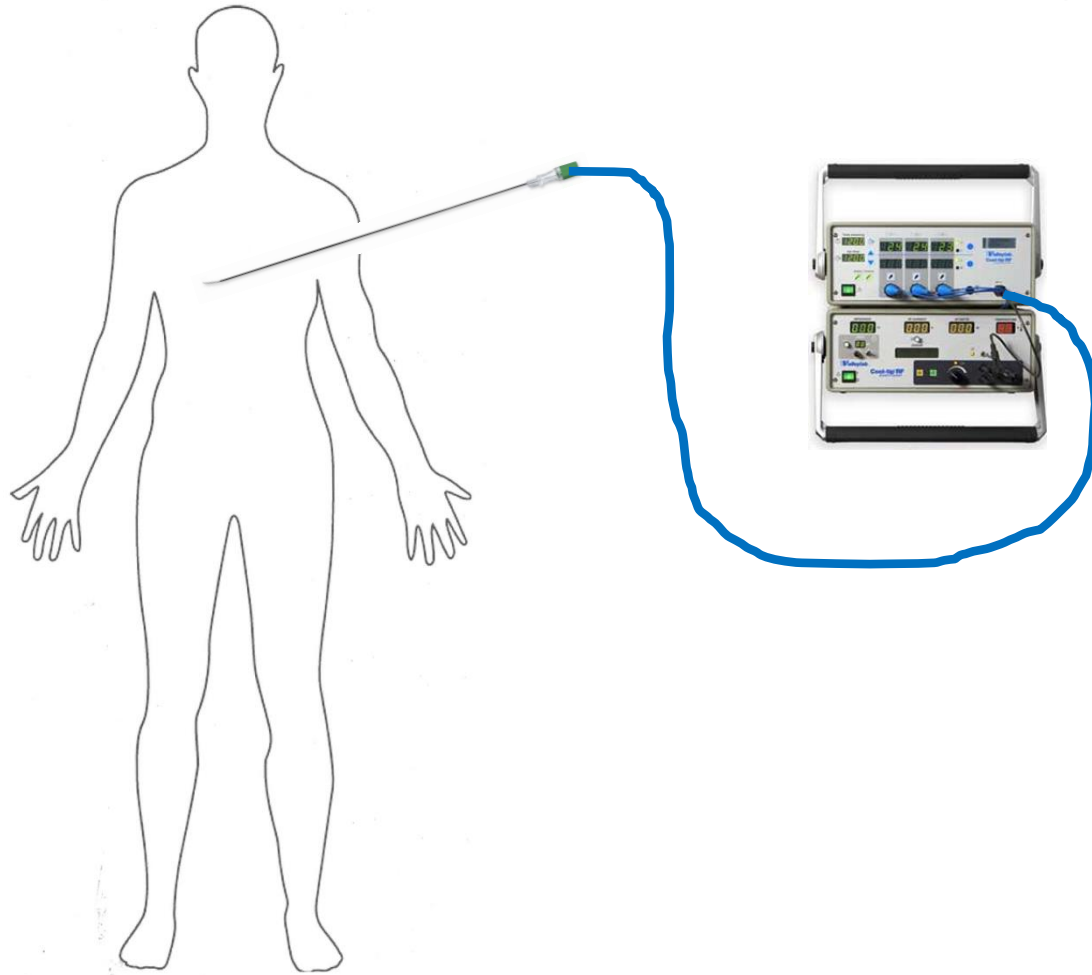


# Perkutane Schilddrüsenablation - Technik und Limitationen

Lukas Hechelhammer

Leitender Arzt interventionelle Radiologie

- Ablationsverfahren
  - Radiofrequenzablation
  - Mikrowellenablation
- Technik
- Daten
- Probleme





