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Tomosynthesis Mammography

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Abstract

Advanced digital mammographic technology such as digital breast tomosynthesis is an exciting new development for breast cancer screening and diagnostic applications . An understated but important aspect of DBT theory is that the basic technology used is mammography. To date, mammography is the only screening imaging technology which has proven itself in randomized controlled trials to show survival benefit . Improvement in mammographic technology with DBT would therefore be closer to the original mammographic methods than other competing technologies such as MR, ultrasound, or CT with the clinical implication of improved screening. This study discusses recent developments in advanced derivative technologies associated with digital mammography. Digital breast tomosynthesis – its principles, development, and theoretical aspect are reviewed.Radiographic imaging techniques ,c ombined imaging systems with digital mammography and ultrasound and Potential Clinical Benefits are also discussed. Although all these methods are currently research programs, they hold promise for improving cancer detection and characterization if early results are confirmed by clinical trials.

Keywords: *Tomosynthesis, Breast Cancer,Digital imaging technique, Theory, Mammography, Ultrasound, Clinical Benefits*

INTRODUCTION

Breast tomosynthesis is a three-dimensional imaging technology that involves acquiring images of a stationary compressed breast at multiple angles during a short scan. The individual Images are then reconstructed into a series of thin high-resolution slices that can be displayed individually or in a dynamic ciné mode. Reconstructed tomosynthesis slices reduce or eliminate the problems caused by tissue overlap and structure noise in single slice two-dimensional mammography imaging. Digital breast tomo synthesis also offers a number of exciting opportunities including improved diagnostic and screening accuracy, fewer recalls, greater radiologist confidence, and 3D lesion localization.1,2 As no tomosynthetic system is currently clinically approved by the Food and Drug administration for use in the United States, there are differences of opinion regarding what the "best" clinical practice acquisition and display methods will be 3. Of particular interest is whether DBT would replace conventional mammographic views or would be an adjunct to current mammographic views or some combination of the two. The number of DBT views and number of conventional views that would constitute a "routine mammogram" have not been determined. From a physician's standpoint, one may consider two extremes and then postulate multiple hybrid reading scenarios. If tomosynthesis is extremely sensitive for masses and calcifications, it may be theoretically possible that a single tomographic view would constitute a routine "mammogram". Masses, calcifications, distortions, etc. would all be detected. determined. This determination may be manufacturer dependent, technology dependent, and likely will be a compromise among sensitivity, dose, and practice guidelines. Different manufacturers may seek to solve the same problem with different theories and methods to achieve the same end point result 4.

In review of several early experimental clinical DBT studies, These DBT studies for masses have generally shown good patient acceptance, physician preference for DBT images, improvement in sensitivity, improvement in characterization, and often longer physician reading times 5-8. The findings with calcifications have been mixed. The test is neither 100% sensitive nor 100% specific. The real world performance of DBT may be different than these experimental clinical studies because actual decisions regarding clinical care are not made in these studies.

In the present study,several derivative digital technologies being developed to overcome the weakness of conventional mammography (film screen and/or digital mammography) will be discuss. The emphasis will be on digital breast tomosynthesis with secondary discussion of contrast-enhanced digital mammography and combined digital mammographic and ultrasound equipment.

Digital Breast Tomosynthesis Mammography

Digital breast tomosynthesis mammography (DBT) is one technology being developed to improve detection and characterization of breast lesions especially in women with non-fatty breasts. In this technique, multiple projection images are reconstructed allowing visual review of thin breast sections offering the potential to unmask cancers obscured by normal tissue located above and below the lesion. DBT involves the acquisition of multiple projection exposures by a digital detector from a mammographic X-Ray source which moves over a limited arc angle 2-11. These projection image data sets are reconstructed using specific algorithms. The clinical reader is presented with a series of images (slices) (figure1)through the entire breast that are read at a workstation similar to review of a CT or MRI study. Because each reconstructed slice may be as thin as 0.5 mm, masses and mass margins that may otherwise be superimposed with out of plane structures should be more visible in the reconstructed slice. This should allow visualization (detection) and better characterization of non-calcified lesions in particular.

