THYROID ELASTOGRAPHY& INTERVENTIONS

RADIOLOGY WEBINAR FALL 1400

USAGE

- Elastography provides information on tissue elasticity, based on the premise that pathologic processes such as cancer alter the physical characteristics of the involved tissue.

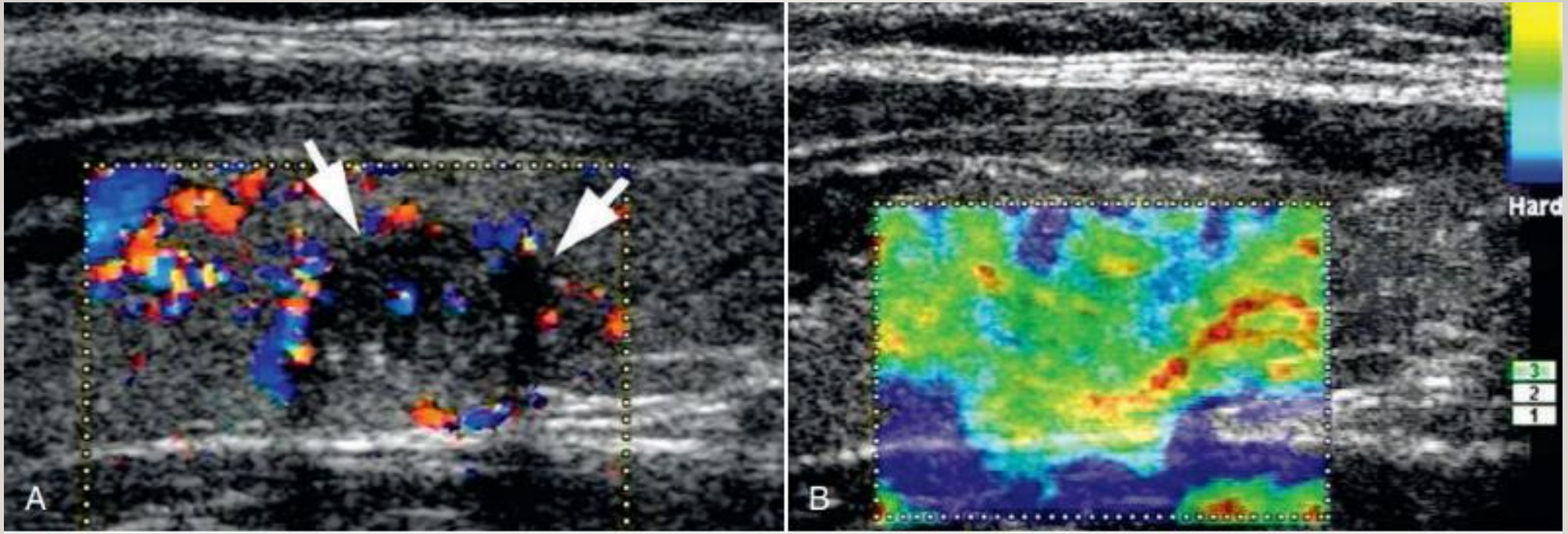
TWO DIFFERENT APPROACHES

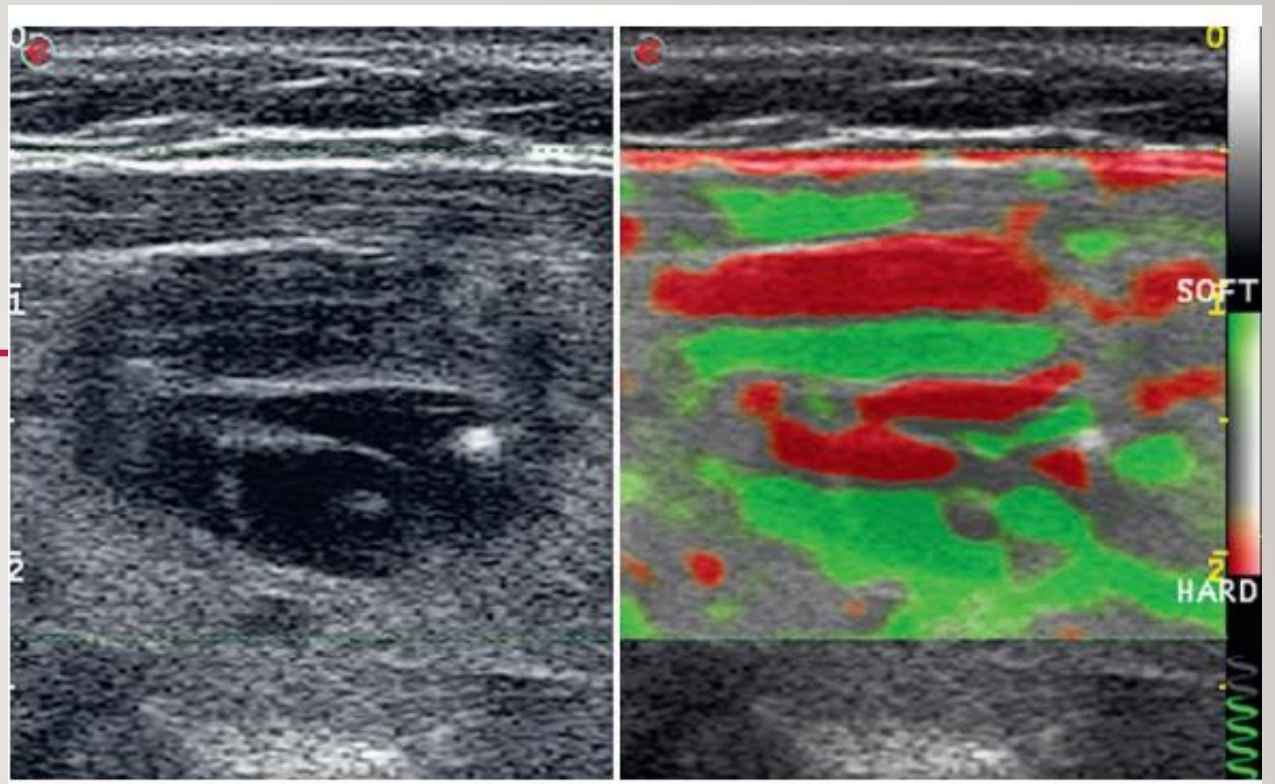
- : (1) freehand ultrasound strain elastography, with its qualitative (based on colorimetric maps and divided into four or five classes) and semiquantitative variants (strain ratio value)
- (2) quantitative approach with transducer-induced high acoustic pulse and measures of the speed of the shear wave generated (shear wave elastography [SWE])

