MICROWAVE ABLATION: A Safe and EffectiveTreatment for Large (≥3 cm) Benign Thyroid Nodules

A. Prof. PhD. Dr Huynh Quang Khanh

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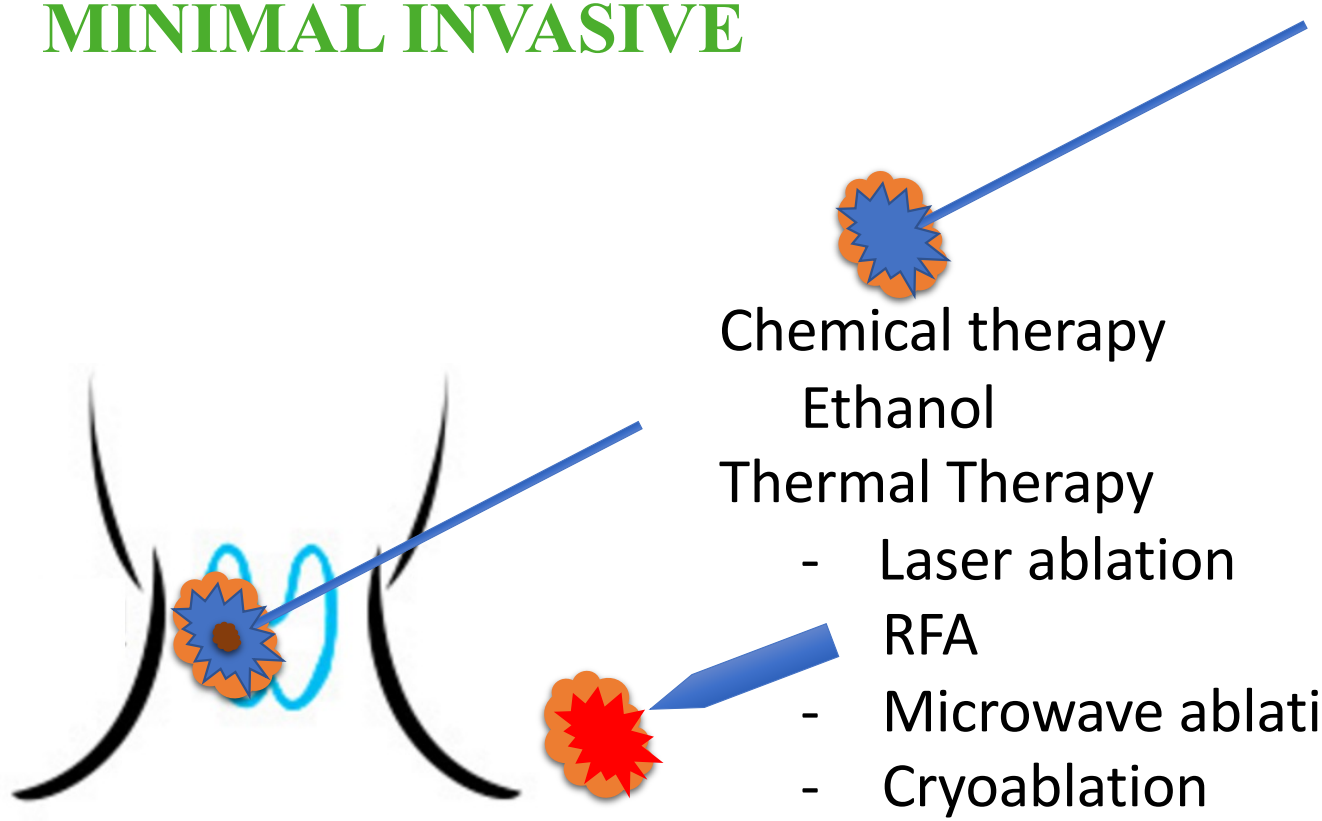
MINIMAL INVASIVE



Chemical therapy

Ethanol

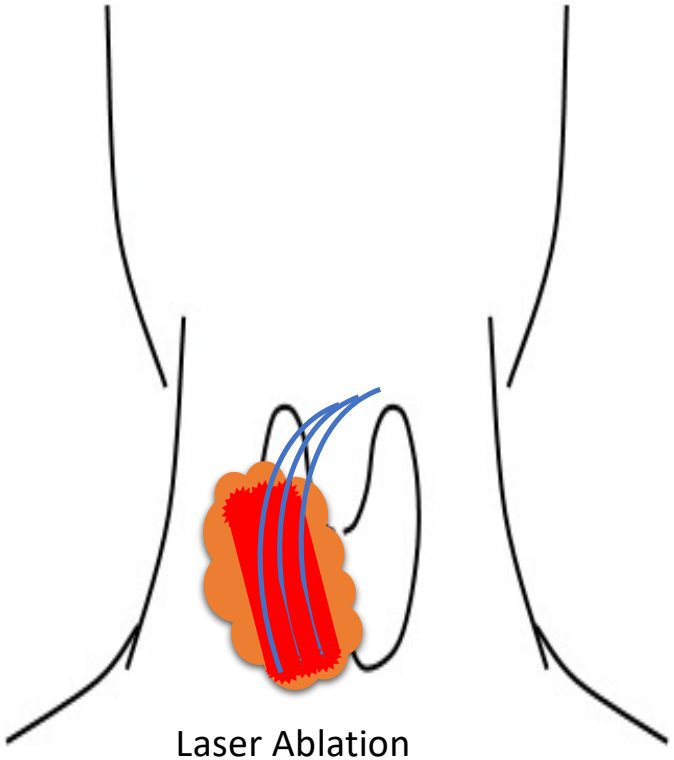
Thermal Therapy

- Laser ablation
- RFA
- Microwave ablation
- Cryoablation
- HIFU: ECHOPULS

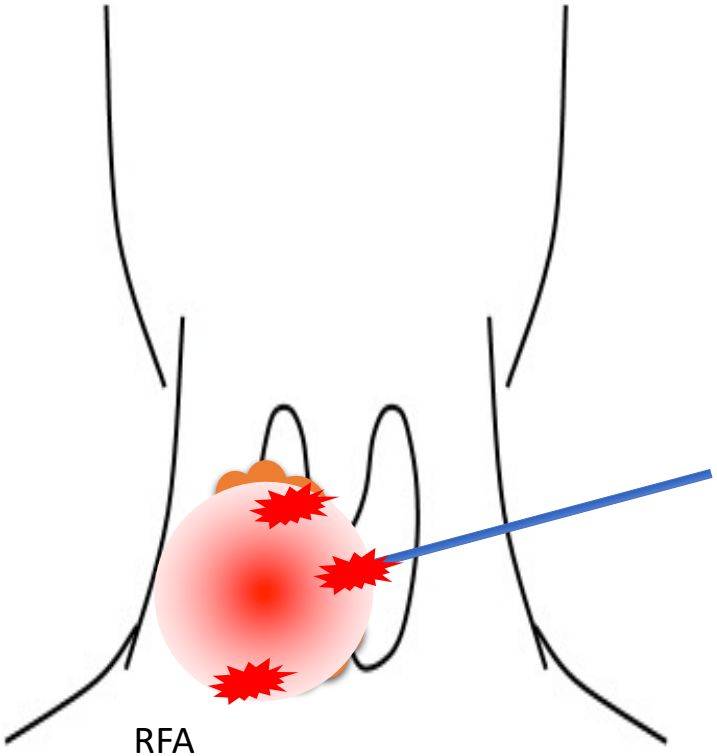
Ethanol Therapy

- Since 1990s, European, especially Italy
- 96% ethanol, which was injected slowly into the cyst
- Percutaneous ethanol injection therapy as the first line of treatment of symptomatic thyroid cysts
- Limitations in solid tumor or large tumor

Limitations



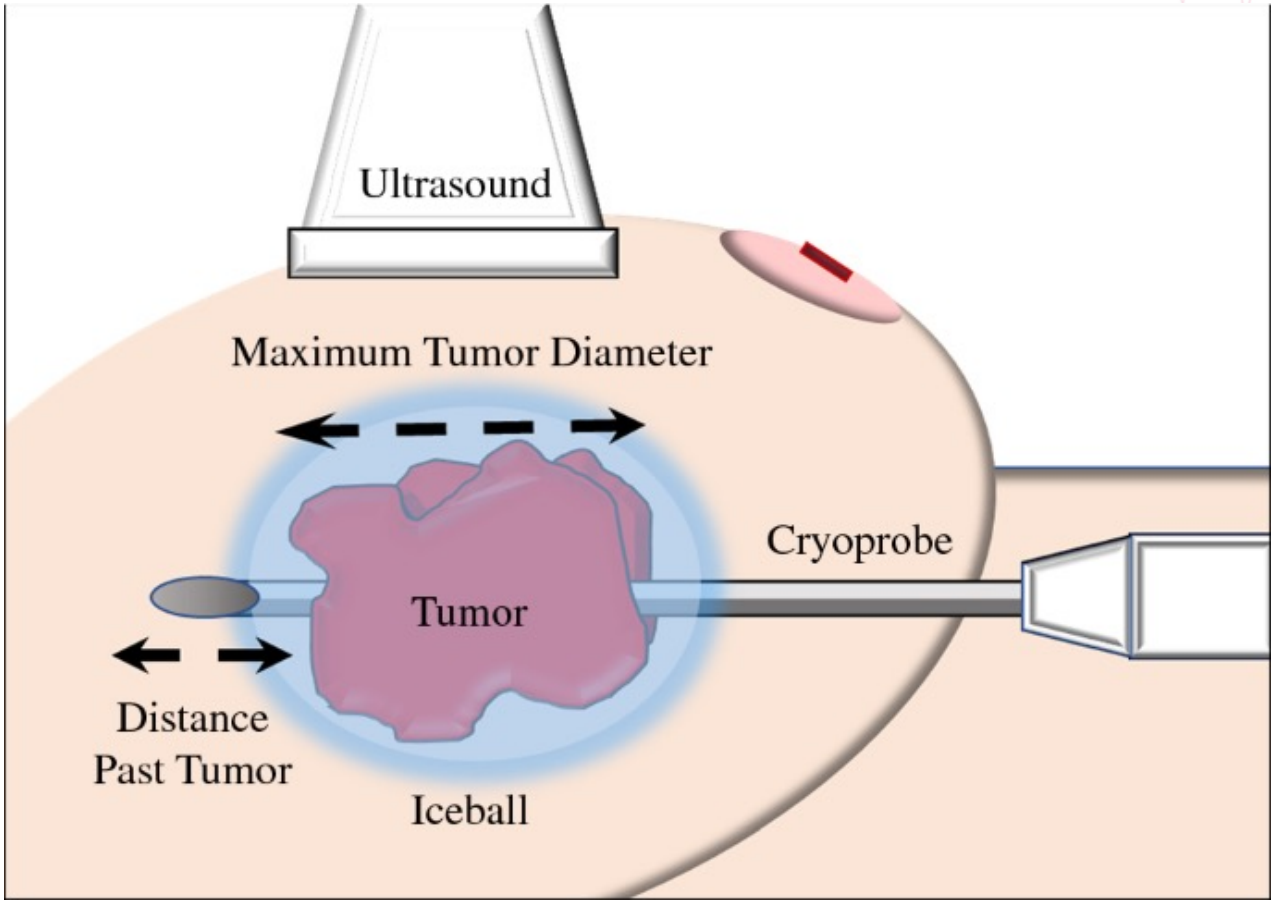
Laser Ablation
Pull back tenique
Incomplete treatment



RFA
Moving shot tenique
Complications

Limitations

If the tumor is larger than 2cm, you will need multiple probe placements.



