INTELLIGENT MICROWAVE ABLATION

Designed for the Pulmonary Environment

MedWaves Microwave Ablation

EXPERIENCE • **CONTROL** • **CLINICAL UNDERSTANDING**

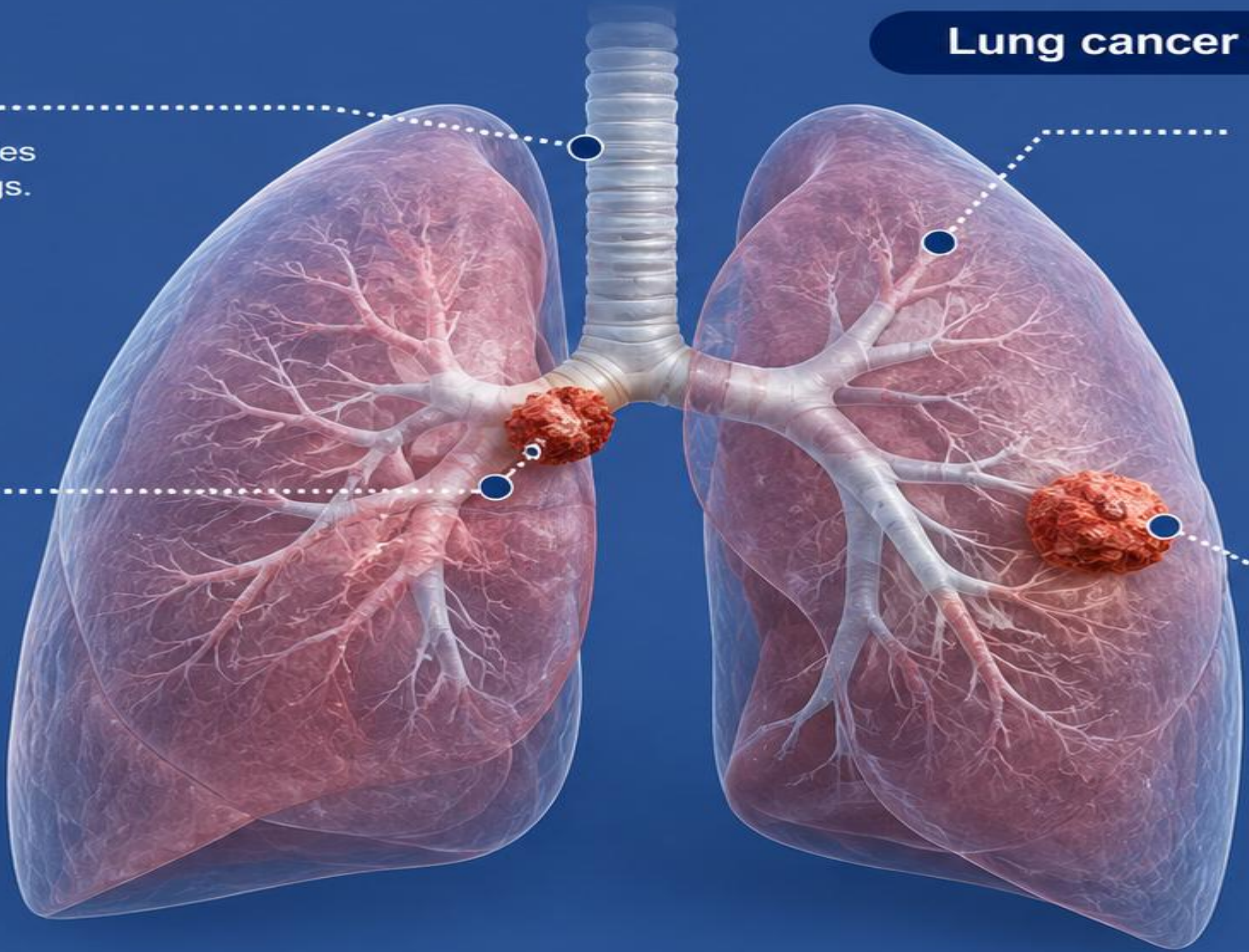
Medwaves Focus

Energy Therapeutics for Lung Cancer and Airway Disease

Lung cancer locations

Trachea
The windpipe that carries air to and from the lungs.

Bronchi
Cancer that starts in the bronchi, the large airways that branch off the trachea.

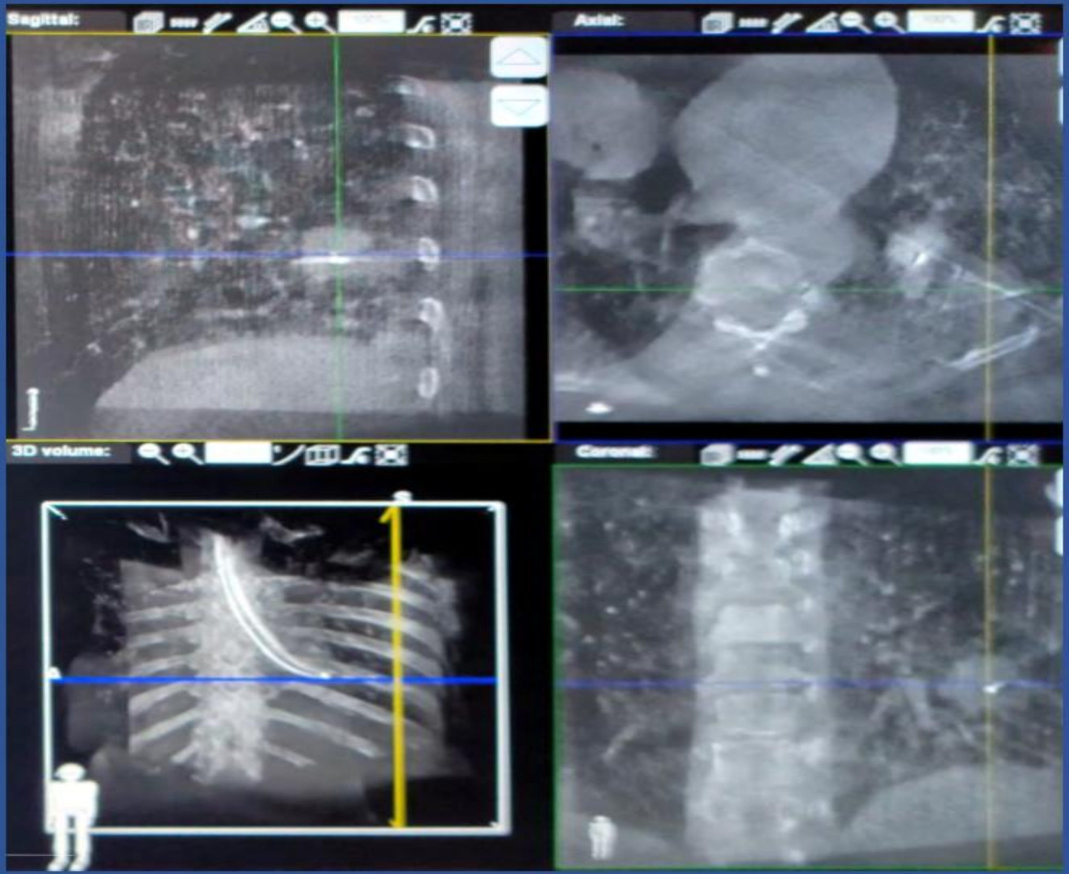


Central lung cancer
This type of cancer occurs near the entrance to the lungs and is common in smokers.

Peripheral (lung field) cancer
Peripheral cancer occurs in the smaller airways deep in the lungs. It affects both smokers and non-smokers.

