# ”Open RFA” ” Pringle ”



# “Open” RF Ablation

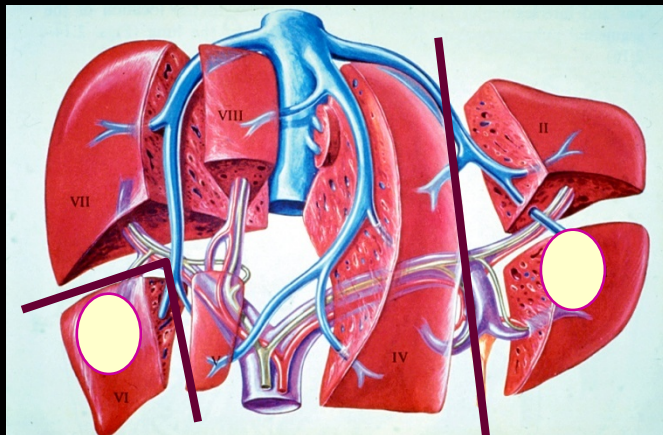
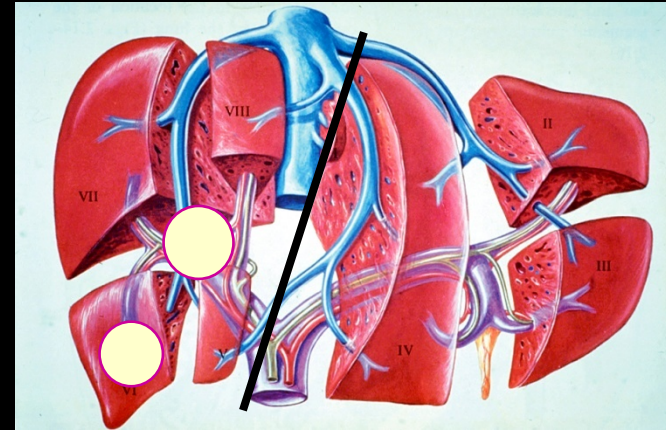
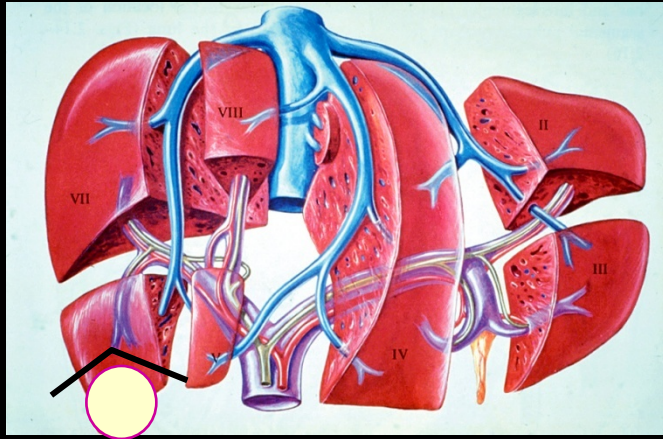