Sonia Y. Khan BS, The Role of Cryoablation in Breast Cancer Beyond the Oncologic Control: COST and Breast-Q Patient-Reported Outcomes Annals of Surgical Oncology volume 30, pages1029–1037 (2023)

HIFU- ECHOPULS

Echopulse: non-invasive tumors treatment by ultrasound

Fundamentals of thermal ablation

Thyroid MW Ablation

classical hyperthermia 42 ° -45 ° C

Protein denaturation from 40 ° C

cytotoxic effect of exposure to heat 1

irreversible coagulation necrosis of 60 ° -100 ° C

Thermoablation of tumors> 100 ° C

Gas formation (vaporization) and charring (carbonization) of the fabric> 150 ° C

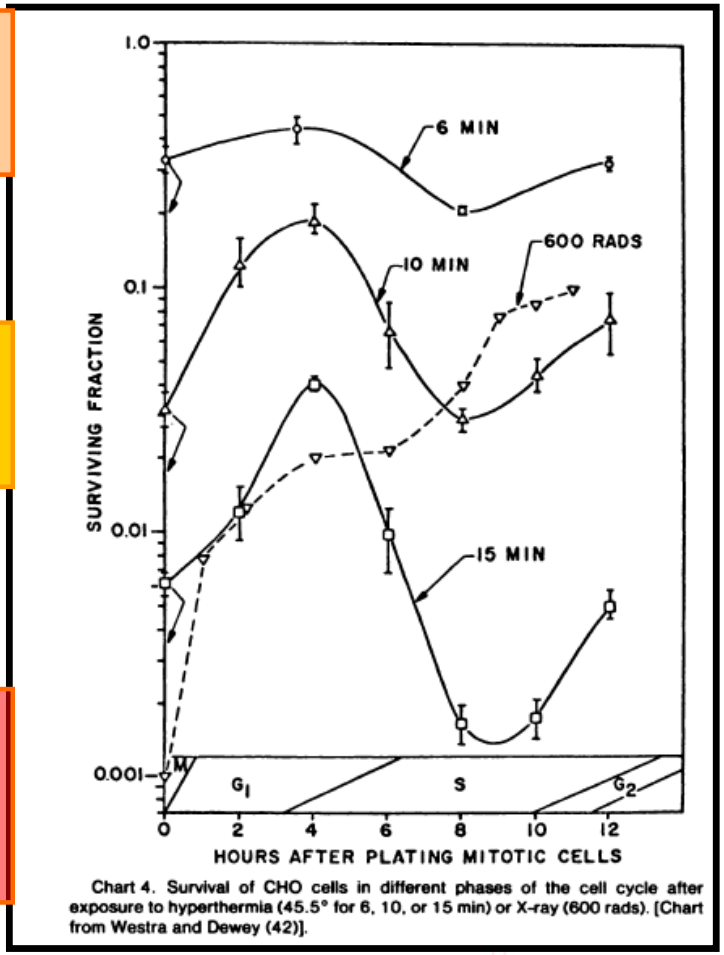


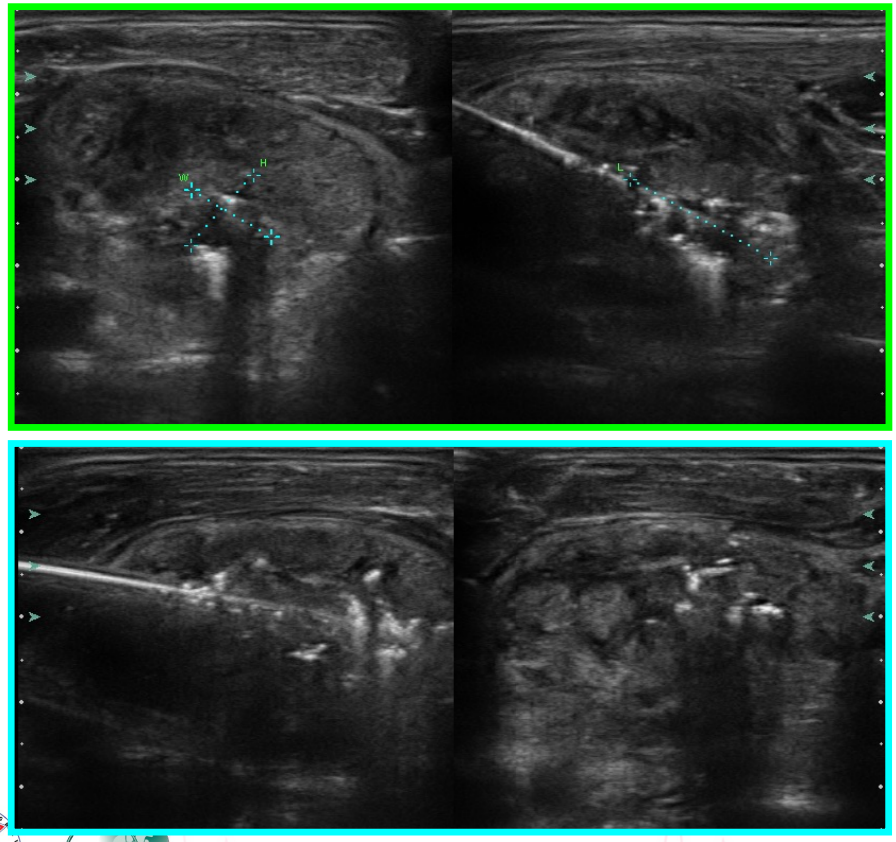
Chart 4. Survival of CHO cells in different phases of the cell cycle after exposure to hyperthermia (45.5° for 6, 10, or 15 min) or X-ray (600 rads). [Chart from Westra and Dewey (42)].

[1] *Bhuyan BK. Kinetics of cell kill by hyperthermia. Cancer research 1979;39:2277-2284*

Performing microwave ablation

Thyroid MW Ablation

a skin incision (2-3 mm) - a branch canal

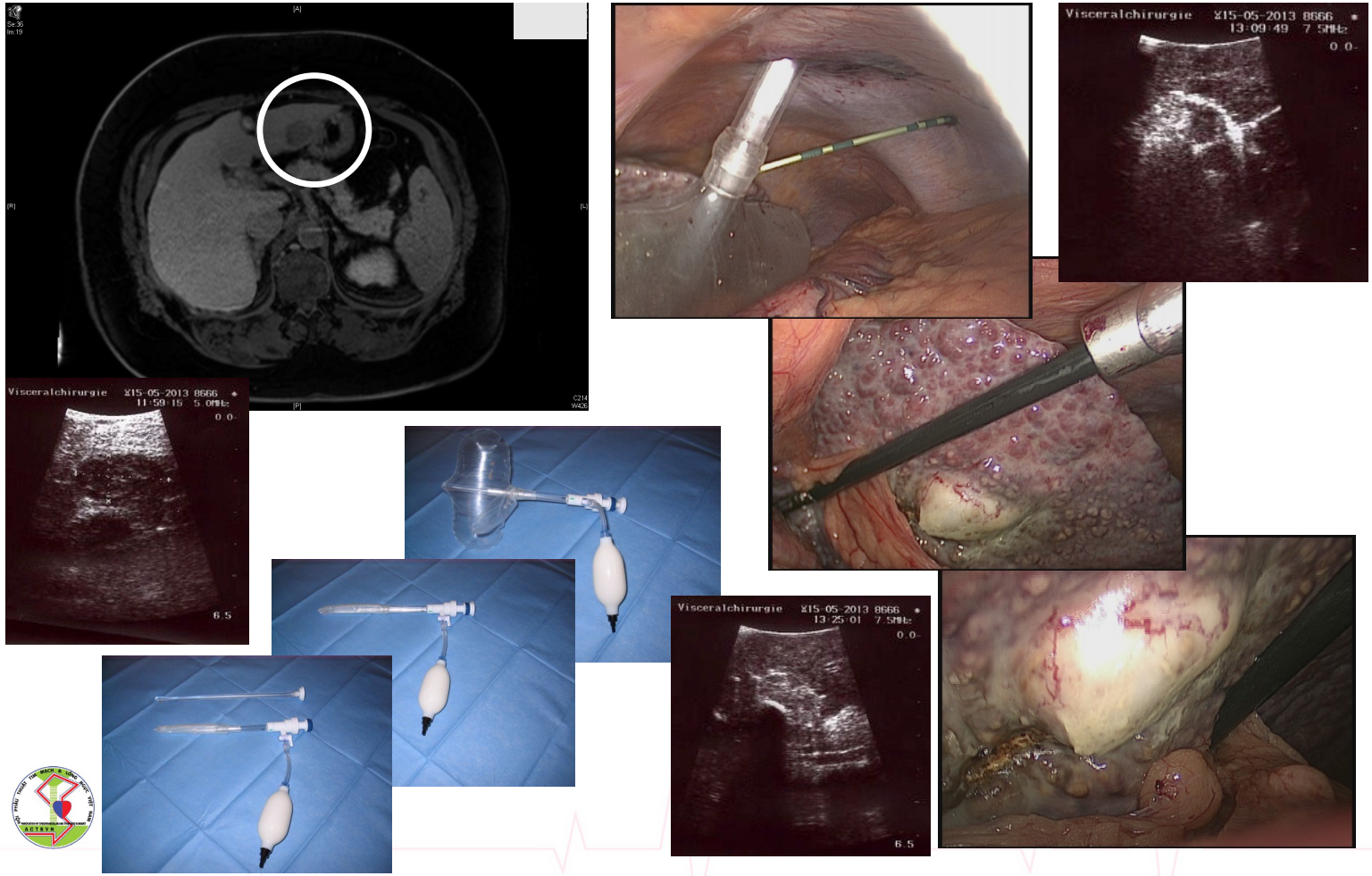


"single shot"

Re-Positionierung the MWA-antenna

"multi shot"

Hepatic ablation: difficult localization



Pulmonary Micro-wave ablation

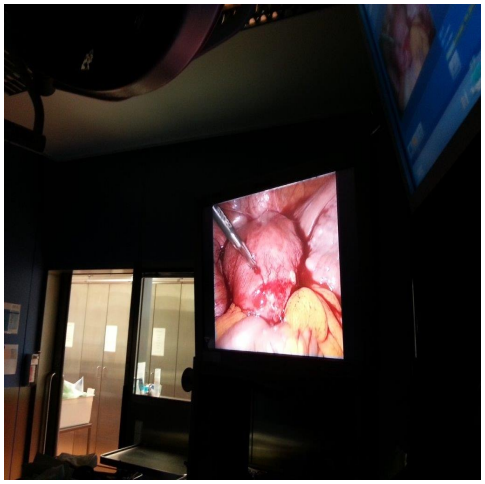
Lung tuomor *ablation:*

- *CT guidance*
- *Thoracoscopic*

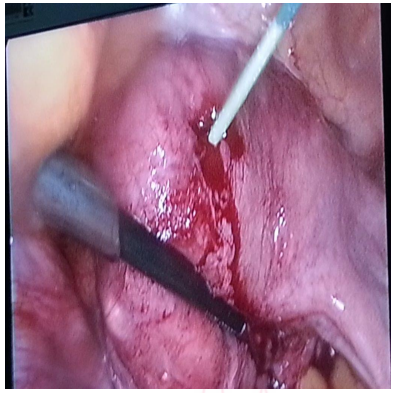
Microwave Ablation

MW of uterine myoma

Laparoscopic procedure, also transcervical access described, but risk of thermal injury for abdominal organs



Ablation under ultrasound control; sonography may be performed laparoscopically or transvaginally



Kanapka et al., J Obstet Gynecol Res (2009) 35:717-

www.impactjournals.com/oncotarget/ Oncotarget, 2017, Vol. 8, (No. 45), pp: 79376-7938

Clinical Research Pap

Ultrasound guided percutaneous microwave ablation of benign breast lesions

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Keywords: breast, benign, microwave ablation, ultrasound, volume reduction

Received: *January 05, 2017* **Accepted:** *April 12, 2017* **Published:** *May 23, 2017*

ABSTRACT

The benign breast lesions (BBLs) share a high incidence for women and therapy methods with minimal invasion and better cosmetic outcome are thirsted for. In this study, 122 patients with 198 biopsy-proved BBLs were enrolled. Ultrasound (US)-guided microwave ablation (MWA) was performed with local anesthesia from November, 2013 to April, 2016. The mean longest tumor size assessed was 1.6±0.7 cm (ranging 0.7-4.9 cm). MWA was successfully performed in all cases including 85 lesions adjacent to the skin, pectoralis and areola. The mean ablation time was 3.2mins (ranging 0.5-18.3 mins). 99.5% of BBLs showed complete ablation when assessed by magnetic resonance imaging and 100% of them by US. At the median 14-month follow-up, the BBLs were not palpable in 45.9 % of the cases (palpable in 90.2 % of the cases before MWA) and the mean volume reduction ratio was 78.4±33.5% for total lesions and 89.3±20.8%, 84.7±27.6% and 55.9±32.9% for ≤1.0 cm, 1.1-2.0cm and >2.0 cm lesions in 12-month follow-up, respectively. Cosmesis were reported as good or excellent in 100 % by physician and patients. No side effect was found. The MWA of the BBLs proved feasible and effective, while showing meaningful reduction in volume, palpability and cosmetic satisfying outcomes.