FOUR ELASTOGRAPHIC PATTERNS HAVE BEEN CLASSIFIED AS FOLLOWS

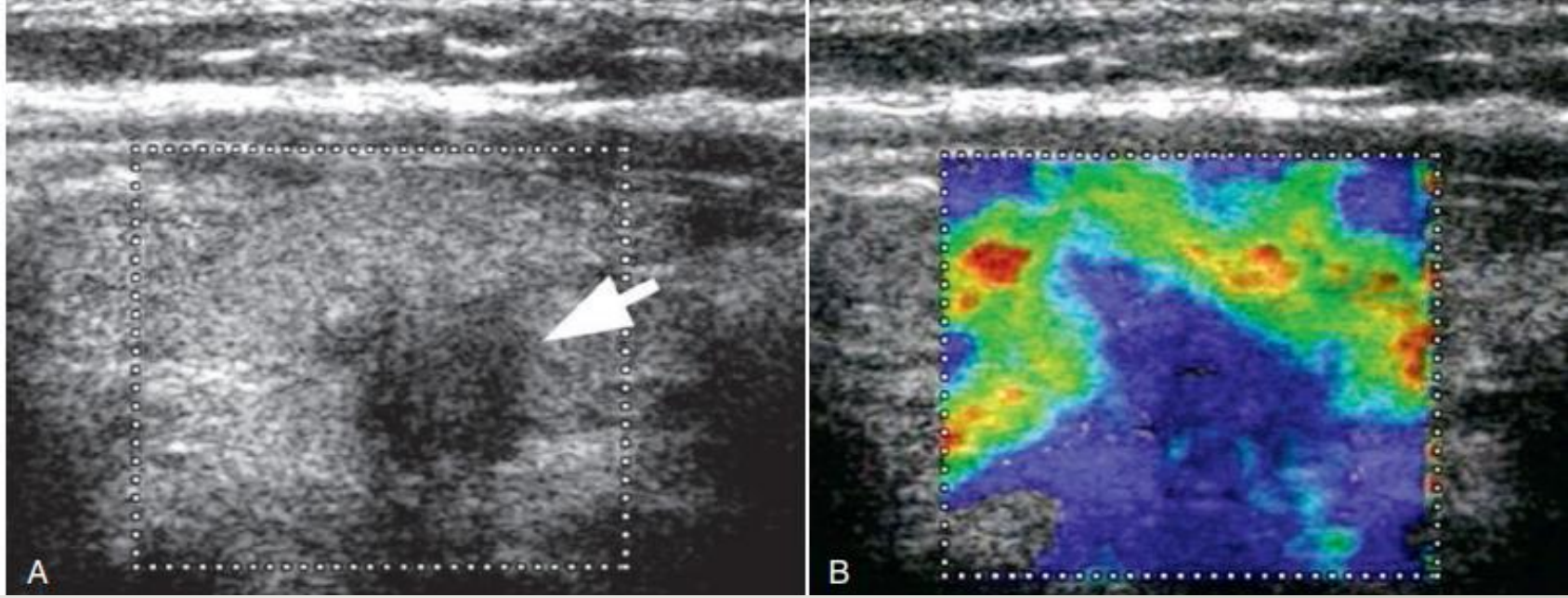
- Pattern 1: Elasticity in the whole nodule
- Pattern 2: Elasticity in a large part of the nodule, with inconstant appearance of anelastic areas
- Pattern 3: Constant presence of large unelastic areas at the periphery
- Pattern 4: Uniformly unelastic

Use of Ultrasound Elastography on Thyroid Nodule: Benign Nodular Hyperplasia (Pattern 1). (A) Conventional longitudinal B-mode sonogram with color Doppler shows a hypoechoic solid nodule (arrows) with peripheral halo, internal comet-tail artifacts, and perilesional blood flow pattern. (B) Longitudinal ultrasound elastography at same location demonstrates a “soft” color pattern.

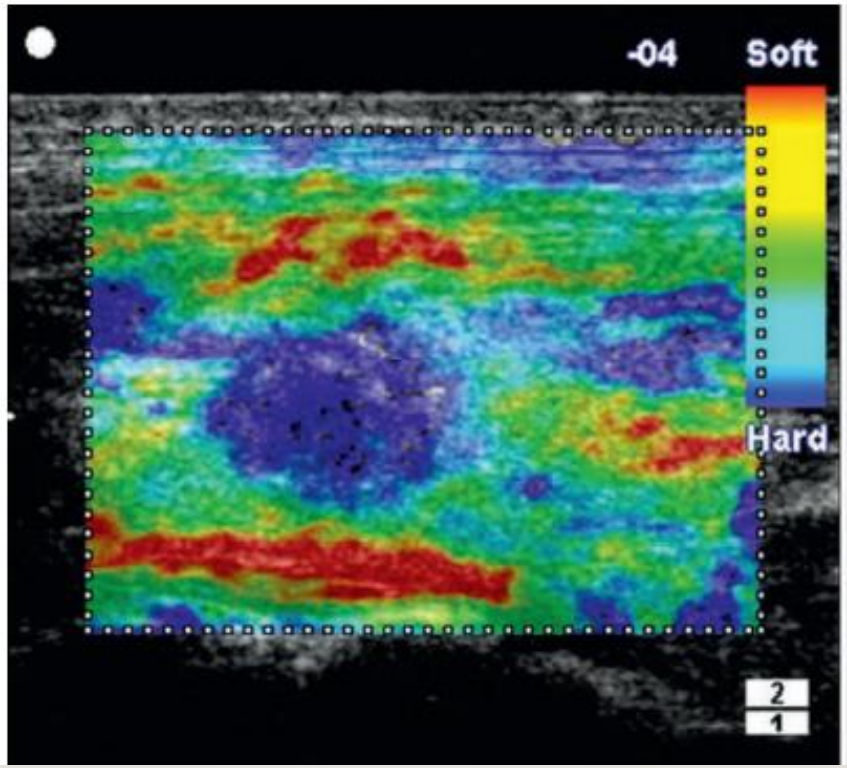


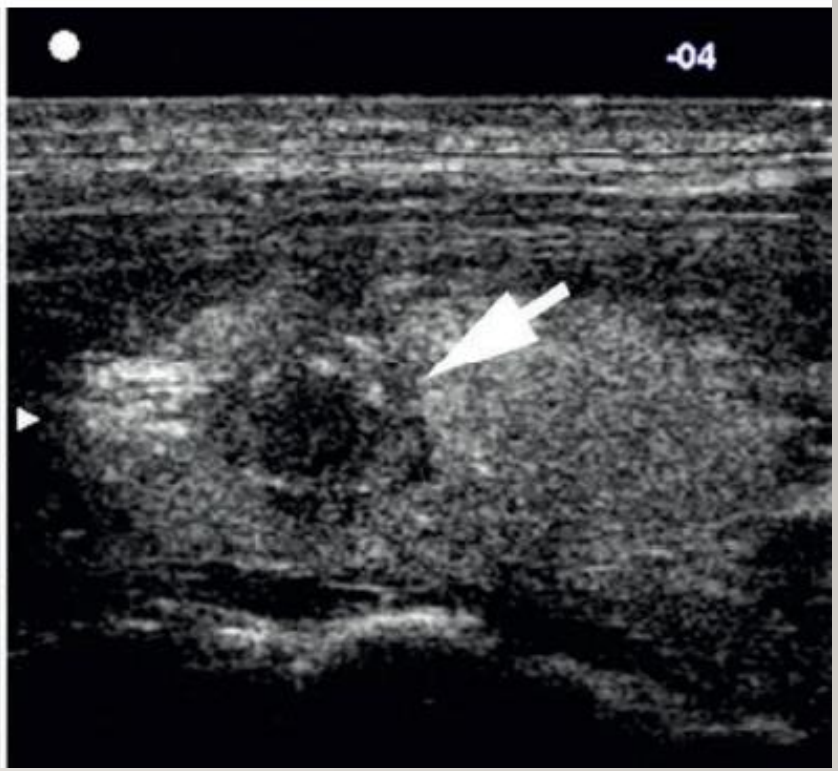


Benign Nodular Hyperplasia With Cystic Changes (Pattern 2). Left half of image shows a cystic, poorly defined nodule on conventional B-mode gray-scale sonogram. Right half of elastogram of the nodule shows a predominantly elastic (green) pattern with a few internal anelastic bandlike areas.



Use of Ultrasound Elastography on Thyroid Nodule: Papillary Thyroid Carcinoma (Pattern 3). (A) Conventional longitudinal B-mode sonogram demonstrates a hypoechoic papillary carcinoma with irregular, poorly defined margins (arrow). (B) Ultrasound elastography shows a predominantly inelastic (blue) pattern with a few small, elastic (green) areas in the posterior portion.