Peripheral and CAO (100% FiO2)

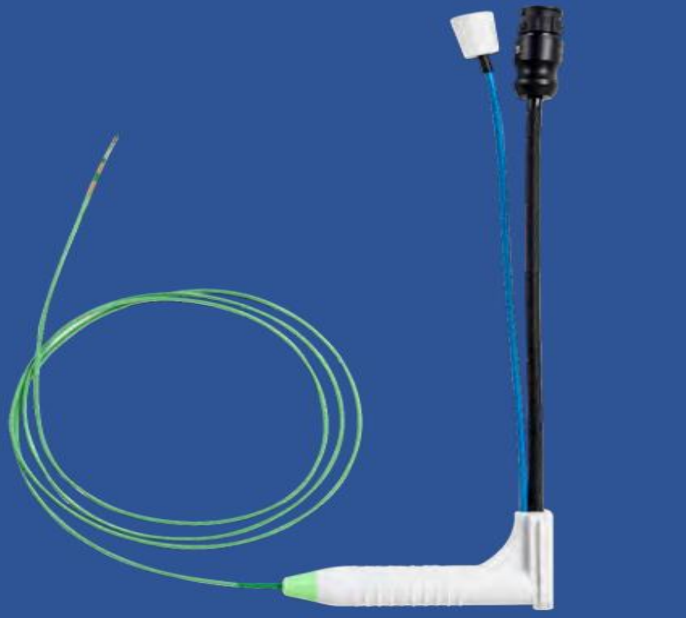
Peripheral lung MWA



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 INCORPORATED

Ablation **Algorithm**

AveCure®

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)

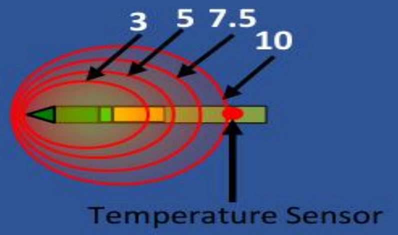
Time (minutes)	Temperature (°C)	Ablation coverage Short x Long axis (cm)	Beyond the tip of the antenna (mm)	Energy delivered (K-Joule)
5	80	1.8 x 2.5	1	5.5 kJ
7.5	80	2.3 x 3.0	2	8.0 kJ
10	80	2.8 x 3.5	3	10.0 kJ

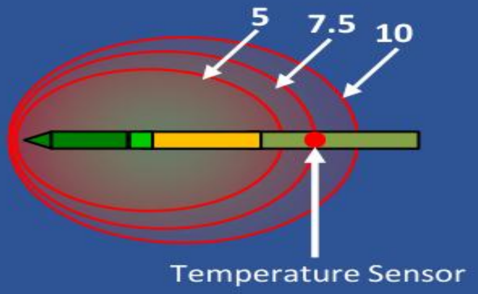
Medium Antenna Catheter (16-123-01-20)

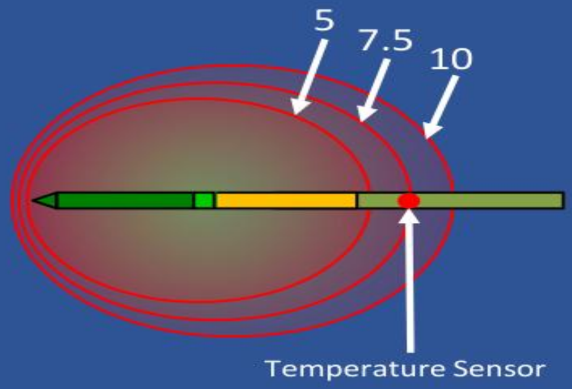
Time (minutes)	Temperature (°C)	Ablation coverage Short x Long axis (cm)	Beyond the tip of the antenna (mm)	Energy delivered (K-Joule)
5	80	2.8 x 3.5	3	7.5 kJ
7.5	80	3.0 x 3.6	4	11.0 kJ
10	80	3.4 x 4.0	5	13.5 kJ

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: ±10%, Temperatures: +3%/-10%, Energy delivered: ±10%

MedWaves INCORPORATED

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.

HOW MEDWAVES MANAGES THE INTERACTION

MONITOR

Real-time temperature and tissue permittivity feedback

RESPOND

Recognizes changes in the tissue environment

ADAPT

Adjusts pulsed microwave energy delivery as tissue changes

CONTROL

Multiple active-tip designs

DESIGNED FOR PULMONARY ABLATION

Flexible bronchoscopic antenna • Sharp tip • Compatible with all robotic systems

MedWaves monitors and responds to the ever-changing tissue environment.

Monitor • Respond • Adapt • Control

Variables Influencing Treatment Zone Development

MedWaves® INCORPORATED

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.

