Radiofrequency Ablation for Thyroid Nodules: An Emerging Technique

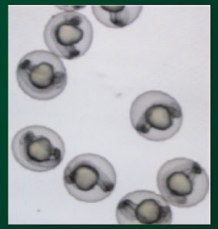
Dr. Erin Buczek - Department of Otolaryngology Head and Neck Surgery

Dr. Jessica Fazendin - Department of Surgery, Division of Endocrine Surgery

UAB MEDICINE








Disclosures

We have no financial disclosures to report.

We are passionate about the treatment of our patients in Alabama and surrounding regions for both benign and malignant diagnoses.

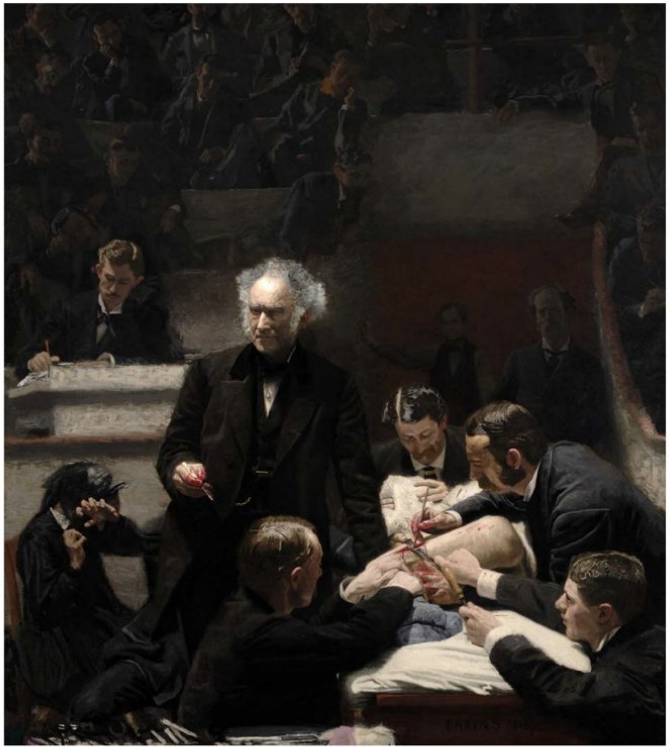
While RFA for thyroid nodules is not a new technique, we are the first to offer in the state and our program is in its early stages!

Objectives

1. Learn the basics about radiofrequency ablation (RFA)
2. Determine the indications for RFA
3. Evaluate the pros and cons of using RFA for treatment of benign thyroid nodules vs open surgical management

History of Thyroid Surgery

- "No sensible man will… attempt to extirpate a goitrous thyroid gland. Every step he takes will be envisioned with difficulty, every stroke of his knife will be followed by a torrent of blood and lucky will it be for him if his victim lives long enough to enable him to finish his horrid butchery." (Gross-1866)



Thomas Eakins, 'The Gross Clinic', 1875

History of Thyroid Surgery

Theodor Billroth

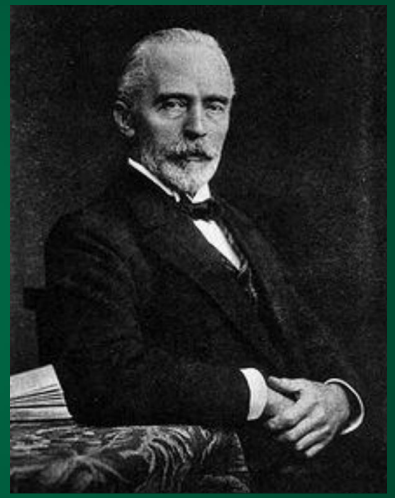
Performed the first esophagectomy, gastrectomy, laryngectomy

Thyroid surgery outcomes were not so good…

25% recurrent laryngeal nerve injury

10.5% tracheotomy

40% mortality initially



Theodor Kocher

Father of modern thyroid surgery

Nobel prize 1909 for "works in the physiology, pathology and surgery of the thyroid"

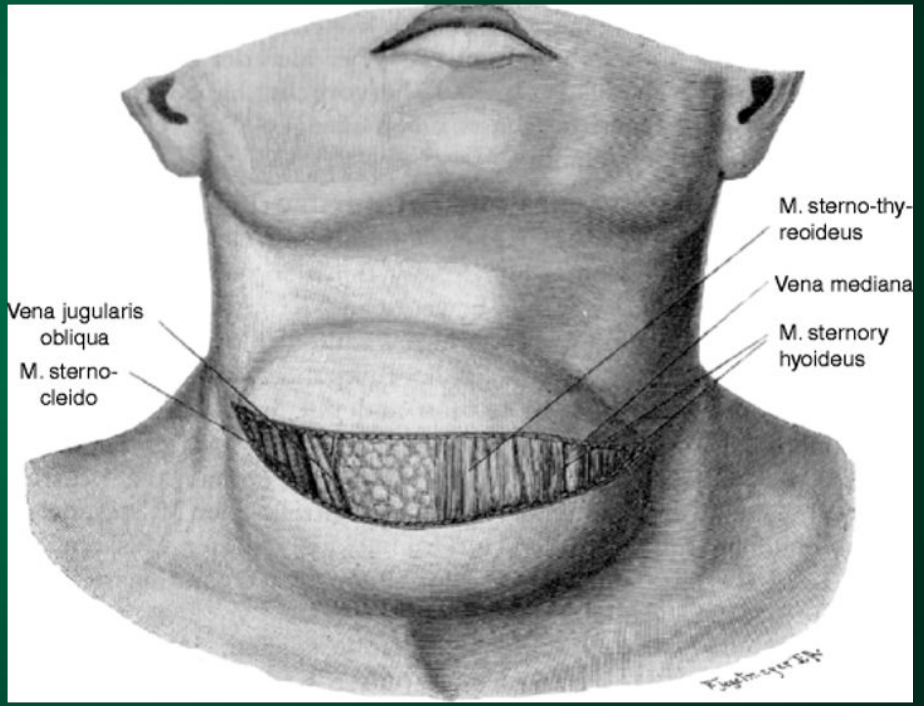
>5000 thyroidectomies

Mortality rate 14.8% --> 0.18%

RLN injury rate < 1%

Enduring Principles

- Preserve the nerves and parathyroid glands
- Limit bleeding
- Replace thyroid hormone appropriately
- Traditional collar incision = Kocher incision



Hamberger B. (2012) History of Thyroid Surgery: The Kocher Incision. In: Linos D., Chung W. (eds) Minimally Invasive Thyroidectomy. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-23696-9_1

Patient's Perspectives: Scarring

- Goldfarb & Casillas, *Thyroid* 2016
- 1028 pts identified through ThyCa
- THYCA-QoL, SF-12v1, and SF-6FD survey tools analyzed
- 277 young adults compared to controls

Thyroid Cancer–Specific Quality of Life and Health-Related Quality of Life in Young Adult Thyroid Cancer Survivors

TABLE 2. COMPARISON OF THYCA-QOL SCORES IN AYAS VERSUS OLDER PATIENTS

	AYA now, M (SD)	*>40 years now*, M (SD)	p-*Value*	*Partial eta*^{2}
Neuromuscular	44.60 (27.70)	49.90 (27.19)	0.006	0.01
Voice	19.61 (20.47)	24.48 (20.84)	0.001	0.01
Concentration	46.63 (31.13)	42.57 (29.19)	0.052	
Sympathetic	36.34 (31.51)	41.83 (30.12)	0.011	0.01
Throat/mouth	25.27 (22.11)	29.01 (22.27)	0.017	0.01
Psychological	40.88 (19.24)	35.41 (16.93)	<0.001	0.02
Sensory	31.11 (27.58)	32.51 (25.83)	0.448	
Scar	30.57 (29.43)	18.11 (24.41)	<0.001	0.05
Chilly	47.17 (34.71)	40.99 (33.21)	0.009	0.01
Tingling	36.58 (32.50)	36.09 (33.66)	0.832	
Weight gain	43.92 (34.52)	43.45 (33.39)	0.843	
Headache	41.28 (33.35)	32.53 (30.20)	<0.001	0.02
Anxiety	81.47 (31.87)	75.68 (27.86)	0.005	0.01
PCS12	45.89 (10.29)	43.01 (10.89)	<0.001	0.01
MCS12	39.36 (10.21)	40.75 (10.33)	0.057	
SF-6D[a]/HUI	0.70 (0.14)	0.69 (0.14)	0.558	

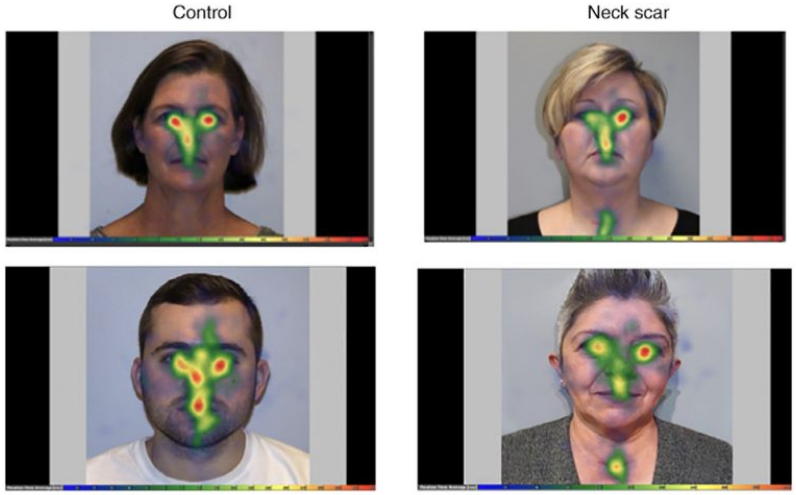
[a]Norm SF-6D for ages 35–44 = 0.80.

