Araştırma Makalesi – Original Article

Determination of Typical Dose Levels in Mammography Examinations: A Case Study from Türkiye*

Mamografi İncelemelerinde Tipik Doz Seviyelerinin Belirlenmesi: Türkiye'den Bir Vaka Çalışması

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ABSTRACT

Introduction: Mammography is essential for early breast cancer detection, but radiation exposure must be managed effectively to ensure patient safety. Accurate average glandular dose (AGD) calculation is critical for dose optimization.

Objective: This study aims to evaluate the typical dose levels in mammography examinations in Türkiye using the DANCE and 2ABD methods and compare these values with international reference standards.

Methods: This study evaluates typical dose levels in mammography examinations in Türkiye using the DANCE and 2ABD methods and compares them with international reference values. A total of 287 patients (40–64 years) underwent mammography at a community health center. Average glandular dose values were calculated for craniocaudal (CC) and mediolateral-oblique (MLO) projections using DANCE and 2ABD methods.

Results: The results indicated that all calculated AGD values remained below the European Commission's maximum acceptable dose (2,5 mGy, 2,0 mGy and 1,5 mGy) levels. MLO projections demonstrated higher AGD values than CC projections, and AGD increased with breast compression thickness.

Conclusion: The findings suggest that the examined facility does not require dose optimization, and dose levels remain within international standards. These results contribute to further research on establishing national diagnostic reference levels (DRLs). This study found that the AGD during mammography in women aged 40–64 remained below the 2,5 mGy, 2,0 mGy and 1.5 mGy limits set by European standards. The findings support the consistency of the 2ABD and DANCE methods and highlight the potential for broader research to establish national diagnostic reference levels in Türkiye.

Keywords: Mammography, Average Glandular Dose, Radiation Dose Optimization, Digital Mammography, Patient Safety, Typical Dose

ÖZ

Giriş: Mamografi erken meme kanseri tespiti için önemlidir, ancak hasta güvenliğini sağlamak için radyasyon maruziyetinin etkili bir şekilde yönetilmesi gerekir. Doğru ortalama glandüler doz (AGD) hesaplaması doz optimizasyonu için kritik öneme sahiptir.

Amaç: Bu çalışmada, Türkiye'deki mamografi tetkiklerinde DANCE ve 2ABD yöntemleri kullanılarak tipik doz seviyelerinin değerlendirilmesi ve bu değerlerin uluslararası referans standartları ile karşılaştırılması amaçlanmıştır.

Yöntemler: Bu çalışmada Türkiye'de mamografi tetkiklerinde tipik doz seviyeleri DANCE ve 2ABD yöntemleri kullanılarak değerlendirilmiş ve uluslararası referans değerleriyle karşılaştırılmıştır. Toplum sağlığı merkezinde toplam 287 hastaya (40-64 yaş) mamografi tetkiki yapılmıştır. AGD değerleri DANCE ve 2ABD yöntemleri kullanılarak kraniokaudal (CC) ve mediolateral-oblik (MLO) projeksiyonları için hesaplanmıştır.

Bulgular: Sonuçlar, hesaplanan tüm AGD değerlerinin, Avrupa Komisyonu'nun maksimum kabul edilebilir doz (2,5 mGy, 2,0 mGy ve 1,5 mGy) seviyelerinin altında kaldığını göstermiştir. MLO projeksiyonları, CC projeksiyonlarına göre daha yüksek AGD değerleri göstermiş olup AGD doz değerlerinin memenin sıkıştırılma kalınlığı ile arttığı tespit edilmiştir.

Sonuç: Bulgular incelenen tesisin doz optimizasyonuna ihtiyaç duymadığını ve doz seviyelerinin uluslararası standartlar dahilinde kaldığını göstermektedir. Bu sonuçlar ulusal tanı referans seviyelerinin (DRL'ler) belirlenmesine yönelik daha fazla araştırmaya katkıda bulunacaktır. Bu çalışma, 40-64 yaş arası kadınlarda mamografi sırasında AGD'nin Avrupa standartlarına göre belirlenen 2,5 mGy, 2,0 mGy ve 1,5 mGy sınırının altında kaldığını göstermektedir. Bulgular, 2ABD ve DANCE yöntemlerinin tutarlılığını desteklemekte ve Türkiye'de DRL'ler belirlemek için daha geniş araştırmalar yapma potansiyelini vurgulamaktadır.

