The role of ultrasound in the diagnosis and follow-up of thyroid nodules and cancer

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Managing an epidemic of thyroid nodules and thyroid cancer

Mazzaferri. 1993

Schvartz, Marne Ardennes Thyroid Cancer registry, France
Managing the epidemic proportion of prescribed ultrasound scans!

- Widespread use of US
- Main tool for thyroid nodules and cancer
- Place of US in the algorithm for management of patients with thyroid nodules and cancer
- Emergence of new diagnostic and therapeutic technologies
Take home messages in 2013

Standardization of the US scanning procedure

Thyroid nodules
- Pitfalls for diagnosis of thyroid nodule
- Criteria for malignancy
- Indications for FNA
- TIRADS and Elastography

Thyroid cancers
- Classification of neck dissection
- Criteria for malignancy in cervical LN and thyroid bed
- Indications for US, FNA and FNA-Tg

Use of US for management of difficult cases
Epidemic of nodules

Cancer is rare but of good prognosis

Nodule with hyperthyroidism

Need for selection

History, palpation

Low TSH

Normal TSH

Scintigraphy Iode 123

US Suspicious criteria

FNA
US screening only if risk factors

- childhood cervical irradiation
- genetic risk factors: hereditary mutations
  - RET (NEM2)
  - PTEN (Cowden) autosomal disease, inactivating mutation
  - APC (hereditary polyposis)
    - autosomal dominant
    - papillary cancer is rare 2% but precocious, sex ratio F10/1 cribiform
  - PRKAR1A (Carney)
    - inactivating mutation, thyroid tumors 16-28%
  - GNAS (McCune-Albright)
    - inherited PTC

Cowden  Polypose CF  Carney’s C.  McCune-Albright
Standardization of the US procedure

- Recent high-resolution ultrasound system
- High-energy linear (10-14 MHz) and convex probes (6-8 MHz)
- Color and Power Doppler mode indispensable
- Study of thyroid gland, trachea, neck compartments
- After surgery
  - wait 3 months to improve US transmission (thyroid bed)
  - Examination of central and lateral neck compartments
  - Detection of omohyoïd muscle
- Trained operator able to spot the different areas of the neck
- Standardized report including key words and a diagram
Anatomical boundaries
Results and report
Thyroid gland

Volume: Height x width x thickness

Nodule:
- size, location
- shape
- margins, halo
- echostructure
- echogenicity
- microcalcifications
- vascularization

Key words
Systematic use of US key words

- Echostructure
  - Liquid
  - Mixed
  - Solid
  - Majority liquid
  - Majority solid

- Echogenicity
  - Hypoechoic
  - Isoechoic
  - Hyperechoic

+ Margins + Microcalcifications + Vascularization
Diagnosis of thyroid nodules

Pitfalls

Œsophagus

Hyperechoic septum
Color Doppler
Criteria for malignancy

- Color Doppler and Power Doppler

Hypothesis
Type 1 and 2: benign
Type 3 and 4: malignant
Thyroid nodules
Criteria for malignancy

- Large size: no
- Solid Hypoechoic
- More thick than wide
- Irregular margins
- Microcalcifications
- Hyper vascularization
- Increase in volume: no
- Lymph node mets

Papini JCEM 02, Frates 05, ATA 09
# Thyroid nodules

## Criteria for malignancy

<table>
<thead>
<tr>
<th></th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PPV</th>
<th>NPV</th>
<th>OR</th>
<th>( p )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypoechoic</td>
<td>26 - 87</td>
<td>43 - 94</td>
<td>13 - 68</td>
<td>73 - 93</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Microcalcifications</td>
<td>26 - 59</td>
<td>85 - 95</td>
<td>24 - 70</td>
<td>41 - 94</td>
<td>4.97</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>Irregulars margins</td>
<td>17 - 77</td>
<td>39 - 85</td>
<td>13 - 60</td>
<td>39 - 98</td>
<td>16.8</td>
<td>&lt; 10^{-3}</td>
</tr>
<tr>
<td>More thick than wide</td>
<td>32</td>
<td>92</td>
<td>67</td>
<td>74</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intranodular vascularization</td>
<td>54 - 74</td>
<td>79 - 80</td>
<td>24 - 42</td>
<td>85 - 97</td>
<td>14.3</td>
<td>&lt; 10^{-3}</td>
</tr>
</tbody>
</table>

