



INTELLIGENT MICROWAVE ABLATION

Designed for the Pulmonary Environment

MedWaves Microwave Ablation

EXPERIENCE



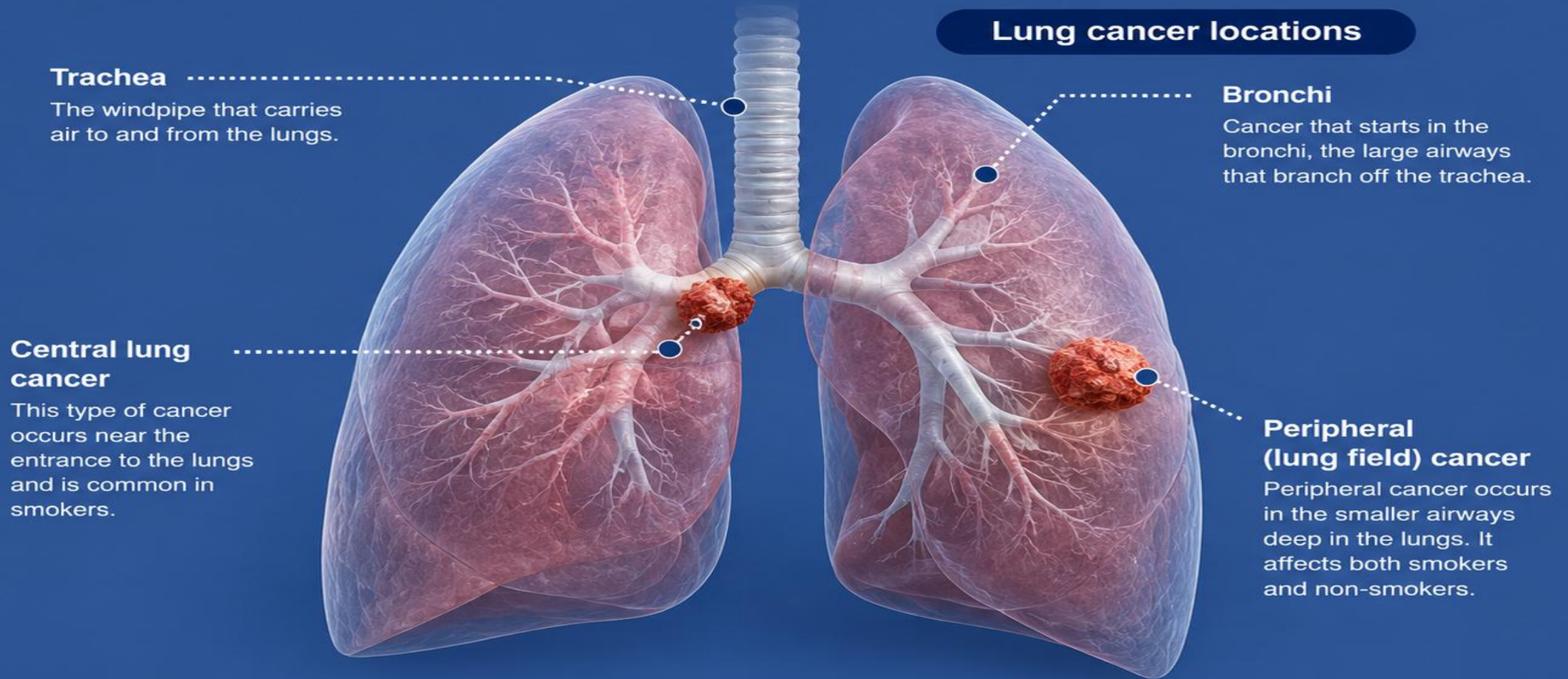
CONTROL



CLINICAL UNDERSTANDING

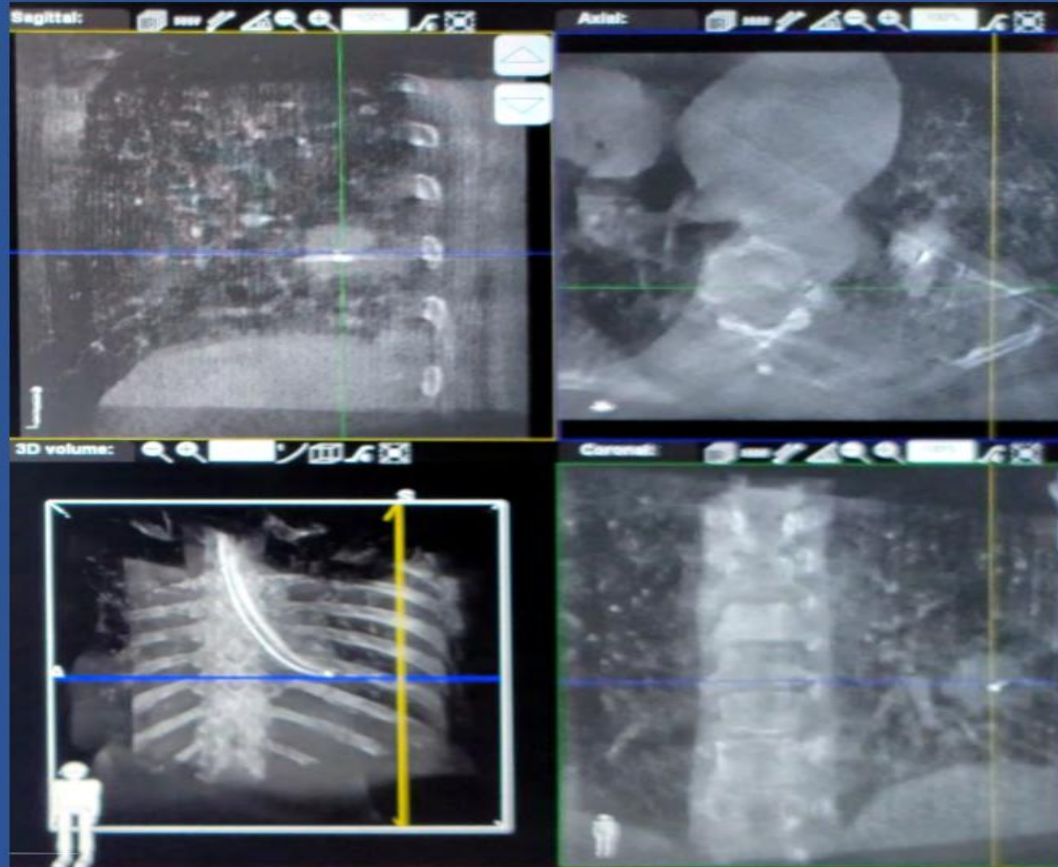
Medwaves Focus

Energy Therapeutics for Lung Cancer and Airway Disease

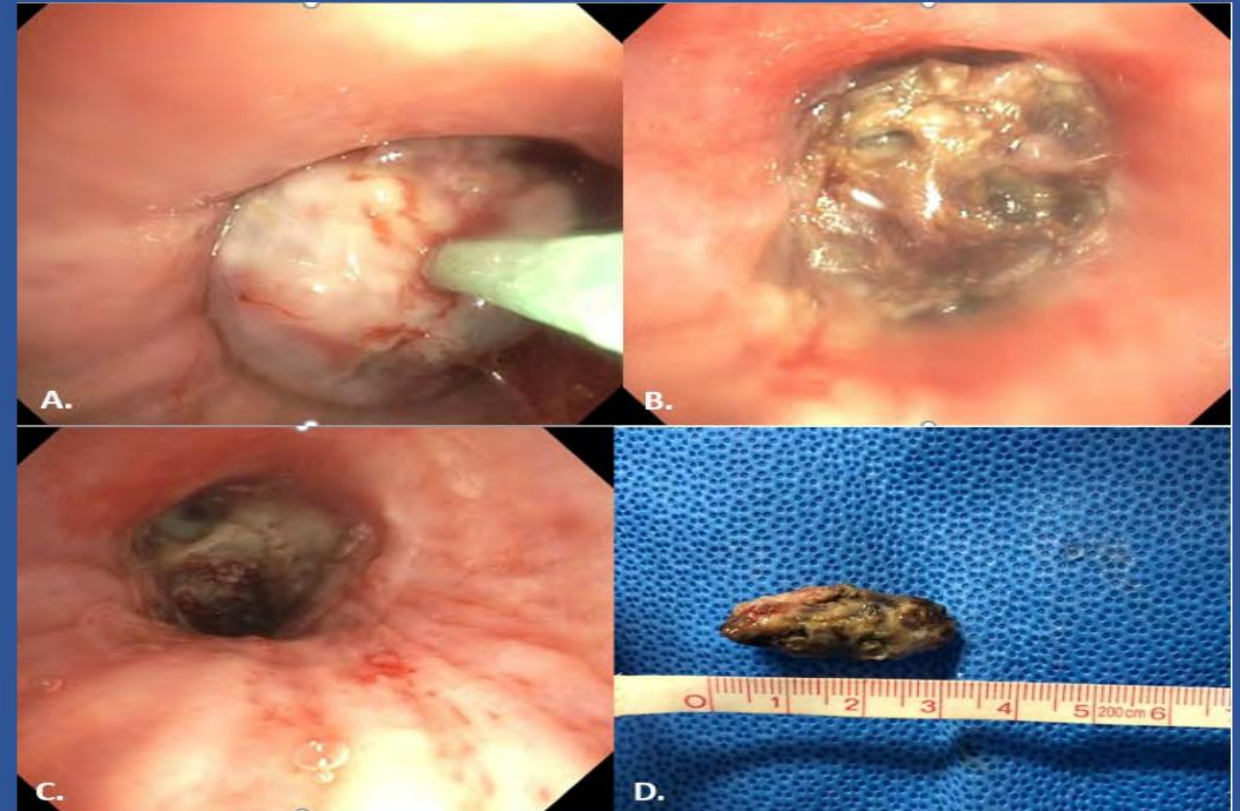


Peripheral and CAO (100% FiO2)

Peripheral lung MWA



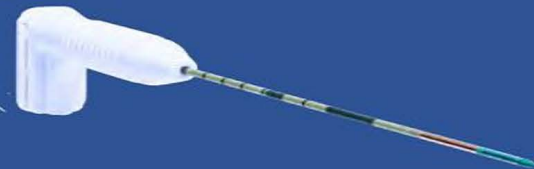
CAO lung MWA



Overview



- FDA 510(k) cleared and CE Marked.
- Soft-Tissue Indication. Same as others.
- The ONLY intelligent energy system in ablation therapy.
- MWA is Curative Therapy.



