Digital Breast Tomosynthesis: The Pros and Cons

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Abstract

Radiologic imaging plays a vital role in the detection of breast cancer in patients. This literature review highlights the effects, both positive and negative, that digital breast tomosynthesis (DBT) may have on this process. Three-dimensional (3D) images produced in DBT can provide radiologists with more detail from reduced breast tissue overlap. This can help to improve screening outcomes, particularly for patients with dense breasts. Although it is somewhat limited by extremely dense breasts, DBT has been shown to overall increase true-positive cancer detection rates while decreasing false-positive rates. Recall rates may also decline with the addition of DBT. DBT is mainly limited by radiation dose and costs, but longer interpretation and exam times, as well as motion and reconstruction artifacts are also factors. Despite these limitations, DBT is a promising new modality that may help improve breast cancer screening. Thus, many clinical settings are choosing to adopt DBT. Radiologic technologists will have to undergo additional training to perform DBT exams and should understand its advantages and disadvantages.

Digital Breast Tomosynthesis: The Pros and Cons

Digital breast tomosynthesis (DBT) is a relatively new advanced form of mammography that is being utilized more in clinical practice. Subsequently, there is a substantial amount of current literature that describes its benefits and challenges. DBT produces quasi-three-dimensional (3D) images of the breast from a series of reconstructed radiographs (Sujlana et al., 2019). These radiographs are obtained with a moving x-ray source, which allows the radiologic technologist to capture multiple images from different angles (Tirada et al., 2019). The benefits and challenges associated with DBT are mainly studied in comparison to traditional full-field digital mammography (FFDM). For example, Mandoul et al. (2019) reported that the 3D images produced by DBT address the limitation of overlapping tissues linked to FFDM. Therefore, DBT may allow for increased specificity and breast cancer detection rates, in addition to decreased recall rates (Conant et al., 2019). However, cost and radiation doses are also increased with DBT compared to FFDM (Mandoul et al., 2019). The current literature thus suggests that the further implementation of DBT should take into account a risk-benefit ratio.

The implementation of DBT into clinical practice will have several effects on radiologic technologists. For example, there are image acquisition parameters, artifacts, and quality control protocols that are specific to DBT (Tirada et al., 2019). Thus, the FDA’s Mammography Quality Standards Act (MQSA) requires radiologic technologists to receive eight hours of DBT training (Friedewald et al., 2019). DBT also has different workstation and technology requirements than FFDM, meaning technologists may have to learn how to use new systems (Hooley et al., 2017). Understanding the basic principles can aid technologists in the transition to DBT.

The problem that this review will analyze is what the current literature says about the benefits and challenges of utilizing DBT. This problem is important for two main reasons. First, DBT is a relatively new imaging modality. It was approved by the United States Food and Drug Administration (FDA) in 2011 (Alsheik et al., 2021). Subsequently, some patients are wary of opting to use DBT over conventional FFDM, primarily due to its increased cost (Chiu et al., 2020). The option of DBT is also not yet available to all patients, which is influenced by social, economic, cultural, and educational disparities (Alsheik et al., 2021). Second, mammography is the standard of care for breast cancer screening. Breast cancer is the most commonly diagnosed cancer in women, accounting for about 30% of all female cancers, and is the second-highest cause of cancer-related death in women (Siegel et al., 2021). Thus, efficient mammographic imaging is vital. DBT may improve screening outcomes and detect additional cancers that are smaller, lower grade, and have a more favorable prognosis (Chong et al., 2019). However, the impact of DBT on long-term clinical outcomes is not yet known (Lowry et al., 2020). Although research into DBT is still ongoing, the current literature provides useful insight into its opportunities and obstacles.

This literature review will investigate the benefits of DBT for screening and diagnostic purposes, the impact of DBT on patients with dense breasts, and the limitations of DBT. The purpose of this review is to identify what these benefits and limitations may mean for patients.

Methods

Articles used for this literature review were primarily found through Google Scholar, CINAHL Complete, and ScienceDirect College Edition. The starting point for all searches was digital breast tomosynthesis or DBT. Limiters on the search included: full text, publication dates within five years, and peer-reviewed. Key terms used to narrow the results included: radiographers, benefits, cost, cons, techniques, and dense breasts. Articles were chosen based on their relevance to this topic and paper.

Discussion

Screening and Diagnostic Benefits

Many authors emphasized improved screening and diagnostic outcomes associated with DBT as compared to traditional FFDM. These improvements are mainly attributed to the additional information obtained from the 3D images (Chong et al., 2019). Mandoul et al. (2019) and Kim et al. (2021) stated that DBT provides a dual screening benefit to patients as it increases the cancer detection rate and reduces the recall rate. Correspondingly, Tirada et al. (2019) found that the combination of FFDM and DBT is superior for cancer detection. As breast cancer remains a prevalent issue for women, this research indicates that DBT could play a valuable role in the screening process.