Thyroid Vol 26, Number 7, 2016

Patient's Perspectives: Scarring

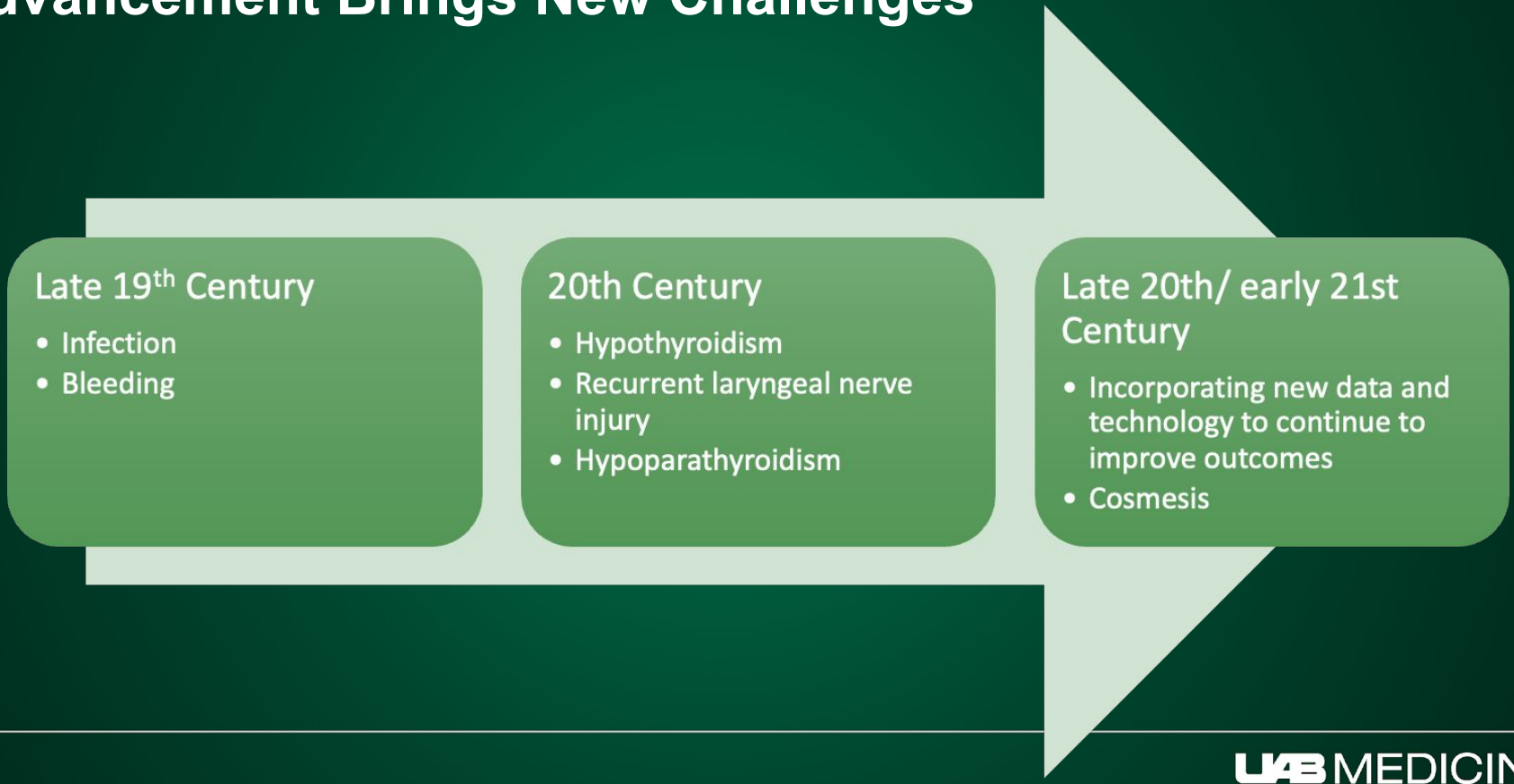
- Juarez et al, *Laryngoscope* 2019
- 130 participants
- Eye-tracking assessment of photos of people with and without neck scars
- Observers paid more attention to the neck and less to the peripheral face in patients with neck scars

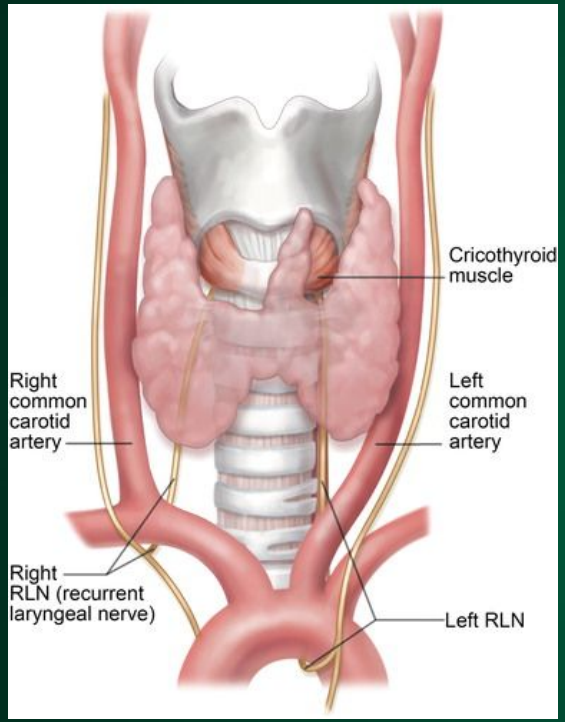
Objectively Measuring Social Attention of Thyroid Neck Scars and Transoral Surgery Using Eye Tracking