Eur Radiol (2008) 18: 1431–1441
DOI 10.1007/s00330-008-0906-0

INTERVENTIONAL

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Image-guided focused ultrasound ablation of breast cancer: current status, challenges, and future directions

Received: 26 September 2007
Revised: 4 December 2007
Accepted: 15 January 2008
Published online: 20 March 2008

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to 100%, depending on FUS system type, imaging technique, ablation protocol, and patient selection. Specific issues related to FUS ablation of breast cancer, such as increased treatment time for larger tumours, size of

BREAST MICROWAVE ABLATION

World Journal of Surgery and Surgical Research

Research Article
Published: 11 Apr, 2020

Microwave Ablation of Benign Breast Lesions: An Initial Study

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Abstract

Background: To evaluate the safety and efficiency of Microwave Ablation (MWA) in the treatment of benign breast tumors and cysts.

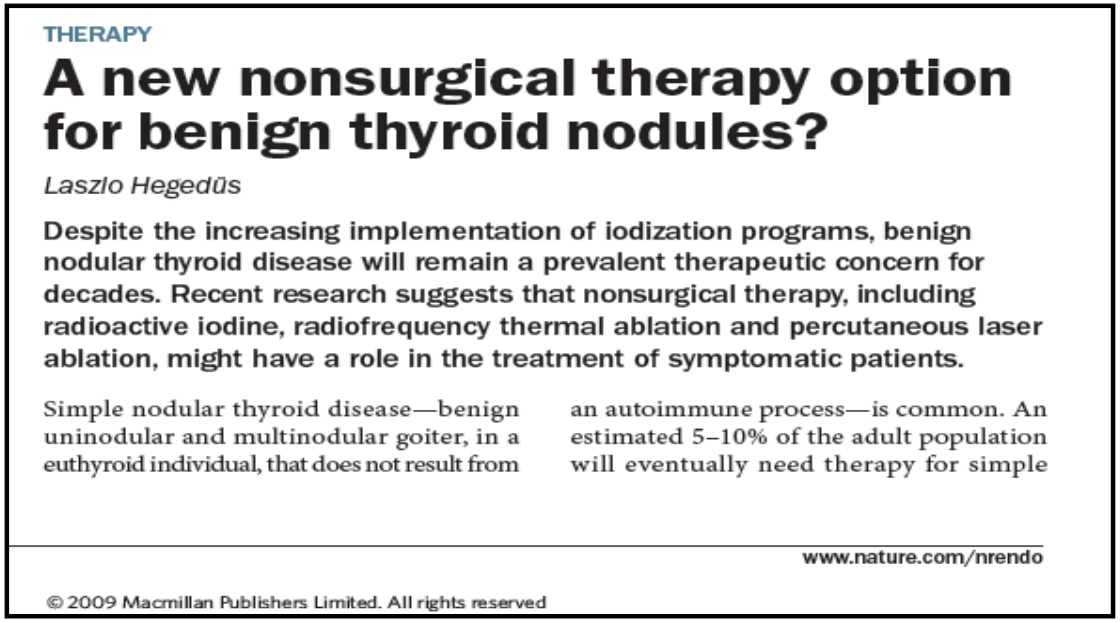
Methods: 41 patients with a total of 64 benign breast tumors and cysts underwent MWA. Patients were followed up from August 2018 to September 2019.

Results: The average diameter of these lesions was 2.8 ± 0.6 cm (1.5 cm to 4.0 cm). MWA was performed with the medium 2.4 min (0.5 min to 7.5 min). Outcome of MWA treatment which was check by ultrasound imaging revealed that 100% of cystic lesions and 85% of tumor lesions were complete response, 15% of benign tumors were partial response during monitoring. And 100% of patients rated excellent about post-ablative aesthetics. There was no side effect, relapse or malignancy during follow-up.

Conclusion: This study shows that the application of MWA to benign breast tumors and cysts is feasible and highly efficient. Symptoms and size of lesions are significantly reduced after treatment. At the same time, fast resilience and aesthetic are guaranteed.

Keywords: Benign breast lesions; Breast tumors and cysts; Microwave ablation

Thermoablation of thyroid nodules



THERAPY

A new nonsurgical therapy option for benign thyroid nodules?

Laszlo Hegedüs

Despite the increasing implementation of iodization programs, benign nodular thyroid disease will remain a prevalent therapeutic concern for decades. Recent research suggests that nonsurgical therapy, including radioactive iodine, radiofrequency thermal ablation and percutaneous laser ablation, might have a role in the treatment of symptomatic patients.

Simple nodular thyroid disease—benign uninodular and multinodular goiter, in a euthyroid individual, that does not result from an autoimmune process—is common. An estimated 5–10% of the adult population will eventually need therapy for simple

www.nature.com/nrendo

Indication[5,6,7]:

- in benign and malignant thyroid nodules
- when the standard therapy (surgery or Radiojodidtherapie in benign nodes) promises no success or is too risky

Contraindication[5,6,7] :

- Node> greater than 5 cm in diameter
- critical situation have (vessels, nerves, trachea, esophagus)

[5] Thyroid nodules and related symptoms are stably controlled two years after radiofrequency thermal ablation. Spiezia S et al Thyroid. 2009 Mar;19(3):219-25
[6] A new nonsurgical therapy option for benign thyroid nodules? Laszlo Hegedüs nature reviews endocrinology volume 5 september 2009
[7] Inoperable symptomatic recurrent thyroid cancers: preliminary result of radiofrequency ablation. Park KW et al Ann Surg Oncol. 2011 Sep;18(9):2564-8

Thyroid MW Ablation

Guidelines of the American Association of clinical endocrinologists, American college of endocrinology, and associazione medici endocrinologi: Medical guidelines for clinical practice for the diagnosis and management of thyroid nodules – 2016 update

Altogether, the procedures described above may offer a less expensive and less invasive alternative to thyroid surgery, without the risks of subsequent cutaneous scar or hypothyroidism, for patients with steadily growing benign thyroid nodules who warrant treatment for cosmetic reasons or local symptoms.

Gharib et al., Endocrin Practice (2016) 22(Suppl 1):1-60

Indication

- Confirmed benignity
  : only for Bethesda II
  - 2 or more benign cytology/biopsy results
  - No malignant feature in US image
  - Calcitonin (-)
- Symptomatic
  : don’t do for asymptomatic pt.
  - Pain
  - Foreign body sense
  - Cosmetic problem

Radiofrequency ablation of benign thyroid nodules and recurrent thyroid cancers: consensus statement and recommendations.
- *Korean J Radiol. 2012 Mar*

Checking Clinical Condition

- Symptom Score
  - 10 point scale
- Cosmetic Score

  1: not palpable

  2: palpable but not visible

  3: visible when neck extension

  4: visible

European
Thyroid Journal

Guidelines

Eur Thyroid J 2021;10:185–197
DOI: 10.1159/000516469

Received: 03 23, 2021
Accepted: 04 10, 2021
Published online: May 25, 2021

European Thyroid Association and Cardiovascular and Interventional Radiological Society of Europe 2021 Clinical Practice Guideline for the Use of Minimally Invasive Treatments in Malignant Thyroid Lesions

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World J Surg (2020) 44:2272–2279
https://doi.org/10.1007/s00268-020-05432-2

ORIGINAL SCIENTIFIC REPORT

Efficacy of Microwave Ablation in the Treatment of Large (≥3 cm) Benign Thyroid Nodules

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Published online: 25 February 2020

Abstract

Background Large (≥3 cm) benign thyroid nodules usually cause clinical symptoms or cosmetic concerns and therefore require treatment. Microwave ablation (MWA) is a potential valid non-surgical treatment alternative, but there is a lack of evidence. Thus, this study is to evaluate the safety and efficacy of MWA in the treatment of large benign thyroid nodules.

Methods A retrospective study was conducted on 42 large benign thyroid nodules in 40 patients treated with MWA. We used the trans-isthmic approach and moving-shot technique to perform the procedure under ultrasound (US) guidance. Patients were followed by clinical and US examinations at 1, 3, 6, and 12 months after the MWA. Study outcomes were complications, volume reduction ratio (VRR), symptom and cosmetic scores, and the requirement of multiple MWA sessions.

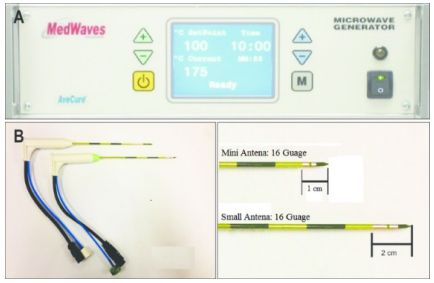
The inclusion criteria were:

(1) Benign thyroid nodule(s) proven by two separate US-guided fine-needle aspiration (US-FNA) biopsies;

(2) The largest diameter of the nodule was ≥ 3 cm;

(3) The presence of clinical symptoms (e.g., pain, compressive symptoms, neck discomfort, or foreign body sensation), anxiety about malignant transformation, or cosmetic concerns.

How I do it: thyroid ablation



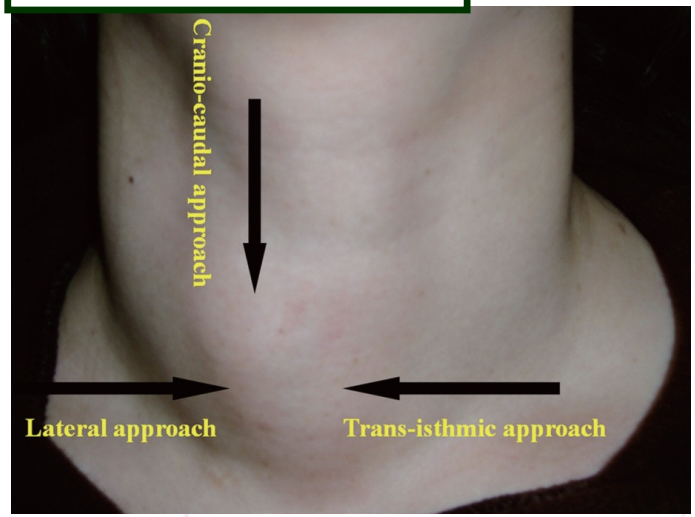
Firstly, we used 10 ml of 1% lidocaine to perform local anesthesia at the puncture site and to dissect the thyroid and subcutaneous tissues.