Increased Cancer Detection Rates

Increased cancer detection rates are one major screening and diagnostic benefit of DBT. Different researchers mentioned a variety of advancements that make this possible (Chong et al., 2019, Mandoul et al., 2019, & Tirada et al., 2019). For example, Chong et al. (2019) reported that the ability of DBT to improve lesion conspicuity and unmask additional cancers increases the cancer detection rate. These additional cancers may also be associated with a better prognosis (Conant et al., 2019). Likewise, Mandoul et al. (2019) stated that DBT highlights architectural distortions and allows for a better assessment of the shapes and margins of masses. Tirada et al. (2019) also found that DBT, in combination with FFDM, better detects microcalcifications. These advancements show that DBT may outperform FFDM in sensitivity and specificity, thus increasing cancer detection.

Many researchers also reported statistics that back up the claim that DBT increases the cancer detection rate. Chong et al. (2019) summarized that overall cancer detection rates increased by 1.2 to 4.6 per 1000 examinations with the addition of DBT. Conant et al. (2019) similarly found the cancer detection rates to increase with an odds ratio (OR) of 1.41. Lowry et al. (2020) predicted that these improvements could reduce breast cancer deaths by 0.16 to 0.26 per 1000 women. The ability of DBT to increase the detection of cancers, especially ones with a better prognosis, is an important benefit for patients.

Reduced Recall Rates

Reduced recall rates are another screening and diagnostic benefit associated with DBT. Recall rates are the proportion of examinations that result in a need for further investigation. Mandoul et al. (2019) stated that DBT reduces recall rates because it allows the radiologist to discard asymmetries related to tissue overlap, a known limitation of FFDM. Similarly, Kim et al. (2021) explained that the addition of DBT reduces the amount of false-positive findings in asymmetries and calcifications, thus reducing the recall rate. Conant et al. (2019) found that recall rates reduced across all age groups and breast densities, with an overall reduction of 2.5%. Comparatively, Alsheik et al. (2021) reported an overall decrease in recall rates of 1.32% across racial and age groups. Hooley et al. (2017) also observed that asymmetries are associated with the greatest reduction in recall rates, with a decrease of 58% when DBT is combined with FFDM. Reduced recall rates would have a valuable impact on patient anxiety as it decreases the need for unnecessary follow-ups and biopsies.

Dense Breast Imaging

Research into the value of DBT for women with dense breasts is a recurrent theme among authors. High breast density reflects that the proportion of fibrous and glandular tissue is greater than fatty tissue and describes over 40% of U.S. women (Shen et al., 2021). Risks such as future breast cancer and masked or hidden cancers in traditional FFDM increase as breast density increases (Kerlikowske et al., 2019). Hadadi et al. (2021) and Osteras et al. (2019) reported that DBT may be able to reduce the latter, as it is associated with greater sensitivity in dense breasts. However, Mandoul et al. (2019) observed that DBT can be limited by high breast density to some extent. As high breast density is common, it is important to consider the advantages and disadvantages that this new modality may bring for these patients.

Benefits

There are many possible benefits highlighted by authors for using DBT in dense breast imaging. These benefits are mainly brought about by the ability of DBT to overcome limitations associated with FFDM. Mandoul et al. (2019) stated that DBT reduces tissue superimposition, an issue that is more prevalent with dense breasts in FFDM. Likewise, Hadadi et al. (2021) reported that by decreasing the overlap of breast tissue, DBT can decrease summation artifacts and improve the visualization of breast lesions in dense breasts. Furthermore, Osteras et al. (2019) summarized that DBT increases true-positive findings and decreases false-positive findings across all breast densities, except for in extremely dense breasts. Conant et al. (2019) also found DBT to significantly increase cancer detection rates among women aged 40 to 49 with dense breasts, reporting a rise of 2.7 per 1000 women. These findings demonstrate that DBT may be able to improve screening outcomes for patients with dense breasts.

Limitations

While there is an array of benefits associated with DBT for dense breasts, authors have also discussed some important drawbacks. First, the higher radiation dose already present in DBT is increased as breast density increases (M.Ali et al., 2020; Sheng et al., 2021). Osteras et al. (2019) and Chong et al. (2019) also found that the improvements in cancer detection rates and false-positive findings were lower to non-existent in extremely dense breasts. Similarly, Phi et al.

(2018) reported that specificity was not changed with the addition of DBT. Moreover, Tirada et al. (2019) also noticed a loss of skin and superficial tissue resolution in DBT mammograms of dense breasts. These limitations imply that DBT may be more advantageous in non-dense and heterogeneously dense breasts.

Cons

The general cons associated with DBT vary according to the author. For example, Sujlana et al. (2019) and Tirada et al. (2019) stated that patient motion and 3D reconstruction can lead to artifacts in DBT. Kim et al. (2021) observed no change in non-invasive cancer detection and increased false-positive findings with the addition of DBT for mass and architectural distortion. Mandoul et al. (2019) also reported an increased architectural distortion recall rate but found the main constraint of DBT to be a lack of reduction in interval breast cancer. Additionally, Pujara et al. (2020) explained that the larger image sets in DBT lead to increased interpretation times. These findings all suggest that the overall limitations of DBT may be ambivalent. However, two common themes across multiple articles were radiation dose and cost.