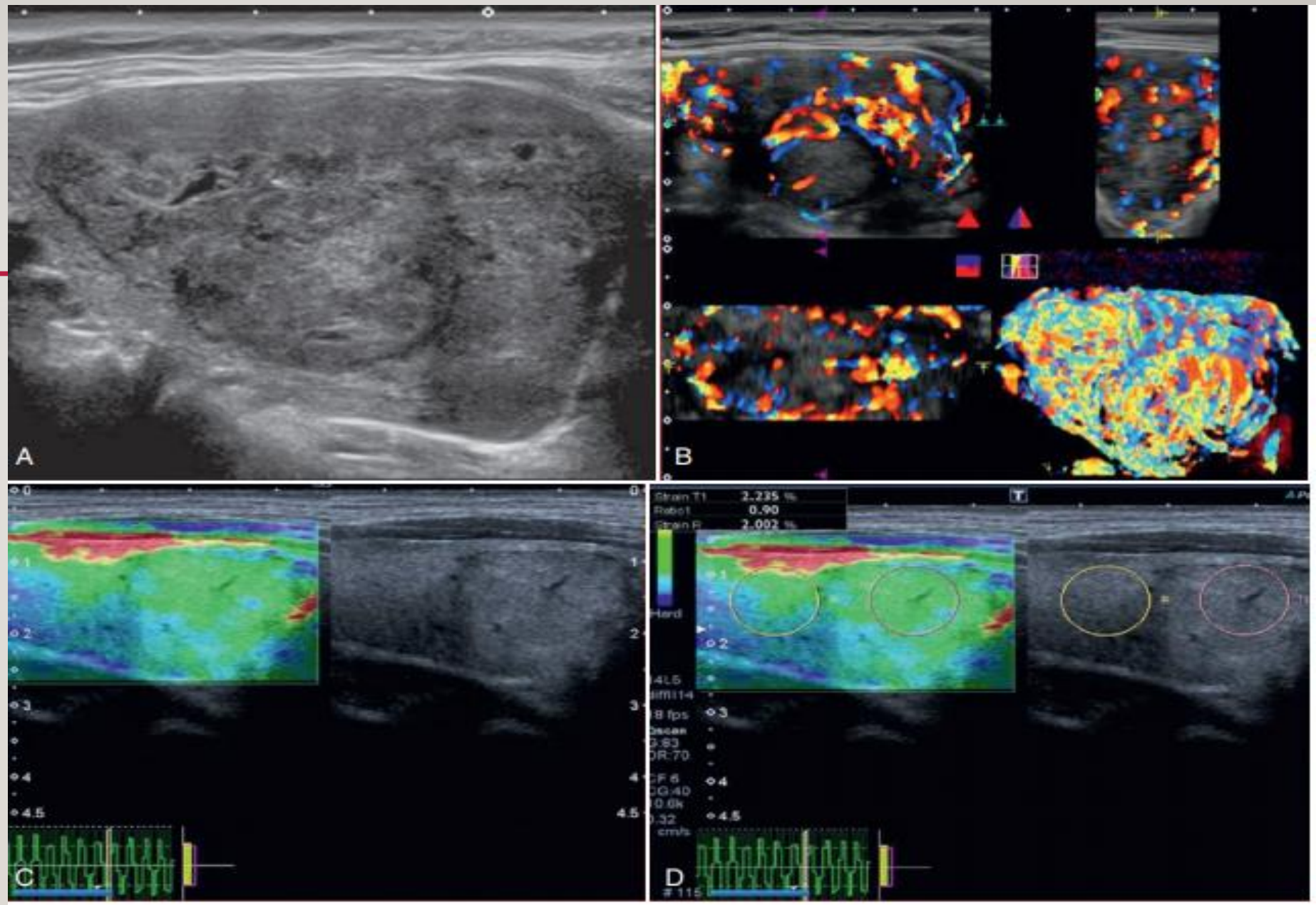


Papillary Thyroid Carcinoma (Pattern 4). Right half of image shows a hypoechoic solid nodule (arrow) with microcalcifications, typical of papillary carcinoma. Left half of image shows that on ultrasound elastography, the nodule is almost entirely inelastic (blue) pattern 4. The small, elastic areas in the posterior portion of the lesion are artifacts caused by pulsations of the underlying carotid artery.

THE BEST ACCURACY

- small nodules ; when FNA biopsy is nondiagnostic or suggests a follicular lesion, provided the nodule is solid and devoid of coarse calcifications.

MULTIPARAMETRIC EVALUATION



Research Article

Combination of Maximum Shear Wave Elasticity Modulus and TIRADS Improves the Diagnostic Specificity in Characterizing Thyroid Nodules: A Retrospective Study

Table 4

SWE parameters for differentiating thyroid lesions.

	Benign (kPa)	Malignant (kPa)	*P* value	Odds ratio	95% CI
E_{mean}	22.5 ± 9.4	31.1 ± 10.5	0.049	1.014	0.961–1.069
E_{max}	49.6 ± 25.5	78.7 ± 41.1	0.001	1.520	1.021–2.132
E_{ratio}	2.68 ± 3.30	3.42 ± 2.08	0.742		

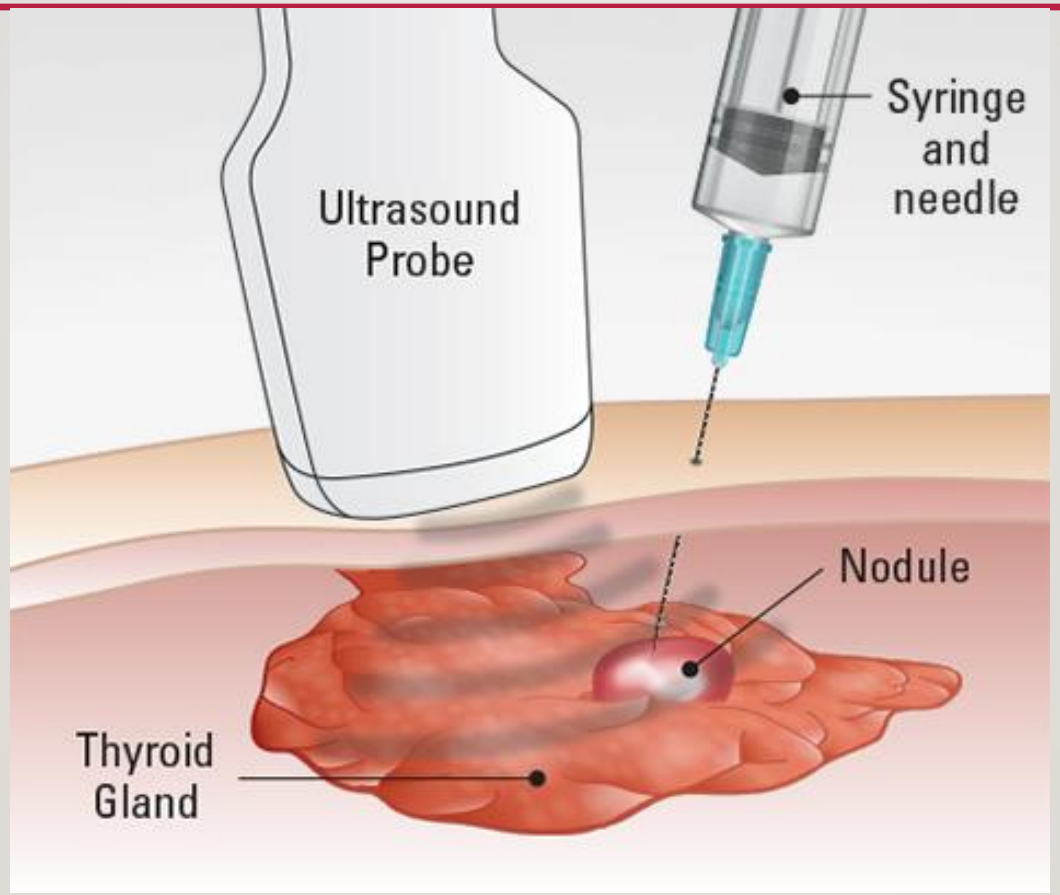
Combination of Maximum Shear Wave Elasticity Modulus and TIRADS Improves the Diagnostic Specificity in Characterizing Thyroid Nodules: A Retrospective Study

Table 5

Statistical results of E_{max} in benign and malignant thyroid nodules.

	No.	Distribution range (kPa)		Expected values		Variance yields σ
		Minimum	Maximum	Log (x)	X (kPa)	
Benign	121	18.0	177.8	3.812	45.2	0.4297
Malignant	177	22.8	278.5	4.225	69.1	0.4465