Frates Radiology 05, Papini JCEM 02 (n=402)
US guided FNA
Indications for FNAB

Backgrounds at risk:
- childhood external irradiation
- family history of medullary cancer or MEN2
- Cowden, polyposis, Carney, McCune-Albright
- elevated calcitonine
- Lymph node mets or distant mets

Nodule types at risk:
- increase in volume
- 2 or more suspicious US criteria
- FDG PET CT uptake
- Non significant FNA result
### Consensus on thyroid nodules SFE - GRT 2011

**Nodule size determines the indication for FNA**

<table>
<thead>
<tr>
<th>Nodule Size</th>
<th>Indication for FNA</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤1</td>
<td>Non significant FNA 35%</td>
</tr>
<tr>
<td>≥7mm</td>
<td>FNA if</td>
</tr>
<tr>
<td>≥10mm</td>
<td>- Background at risk</td>
</tr>
<tr>
<td>&gt;20mm</td>
<td>- Nodule type at risk</td>
</tr>
<tr>
<td></td>
<td>Systematic FNA to avoid overlooking pT2 cancers</td>
</tr>
</tbody>
</table>

**FNA is not recommended in the case of:**
- incidentaloma < 1 cm **and** absence of risk factors
- totally cystic nodule
Meta analysis: compressive elastography

8 studies, 639 thyroid nodules, 153 (24% malignant)
Sensitivity 92%, Specificity 90%

Bojunga Thyroid 2010
Shear Wave Elastography: A New Ultrasound Imaging Mode for the Differential Diagnosis of Benign and Malignant Thyroid Nodules


93 pts (146 nodules, 29 cancers) / 39 controls
vascularity, hypoechogenicity, and microcalcifications
EI

Sebag JCEM 2010
SWE elastography

**TABLE 1.** Conventional US patterns and EI in 126 patients (out of 93 patients) with complete data set for all those parameters

<table>
<thead>
<tr>
<th></th>
<th>Benign (n = 99)</th>
<th>Cancer (n = 27)</th>
<th>Sensitivity</th>
<th>Specificity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intranodular vascularity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Present</td>
<td>6</td>
<td>14</td>
<td>51.9 (33.1; 70.7)</td>
<td>93.9 (89.2; 98.6)</td>
</tr>
<tr>
<td>Absent</td>
<td>93</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Microcalcifications</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Present</td>
<td>15</td>
<td>18</td>
<td>66.7 (48.9; 84.5)</td>
<td>84.8 (77.7; 91.9)</td>
</tr>
<tr>
<td>Absent</td>
<td>84</td>
<td>9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Macrocalcifications</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Present</td>
<td>20</td>
<td>6</td>
<td>22.2 (6.5; 37.9)</td>
<td>79.6 (71.7; 87.5)</td>
</tr>
<tr>
<td>Absent</td>
<td>78</td>
<td>21</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Halo sign</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Absent</td>
<td>58</td>
<td>25</td>
<td>92.6 (82.7; 100)</td>
<td>41.4 (31.7; 51.1)</td>
</tr>
<tr>
<td>Present</td>
<td>41</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypoechojenicity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Present</td>
<td>18</td>
<td>19</td>
<td>70.4 (62.4; 78.3)</td>
<td>81.8 (75.1; 88.6)</td>
</tr>
<tr>
<td>Absent</td>
<td>91</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EI</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\geq 65$ kPa</td>
<td>6</td>
<td>23</td>
<td>85.2 (71.8; 98.6)</td>
<td>93.9 (89.2; 98.6)</td>
</tr>
<tr>
<td>$&lt;65$ kPa</td>
<td>93</td>
<td>4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Data are expressed as number of subjects or percentage (95% CI).

