

Photoacoustic visualization of inflammation in an arthritis mouse model: First results of ex-vivo knee study

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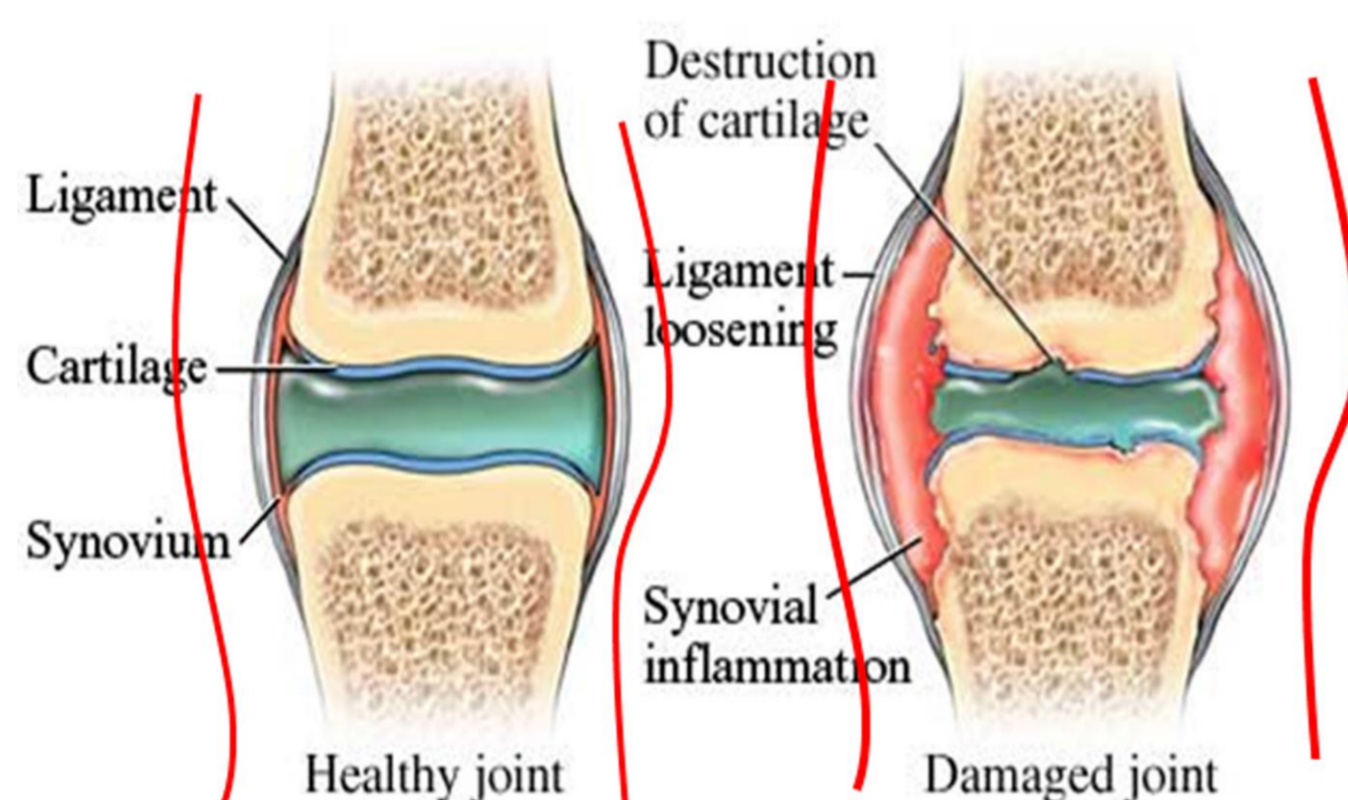
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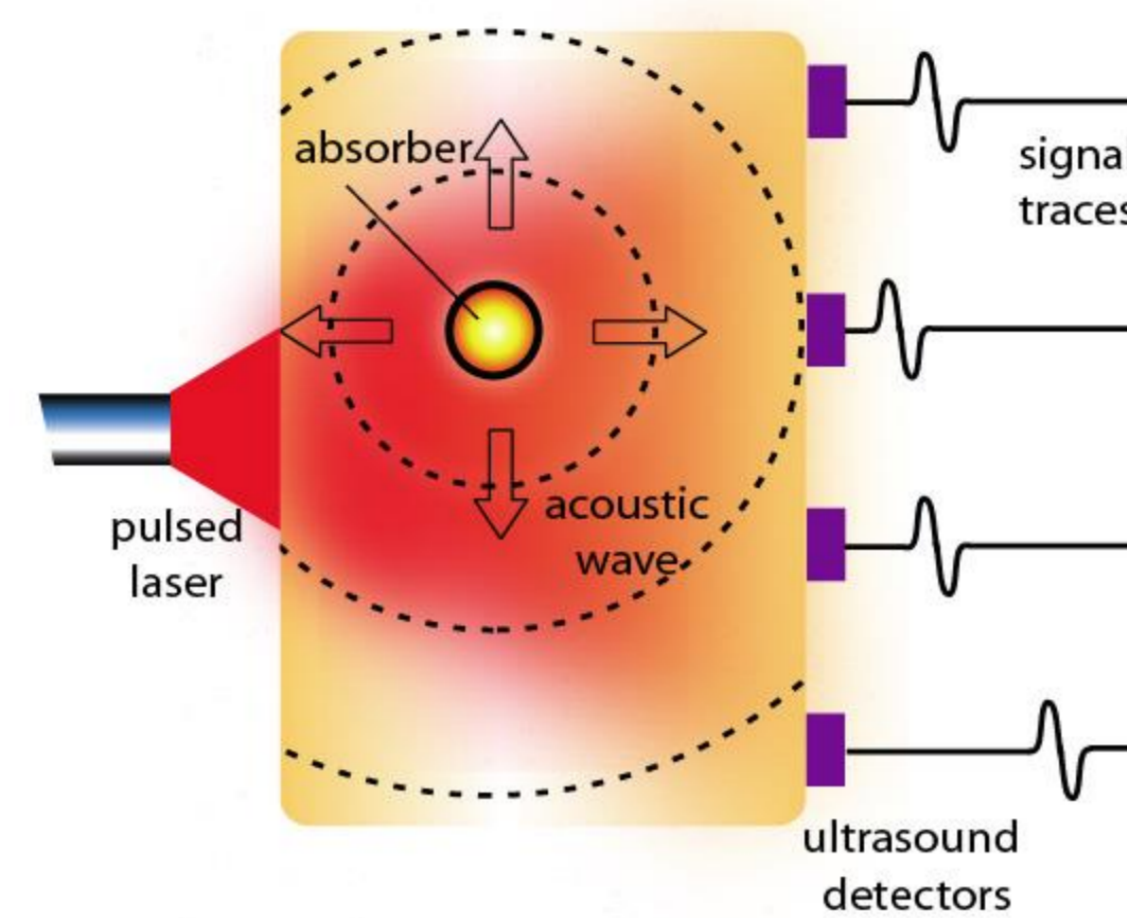
Rheumatoid arthritis (RA) in joint and optical contrast