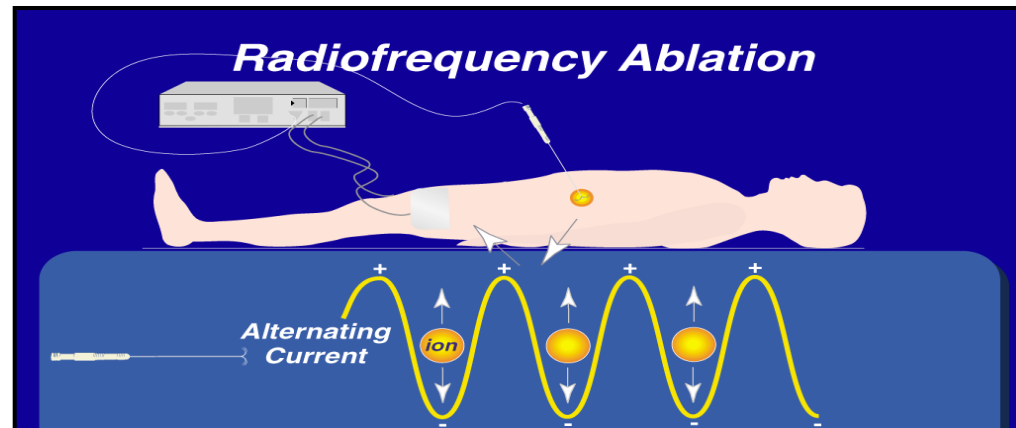
# Radiofrequenzablation

420-500 kHz sinusoidaler Strom

→ Ionenbewegung

→ Reibungsenergie

→ Koagulationsnekrose



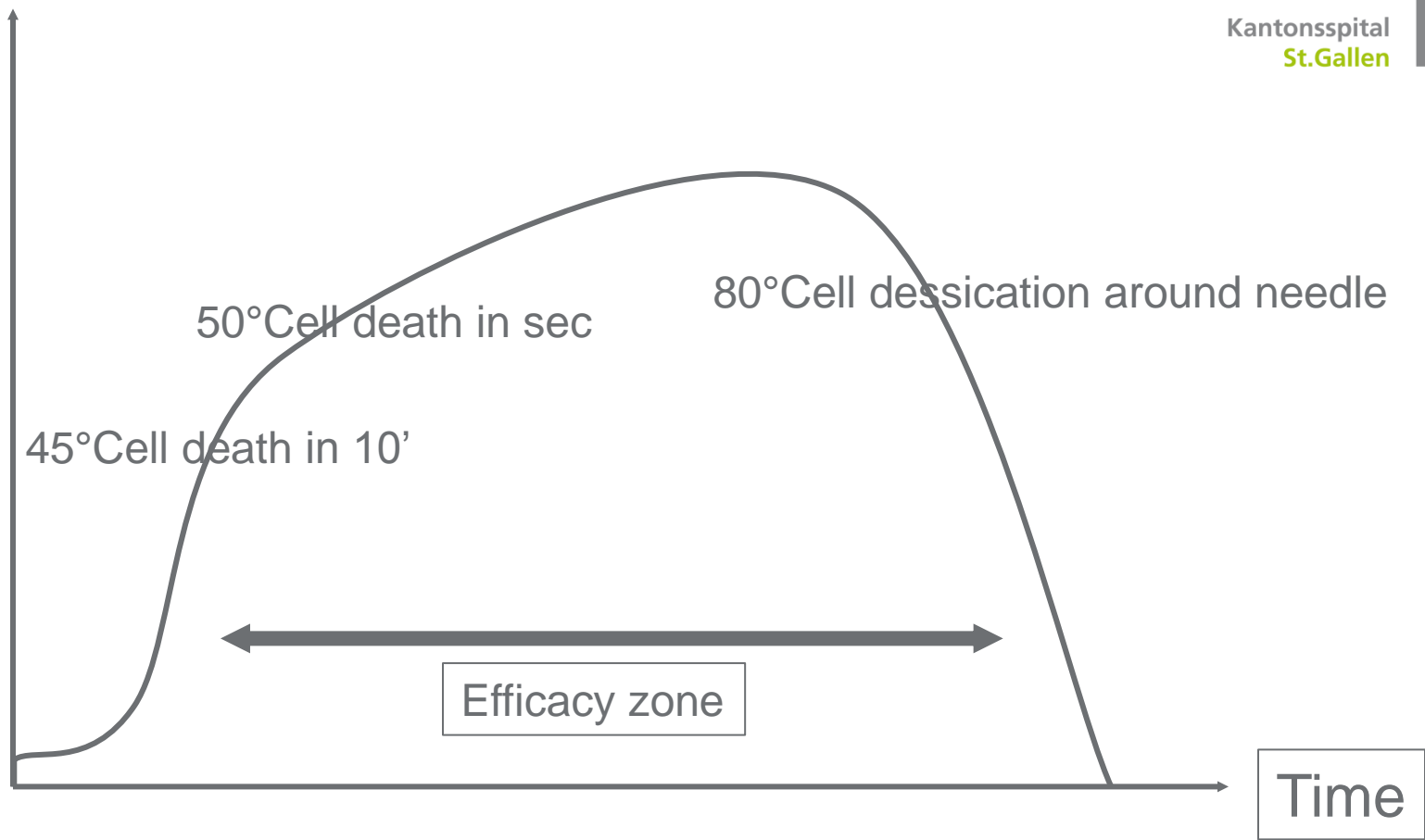
$$\rho c_t \frac{\partial T(r,t)}{\partial t} = (k_t T) - c_b \rho_b m \rho_t (T - T_b) + Q_p(r,t) + Q_m(r,t)$$

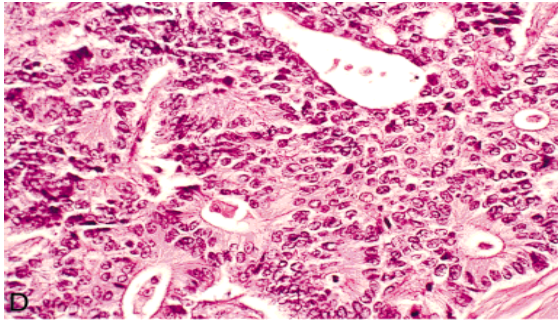
***Koagulationsnekrose =  
deponierte Energie x lokale Gewebsinteraktionen – Wärmeverlust***

