UNIVERSITY of ROCHESTER

Cone it Down: a countdown of the top 10 cone beam breast CT pearls

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The authors have nothing to disclose

Goals and Objectives

- The purpose of this education exhibit is to explore the top 10 reasons why cone beam breast CT should be considered.
- After taking part in this exhibition the learner will be able to compare the standard imaging modalities including mammogram, tomosynthesis, ultrasound and MR, with the emerging technology of CBCT.
- Multimodality assessment of pathology will ultimately define the benefits and drawbacks of each imaging modality used in diagnostic breast imaging.

10

True 3D images are obtained

True isotropic 3D images are obtained

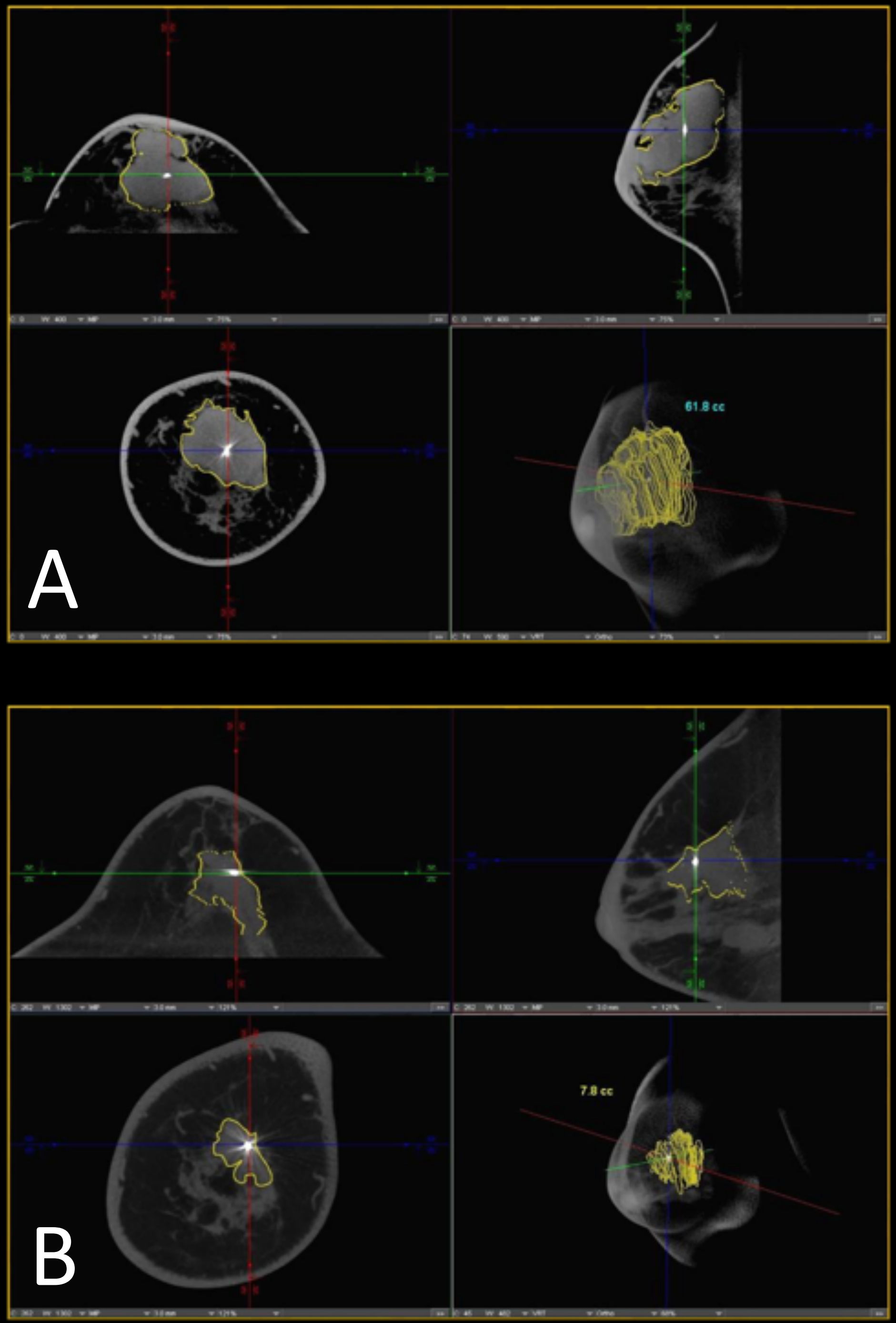
- One image is obtained and all viewing planes are immediately available
- In this way Cone Beam Breast CT (CBBCT) is able to demonstrate the most true anatomy of the breast without distortion
- How?
- The xray tube and detector rotate a full 360 degree rotation and acquire 300 low dose projection images within **10 seconds** without compression
- Acquired projection images can then be reconstructed using cone beam CT reconstruction algorithm to create a 3D isotropic image of the breast
- 3D and reformats in any plane can be instantly available (sagittal, coronal and axial)

