Opto-Acoustic Correlation with the Gold Standard; Histopathology

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Symposium Agenda

T. Stavros, MD, FACR
Opto-acoustic Overview: Correlation with the Gold Standard; Histopathology

R. Pijnappel, MD, PhD
MAESTRO Interim results from 75 of the 200 subject MAESTRO Study

J. Veltman, MD, PhD
Downclassification and upclassification of suspicious breast masses using opto-acoustic imaging: Case results for the MAESTRO Study in the Netherlands

R. Mann, MD, PhD
Opto-acoustics as a potential new diagnostic technology in breast care: Clinical implications and future potential applications
The Fundamentals of Opto-Acoustics

• dual fusion imaging
  ✦ fusion 1 - laser light in and ultrasound out
  ✦ fusion 2 - morphology and function
    ✷ morphology
      ✶ gray scale ultrasound
      ✶ OA demonstration of tumor neoangiogenesis
    ✷ function
      ✶ OA demonstration of relative degree of oxygenation / deoxygenation
OA is not a “super” color or power Doppler

color Doppler
1. OA is not angle dependent - Doppler is
2. OA does not require a critical velocity - Doppler does
3. OA does not alias – Doppler does
4. OA has high contrast ratio - Doppler does not
5. OA shows relative deoxygenation - Doppler does not

discrepancy between OA and CDI performance is the rule, not the exception
There is a 0 to 5 or 6 scoring system for 3 internal findings and 2 external findings.
There are other imaging precedents for the (boundary zone) being important -- shear wave elastography zone of stiffness and MRI ring enhancement.

Active growth, high cellularity, high vessel density, and desmoplasia are all in the boundary zone.
8 mm IDC, **grade III**

**typical internal and external boundary zone findings, but absent external peripheral zone findings**
3.5 mm IDC, **grade I**

typical external boundary zone and peripheral zone findings, but absent internal findings
6 mm IDC, **grade II**

typical OA findings in all 3 zones
5 mm colloid and invasive papillary carcinoma

typical circumscribed special type tumors have very thin boundary/capsular zones and tortuous vessels unevenly distributed over surface of lesion
benign fibroadenoma
more than red vs green

thin capsular zone - even normal tissue and benign masses must have both arteries and veins - this is a classically benign appearing capsular vein long, gently curved, uniform diameter, parallel to and draped over surface
benign fibroadenoma

anterior and posterior parallel oriented capsular veins
2 external zone OA findings - pilot - expert reader
benign vs. malignant

pilot T 9-2 % of expert reader OA deoxy blush scores - benign vs. malignant
(intent-to-diagnose; all biopsied and truth panel benign masses)

p = 0.0003

pilot T 9.4 - % of expert reader without ATS OA BZ vessel score - benign vs. CA
(intent-to-diagnose; biopsied masses + TP8 masses)

p<0.0001
pilot ad hoc - mean OA internal total Hgb score and 99% CI - benign vs. malignant ITD population; all biopsies + TP benign; expert reader

OA internal deoxygenated blush score
best internal OA feature

OA external boundary zone score
best external OA feature

+0.2 separation

+1.8 separation
Does it make sense that external OA findings, particularly boundary zone findings, affect OA more than internal findings?

Absolutely, it does!

• It is the battle zone between growing and invading tumor and host response (desmoplastic and immune) to the tumor
• It is where tumor neovessels are densest
• It corresponds to zone of stiffness on shear wave elastography
• It corresponds to “ring enhancement” on contrast enhanced MRI (abnormal leaky neovessels)
• OA boundary zone findings are present in all 3 grades of invasive malignant breast masses
  ✦ internal zone often absent in grade I IDC’s
  ✦ peripheral zone findings often absent in circumscribed grade III IDC’s
boundary zone vessel morphology
invasive malignancy - grades I and II vs. grade III

most vessels in BZ are neovessels

most vessels in PZ are parasitized native vessels

paired a. and v

dot-dash pattern - too small to see individual neovessels
volume average to simulate single beaded tortuous vessel

thick-walled BZ whisker oxygenated parasitized native artery

deoxygenated neovessels
OA external boundary zone blush
numerous tiny neovessels, each too small to resolve individually

BZ - numerous small neovessels too small to see give rise to blush

numerous small BZ vessel giving rise to blush

"whiskers"
Boundary zone blush caused by numerous tiny vessels in invasive malignancy - grades I and II vs. grade III.
peripheral zone vessel morphology
invasive malignancy - grades I and II vs. grade III

most vessels in PZ are parasitized native vessels
paired a. and v

whiskers
dot-dash