60°-100°      sofortige irreversible Proteindenaturierung

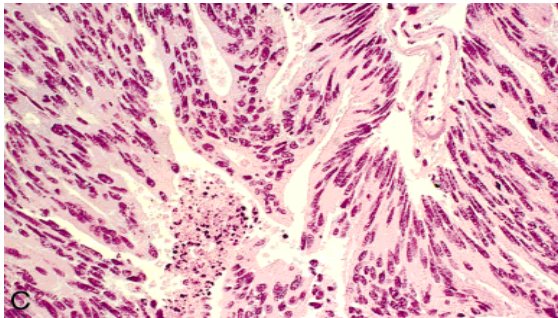
>100°      Karbonisation ± Gasbildung

 elekt. Leitfähigkeit wird herabgesetzt

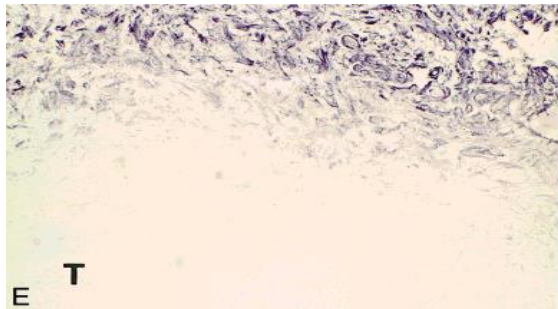




Untreated tumor



2h after RFA: Tumor cells are abnormal (elongated, with dense spindle-form nuclei and streaming cytoplasm).



Magnified scan of the margin of the zone of ablation stained for LDHase activity. The treated portion of the tumor (T) shows no evidence of active cytosolic enzyme function.



- Generatoren weit verbreitet
- «Prediktive» Ablationsgrösse
- Datenlage



- Schmerzhaft
- Darstellung des Ablationsvolumens  
sehr schwierig (Nerven, Nachbarorgane)
- «heat sink»



# Heat Sink

Kontakt zu grossen Gefässe



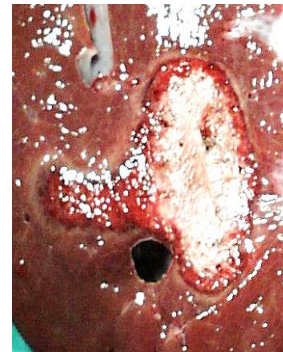
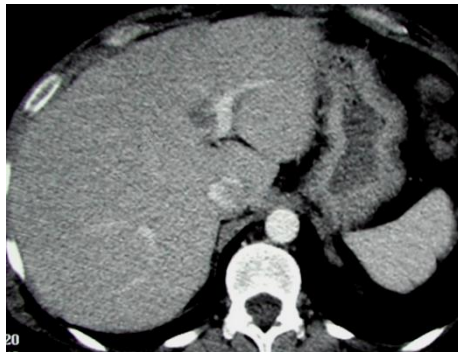
Hohe Rezidivrate !!

## Radiology

David S. K. Lu, MD  
Nam C. Yu, MD  
Steven S. Raman, MD  
Piyaporn Limanond, MD  
Charles Lassman, MD  
Kathryn Murray, BS  
Myron J. Tong, MD, PhD  
Rafael G. Amado, MD  
Ronald W. Busuttill, MD,  
PhD

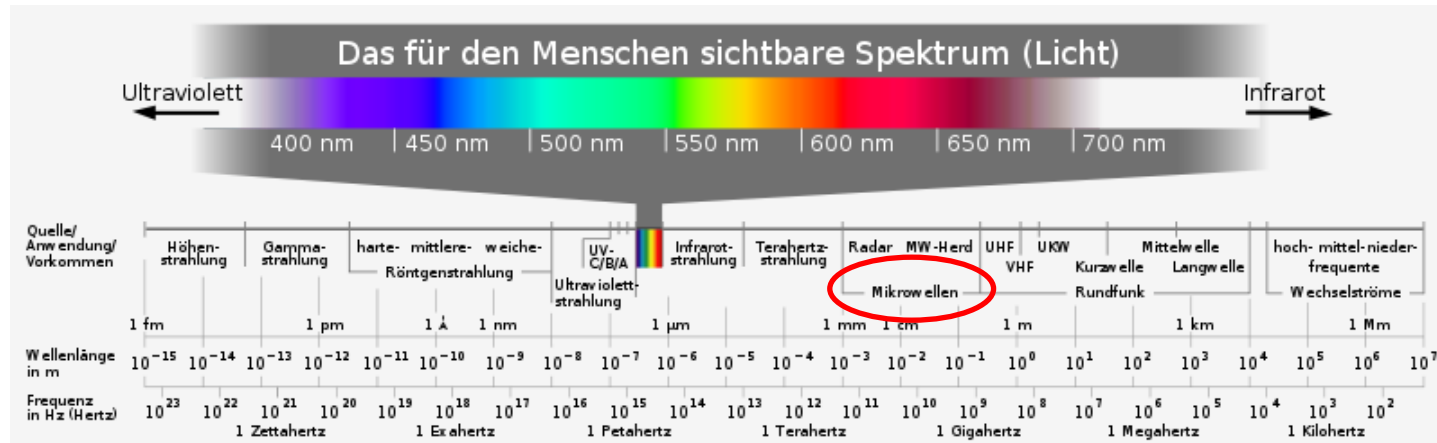
## Radiofrequency Ablation of Hepatocellular Carcinoma: Treatment Success as Defined by Histologic Examination of the Explanted Liver<sup>1</sup>

**RESULTS:** ....Seven (47%) of 15 perivascular lesions were successfully treated whereas 28 (88%) of 32 nonperivascular lesions were successfully treated ( $P < .01$ ).....