Approach

- Small antennas are often used for lesions larger than 2 cm, and mini antennas for lesions smaller than 2 cm.
- An uncooled 16-gauge MWA antenna was percutaneously inserted to the center of the nodule through a low-thermal-conductivity core guide under US monitoring.
- We used the "trans-isthmic approach" to insert the antenna to minimize the risk of injury to the recurrent laryngeal nerve,

MedWaves Antennen MW Feldgröße

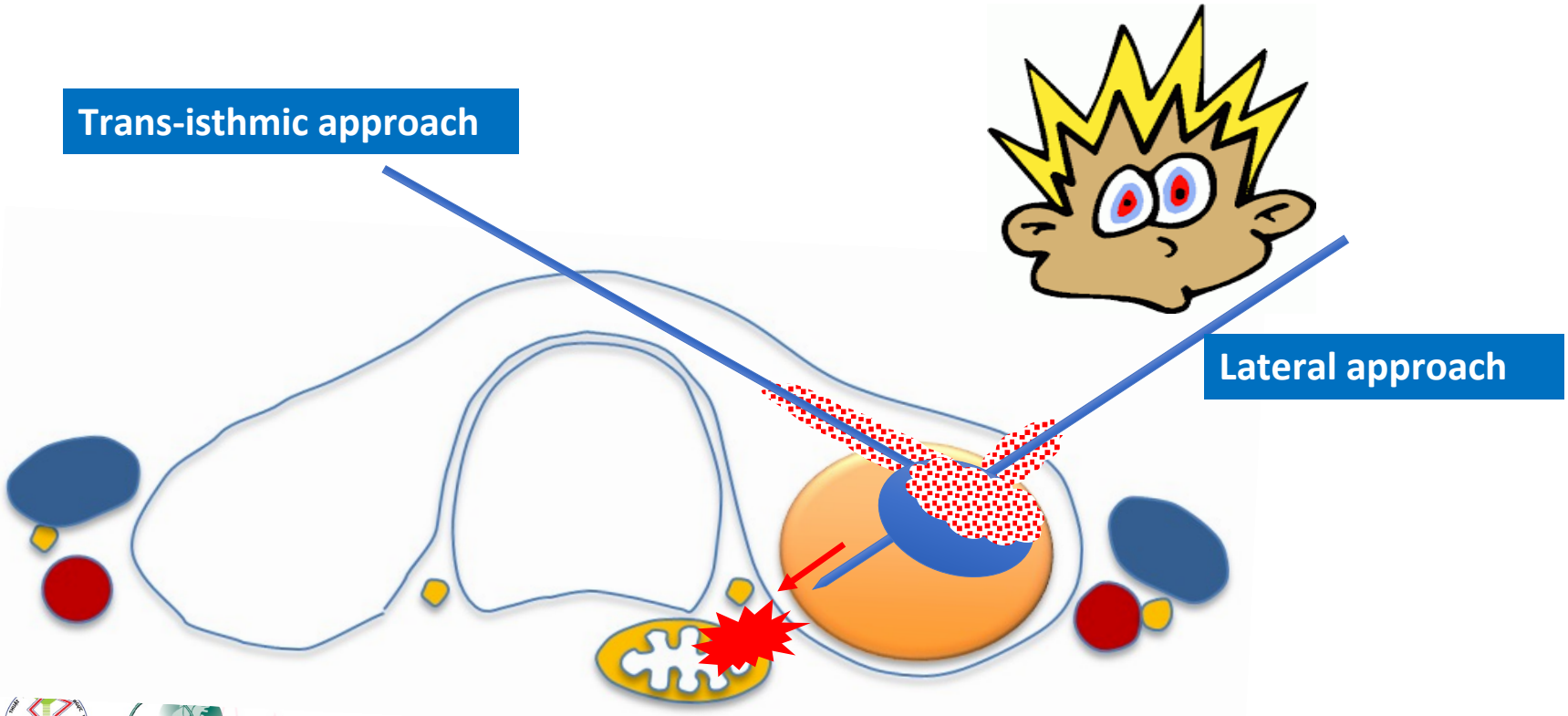
Antennen Typen	MW Antennen Feld Größe	Ablation Querachse Max	Ablation Längsachse Max	Mode Zeit
Large	4 cm	4,8 cm	5,8 cm	Temperatur oder Power 15 Minuten
Small	2 cm	2.8 cm	3,2 cm	Power 5 Minuten
Mini	1 cm	1.2 cm	1.3 cm	Power 3 Minuten



How I do it: Thyroid nodules ablation
microwave energy selection

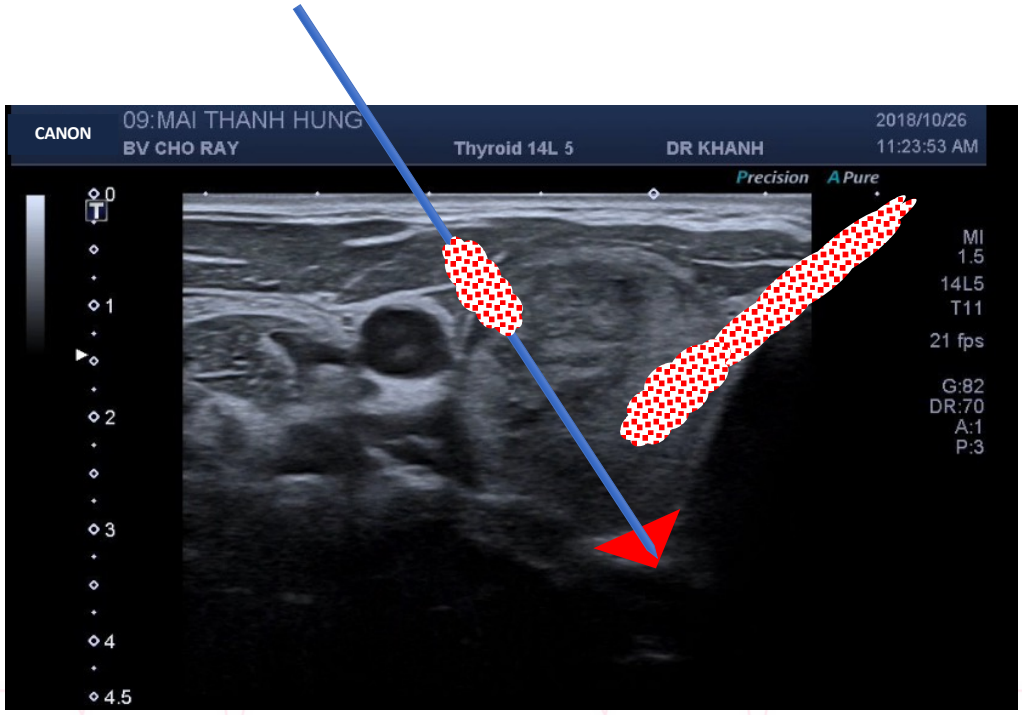
- Ablation temperature should be around 60ºC to 100ºC.
- However, due to thermal conductivity, if the target temperature is too high, skin burn (at the puncture site) will occur easier and sooner.
- In contrast, the ablation time will be longer if the target temperature is too low.
- In this study, we set the target temperature at 70ºC to destroy tumor cells completely and avoid skin burns.

Trans-Isthmic Approach

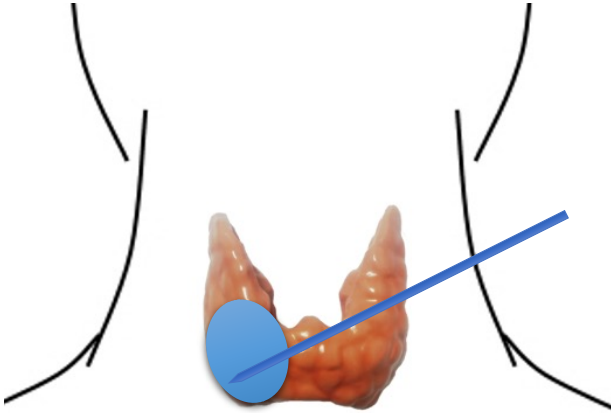


Trans- isthmic approach: Advantage

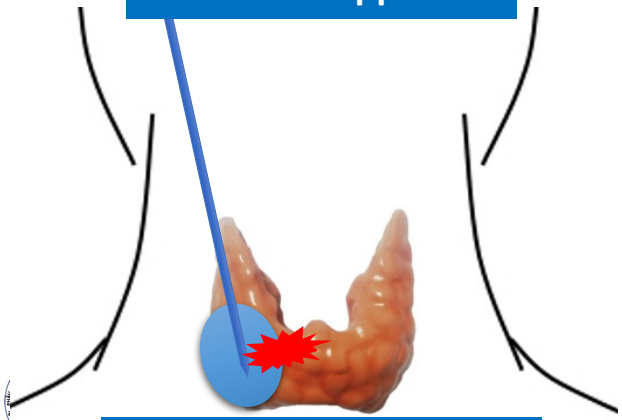
- Clearly visible anatomical relationship between nodule – danger triangle – electrode
- Prevent back leakage of hot liquid
- Stability on swallowing, gag, or cough