Radiation Dose

The increased radiation dose received by patients is one of the primary disadvantages linked to DBT. There are a few possible reasons as to why the radiation dose is increased in DBT. For example, Sheng et al. (2021) stated that the imaging process of DBT increases the patient's radiation dose, as multiple low-dose exposures are required for an exam. Similarly, Tirada et al. (2019) explained that while a higher number of projections can have a positive effect on image quality, it also increases the radiation dose. In addition, Tirada et al. (2019) analyzed that the anode targets and filters used in DBT systems can slightly increase the radiation dose. M.Ali et al. (2020) confirmed that both mean glandular dose (MGD) and effective dose increase with DBT, with rises of 0.77 mGy and 0.1 mSv, respectively. Mandoul et al. (2019) also noted that the combination of DBT and FFDM more than doubles the dose of radiation but can be removed by using synthesized mammography (SM). While the risk of adverse effects from medical imaging radiation may be low, the increased dose in DBT should still be taken into account.

Cost

Another potential downside to DBT is the additional costs compared to FFDM. Although DBT is now covered by the Centers for Medicare and Medicaid Services (CMS) for screening exams, diagnostic exams still require a copayment (Chong et al., 2019). Thus, the cost may still be an issue for some patients. Survey findings from Chiu et al. (2020) demonstrated this, as cost was cited as the leading factor in patients declining DBT. Clark et al. (2017) also reported that DBT is not yet uniformly covered by insurance types, leading to disparities in utilization and access. Alsheik et al. (2021) found similar disparities, highlighting that differences in race and socioeconomic status factor into this. Despite these valid concerns, Lowry et al. (2020) predicted that DBT could be cost-effective when considering the benefits gained.

Conclusion

The current literature provided an understanding of the benefits and limitations of utilizing DBT. Overall, DBT was shown to increase cancer detection rates, including those with a better prognosis, while also reducing recall rates. These benefits suggest that DBT may improve diagnostic and screening outcomes for breast cancer, which is the most common type of cancer in women. In addition, reduced recall rates can have positive effects on patient anxiety. The limitations associated with DBT varied among authors, but increased radiation dose and cost were two consistent issues that should be considered. In dense breasts, sensitivity, cancer detection rates, and false-positive findings were reported to be improved with DBT. As FFDM is notably limited by breast density, DBT could have a valuable impact on these patients. However, these benefits were not as prevalent in extremely dense breasts and were accompanied by increased radiation doses. In all cases, both radiology personnel and patients need to be aware of these strengths and weaknesses to make informed decisions.

Suggestions for Future Research

Future research into the clinical outcomes associated with DBT could develop insight into its long-term effects. This would give us a more complete picture of the benefits and risks. Additionally, future research could investigate techniques for reducing radiation dose, interpretation times, and cost. These are areas limited by DBT that could be potentially resolved, allowing for more focus on the screening positives and negatives.

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Multiple Choice Questions

1. Breast cancer accounts for about ______% of all diagnosed female cancers.
   a. 20
   b. 30
   c. 60
   d. 70
2. What type of images are produced by digital breast tomosynthesis (DBT)?
   a. 2D
   b. 3D
   c. Moving
   d. Magnified
3. Digital breast tomosynthesis (DBT) was approved by the United States Food and Drug Administration (FDA) in ________.
   a. 1991
   b. 2001
   c. 2011
   d. 2021
4. _____________________ is a limitation of traditional mammography that is improved with digital breast tomosynthesis (DBT).
   a. High cost
   b. Distortion
   c. Low sensitivity
   d. Tissue overlap

5. What are the two main benefits of digital breast tomosynthesis (DBT) that are discussed in this paper?
    a. Increased cancer detection rates and reduced recall rates
    b. Improved sensitivity and reduced false-positive findings
    c. Increased cancer detection rates and decreased radiation dose
    d. Decreased cost and decreased radiation dose
6. How does digital breast tomosynthesis (DBT) increase cancer detection rates?
    a. Improved lesion conspicuity
    b. Better assesses shapes and margins of masses
    c. Ability to detect microcalcifications and unmask additional cancers
    d. All of the above
7. What are "dense" breasts?
    a. Breasts with a higher proportion of fatty tissue
    b. Breasts with a higher proportion of glandular and fibrous tissues
    c. Breasts with equal proportions of fatty tissue and glandular and fibrous tissues
    d. Breasts with implants
8. What are the two main drawbacks of digital breast tomosynthesis (DBT) that are discussed in this paper?
    a. Increased false-positive findings and increased exam time
    b. Increased exam time and increased radiation dose
    c. Increased radiation dose and increased cost
    d. Decreased sensitivity in dense breasts and access disparities

9. Which of the following is **not** a factor in the increased radiation dose seen with digital breast tomosynthesis (DBT)?
    a. Multiple projections
    b. Anode target and filters
    c. Higher exposure factors
    d. Breast density
10. Why do most patients decline the option of digital breast tomosynthesis (DBT)?
    a. Cost
    b. Radiation
    c. Anxiety about newer technology
    d. Discomfort associated with the exam

Answer Key

1. B
2. B
3. C
4. D
5. A
6. D
7. B
8. C
9. C
10. A