SWE: Sensitivity 85.2%, and specificity 93.9%
US: Sensitivity 51.9%, and specificity 97%
both: Sensitivity 81.5%, and specificity 97%.
498 nodules (126 malignant): US, CFD, RTE
At least 1 US criteria: Sen 85%, Sp91%
RTE + US: Sens 97%, NPV 97%

US, RTE, and CFD risk factors in 126 cancers
194 patients with 237 thyroid nodules
58 (25%) cancer
Mode B US, Power Doppler, and US Elastography

USE had a
-limited sensitivity
-a positive predictive value in detecting K
-was not superior to mode B US.
Design: prospective comparative study
Assess diagnostic accuracy of the TI-RADS score using:

- gray-scale US alone
- elastography alone
- the combination of gray-scale score + elastography

Compared with cytological results and histological results.

Russ EJE 2013
<table>
<thead>
<tr>
<th>TI-RADS SCORE</th>
<th>MEANING</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>NORMAL EXAMINATION</td>
</tr>
<tr>
<td>2</td>
<td>BENIGN</td>
</tr>
<tr>
<td>3</td>
<td>VERY PROBABLY BENIGN</td>
</tr>
<tr>
<td>4A</td>
<td>LOW RISK OF MALIGNANCY</td>
</tr>
<tr>
<td>4B</td>
<td>HIGH RISK OF MALIGNANCY</td>
</tr>
<tr>
<td>5</td>
<td>PRACTICALLY CERTAINLY MALIGNANT</td>
</tr>
</tbody>
</table>
SUSPECT PATTERNS

HIGHLY SUSPECT
- Irregular shape taller-than-wide
- Irregular borders
- Microcalcifications
- Markedly hypoechoic
- High stiffness with elastography

- 3 to 5 signs and/or
  - Metastatic lymph node
  TI-RADS SCORE 5

- 1 or 2 signs
  - No metastatic lymph node
  TI-RADS SCORE 4B

MILDLY SUSPECT
- No sign of high suspicion
- Mildly hypoechoic

TI-RADS SCORE 4A
TIRAD 3 = 4.3% K

TIRAD 4B = 32% K

TIRAD 4A = 54% K
BENIGN PATTERNS

VERY PROBABLY
- No sign of high suspicion
  AND
- Isoechoic or Hyperechoic

CONSTANTLY
- Simple cyst
- Spongiform nodule
- “White knight”
- Isolated macrocalcification
- Nodular hyperplasia

TI-RADS SCORE 3

TI-RADS SCORE 2
TI-RADS 2

Simple cyst

Spongiform

Macrocalcification

White Knight

Russ, EJE 2013
<table>
<thead>
<tr>
<th>Imaging method</th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
<th>NPV (%)</th>
<th>Accuracy (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TI-RADS gray-scale score only (3658 cases)</td>
<td>95.7</td>
<td>61</td>
<td>99.7</td>
<td>62</td>
</tr>
<tr>
<td>Elastography only (991 cases)</td>
<td>74.2</td>
<td>91.1</td>
<td>98</td>
<td>90</td>
</tr>
<tr>
<td>Combined TI-RADS (991 cases) Gray-scale + elastography</td>
<td>98.5</td>
<td>44.7</td>
<td>99.8</td>
<td>48.3</td>
</tr>
</tbody>
</table>

NPV, negative predictive value.

ROC curve analysis

Russ, EJE 2013
Take home messages for elastography

TI-RADS GRAY-SCALE score alone has high sensitivity and negative predictive value for the detection of carcinomas.