- Inflammation in RA results in enhanced blood vessels around the joint.
- Increased concentration of hemoglobin provides absorption contrast for photoacoustic signal detection using light



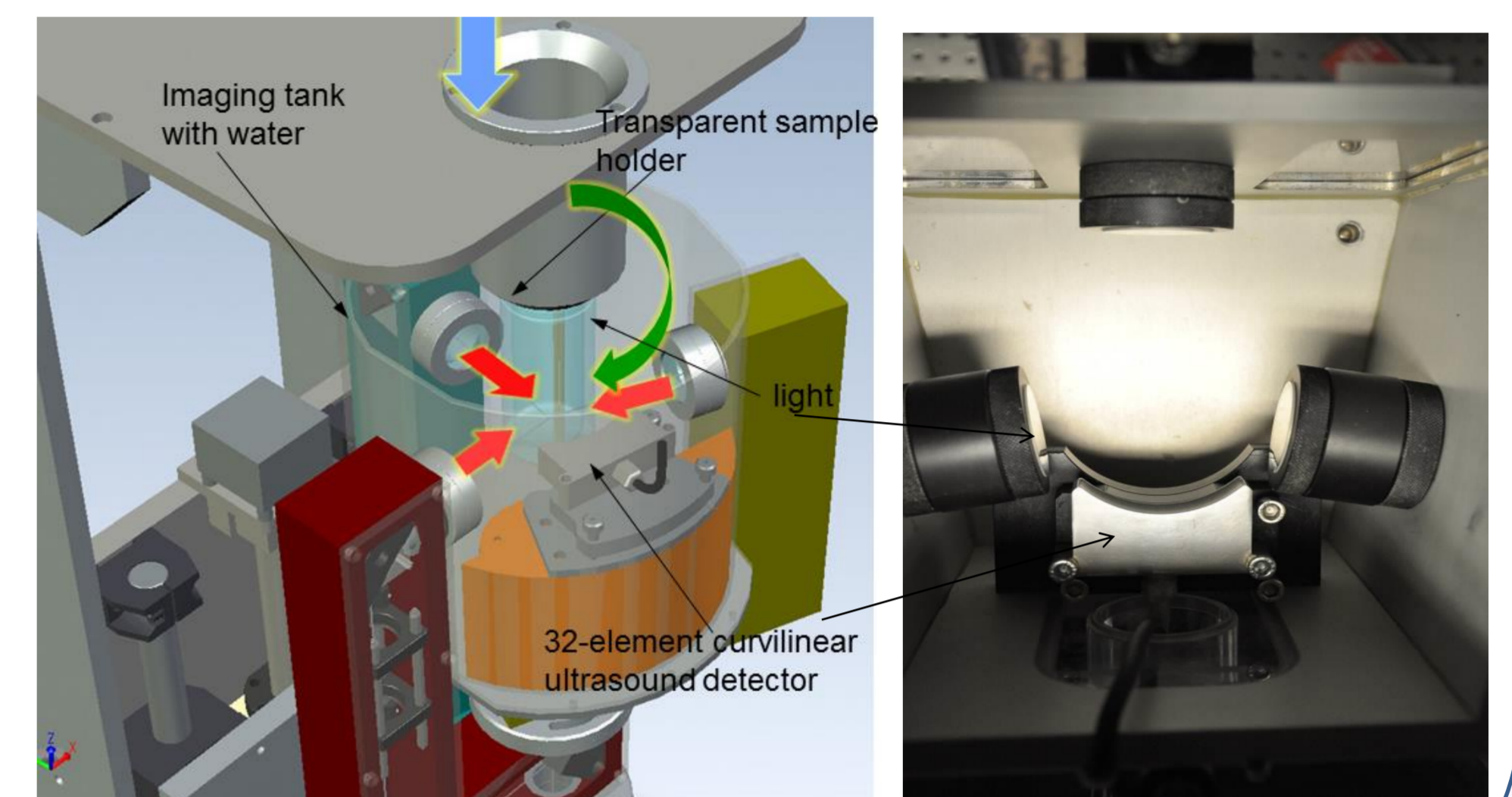
Photoacoustic imaging

- Light pulses converted to acoustic pulses at absorbing sites in tissue
- Acoustic pulses detected using ultrasound detectors
- Arrival time of pulses localizes position of absorber