# Mikrowellenablation

- Basierend auf elektromagnetischen Wellen 900-2450 MHz

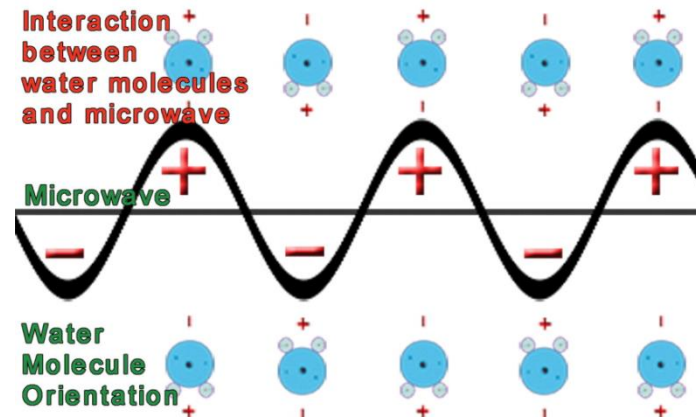


# Mikrowellenablation

Aufgrund des DIPOLS von  $\text{H}_2\text{O}$  Molekülen beginnen diese im Feld zu oszillieren

→ Reibungsenergie

→ Koagulationsnekrose



- «aktives» Feld der Antenne (Nadel) bis 2cm
- Höhere Ablationstemperaturen als RFA
- Sehr schnell
- Keine Neutralelektrode

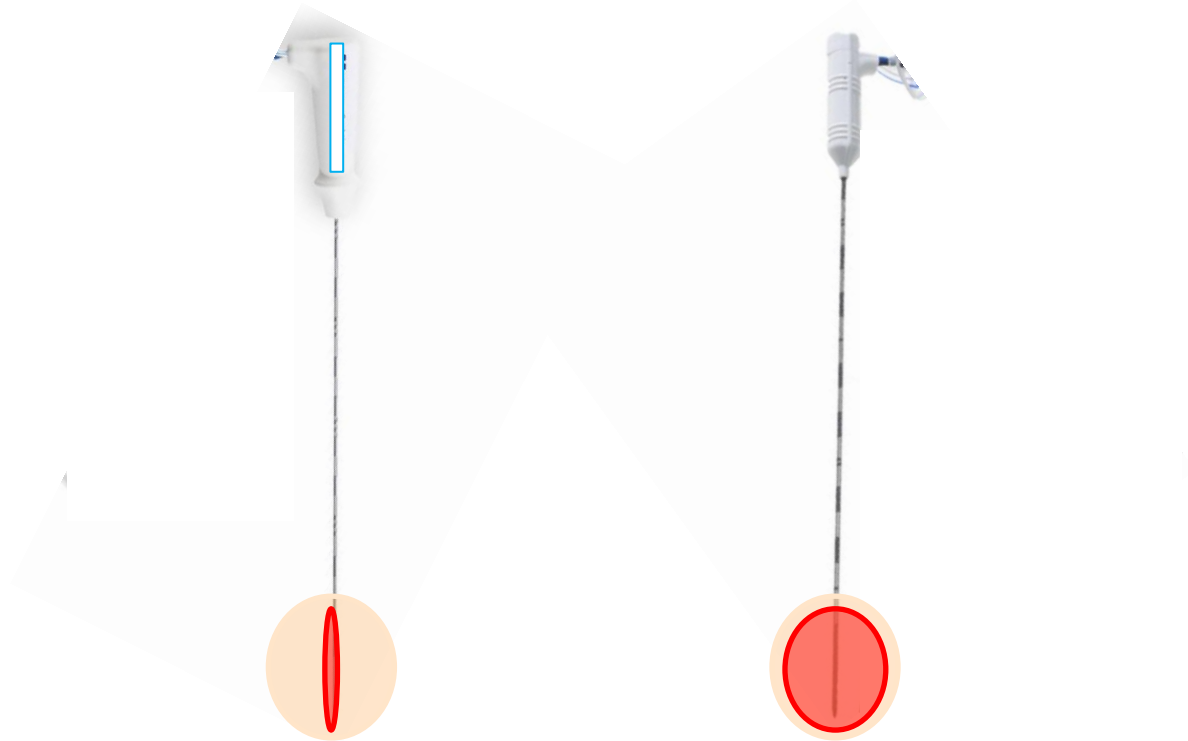


- Schmerzhaft
- Isolation der Antenne
- Darstellung des Ablationsvolumens  
sehr schwierig (Nerven, Nachbarorgane)