# CE-IUS : Small undetected Lmet

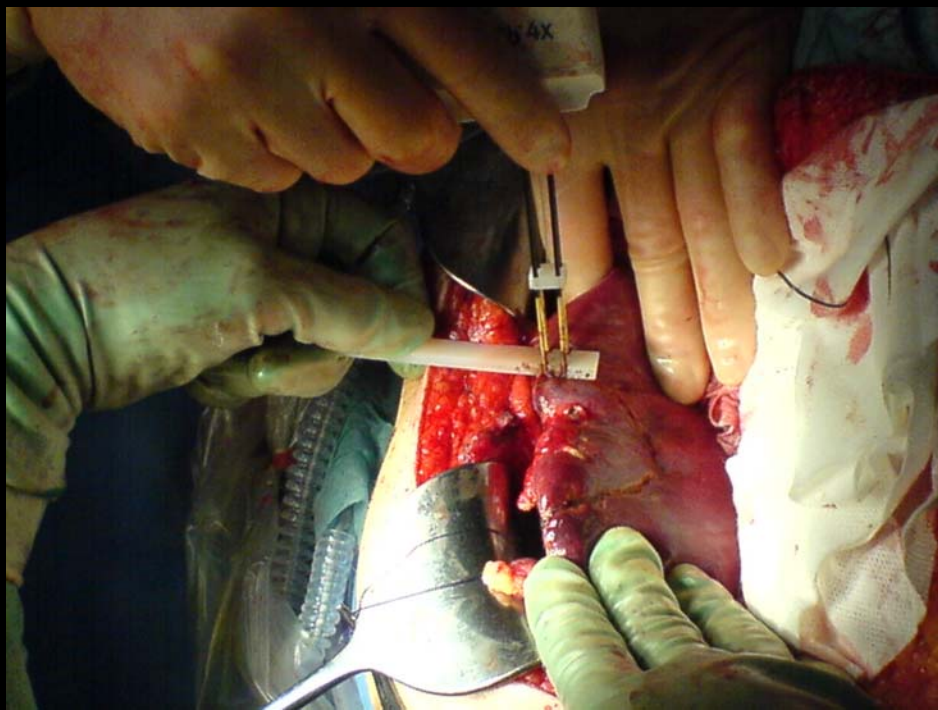




# Surgical treatment



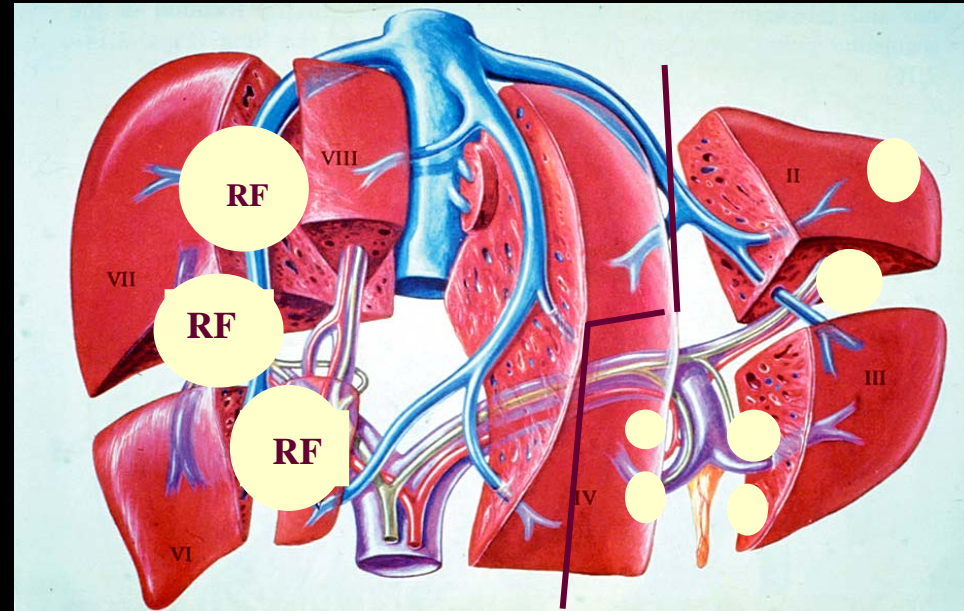
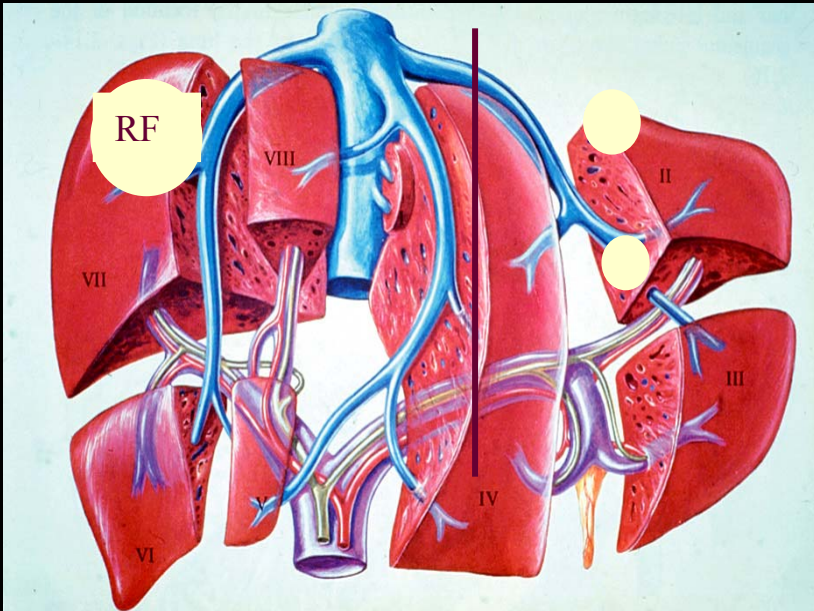
# RF resection: The Habib Needle



# Resection of liver metastasis from colorectal cancer

	1994	2008
<b>Operative mortality</b>	<b>5 %</b>	<b>≤ 1-2 %</b>
<b>Recurrence rate</b>	<b>50 %</b>	<b>25 - 35%</b>
<b>5-year survival</b>	<b>35 %</b>	<b>50%</b>

# Resection and RFA



# Herlev 1994

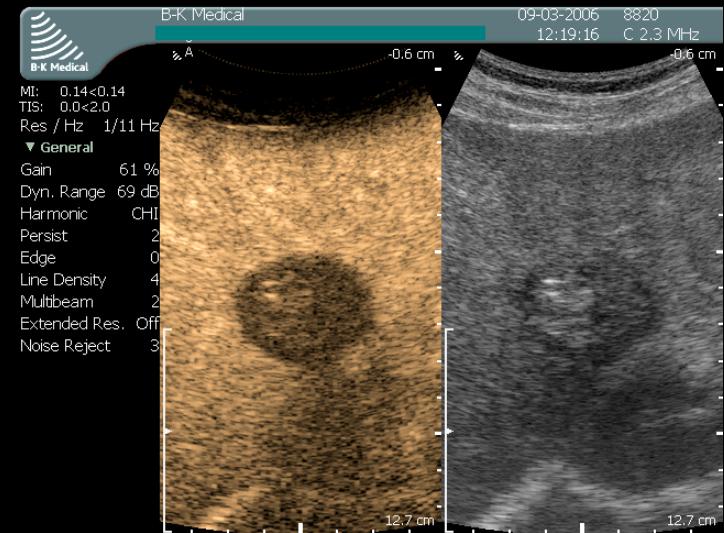
## Focal ablation of liver tumors

- Inclusion criteria: "The Rule of 5"
  - No. of Liver-mets  $\leq 5$
  - Largest  $\emptyset < 5$  cm
  - Non-resectable
  - No extra hepatic disease

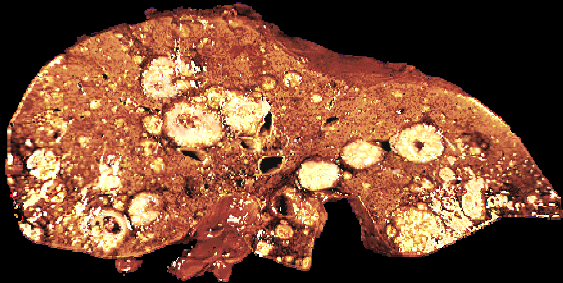
# Herlev 2008

## Focal ablation of liver tumors

- Multidisciplinary conference
- Down Staging
- Critical No.  $> 5$
- Critical Size  $> 4$  cm
- Resectability:
  - Non resectable
  - Open RF/ Resection
- Extra hepatic:
  - none
  - stable disease