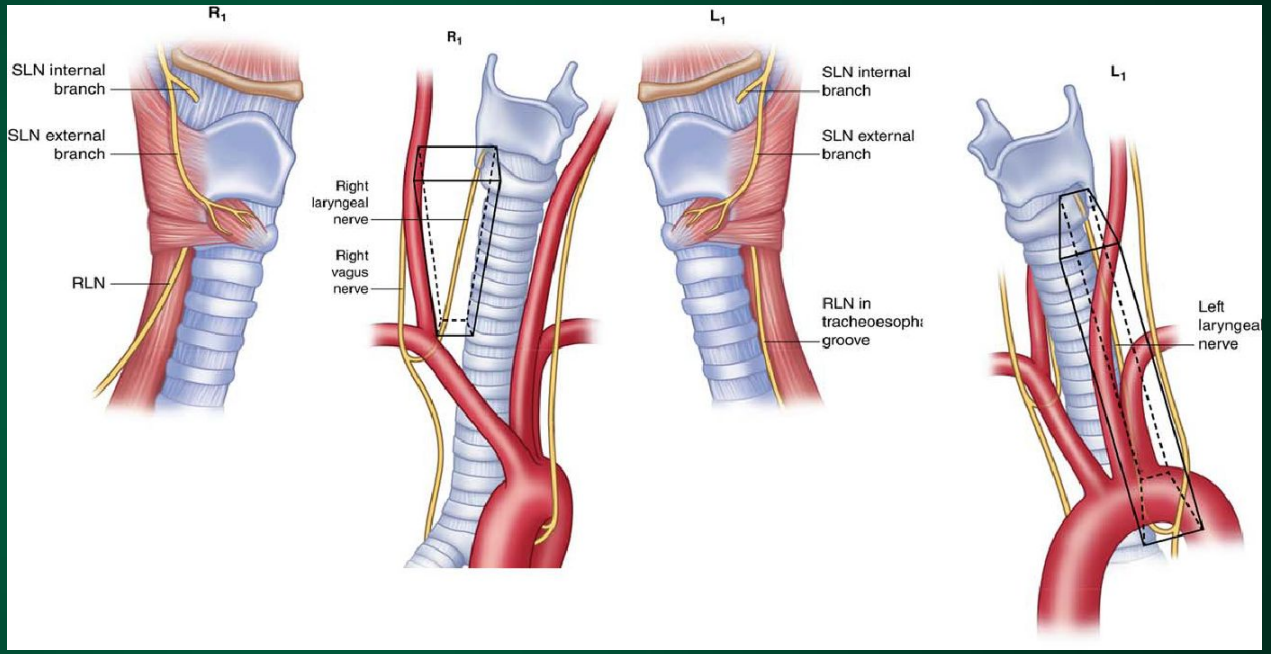


Laryngoscope, 129:2789-2794, 2019

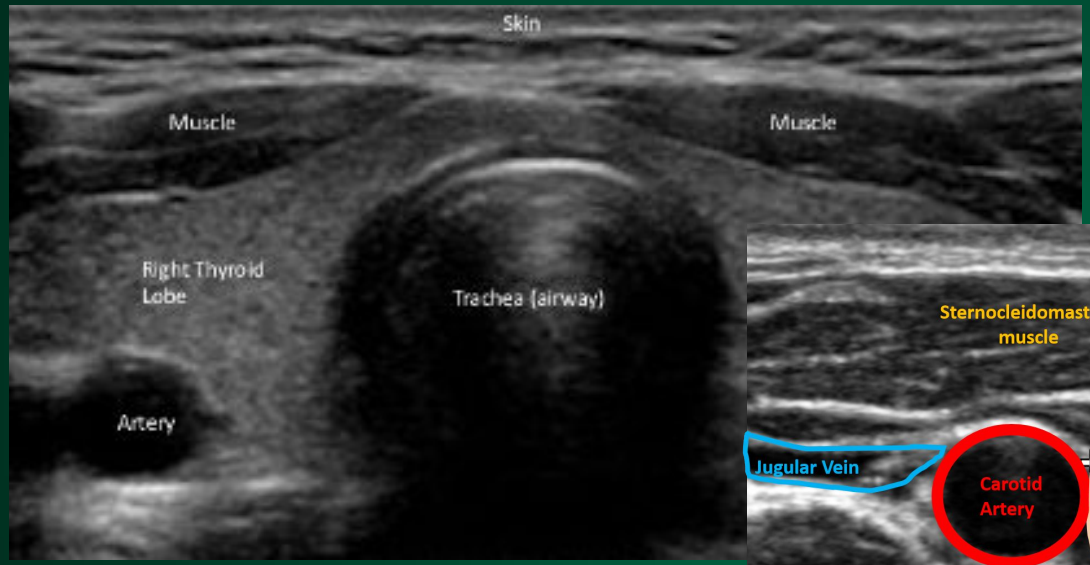
Advancement Brings New Challenges

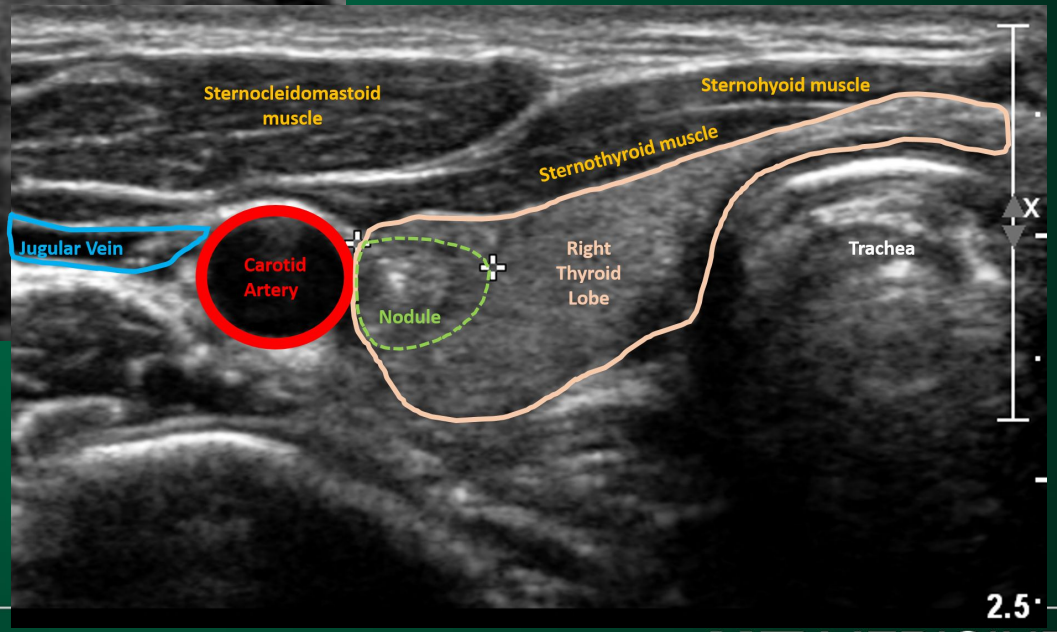



Cricothyroid muscle
Right common carotid artery
Left common carotid artery
Right RLN (recurrent laryngeal nerve)
Left RLN


R1
SLN internal branch
SLN external branch
RLN
R1
Right laryngeal nerve
Right vagus nerve
L1
SLN internal branch
SLN external branch
RLN in tracheoesopha
groove
L1
Left laryngeal nerve

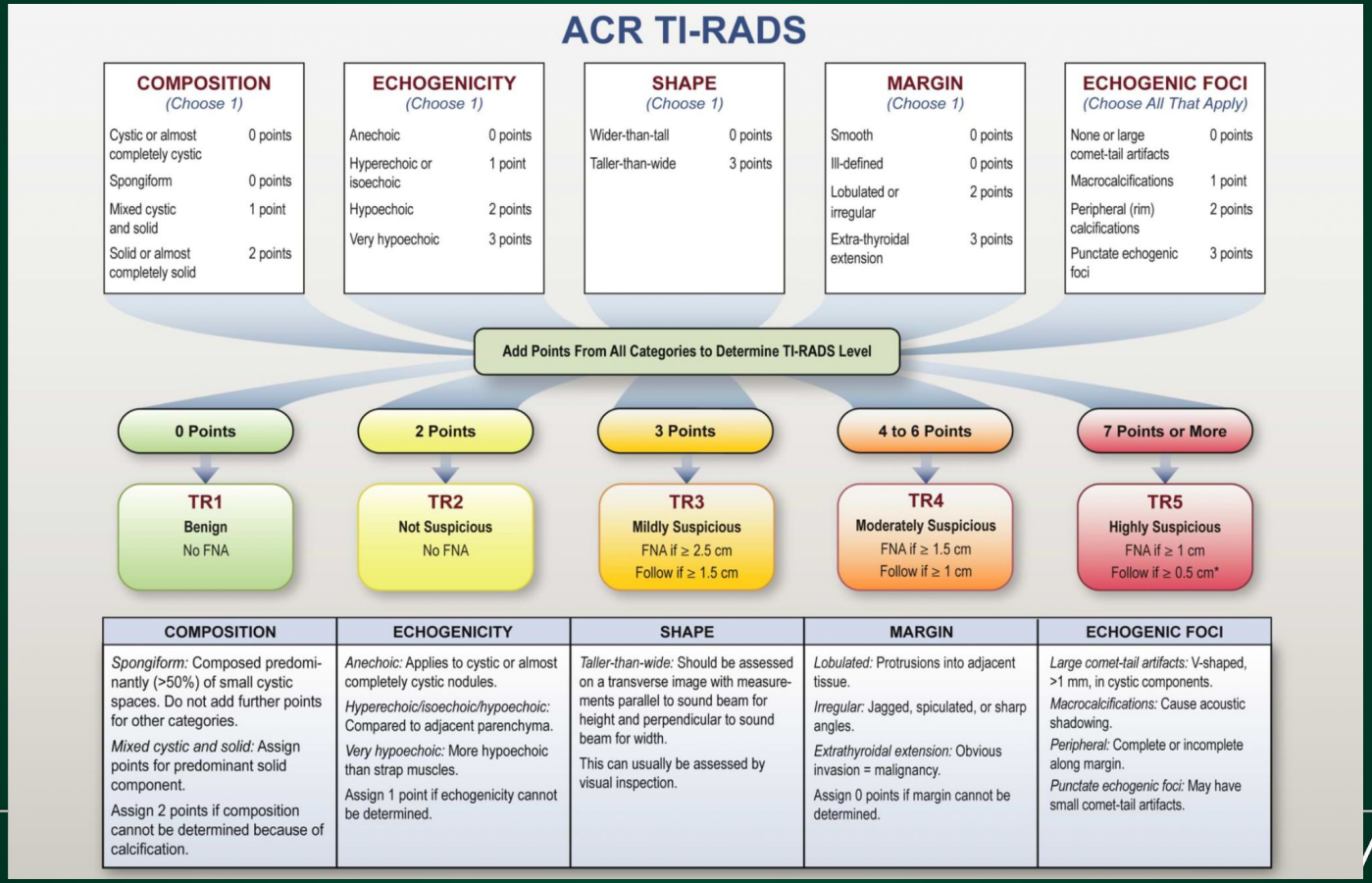
Appearance on Ultrasound





UAB MEDICINE

TiRADS Classification (Based on Ultrasound)

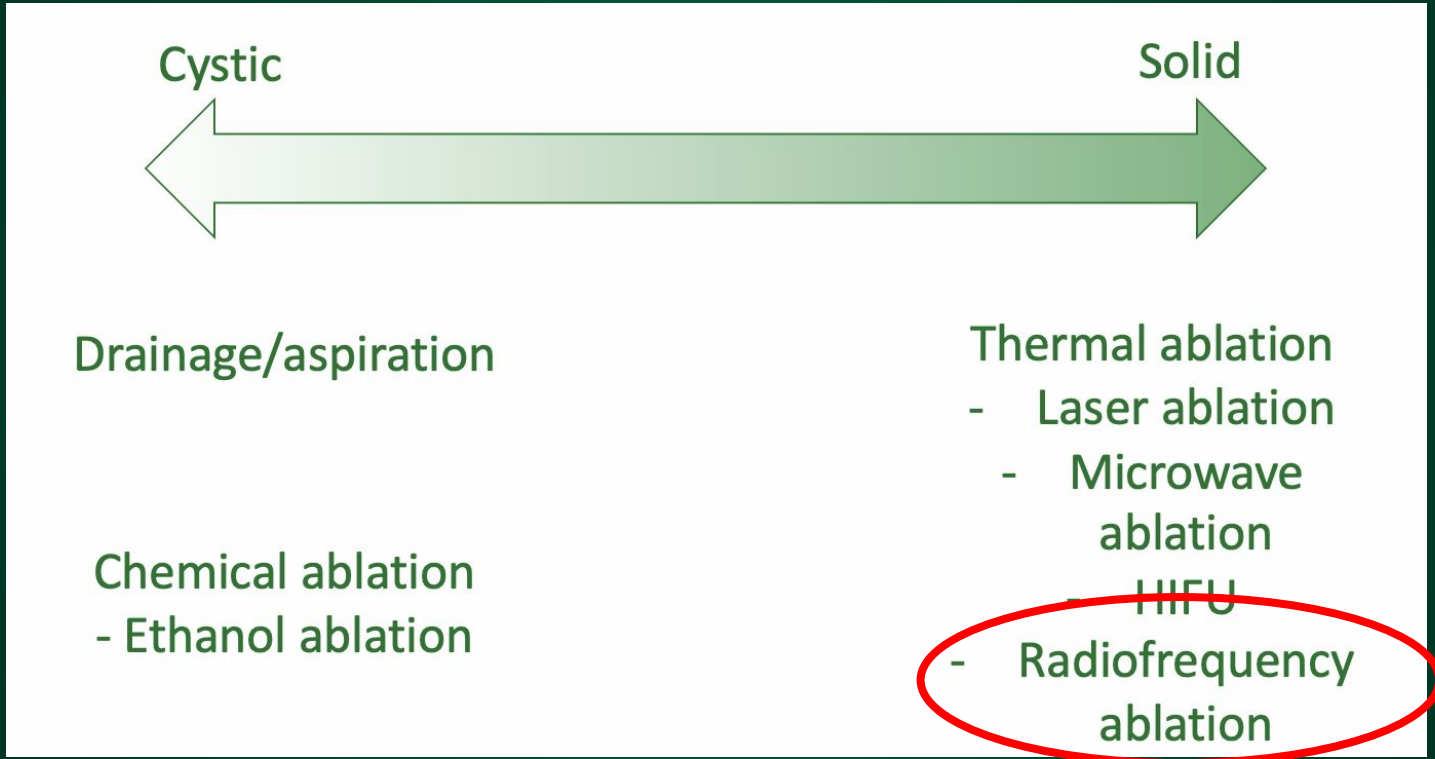


Bethesda Classification (Based on FNA)