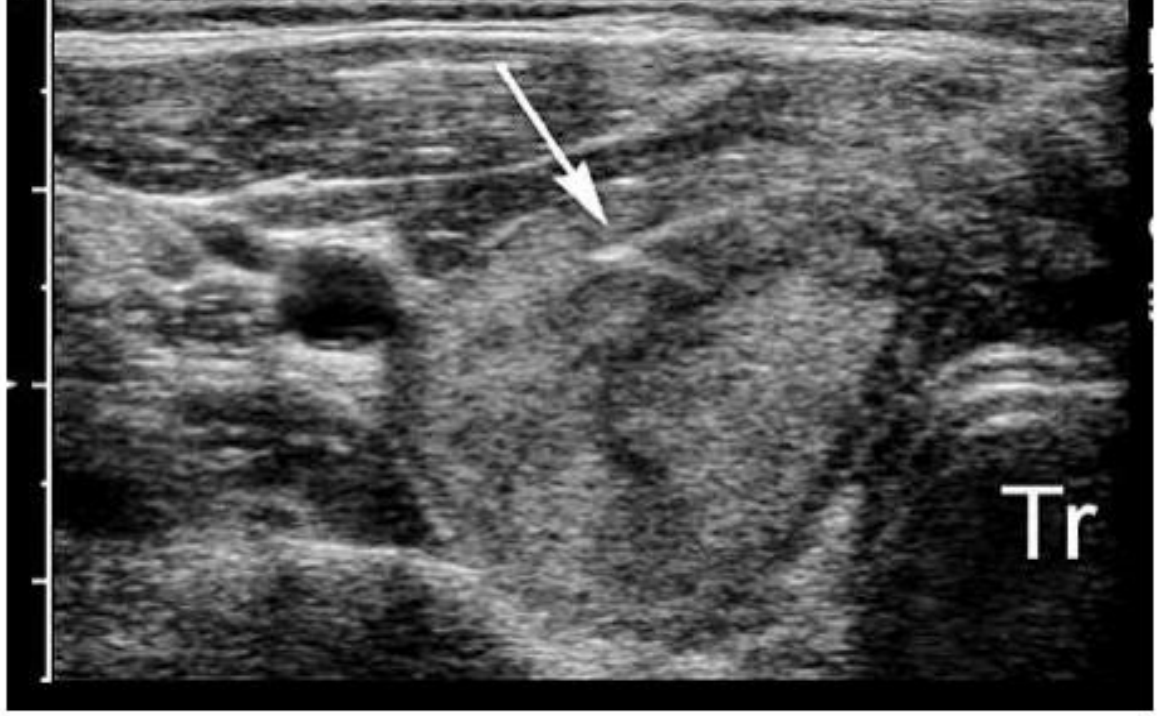
THYROID INTERVENTIONS

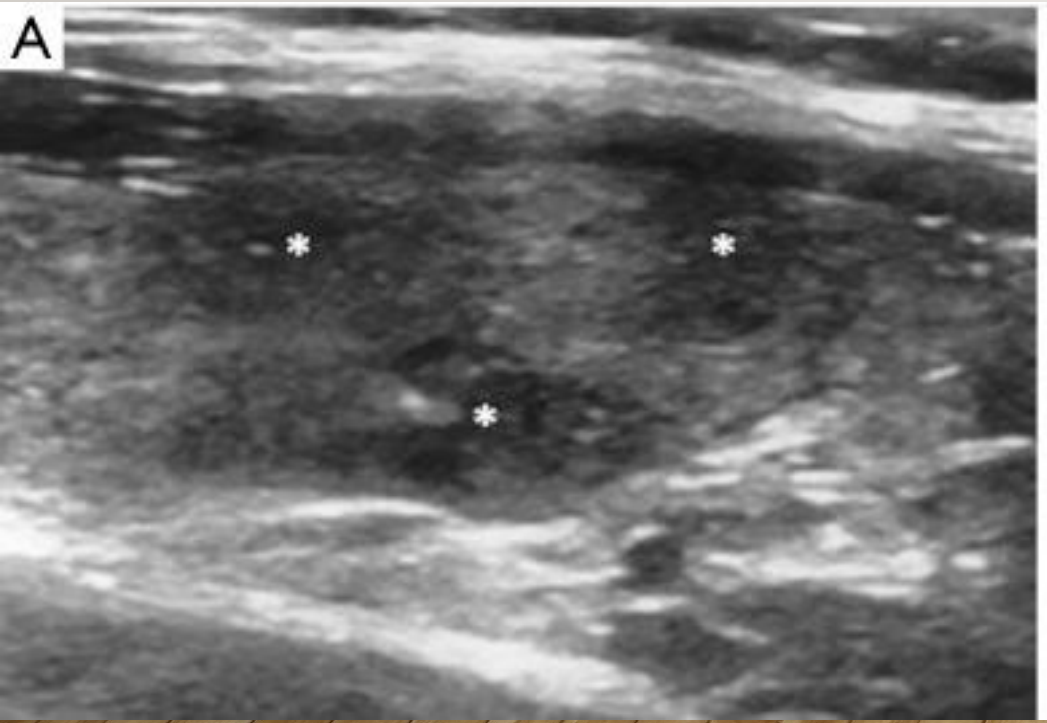


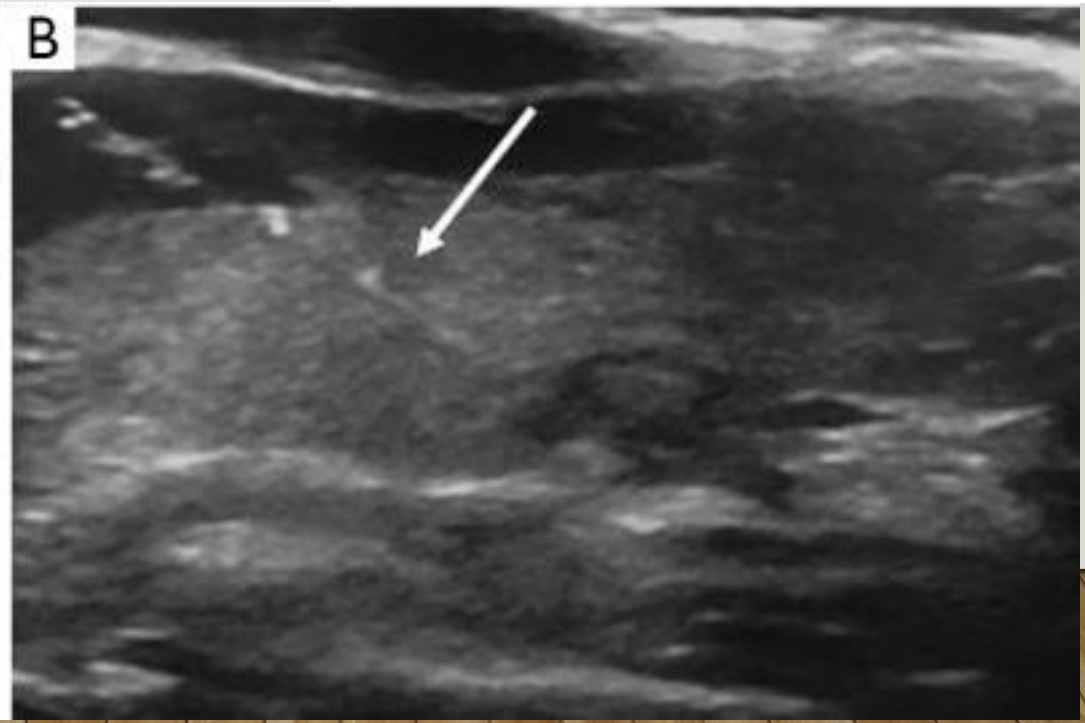
THYROID INTERVENTIONS

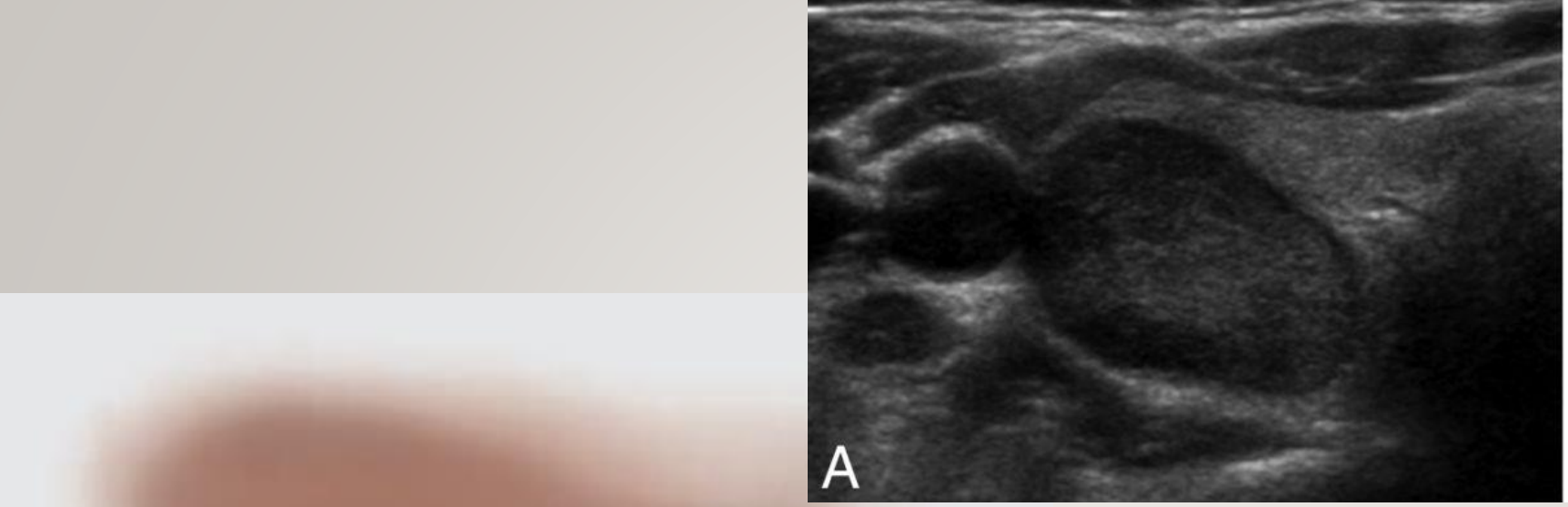
- in the radiological field, new non-invasive procedures have been developed as alternative to surgery .The aim of this ppt, based on newly revised guidelines, is to provide some information regarding the basic principles, indications, materials, techniques and results of mini-invasive procedures or treatments for thyroid nodules.