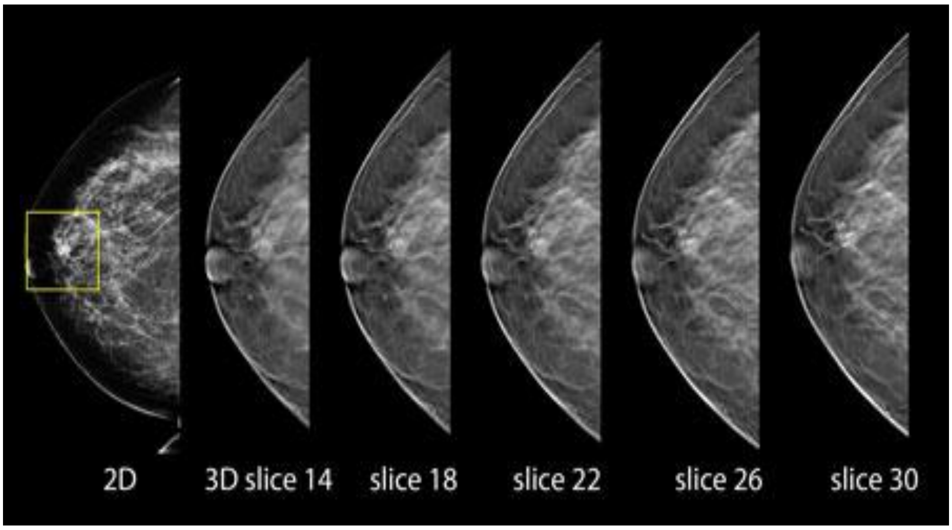

Figure 1 Series of Breast Images (slices)

Theory of Tomosynthesis:

Conventional x-ray mammography is a two-dimensional imaging modality. In conventional mammography, pathologies of interest are sometimes difficult to visualize because of the clutter of signals from objects above and below. This is because the signal detected at a location on the film cassette or digital detector is dependent upon the total attenuation of all the tissues above the location.

Tomosynthesis 1,2,3,4 is a three-dimensional method of imaging that can reduce or eliminate the tissue overlap effect. While stabilizing the breast, images are acquired at a number of different x-ray source angles. Objects at different heights in the breast display differently in the different projections. In theory DBT, with thin section display, should allow superior detection of lesions that historically have been masked by overlying tissue. The primary benefit of DBT would be expected to be for non calcified mammographic findings such as masses, asymmetries and distortion. In the most basic application, DBT would allow visualization of cancers not apparent by conventional mammography thus improving sensitivity.5,6 While many regard tomosynthesis as a technique for dense breast tissue, it may also have significant applications for those patients with non-dense breasts by allowing detection of smaller lesions. This is a variant of improved sensitivity as a decrease in size at time of detection may be associated with improvement in clinical outcome. DBT also offers the possibility that characterization or specificity may be increased by better assessment of detected lesions and reduction in false positive recalls. This is because the margin of a mass or character of an asymmetry may be better visualized. Malignant lesions may appear "more" malignant and benign lesions "more" benign. If these concepts are born out, DBT may allow for improved sensitivity coupled with improved specificity. Recall rates for asymmetries and possible masses may be lowered if DBT better depicts the morphologic characterization of such findings. Diagnostic evaluation of potential masses and asymmetries found by screening mammography could also be a DBT function. It is unlikely that calcification characterization would improve dramatically.7,8,9

Imaging Technique:

The advent of digital mammography and computer reconstruction algorithms has allowed derivative technology to be developed including tomosynthesis. In conventional digital mammography, a compressed breast is exposed to ionizing radiation. Energy which passes through the breast is transformed into an electrical signal by a detector which produces the clinical image.

10,11 The x-ray tube is stationary, the breast is stationary, and the detector is stationary. The image that is produced in any one projection such as a CC or MLO view is a two-dimensional representation of three-dimensional space. Each pixel is therefore an average of the information obtained through the full thickness of the breast. A three-dimensional depiction of the breast would be advantageous similar to three-dimensional depictions allowed by CT, MR, or ultrasound scanning.12-15.