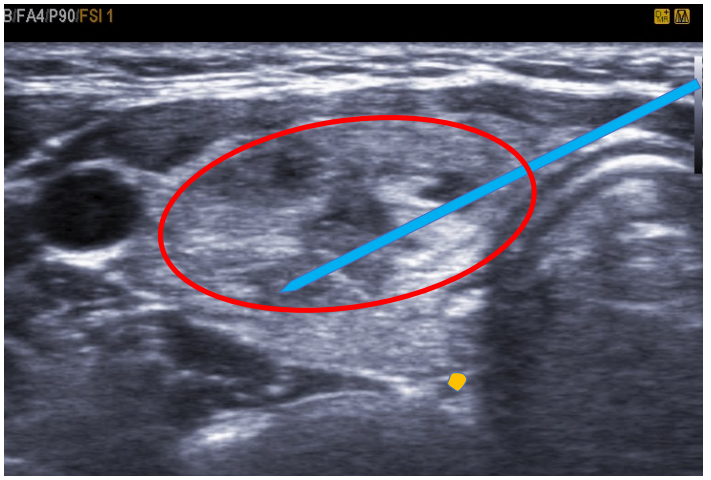
Transverse Approach

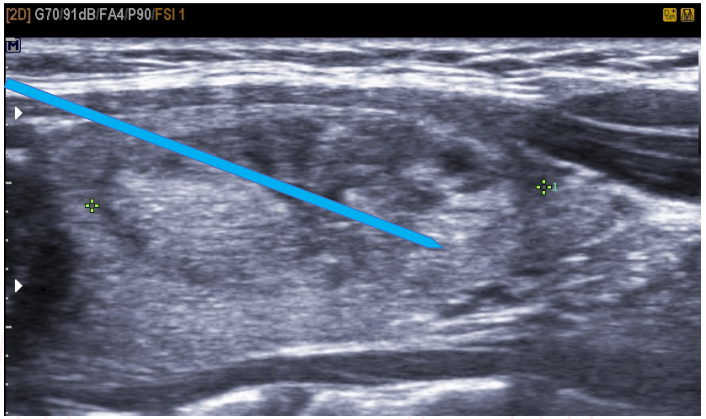


Transverse approach



Longitudinal approach

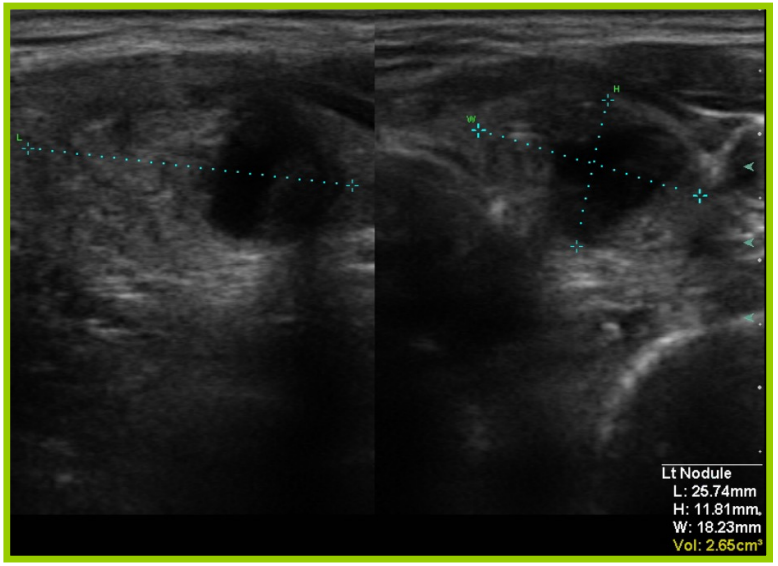


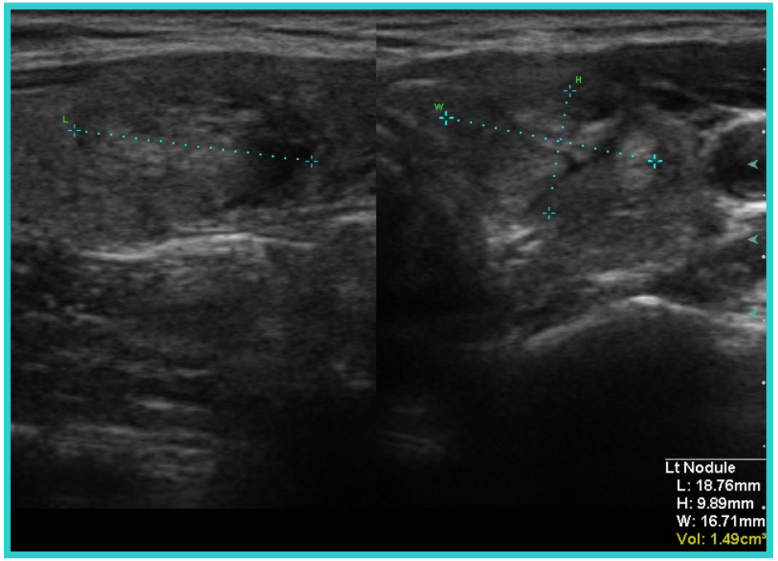


Puncture before microwave ablation

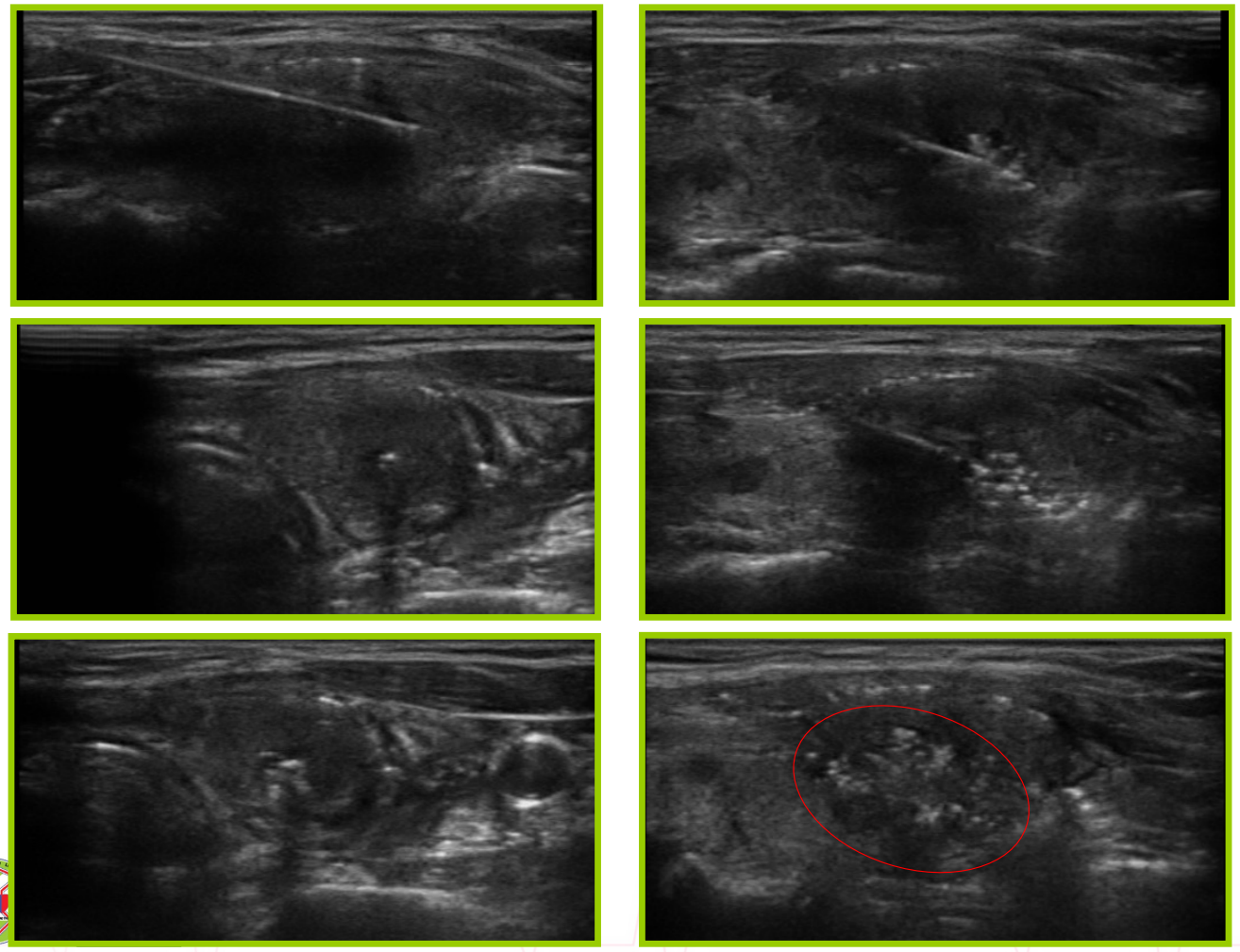
cystic echo complex node

Relief puncture → decrease ablation





Performing microwave ablation



RESULTS

Research group characteristics:

- There were 40 patients: 31 Female (78%), 9 Male (22%).
- Average age is 46 years old, From 24 to 61 years old
- There were 4 patients (10%) who had previously had RFA, but the tumor volume was not significantly reduced.
- All had complaints of tumors. Symptom scale: Average is 8; The lowest level is 5, the maximum is 10.
- Aesthetic score: level 2 has 8 cases (20%), level 3 has 32 cases (80%). There is no case at 0 or 1

RESULTS

Characteristics of thyroid nodules:

- There are 42 thyroid nodules. Average size 44mm Average volume 22ml.
- Nodules classification: solid 48%, mixed 50%. Only 1 case (2%) was a simple thyroid cyst.
- Most thyroid nodules (71%) were in the left lobe.
- No patient had increased blood vessels in the thyroid nodule.
- Number of thyroid nodules treated: 1 nodule in 38 cases (95%) and 2 nodules in 2 cases (5%)

RESULTS

Safety

- In of the 40 patients treated by microwaves:
- There were 4 cases (10%) with minor complications after ablation: 1 case had skin burns at the site where the needle was inserted, and 3 other cases had minor skin redness at the site where the thyroid nodule was ablated.
- All of these lesions recovered after 1 week of treatment and did not form scars.
- There were no cases of serious complications

RESULTS- DISCUSSION

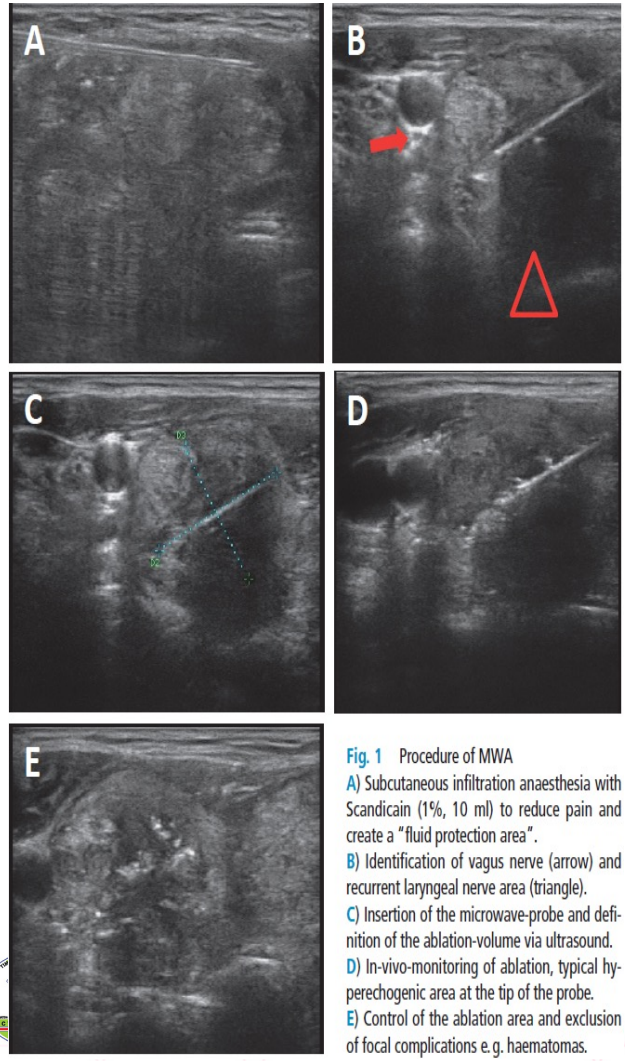
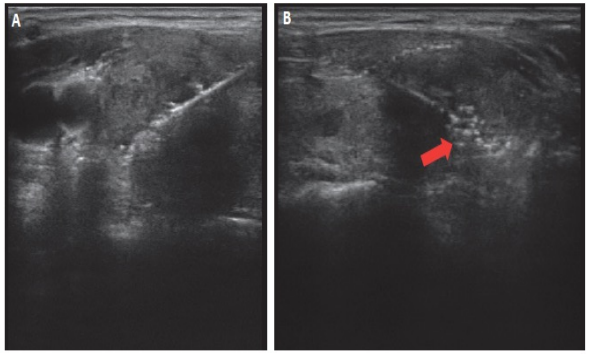


Fig. 1 Procedure of MWA
A) Subcutaneous infiltration anaesthesia with Scandicain (1%, 10 ml) to reduce pain and create a "fluid protection area".
B) Identification of vagus nerve (arrow) and recurrent laryngeal nerve area (triangle).
C) Insertion of the microwave-probe and definition of the ablation-volume via ultrasound.
D) In-vivo-monitoring of ablation, typical hyperechogenic area at the tip of the probe.
E) Control of the ablation area and exclusion of focal complications e.g. haematomas.

complication	number of complications (%)	
pain during ablation	11	(100)
swallowing problems	11	(100)
hoarseness	0	(0)
dragging pain in mandibular angle and ear	3	(27.3)
voice changes	0	(0)
superficial haematomas	11	(100)
deep haematomas	0	(0)
first-degress burns	2	(18.2)
infection	0	(0)
nodule rupture	0	(0)



Korkusuz et al., Nuklearmedizin (2014) 53:123-130

ounding
area (B).