1.THYROID NODULE FNA





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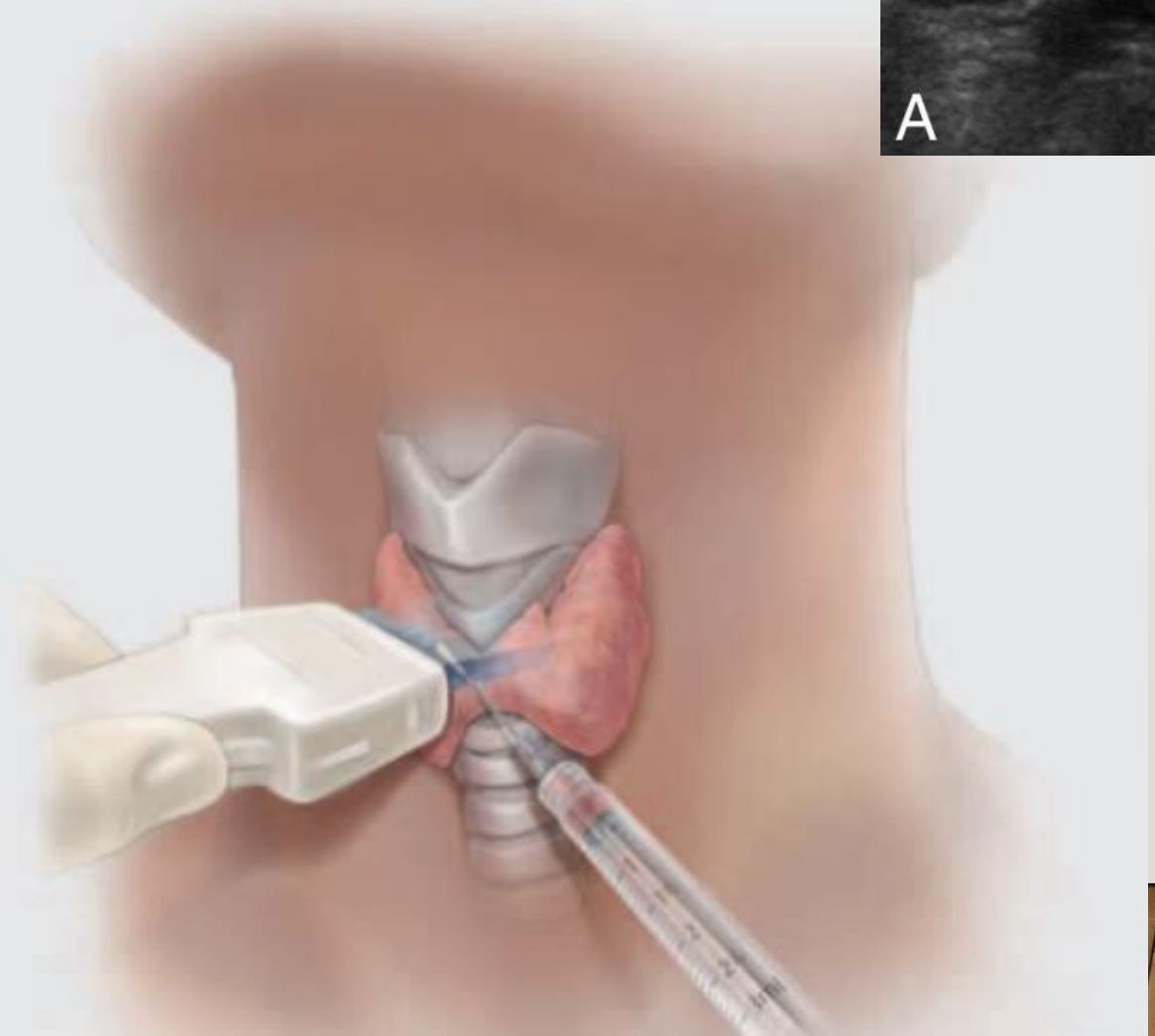


EQUIPMENT

- linear high-resolution ultrasound probe (>9 MHz)
- 25-27 gauge needle (fine needle)
- antiseptic agent (povidone iodine, chlorhexidine, etc)
- 10 mL of 1% lidocaine (optional)
- 5-10 mL syringe for the needle (optional)
- 5 to 10 lames

TECHNIC

- For all interventional procedures on the thyroid gland, the patient is on the supine position, with or without a pillow under the shoulders allowing hyperextension of the neck. The neck is cleansed with betadine or alcohol.

ULTRASOUND GUIDANCE

- Focusing on nodule ,while entering into the nodule, the tip of the needle is continuously visualized by the operator under US-guidance. With or without aspiration, depending on the structure and vascularization of the nodules, the needle is moved to and fro of some millimeters to remove cells and, in the end, the material extracted is fixed in alcohol or dried air and sent to the cytopathologist.

- Low rates of complications are described in literature, when the procedure is performed by expert operators, and include bleeding with risk of cervical hematoma, local infections and vasovagal syncope. Proper use of antiseptics, US assistance (for identification of intra and extra-gland vascular structures) and the manual compression of the entry site may help reduce the likelihood of complications

INDICATIONS

- 1.The first situation is the questionable or inconclusive physical examination in which a nodule is suggested but cannot be palpated with certainty. In these patients, sonography is used to confirm the presence of a nodule and to provide guidance for accurate biopsy.
- 2.The second setting involves patients at high risk for thyroid cancer with a normal gland on physical examination but a sonographicaly demonstrated nodule. This group includes patients with a previous history of head and neck irradiation, a positive family history of MEN II syndrome, or a previous subtotal thyroid resection for malignancy.
- 3.The third situation for ultrasound FNA guidance involves patients who have had a nondiagnostic or inconclusive biopsy performed under direct palpation.

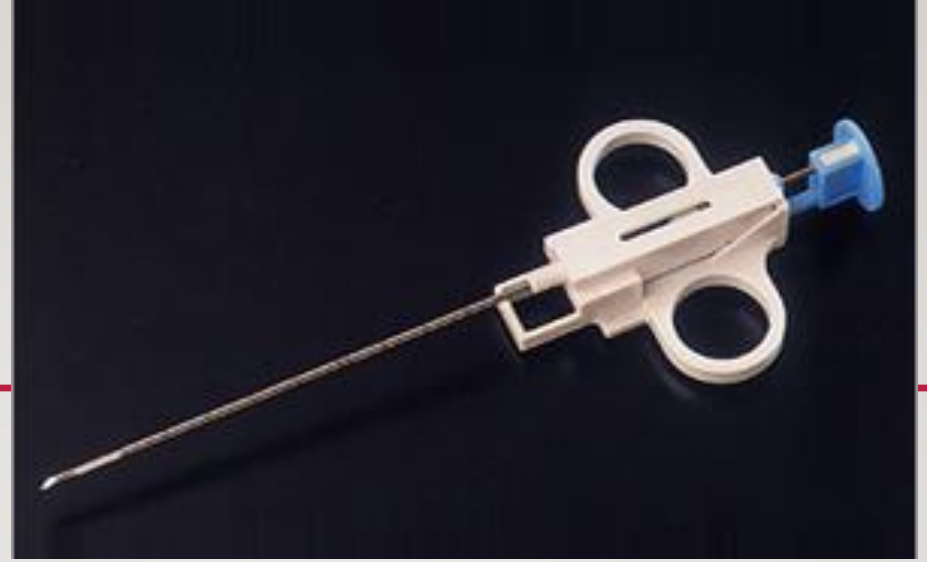
AND FINALLY

- 4.incidentalomas that exhibit sonographic features strongly associated with malignancy, such as marked hypoechogenicity, taller-than-wide shape, and thick irregular margins, as well as lesions containing microcalcifications.
- 5.Lymph nodes that are suspicious to malignancy