In digital breast tomosynthesis, the x-ray tube is moved through a limited arc angle while the breast is compressed and a series of exposures are obtained . These individual exposures are only a fraction of the total dose used during conventional digital mammography. The total dose used should be within FDA limits and is expected to be near or slightly above the routine mammographic dose if DBT becomes clinically approved. A major consideration for DBT manufacturers and regulators is the balance between dose and image quality. Because image quality tends to be directly related to dose, compromises are necessary. All manufacturers have produced equipment with dosing parameters less than current FDA limit of 300 millrads per exposure. Common convential mammographic dose per view is 150-250 millirads.16,17

Combining Digital Mammography with Digital Ultrasound:

Digital imaging allows the potential to co-register systems' different technologies to produce fused images. Screening breast ultrasound detects mammographically occult cancers in women with dense breasts. improvement in cancer detection with the addition of physician-performed hand-held ultrasound screening of high risk women with dense breasts 21. However, there are potential limitations of whole breast ultrasound screening by physician due to the time necessary to perform the examination and resources available. In Berg's study, the mean scanning time was approximately 20 minutes. Automated ultrasound scanning methods have appeal. Methods to combine simultaneous mammography and automated ultrasound would have the theoretical advantage of the improved sensitivity of ultrasound with an automated approach and the ability to simultaneously correlate the sonographic findings with the mammographic findings. Screening and diagnostic scanning could occur simultaneously. Equipment and methods have been developed which allow automated digital mammography (with or without tomosynthesis) and automated ultrasound at the same patient sitting 18-21.Using prototypes, the patient's breast is compressed as with a typical mammographic image. A conventional mammographic image is obtained. Subsequently, while still under compression, the breast is scanned mechanically by ultrasound. The mammograms and ultrasound images can be reviewed independently. In addition, a direct 3-D registration is possible which allows correlation of a lesion found by one technology with the other technology. For example, a circumscribed mass detected by mammography could be correlated with a simple cyst found at sonographic scanning and no recall would be necessary. Conversely, if a sonographic suspicious finding is detected and the mammogram is normal, the improved sensitivity of ultrasound screening could be realized. There are other potential combined systems under early investigation including combining DM with nuclear medicine functional imaging or optical scanning.

Potential Clinical Benefits:

The potential benefits of DBT include improvement in screening sensitivity, improvement in lesion size at detection, improvement in characterization, and decrease in recall rates. DBT may be useful in both the screening and diagnostic evaluation. Neither has been proven in randomized controlled trials.

Tomosynthesis should resolve many of the tissue overlap reading problems that are a major source of the need for recalls and additional imaging in 2D mammography exams. The biopsy rate might also decrease through improved visualization of suspect objects. Some pathologies that are mammographically occult will be discernable through the elimination of structure noise and tomosynthesis may therefore allow improved detection of cancers. Because the location of a lesion in a tomosynthesis slice completely determines its true 3D coordinate within the breast, biopsy tissue sampling methods can be performed using the tomosynthesis generated coordinates.And because the images are presented with reduced tissue overlap and structure noise, objects are expected to be visualized with improved clarity. This will likely lead to more confident readings.

Figure 2 Breast Tomosynthesis System

CONCLUSION

Breast tomosynthesis provides a 3D imaging capability that allows the more accurate evaluation of lesions by enabling better differentiation between overlapping tissues. A lower recall rate, higher positive predictive value for a biopsy recommendation, higher cancer detection rates, fewer recalls, fewer biopsies, and improved radiologist confidence are expected to result from the use of this technology. Breast tomosynthesis should be valuable in both screening mammography and diagnostic mammography. Even if the technology proves useful, there are many clinical considerations that will impact on potential use. Work flow issues need careful attention as does technologist and physician training. Favorable preliminary experimental

Clinical trial results especially for masses must be confirmed with larger more representative clinical trials. The assessment of micro calcifications awaits further study.