COMPLICATIONS

Serious complication

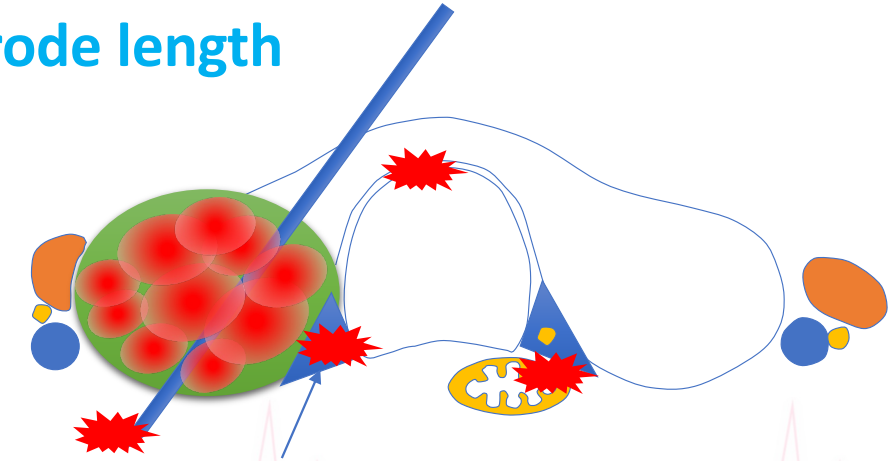
- Esophageal rupture
- Tracheal rupture
- Pneumothorax

Attention to the electrode length

- Voice loss
  - Caution Danger triangle

Minor complication

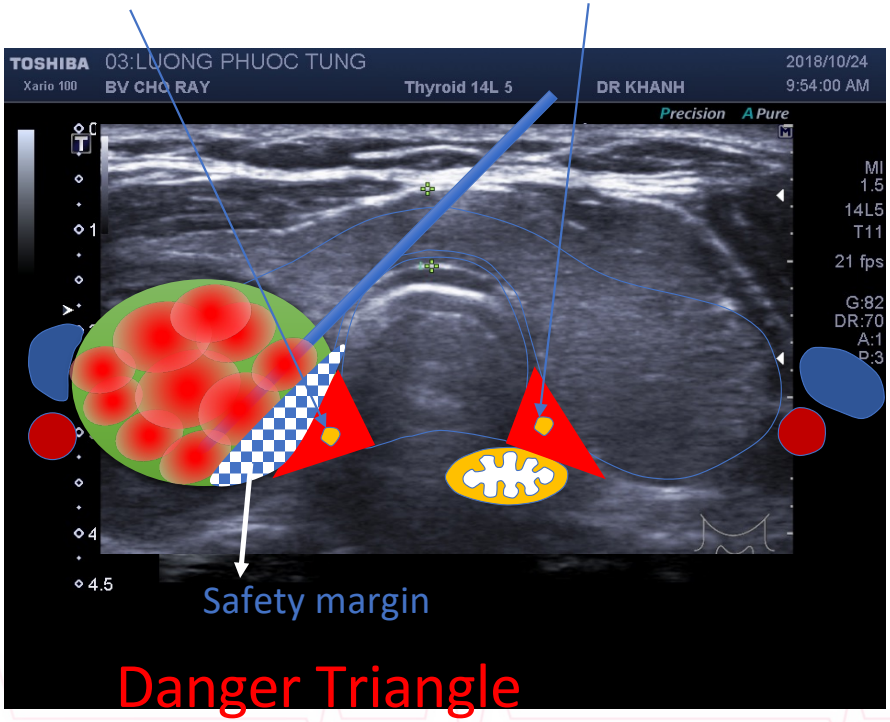
- Voice change



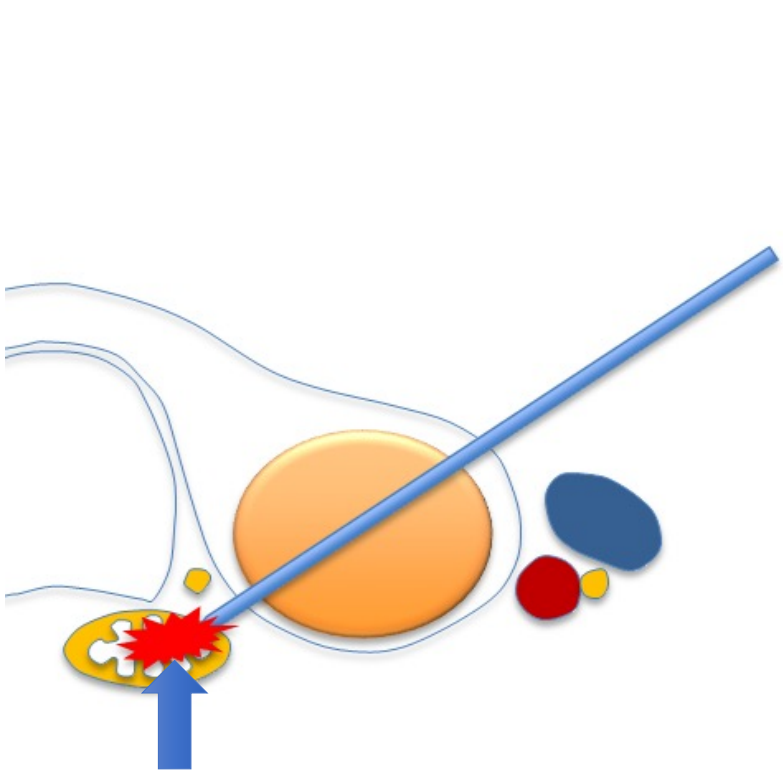
Danger triangle

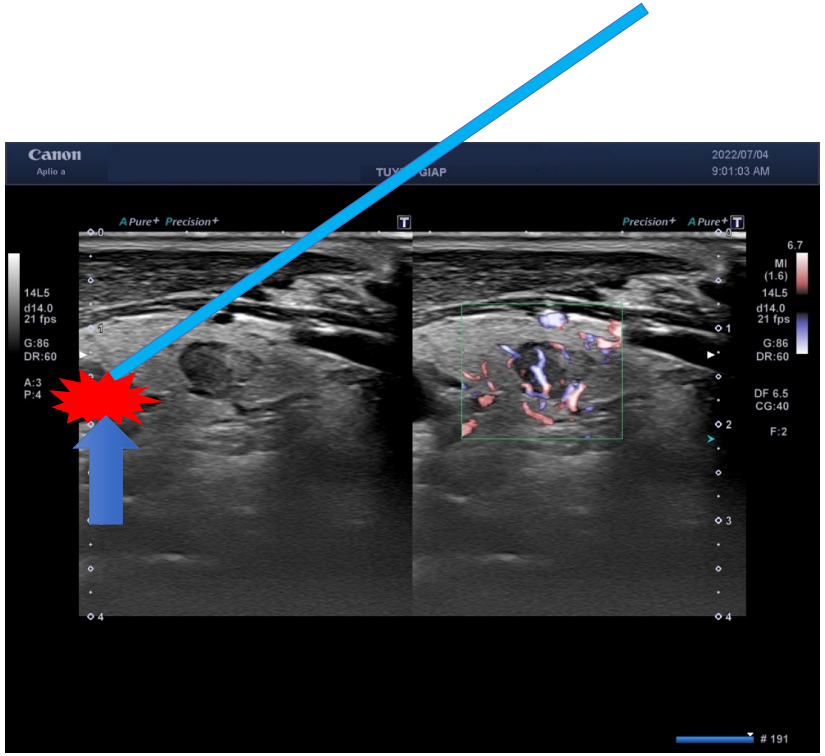
Recurrent Laryngeal Nerve and Danger Triangle