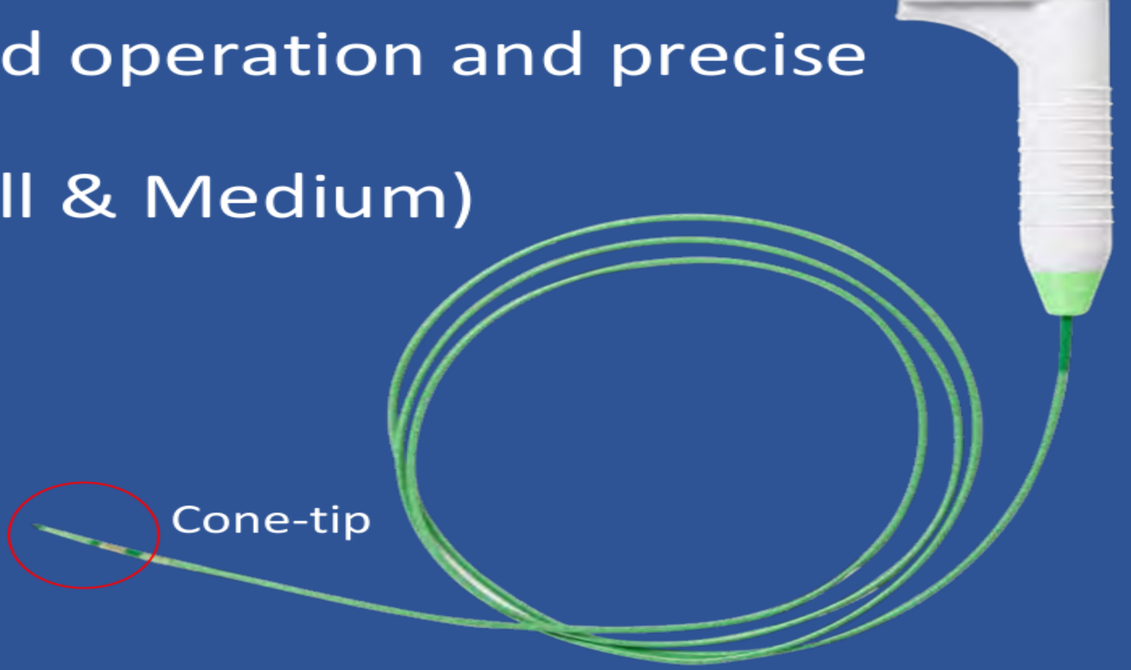
Smart Antenna Design

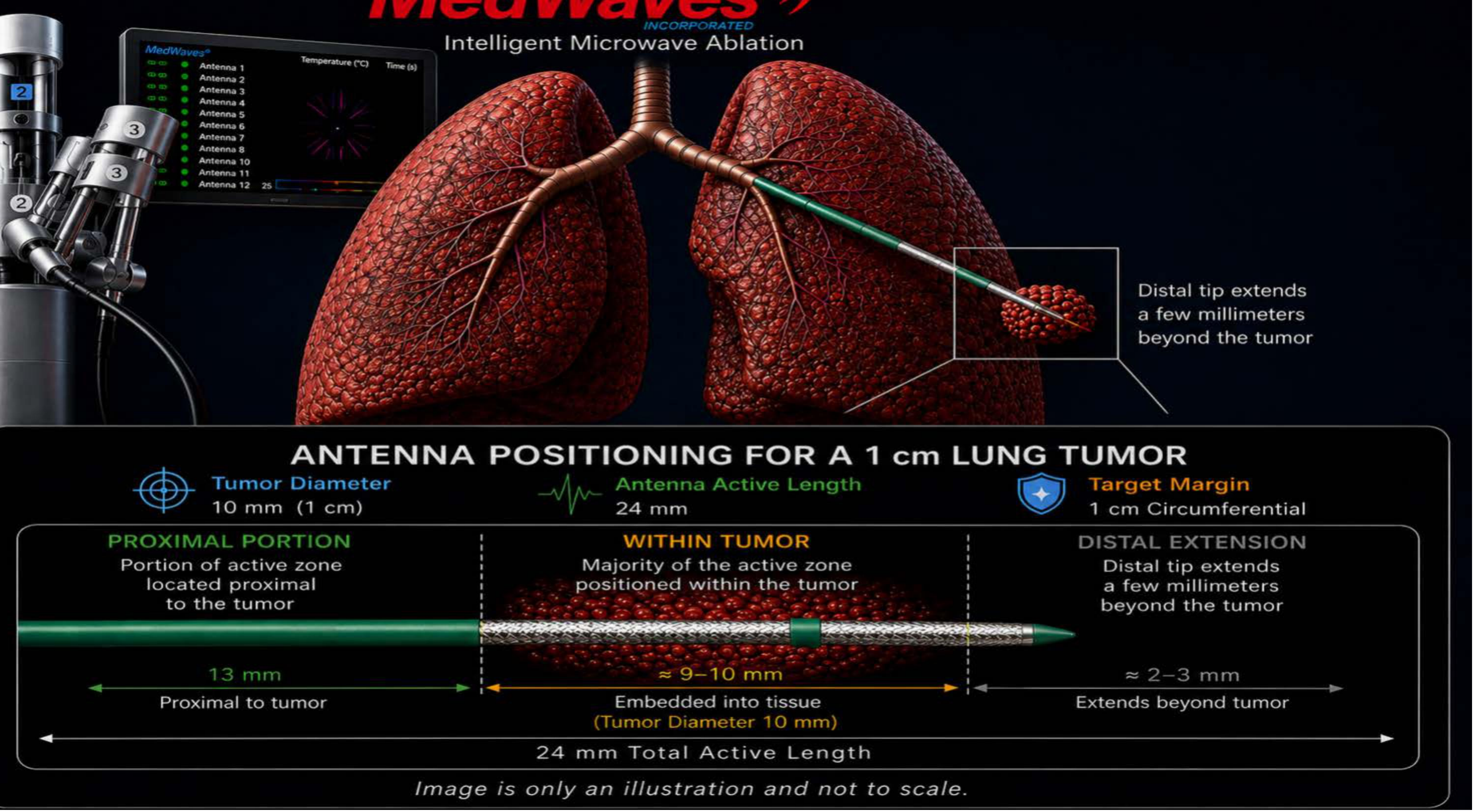
- Integrated temperature sensor within antenna tip.
- 1.8mm flexible catheter navigates complex bronchial anatomy.
- Cone-tip design penetrates soft tissue with accuracy.

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




INCORPORATED
Intelligent Microwave Ablation
MedWaves
Temperature (°C)
Time (s)
Antenna 1
Antenna 2
Antenna 3
Antenna 4
Antenna 5
Antenna 6
Antenna 7
Antenna 8
Antenna 10
Antenna 11
Antenna 12
25
2
3
3
2
Distal tip extends a few millimeters beyond the tumor
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
WITHIN TUMOR
Majority of the active zone positioned within the tumor
DISTAL EXTENSION
Distal tip extends a few millimeters beyond the tumor
13 mm
Proximal to tumor
≈ 9–10 mm
Embedded into tissue
(Tumor Diameter 10 mm)
≈ 2–3 mm
Extends beyond tumor
24 mm Total Active Length
Image is only an illustration and not to scale.

Ablation **Algorithm**

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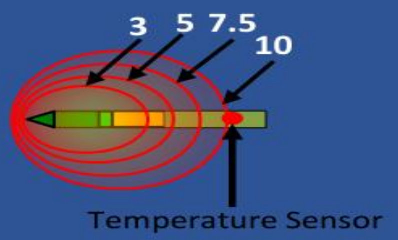
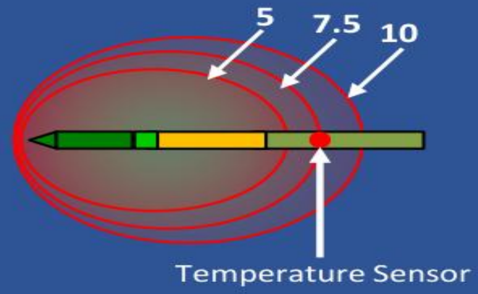
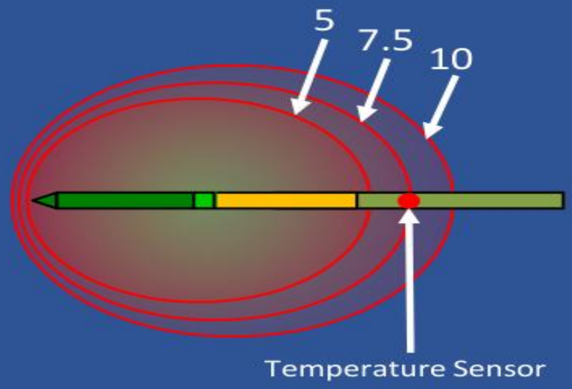






Standard Deviations: Ablation zone: ±10%, Temperatures: +3%/-10%, Energy delivered: ±10%

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

$$\boxed{\mathrm{SAR} = \frac{(\sigma + \omega\varepsilon_0\varepsilon_r'')\,|E|^2}{2\rho}}$$

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

THE CLINICAL CONNECTION

Variables + Antenna Position

↓

Ablation Environment

↓

Energy Absorption x Time

↓

Temperature Spread × 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

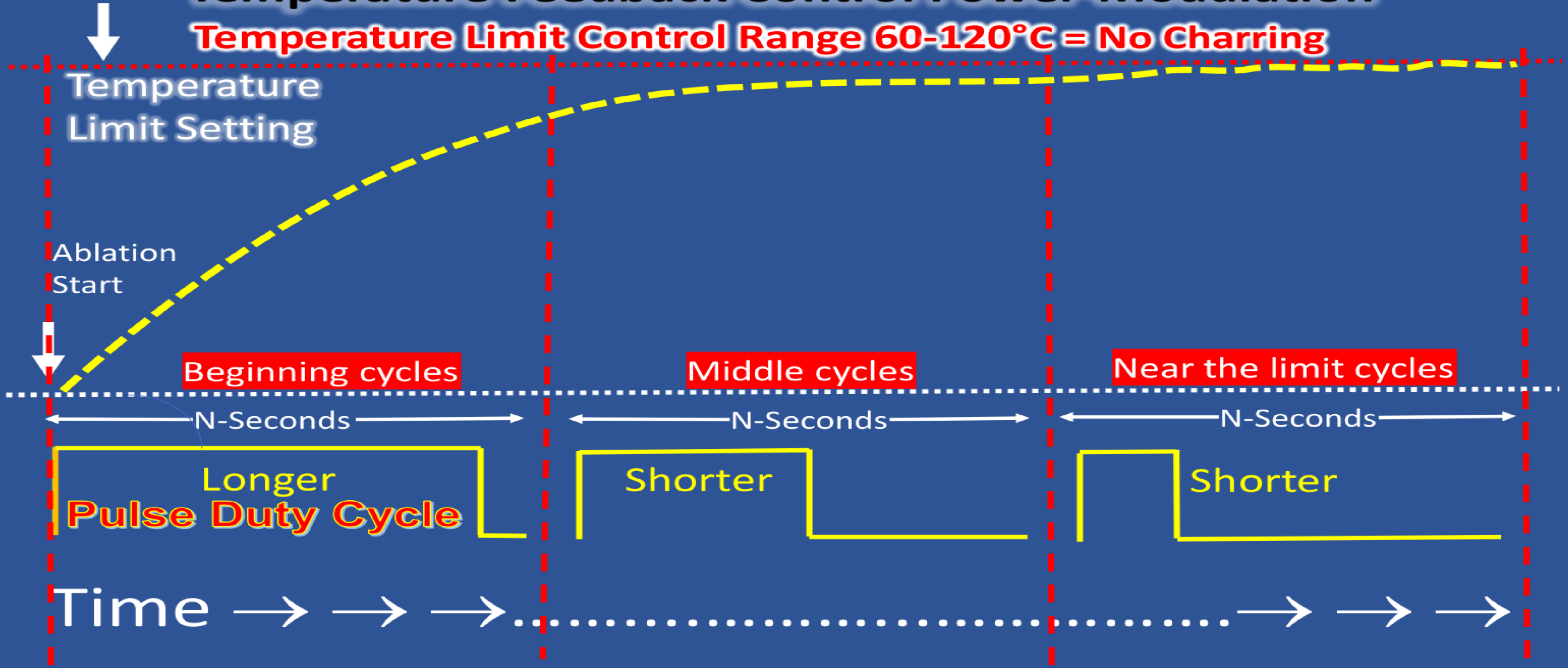
Do not assume the clinical zone will be smaller.