ELASTOGRAPHY

Is of little help:
- For the detection of thyroid carcinomas, compared to gray-scale score
- For cytological lesions read as suspicious for follicular neoplasms or malignancy

High stiffness should always be considered as suspect (TI-RADS 4B)
Low stiffness does not discard malignancy

More specific elastographic techniques are required:
- Quantitative (avoid color scale)
- Using transmitted waved and not manual compression
  - Shear wave, ARFI

Clinical trial on undetermined lesions
US for thyroid cancer

- Standardization of US procedure
- Lymph node anatomy
- US criteria for malignancy
  - lymph nodes
  - thyroid bed
- Indications for US-FNAB

Good practice guide for US
Leenhardt, Annal of Endocrinol 2011

ETA Guidelines for cervical US scan and US guided techniques in the post operative management of patients with thyroid cancer
ETJ 2013 in press
### UICC pTNM for thyroid cancer

<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1a</td>
<td>≤ 10 mm</td>
<td></td>
</tr>
<tr>
<td>T1b</td>
<td>11 - 20 mm</td>
<td></td>
</tr>
<tr>
<td>T2</td>
<td>21 - 40 mm</td>
<td></td>
</tr>
<tr>
<td>T3</td>
<td>&gt; 40 mm</td>
<td>Extra thyroidal minimal invasion</td>
</tr>
<tr>
<td>T4</td>
<td>Extra thyroidal extension</td>
<td>T4a and T4b</td>
</tr>
<tr>
<td>N1a</td>
<td>Pre and para-tracheal</td>
<td></td>
</tr>
<tr>
<td>N1b</td>
<td>Others</td>
<td></td>
</tr>
</tbody>
</table>

#### Other criteria
- Multifocality
- Number and type of LN
- Histological aggressive subtypes
- Extent of the surgery: R0, R1, R2
- Age <45 ans vs > 45 ans
Sensitivity of diagnostic tests according to the risk level

Pacini 2003
## Dynamic risk assessment of recurrence at 6-12 months after initial treatment

<table>
<thead>
<tr>
<th></th>
<th>2010</th>
<th>Restratification at 6-12 months</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>( n = 588 \text{TuttleThyroid 2010} )</td>
</tr>
<tr>
<td>T1a</td>
<td>( \leq 10 \text{ mm} )</td>
<td>3%</td>
</tr>
<tr>
<td>T1b</td>
<td>11-20 mm</td>
<td>2%</td>
</tr>
<tr>
<td>T2</td>
<td>21 - 40 mm</td>
<td></td>
</tr>
<tr>
<td>T3</td>
<td>( &gt; 40 \text{ mm} ) Extra thyroidal minimal invasion</td>
<td>68%</td>
</tr>
<tr>
<td>T4</td>
<td>Extra thyroidal extension T4a and T4b</td>
<td></td>
</tr>
<tr>
<td>N1a</td>
<td>Pre and para-tracheal</td>
<td>21%</td>
</tr>
<tr>
<td>N1b</td>
<td>Others</td>
<td></td>
</tr>
</tbody>
</table>
Local recurrences

- Neck lymph nodes (LN) 75%
- Soft tissues 5%
- Thyroid bed 20%

- 5 to 20% of patients with DTC
- 70% in the first 5 years
- Depends on the disease stage
- Risk factors for recurrence when N1
  - More than 10 N1, central location
  - More than 3 capsular effractions

49% at 10 yrs

Pacini 03, Torlontano 03, Bernier 04, Pelettari 2008, 2010

Roussel JCEM 04, n=172
Lymph node anatomy

The lymphatic fluid is drained through the lymphatic vessels which drain into lymph nodes.

The lymphatic flow goes through the cortex and the medulla and exits through the hilum.

Metastatic invasion

Cortex
Medulla
Capsule

Tramalloni courtesy
Vascular changes: from a benign to a malignant lymph node

Normal lymph node: Central vascularization

Malignant node: Peripheral vascularization

Sato N, Kawabe R, Fujita K
Neck dissection classification

For an effective communication with your surgeon.