CORE BIOPSY

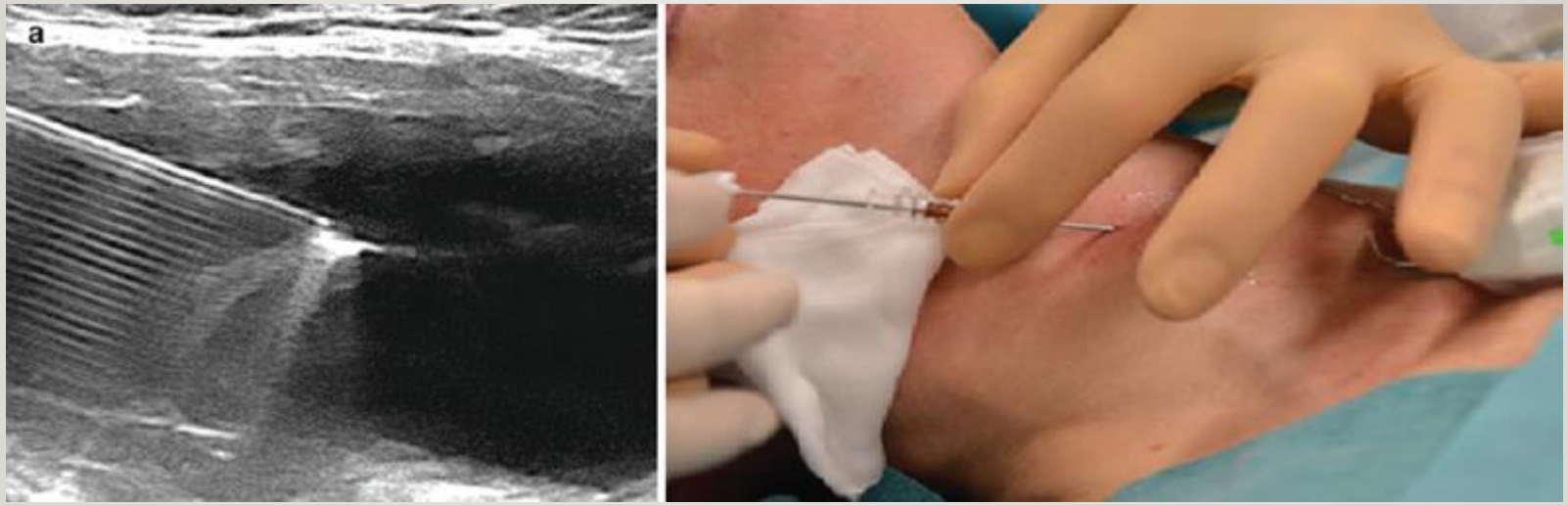
- US-guided CNB has been suggested as a complementary diagnostic technique for thyroid nodules. Although CNB may not always be technically feasible and requires a significant amount of experience in image-guided thyroid intervention, recent studies have revealed that US-guided CNB of the thyroid gland is safe and can help patients avoid repetitive FNA or a diagnostic operation.

CNB GUN



- US-guided CNB was performed by using a disposable 18-ga, double-action spring-activated needle (1.1-cm excursion with a 7-mm sample notch) (TSK Ace-cut; Create Medic, Yokohama, Japan) after administration of local anesthesia with 1% lidocaine. Using a freehand technique, we obtained 3 biopsy specimens for each thyroid nodule. The first biopsy specimens were retrieved from the nodule (intranodular target). The second and third biopsy specimens targeted the capsular portion (margin target) of the thyroid nodule to include a suspicious nodule, a capsule if present, and surrounding normal parenchyma

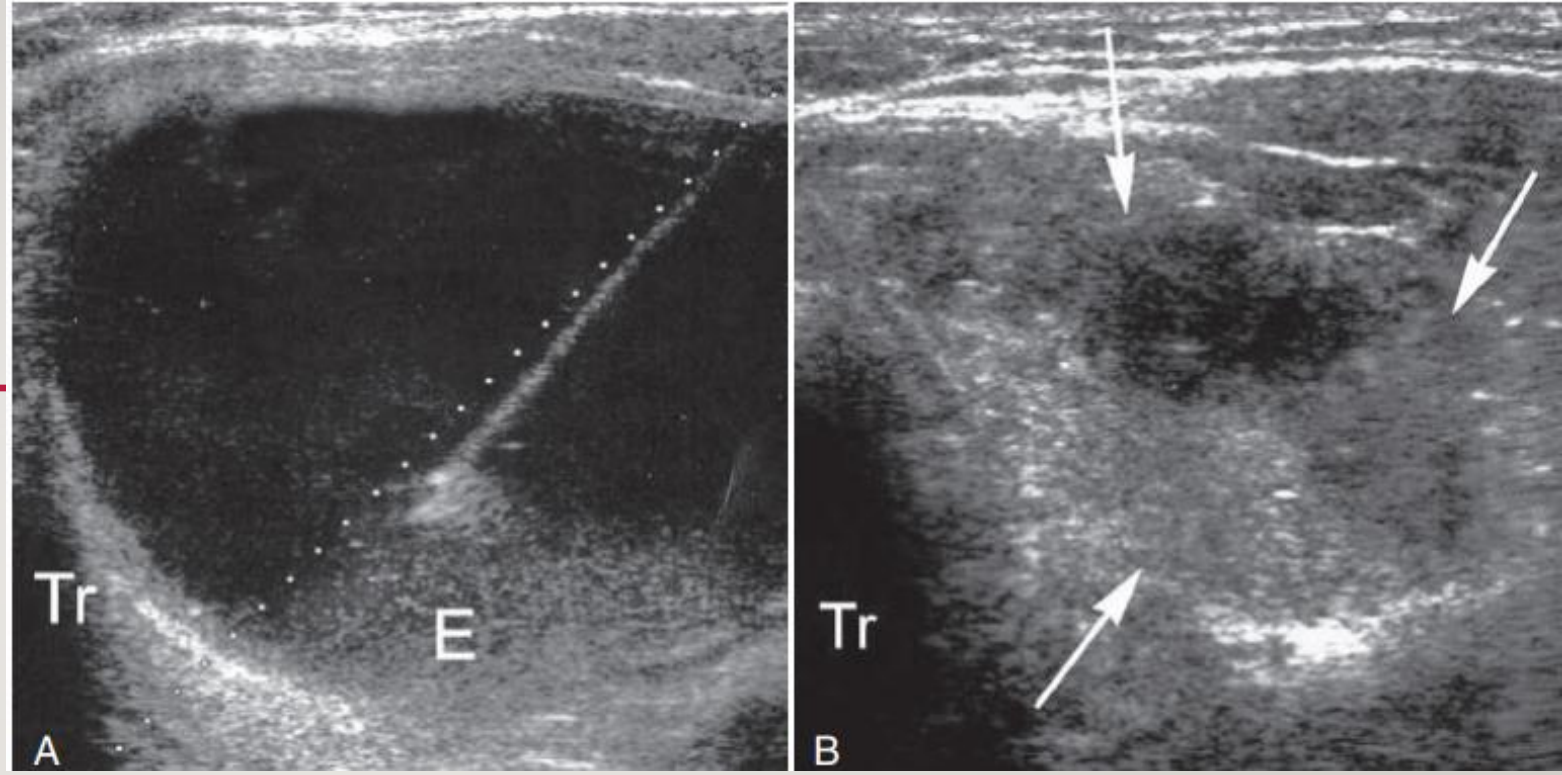
PERCUTANEOUS ETHANOL INJECTION (PEI)



ETHANOL INJECTION OF BENIGN CYSTIC THYROID LESIONS

- Simple aspiration may result in permanent shrinkage of the lesion, but the recurrence rate after aspiration is high, 10% to 80%, depending on the number of aspirations and the cyst volume; the greater the volume, the greater the recurrence risk
- Ethanol sclerotherapy mechanism:. Ethanol is distributed within tissues by diffusion cellular dehydration → protein denaturation → coagulation necrosis → reactive fibrosis
- The cyst fluid is completely aspirated with a fine needle, and then sterile 95% ethanol is injected under ultrasound guidance, in an amount varying from 30% to 60% of the aspirated fluid. Subsequently, ethanol can be either reaspirated in 1 to 2 days or permanently left in place.