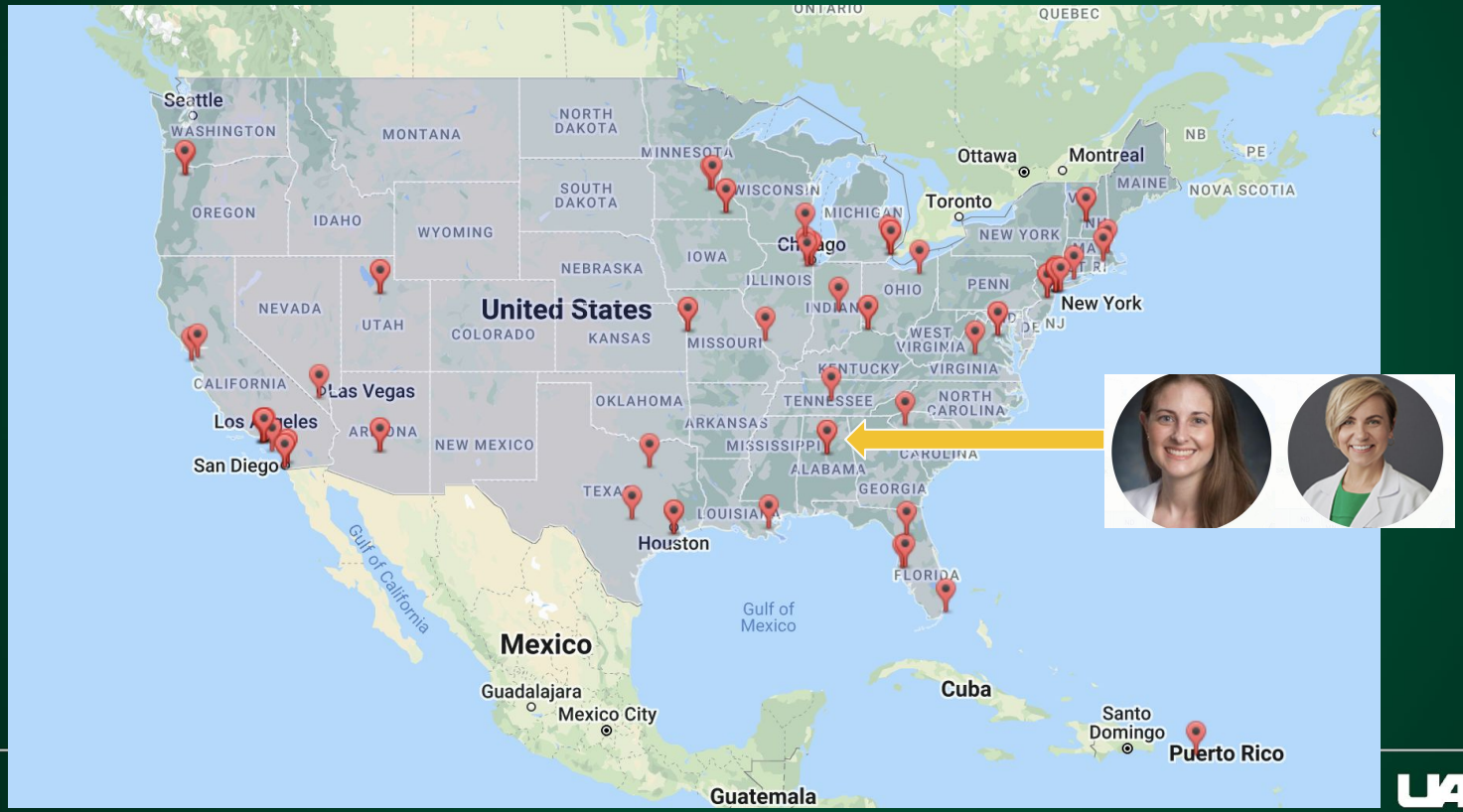
Diagnostic category	Risk of malignancy if NIFTP is considered non malignant (%)	Risk of malignancy if NIFTP is considered malignant (%)	Usual management
Nondiagnostic or unsatisfactory	5-10%	5-10%	Repeat FNA with ultrasound guidance
Benign	0-3%	0-3%	Clinical and sonographic follow-up
Atypia of undetermined significance or follicular lesion of undetermined significance (AUS/FLUS)	6-18%	10-30%	Repeat FNA, molecular testing or lobectomy
Follicular neoplasm or suspicious for a follicular neoplasm	10-40%	25-40%	Molecular testing, lobectomy
Suspicious for malignancy	45-60%	50-75%	Near total thyroidectomy or lobectomy
Malignant	94-96%	97-99%	Near total thyroidectomy or lobectomy

The 2017 Bethesda system for reporting thyroid cytopathology: implied risk of malignancy and recommended clinical management.

Minimally-Invasive Therapy for Nodules



RFA in the United States

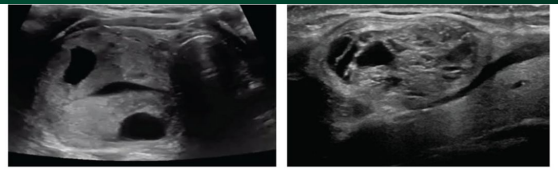


UAB MEDICINE

Radiofrequency ablation and related ultrasound-guided ablation technologies for treatment of benign and malignant thyroid disease: An international multidisciplinary consensus statement of the American Head and Neck Society Endocrine Surgery Section with the Asia Pacific Society of Thyroid Surgery, Associazione Medici Endocrinologi, British Association of Endocrine and Thyroid Surgeons, European Thyroid Association, Italian Society of Endocrine Surgery Units, Korean Society of Thyroid Radiology, Latin American Thyroid Society, and Thyroid Nodules Therapies Association

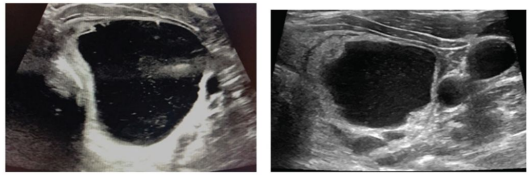
Lisa A. Orloff MD, Julia E. Noel MD, Brendan C. Stack Jr MD, Marika D. Russell MD, Peter Angelos MD, PhD, Jung Hwan Baek MD, PhD, Kevin T. Brumund MD, Feng-Yu Chiang MD ... See all authors

(A) Benign solid or mostly solid thyroid nodules suitable for RFA

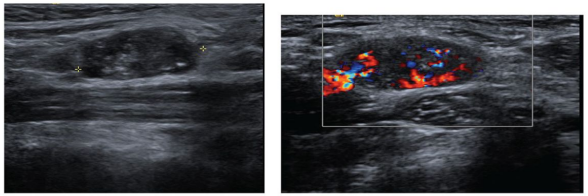


(B) Benign mixed solid and cystic thyroid nodules suitable for combination RFA and EA

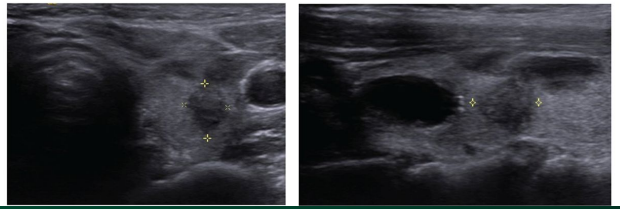
(C) Predominantly cystic nodules suitable for EA



(D) Recurrent malignant lesions suitable for RFA



(E) Primary PTMC considered for RFA



European Guidelines

Table 1. Summary of recommendations

Recommendation 1	In adult patients with benign thyroid nodules that cause pressure symptoms and/or cosmetic concerns and decline surgery, image-guided thermal ablation (TA) should be considered as a cost- and risk-effective alternative option to surgical treatment or observation alone (1, ØØOO)
Recommendation 2	We recommend against the use of TA for asymptomatic lesions (1, ØØØO)
Recommendation 3	Before TA of thyroid lesions, a benign cytological diagnosis is needed; a repeat FNA is suggested for cytologically benign nodules with the exception of spongiform nodules and pure cystic lesions (EU-TIRADS Class 2); we recommend against TA for nodules with high-risk US features (EU-TIRADS Class 5; 1, ØØØO)
Recommendation 4	Patients should be carefully informed before the procedure, orally and in writing, about the TA treatment options, their potential efficacy and side effects, the therapeutic alternatives, and the necessity of being compliant (1, ØOOO)
Recommendation 5	Before the TA procedure, thyroid and vocal cord function, comorbidities, and contraindications to TA treatment should be evaluated; laryngoscopy is recommended in patients with hoarseness, previous neck surgery, or with nodules close to critical structures ("danger areas"; 1, ØØOO)

Eur Thyroid J 2020; 9:172-185

UAB MEDICINE

	European Thyroid Association (ETA)[77]	Korean Society of Thyroid Radiology (KSThR)[62]
Thermal ablation for compressive or cosmetic reasons.	Yes	Yes
Benign cytopathology confirmation	Yes	Yes
First line treatment for AFTN	Radioiodine (RI) or surgery	RI or surgery
First line treatment for cystic or predominantly cystic nodules.	Ethanol ablation (TA only if relapse or residual large solid component)	EA
First line TA for solid nodules.	RFA or LA	RFA
RFA and nodule's size	NA	Growing nodule >2 cm

2017 Thyroid Radiofrequency Ablation Guideline: Korean Society of Thyroid Radiology

Table 6. Pre-Procedural Checklist before RFA

Benign Thyroid Nodule	Recurrent Thyroid Cancer
Pathologic diagnosis	Pathologic and/or serologic diagnosis
Benign diagnosis at least two US-guided FNA or CNB	Cancer recurrence at US-guided FNA or CNB
Benign diagnosis at least one US-guided FNA or CNB in AFTN	Increased washout Tg level in aspirate or Tg immunostain of CNB specimen
Benign diagnosis at least 1 US-guided FNA or CNB in thyroid nodules with highly specific benign US features	Increased washout calcitonin level in aspirate or calcitonin immunostaining of CNB specimen in patients with medullary cancer
US	US
Features of nodule and surrounding critical structures	Features of nodule and surrounding critical structures
Nodule volume	Tumor volume
Symptom score	
Cosmetic score	
Laboratory tests	Laboratory tests
Complete blood count	Complete blood count
Blood coagulation battery	Blood coagulation battery
Thyroid function test	Thyroid function test
Serum TSH	Serum TSH
Serum T3	Serum T3
Serum fT4	Serum fT4
CT or MRI*	CT or MRI*
^{99m}Tc pertechnetate or ^{123}I thyroid scan†	