# Systemic Chemotherapy



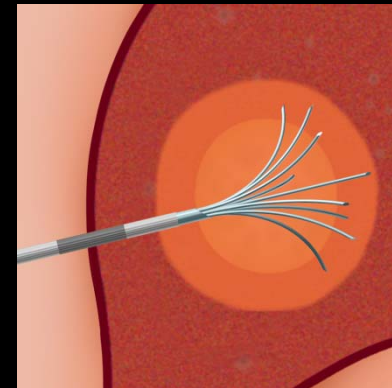
# Regional Chemotherapy



# Surgical resection



# RF-ablation



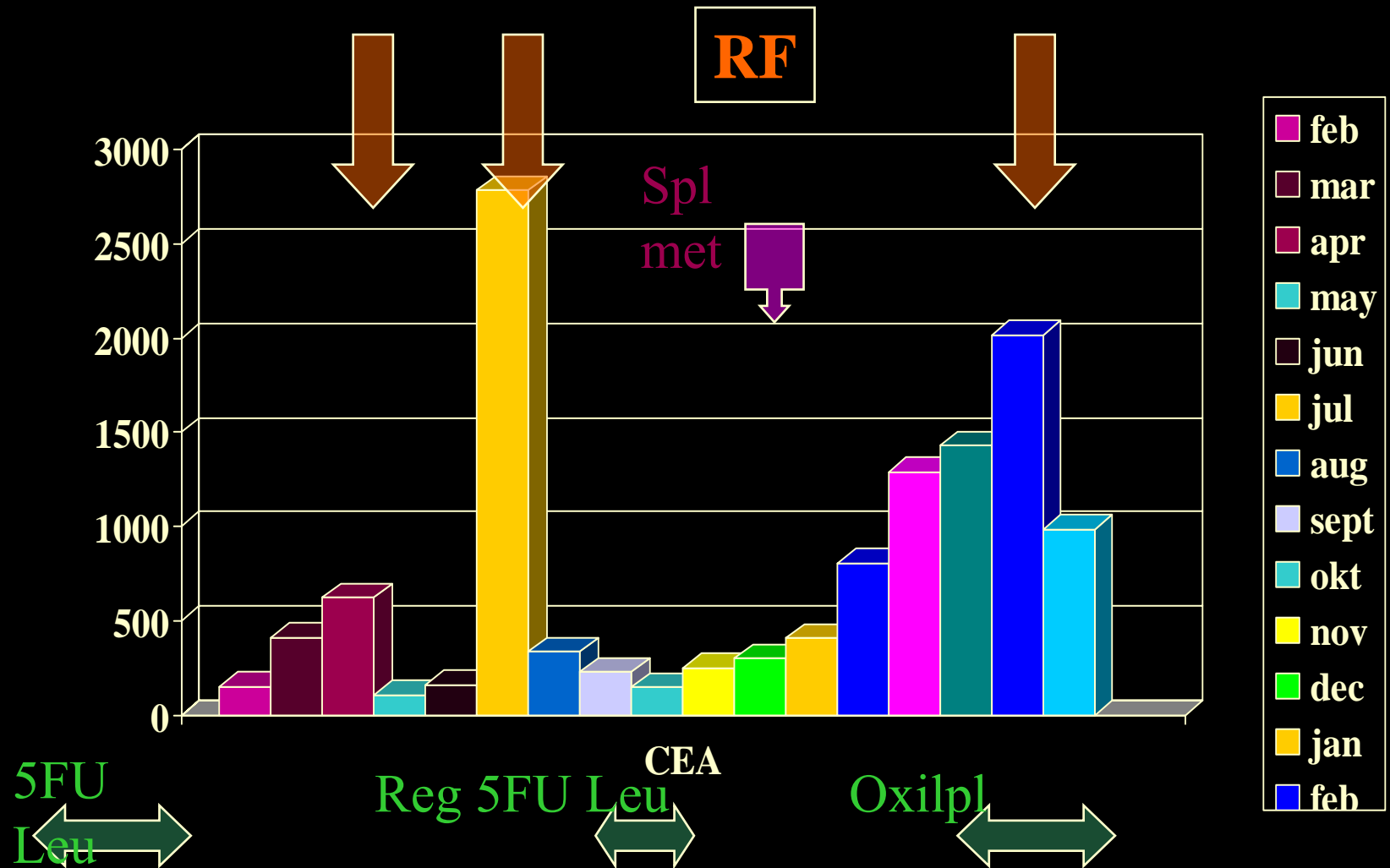
# Gene therapy

# Immunomodulation



