SenoClaire* White Paper
Boosting Dose Efficiency with Digital Breast Tomosynthesis

Henri Souchay, Ph.D., Principal Engineer Mammography
Ann-Katherine Carton, Ph.D., Applications Engineer
Răzvan Iordache, Ph.D., 3D Applications Architect
Introduction

Digital Breast Tomosynthesis offers novel imaging of the breast, where sections of the breast are reconstructed from multiple projection views. In this white paper, we discuss key aspects of this new imaging mode that affect patient dose, and show how GE SenoClaire image acquisition has been designed to deliver tomosynthesis imaging at the same dose as a standard GE digital mammography examination.

Digital Breast Tomosynthesis

Digital Breast Tomosynthesis (DBT) is an imaging technique performed in two steps. Firstly, projection views are acquired at a variety of angles, and are then used to digitally reconstruct a set of planar images covering the area of interest. The reconstruction happens in such a way that only features that exist on the imaged plane appear sharply, whereas those above or below appear out of focus. This technique works on very similar principles to linear tomography. Tomography relies on tube-detector motion and the parallax effect to blur the out-of-plane features during acquisition, and displays just one plane per scan. Today’s tomosynthesis also relies on the parallax effect, but combines this with digital processing to blur the out-of-plane features and create a three dimensional image from each scan.

Calculating the dose in DBT

Patient dose in mammography is defined as the mean glandular dose (MGD), a conventional term that gives an indication of the degree of ionization of glandular tissue in the breast due to X-ray exposure. The MGD is the product of two terms: the amount of radiation entering the breast, or ‘entrance surface air kerma’ (ESAK), which is measurable with a dosimeter; and the normalized glandular dose (DgN), which is the amount of effective ionization in the breast per unit ESAK. In practice, for each exposure, the ESAK is typically assessed from system settings and calibrations, whereas the DgN is derived from tables created using Monte Carlo simulations.

The other main factor to take into consideration is the angle of view. This is shown in detail in reference 2, where results show less than 2% deviation in MGD between a particular acquisition sequence taken by a GE system (nine projections distributed over a 25° angular span) and a 2D mammogram using the same X-ray technique. This demonstrates that there is therefore no practical need to change the MGD evaluation between 2D and 3D for this particular geometry.

Maintaining detector performance at a fraction of the FFDM exposure

Maintaining detector performance when the exposure is a fraction of the full-field digital mammography (FFDM) exposure is a key requirement of tomosynthesis. This performance is best captured by a DQE measurement, which quantifies how well the detector transfers the signal-to-noise ratio (SNR) over the visual bandwidth. If the DQE decreases by 50% when imaging with low-dose DBT exposures, then twice as much accumulated exposure is required to image with the same SNR as FFDM.

GE’s independent detection technique, based on a CsI scintillator, works in DBT with an unchanged detector bandwidth of 5 lp/mm. This, combined with low-noise readout electronics, means that DQE changes by less than 15% at 0.5 lp/mm, despite a detector exposure reduction of 88% (Fig. 1).

Figure 1: DQE of the detector in DBT mode at 0.5 lp/mm over the operating range 4-32 mAs/view. Using Rh/Rh at 30 kV with 50 mm PMMA added filtration, the incident air kerma for the detector range from 10 to 80 µGy/view.

References

Budgeting the dose in GE SenoClaire

Tomosynthesis is far more dose-efficient than tomography, simply because a full three-dimensional image can be reconstructed from a single scan. In DBT, each projection view is acquired digitally at a fraction of a FFDM dose, and each plane is reconstructed by adding information from all these projections. The detector efficiency is preserved when working with a fraction of the FFDM dose and, as a result, the information collected from multiple projections is almost equal to what would normally be expected from a full-dose FFDM. Applied to flat field phantom images, this can be verified by the preservation of the detectability of inserts inside the phantom (Fig. 2). On textured backgrounds, the detectability is further improved because the tomosynthesis resolves overlapping texture and inserts.

Patient dose on the GE SenoClaire

With such an efficient detector, it is reasonable to expect superior conspicuity of clinical features on breast texture, while exposing patients to doses similar to FFDM devices. The SenoClaire DBT add-on includes a fully automatic exposure control system that delivers the same dose as the Senographe Essential automatic optimization of parameters (AOP) used in Standard mode (Fig. 3).

The effect of the DBT grid on patient dose

The inclusion of a grid compatible with tomosynthesis in the image chain does not affect the target dose (see Fig. 3). The grid delivers improved image quality on thicker or denser breasts (see Fig. 4), which are the most demanding in terms of requiring higher doses. As in 2D, the net effect is that the dose levels remain under control, because no additional dose is required to compensate for the degradation of image quality by scattered radiation. This has a knock-on effect preserving the heat load of the tube, which means that a high patient throughput can be maintained.

Conclusion

The GE SenoClaire digital breast tomosynthesis add-on to the GE Senographe Essential offers the benefits of tomosynthesis for imaging overlapping tissues at the same dose levels as FFDM, while delivering image quality comparable to FFDM images on small features.
About GE Healthcare

GE Healthcare provides transformational medical technologies and services that are shaping a new age of patient care. Our broad expertise in medical imaging and information technologies, medical diagnostics, patient monitoring systems, drug discovery, biopharmaceutical manufacturing technologies, performance improvement and performance solutions services help our customers to deliver better care to more people around the world at a lower cost. In addition, we partner with healthcare leaders, striving to leverage the global policy change necessary to implement a successful shift to sustainable healthcare systems.

Our “healthymagination” vision for the future invites the world to join us on our journey as we continuously develop innovations focused on reducing costs, increasing access and improving quality around the world. Headquartered in the United Kingdom, GE Healthcare is a unit of General Electric Company (NYSE: GE). Worldwide, GE Healthcare employees are committed to serving healthcare professionals and their patients in more than 100 countries. For more information about GE Healthcare, visit our website at www.gehealthcare.com.

GE Healthcare
Chalfont St.Giles,
Buckinghamshire,
UK

GE Healthcare Europe
Headquarters Buc, France
+33 800 90 87 19

GE Healthcare, Middle East and Africa
Istanbul, Turkey
+ 90 212 36 62 900

GE Healthcare, North America
Milwaukee, USA
+ 1 866 281 7545

GE Healthcare, Latin America
Sao Paulo, Brazil
+ 55 800 122 345

GE Healthcare, Asia Pacific
Tokyo, Japan
+ 81 42 585 5111

GE Healthcare, ASEAN
Singapore
+65 6291 8528

GE Healthcare, China
Beijing, China
+ 86 800 810 8188

GE Healthcare, India
Bangalore, India
+91 800 209 9003

Data subject to change.
Marketing Communications GE Medical Systems
Société en Commandite Simple au capital de 85 418 040 Euros
283 rue de la Minière – 78533 Buc Cedex France
RCS Versailles B 315 013 359
A General Electric company, doing business as GE Healthcare

GE and GE Monogram are trademarks of General Electric Company.
* Trademarks of General Electric Company.
**SenoClaire is the brand name of GE Breast Tomosynthesis
©2013 General Electric Company. All rights reserved.
All third party trademarks are the property of their respective owner.
© 2013 Copyright GE Healthcare – DOC1403841

GE imagination at work