*Selectively indicated, †Indicated for AFTN. AFTN = autonomous functioning thyroid nodule, CNB = core-needle biopsy, CT = computed tomography, FNA = fine-needle aspiration, fT4 = free thyroxine, MRI = magnetic resonance imaging, Tg = thyroglobulin, TSH = thyrotropin, T3 = triiodothyronine

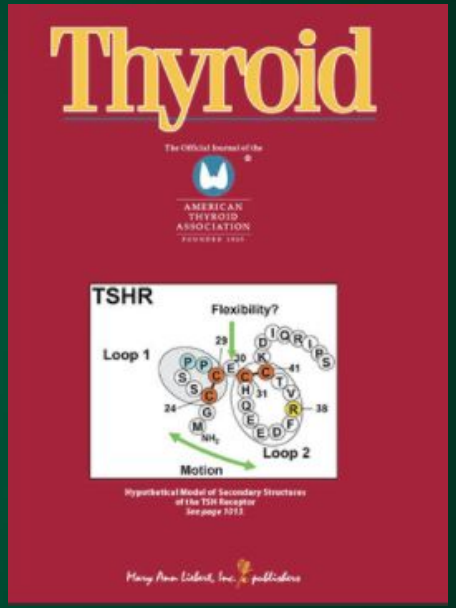
Evaluate Appropriateness for RFA

Ultrasound	Defined nodule, able to completely visualize, no high-risk ultrasound features (microcalcifications, extra-thyroidal extension, etc.) *try EA first for cystic nodules Calculate dimensions and volume Assess location and surrounding critical structures Other nodules that need to be assessed?

Why the size cut-off?

Nodules >3cm have increased incidence of cancer

Jung Hyun Yoon, Jin Young Kwak, Hee Jung Moon, Min Jung Kim, and Eun-Kyung Kim.
Thyroid. Sep 2011. 993-1000. http://doi.org/10.1089/thy.2010.0458



Published: 01 October 2013

Thyroid Nodules (≥4 cm): Can Ultrasound and Cytology Reliably Exclude Cancer?

Laura I. Wharry, Kelly L. McCoy, Michael T. Stang, Michaele J. Armstrong, Shane O. LeBeau, Mitch E. Tublin, Biatta Sholosh, Ari Silbermann, N. Paul Ohori, Yuri E. Nikiforov, Steven P. Hodak, Sally E. Carty & Linwah Yip

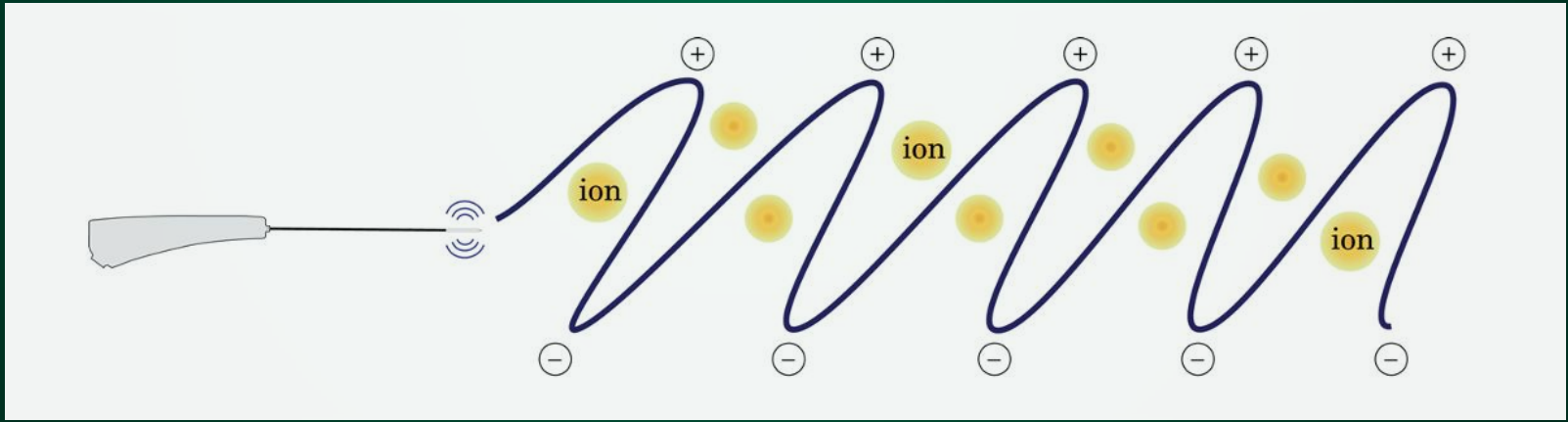
**Almost 400 Nodules Evaluated >4cm

World Journal of Surgery **38**, 614–621 (2014) | Cite this article

Conclusions: In a large consecutive series in which all ≥4 cm nodules had histology and were systematically evaluated by preoperative US and US-guided FNAB, the incidence of TC within the nodule was 22 %. The false negative rate of benign cytology was 10.4 %, and the absence of suspicious US features did not reliably exclude malignancy. At minimum, thyroid lobectomy should be strongly considered for all nodules ≥4 cm.

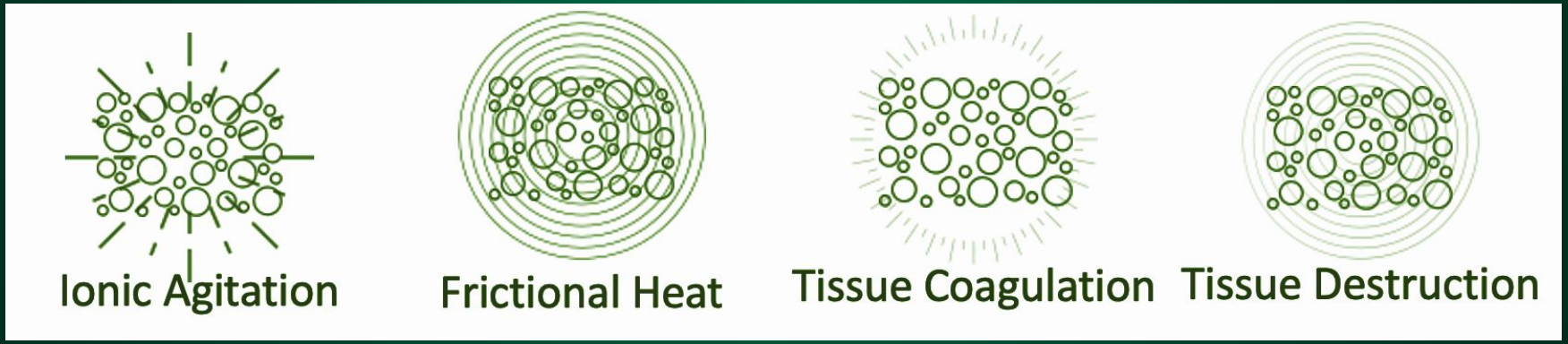
What is Radiofrequency Ablation?

“Radiofrequency” refers to a high-frequency alternating electric current oscillating between 200-1200 kHz.

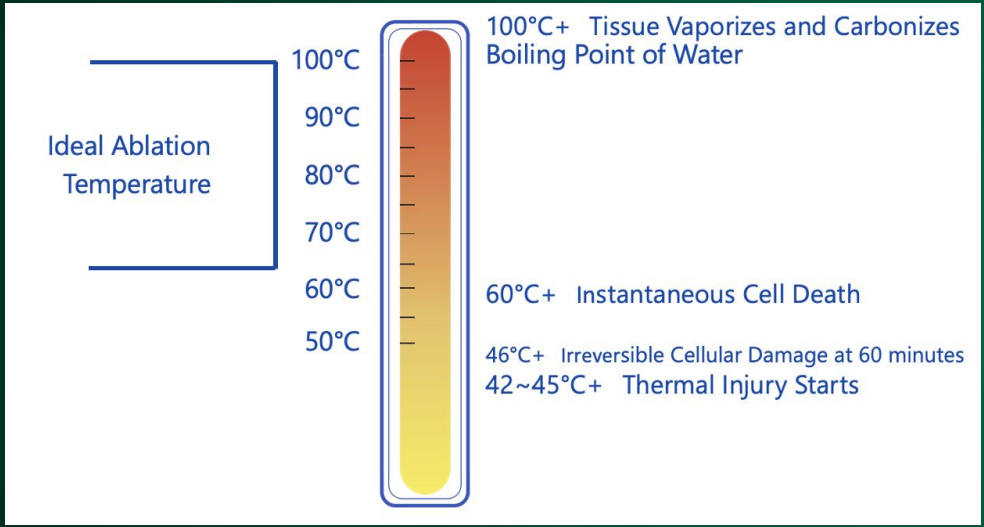


RFA Technology

RFA destroys targeted tissue through a combination of frictional and conduction heat.