RESPECT THE FULL PUBLISHED ZONE

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

PulsaBlade™ Technology

Temperature Feedback Control Power-Modulation



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

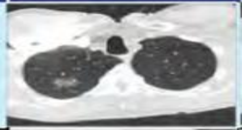
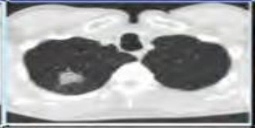
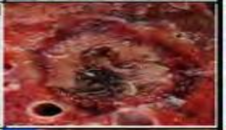
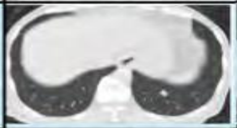
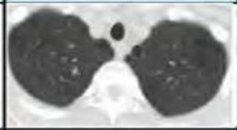
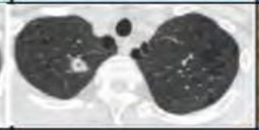
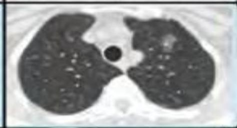
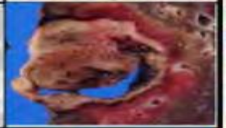
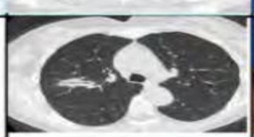
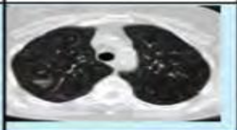
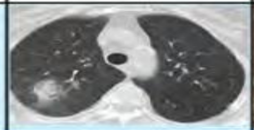
- In collaboration with Dana Farber Cancer Institute
- AveCure Flexible Microwave Ablation Probe for Lung Nodules
- ClinicalTrials.gov ID NCT05281237
- Lung Suite Cone beam CT with ION Robotic Bronchoscopy
- Peripheral Lung Nodule

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

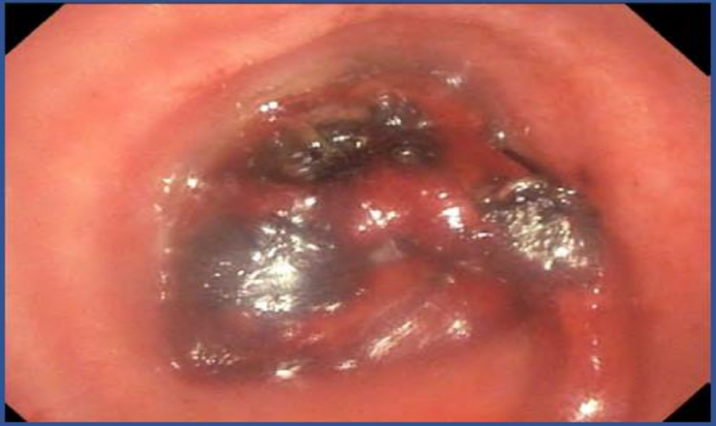
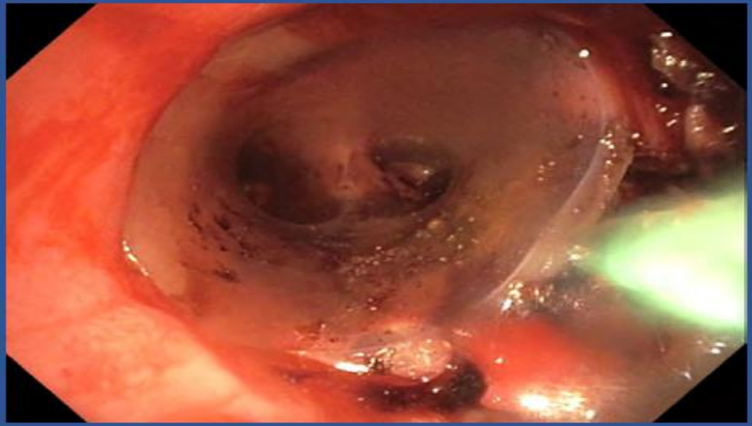
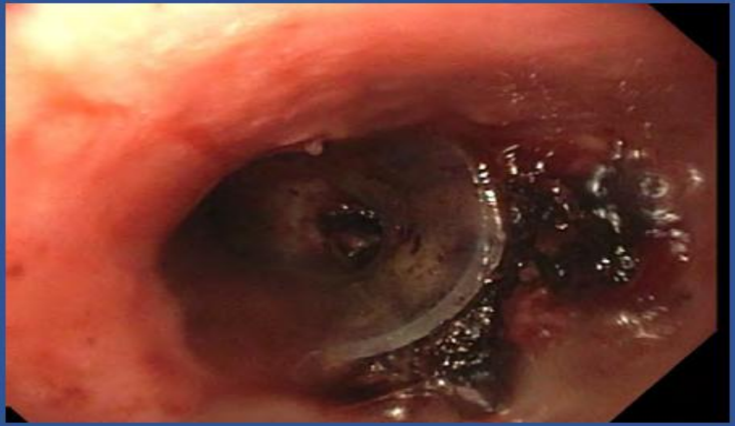
Bronchoscope MWA therapy Airway tumor removal
AveCure Ablation System

Michal Senitko, M.D., DAABIP, University of Mississippi Medical Center

Case 1

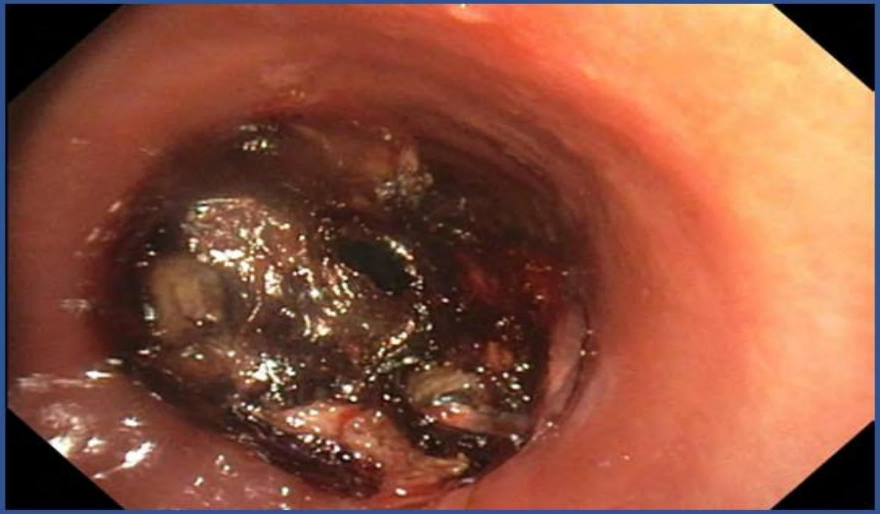
- 58 year old man
- Found to have left main obstruction
- EBUS with N1 disease only
- Squamous cell Ca
- Able to undergo surgical resection post tumor removal

