Visualizing breast malignancies using the Twente photoacoustic mammoscope

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Angiogenesis
- Angiogenesis results in enhanced blood content at tumor site.
- Hemoglobin provides optical absorption contrast.

Photoacoustic Imaging
- Light pulses are converted into acoustic pulses at absorbing sites.
- Acoustic pulses are detected using ultrasound.
- Arrival time of pulses localizes position of absorber.

Background
- Forward mode, planar geometry
- 1064 nm, 10 ns pulsed light
- 90 mm diameter, 1 MHz unfocused US detector array
- Reconstruction by 3D backprojection

Clinical study
- Medisch Spectrum Twente
- Adult female patients with symptomatic breasts
- Inclusion based on level of suspiciousness from conventional imaging
- Results are compared with X-ray, US, MRI and histopathology

Phase 1 & 2:
Nr. of subjects: 60-80 (BI-RADS 3,4,5)
Goals:
- Improve measurement methods
- Find photoacoustic malignancy markers
- Guide developments towards PAM II

Phase 3:
Nr. of subjects: 20 (BI-RADS 1,2)
Goals:
- Evaluate absence of malignancy markers
- Guide developments towards PAM II

Results
- 10 malignancies, 2 cysts, 1 control
- All malignancies visible as high contrast areas
- Measurement time too long: 4x4 cm², 25 minutes
- Lesion size underestimated

Used patient data for stepwise technological improvements
- 16 malignancies, 5 cysts, 1 fibroadenoma
- Faster system and larger Field of View: 9x8cm² in 10 minutes
- All malignancies are visible using PAM
- Highly varying appearance of malignancies
- More standardized measurements allow for coregistration with X-ray image

44 year old patient with infiltrating ductal carcinoma
- Annual check at center for breast care after history of cancer in left breast
- Clinical investigation: palpable mass in lateral quadrant right breast.

Progress and plans
Progress
- Cooperation with department of pathology for evaluation of vascularity
- Cooperation with Erasmus MC/Luminostix for combined PAM and SFR measurements.

Plans:
- Control study in healthy breasts
- Investigation of photoacoustic appearance of cysts
- Improvements in data handling and quantification.