MEDWAVES AT A GLANCE

Key capabilities for pulmonary microwave ablation

0
1

INTELLIGENT ENERGY DELIVERY

Tissue permittivity feedback allows the system to recognize tissue changes and adapt energy delivery.

0
2

TEMPERATURE CONTROL

Real-time temperature monitoring with a physician-selected temperature set point.

0
3

PULSED MICROWAVE ENERGY

Modulates energy delivery throughout the ablation cycle.

0
4

FLEXIBLE BRONCHOSCOPIC ANTENNA

Navigates complex bronchial anatomy and supports robotic workflows.

0
5

MULTIPLE ACTIVE-TIP DESIGNS

Treatment-zone options for different targets and clinical situations.

0
6

SIMPLIFIED WORKFLOW

No external cooling system • 100% FiO₂ capability

MONITOR • RESPOND • ADAPT • CONTROL

EXPERIENCE • CONTROL • CLINICAL UNDERSTANDING

MICROWAVE ABLATION IS AN INTERACTION

Microwave energy creates an electromagnetic field that interacts with the local parenchymal environment.

THE PARENCHYMAL ENVIRONMENT IS NOT STATIC

Tissue Density

Airways

Blood Flow /
Perfusion

Parenchyma

Tissue Change

As tissue heats during the ablation cycle, the local environment can change.

THE CHALLENGE ISN'T SIMPLY DELIVERING MICROWAVE ENERGY.

It's managing the interaction between the energy and the tissue.

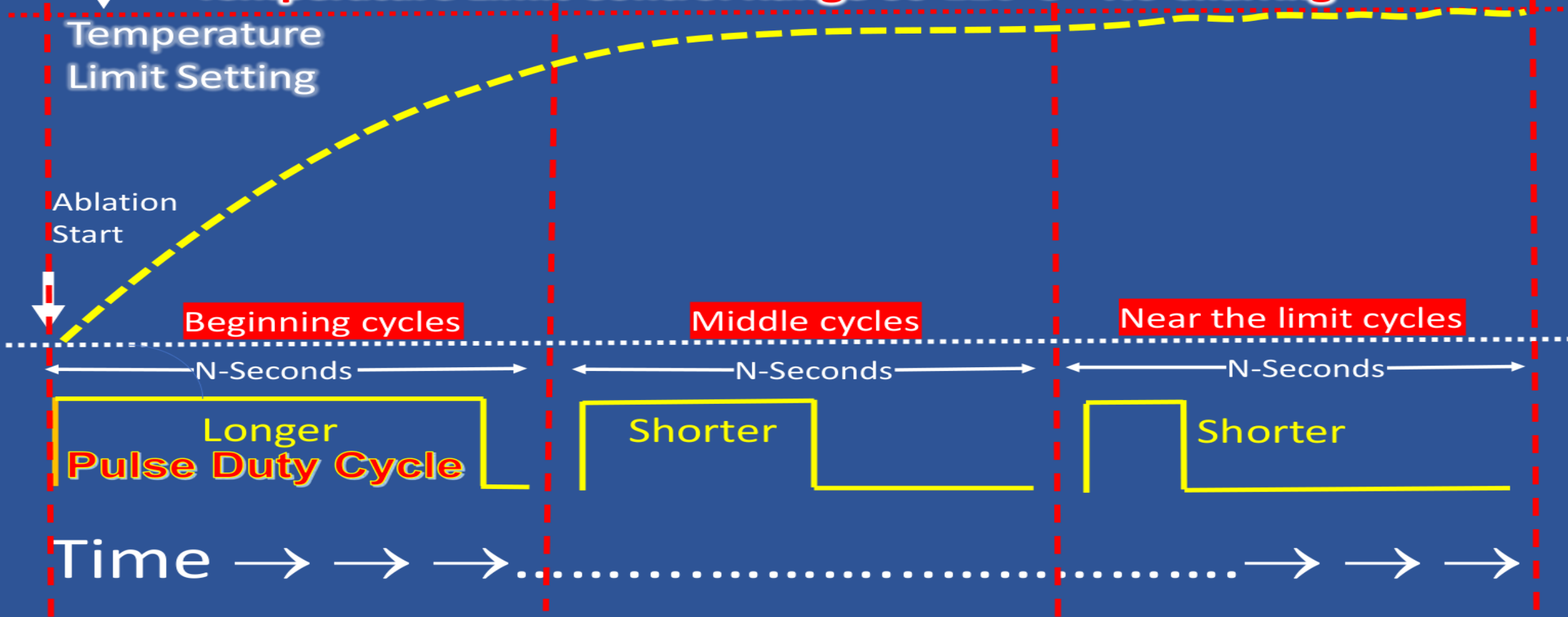
Energy creates the field. The parenchymal environment influences what happens next.

PulsaBlade™

Technology

Temperature Feedback Control Power-Modulation

Temperature Limit Control Range 60-120°C = No Charring



Mini Antenna Catheter (16-123-01-10)

Time (minutes)	Temperature (°C)	Ablation coverage Short x Long axis (cm)	Beyond the tip of the antenna (mm)	Energy delivered (K-Joule)
3	80	1.5 x 1.7	1	2.3 kJ
5	80	1.6 x 1.8	2	3.5 kJ
7.5	80	1.8 x 2.0	3	5.0 kJ
10	80	2.0 x 2.2	4	7.0 kJ

Small Antenna Catheter (16-123-01-15)

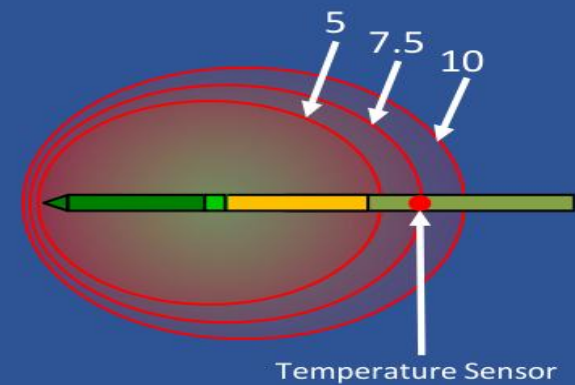
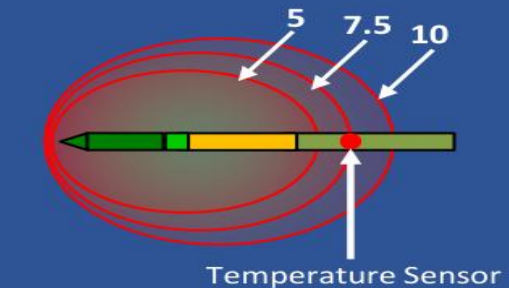
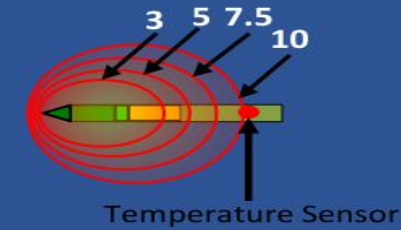
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5	80	1.8 x 2.5	1	5.5 kJ
7.5	80	2.3 x 3.0	2	8.0 kJ
10	80	2.8 x 3.5	3	10.0 kJ

Medium Antenna Catheter (16-123-01-20)

Time (minutes)	Temperature (°C)	Ablation coverage Short x Long axis (cm)	Beyond the tip of the antenna (mm)	Energy delivered (K-Joule)
5	80	2.8 x 3.5	3	7.5 kJ
7.5	80	3.0 x 3.6	4	11.0 kJ
10	80	3.4 x 4.0	5	13.5 kJ

Medium Antenna Catheter (16-123-01-20)

Time (minutes)	Temperature (°C)	Ablation coverage Short x Long axis (cm)	Beyond the tip of the antenna (mm)	Energy delivered (K-Joule)
5	90	3.0 x 3.5	3	7.9 kJ
7.5	90	3.2 x 3.7	4	11.4 kJ
10	90	3.5 x 4.0	5	14.6 kJ



Standard Deviations: Ablation zone: $\pm 10\%$, Temperatures: $+3\%/-10\%$, Energy delivered: $\pm 10\%$

Variables Influencing Treatment Zone Development



OPERATOR-CONTROLLED VARIABLES



Active Field Positioning

Maximize the active field of the antenna within the nodule.