Anahtar Kelimeler: Mamografi, Ortalama Glandüler Doz, Radyasyon Dozu Optimizasyonu, Dijital Mamografi, Hasta Güvenliği, Tipik Doz

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Introduction

In mammographic applications, accurately estimating the radiation dose absorbed by breast tissue is crucial for both diagnostic quality and patient safety. The most commonly used metric for this purpose is the Average Glandular Dose (AGD), which represents the amount of radiation absorbed by the glandular tissues.[1] AGD is not measured directly; instead, it is calculated using mathematical models and conversion coefficients based on exposure parameters and breast composition.[2]

In this study, AGD values were estimated using two widely recognized calculation methods: the DANCE method and the 2ABD method. The DANCE method calculates AGD by employing conversion factors derived from Monte Carlo simulations, considering factors such as compressed breast thickness, anode/filter combinations, and tube voltage.[3,4] DANCE is also recommended among the standard tools for dosimetry in digital mammography.[5] In contrast, the 2ABD method estimates AGD based on air kerma values measured at two different points and uses standardized conversion coefficients to derive typical glandular dose levels.[2] Both methods provide reliable estimates of glandular dose under clinical conditions and are widely used for dosimetric evaluation in mammographic.[1]

This study was conducted in Bartın province, located on the Black Sea coast in northern Türkiye. As part of the study, mammogram data of a total of 287 patients in the 40-49 and 50-64 age groups who underwent mammography screening at Bartın Community Health Center Şehit Furkan Yılmaz Healthy Life Center as of 2024 were analyzed. Four different projections Right Cranio Caudal (RCC), Left Cranio Caudal (LCC), Right Medio Lateral (RMLO), Left Medio Lateral (LMLO) were used for each patient, and the obtained dose information was evaluated through Structured Reports (SR) containing only numerical dose data via the National Teleradiology System. Average glandular doses were calculated using The method frequently used in the literature is DANCE and 2ABD methods for a total of 424 projections from 106 female patients in the 40-49 age group and 724 projections from 181 patients in the 50-64 age group.[1] The dosimetric quantity in mammography examinations is the Average Glandular Dose.[6] The typical dose value is defined as the median values of AGDs calculated according to compressed breast thickness, determined with data from a minimum of 50 patients in a mammography device.[3] Typical dose is a parameter that indicates the level of dose to which the patient is exposed according to established standards and whether the device requires optimization if the dose is high. In mammography, AGD calculations are performed for both right and left breasts in Cranio-Caudal (CC) and Mediolateral-Oblique (MLO) views.[7] CC is an imaging position used in mammography that provides visualization of breast tissue from top to bottom, while MLO is an angle used in mammography that enables visualization of breast tissue from inside to outside at a diagonal angle and helps better evaluate lymph nodes. Compressed breast thickness is the most important parameter for ensuring that the breast is exposed to minimum radiation dose without compromising image quality.

Conceptual Framework

In the field of mammography, research conducted in the literature regarding planned x-ray doses for patient tissue imaging emphasizes the use of various filters and techniques to obtain high-quality images with lower doses in mammographic examinations.[8] Additionally, the effects of different mammography devices and quality control measurements on patient dose and image quality have been examined in detail.[9]

Research conducted in the United States reveals that significant changes in patient doses have occurred with the transition to digital mammography technology. In a comprehensive study conducted by Hendrick and colleagues, it was determined that digital mammography systems reduced patient dose by 22% compared to traditional film-based systems.[10]

In another study, data from 20,137 images of 5,034 patients who underwent full-field digital mammography (FFDM) over a two-year period were analyzed using information extracted from DICOM headers, and ESAK and AGD were calculated according to the European Protocol on Dosimetry in Mammography. The mean patient age was 56 ± 11 years, mean breast thickness 52 ± 13 mm, mean ESAK 8,1 mGy, and mean AGD 1,9 mGy.[11]