American Head and Neck Society
Robbins KT, 98

Monpeysen H, 2010
US criteria for malignancy
Neck lymph nodes (LNs)

8 US criteria must be assessed:

- size and shape (long axis/short axis<2)
- echogenicity
- hilum
- Irregular borders
- cystic appearance
- microcalcifications
- vascularization
- when LN looks like normal thyroid tissue

*No single US feature is adequately sensitive*

Tramalloni J, Monpeyssen H
## Ultrasound criteria of malignancy for cervical lymph nodes

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Se %</th>
<th>Sp%</th>
</tr>
</thead>
<tbody>
<tr>
<td>L/S &lt; 2</td>
<td>46</td>
<td>64</td>
</tr>
<tr>
<td>No hilum</td>
<td>100</td>
<td>29</td>
</tr>
<tr>
<td>Hypoechogenicity</td>
<td>39</td>
<td>18</td>
</tr>
<tr>
<td>Cystic patterns</td>
<td>11</td>
<td>100</td>
</tr>
<tr>
<td>Hyperechoic punctuations</td>
<td>46</td>
<td>100</td>
</tr>
<tr>
<td>Peripheral vascularization</td>
<td>86</td>
<td>82</td>
</tr>
</tbody>
</table>

*Low sensitivities*  
*Lebouleux 2007*
Neck lymph nodes
4 specific criteria
Neck lymph nodes
Criteria for malignancy

- **Size** is not a good predictor of malignancy
  Most normal lymph nodes have a short axis < 8 mm
  >8 mm: good indicator of malignancy
  The **location** of the LN is useful for decision-making

- **Shape**: rounded

Steinkamp’s index:
Longest / Shortest axis < 2

Steinkamp 1995, Alzahrani, 2005
Neck lymph nodes
Criteria for malignancy

- Non visibility of the hilum

- All lymph nodes with normally echoic hilum are histologically normal

- But hilum is not visible in around 30% of histologically normal lymph nodes

None of the 4 specific signs:
Neither microcalcification
Nor cystization
Nor feature that looks like thyroid tissue
Nor peripheral vascularization

Definition:
Loss of hilum and
Small axis ≥ 8mm in level II and ≥ 5 in levels III and IV
Round shape
Increased central vascularization

Be careful when considering sector II
Please, ask for the Tg result and the initial staging before indicating FNAB
Neck lymph nodes
Criteria for benign LN

- Presence of a hilum
- Long, flat aspect
- L/S > 2
- Neither microcalcifications nor cystization
- Well-vascularized hilum
US evaluation of thyroid bed

- **Normal thyroid bed**
  - hyperechoic area between the trachea and the carotid
  - internalization of carotid and jugular axis
  - thyroid remnant: regular and homogeneous tissue

=> No Indication for US-FNAB nor FNAB-Tg

- **Suspicious thyroid bed**
  - vascularized hypoechoic mass
  - and/or cystization
  - and/or microcalcifications

=> Indication for US-FNAB
Most TB nodules do not show significant growth over several yrs of FW
Median FW: 5 yrs
9% (17/191) increase
Median size : 5 mm (range 2-11mm)
Rate of growth: 1.3 mm/yr

Rondeau G. Thyroid 2011; 21:845
US-FNAB procedure

- Fine needles (25 to 27 Gauge)
- Trained operator and diagram
- Disinfection of the skin and the probe

- Drops are smeared onto glass slides
- Samples are air-dried and stained with MGG stain or aqueous medium

- Contraindications in case of hemostatic problems
- Precautions in case of anticoagulant treatment
- Assessment of the risk/benefit ratio to stop or not aspirin intake
Indications for US-FNAB

- **US-FNAB strongly indicated:**
  - Cystic appearance and/or hyperechoic punctuations and/or peripheral or scattered vascularization and/or when LN looks like normal thyroid tissue: take into account the LN size
  - QOE = +++; SOR= grade 1
  - thyroid bed lesion > 1cm Grade: QOE= +; SOR= grade 1

- **US-FNAB must be discussed:**
  - Loss of hilum and round shape L/S<2 and small axis ≥ 8 mm. Take into account stage, histology, size of the LNs, Tg level. QOE = +++; SOR= grade 1

- **US-FNAB not indicated:**
  - Hyperechoic hilum with no associated malignant criteria
FNAB-Tg washout measurement

- Each FNAB needle is washed with 1mL (Tg free serum).
- Tg measurement by immunometric assay (calibrated to the CRM 457 standard)
- Functional sensitivity 0.1 to 1.0 µg/L

