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From the Editor,

The Journal of Radiology and Molecular Imaging (Rad & Mol Image) has published its second issue in its inaugural year. I would like to extend my heartfelt gratitude to the esteemed authors of the articles featured in this issue, as well as to the referees for their invaluable contributions. Additionally, I wish to acknowledge our distinguished field editors and advisory board members for their support throughout the article evaluation process. I hope that the **"Rad & Mol Image 2024;1(2)"** issue will prove beneficial to all academic researchers, and I offer my sincere respects.

Editor-in-Chief
Türkan Ikizceli

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Review

Radiation Protection and Radiobiology

Radyasyondan Korunma ve Radyobiyoloji

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Keywords
radiation
radiation protection
radiobiology

Absract
This study provides a comprehensive overview of the principles of radiation protection and radiobiology. It defines and classifies radiation, distinguishing between ionizing and non-ionizing radiation. The biological effects of radiation, with a particular emphasis on its impact on DNA and cellular structures, are examined in detail. The text specifies radiation-sensitive and radiation-resistant tissues and explains both deterministic and stochastic effects. Additionally, the discussion encompasses radioepidemiological information and the relationship between linear energy transfer and DNA damage. The article delineates the classification of radiation areas as either controlled or supervised. It offers an extensive overview of the safety and protection methods employed in radiation work, including the ALARA (As Low As Reasonably Achievable) principle, the use of personal protective equipment, and dosimeters. Furthermore, it explains the radiation protection methods utilized in radiology units and outlines the precautions that should be taken during pregnancy. The article also presents recommendations for reducing radiation exposure. Overall, this article serves as a valuable resource on radiation safety for radiation workers and the public, containing essential information on protection from the harmful effects of radiation and safe working practices.

Anahtar Kelimeler
radyasyon
radyasyondan korunma
radyobiyoloji

Özet
Bu çalışma, radyasyondan korunma ve radyobiyoloji ilkelerine dair kapsamlı bir genel bakış sunmaktadır. Radyasyonun tanımı ve sınıflandırması ile iyonlaştırıcı ve iyonlaştırıcı olmayan radyasyon arasındaki ayrım açıklanmaktadır. Radyasyonun biyolojik etkileri, özellikle DNA ve hücresel yapı üzerindeki etkisi ayrıntılı olarak incelenmektedir. Metin, radyasyona duyarlı ve dirençli dokuları belirtmeye ve deterministik ve stokastik etkileri açıklamaya devam etmektedir. Tartışma ayrıca radyo-epidemiyolojik bilgileri ve doğrusal enerji transferi ile DNA hasarı arasındaki ilişkiyi de kapsamaktadır. Makale, radyasyon alanlarının kontrollü veya denetlenen olarak sınıflandırılmasını açıklamaktadır. ALARA ilkesi, kişisel koruyucu ekipman kullanımı ve dozimetre kullanımı dahil olmak üzere radyasyon çalışmalarında kullanılan güvenlik ve koruma yöntemlerine dair kapsamlı bir genel bakış sunmaktadır. Ayrıca radyoloji ünitelerinde kullanılan radyasyon koruma yöntemlerini ve gebelik durumunda alınması gereken önlemleri açıklamaktadır. Ayrıca, radyasyon dozunu azaltmaya yönelik öneriler sunmaktadır. Makale, radyasyon çalışanları ve halk için radyasyon güvenliği konusunda kapsamlı bir kaynak olup, radyasyonun zararlı etkilerinden korunma ve güvenli çalışma uygulamaları hakkında önemli bilgiler içermektedir.

Introduction

This study addresses the following key areas: the types of radiation, their biological effects, the fields in which they are used, and the necessary safety precautions that must be implemented. It also emphasizes the importance of protecting workers, methods for reducing radiation exposure, and the knowledge and awareness required among employees.

1.What is Radiation?

The term "radiation" is used for the transfer of energy through the action of particles or electromagnetic forces. When radiation interacts with the tissues and organs of the human body, it can lead to significant alterations to their intrinsic structures (1).