Parenchyma Positioning

Maintain a fully parenchymal path with the active tip completely within the nodule.



Ablation Strategy

Determine single vs. overlapping ablations to achieve complete margin coverage.



Energy Delivery

Optimize microwave energy delivery to create the intended treatment zone.



NODULE / PATIENT VARIABLES



Nodule Size

Larger nodules require greater treatment volume and may necessitate overlapping ablations.



Bronchus Sign

The presence of a visible airway leading to the nodule may affect treatment zone.



Nodule Morphology

Ground-glass, part-solid, and solid nodules influence energy deposition and heat distribution.

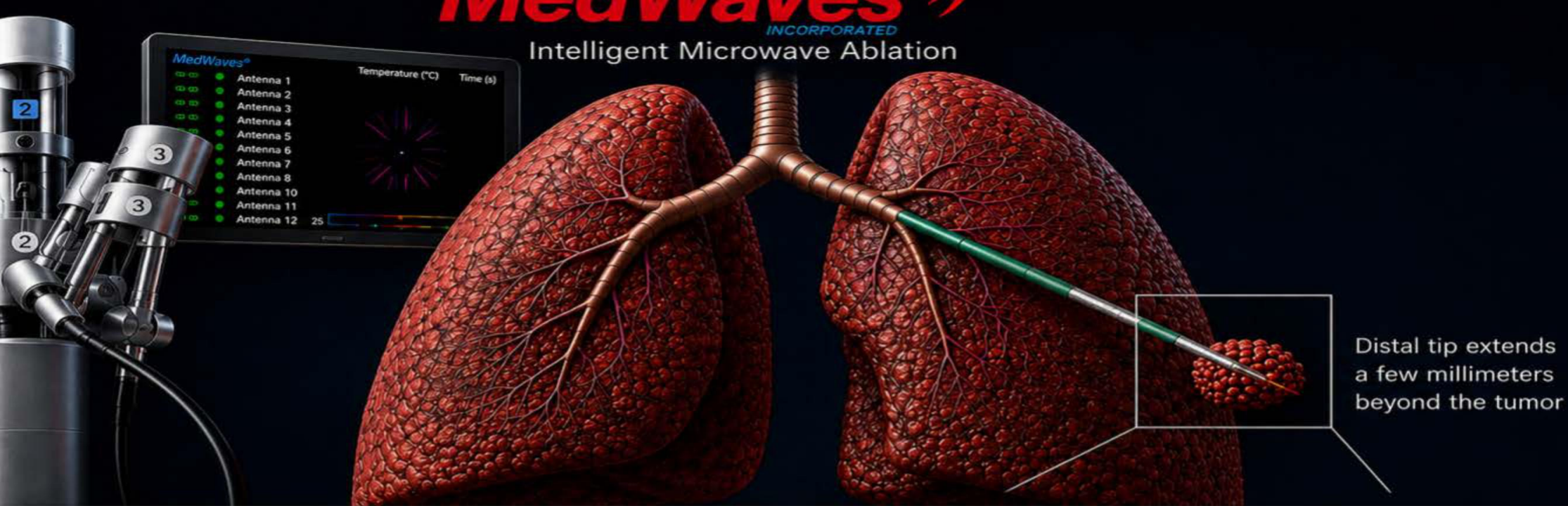


Regional Perfusion

Intranodular or adjacent vessels can create heat-sink effects and limit ablation size.



Understand the variables. Control what you can. Anticipate what you cannot.



ANTENNA POSITIONING FOR A 1 cm LUNG TUMOR



Tumor Diameter
10 mm (1 cm)



Antenna Active Length
24 mm



Target Margin
1 cm Circumferential

PROXIMAL PORTION

Portion of active zone located proximal to the tumor

13 mm

Proximal to tumor

WITHIN TUMOR

Majority of the active zone positioned within the tumor

≈ 9–10 mm

Embedded into tissue
(Tumor Diameter 10 mm)

DISTAL EXTENSION

Distal tip extends a few millimeters beyond the tumor

≈ 2–3 mm

Extends beyond tumor

24 mm Total Active Length

Image is only an illustration and not to scale.

LET'S REVIEW THE ZONE GUIDE

PUBLISHED ZONE

Ex vivo porcine tissue with reproducible variables

CLINICAL LUNG TISSUE VARIABLES

Airflow • Perfusion • Density • Dielectric

Remember the variables + antenna position?

Together, they define the ablation environment.

ABLATION PHYSICS

$$\text{SAR} = \frac{(\sigma + \omega\epsilon_0\epsilon_r'')|E|^2}{2\rho}$$

ϵ Permittivity • σ Conductivity • E Electric Field • ρ tissue density

THE CLINICAL CONNECTION

Variables + Antenna Position

↓
Ablation Environment

↓
Energy Absorption x Time

↓
Temperature Spread x Time

↓
Thermal Dose

↓
ABLATION ZONE

THE ENVIRONMENT IS DYNAMIC

As tissue heats, dielectric properties change during the ablation cycle.

HOW DO WE USE THE CHART?

TREATMENT

Clinical zones may vary from the published reference.

EXPECT VARIABILITY

SAFETY

Do not assume the clinical zone will be smaller.

RESPECT THE FULL PUBLISHED ZONE

The chart is the reference. The patient is the environment.

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Small Antenna Catheter (16-123-01-15)

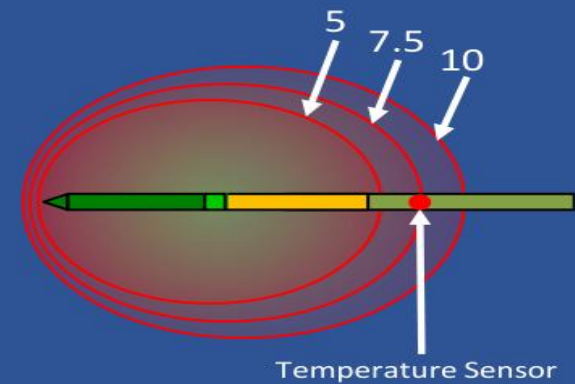
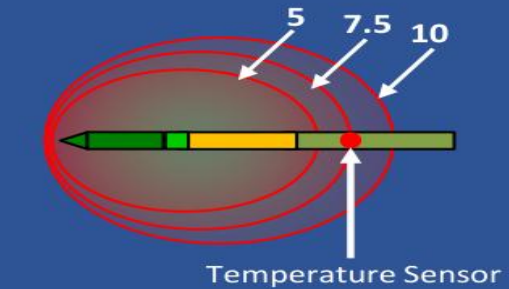
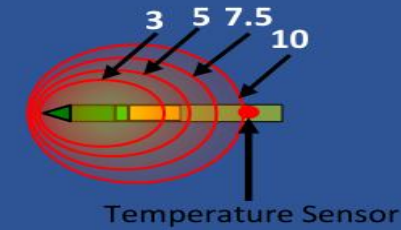
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Smart Antenna Design

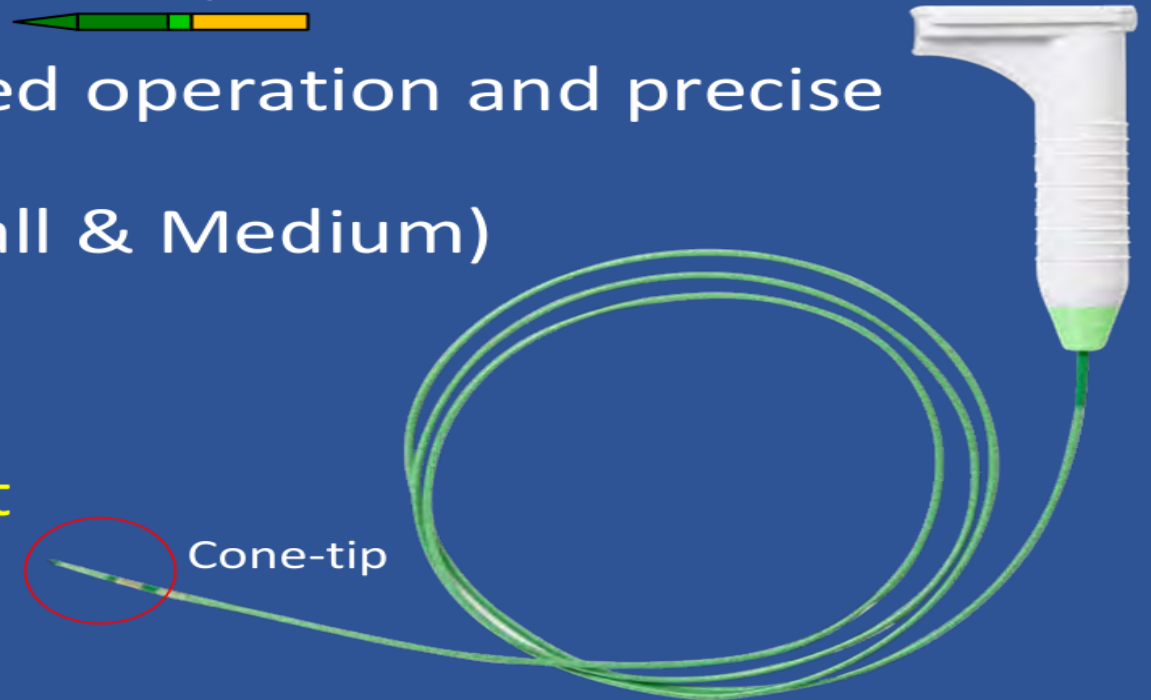
- Integrated temperature sensor within antenna tip.
- 1.8mm flexible catheter navigates complex bronchial anatomy.
- Cone-tip design penetrates soft tissue with accuracy.