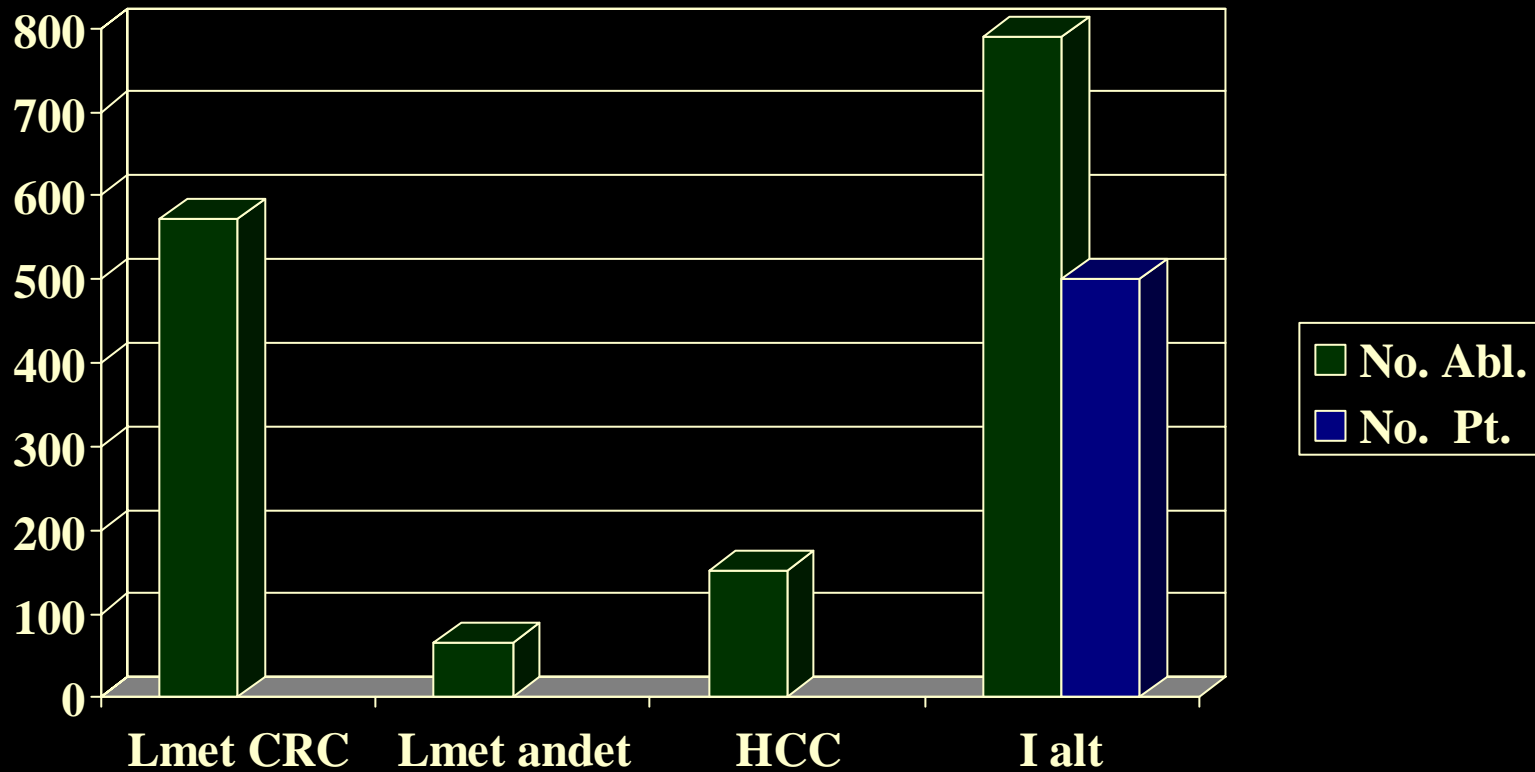
# Multidisciplinary Approach

## Case illustration

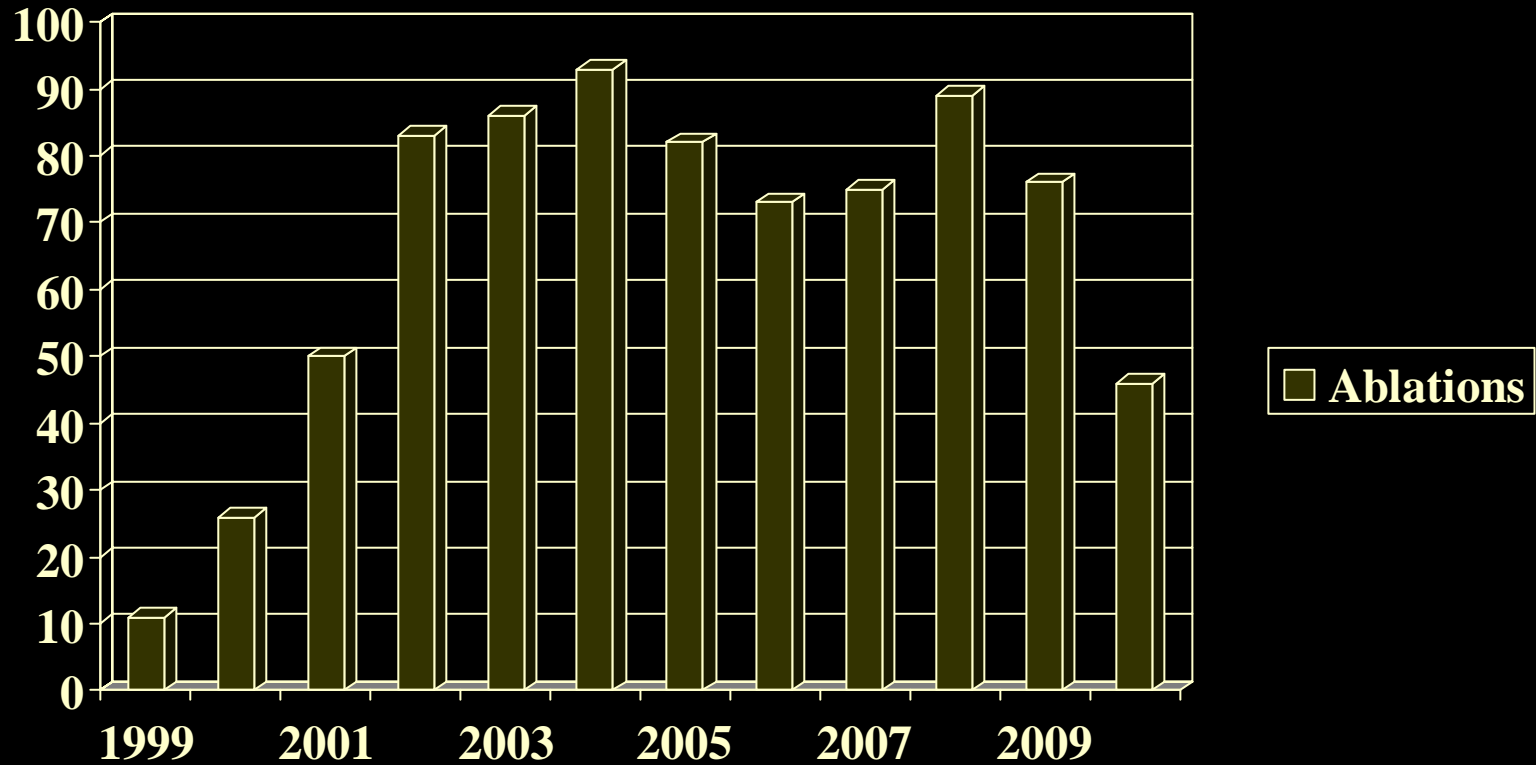




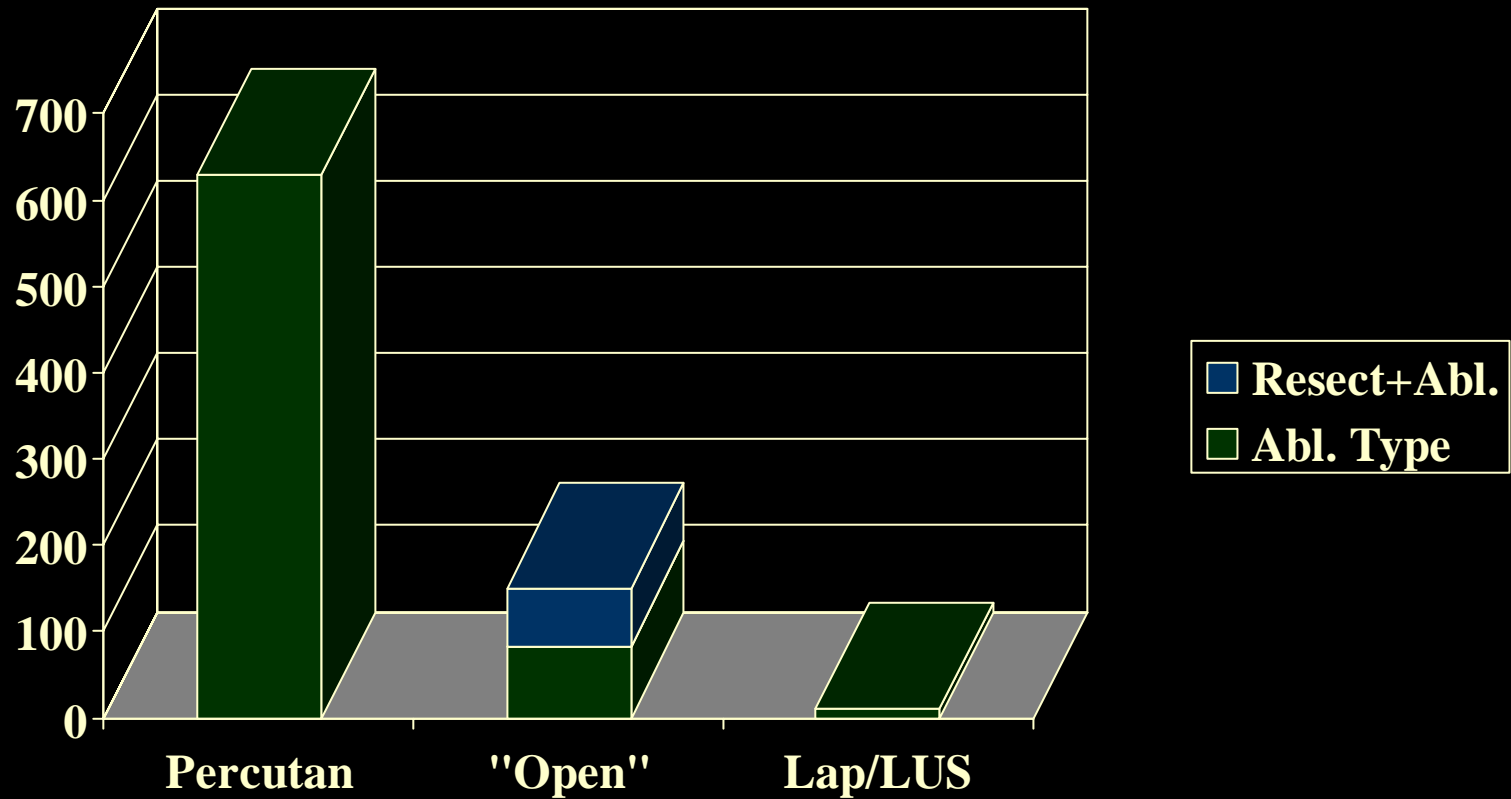
# Herlev 1999-2009



# Herlev 1999-2008