Studies on mammography dose calculations in Europe are increasing day by day. The European Commission recommends keeping the average glandular dose below 2,5 mGy.[12] In a multi-center study conducted in Italy using the DANCE method, dose differences of up to 15% were detected in different mammography devices. These findings indicate that digital mammography systems have the potential to reduce patient doses and highlight the importance of comparing dose levels between different devices. They also emphasize the importance of quality control programs and regular dose optimization.[13]

In a study conducted in the Republic of North Macedonia, 31,040 digital mammography images obtained from eight state-managed mammography centers/units were analyzed to establish diagnostic reference levels (DRLs) for different breast thickness ranges.[14] Similarly, another study established local DRLs in two tertiary hospitals in northwest Nigeria and demonstrated that mean glandular doses were significantly higher with manual exposure compared to the automatic optimization parameter mode.[15]

The common point of research in this field shows that the performance of digital mammography devices and patient x-ray doses can vary depending on the characteristics of the device used, the stability of automatic exposure control, and the characteristics of breast tissue. Therefore, optimizing patient x-ray doses in digital mammography applications and comparing the performance of different devices are important for improving patient safety and image quality. In addition to economic and technical efficiency, clinical efficiency achieved through optimization of the dose to which the patient will be exposed in other words, medical efficiency is very important for early diagnosis, treatment, and survival. Furthermore, this highlights the necessity for more and more comprehensive research in this field.

Materials and Methods

In this study, mammogram data obtained from Structured Reports (SR) via the National Teleradiology System for mammography examinations performed with a Fujifilm Amulet Innovality model digital mammography device at Bartın Community Health Center Şehit Furkan Yılmaz Healthy Life Center in 2024 were utilized. Anonymous use permission for the secondary data used in this research was granted through administrative permission from the Republic of Türkiye Ministry of Health. The population of this study consists of digital mammography devices across Türkiye that perform mammographic imaging and are capable of regularly transmitting radiation dose data. These devices serve as a primary source of data for monitoring patient radiation doses and conducting comparative analyses. As a sample, a digital mammography device located in the province of Bartın where the data transmission infrastructure is actively functioning was selected. The choice of the device in Bartın was not due to any specific characteristic or extreme case, but rather because it represents a typical example of functioning systems and was among the devices providing uninterrupted data during the study period. In this respect, the sample selection carries a random nature and enables preliminary evaluations regarding the generalizability of the study findings.

Initially, within the scope of the data included in this study, the Average Glandular Dose was calculated using conversion coefficients proposed by Dance.[4] For mammography x-ray exposure parameters and compressed breast thickness.[3] For each mammogram, tube load (mAs) and voltage (kVp), patient age, anode/filter combination, and compressed breast thickness (CBT) data were obtained from CC and MLO projections to calculate the average glandular dose and subsequently the typical dose.

Average glandular doses were calculated using DANCE and 2ABD methods for mammogram data of 287 female patients in the 40-49 and 50-64 age groups commonly grouped in literature, including 424 projections from 106 female patients in the 40-49 age range and 724 projections from 181 female patients in the 50-64 age range. Subsequently, typical dose levels according to age groups and projection types were determined, and the obtained values were compared with studies in international literature and reference values established by the European Commission.[16] In the study, groupings based on age ranges and compressed breast thicknesses were determined in accordance with classification criteria widely used in the literature. Particularly, the 40-49 and 50-64 age grouping and 40-49 mm and 50-59 mm compression thickness ranges are frequently used methods in mammography screenings and radiation dose analyses. In this study, patients were divided into two age groups 40–49 and 50–64 years based on the most commonly used age classification in the literature. In this study, compressed breast thickness (CBT) was classified into three groups 30–39 mm, 40–49 mm, and 50–59 mm based on the most commonly reported compression intervals in the literature, and we employed these ranges to ensure comparability with prior research findings.[17] Calculations were performed using two different methods: DANCE and 2ABD.