1.1. Ionizing and Non-Ionizing Radiation: The interaction of high-energy radiation with matter leads to the ionization of the latter (2). Ionizing radiation includes alpha particles, beta particles, neutrons, gamma and X-rays, while non-ionizing radiation encompasses radio waves,

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microwaves, infrared rays, and ultraviolet rays. Ionizing X-rays and gamma rays can easily penetrate the human body due to their neutral charge and minimal mass, which grants them significant penetrating power. The effects of radiation dose depend on several factors, including the surrounding environment, the presence or absence of ionizing radiation, charge and charge-free properties, dose rate per unit time, and duration of exposure. Additionally, the units used to quantify radiation doses include activity, irradiation dose, absorbed dose, and dose equivalent (3). The average global radiation dose is 2.7 mSv per year, resulting from exposure to both natural and artificial sources of radiation.

1.2. Internal Irradiation: Internal irradiation is defined as the introduction of radiation into the body through internal pathways, such as inhalation or ingestion. The term "internal irradiation" refers to the exposure of the body to radiation resulting from the contamination of the skin or body by gamma, alpha, or beta-radioactive sources.

1.3. External Irradiation: The term "external irradiation" is defined as the exposure of the body to ionizing radiation, such as X-rays and gamma rays, originating from external sources. This term specifically denotes the body's exposure to ionizing radiation. For illustrative purposes, imaging techniques can be broadly classified into three categories: computed tomography, X-ray radiography, and radioscopy.

1.4. Biological Effects of Radiation: The field of radiobiology primarily focuses on the physical and biological effects of radiation on living tissues. As a result, various complications may arise in the structure of DNA and cells, leading to a range of abnormalities due to damage to DNA and RNA (4). Irreversible conditions, including chromosomal anomalies, mutations, and cancer, may result from radiation-induced DNA damage.

1.5. Basic Principles of Radiobiology: Stem cells, young tissues, tissues with high metabolic activity, and rapidly growing tissues are more susceptible to the effects of radiation (i.e., they are more radiosensitive). In contrast, mature cells exhibit greater resistance to ionizing radiation (i.e., they are more radioresistant).

1.6. Tissues Most Sensitive to Ionizing Radiation: The highest degree of sensitivity is observed in cells with a high capacity for proliferation. This includes white blood cells, such as lymphocytes and erythrocytes, as well as cells from the digestive system, bone marrow, testes, ovaries, skin, and blood vessels.

1.7. Tissues Most Resistant to Ionizing Radiation: Moderate sensitivity to ionizing radiation is observed in the thyroid, skin, cornea, kidneys, bones, liver, and gastrointestinal tract.

1.8. Tissues Most Resistant to Ionizing Radiation: In adult organisms, tissues that exhibit resistance to ionizing radiation are typically differentiated and non-dividing. These tissues include bone, brain, and cartilage.

1.9. Deterministic Effects: The radiobiological effects of ionizing radiation encompass a range of conditions, including but not limited to temporary or permanent infertility, skin injuries, alterations in blood parameters, alopecia, modifications to the central nervous system, erythema, loss of transparency in the eye, cataracts, and acute damage that surpasses the body's capacity for repair (5). In these cases, a threshold dose exists, above which the extent of damage increases with the dose. While this effect is not typically observed in X-ray diagnostics, it is frequently seen in incidents involving nuclear weapons, reactor accidents, gamma radiation leaks, and radiotherapy treatments.

1.10. Stochastic Effects: The term 'stochastic effects' is employed to delineate the random, unpredictable, and non-deterministic effects that may arise from a specific stimulus. In particular, hereditary diseases, genetic mutations, and cancer may result from inadequate or erroneous repair of DNA damage caused by radiation exposure (6). No specific threshold dose has been identified for these effects. Generally, an increase in radiation dose correlates with an increased risk. It is recognized that low-level radiation exposure and late-term stochastic effects from diagnostic X-rays can lead to long-term consequences. In this context, the likelihood of developing a disease increases in proportion to the level of exposure. No established threshold dose exists for the development of cancer due to exposure to ionizing radiation. Therefore, it is crucial to note that even at the lowest dose capable of causing tissue and cellular damage, the radiation dose is not zero.