# Herlev 1999-2008

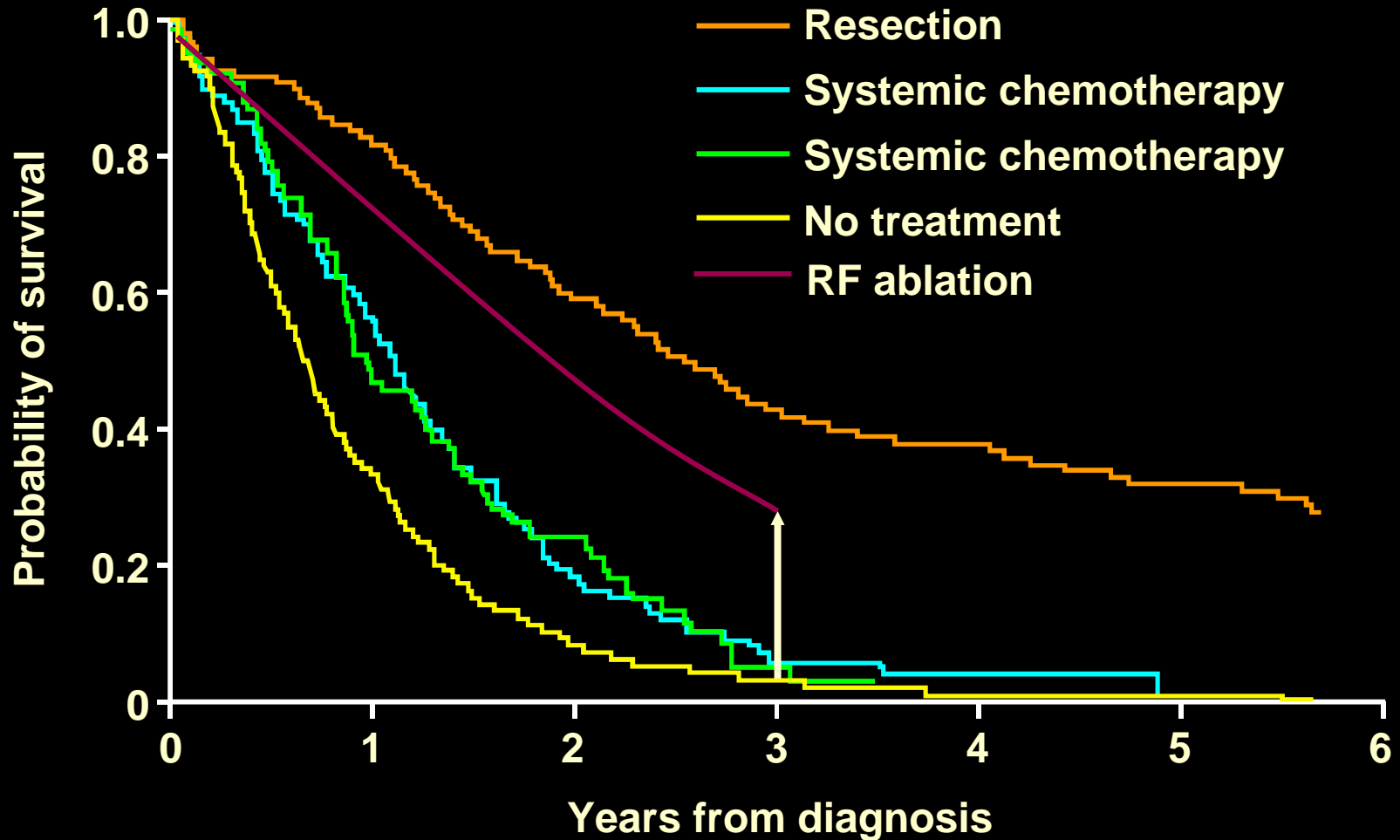


# Focal ablation of liver tumors 1999-2008

Mortality	0,16 %
Rate of complications	5,5%
Mean survival *	2,7 yr (date = 1. RF)
5 year survival	20% (date = 1. RF)