Modality	Yes	No	Comments
Mammography		✓	2D images created
Tomosynthesis		✓	3D images created from 2D
Ultrasound		✓	User dependent, limited 3D reformats
MR	✓		Comparable

Image acquisition video

What does 3D imaging mean?

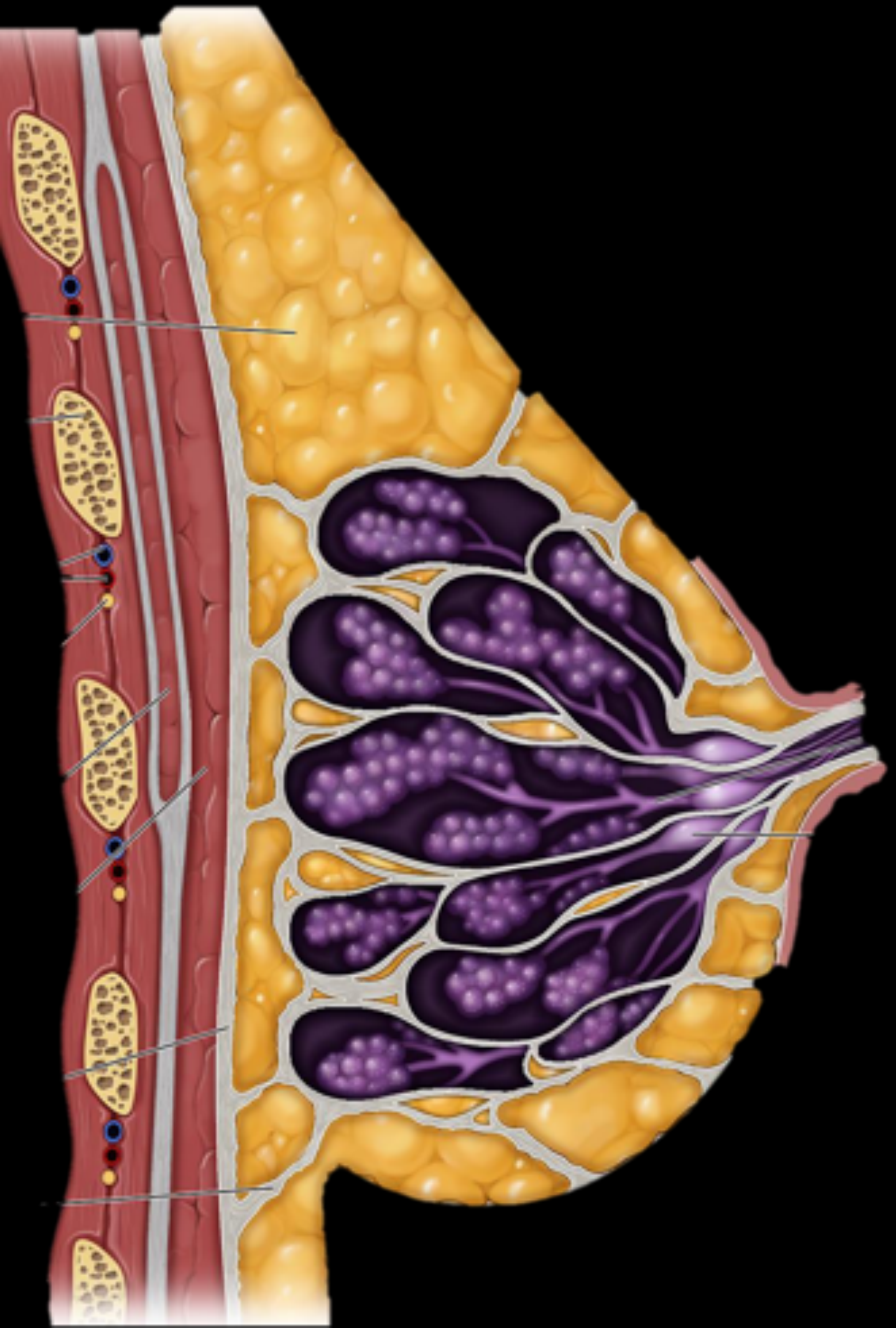
- More accurate pre surgical planning
- Volumetric analysis (for neoadjuvant treatment response)
- Quantitatively detect rupture/leak of implants
- Downgrade BIRADS (decreasing false positives and recalls, decreasing additional imaging/biopsy, healthcare cost)
- Improve diagnostic accuracy