The frequency distribution by age of 106 female patients in the 40-49 age range and 181 female patients in the 50-64 age range who underwent breast screening is given in Graph 1. The calculation of AGD varies depending on the technical specifications of the mammography device, imaging positions, and anode/filter values. The calculation of AGD is based on two calculation methods used in the literature. These methods are the DANCE method which assumes the breast structure as 50% fat-50% glandular tissue, and the 2ABD Method, which calculates breast dose independently of glandularity. [4] The DANCE method assumes breast tissue as 50% fat-50% glandular to calculate the average amount of radiation absorbed by breast tissue and is calculated with the following formula:

AGD = ESAK × g × c × s

ESAK: Entrance Skin Air Kerma value.

g: Conversion coefficient of radiation to glandular tissue.

c: Conversion coefficient calculated according to compressed breast thickness.

s: Geometric factor of the mammogram projection.

In this formula, ESAK is the air kerma value measured at the upper surface of the breast without the backscatter factor (BSF), the g factor represents a breast with 50% glandularity for the specified CBT (Compressed Breast Thickness) and HVL (Half Value Layer) value, the c factor represents conversion factors according to age, HVL, and CBT, and the s factor is a parameter dependent on the X-ray spectrum (anode/filter combination). The 2ABD (Average Absorbed Breast Dose) method is shown in the equation below as a dose index independent of breast glandularity in accordance with the directive of the European Atomic Energy Community (EURATOM), which continues its activities for the safe, sustainable, and efficient use of nuclear energy.[18]

$$AGD = \frac{k_{a,i}}{\mu_{en} d}\left(1 - e^{-\mu_{en} d}\right)$$

AGD = Average Glandular Dose (mGy)

k_(a,i) = Air kerma incident on the breast surface (mGy)

μ_en = Mass energy absorption coefficient for breast tissue at a specific energy

d = Glandular tissue depth or thickness

In this study, mammography data from 287 female patients aged 40-64 years at Bartın Community Health Center in Türkiye were analyzed using DANCE and 2ABD methods to evaluate radiation dose levels in mammography examinations. A total of 1148 projections were examined, and average glandular dose (AGD) values were calculated for craniocaudal (CC) and mediolateral-oblique (MLO) projections. The analysis results showed that all calculated AGD values remained below the European Commission's maximum acceptable dose limit of 2,5 mGy, 2,0 mGy and 1,5 mGy. It was found that MLO projections exhibited higher dose values compared to CC projections, AGD increased with breast compression thickness, and the DANCE method produced higher dose calculations than the 2ABD method due to its glandularity dependency. These findings revealed that the examined facility does not require dose optimization and that current practices are within international safety standards, establishing an important foundation for determining national diagnostic reference levels in Türkiye.

Results

In this study, 1148 projections from 287 female patients were examined within the scope of average glandular dose and typical dose calculations. Calculations were performed using two different methods: DANCE and 2ABD. In the 40-49 age group, for 30-39 mm compression thickness, minimum and maximum AGD values were calculated using DANCE and 2ABD methods for four projections. The calculated results are listed in tables 1 and 2.

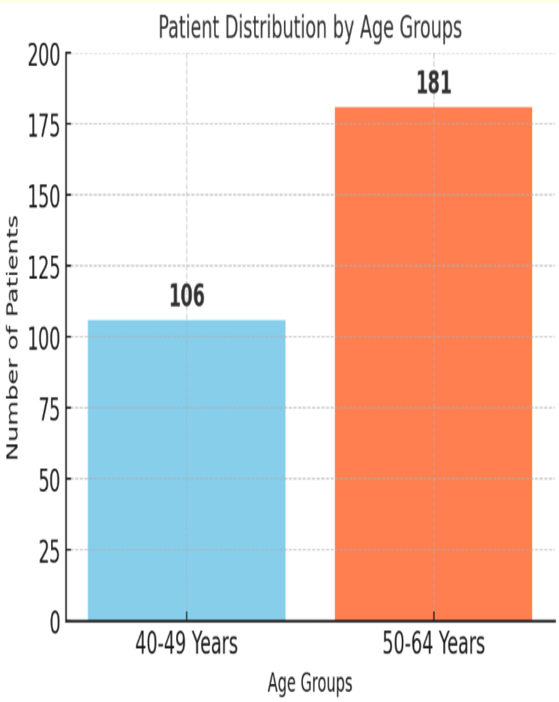
Table 1. DANCE and 2ABD Values by Different Breast Thicknesses and Projections in Women Aged 40–49