Case 2

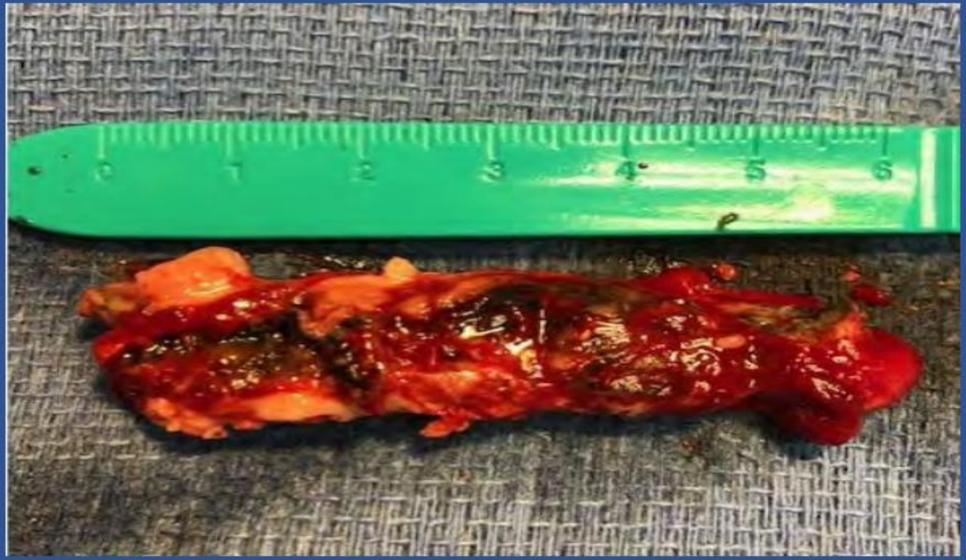





- 32 year old man with high grade neuroendocrine tumor
- Ball valve tracheal tumor completely obstructing the proximal end of a silicone **stent**
- No damage to the stent

Case 3



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



CAO Experience & Conclusions

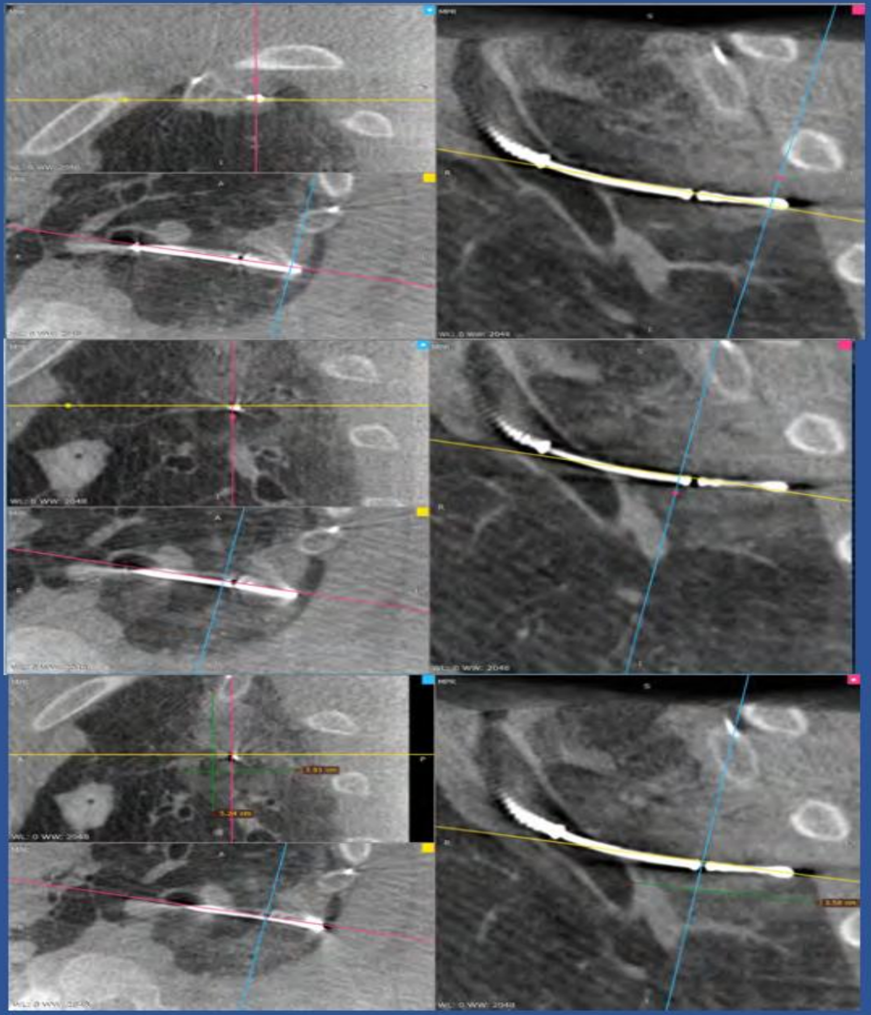
- Safe and effective for both central airway and peripheral lung.
- Short learning curve.
- Can use with 100% O_2.
- Recanalization can happen in the same setting.
- Sharp tip designed to penetrate tissue.
- Significantly reduced bleeding during procedures.
- Supports complete tumor devitalization and en-bloc removal.

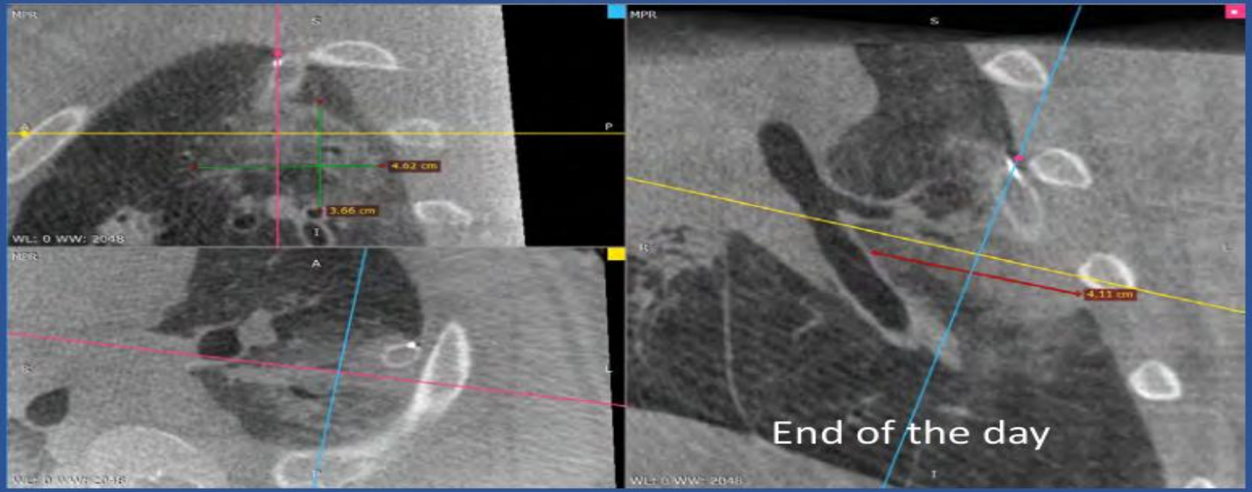
Endoluminal Robotic: In Vivo Animal Lung MWA, LML