RFA Technology



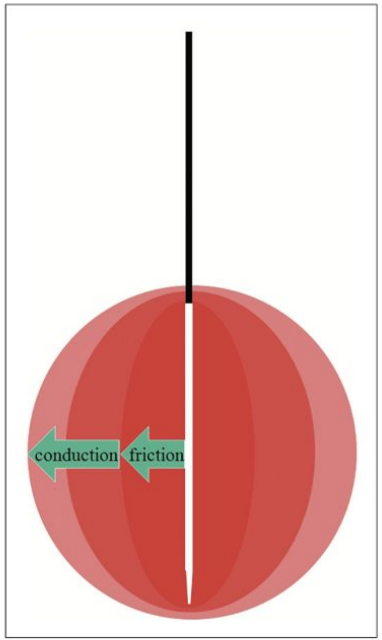
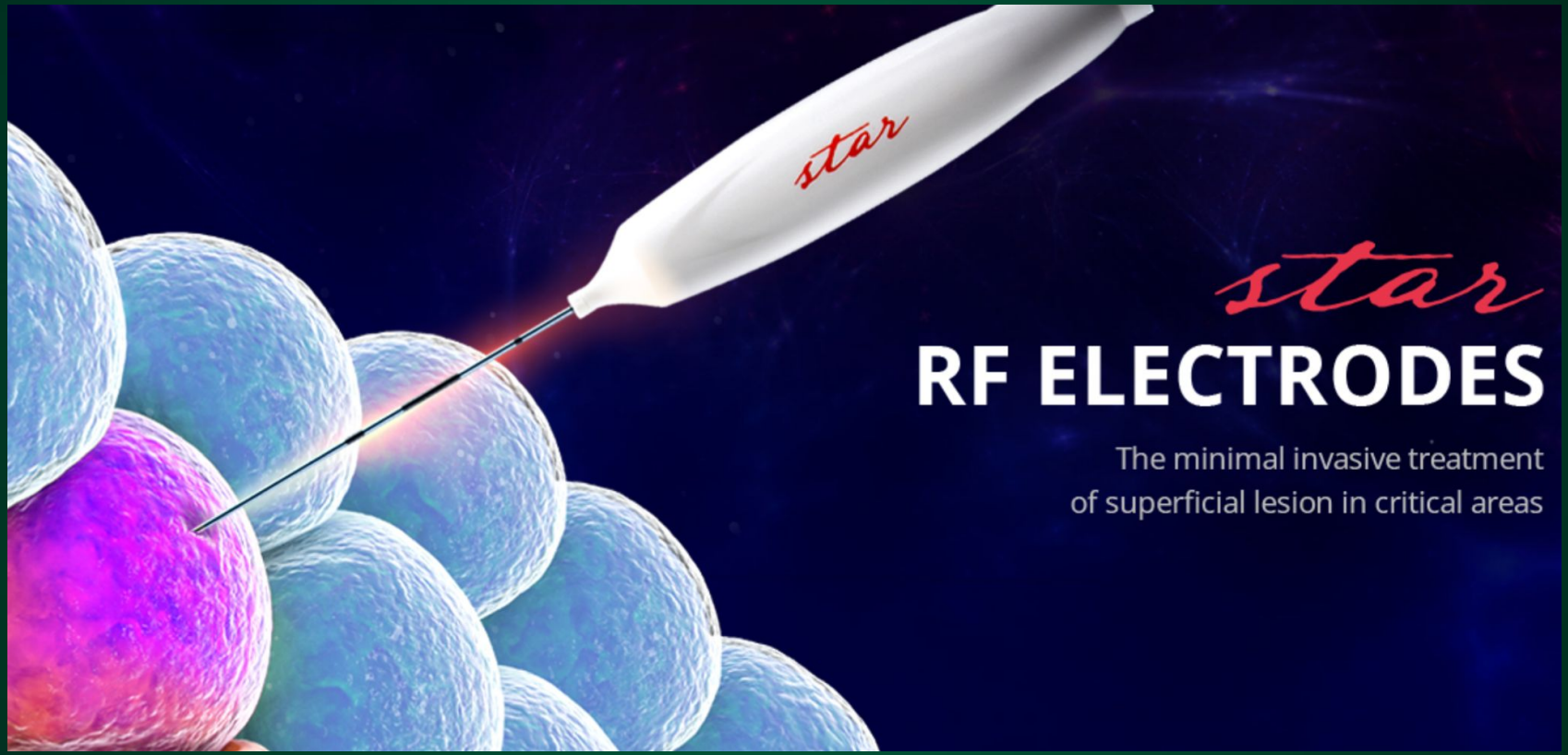


Fig. 2. Heat propagation through target tumor. Immediate tissue coagulation necrosis is achieved by frictional heat generated in vicinity of electrode, but electrode-remote tumor tissue is ablated more slowly, via conductive heat.

Baek et al. Korean J Radiol 12(5), Sep/Oct 2011

UAB MEDICINE



UAB MEDICINE

RFA Setup

UAB MEDICINE

RFA Technique

Ambulatory procedure

Avoid deep sedation, as awake patients can alert the team to pain as a warning of thermal injury

Pericapsular numbing with lidocaine

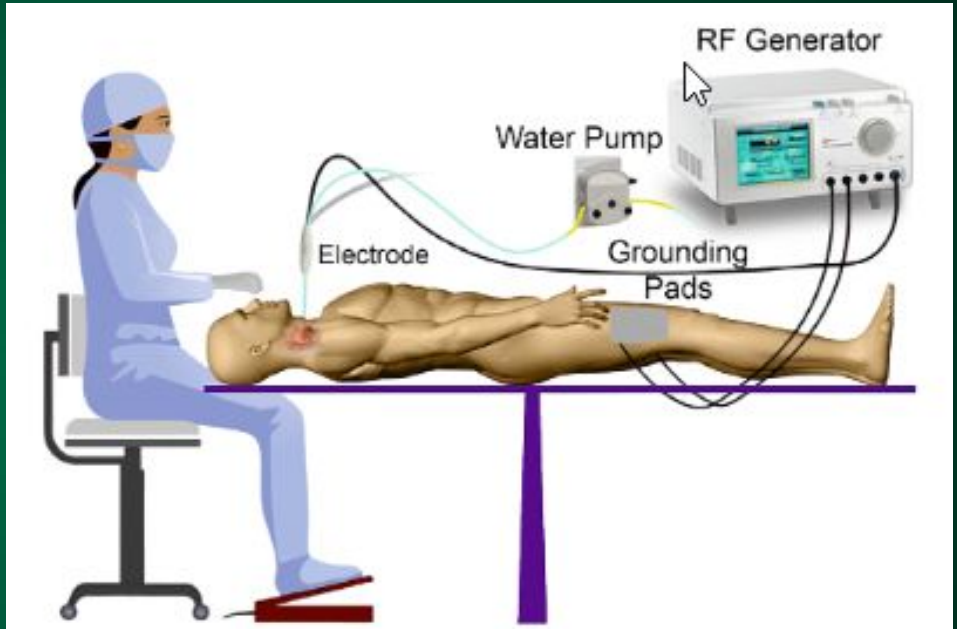


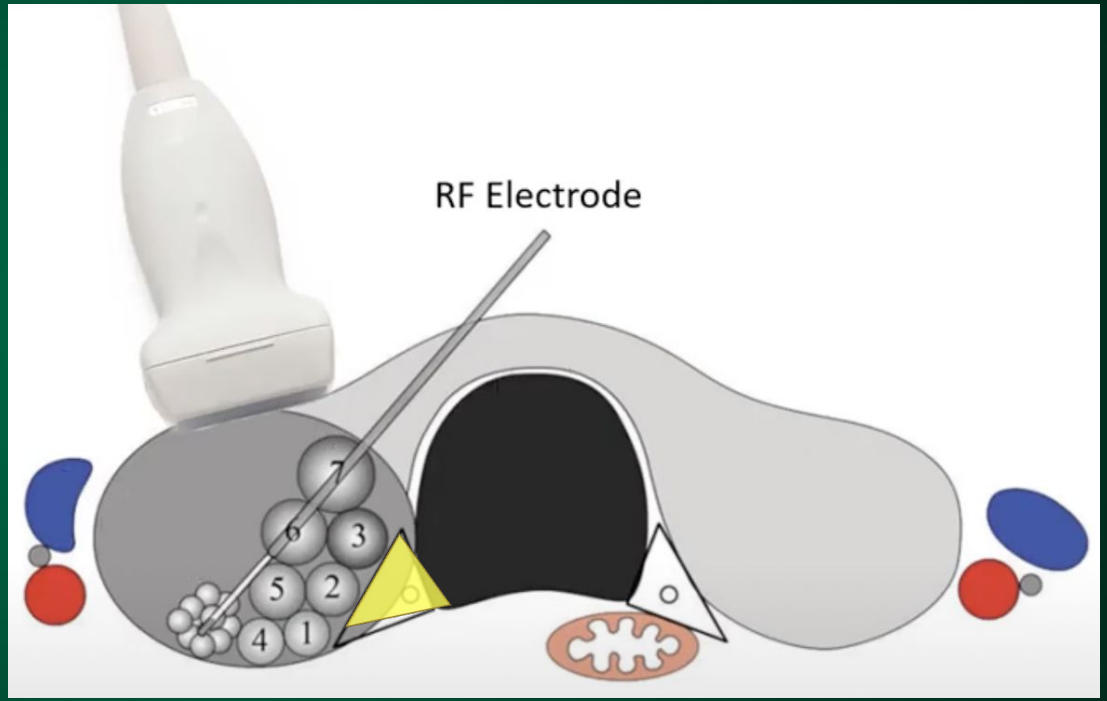
FIGURE 3 Positioning and set up for RFA procedure