Cone-tip for smooth insertion through turns vs trocar tip



- No cooling system—streamlined operation and precise feedback.
- Available in 3 sizes. (Mini, Small & Medium)

Provides tissue condition feedback to the generator for adaptive efficient energy deposit



Intelligent Ablation Control

- *Simple to set up and operate*
- *No cooling system hookups*
- *Intelligent Control*
 - Menu selectable device configurations
 - Customizable temperature setpoint range: 60°C - 100°C
 - Customizable ablation cycle time for desired results
 - Energy (k-joules) measures work done
 - Reverse-reflected power (measure of efficiency)
 - Automatic alert of unsafe system conditions: over-temperature, power output error, etc.

Prevents complications from over-ablation and high temperature



COMPETITIVE LANDSCAPE

Different technologies.

VARIABLE	MEDWAVES	J&J NEUWAVE	MEDTRONIC / COVIDIEN	ANGIODYNAMICS
Intelligent Energy Delivery	✓	—	—	—
Temperature Control	✓	—	—	—
Power Range	24–32 W	60–140 W	60–140 W	60–140 W
Pulsed Energy	✓	—	—	—
Frequency	902–928 MHz	2.45 GHz	2.45 GHz	2.45 GHz
External Coolant Required	—	✓	✓	✓
Robotic / Bronchoscopy Compatible	✓	Semi-Flex	Semi-Flex	—
Commercially Available	✓	—	—	—
Wide-Ranging Therapies	✓	—	—	—

EXPERIENCE • CONTROL • CLINICAL UNDERSTANDING

Proven Clinical Experiences

- 20 peer reviewed publications
- 621 patients • 766 nodules • Across 8 organ systems
- Zero major complications reported in multi-site studies
- More than 45,000 successful ablations world wide.
- Validated in bile duct, bone, brain, breast, kidney, liver, lung, and thyroid ablations
- Est. 500,000 ('24) MWA procedures.
- Trusted globally for precision and safety.

MedWaves Clinical Study Experience

Lung Ablation – Peer-Reviewed Publications

2012 – Intraoperative Microwave Ablation of Pulmonary Malignancies with Tumor Permittivity Feedback Control: Ablation and Resection Study in 10 Consecutive Patients

Farrah J. Wolf et al.

Radiology. 2012;262(1).

2016 – CT-guided Percutaneous Microwave Ablation of Pulmonary Malignant Tumors

Wei-Chun Ko et al.

Journal of Thoracic Disease. 2016;8(Suppl 9):S659–S665.

2022 – Microwave Ablation for Malignant Central Airway Obstruction: A Pilot Study

Michal Senitko et al.

Respiration. Published online March 22, 2022.

2025 – Shape-Sensing Robotic-Assisted Bronchoscopic Microwave Ablation for Primary and Metastatic Pulmonary Nodules: Retrospective Case Series

Liqin Xu et al.

Diagnostics. 2025;15:3248.

Published MedWaves Ablation Portfolio

Clinical Area	Number of Publications
Bile Duct	3
Brain / Neuro	2
Bone & Spine	7
Breast	1
Cardiac	2
Gynecologic	1
Kidney	1
Liver	8
Lung	4
Thyroid	4

Clinical Bronchoscopy Experiences

Clinical Study at Beth Israel Deaconess Medical Center

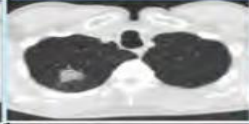
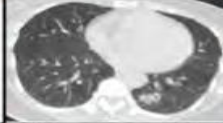
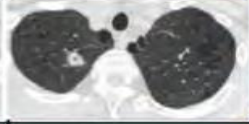
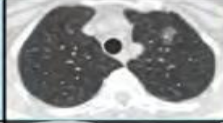
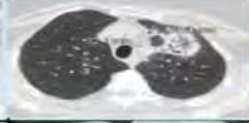
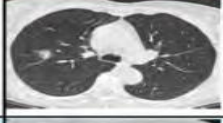
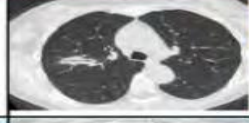
- In collaboration with Dana Farber Cancer Institute
- AveCure Flexible Microwave Ablation Probe for Lung Nodules
- ClinicalTrials.gov ID NCT05281237
- Lung Suite Cone beam CT with ION Robotic Bronchoscopy
- Peripheral Lung Nodule

Clinical Evaluations at:

- Mass General Boston
- UCSD, San Diego, CA
- UMMC, Jackson, MS
- MD Anderson, Houston, TX
- Hong Kong University, HK

200+ peripherals and 300+ CAO cases without complications

Initial Peripheral Ablate and Resect BIDMC

Patient	Histologic Subtype	Nodule size	Distance from pleura	Energy Applied	Radiographic Ablation Zone	Pathologic Ablation Zone	Residual Viable Tumor (%)	Pre-Ablation CT	Post-Ablation CT	Gross Pathology
1	Acinar predominant adenocarcinoma	26 x 27 mm	9 mm	9.4 kJ	33 x 23 mm	28 x 13 mm	15%			
2	Acinar predominant adenocarcinoma	22 x 11 mm	7 mm	9.3 kJ	26 x 25 mm	15 x 14 mm	25%			
3	Invasive mucinous adenocarcinoma	12 x 9 mm	6 mm	9.1 kJ	17 x 14 mm	20 x 12 mm	20%			
4	Acinar predominant adenocarcinoma	10 x 8 mm	12 mm	11.2 kJ	16 x 12 mm	18 x 9 mm	10%			
5	Acinar predominant adenocarcinoma	25 x 17 mm	7 mm	11.1 kJ + 11.4 kJ	32 x 35 mm	42 x 31 mm	0%			
6	Mixed lepidic and acinar adenocarcinoma	23 x 20 mm	13 mm	11.3 KJ *90C	23 x 13 mm	24 x 12 mm	20%			
7	Invasive acinar adenocarcinoma	25 x 18 mm	14 mm	13.1 KJ *90C	32 x 18 mm	14 x 11 mm	15%			

Airway Lung Tumor



Bronchoscope MWA therapy Airway tumor removal
AveCure Ablation System



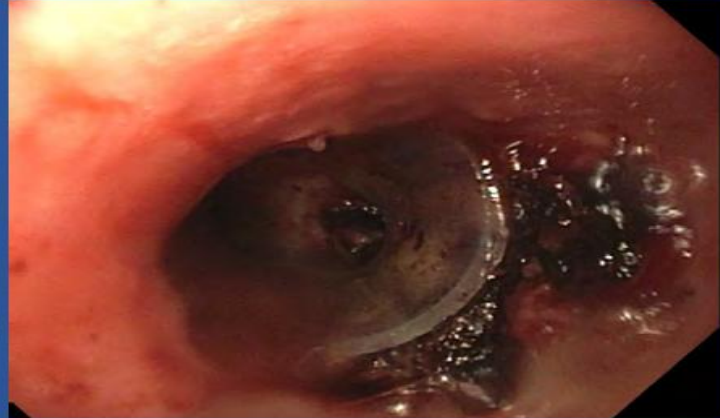
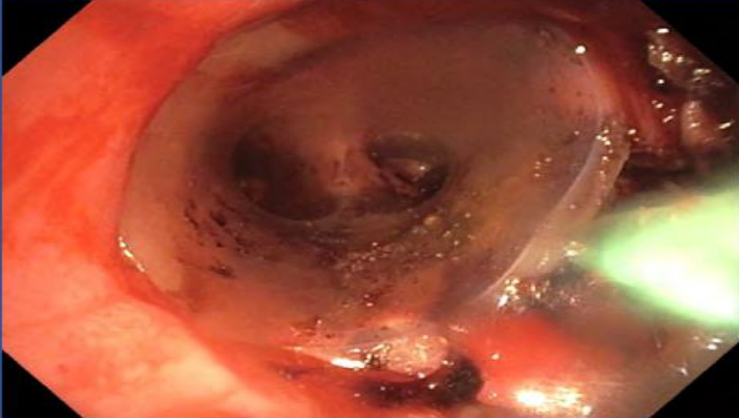
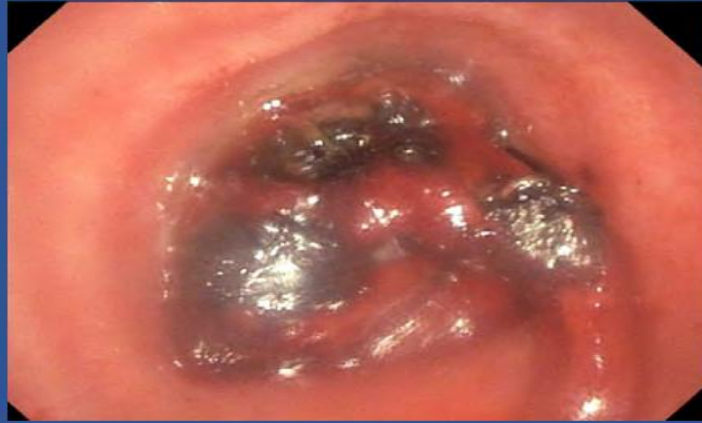
Michal Senitko, M.D., DAABIP, University of Mississippi Medical Center
MedWaves MWA system presentation