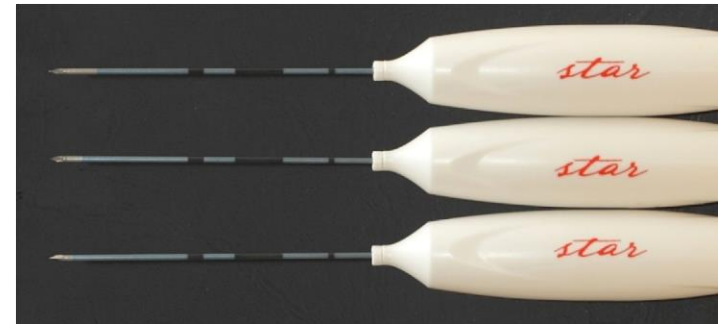


RFA

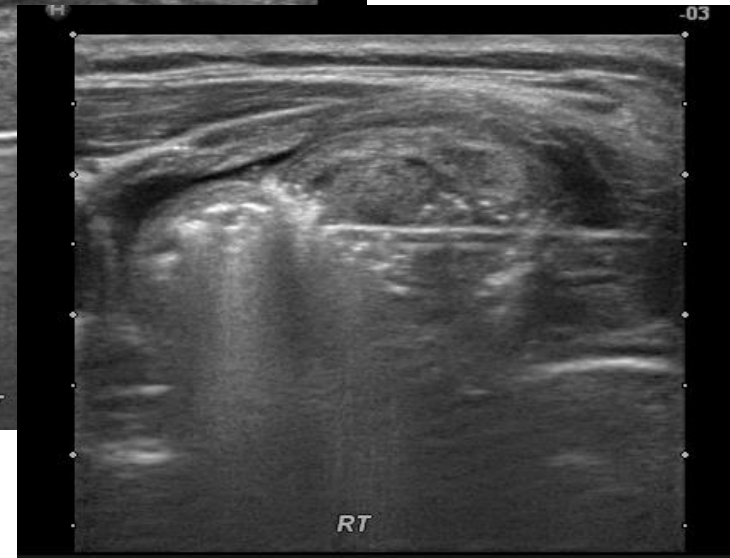
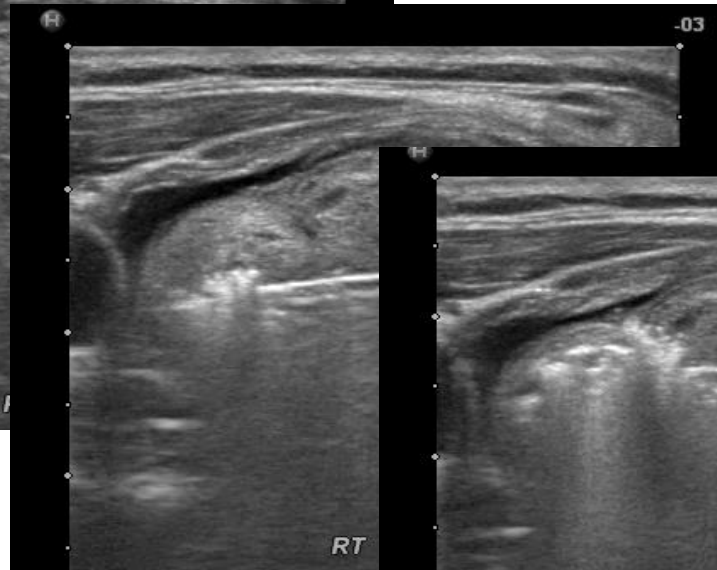
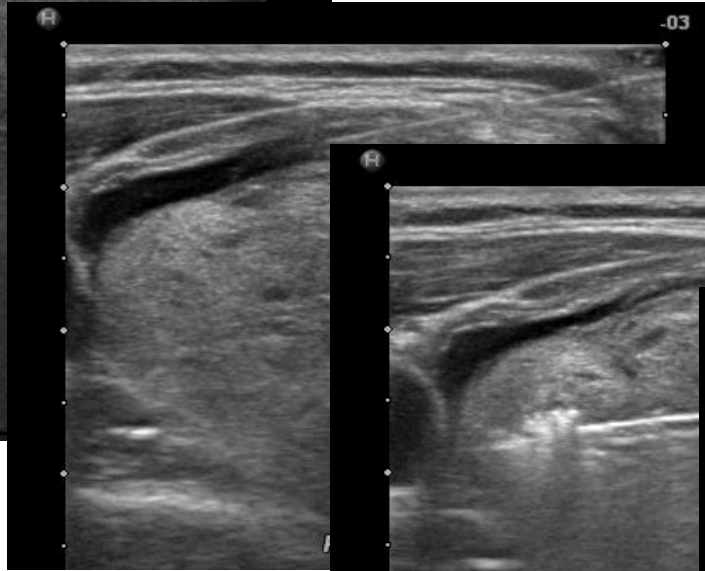
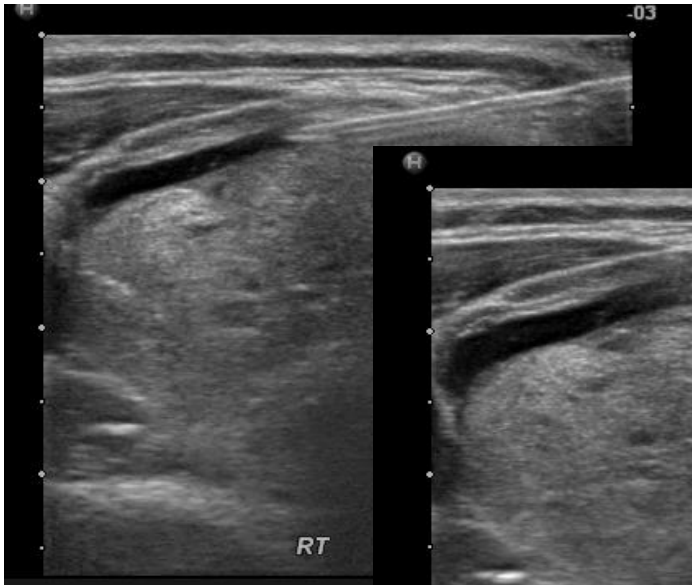
MWA