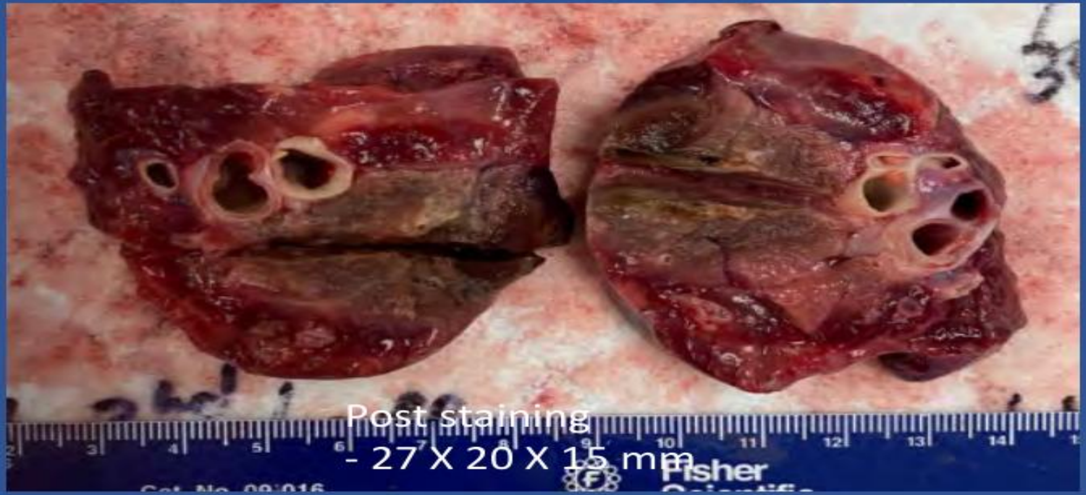
0 min

5 min

10 min







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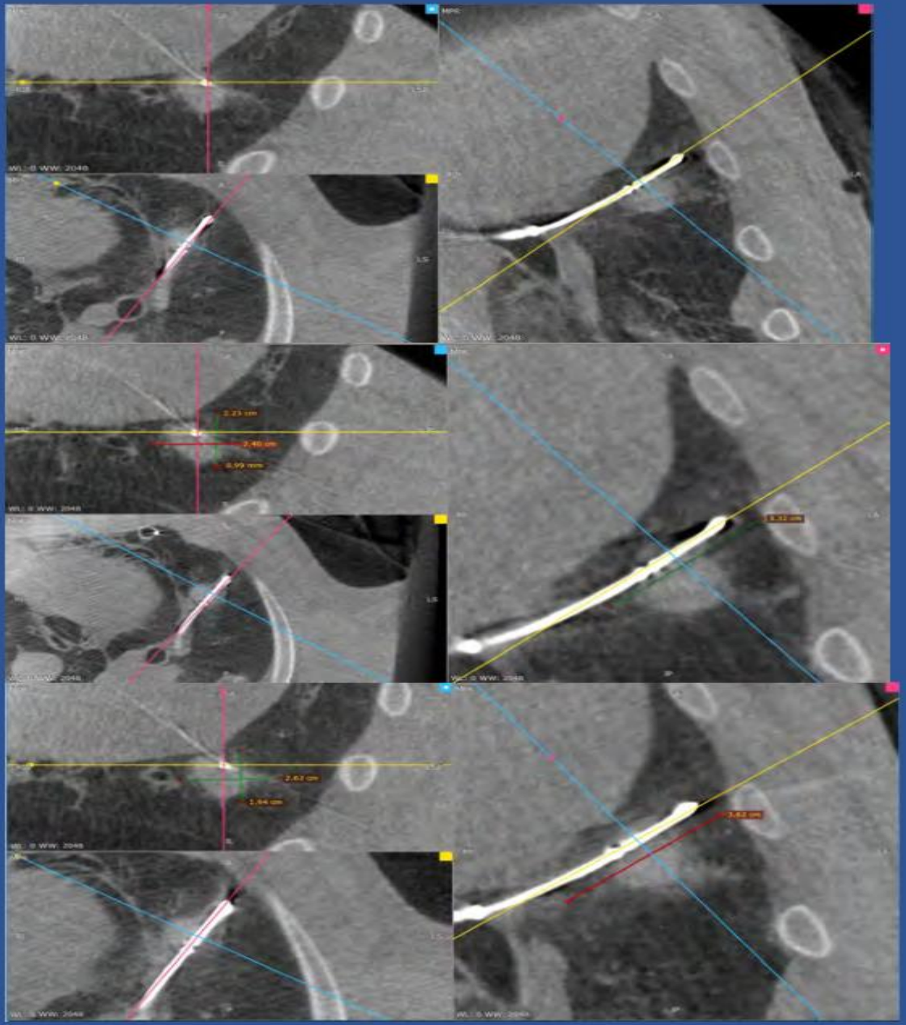
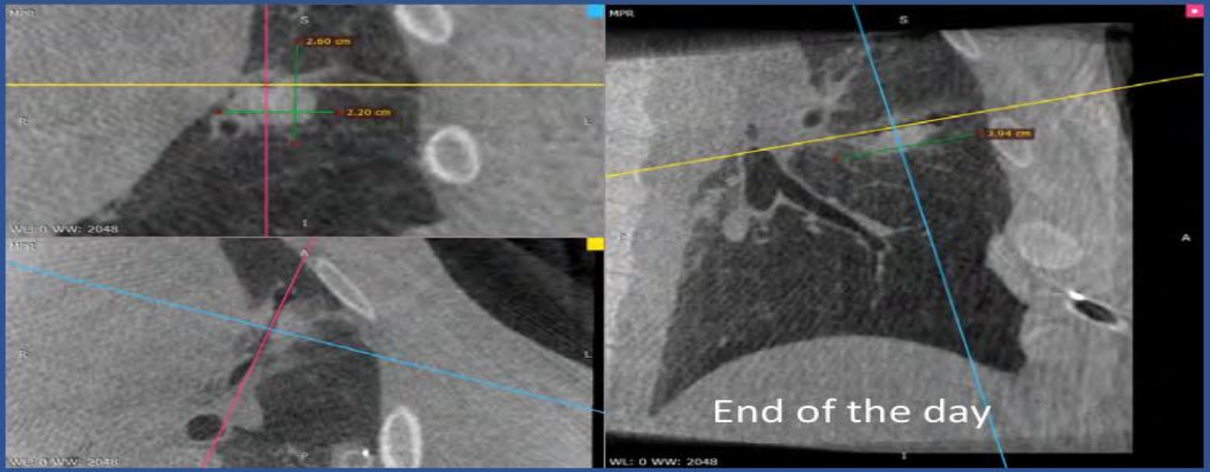
0 min