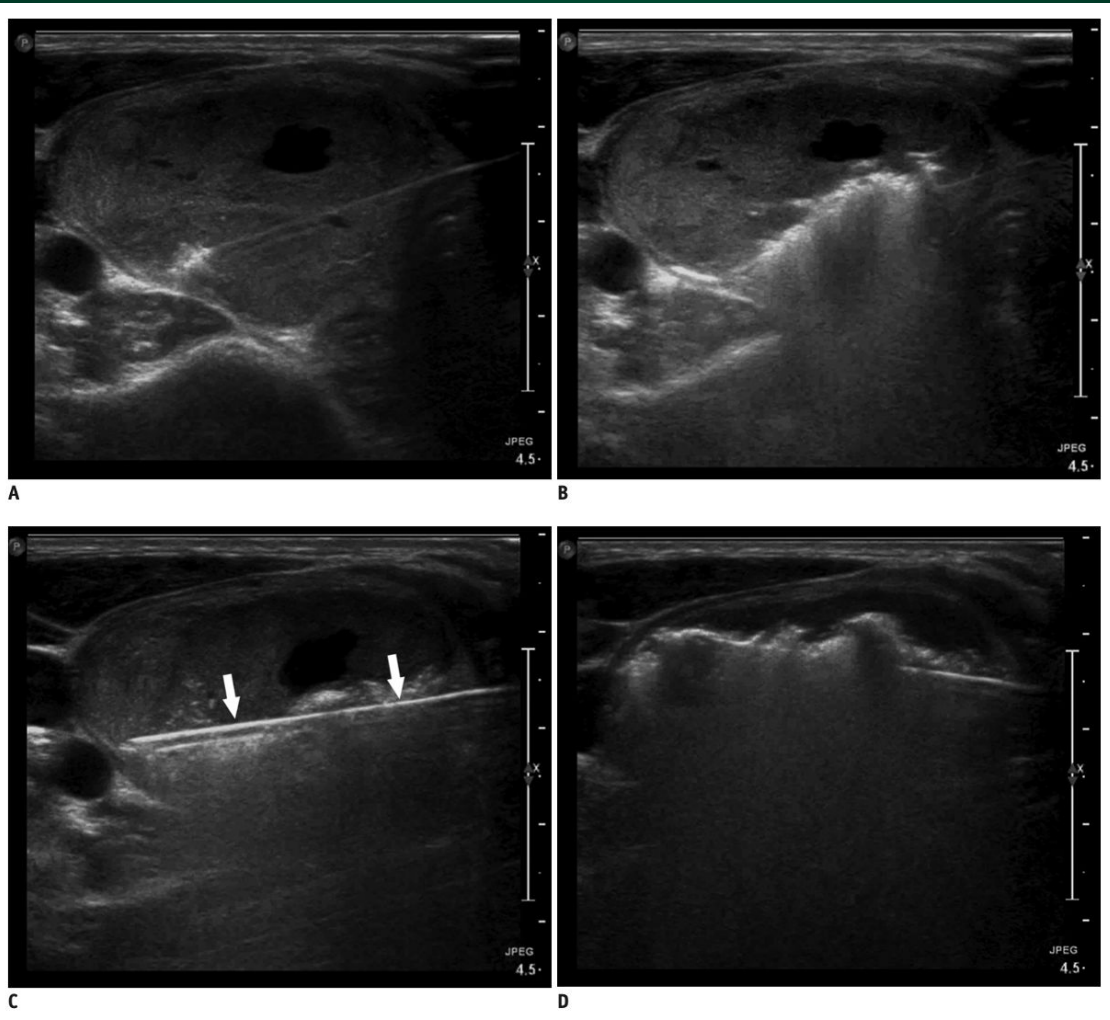
Ultrasonographic Anatomy in Radiofrequency Ablation of the Thyroid

Jared A. Shenson, MD , Lisa A. Orloff, MD, and Julia E. Noel, MD

RFA Technique

- **Trans-isthmus moving shot technique**
- Needle entry through isthmus avoids muscle and vessels, stabilizes electrode
  - Most dangerous to least
  - Improved visualization
  - Avoid the “danger triangle”
  - Trans-isthmus angle helps
  - May leave some nodule behind





UAB MEDICINE

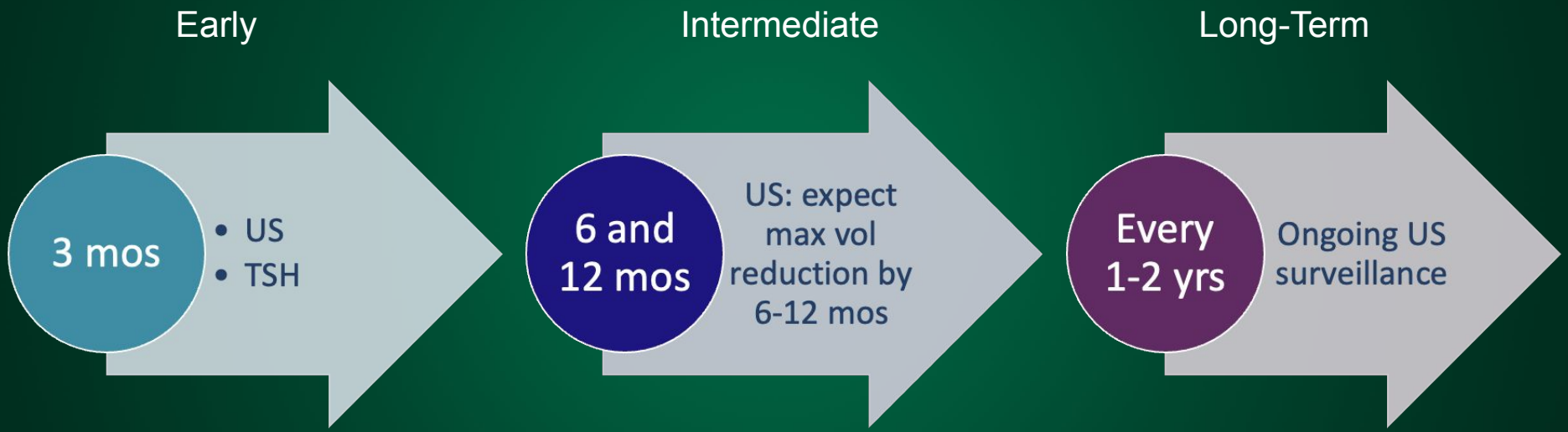

UAB SURGERY

Acute Post Procedure Management

- Ice Pack and Ibuprofen
- Steroids and antibiotics are not indicated
- Some swelling is expected
- Difficulty swallowing, breathing or changes in voice should be admitted for observation

A Pre-procedure B. 2 hours after RFA
C. 48 hours after RFA D. 27 days after RFA

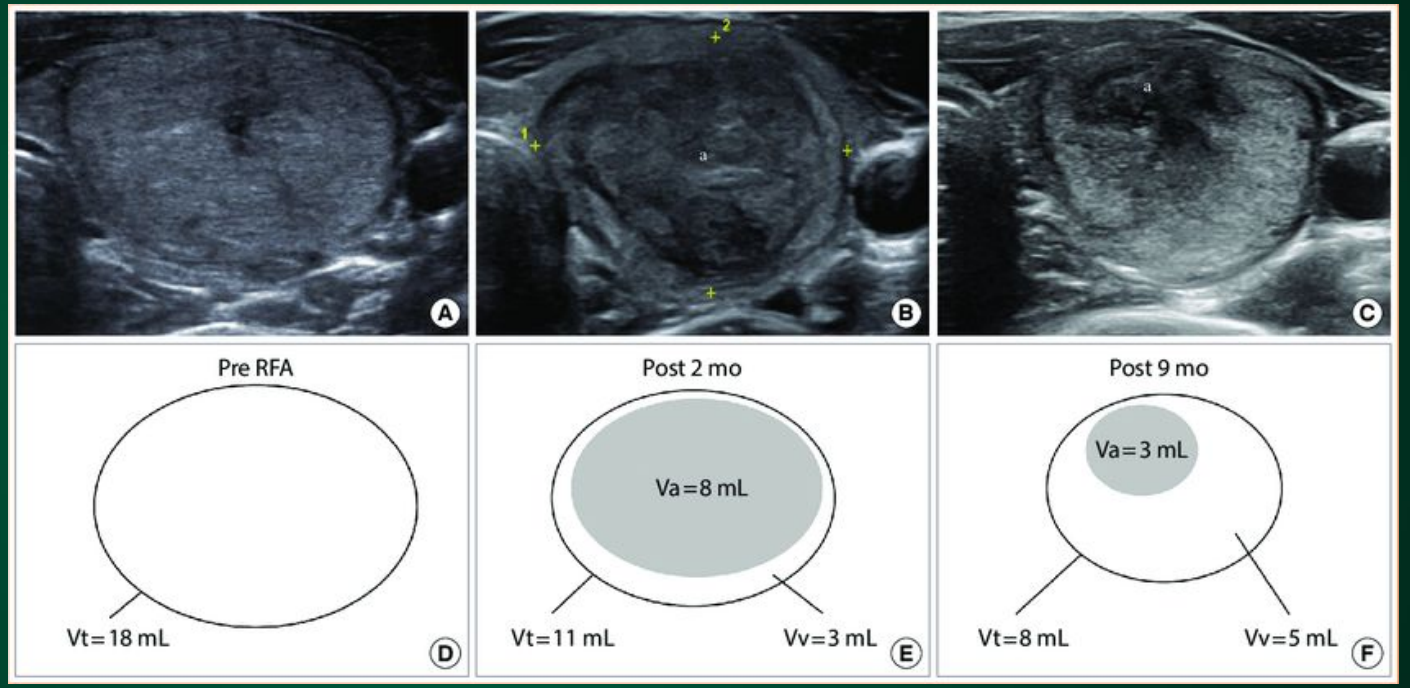
Surveillance



If identify untreated areas or early regrowth⟶ second treatment

Ultrasound after RFA

- Focus on nodule volume AND change in volume from pre-procedure
- No TI-RADS score given but evaluate for signs of aggressiveness
- Changes in blood flow



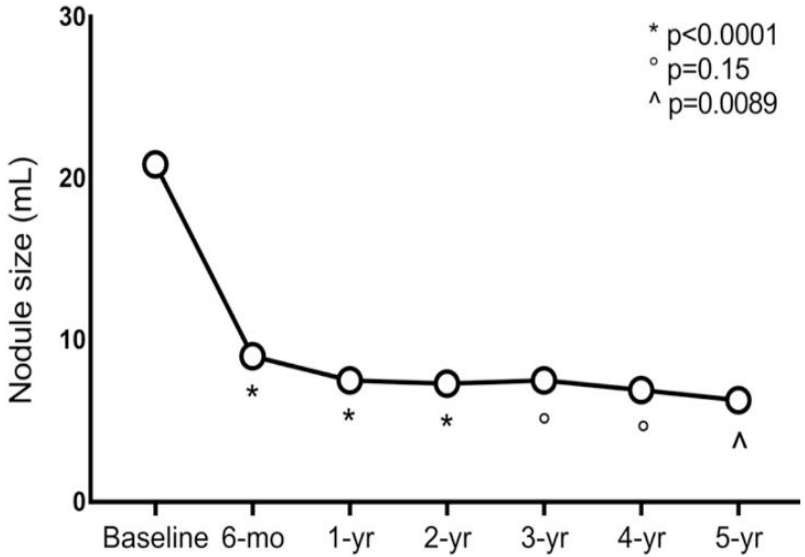
Long-Term Efficacy of a Single Session of RFA for Benign Thyroid Nodules: A Longitudinal 5-Year Observational Study