Case 1



- 58 year old man
- Found to have left main obstruction
- EBUS with N1 disease only
- Squamous cell Ca
- Able to undergo surgical resection post tumor removal

Case 2

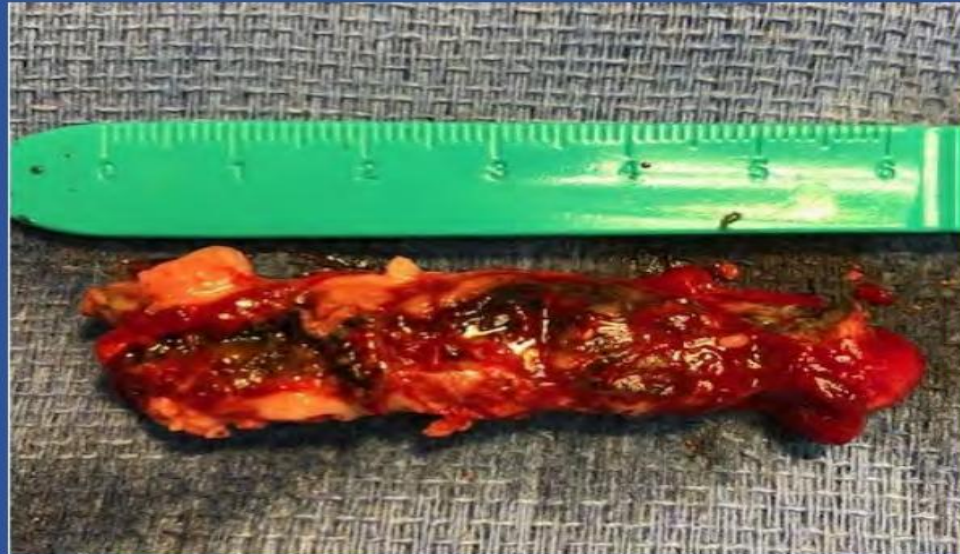
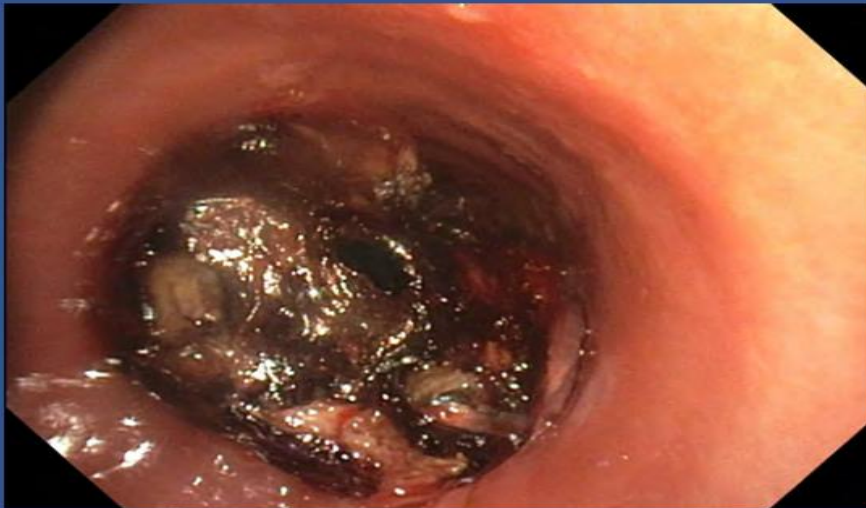


- 32 year old man with high grade neuroendocrine tumor
- Ball valve tracheal tumor completely obstructing the proximal end of a silicone **stent**
- No damage to the stent

Case 3



- 65 year old man presented with dyspnea
- Right main stem obstruction
- Able to remove tumor enblock

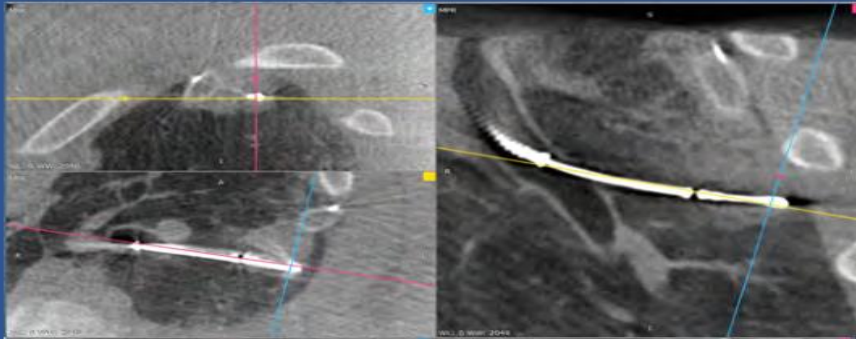


CAO Experience & Conclusions

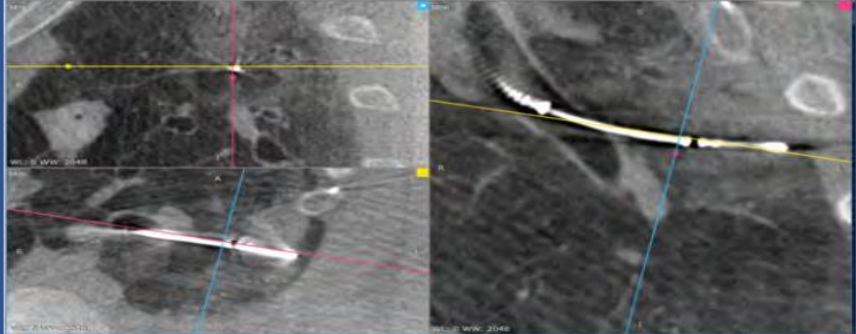
- Safe and effective for both central airway and peripheral lung.
- Short learning curve.
- Can use with 100% O₂.
- Recanalization can happen in the same setting.
- Sharp tip designed to penetrate tissue.
- Significantly reduced bleeding during procedures.
- Supports complete tumor devitalization and en-bloc removal.

Endoluminal Robotic: In Vivo Animal Lung MWA, LML

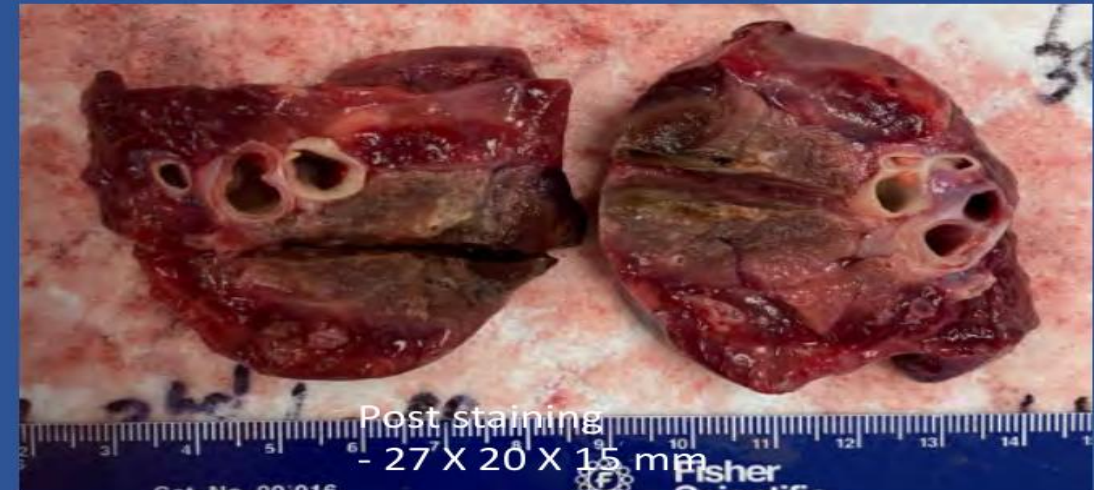
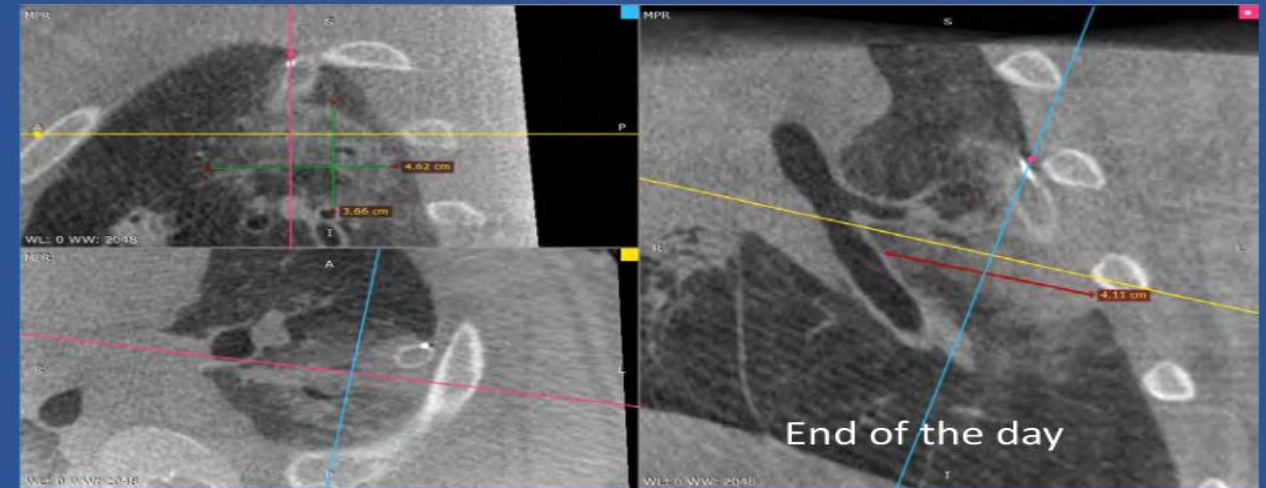
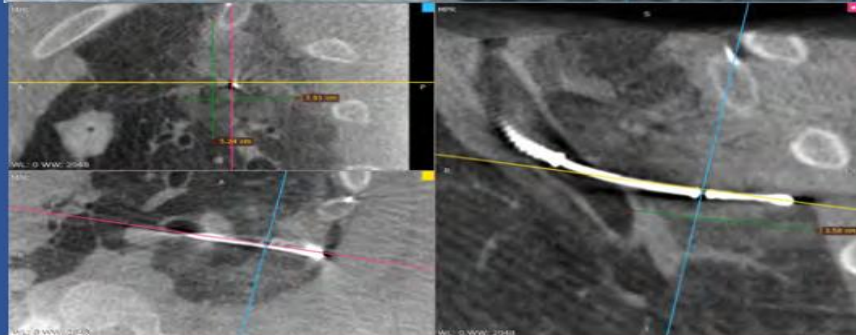
0 min