5 min

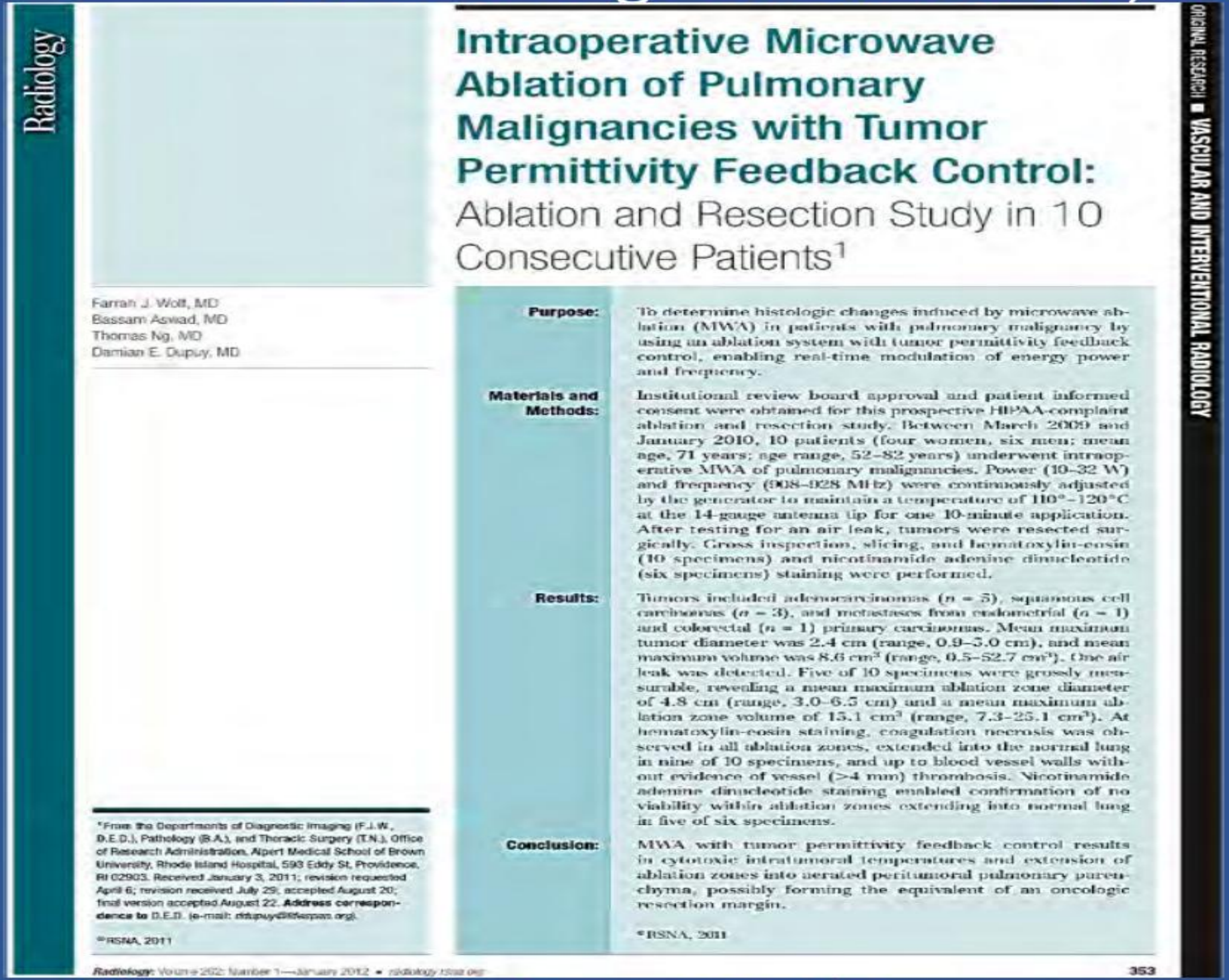
10 min





MedWaves MWA: Surgical Ablate and Resect Study

No Charring and Cavitation; vessels >3mm are patent



Radiology

ORIGINAL RESEARCH ■ VASCULAR AND INTERVENTIONAL RADIOLOGY

Intraoperative Microwave Ablation of Pulmonary Malignancies with Tumor Permittivity Feedback Control: Ablation and Resection Study in 10 Consecutive Patients[1]

Farrah J. Wolf, 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, 0.9–3.0 cm), and mean maximum volume was 8.6 cm^3 (range, 0.5–52.7 cm^3). 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 cm^3 (range, 7.3–25.1 cm^3). 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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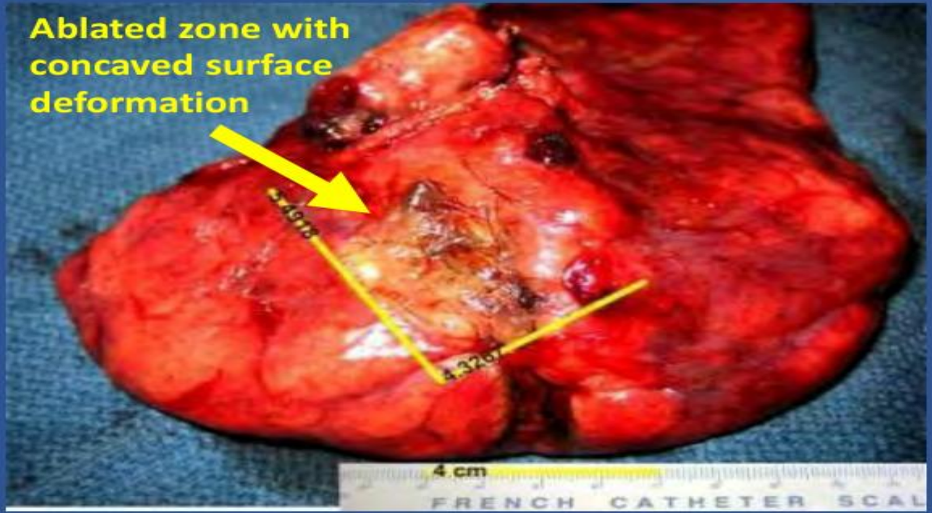
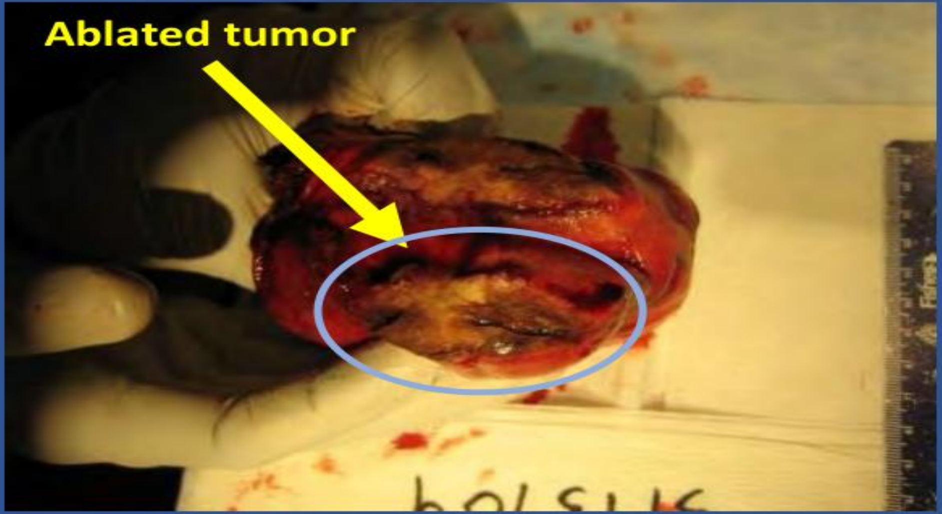




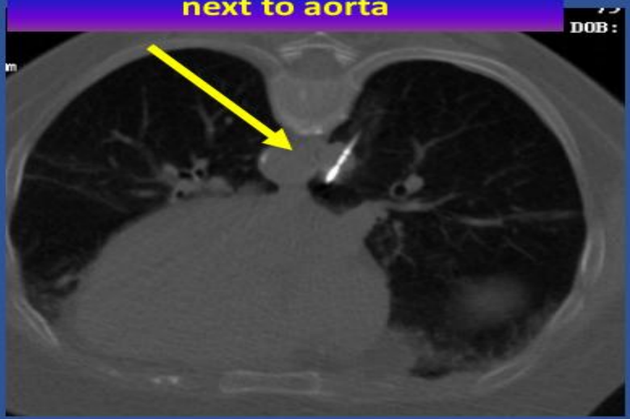
Lung Tumor, Biopsy proven Carcinoid next to Aorta

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

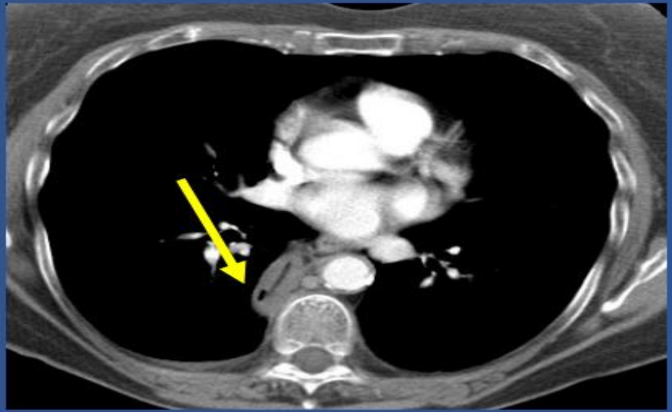
Large antenna positioned in the tumor next to aorta