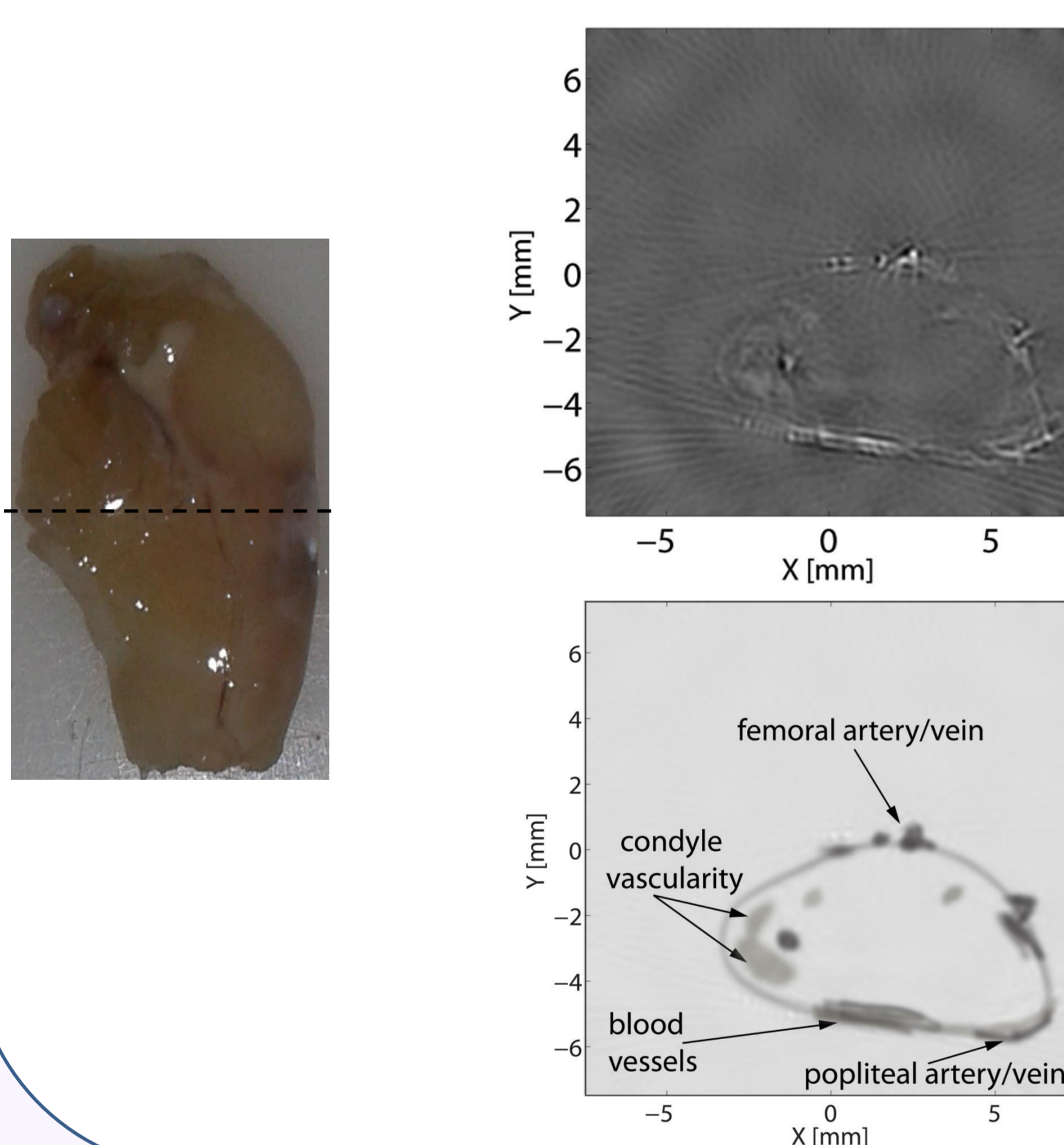
Photoacoustic computed tomography

- 720 nm, 6 ns pulsed light for excitation
- 32 element array detector, $F_c = 6.25$ MHz, 80% bandwidth¹
- 12 projections for tomography