1.11. Results of Radioepidemiological Information: The risk of developing cancer due to radiation exposure is influenced by the sensitivity and resistance of the affected organs to radiation (7). Exposure to radiation at an early age increases the likelihood of developing radiation-induced malignancies as individuals age. Furthermore, the risk of developing cancer from irradiation is higher in women than in men. In addition to cancer, several other radiation-associated diseases may also manifest. Populations most vulnerable to these risks include children, adolescents, pregnant women, and women of childbearing age.

Moreover, the dosage administered to patients undergoing radiological scans, particularly those involving invasive procedures, is significantly higher than that used for other forms of medical imaging, such as computed tomography, X-rays, and mammography. Patient dose exposures are substantial and can be attributed to several factors, including the experience of the physician, the complexity of interventional procedures, the geometry of patient irradiation, the continuous irradiation mode, the use of high-dose options, and the utilization of a fluoroscopy system.

In recent years, there has been a notable increase in both the radiation doses to which patients are exposed and the utilization of computed tomography (CT). This trend is particularly evident in the context of interventional examinations. The frequency of lung, heart, colon, and full-body scans has risen significantly, with CT examinations becoming routine. Multiple scans are often performed, examinations are conducted at an accelerated pace, and protocols for radiation use are not consistently adhered to. Additionally, there is a lack of compliance with the principle of necessity, evident dosage and calibration issues with imaging devices, and a pressing need to consider the expertise of radiology technicians.

1.12. Linear Energy Transfer (LET) and DNA Damage: The relationship between linear energy transfer (LET) and DNA damage can be described as follows: LET is defined as the amount of energy transferred per unit length by ionizing radiation (8). X-rays and gamma rays exhibit low LET due to their uncharged nature. In contrast, charged particles, such as alpha, beta, and neutron particles, demonstrate a high LET. The lethal and damaging effects of ionizing radiation are directly proportional to the LET.

The interaction between the human body and ionizing radiation occurs at the atomic level. Certain molecular alterations in DNA are associated with the energy emitted by ionizing radiation. If these molecular changes are repaired by the appropriate enzymes, the affected tissues or cells will return to their normal function. However, if enzymatic repair is insufficient, the observable effects of ionizing radiation will become evident at the macroscopic level. If molecular damage occurs immediately, ionizing radiation can lead to cell death by directly affecting DNA. Conversely, if the damage occurs indirectly, free radicals generated by the breakdown of water can cause DNA damage.

2. Radiation Fields

The Turkish Energy, Nuclear and Mineral Research Agency (TENMAK) is the official institution responsible for ensuring radiation safety in Turkey. TENMAK is also tasked with the licensing of radiation fields. The categorization of these fields is based on both the type of radiation and its energy level. For example, if the human body is exposed to a radiation dose exceeding 1 mSv per year, that area is designated as a radiation zone. The classification of areas is determined by the radiation level and is divided into two distinct categories: supervised and controlled.

2.1. Controlled Areas: The term “Controlled Areas” refers to locations where the entry and exit of personnel are regulated, and where working conditions adhere to the principles of radiation protection (9). These areas are characterized by a personnel control system that governs access and egress, ensuring that working conditions align with radiation safety standards (9). If the average radiation dose over five consecutive years exceeds 6 mSv per year, which is equivalent to 3/10 of the permitted dose of 20 mSv, these areas will be classified as supervised areas. Personal dose measurements must undergo rigorous and regular monitoring in these locations.