Volume analysis of a breast cancer patient to evaluate treatment response. The first evaluation shows 61.8 cc (A)and follow up imaging shows 7.8cc (B), demonstrating treatment response

9

No Compression

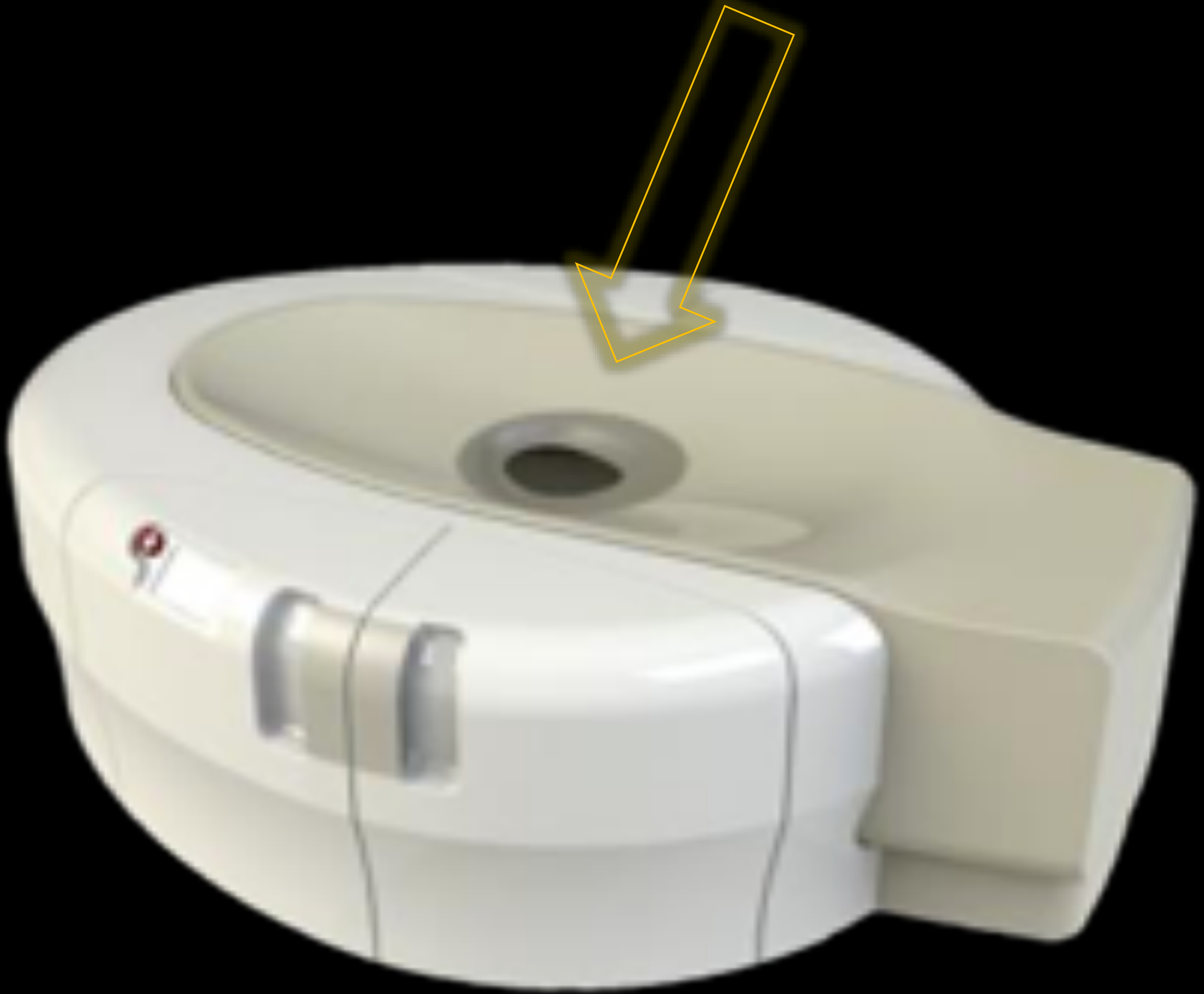


No Compression

- In mammography, breast compression is applied to reduce the thickness of the breast.
- Compression is done with ~20 pound and at least twice (2 views minimum)
- Although controversial some studies have linked pain with decreased compliance of patient screening.
- Cone beam CT allows for no compression and demonstrates the true anatomy of the breast

- Comfortable scanner where the patient is able to lay on the table and the breast is pendant into the machine

Breast Goes here



Is Compression Necessary?

Modality	Yes	No
Mammography	✓	
Tomosynthesis	✓	
Ultrasound		✓
MR		✓

8

Iodine Contrast Compatible

Iodine contrast compatible

- A maximum bolus of 100 cc of non-ionic contrast is used
- Contrast used in CBBCT has been long used in CT imaging without complication
- Increased concern regarding gadavist deposition in the brain, especially in high risk patients who receive yearly MRI screening from a younger age.
- Dual energy contrast enhanced mammography is iodine compatible however in comparison to CBBCT requires additional time and efficient positioning to ensure all views are obtained.

Contrast comparison

Modality	Yes	No	Comments
Mammography	✓		Dual energy contrast enhanced mammography with iodine contrast. Currently not widely used.
Tomosynthesis		✓	Contrast is not currently being used in tomosynthesis.
Ultrasound	✓		Ionosphere bubbles can be used, but not common practice.
MR	✓		Gadavist contrast used.

7

Biopsy Capable

Biopsy Capable

- Biopsy capability with accurate targeting of asymmetry/mass
- Biopsy bracket system which can be rotated 360º for shortest skin to lesion distance
- Potential to evaluate surrounding vasculature around tumors

Modality	Yes	No
Mammography	✓	
Tomosynthesis	✓	
Ultrasound	✓	
MR	✓	

Image Source:
Guangxi Tumor Hospital, Guangxi, China

- Grid is used for accurate biopsy planning and measurements.

- Capable of taking real time images without significant hardware artifact to demonstrate accurate biopsy position.
- Easy post clip deployment without significant artifact on subsequent images.