- RFA is a minimal invasive, simple and effective ablation technique
- RFA is relatively inexpensive and easy to access.
- RFA can be performed percutaneously, laparoscopically and intraoperatively depending on the individual case.
- Short hospitalisation time

# *Survival in patients with colorectal liver metastases*

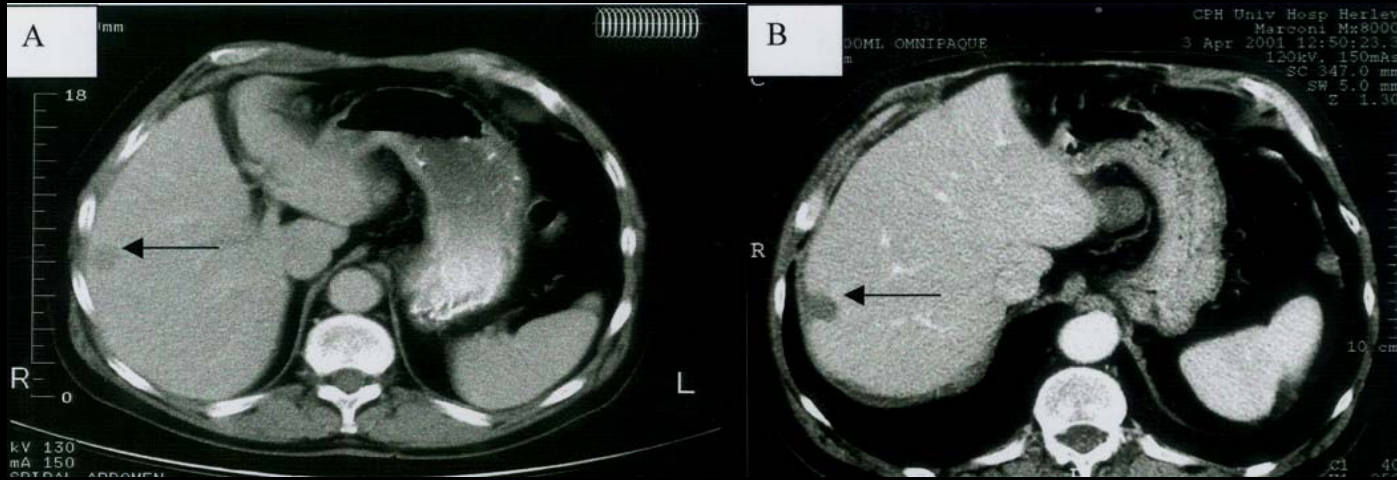


# Complications

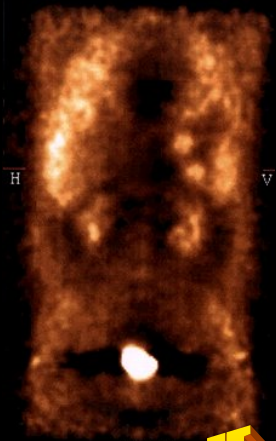
- Abscess 2 %
- Biliary fistulas 3%
- Bleeding 1%
- Skin necrosis 2%
- Perf. of the intestine < 0,3%
- Tumour seeding < 1%



# Follow Up after RF treatment



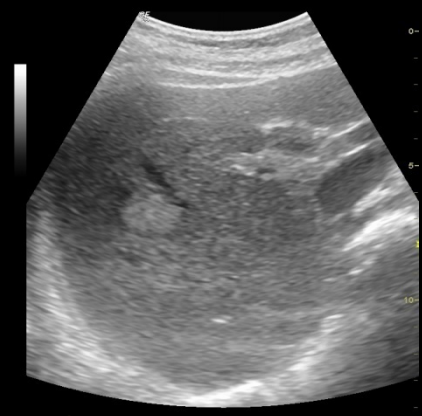
- 5 weeks: CT + “tumor marker” (tm)
- 6 weeks: US + CEUS / biopsy (fnac)
  - 3 month: (CT) + US + (tm)
  - 6 month: (CT) + US + ( tm)
- 9,12,18,24,36,48 & 60 months: US + ( tm)
- CT, PET & US-guided biopsy on indication.



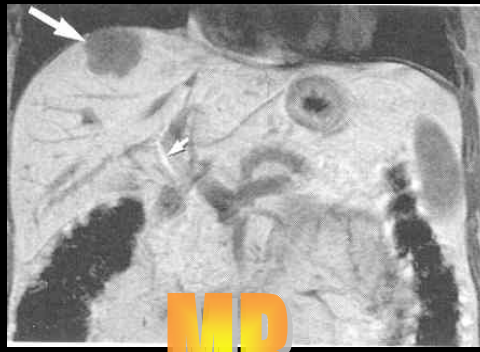
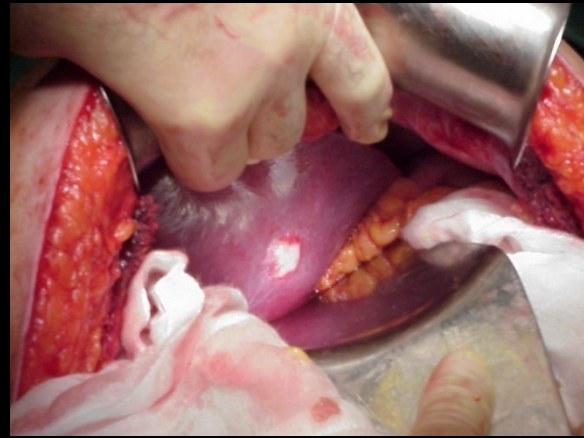
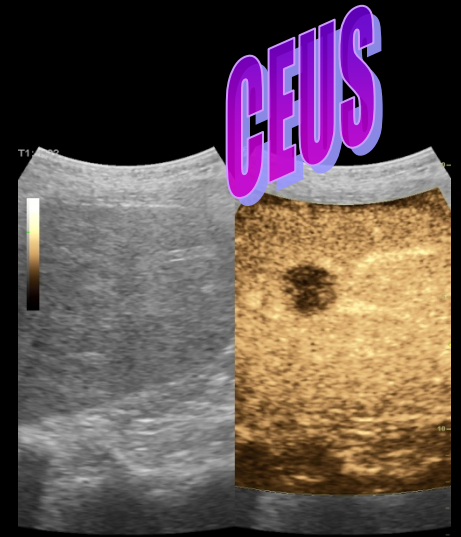
CORONAL NEDAD **PET**