# Generator



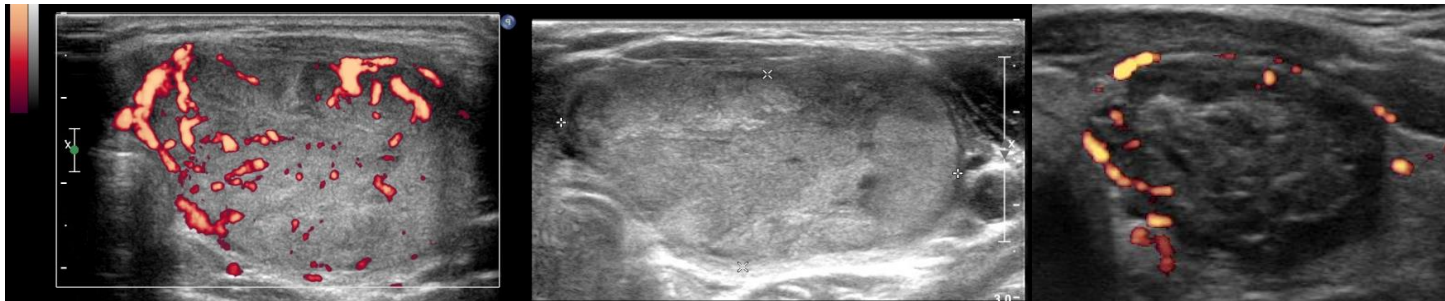
- Kurz: 7cm Länge
- Dünn: 18-19G
- Versch. Spitzen





# Sonographischer Verlauf

- Folgetag: 67% der abladierten Knoten zeigen ein Volumenzunahme aufgrund hitzebedingter Schwellung
- Tag 3-7: Beginn der Volumenabnahme
- Tag 7-30: schnelle Volumenabnahme (ca. 30-50%)
- Ab Tag 30: langsamere Volumenabnahme
- Knoten werden hypoechogen und weniger vaskularisiert



# Guidelines

- Korea
  - Benigne symptomatische Knoten (Dysphagie, Husten, FK-Gefühl)
  - Benigne Knoten mit kosmetischen “Beschwerden“
  - Autonome Knoten
  - Rezidive von SD-Karzinomen in Hoch-Risiko-Patienten
- Italien
  - Grosse, benigne, Knoten (>20ml) in symptomatischen Patienten, falls Chirurgie kontraindiziert oder abgelehnt
  - Autonome Knoten, falls Chirurgie oder Radioiod kontraindiziert oder abgelehnt
  - Palliative Therapie bei Rezidiven von SD-Karzinomen, falls Chirurgie oder Radioiod kontraindiziert oder abgelehnt
- USA
  - RFA Rezidive von SD-Karzinomen in Hoch-Risiko-Patienten

# Daten

Study	No. of Patients	Volume At baseline (ml)	Volume reduction %	Follow-up	Design	Sonographic characteristics	Number of sessions	Symptom score reduction
Kim et al. <sup>11</sup>	30	6.3	64	6.5 mo	Not controlled study	Mainly cystic	1	88% reduction compressive symptoms
Jeong et al. <sup>18</sup>	236	6.13±9.59	84.1	6 mo	Retrospective cohort	Solid/cystic/mixed	1.4	NA
Deandrea et al. <sup>19</sup>	10	39.3±27.8	46.3±17.1	6 mo	Prospective cohort	Solid/mixed	Retreatment in larger nodules	NA
Spiezia et al. <sup>20</sup>	66	21.1±1.7	79.4 ± 2.5	24 mo	Prospective cohort	Solid component (>70%)	More treatment in larger nodules	NA
Baek et al. <sup>35</sup>	15	7.5±4.9	82.6±8.1	8 mo	Controlled study	Solid component (>50%)	1	3.33±0.90 vs 1.00 ± 0.76
Faggiano et al. <sup>22</sup>	10	About 8	About 82	12 mo	Randomized controlled study	Solid component (>70%)	1	NA
Lim et al. <sup>23</sup>	126	9.8±8.5	93.5±11.7	49.4 mo	Retrospective study	Solid and mixed	2.2±1.4	4.3±1.6 vs 0.8±0.9
Turtullici et al. <sup>24</sup>	45	13.5±6.7	72.6±11.3	6 mo	Retrospective	NA	NA	NA
Deandrea et al. <sup>26</sup>	40	15.1±3.1	72±12	6 mo	Randomized controlled study	Solid (>70%)	Probably one session	3.6±1.9 vs 0.4±0.7
Cesareo et al. <sup>27</sup>	42	24.5±19.6	68.6±13.5	6 mo	Randomized controlled study	Solid (>70%)	One session	2.8±3.3 vs 0.4±2.2
Valcavi et al. <sup>28</sup>	45	30.0±18.2	-80.1±16.1	2 y	Retrospective	Solid (>70%)	One session	5.6±3.1 vs 1.9±1.3
Cesareo et al. <sup>30</sup>	48	23.5±18.6	71.1±14.3	1 y	Retrospective	Solid (>70%)	One session	3.4±3 vs 0.4±0.8