5 min

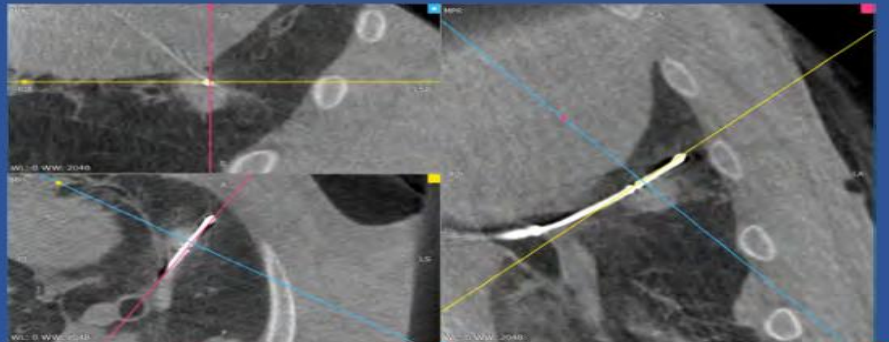


10 min

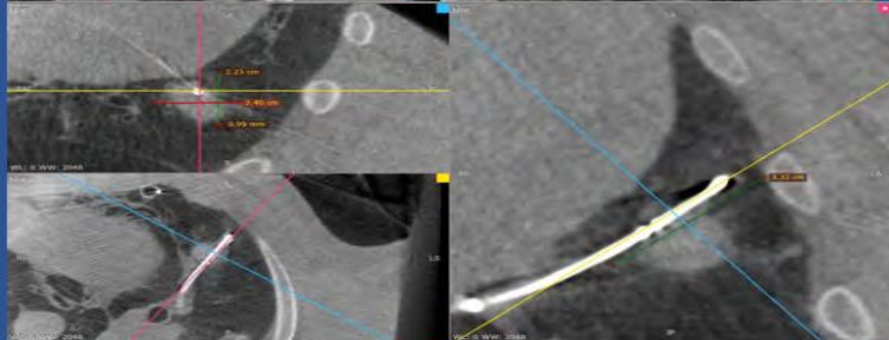


Endoluminal Robotic: In Vivo Animal Lung MWA, LUL

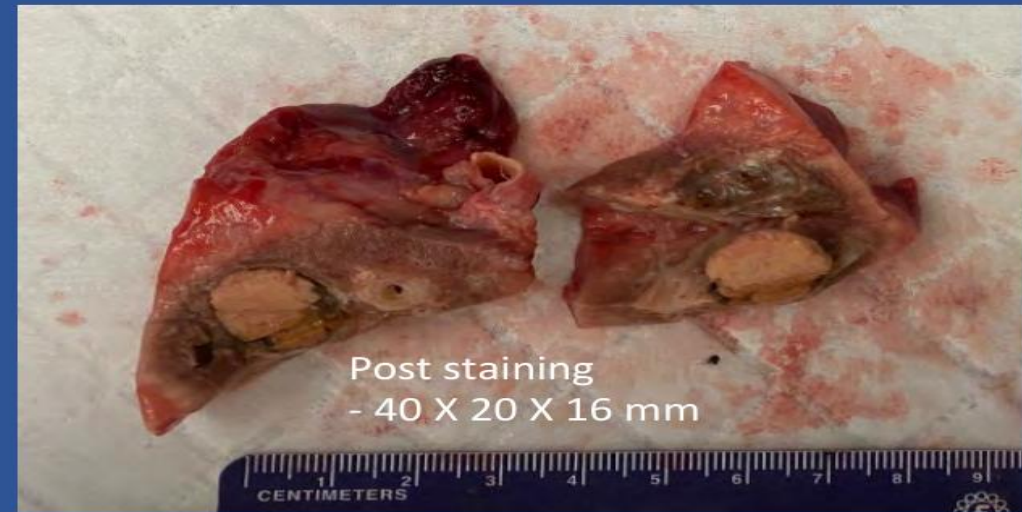
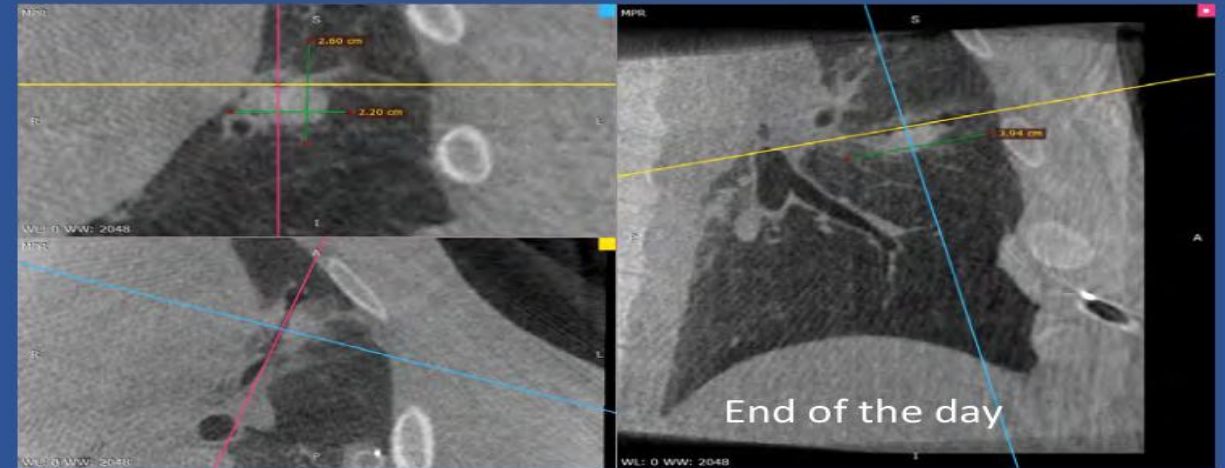
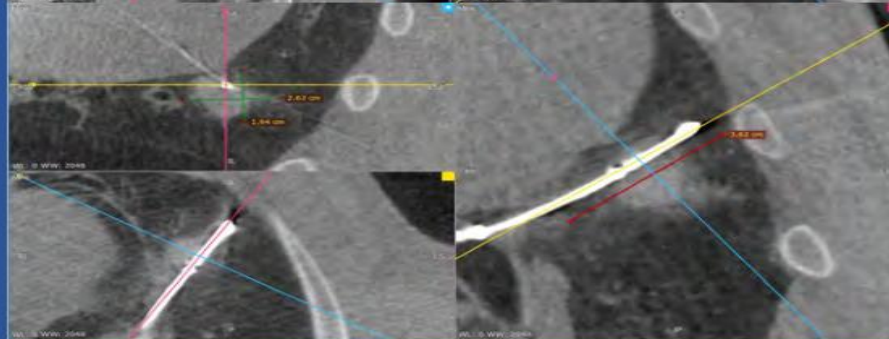
0 min



5 min



10 min



MedWaves MWA: Surgical Ablate and Resect Study

No Charring and Cavitation; vessels >3mm are patent

Intraoperative Microwave Ablation of Pulmonary Malignancies with Tumor Permittivity Feedback Control: Ablation and Resection Study in 10 Consecutive Patients¹

Farrah J. Wolt, MD
Bassam Aswad, MD
Thomas Ng, MD
Damian E. Dupuy, MD

Purpose:

To determine histologic changes induced by microwave ablation (MWA) in patients with pulmonary malignancy by using an ablation system with tumor permittivity feedback control, enabling real-time modulation of energy power and frequency.