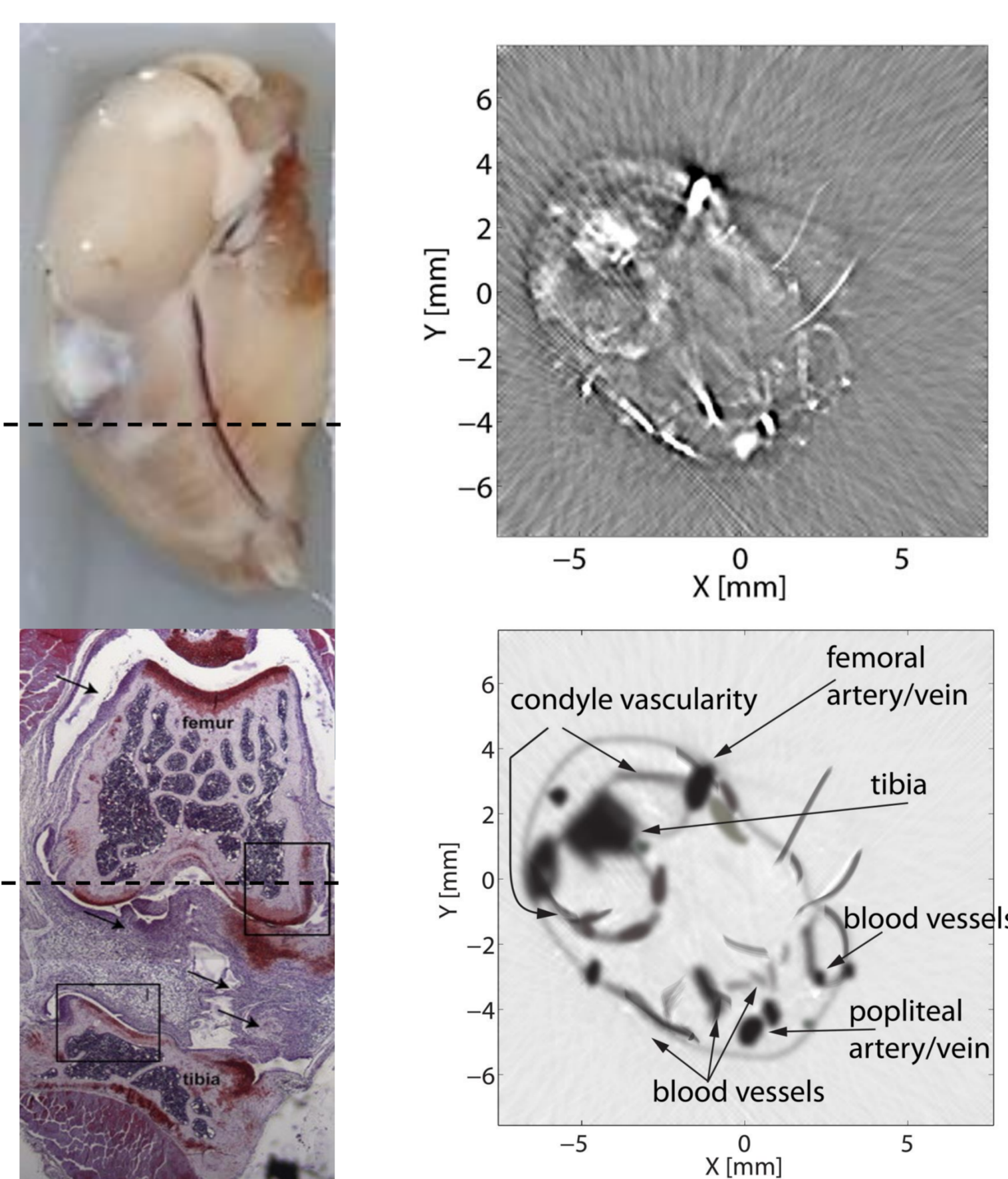


¹Jithin Jose et al., Medical Physics, 2012

Case 1: Normal mouse knee



Case 2: Inflamed mouse knee



Discussion

- High intensity regions correspond to higher optical absorption due to hemoglobin concentration
- Heterogeneous micro blood vessels distribution indicates possible vascularization associated with RA inflammation
- The region around the knee joint shows photoacoustic response. Photoacoustic computed tomography (PACT) may provide useful synovial information around the femur condyles²

²J. L. Tremoleda et al., EJNMMI Research, 2011

Conclusion:

- Images show that PACT can see small blood vessels and peripheral changes in and around the inflamed mouse knee joints.
- Artifacts are present associated with FBP reconstruction algorithm and non-uniform illumination

Planned study:

Compare MRI and Micro CT, PAT Imaging

Goals:

- Find photoacoustic markers in RA affected joints
- Study various degree of inflammation at knee joints
- Guide developments towards finger joint RA imager

Outlook:

- Improve measurement speed and reconstruction algorithm
- Measure on a large number of knee joints with different amount of inflammation
- Perform histological validation

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