- thyro-tracheal and tracheo-esophageal groove

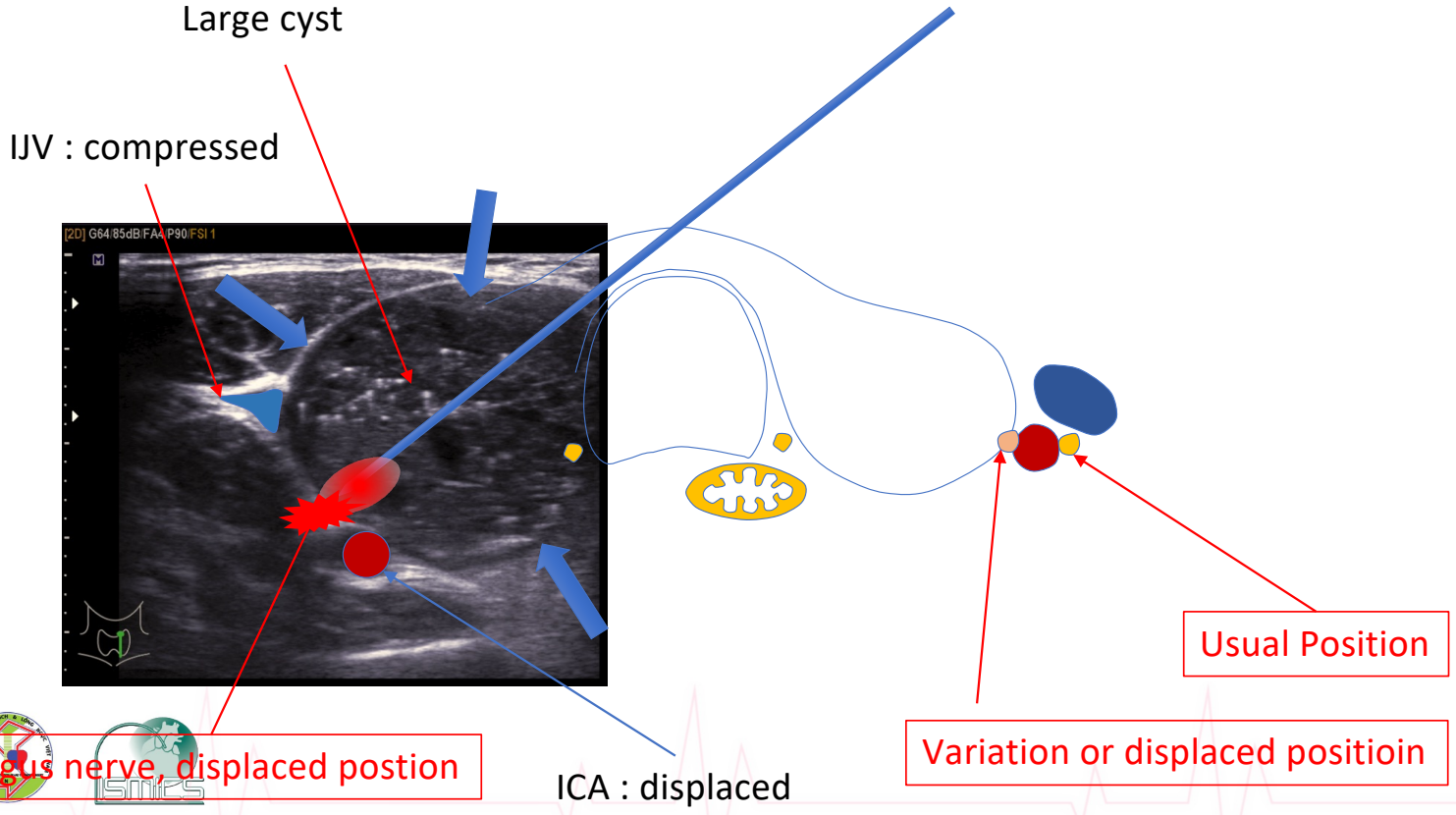


Esophageal rupture

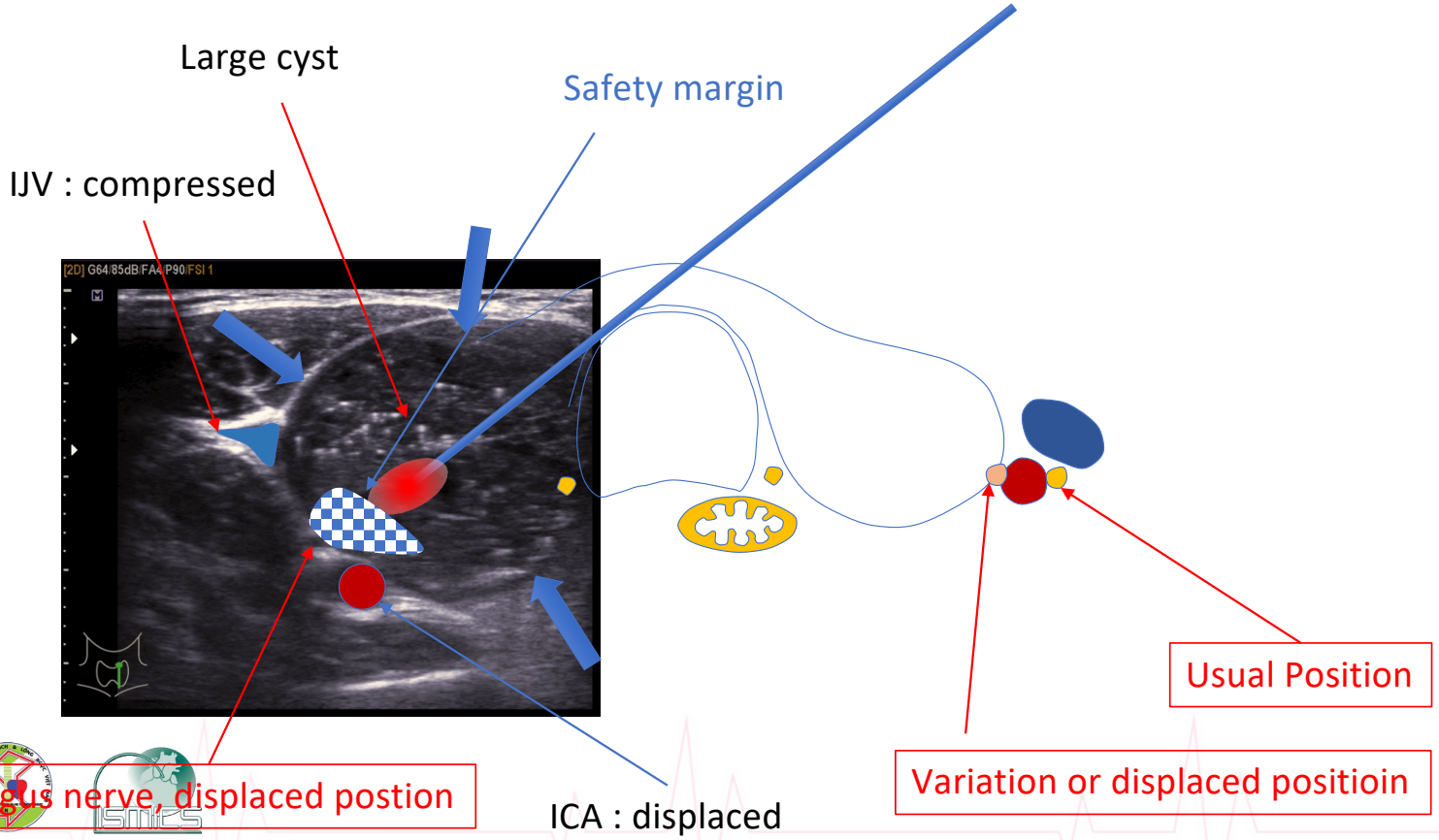




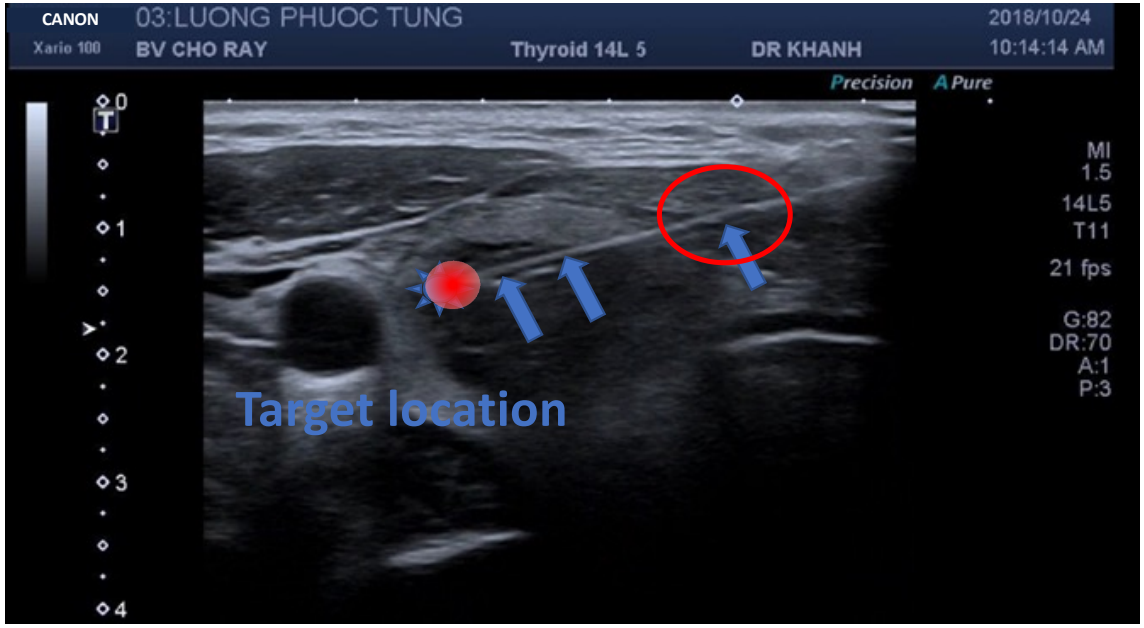
Vagus nerve, Sympathetic ganglion



Vagus nerve, Sympathetic ganglion



Trans-isthmic approach: 5 As



Appearance

Alignment

Advance

All the length

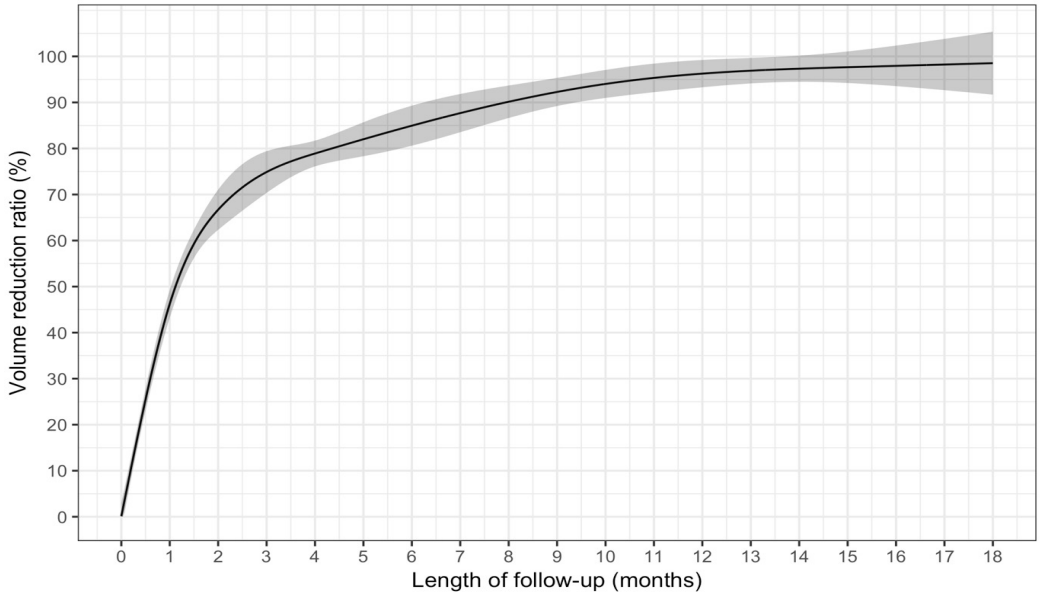
Ablation

RESULTS

Results	Pre- MWA	1 month	3 months	6 months	12 months
VRR (%)	0 (0; 0)	46.7 (43.7; 50.0)	75.1 (70.7; 79.6)	85.2 (80.8; 89.6)	96.4 (93.5; 99.3)
Symptom scores	8.0 (7.7; 8.3)	6.0 (5.8; 6.3)	4.1 (3.8; 4.4)	3.6 (3.3; 3.9)	2.8 (2.5; 3.0)
Aesthetic scores	2.8 (2.6; 3.0)	2.6 (2.5; 2.7)	2.3 (2.2; 2.4)	2.0 (1.8; 2.1)	1.3 (1.2; 1.5)

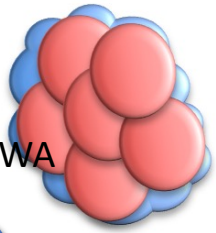
- The rate of tumor volume reduction was achieved after 3 months.
- Symptom scores decreased clearly after 3 months.
- Aesthetic scores decrease more slowly after 6 months.

RESULTS



The tumor volume reduction rate reached 70% after 3 months and increased to more than 90% after 12 months

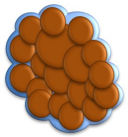
Natural Course



1 ~ 2 weeks

#2 RFA, MWA

1 month : 30-50%
volume reduction



6-12 months：50-80%
volume reduction

1 ~ 2 weeks

#3 RFA, MWA

1 month : 30-50%
volume reduction

6-12 months：50-80%
volume reduction

Completely ablated
Not needed to do
additional ablation

Expected Number of Treatment Sessions

Table 4 Number of sessions and last VRR according to initial nodule volume

Initial nodule volume	0–10 ml (n=81)	10–20 ml (n=28)	> 20 ml (n=17)
Number of session	1.7±0.9	2.8±1.7	3.8±1.5
P value	0.001	0.023	
Last VRR (%)	94.5±9.6	93.6±9.7	88.2±20.4
P value	0.928	0.297	

Values are presented as mean ± SD (%)

Lim et al, Eur Radiol (2013) 23:1044-1049

Springer

Thyroid Nodules Ablation

ORIGINAL ARTICLE

Factors Associated with the Efficacy of Radiofrequency Ablation in the Treatment of Benign Thyroid Nodules

Huynh Q Khanh[1], Nguyen L Vuong[2], Tran Q Tien[3]

Abstract

Background: Minimally thermal treatments, including radiofrequency ablation (RFA), have been widely used for benign thyroid nodules (BTNs). However, factors related to the efficacy are not consistent among studies. Therefore, this study aimed to investigate factors associated with the efficacy and the risk of having multiple RFA sessions in the treatment of BTNs.

Materials and methods: We performed a retrospective study of 83 patients with 96 BTNs undergoing RFA from 2018 to 2019. Clinical and ultrasound evaluations were performed before and after RFA 1, 4, 10, and every 6 months afterward. Efficacy outcomes were volume reduction ratio (VRR), symptom and cosmetic scores, and the requirement of multiple RFA sessions.

Results: Female was predominant (86%) and the median age was 45 years. Most nodules were solid (64%) with a median volume of 3 mL. Two (2%) minor complications occurred and median time of follow-up was 17 months. The VRR reached to 56.7, 77, 89.4, and 92.8% at 4, 10, 16, and 22 months after the RFA, respectively. The symptom and cosmetic scores also significantly reduced. Multiple RFA sessions were required in 14 nodules (15%). Male had lower VRR of 5.59% than female, while mixed and cystic nodules had higher VRR of 4.88 and 12.7% compared with solid nodule. Larger nodule increased the risk of multiple RFA sessions.

Conclusion: Radiofrequency ablation is a safe and effective treatment for BTNs. Gender and solidity associate with VRR, but the large nodule is the risk factor of multiple sessions. More studies are required to reduce the risk of multiple RFA sessions.

Keywords: Goiter, Radiofrequency ablation, Thyroid nodule, Volume reduction ratio.