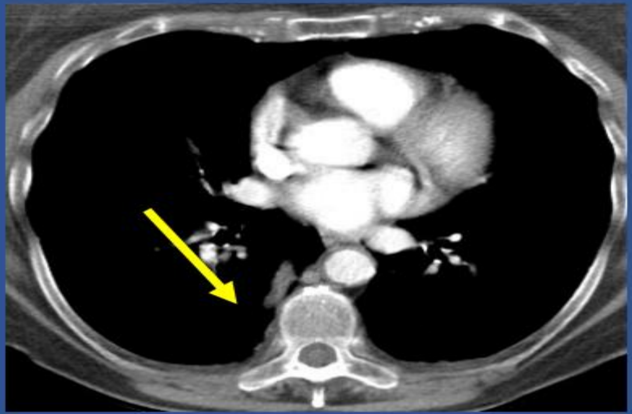
Post ablation Ground-glass

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



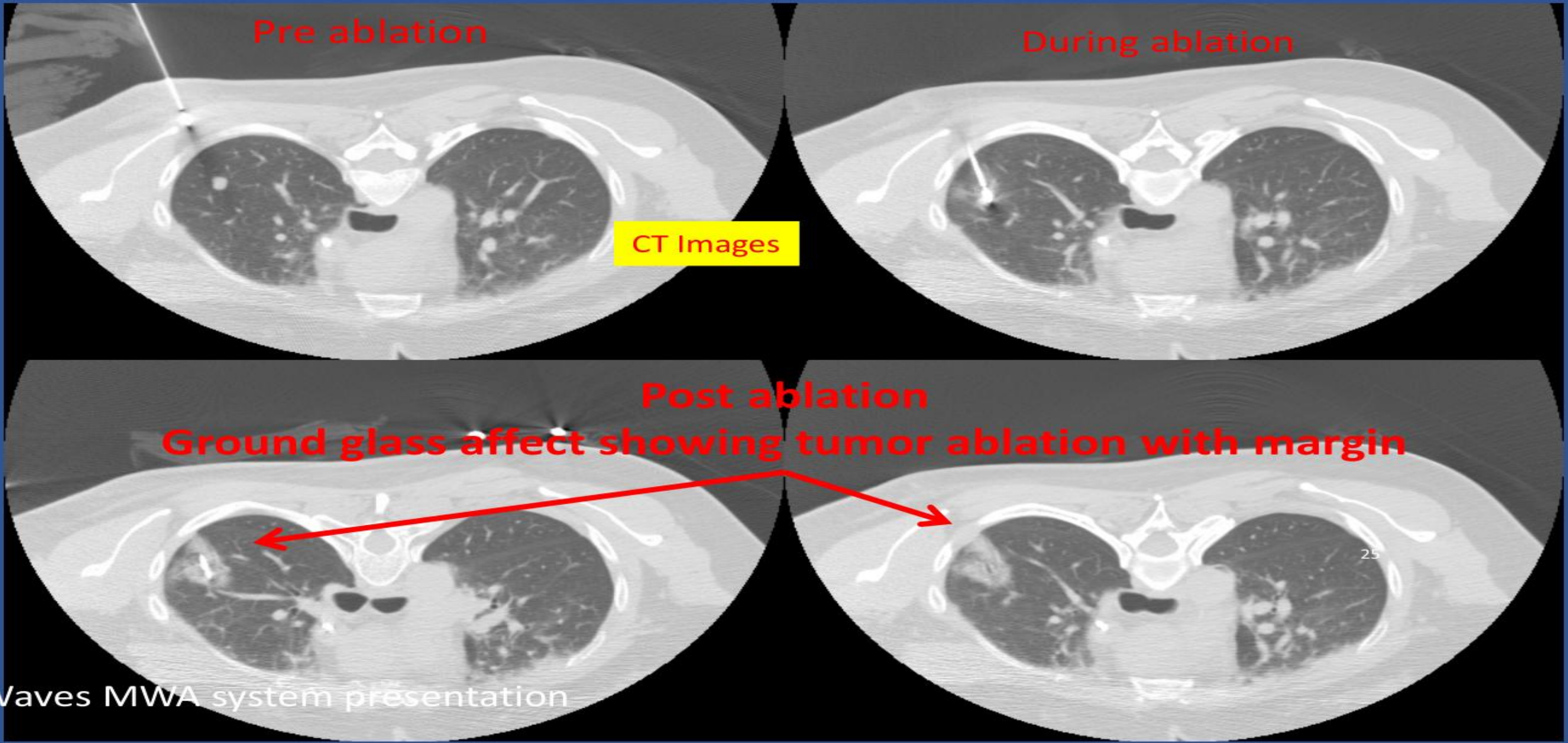
6-mos post MWA shows no enhancement, but mass shrinkage



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

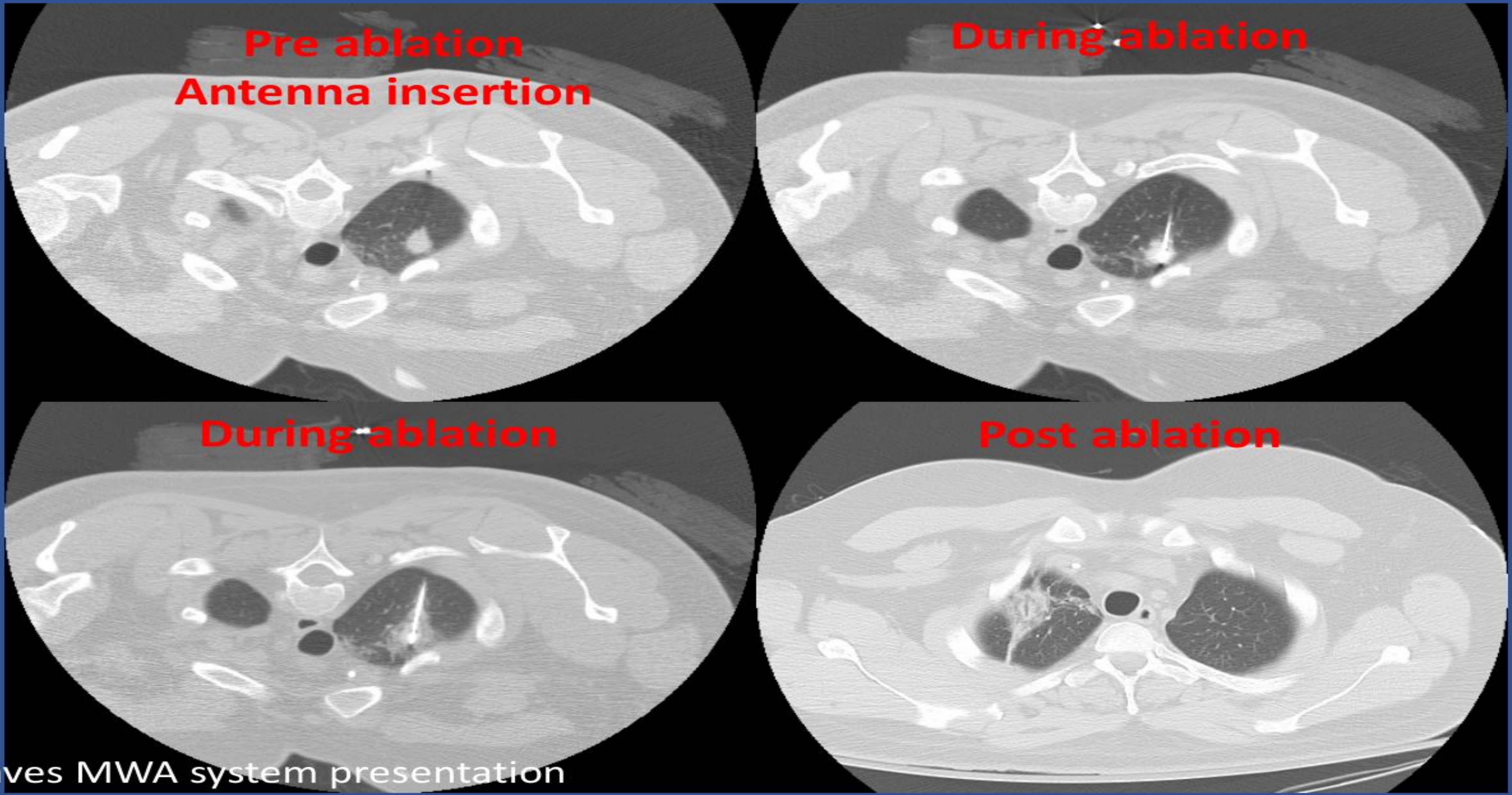
Lung Tumor Percutaneous MWA

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)