Volumen 6-39ml  
Schrumpfung 46-93%  
Grössere Knoten >1 Sitzung

# Daten

- 277 Patienten; 300 Knoten bzw. 154 Knoten nach 3 /12 Mt
- Volumen  $13.8 \pm 15.9$  ml
- 40 Patienten mit 47 Knoten hyperthyreot
  
- 3 Monate VR  $68 \pm 16\%$ ; 12 Monate  $82 \pm 13\%$ ; 2% der Knoten VR  $< 50\%$
- Von 32 hyperthyreoten Patienten
  - 27 euthyreot, 4 subklinisch hyperthyreot, 1 hypothyreot
  
- 1,8% Stimmveränderung rev.; permanent hypothyreot 0.3%; Infektion 0.3%

# Ablation vs. Chirurgie

- 37 RFA vs. 74 Chir.
- VR 70% nach 12 Monaten (12.45 vs. 4.56ml)
- Single Session 36 Fällen

Outcomes	RFA (=37)	Surgery (=74)
Tolerability		
Patients without levothyroxine prior to treatment	31	68
<b>Hypothyroidism</b>	<b>0</b>	<b>17*</b>
Total number of procedures	38	74
<b>Postoperative pain</b>	<b>2</b>	<b>74*</b>
<b>Complication rate</b>	<b>2</b>	<b>10*</b>

\*P < 0.05 versus RFA. ATD, antithyroid drugs; RFA, radiofrequency ablation.

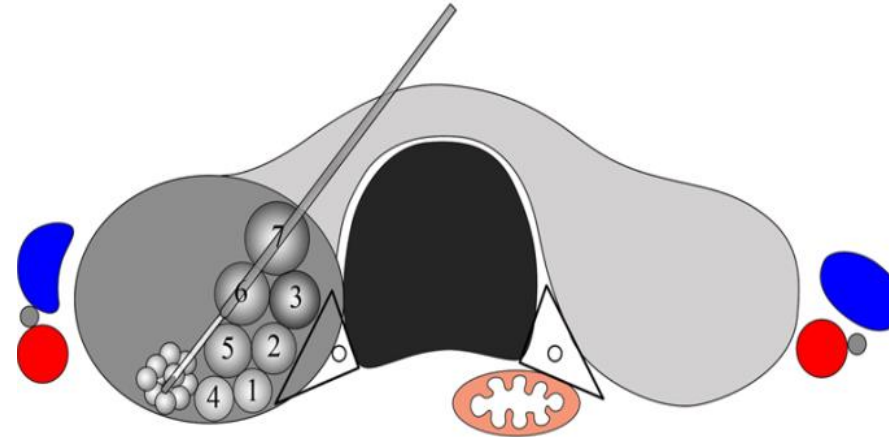
	RFA	hEMItx	Short-stay
Preprocedural costs			
Radiological visit	25.30	Surgical visit	25.30
Laboratory tests	100.20	Laboratory tests	291.10
US	41.70	ECG	14.40
Otolaryngological visit	1.70	Chest X-ray	26.90
Anaesthesiological visit	34.50	Otolaryngological visit	34.50
		Anaesthesiological visit	34.50
		Operating theatre	1,920.00
Needle	1,240.70	Tools	197.60
US machine	3.00	Drugs	664.00
Drugs	1.70	(B) Personnel	
		Surgeon (x2)	202.60
Radiologist	57.00	Theatre nurse	41.50
Nurse (x2)	45.50	Nurse (x2)	82.90
Anaesthetist	57.00	Anaesthetist	101.30
		(C) Hospitalization	
Hospital day	—	>24 hours hospital stay	862.50
		<24 hours hospital stay	375.00
Follow-up costs			
Laboratory tests	11.50	Laboratory tests	22.70
US	41.70	Otolaryngological visit	34.50
		Otolaryngological visit	34.50
<b>Total</b>	<b>€1661.50</b>	<b>Total</b>	<b>€4556.30</b>
		<b>Total</b>	<b>€4139.40</b>