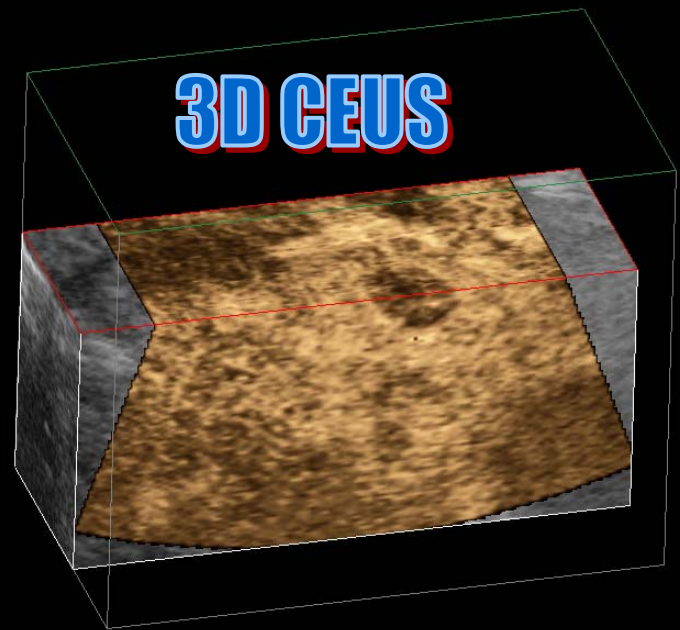
**CT**



**US**

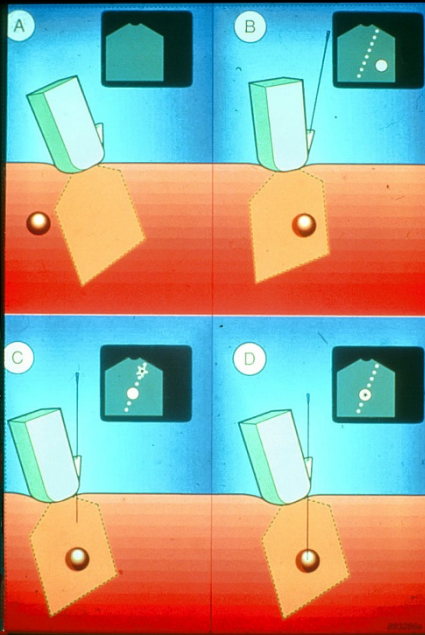


**MR**



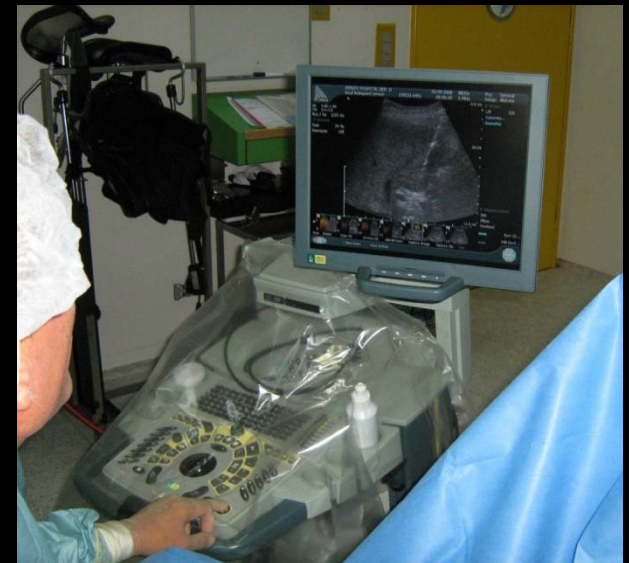


# WHY ULTRASOUND?

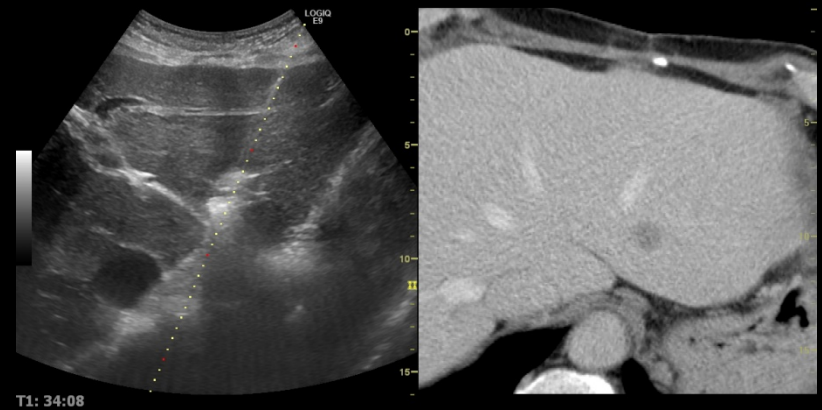
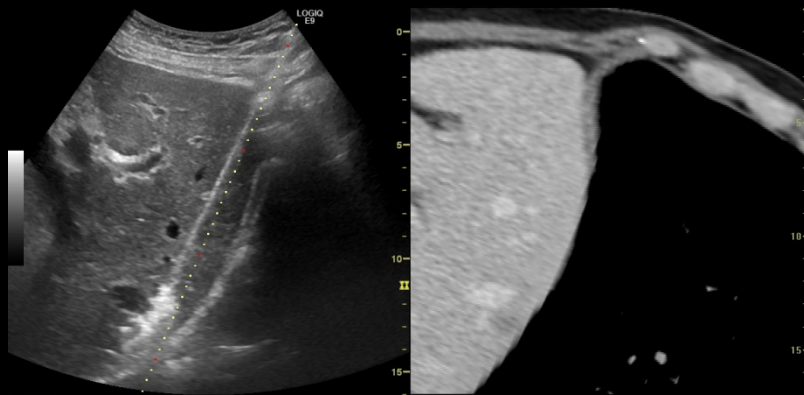


