Practical Applications of Doppler in Neck US-Principles US course 2019

Dev Abraham MD
Professor of Medicine,
University of Utah
Doppler Physics

• The apparent shift in frequency of sound observed by a stationary or moving receiver (listener) in relation to generator (source).

• if the source is moving away (positive velocity) the observed frequency is lower and the observed wavelength is greater (redshift).

• if the source is moving towards (negative velocity) the observed frequency is higher and the wavelength is shorter (blue shift).

• Doppler Signal Processing and Display
  • Doppler Frequency Spectrum
  • Color Flow
  • Power Mode
Illustration of Doppler Shift
Two types: Color and Power Doppler
Color and Power Doppler

- **Color Doppler**
  - Provides information regarding direction of shift and enable velocity/gradient calculation
  - More useful in vascular studies
  - Larger blood vessels

- **Power Doppler**
  - No information regarding velocity
  - Less angle dependence
  - Less noise
  - Increased sensitivity for detection of flow
  - Useful for detecting low level / smaller vessel blood flow
Uses of Doppler in NECK US

1. Nodular thyroid disease
2. Lymph node assessment
3. Parathyroid adenoma localization
4. Clarification of structures and FNA / PEI planning
5. Intervention – planning and response to PEI
6. Diffuse thyroid disease – Amiodarone induced hyperthyroidism
MOSTLY NOT USEFUL

• Hashimoto’s thyroiditis
• Graves disease

• The ‘GOLD STANDARD’ test is still nuclear I 131 uptake study
Lack of blood flow- Can be an important clue also!

- Papillary thyroid cancer
- Lack of flow in Amiodarone thyroiditis
1. Thyroid Nodules
1. Doppler Uses – Blood flow within Nodules

• User Variability- setting gain properly
• Grading Scales (for thyroid nodules)
  • 1 (absent vascularity)
  • 2 (mostly peripheral vascularity)
  • 3 (peripheral greater than intra-nodular)
  • 4 (predominately intra-nodular)
Grade 1 – No flow to nodule
Grade 2 – Peripheral Flow
Grade 3 – Moderate Central Flow
Grade 3 - Moderate Central Flow

Suspicious for cystic papillary carcinoma
Grade 4 – High Velocity Penetrating Flow
Increased Intra-nodular Flow – Predictive of Malignancy?

NO LONGER CONSIDERED AN INDEPENDENT RISK
Vascularity of nodules - How is it used?

• Consider whether features are suspicious for papillary or follicular cancers.
  • Hypoechoic or features of papillary:
    • Vascularity may be less important
  • Iso or hyperechoic with variable thickness halo:
    • Consider intranodular vascularity as possible risk.

• AACE & 2009 ATA guidelines do consider vascularity.
• Korean guidelines do not consider vascularity
• ATA 2015 guidelines do not consider vascularity
• **Don’t be reassured by absence of vascularity.**
Reduced blood flow in PTC
2. Doppler Evaluation of Malignant Lymph Nodes

Suspicious – Peripheral

Normal – Central/Hilar

Kim et al, JUM 2013
3. Doppler – Parathyroid Glands
4. Targeting of blood flow during PEI
Doppler pre and post PEI LN
5. Doppler for the Clarification of interpretation – Central Compartment Lymph Nodes?

Blood Vessels, Not Nodes
Clarification of Interpretation - Cyst?
Is this nodule cystic or solid?

a. Cystic
b. Solid
Doppler before FNA
Doppler in the diagnosis of Thyrotoxicosis – Definitive test RAI-NM study

• Graves
  • “Thyroid inferno”
  • Peak systolic velocity (PSV) 8-20 cm/sec

• Thyroiditis
  • Various vascular patterns – absent to hypervascular

• Thyrotoxicosis Factitia
  • Minimal intrathyroidal vascular flow
  • Peak systolic velocity (PSV) 3-5 cm/sec

• Amiodarone Induced
  • Type 1 (Grave’s like)– increased or normal flow (ATD – Thionamides, perchlorate)
  • Type 2 (Destructive) – decreased flow (steroids)
Graves Disease
Thyroid Inferno – cannot differentiate from thyroiditis

GOLD STANDARD TEST – RAI UPTAKE STUDY
Summary

- Power Doppler used more often for low flow system assessment in neck sonogram
- Blood flow within nodules – useful if FN FLUS cytology
- Identification of PA and metastatic LN
- Not useful for Graves vs Hashimoto’s
- Useful for differentiating Type 1 (high flow) vs Type 2 (low flow) Amiodarone thyroid disease
- Targeting of vascularity during PEI