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REFERENCES

1. Dobbins JT III and Godfrey DJ. Digital x-ray tomosynthesis: current state of the art and clinical potential, Phys. Med. Biol. 2003 Oct 7; 48(19) R65-106.
2. Newman, L. Developing technologies for early detection of breast can- cer: a public workshop summary. Washington, D.C.: Institute of Medi- cine and Commission on Life Sciences National Research Council, 2000.
3. Niklason LT, Christian BT, Niklason LE, Kopans DB, et al. Digital to- mosynthesis in breast imaging. Radiology. 1997 Nov; 205(2): 399-406.
4. Rafferty EA, Kopans DW, Wu T, Moore RH. Breast Tomosynthesis: Will a Single View Do? Presented at RSNA 2004, Session SSM02-03 Breast (digital mammography).
5. Rafferty EA, Niklason L, Halpern E et al. Assessing Radiologist Performance Using Combined Full-Field Digital Mammography and Breast Tomosynthesis Versus Full-Field Digital Mammography Alone: Results of a Multi-Center, Multi-Reader Trial. Presented at RSNA 2007, Session SSE26-02 Late Breaking Multicenter Clinical Trials.
6. Rafferty EA, Niklason L, Jameson-Meehan L. Breast Tomosynthesis: One View or Two? Presented at RSNA 2006, Session SSG01-04 Breast Imaging (digital tomosynthesis.)
7. Smith A, Hall PA, Marcello DM. Emerging technologies in breast cancer detection. Radiology Management. July-August 2004; 16-27.
8. Smith AP, Ren B, De Freitas K et al. Initial Experience with Selenia Full Field Digital Breast Tomosynthesis. In: Proceedings of IWDM Durham North Caroline, June 2004, Ed. Etta Pisano.
9. Roubidoux MA, Bailey JE, Wray LA, Helvie MA. Invasive Cancers Detected after Breast Cancer Screening Yielded a Negative Result: Relationship of Mammographic Density to Tumor Prognostic Factors. Radiology. 2004;230: 42–48.
10. Niklason LT, Christian BT, Niklason LE, et al. Digital tomosynthesis in breast imaging. Radiology. 1997;205: 399–406.
11. Niklason LE, Kopans DB, Hamberg LM. Digital breast imaging: tomosynthesis and digital subtraction mammography. Breast Disease. 1998;10:151–164.
12. Eberhard JW, Albagli D, Schmitz A. Mammography tomosynthesis system for high performance 3D imaging. In: Astley SM, B M, R C, Zwiggelaar R, editors. 8th Intl Workshop on Digital Mammography, Lecture Notes in Computer Science -- Digital Mammography. Manchester, U.K: Springer-Verlag; 2006. pp. 137–143.
13. Dobbins J, Godfrey D. Digital x-ray tomosynthesis: Current state of the art and clinical potential. Physics in Medicine and Biology. 2003;48: R65–R106. 14. Suryanarayanan S, Karellas A, Vedantham S, et al. Evaluation of linear and nonlinear tomosynthetic reconstruction methods in digital mammography. Academic Radiology. 2001;8:219–224.
14. Smith RA, Duffy SW, Gabe R, Tabar L, Yen AMF, Chen THH. The randomized trials of breast cancer screening: what have we learned? Radiologic Clinics of North America. 2004;42:793–806.
15. Helvie MA, Roubidoux MA, Hadjiiski L, Zhang Y, Carson PL, Chan H-P. Tomosynthesis mammography versus conventional mammography: comparison of breast masses detection and characterization. Radiological Society of North America 93rd Scientific Assembly and Annual Meeting; Chicago, IL. 2007.

16. Gur D, Abrams GS, Chough DM, et al. AJR; American Journal of Roentgenology. Vol. 193. 2009. Digital breast tomosynthesis: observer performance study; pp. 586–591.
17. Teertstra H, Loo C, van den Bosch M, et al. Breast tomosynthesis in clinical practice: initial results. European Radiology. 2010;20(1):16–24.
18. Berg WA, Blume JD, Cormack JB, et al. Combined Screening With Ultrasound and Mammography vs Mammography Alone in Women at Elevated Risk of Breast Cancer. JAMA. 2008;299:2151–2163.
19. Booi RC, Krucker JF, Goodsitt MM, et al. Evaluating Thin Compression Paddles for Mammographically Compatible Ultrasound. Ultrasound in Medicine & Biology. 2007;33:472–482
20. Kapur A, Carson PL, Eberhard J, et al. Combination of digital mammography with semi-automated 3D breast ultrasound. Technology in Cancer Research & Treatment. 2004;3:325–334.
21. Sinha SP, Goodsitt MM, Roubidoux MA, et al. Automated Ultrasound Scanning on a Dual-Modality Breast Imaging System: Coverage and Motion Issues and Solutions. J Ultrasound Med. 2007;26:645–655