- Ethanol Treatment of Large Colloid Cyst. (A) Transverse image shows large colloid cyst with needle. Injected ethanol appears as low-level echoes (E). Tr, Tracheal air shadow. (B) Follow-up image 1 month later shows that the large cystic component has mostly resolved, leaving a slightly enlarged residual gland (arrows).



- Ethanol injection is usually well tolerated by the patient. Transient mild to moderate local pain is the most common complication, a result of ethanol leaking into subcutaneous tissue. Rare complications of ethanol sclerotherapy are transient hyperthyroidism, hoarseness, hematoma, and dyspnea

ETHANOL INJECTION OF AUTONOMOUSLY FUNCTIONING THYROID NODULES

- The currently available treatments of autonomous nodules include surgery and radioactive iodine therapy
- Sterile 95% ethanol is injected through a 21- or 22-gauge spinal needle with closed conical tip and three terminal side holes. This allows the injection of a large amount of ethanol, reduces the total number of sessions, increases the treated volume, and minimizes the risk of laryngeal nerve damage because of the lateral diffusion of ethanol. Several treatment sessions are needed (usually four to eight), typically performed at 2-day to 2-week intervals. The total amount of ethanol delivered is usually 1.5 times the nodular volume.

TREATMENT

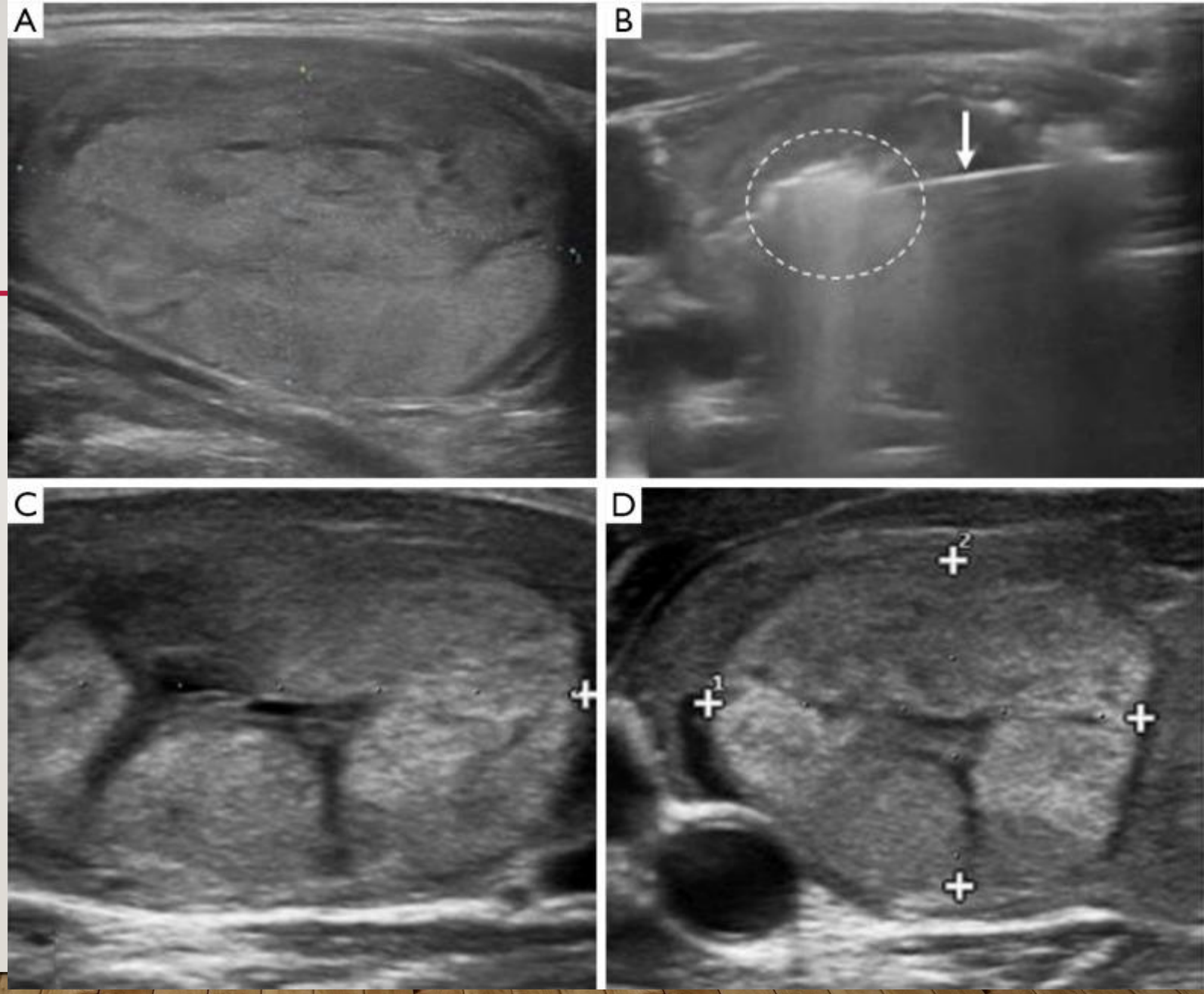
- The reduction (up to complete disappearance) of vascularity is directly related to the ethanol-induced necrosis. In addition, residual vascularity after treatment can be targeted to achieve complete ablation.
- Complete cure is defined as normalization of serum free thyroid hormones and serum thyrotropin and scintigraphic reactivation of extranodular tissue. Partial cure occurs when serum free thyroid hormones and thyrotropin levels are normalized, but the nodule is still visible on scintigraphy.

PERCUTANEOUS TREATMENT OF SOLITARY SOLID BENIGN "COLD" THYROID NODULES

- With percutaneous ethanol injection, a mean nodule volume reduction of 84% (range, 73%-98%) has been reported after 3 to 10 treatments.
- Goal is treatments, to achieve marked shrinkage of the nodule to a small, fibrous-calcified mass
- But with low-power interstitial laser photocoagulation, mean thyroid nodule volumes decreased by 40% to 50% after 6 months,
- And RFA with internally cooled electrodes and low power (20-70 W) has also been employed for the treatment of benign cold thyroid nodules, with only one ablation session for a single nodule. A significant volume reduction of the treated nodules without adverse effects has been reported at follow-up.