6

Radiation Comparison

Radiation

- Radiation dose of CBBCT is comparable to diagnostic mammography.
- CBBCT has 5.8 mGy for standard breast (13 cm in diameter, 10 cm in length, tissue/fat ratio 20/80)
- Mean AGD range in diagnostic mammography is 31.6 - 36 mGy (due to multiple views and magnifications)
- Screening mammography has approximately an average glandular dose (AGD) of 3.2 – 5 mGy (2 views CC and MLO)
- Tomosynthesis comparison

Modality	Yes	No
Mammography	✓	
Tomosynthesis	✓	
Ultrasound		✓
MR		✓

5

Field of View and Coverage

Field of View and Coverage

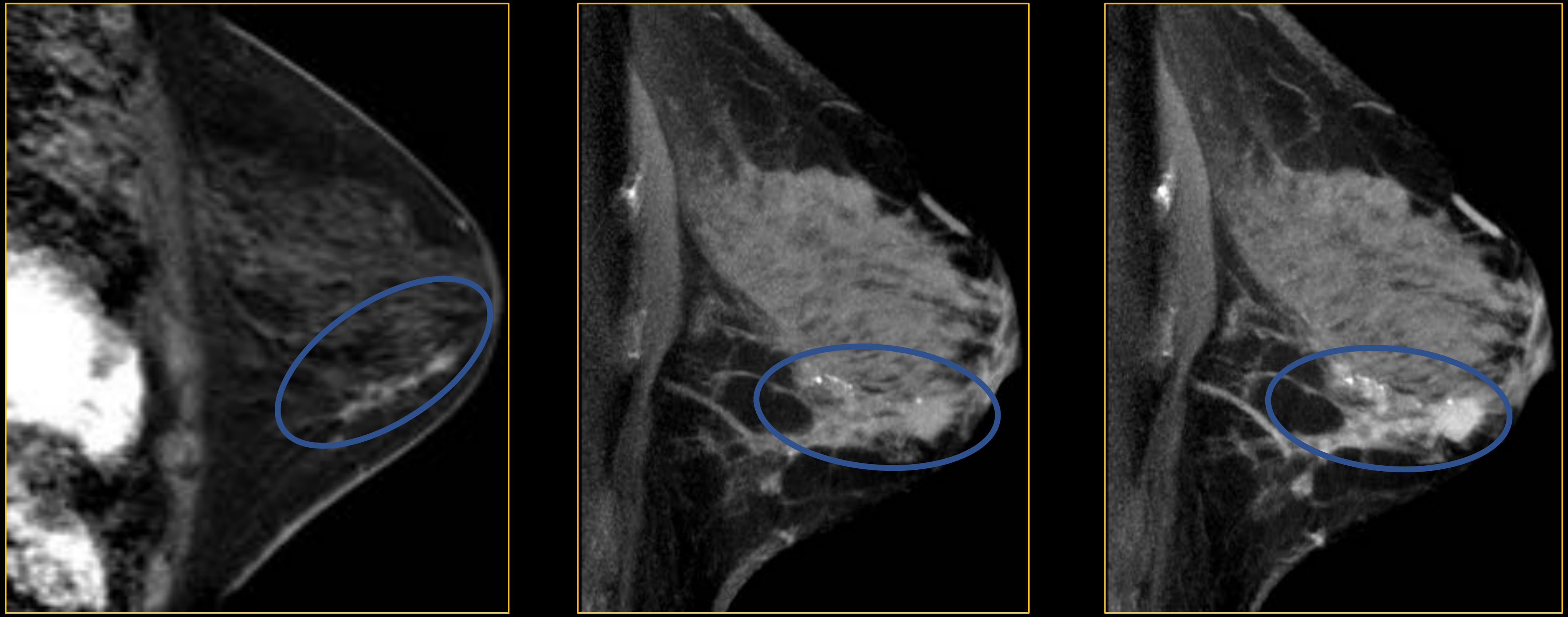
- CBBCT able to obtain information from the entire breast including the axilla and chest wall.
- The field of view and coverage in CBBCT is comparable to MR while requiring a fraction of the table time.

Is the Field of View large with complete coverage ?