2.2. Supervised Areas: This category includes radiation workers who are likely to exceed the annual dose limit of 1/20, as well as those who are not expected to exceed the annual dose limit of 3/10. Therefore, it is recommended that environmental radiation be monitored regularly, rather than focusing solely on individual exposure. In areas where ionizing radiation is controlled and supervised, the presence of X-rays and gamma rays should be indicated to individuals and radiation workers through the use of appropriate warning signs and symbols. Ionizing radiation is a pervasive phenomenon in radiology, nuclear medicine, and radiotherapy units within hospitals, where it is extensively utilized for both diagnostic and therapeutic purposes.

3.Radiation Safety and Radiation Protection

3.1. Purpose of Radiation Protection: International organizations, of which Turkey is a member through TENMAK, have been established to formulate regulations that align with the standards outlined in EU directives on radiation protection and nuclear safety. Beneficial practices aimed at safeguarding individuals and community members from radiation exposure by minimizing the dose of ionizing radiation during medical diagnosis and treatment will continue to be implemented. To achieve this goal, a proposal for a dose limitation system was presented in Report No. 26 published by the International Committee on Radiation Protection (ICRP) (10). The principles of time, distance, and shielding are of paramount importance in the field of radiation protection.

3.2. Methods of Protection from External Irradiation: The objective of this study is to examine the efficacy of various methods for protecting against external irradiation. The development of modern shielding has depended on the thickness of the concrete used, with the effectiveness of protection increasing when the shielding is positioned at the greatest distance from the radioactive source. Furthermore, limiting the duration of exposure to ionizing radiation in the workplace can also serve as an effective protective measure. For example, if a measuring device indicates a radiation dose of 50 mSv in one hour, 100 mSv in two hours, and 150 mSv in three hours (the total dose is the product of the dose rate and time), the selection of shielding material should be based on the specific type and energy level of the radiation involved, in accordance by relevant standards and guidelines. The use of thin paper can impede the passage of alpha particles, while aluminum sheets can obstruct beta particles. Additionally, lead alloy concrete can be utilized to attenuate X-rays and gamma rays.

3.3. Radiation Protection for Employees

3.3.1. ALARA Principle: The ALARA principle represents a fundamental tenet of radiation protection. It is based on the concept of administering the lowest possible dose while considering all relevant factors, including the source of radiation and associated risk factors. The ALARA principle can be classified into three categories.

3.3.2. Justification: The following section justifies a justification for the argument. It is unjustifiable to permit radiation applications and exposures that do not involve ionizing radiation, as they do not offer a clear benefit to individuals or society. For instance, unnecessary CT or X-ray scans should be avoided.

3.3.3. Optimization: The objective of optimization is to ensure that, if a clear benefit is to be derived from radiation-induced applications, the lowest possible dose is administered to patients. Additionally, factors such as the type and energy of the radiation dose must also be taken into account.

3.3.4. Dose Limits: In the context of radiation applications, doses must be maintained below specified threshold values. It is recognized that both healthcare workers and members of the public are exposed to natural or artificial radiation at certain annual doses (11). For instance, the effective dose limit for radiation workers is 20 mSv on average, while the limit for the general public is 1 mSv. The effective dose limit of 50 mSv per year for radiation workers mustn’t exceed 5 mSv for community members. Conversely, the equivalent dose value for the stomach area should not surpass 1 mSv following the reporting of a pregnancy by a radiation worker. The equivalent dose is defined as the dose absorbed by the relevant tissues and organs, expressed in units of radiation energy and type, multiplied by the radiation weighting factor. The sievert (Sv) is the unit used to express this equivalent measurement. The effective dose varies depending on the specific cellular structure of the tissue or organ in question, which in turn influences the radiation dose response. The effective dose is calculated by multiplying predetermined tissue weighting factors by the equivalent dose received by various tissues and organs. The unit of measurement is the sievert (Sv); however, the millisievert (mSv) format is more commonly used.