- 2D imaging.
- Free choice of image plane.
- Real Time Imaging.
- Availability

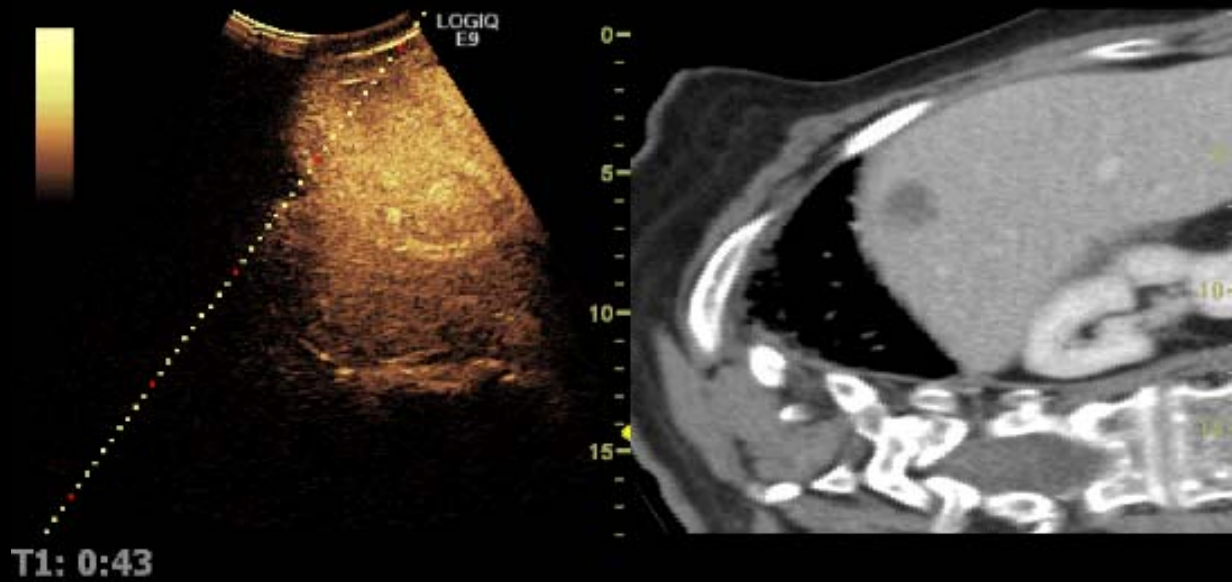
CT



# FIUS guided ablation



# Fusion



# GPS

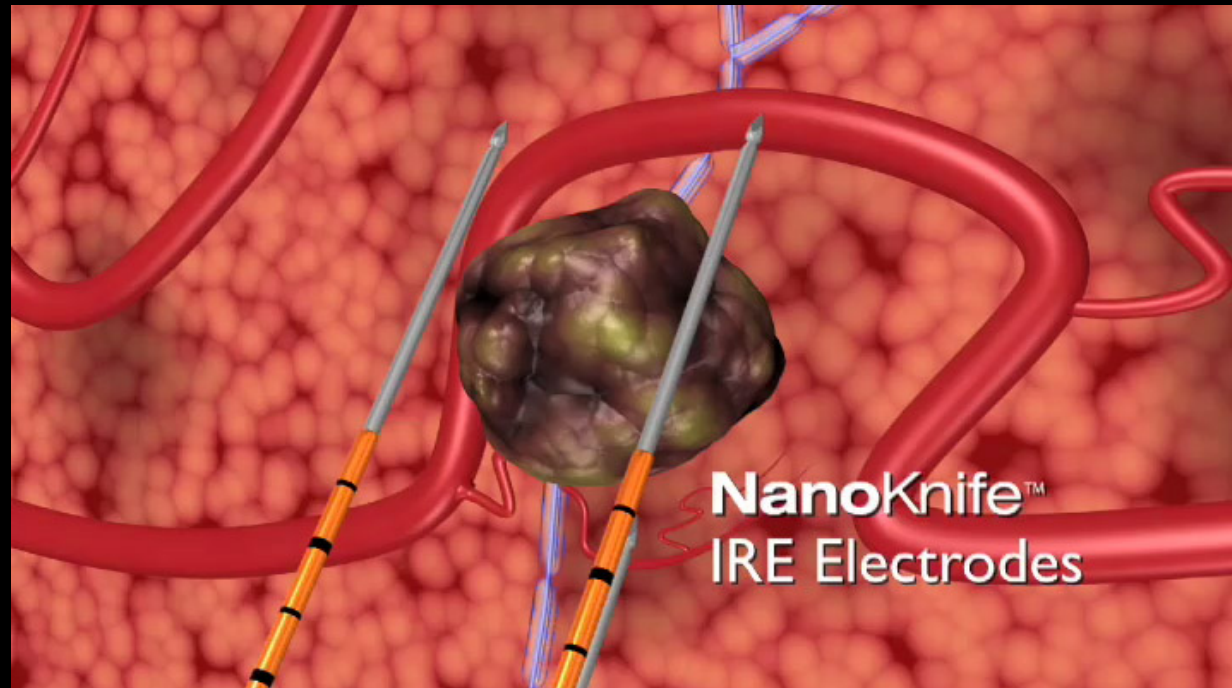


# GPS



# Upcomming modality? Irreversible electroporation; The Nano-Knife

Number of Probe Outputs	1-6
Number of Pulses*	10 to 100
Pulse Amplitude	500 to 3000V
Pulse Length	20 - 100 $\mu$ s
Pulse Interval	240 PPM, 250 ms/3.5 s every 10 <sup>th</sup> pulse 90 PPM, 670 ms/3.5 s every 10 <sup>th</sup> pulse ECG, interval varies depending on heart rate
Max Energy per pulse (nominal)	15 J
Pulse Amplitude Precision	5%
Pulse Length Precision	$\pm 2 \mu$ s or 2% (which ever is larger)
Maximum Current	50 A



# The speakers preferences (2010)



- Imaging guidance
  - Ultrasound & CEUS
- Tumors  $< 2$  cm
  - MW or UniAblate
- Tumors 2-4 cm
  - RF Cluster needle
- Tumors  $> 4$  cm
  - RF Cluster needle with perfusion.

# Where do we stand?

## Recommendations: 2010

### Percutaneous Ablation of liver tumors

- Non-surgical candidates
- Tumor Size: Significant
- Peri-vascularity: Significant
- Number of lesions: Non-significant
- > 4-5 cm = Downstaging
- Max. Tumor size 8 cm (Vogl, 2010)
- Results depends on patient selection



# Status 2010

- Multidisciplinary approach
- Downstaging modalities (e.i. TACE...)
- New minimal invasive techniques
- More aggressive surgery
  
- Fusion Imaging
- Target Tagging