Age Group	CBT (mm)	Projection	DANCE (min–max)	2ABD (min–max)
40–49	30–39	RCC	1,01 – 1,48	0,48 – 0,70
40–49	30–39	LCC	0,93 – 1,39	0,49 – 0,66
40–49	30–39	RMLO	1,13 – 1,44	0,52 – 0,70
40–49	30–39	LMLO	1,09 – 1,34	0,53 – 0,68
40–49	40–49	RCC	1,09 – 1,96	0,49 – 0,93
40–49	40–49	LCC	0,94 – 1,95	0,42 – 0,93
40–49	40–49	RMLO	1,05 – 1,99	0,44 – 0,97
40–49	40–49	LMLO	0,95 – 1,74	0,43 – 0,83
40–49	50–59	RCC	1,24 – 2,45	0,59 – 1,17
40–49	50–59	LCC	1,16 – 1,92	0,55 – 0,93
40–49	50–59	RMLO	1,25 – 2,47	0,59 – 1,05
40–49	50–59	LMLO	1,05 – 2,43	0,48 – 1,14

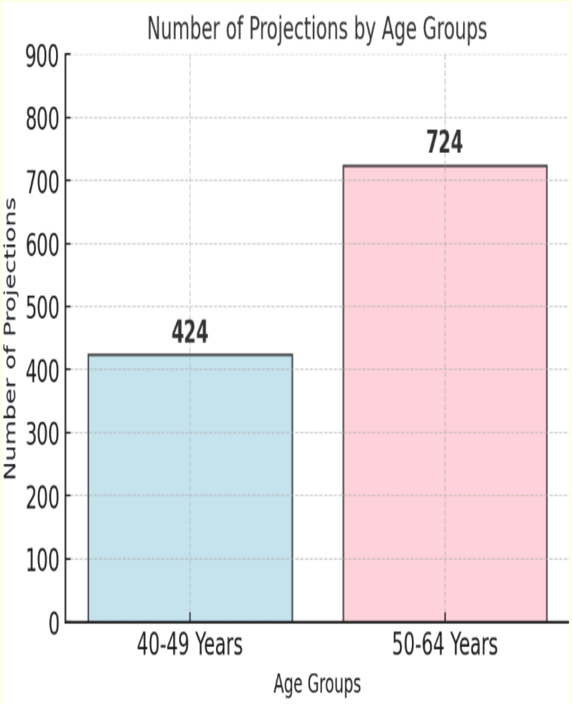
Table 2. DANCE and 2ABD Values by Different Breast Thicknesses and Projections in Women Aged 50–64

Age Group	CBT (mm)	Projection	DANCE (min–max)	2ABD (min–max)
50–64	30–39	RCC	0,86 – 1,49	0,42 – 0,74
50–64	30–39	LCC	0,77 – 1,24	0,38 – 0,61
50–64	30–39	RMLO	0,97 – 1,48	0,42 – 0,68
50–64	30–39	LMLO	0,98 – 1,42	0,46 – 0,67
50–64	40–49	RCC	1,08 – 1,92	0,45 – 0,82
50–64	40–49	LCC	0,98 – 1,58	0,41 – 0,64
50–64	40–49	RMLO	0,94 – 1,87	0,41 – 0,82
50–64	40–49	LMLO	1,06 – 1,61	0,45 – 0,69
50–64	50–59	RCC	1,15 – 2,20	0,51 – 1,00
50–64	50–59	LCC	0,96 – 1,73	0,43 – 0,75
50–64	50–59	RMLO	1,07 – 2,43	0,48 – 1,07
50–64	50–59	LMLO	1,03 – 2,48	0,46 – 1,09