Modality	Yes	No	Comments
Mammography		✓	2D limited field of view
Tomosynthesis		✓	2D limited field of view
Ultrasound		✓	User dependent
MR	✓		

MRI and CBBCT comparable resolution and coverage

Comparison of invasive ductal carcinoma with DCIS involving the inferior breast on MR, noncontract CBCT and post contrast CBCT



CBBCT vs MRI resolution comparison

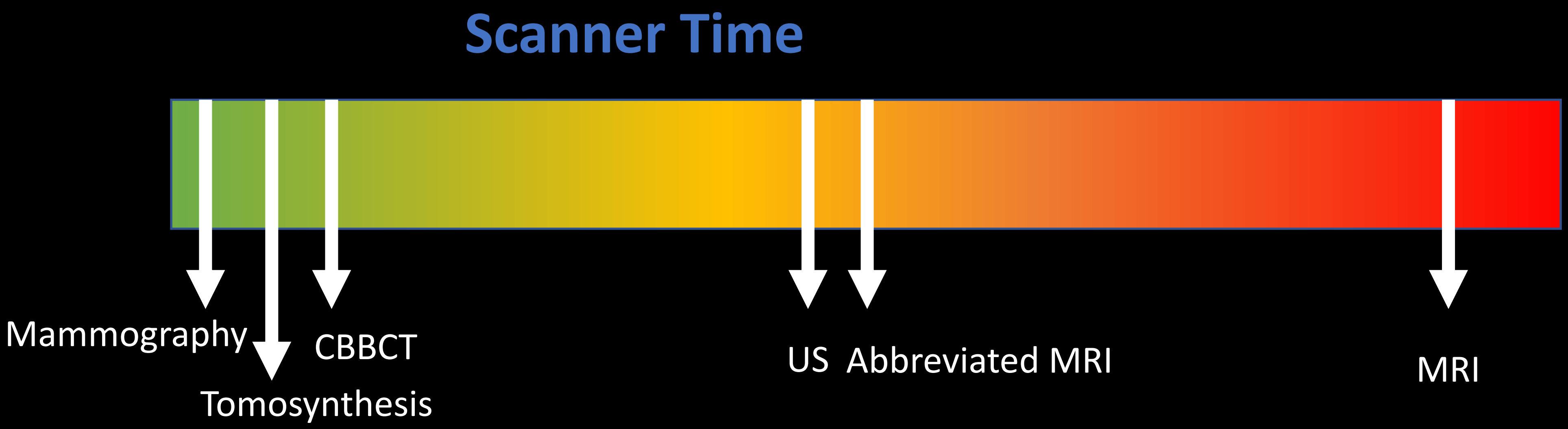
- 3T: in plane spatial resolution- 0.8 x 0.8 mm
  (Slice thickness down to 1.8 mm)
- 1.5T : Spatial resolution can be 1.03 x 1.03mm
  (Slice thickness down to 2 mm)
- CBBCT isotropic 0.273mm standard resolution
  (can be further configured to isotropic 0.155mm, high resolution)

4

Scanner Time

Scanner time

- CBBCT scan takes 10 seconds per breast for a total of 20 seconds
- MRI Scan time is approximately 4 to 8 minutes per sequence resulting in approximately 40 minutes the entire scan. Abbreviated MRI takes



3

Patient cultural and privacy considerations

Patient cultural and privacy considerations

- Some patients and cultures may feel the mammographic exam is intrusive, especially if patients are coming from countries where breast screening is not implemented.
- There is a lot of manipulation of the patient for a screening mammogram with compression for CC and MLO views of each breast. If the patient is called back for diagnostic mammograms additional spots and lateral images are be obtained. All of this together can be uncomfortable for patients.
- In CBBCT the key is to manipulate the images not the patient.
- The patient lies prone on the scanner, with the breast pendant into an opening which they can place themselves.
- A 10 second scan is obtained of each breast and the patient examination is complete. No additional manipulation is required.
- The patient is essentially covered for the entire examination.