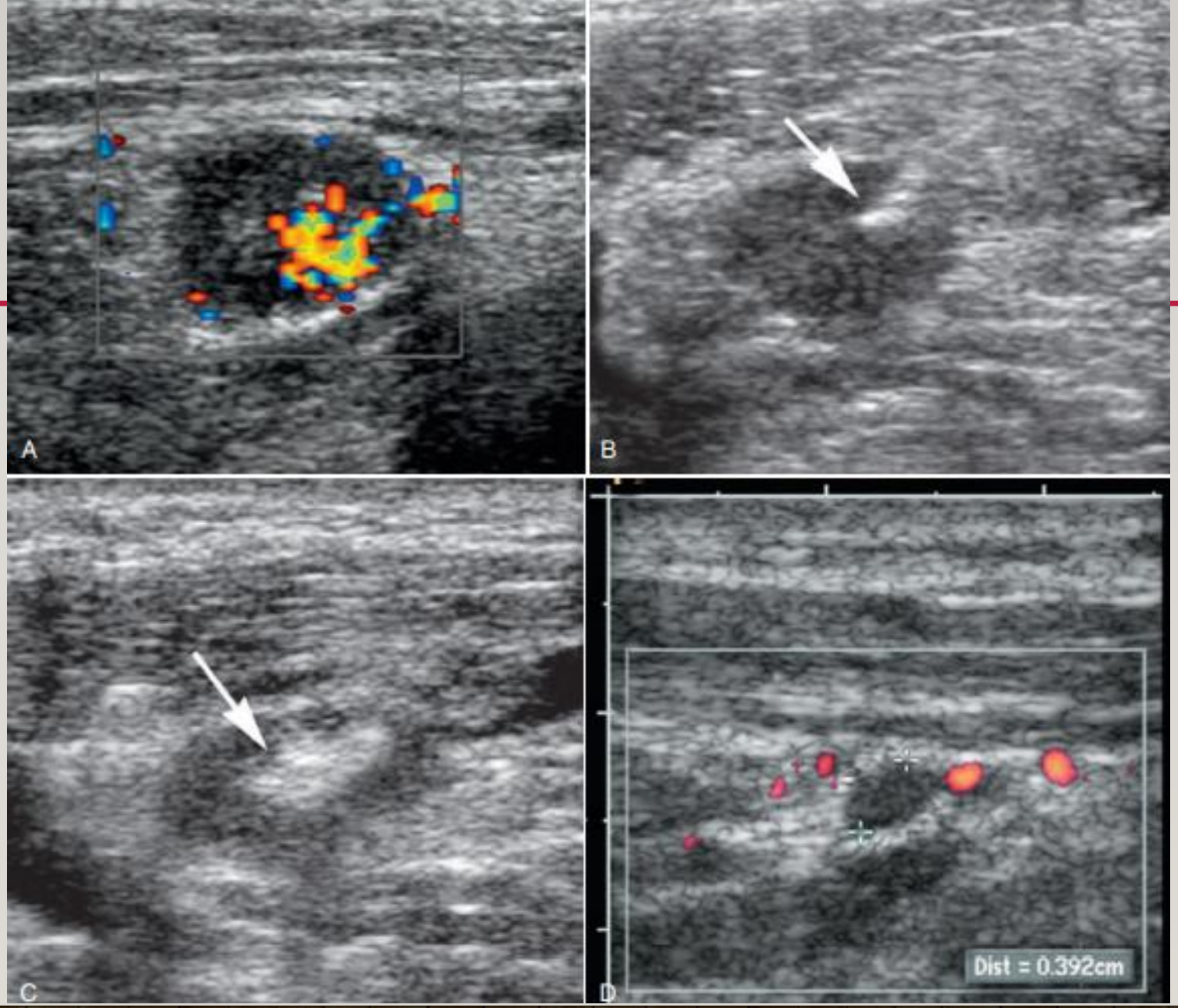
RF ABLATION OF COLD &HOT NODULES

- D is 6 month follow up study



TREATMENT OF CERVICAL NODAL METASTASES FROM PAPILLARY CARCINOMA

- Percutaneous ethanol injection is an effective and safe method of treatment for limited lymph node metastasis from thyroid cancer with 95% size reduction in 2 years f/u.
- A 25-gauge needle is attached to a tuberculin syringe containing up to 1 mL of 95% ethanol.(as parathyroid adenoma)
- node is injected in several sites. The portion of the node that is injected becomes hyperechoic owing to the formation of microbubbles of gas. After usually less than 1 minute, the hyperechoic zone decreases. The needle is repositioned in the node, and several injections are made mild to moderate pain at injection site, but this resolves within minutes.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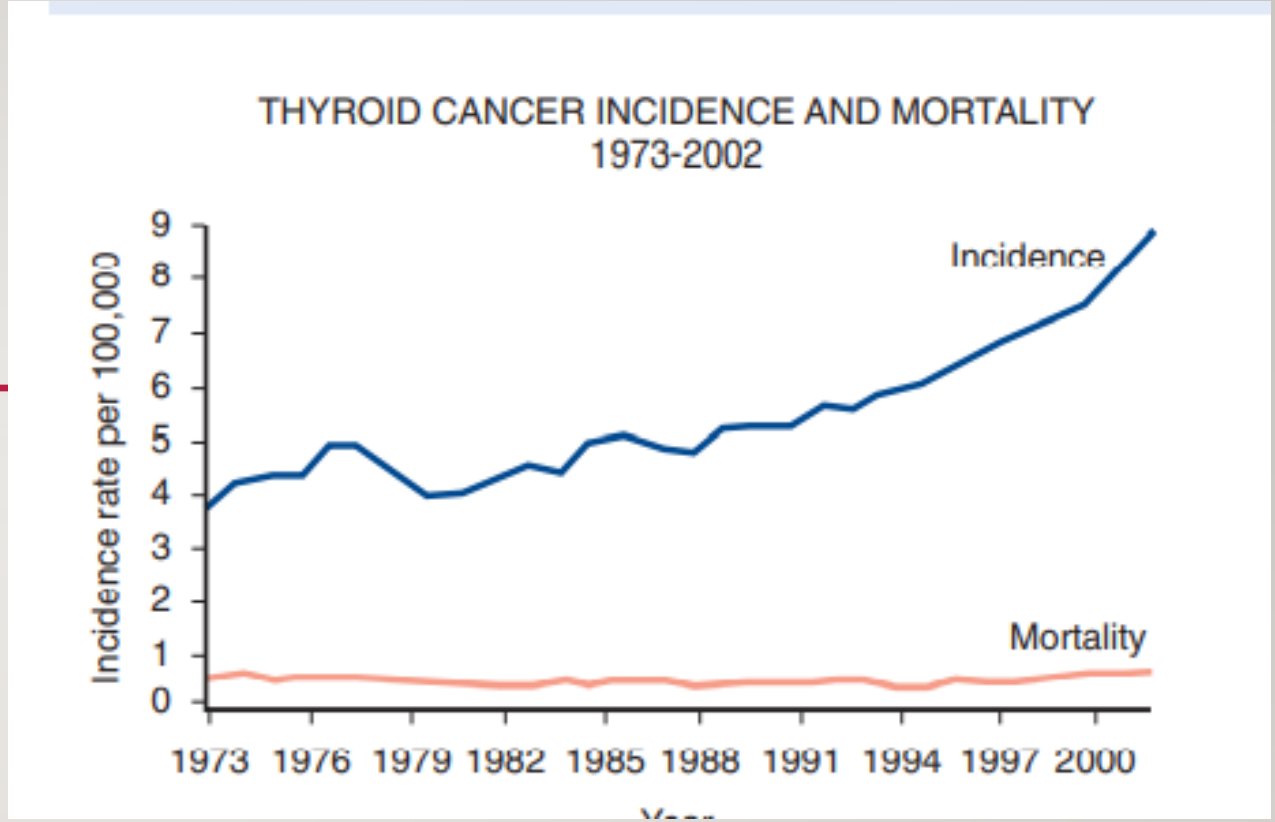
TREATMENT OF CERVICAL NODAL METASTASES FROM PAPILLARY CARCINOMA

- For small nodes about 5 mm in diameter, a single injection may be sufficient. For larger nodes, a reinjection the following day is needed for complete therapy.
- If blood flow was visualized in the node before therapy, it will often be substantially decreased or absent on follow-up. If on 3 or 6 month follow-up the size of the node has not decreased, or if there is residual blood flow on power Doppler examination, a repeat injection is performed. if no vascularity 6-12m F/U
- Thermal ablation of nodal recurrent thyroid cancer has also been tested, with both RFA and laser ablation. In particular, laser ablation seems to be particularly promising in the treatment of nodal metastases from thyroid carcinoma; it is performed using thin (21-gauge) needles, and the energy can be delivered with great precision, allowing avoidance of damage to critical surrounding structures.



Thyroid Cancer: Incidence Versus Mortality. Although the rate of occurrence of thyroid cancer has more than doubled in the last 30 years, the mortality rate is unchanged over that period

WHICH INCIDENTALOMA SHOULD BE NOTICED?

Evaluation of Nodules Incidentally Detected by Sonography

Sonographic Findings	Follow-Up
Nodules < 1.5 cm	Followed by palpation at next physical examination
Nodules > 1.5 cm	Evaluation, usually by fine-needle aspiration
Nodules that have malignant features (marked hypoechogenicity, taller-than-wide shape, thick irregular margins, and/or calcifications or microcalcifications)	Evaluation by fine-needle aspiration

OTHER INTERVENTIONS

- **Percutaneous microwave ablation (PMWA)**
- PMWA is a new technique used to treat thyroid nodules. Due to its novelty, the technique is still scarcely described in literature.
- **High intensity focused ultrasound (HIFU)**
- HIFU is a new mini-invasive technique that induces thermal coagulative necrosis inside the tissues due to high intensity US beam focalized into a target lesion, without skin penetration by devices. This may lead to prolonged duration of the treatment.