In this context, Graph 1 primarily presents the frequency distribution of patients according to age. As indicated in the relevant graph, this study was conducted for 106 patients in the 40-49 age group and 181 patients in the 50-64 age group. When comparing AGD values between age groups, it was determined that patients in the 40-49 age group were exposed to higher AGD values. Graph 2 shows the number of projections according to age groups. In mammography examinations, when comparing the median values calculated in the 40-49 and 50-64 age groups using the DANCE method and 2ABD method, it was observed that the data calculated using the DANCE method were higher than the data calculated using the 2ABD method. While Table 1 presents the typical dose values calculated using the DANCE method for 30-39 mm, 40-49 mm, and 50-59 mm compressed breast thicknesses in the 40-49 and 50-64 age groups, Table 2 presents the typical dose values calculated using the 2ABD method for 30-39 mm, 40-49 mm, and 50-59 mm compressed breast thicknesses in the 40-49 and 50-64 age groups.



Graph 1. Patient Distribution by Age Groups



Graph 2. Number of Projections by Age Groups

Table 3. European Acceptable DRLs Levels

CBT (mm)	European Acceptable DRLs Levels (mGy)
30-39	<1,5
40-49	<2,0
50-59	<2,5

Table 3 represents the dose levels that are considered acceptable according to European standards. These values serve as reference limits established by European guidelines to ensure patient safety and maintain consistent image quality in mammography.

In both age groups, the typical dose value calculated using the DANCE method is higher than the typical dose value calculated using the 2ABD method. For mammography examinations in the 40-49 and 50-64 age groups, the typical dose values of AGDs were calculated for compressed breast thicknesses at every 10 mm between 30-60 mm, expanding the scope beyond the common 40-50 mm range in the literature. The calculated median values, i.e., typical dose, were determined separately for RCC, LCC, RMLO, and LMLO projections using DANCE and 2ABD methods according to compressed breast thicknesses for the 40-49 and 50-64 age groups.

Additionally, for the purpose of monitoring the AGD dose to which each patient was exposed, right, left, and total breast doses with four projections were calculated in both age groups. ***(Table 4. and 5.)***

The AGD values calculated using the DANCE and 2ABD methods were anlyzed with respect to compressed breast thickness. The results indicate that as compressed breast thickness increases, AGD values also increase for both calculation methods.

Table 4 presents the typical dose values calculated using the DANCE method for each projection at compressed breast thicknesses of 30-39 mm, 40-49 mm, and 50-59 mm in the 40-49 and 50-64 age groups.

Table 4. Projection-Based Typical Dose Values for the DANCE Method

Projection-Based Typical Dose Values for the Dance Method					
Age Group	Compressed Breast Thickness (CBT)	Typical Dose (RCC)	Typical Dose (LCC)	Typical Dose (RMLO)	Typical Dose (LMLO)
40-49	30-39	1,31 mGy	1,20 mGy	1,22 mGy	1,13 mGy
	40-49	1,60 mGy	1,62 mGy	1,52 mGy	1,57 mGy
	50-59	1,56 mGy	1,71 mGy	1,88 mGy	1,83 mGy
50-64	30-39	1,21 mGy	1,09 mGy	1,36 mGy	1,23 mGy
	40-49	1,41 mGy	1,38 mGy	1,40 mGy	1,44 mGy
	50-59	1,46 mGy	1,34 mGy	1,56 mGy	1,55 mGy

Table 5 presents the typical dose values calculated using the 2ABD method for each projection at compressed breast thicknesses of 30-39 mm, 40-49 mm, and 50-59 mm in the 40-49 and 50-64 age groups. Accordingly, when Table 1 and Table 2 are compared, it is observed that the DANCE method yields different calculation results due to its dependence on glandularity and produces higher typical dose values.