2

Risk Based Screening

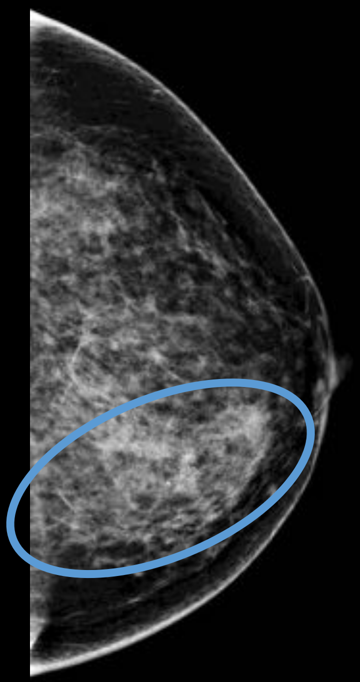
Risk Based screening

- Risk based screening has evolved in every field of medicine as our understanding that each patient is not the same and some individuals have an increased risk for certain pathologies.
- Over the years we have established screening tools that help those more susceptible to specific disease entities. For example:
  - CT lung screening in smokers, 1 time ultrasound evaluation for aneurysm in smokers, earlier colonoscopies for those with familial adenomatous polyposis
- Why does this matter in breast imaging?
- Although screening has improved cancer detection, radiologists are able to detect less than <50% of cancers in dense breasts and ~40% of women in the US have dense breasts.
- There is also an additional risk of cancer in dense breast vs fatty breasts (4-6x relative risk) putting this subgroup of patients at increased risk for cancer and later detection of cancer
- This subgroup of patients needs better screening tools, the use of other modalities is a step in the right direction and CBBCT should also be considered as a cost-effective fast tool

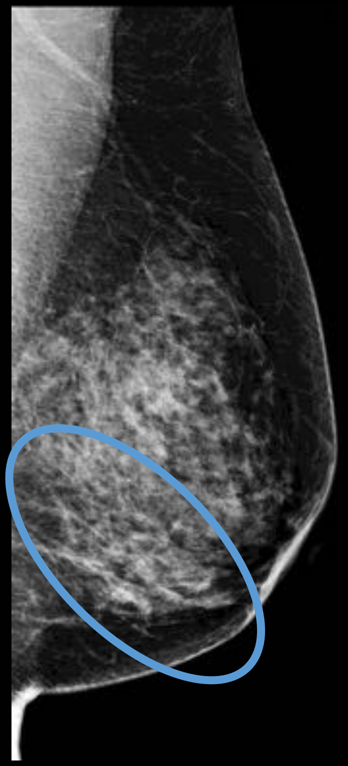
CBBCT is more sensitive looking for cancers in dense breasts

Findings the appropriate test for risk bask screening leads to:

- Better treatment. Longer survival.
- Less invasive surgery
- Less axillary lymph node surgery
- Less radiation therapy
- Less or no chemotherapy