**Aber maligne in 6 chir. Fällen**

# Komplikationen

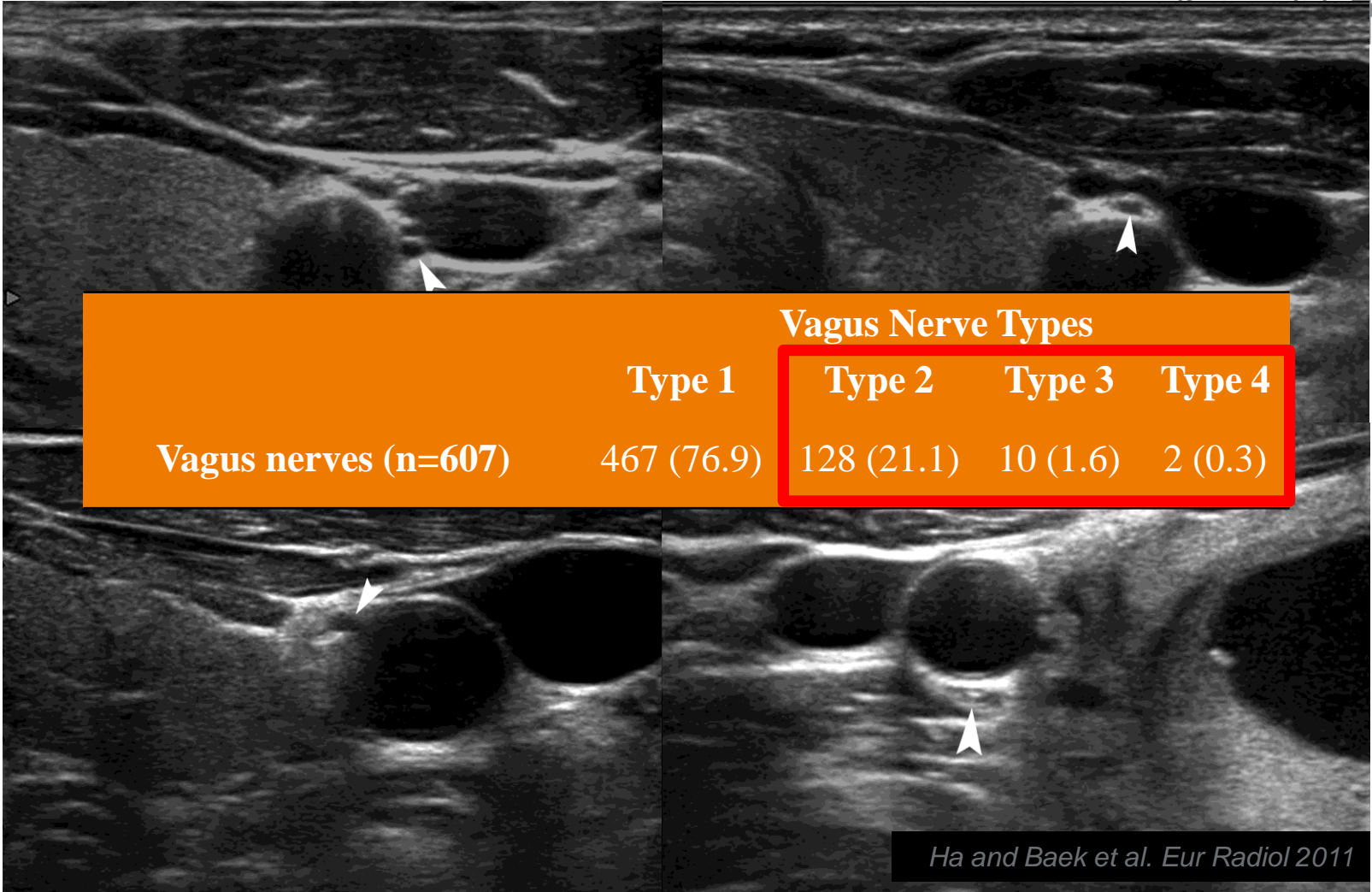
- 2421 Patienten mit 2786 Knoten (benigne und maligne)
- Insgesamt: 2.4%; Major 1.35%
  - Stimmveränderung 1.4%; permanent in 0.2%
  - Knotenruptur 0.2%
  - permanent hypothyreot 1 Patient
  - Schaden am Plexus brachialis; reversibel 1 Patient
- maligne Knoten höheres Komplikationsrisiko

# Trans-isthmischer Zugang



Danger triangle

To minimize recurrent laryngeal nerve damage  
→ Trans-isthmic approach method  
→ RLN saving method



### Vagus Nerve Types

	Type 1	Type 2	Type 3	Type 4
<b>Vagus nerves (n=607)</b>	467 (76.9)	128 (21.1)	10 (1.6)	2 (0.3)



# Zusammenfassung

- Je nach Land, werden Daten unterschiedlich interpretiert
- Bei benignen Knoten (eher klein- mittelgross)
- Minimal-invasive, ambulante Option
- Cave: Malignität, follow-up der Patienten
  
- Spezialfälle: ggf. auch im Rahmen von SD-Karzinomen