Table 5. Projection-Based Typical Dose Values for the 2ABD Method

Projection-Based Typical Dose Values for the 2ABD Method					
Age Group	Compressed Breast Thickness (CBT)	Typical Dose (RCC)	Typical Dose (LCC)	Typical Dose (RMLO)	Typical Dose (LMLO)
40-49	30-39	0,64 mGy	0,57 mGy	0,61 mGy	0,61 mGy
	40-49	0,72 mGy	0,74 mGy	0,71 mGy	0,70 mGy
	50-59	0,75 mGy	0,80 mGy	0,84 mGy	0,84 mGy
50-64	30-39	0,57 mGy	0,52 mGy	0,62 mGy	0,58 mGy
	40-49	0,50 mGy	0,57 mGy	0,58 mGy	0,59 mGy
	50-59	0,64 mGy	0,59 mGy	0,66 mGy	0,66 mGy

Discussion

In this study, it was observed that the Average Glandular Dose (AGD) values calculated using the DANCE and 2ABD methods for women in the 40–49 and 50–64 age groups were consistently higher in MLO (Mediolateral Oblique) projections compared to CC (Craniocaudal) projections. This finding aligns with previous studies highlighting that the MLO position, which involves imaging a larger breast volume from a different angle, leads to increased radiation dose distribution.[1] The methodological differences between the DANCE and 2ABD methods, particularly in terms of glandularity assumptions, are reflected in the variations in dose estimations and are consistent with earlier reports indicating that glandularity-based methods tend to yield higher AGD values than glandularity-independent methods.[3]

The DANCE method assumes a standard breast composition of 50% glandular and 50% adipose tissue, whereas the 2ABD method is independent of glandularity, which may account for the relatively lower dose estimations obtained by the latter. This distinction underscores the importance of selecting appropriate dose calculation methods according to the clinical context and patient-specific characteristics. As emphasized in the literature, single-center studies have inherent limitations in terms of generalizability; therefore, multi-center studies involving diverse mammography systems and broader patient populations are essential for validating and, if necessary, optimizing dosimetric protocols.[16]

Furthermore, this study aligns with the recommendations set forth in ICRP Publication 135, which emphasizes the use of Diagnostic Reference Levels (DRLs) as a key tool for optimizing radiation protection in medical imaging, including mammography. According to ICRP 135, typical dose values obtained from large-scale surveys or local measurements are crucial in establishing DRLs that guide facilities in maintaining doses as low as reasonably achievable while ensuring image quality.[1]

Overall, the findings reinforce the necessity of regular dosimetric monitoring and the comparison of different calculation methods to maintain an appropriate balance between patient safety and diagnostic quality. By presenting typical AGD values in accordance with ICRP 135 guidelines**,** the results of this study contribute valuable insights to ongoing efforts in optimizing radiation dose in mammography screening programs.

Conclusion

This study highlights the importance of accurate dose assessment in mammography by comparing AGD values obtained using DANCE and 2ABD methods in two age groups. To the best of our knowledge, this is the first study conducted in Türkiye that evaluates mammographic dose using both the DANCE and 2ABD methods, providing unique insight into national practices. It was found that AGD values were consistently higher in MLO projections due to greater tissue thickness and a wider imaging area. Importantly, all calculated doses remained below the European Commission’s recommended limit of 2,5 mGy, 2,0 mGy and 1,5 mGy per projection, indicating compliance with international safety standards. The findings confirm that current practices at the examined facility in Türkiye are within acceptable radiation exposure levels.

By offering typical dose values derived from a large dataset collected in a real-world clinical setting, the study establishes a valuable benchmark for other institutions in the country. Establishing typical dose values contributes to national dose optimization efforts and provides a foundation for setting regional or national diagnostic reference levels (DRLs). Furthermore, the use of two distinct calculation methods allows for a more robust evaluation of dose metrics, supporting more informed decisions for future protocol development and quality assurance in breast imaging.

To enhance the generalizability and impact of these findings, future research should include data from all mammography devices across various healthcare institutions in Türkiye. With this broader dataset, national DRL calculations can be accurately performed. Additionally, integrating patient-specific radiation history into clinical decision-making such as displaying a patient's cumulative dose data to physicians before ordering a mammogram could further support individualized risk-benefit assessment and minimize unnecessary radiation exposure.

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Author Contributions

Nihat Barış Sebik: Concept, design, data collection, literature search, writing-review.

Gamze Yorgancıoğlu Tarcan: Design, supervision, analyses and interpretation, editing.

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