CC



MLO

CBBCT

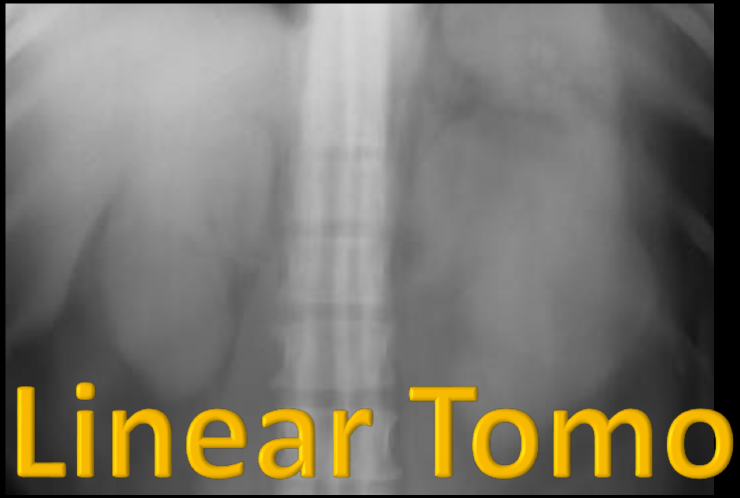
1

Cancer detection Paradigm Shift

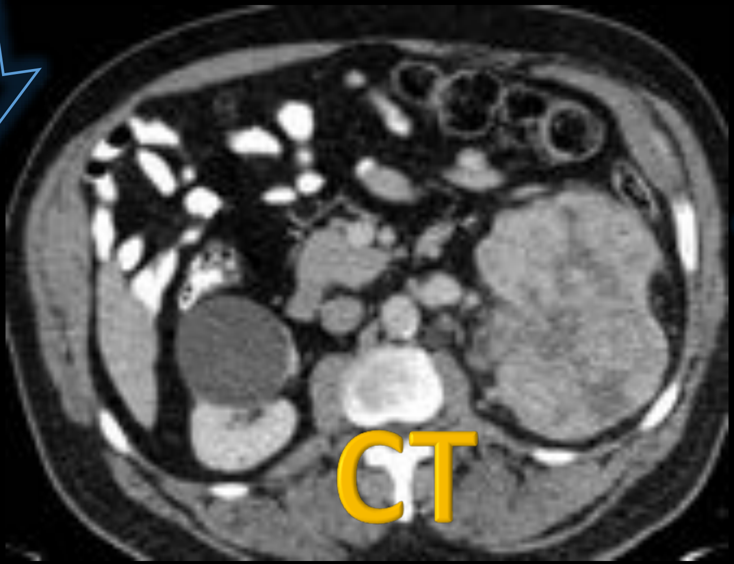
Is it time for a paradigm shift?

- The evolution of cancer detection has led to better imaging practices in many fields
- The recent shift to lung cancer screening to low dose CT is only now showing the decreased mortality
- Most diagnostic and post treatment cancer detection uses contrast
- Post contrast mammography is a step in the right direction, however there are draw backs:
- Still need 2 views per side
- One side at a time
- Timing issues
- Compression will affect vascular flow

The Evolution of RCC detection



True 3D images



Compare these 2 techniques. It would be difficult to return to plain film for diagnosis.

Additional Reasons to Consider CBBCT

- Although Cone Beam CT is not a new technique its use in breast imaging is novel, with the potential of becoming a valuable adjunctive diagnostic tool.

- Better for dense breasts
- Contrast ready
- Can reduce recalls
- Reduce need for ultrasound
- Reduce short interval follow ups
- Reduce number of negative biopsies
- May substitute for MRI for those with contraindication
- More comfortable
- Less costly

Summary

10 True 3D images are obtained

9 No Compression

8 Iodine Contrast Compatible

7 Biopsy Capable

6 Radiation

5 Field of View and Coverage

4 Scanner Time

3 Patient Cultural and Privacy Considerations

2 Risk Based Screening

1 Cancer Detection Paradigm Shift

References

- Andrews F. Pain during mammography: implications for breast screening programmes. Australas Radio. 2001;l 45:113–117.
- Boyd NF, Guo H, Martin LJ et al. Mammographic density and the risk and detection of breast cancer. N Engl J Med. 2007; 356:227–236.
- Dullum JR, Lewis EC, Mayer JA . Rates and correlates of discomfort associated with mammography. Radiology. 2000; 214:547–552
- Keefe FJ, Hauck ER, Egert J, Rimer B, Kornguth P. Mammography pain and discomfort: a cognitive-behavioral perspective. Pain . 1994; 56:247–260.
- Mendat CC, Mislan D, Hession-Kunz L. Patient comfort from the technologist perspective: factors to consider in mammographic imaging. Int J Womens Health. 2017;9:359–364.
- O'Connell A, Conover DL, Zhang Y et al. Cone-beam CT for breast imaging: radiation dose, breast coverage, and image quality. AJR Am J Roentgenol. 2010; 195:496–509
- O'Connell AM, Kawakyu-O'Connor D.Dedicated cone-beam breast computed tomography and diagnostic mammography: comparison of radiation dose, patient comfort, and qualitative review of imaging findings in BI-RADS 4 and 5 lesions. J Clin Imaging Sc. 2012; 2:7
- Zhao B, Zhang X, Cai W, Conover D, Ning R. Cone beam breast CT with multiplanar and three dimensional visualization in differentiating breast masses compared with mammography. 2015; Eur J Radiol 84:48–53.