Maurilio Deandrea,[1] Pierpaolo Trimboli,[2] Francesca Garino,[1] Alberto Mormile,[1] Gabriella Magliona,[1] Maria Josefina Ramunni,[1] Luca Giovanella,[2] and Piero Paolo Limone[1]

N= 215 benign nodules in 215 patients
Followed for at least 3 years

Table 1. Baseline Features of Thyroid Nodules Included in the Study

Feature	Data
Median nodule volume (range), mL	20.9 (15–33)
No. of nodules with median volume < 10 mL	14
No. of nodules with median volume 10–20 mL	82
No. of nodules with median volume > 20 mL	119
Median compressive symptoms score (from 0 to 10) (25%–75% percentile)	5 (2–6)
Median cosmetic score (from 1 to 4) (25%–75%)	3 (2–4)
Median energy delivered (25%–75% percentile), W	55 (50–65)
Median duration of treatment (25%–75% percentile), min	14 (12–19)
Median duration of follow-up after RFA (25%–75% percentile), mo	35 (24–60)



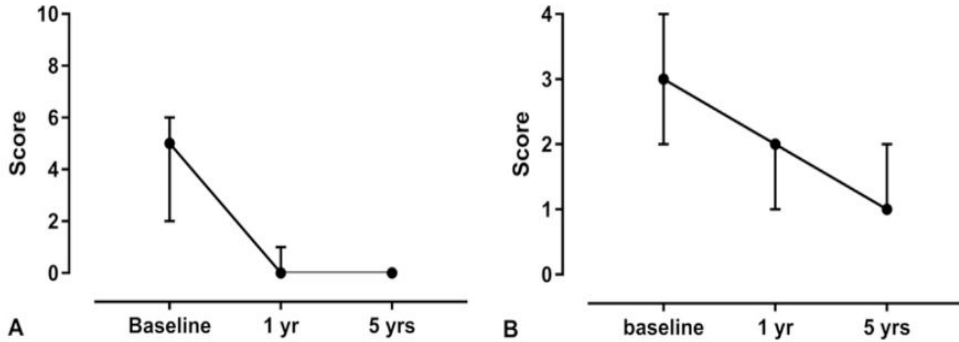


Figure 2. Trend of (A) compressive symptoms and (B) cosmetic disturbances after RFA. Circles represent the median value of the group. Bars represent the interquartile ranges.

Table 2. Percentage of Volume Reduction Recorded for All Nodules According to Baseline Size

Variable	6 mo	1 y	2 y	3 y	4 y	5 y
All nodules	56.2[a]	63[a]	67.4[a]	66.7	66.9	66.9
<10 mL	79[a]	78	76.8	76.8	75	81.8
≥10 and <20 mL	59[a]	66.7[a]	74.2[a]	74.2	70	74.5
≥20 mL	54.5[a]	60.9[a]	62.4[b]	62.4	62	65.3

The rate of reduction was calculated with respect to the baseline volume. All values are expressed as median percentages.

[a] $P < 0.001$ for the comparison of median volume reduction recorded for each time with previous control.

[b] $P < 0.01$ for the comparison of median volume reduction recorded for each time with previous control.

Review > Rev Endocr Metab Disord. 2019 Mar;20(1):37-44. doi: 10.1007/s11154-019-09487-y.

Efficacy of radiofrequency ablation in autonomous functioning thyroid nodules. A systematic review and meta-analysis

Roberto Cesareo [1], Andrea Palermo [2], Domenico Benvenuto [3], Eleonora Cella [3], Valerio Pasqualini [4], Stella Bernardi [5], Fulvio Stacul [6], Silvia Angeletti [7], Giovanni Mauri [8], Massimo Ciccozzi [3], Pierpaolo Trimboli [9]

Table 3 Overall results of the present meta-analysis

Parameter	Pooled effect size (95% CI)	Inconsistency	Egger test (p)
Rate of patients with normalization of TSH (all studies)	57% (40 to 72)	82.6%	0.056
Rate of patients with normalization of TSH (four studies using single session RFA)	61% (40 to 81)	79.1%	0.119
Rate of patients with scintigraphically proven recovery of function	60% (35 to 82)	78.4%	N/A
Volume reduction rate	79% (75 to 83)	87.63%	$p = 0.138$
Mean volume reduction one year after RFA	13 mL (13 to 19)	98%	N/A

Legend. Inconsistency above 50% indicates the presence of a significant heterogeneity between the studies. Significant Egger test indicates the presence of publication bias (this test cannot be performed for pooled data of less than four series

Benefits	Drawbacks
Percutaneous – no incision ★	Decreased volume, but nodule remains. No definitive diagnosis/**possibility of missing a cancer** ⊘
Preserves surrounding thyroid tissue, maintains thyroid function ★	May require multiple treatments; only one nodule (or at most one side) at a time *generally not best option for large MNG
Ambulatory – minimal recovery	Long-term surveillance required
	Reimbursement currently challenging (no CPT code yet) ⊘

Multicenter Study > Radiology. 2012 Jan;262(1):335-42. doi: 10.1148/radiol.11110416. Epub 2011 Oct 13.

Complications encountered in the treatment of benign thyroid nodules with US-guided radiofrequency ablation: a multicenter study

Jung Hwan Baek [1], Jeong Hyun Lee, Jin Yong Sung, Jae-Ik Bae, Kyung Tae Kim, Jungsuk Sim, Seon Mi Baek, Young-sun Kim, Jung Hee Shin, Jeong Seon Park, Dong Wook Kim, Ji-hoon Kim, Eun-Kyung Kim, So Lyung Jung, Dong Gyu Na, Korean Society of Thyroid Radiology

Table 2

Complications and Side Effects in 1459 Patients Who Underwent RF Ablation of Thyroid Nodules

Complication or Side Effect	No. of Complications	Time of Detection (d)	Time to Recovery (d)
Major	20 (1.4)	1–180	1–90
Voice change	15 (1.02)	1–2	1–90
Nodule rupture	2 (0.14)	22–30	<30
Nodule rupture with abscess formation*	1 (0.07)	50	None
Hypothyroidism*	1 (0.07)	180	None
Brachial plexus injury	1 (0.07)	1	60
Minor	28 (1.92)	1–2	1–30
Hematoma	15 (1.02)	1	<30
Vomiting	9 (0.62)	1–2	1–2
Skin burn	4 (0.27)	1	<7
Side effect	46 (3.15)	1	1–2
Pain	38 (2.6)	1	1–2
Vasovagal reaction	5 (0.34)	1	1
Coughing	3 (0.21)	1	1

Note.—Number in parentheses is percentage of complications per total patients.

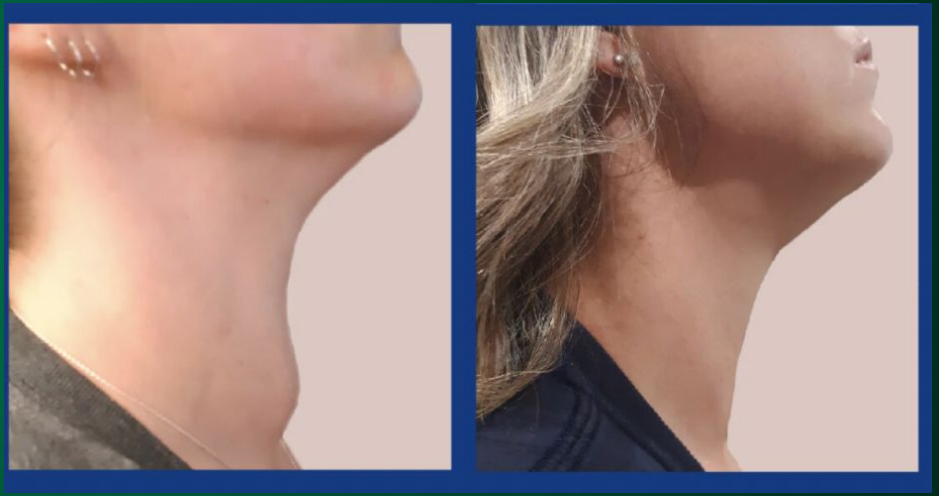
* Complications with remaining sequela.

Scarless Technique

RFA-**Elimination of a neck scar**

Patients at high risk for keloid or hypertrophic scarring -particularly strong indication

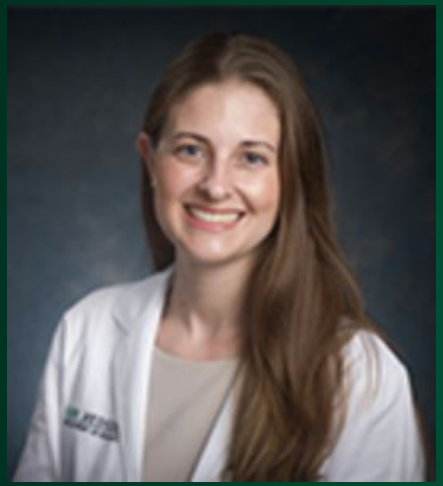
But **all (applicable) patients** stand to benefit from the absence of a scar visible in daily life



Take Home Points

- RFA is a valuable tool for treating thyroid nodules
- Outpatient procedure done under light sedation with scarless technique
- Does not eliminate the nodule therefore needs appropriate workup and follow up
- UAB is only group in the state of AL and only onen of 7 providers in the Southeast offering RFA.

More About the Team



Dr. Erin Buczek
epartington@uabmc.edu
(919) 308-5918 (cell)
@erin_buczek

To Schedule:
205-801-7801

Dr. Jessica Fazendin
jmfazendin@uabmc.edu
262.402.8448 (cell)
@JFazendinMD

To Schedule:
205-934-1211

Thank you!