World Journal of Endocrine Surgery (2020): 10.5005/jp-journals-10002-1309

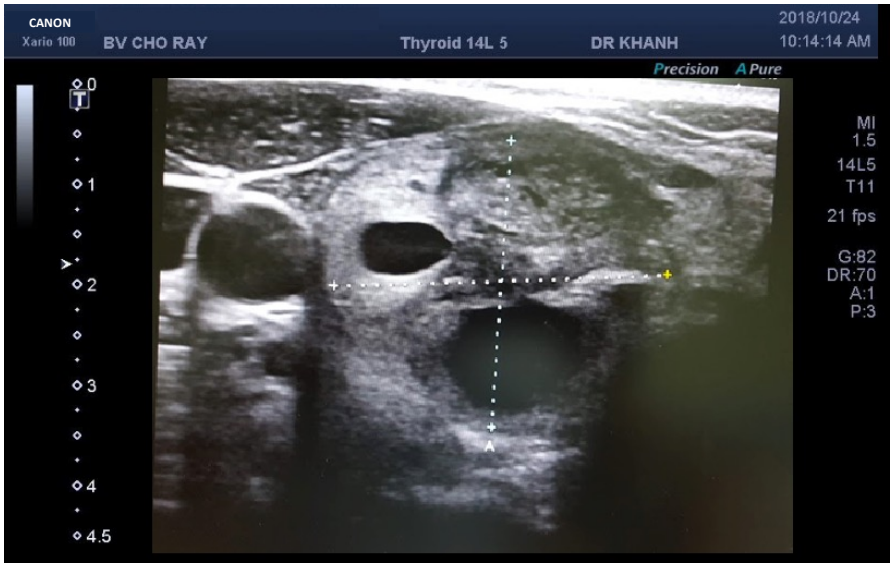
Complications reported by a recent multi centre study in Korea (2012)

- 1459 patients, 1543 nodules, 48 complications.
- **Volume reduction rate: 93%**
- **Complication rate: just 3.3%**
- Major complications (n=20):
  - Voice change (n=15)
  - Brachial plexus injury (n=1)
  - Tumour rupture (n=3)
  - Permanent hypothyroidism (n=1)
- Minor complications (n=28):
  - Hematoma (n=15)
  - Skin burn (n=4)
  - Vomiting (n=9)

All patients recovered except for one patient with permanent hypothyroidism and one patient who underwent surgery. Complications therefore exist but if care is taken they are rare. More experienced users had fewer major complications.

J.H. Baek, J.H. Lee, J.Y. Sung, et al.
Complications encountered in the treatment of benign thyroid nodules with US-guided radiofrequency ablation: a multicenter study Radiology, 262 (2012), pp. 335–342

Thyroid nodules before and after MW Ablation

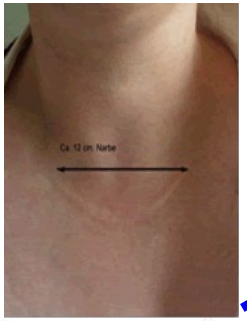


3 ms After Ablation

After Ablation and follow-up 18ms

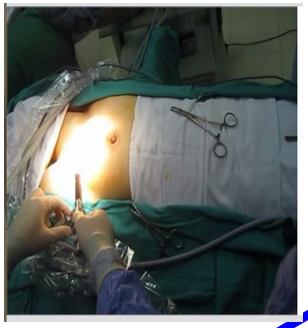
MW ABLATION

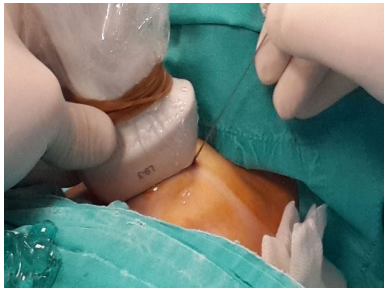
THYROID SURGERY – TREND TOWARDS LESS INVASIVENESS



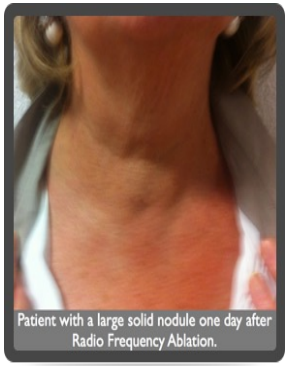
Standard: Open surgery

Minimal-invasive video-assisted thyroid surgery (MIVAT)





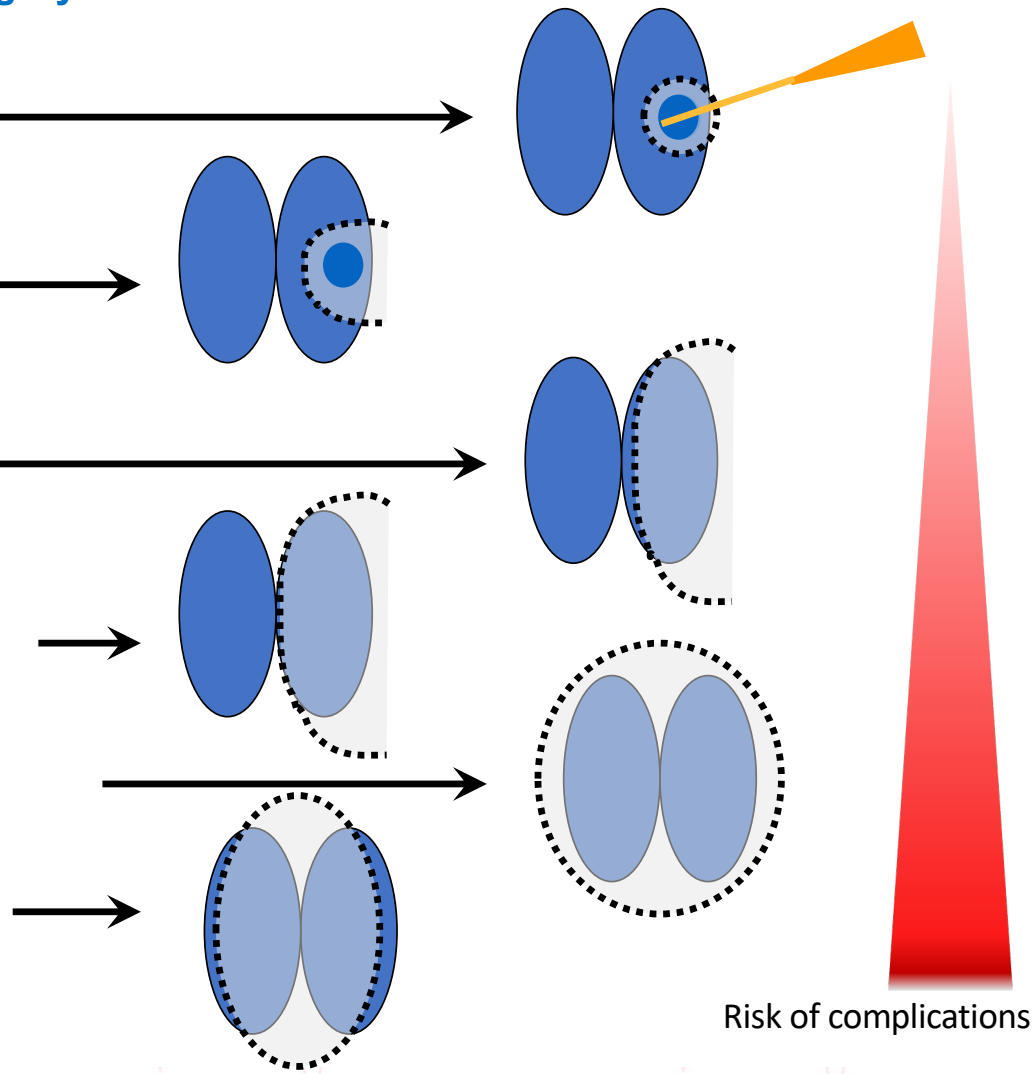
Local ablation (no scar visible)



MW Ablation

Thyroid surgery – trend towards less invasiveness

- Local ablation
- Exstirpation (Enucleation)
- Resection (Surgery)
- Hemithyroidectomy
- (total) Thyroidectomie
- near-total resection

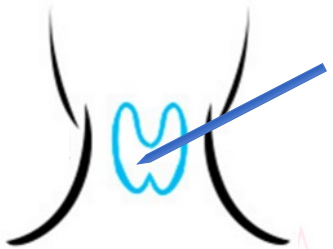


Risk of complications

Patients' Counselling

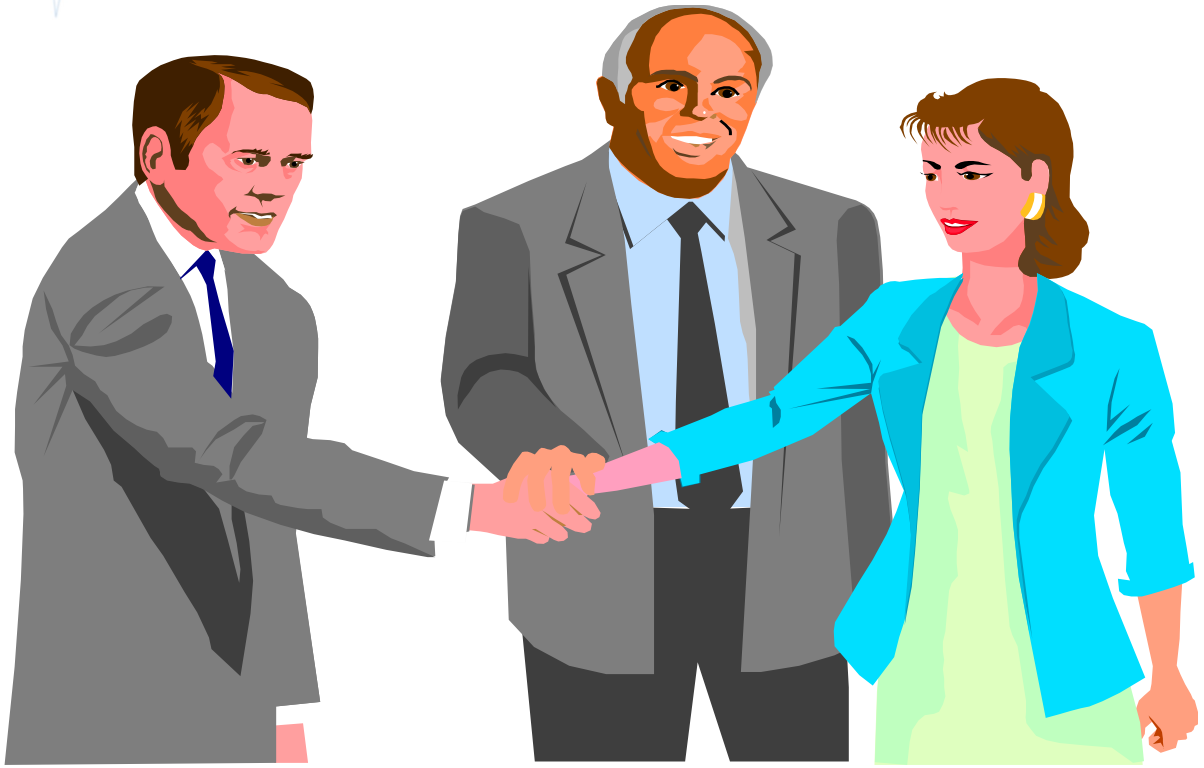
You can choose among: Follow-up | Op. | Ablation

F/U	Op.	Ablation
Do nothing	Single treatment session	No scar No hypothyroidism
Life with nodule: symptom, discomfort, cosmetic problem	Scar Potential Hypothyroidism	FNA/Bx at least twice Multiple treatment session



In conclusion

- MWA is a safe and effective treatment for large (≥ 3 cm) benign thyroid nodules.
- No major complication occurred.
- The mean VRR of the treated nodules was 75.1, 85.2, and 96.4% at 3, 6, and 12 months after the ablation.
- Both the symptom and cosmetic scores significantly decreased during the follow-up period.
- However, 31% of cases required two MWA sessions.
- Microwave ablation can be a good option in the treatment of large benign thyroid nodules.
- More studies with larger dataset and longer follow-up period are required to investigate techniques to improve the safety and efficacy of MWA.



THANK FOR YOUR ATTENTION