A 1ng/ml cut-off provides
100% sensitivity, 96.2% specificity
97.2% PPV


Distribution of FNAB-Tg concentrations according to final diagnosis
### Indications for neck US

#### Preoperative neck US
- Total thyroidectomy
- $^{131}$I ablation + post-therapy WBS
- TSH, FT4, (FT3) on LT4
- rh-TSH-TG on LT4

#### 3 months
- Undetectable TG
  - No other abnormality
  - Yearly evaluation: Biology + Neck US

#### 6-12 months
- Detectable TG < institutional cut-off
  - No other abnormality
  - Repeat rhTSH Tg at > yearly interval
- Detectable TG and/or other abnormality
  - $^{131}$I + post-therapy WBS
  - And/or surgery

**No neck US if low risk**
**Repeated neck US if high risk**

**Pacini 2006**
**Indications of neck US**

- **Preoperative neck US** is recommended for all patients undergoing thyroidectomy for malignant cytology.

- **After total thyroidectomy and before radioiodine ablation**, a neck US is advised to check the lateral compartments (especially if Nx): *Grade: QOE=+, SOR=grade 1*

- **At 3 to 6 months**: US if uptake outside the thyroid bed or high Tg level or pT4 *Grade: QOE=+, SOR=grade 2*

- **At 6-12 months after initial treatment**, a neck US must be done.

- **During follow-up**, a neck US is recommended if Tg level has become detectable.
In low risk patients

- 1-5yrs: a yearly neck US evaluation is not recommended if rhTSH-Tg is undetectable with normal neck US at the first evaluation (6-12 months) QOE=+, SOR=grade 2
- >5 yrs: a final neck US evaluation with rh-TSH-Tg or LT4-Tg is suggested QOE=+, SOR=grade 1

In high risk patients

- 1-5yrs: neck US follow up is recommended yearly depending on pTNM and Tg QOE=+, SOR=grade 1
- >5yrs: on the results of the risk reassessment QOE=+, SOR=grade 2

Indications of neck US (1-5 and >5yrs)

- Very low risk: unifocal T1a (≤1 cm) N0M0
- Low risk: T1b (>1 cm) N0M0 or T2N0M0 or multifocal T1N0M0
- High risk: any T3 and T4 or any T, N1 or any M1
Indications for neck US

- In case of an elevated serum Tg level at 6-12 months, whatever the risk level, the slope of the serum T level should be considered. In case of increase, neck US can be associated with other imaging.

- After lobectomy (microcarcinoma), neck US for the contralateral lobe and cervical LN is recommended at 6-12 months, and then regular with 2-3 year intervals. Grade: QOE=+, SOR=grade 2.
Management of difficult recurrences

Size and location of the recurrence

1/ Combination of 131I and probe-guided surgery
   Travagli JCEM 1998
   - decisive in 20/54 pts
   - 4 false+

2/ Radioguided surgery using an intraoperative PET probe
   Kim Surgery March 2011
   - 2-6h after injection of FDG
   - 12 pts
   - decisive in 8/12

3/ Charcoal suspension tattoo localization
   - 1-15d preoperatively
   - 15 pts
   - lesions found in 84%
   Hartl Ann Surg Oncol 2009
Alternatives to surgical treatment for recurrent cervical thyroid malignancy: place of ultrasound-guided ablation techniques

- Alcool  
  *Monchik 2006, Kim 2008*

- Laser

- Radiofrequency  
  *Monchik 2006*  
  *FW 40 months*

- HIFU
Ultrasound-Guided Laser Ablation of Incidental Papillary Thyroid Microcarcinoma: A Potential Therapeutic Approach in Patients at Surgical Risk
Caveats.. and future

- Variability of procedure, reports and indications of neck US
- Publication on ETA-US guidelines in 2013
- Further studies are needed to evaluate the:
  - Impact of US detection of small recurrences on survival and quality of life
  - Clinical significance of very small metastases
  - Place of new minimally invasive treatments for recurrences of DTC