Materials and Methods:

Institutional review board approval and patient informed consent were obtained for this prospective HIPAA-complaint ablation and resection study. Between March 2009 and January 2010, 10 patients (four women, six men; mean age, 71 years; age range, 52–82 years) underwent intraoperative MWA of pulmonary malignancies. Power (10–32 W) and frequency (908–928 MHz) were continuously adjusted by the generator to maintain a temperature of 110°–120°C at the 14-gauge antenna tip for one 10-minute application. After testing for an air leak, tumors were resected surgically. Gross inspection, slicing, and hematoxylin-eosin (10 specimens) and nicotinamide adenine dinucleotide (six specimens) staining were performed.

Results:

Tumors included adenocarcinomas ($n = 5$), squamous cell carcinomas ($n = 3$), and metastases from endometrial ($n = 1$) and colorectal ($n = 1$) primary carcinomas. Mean maximum tumor diameter was 2.4 cm (range, 0.9–5.0 cm), and mean maximum volume was 8.6 cm³ (range, 0.5–52.7 cm³). One air leak was detected. Five of 10 specimens were grossly measurable, revealing a mean maximum ablation zone diameter of 4.8 cm (range, 3.0–6.5 cm) and a mean maximum ablation zone volume of 15.1 cm³ (range, 7.3–25.1 cm³). At hematoxylin-eosin staining, coagulation necrosis was observed in all ablation zones, extended into the normal lung in nine of 10 specimens, and up to blood vessel walls without evidence of vessel (>4 mm) thrombosis. Nicotinamide adenine dinucleotide staining enabled confirmation of no viability within ablation zones extending into normal lung in five of six specimens.

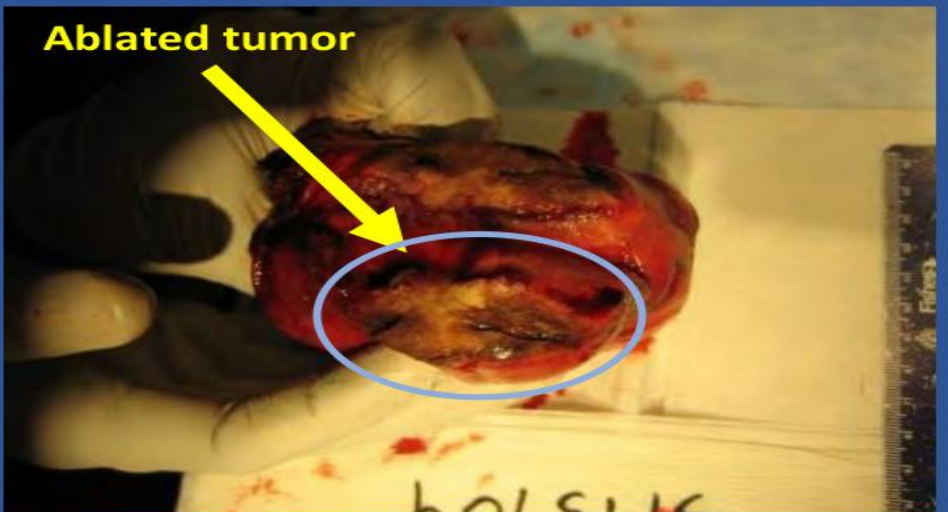
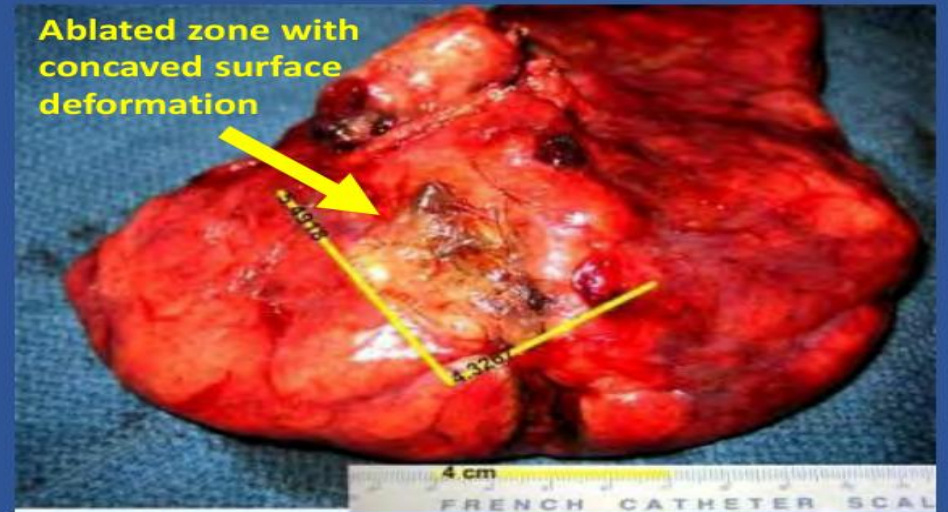
Conclusion:

MWA with tumor permittivity feedback control results in cytotoxic intratumoral temperatures and extension of ablation zones into aerated peritumoral pulmonary parenchyma, possibly forming the equivalent of an oncologic resection margin.

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¹From the Departments of Diagnostic Imaging (F.J.W., D.E.D.), Pathology (B.A.), and Thoracic Surgery (T.N.), Office of Research Administration, Alpert Medical School of Brown University, Rhode Island Hospital, 593 Eddy St, Providence, RI 02903. Received January 3, 2011; revision requested April 6; revision received July 29; accepted August 20; final version accepted August 22. Address correspondence to D.E.D. (e-mail: ddupuy@lifespan.org).

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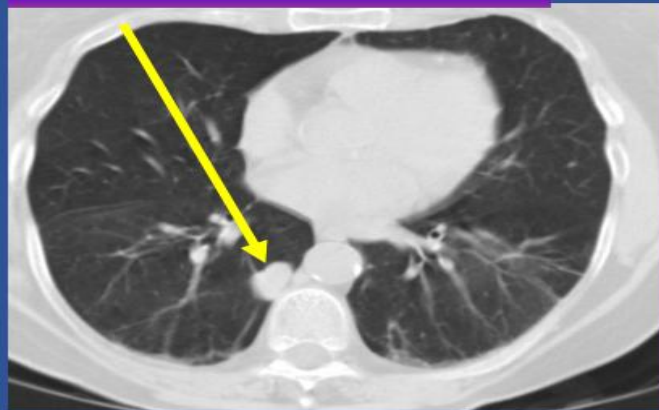
Lung Tumor, Biopsy proven Carcinoid next to Aorta

400 seconds superiorly, 300 seconds inferiorly, 28 watts, 100-106°C

Damian Dupuy, MD Associate Professor, Brown University of

Pre and Post
ablation images of
two lung tumors
positioned
inferior-
superior to
each other

**Pre ablation of tumor
next to aorta**



**Large antenna
positioned in the tumor
next to aorta**



**Post ablation
Ground-glass**

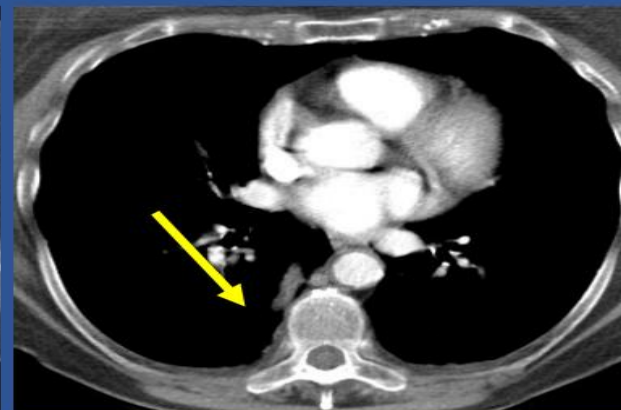


One, Six and 12
months follow
up images
showing no
enhancements,
but mass and
scar tissue
shrinkage

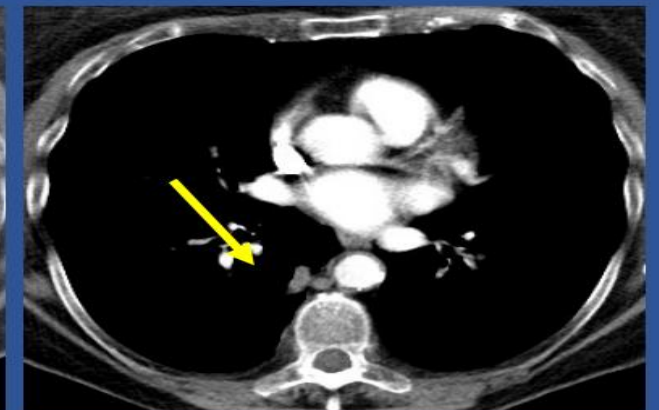
**One (1) month post MWA shows No
evidence of enhancing tumor**



**6-mos post MWA shows no
enhancement, but mass shrinkage**

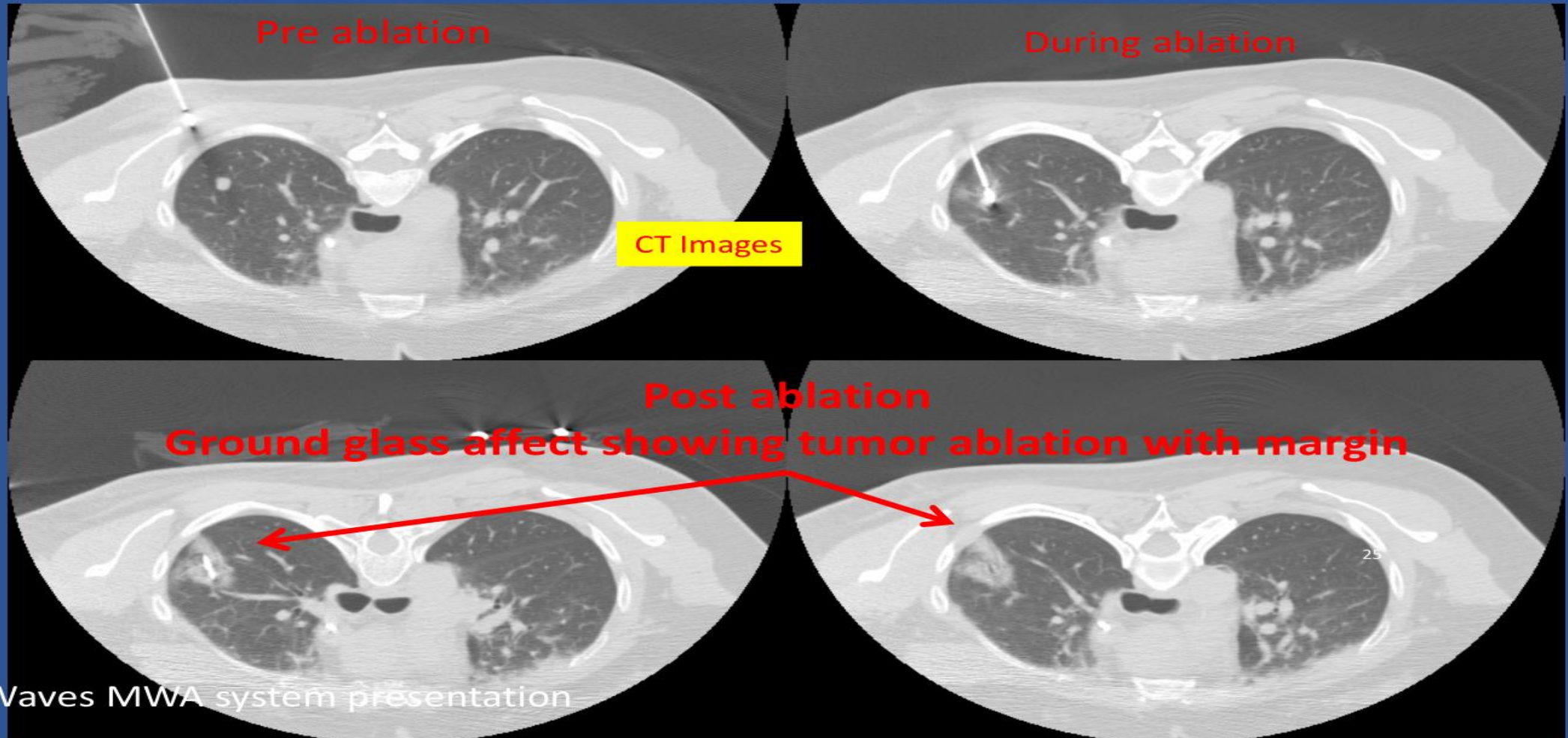


**12-month post MWA shows no
enhancement, but mass shrinkage**



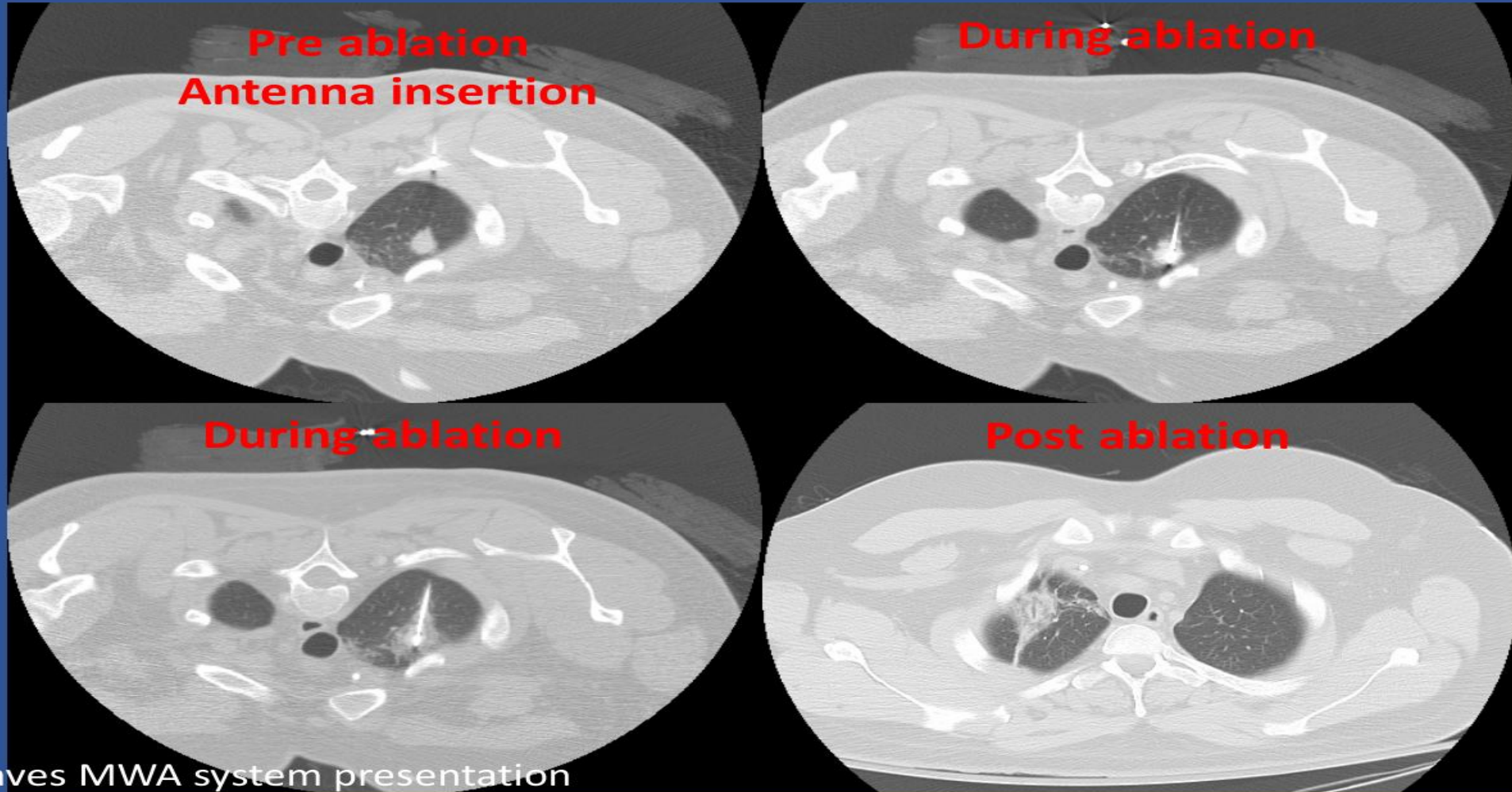
Lung Tumor Percutaneous MWA

Colon met: 1.2cm x 1.2cm, 100 deg-C, 24 watts, 5 minutes, small antenna
Dr. Moore, UC Davis, follow-up showed no recurrence

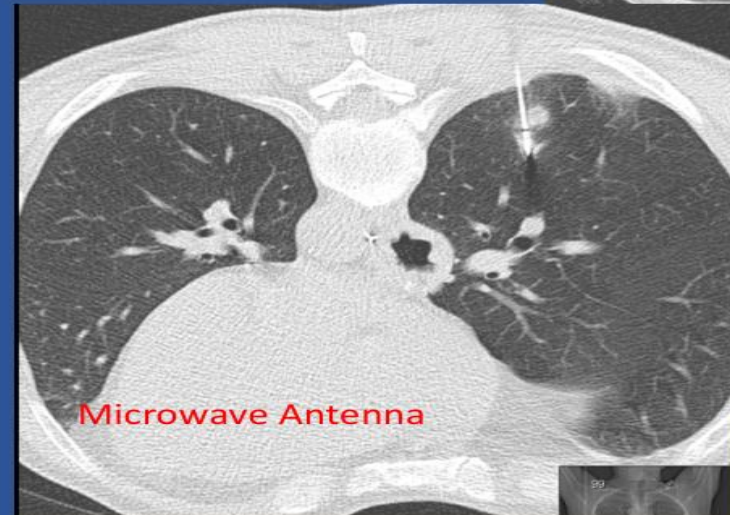


Lung Tumor Percutaneous MWA

Colon met: 1.8cm x 1.7cm, 100 deg-C, 24watts, 7 minutes, small antenna
Dr. Moore, UC Davis, follow-up showed no recurrence



Lung Tumor Percutaneous MWA with MedWaves System



Post microwave ablation followup
13.03.12 (2wks) 20.06.12 (3mos)

24.10.12 (8mos)