3.3.5. Personal Protective Equipment: A variety of personal protective equipment (PPE) is utilized in radiology, radiotherapy, and nuclear medicine units where ionizing radiation is present. This equipment includes lead aprons, gloves, thyroid shields, goggles, lead screens, and gonad protectors. Lead-equivalent protective gear is manufactured in thicknesses ranging from 0.25 mm to 1 mm. It is recommended that 0.5 mm lead-equivalent aprons be used, as they are preferred for routine use when considering factors such as practicality and weight (12). Additionally, lead protective equipment should not be folded; instead, it should be hung on a hanger to prevent radiation leaks caused by the potential cracking of thin lead layers. It is also crucial to protect the reproductive organs of patients with high fertility potential by using lead equipment and administering radiation doses at the most optimal levels, while taking into account the radiation sensitivity of pediatric patients.

3.3.6. Personal Dosimeters: The use of dosimeters is mandatory in radiology, radiotherapy, and nuclear medicine units, depending on the energy and type of ionizing radiation involved. It is recommended that dosimeters be worn at chest level, such as in a shirt pocket. By established manufacturing standards, dosimeters must be protected from humidity and temperature fluctuations. At the end of the working day, these dosimeters should be stored in locations that are not exposed to ionizing radiation. Dosimetry results must be recorded biannually and annually to ensure that dose limits remain within legal parameters. The use of personal dosimeters by healthcare professionals is essential for demonstrating that radiation exposures are within acceptable limits for health and for ensuring health protection.

3.3.7. Health Screenings: It is recommended that healthcare personnel who are exposed to ionizing radiation undergo a peripheral blood smear and a thyroid ultrasound every six months.

3.3.8. Ventilation and Cleaning: Ventilation systems for air circulation and cleaning must be fully operational, as the removal of free radicals generated by the interaction of ionizing radiation is a key objective. Furthermore, the development of customized systems for the containment, storage, and disposal of waste materials containing naturally occurring radioactivity is imperative.

4. Radiation Protection Methods in the Radiology Unit

A variety of healthcare professionals, including technicians, radiologists, and nurses, are at risk of exposure to X-rays due to their occupational responsibilities. It is not uncommon for individuals working in radiation-related fields to encounter X-ray exposure. When establishing X-ray departments, locations on the ground floor and near exterior walls are typically chosen. It is recommended that the walls of the unit be reinforced with lead plates ranging in thickness from 0.5 to 2 mm. In areas where ionizing radiation is present, 1.5 mm lead plates should be used when secondary scattering is significant, while 2 mm lead plates are advisable in areas with intensive primary radiation exposure. To ensure adequate protection for technicians, a lead covering of at least 2 mm in thickness is recommended. In addition to the necessary shielding, an effective ventilation system is crucial for the removal of harmful substances generated in ionized air within X-ray rooms. In rooms where X-ray imaging is conducted, it is essential to implement a ventilation system that includes absorbent units positioned near the floor and blower units located near the ceiling.

4.1. Control Room Layout in Radiology: The layout of the control room in a radiology department should adhere to the following guidelines: It is recommended that control rooms be located away from the controlled area, and if possible, in an external location. However, the screen, positioned at a minimum distance of 2 meters from the patient table being examined, must be constructed with lead glass. The height of this screen should be 1.8 meters, and its width should be 1 meter.

4.2. Effective Doses in Radiology: The effective doses in radiology are as follows: The mean effective dose for dental extraction is 0.005–0.01 mSv; for posteroanterior chest radiography, it is 0.02 mSv; for mammography, 0.4 mSv; for computed tomography of the body, 13.3 mSv; and for interventional radiology, the range is 5–70 mSv.

5. Pregnancy of Radiation Workers

Radiation-exposed workers must inform their supervisors in writing about their pregnancy status, particularly if they are employed in radiology, radiotherapy, or nuclear medicine departments. Following this notification, the worker’s annual dose limit must not exceed the dose limit established for the non-irradiated population, which is 1 mSv. It is well-documented that the most sensitive period to radiation exposure during pregnancy occurs between 18 and 48 days after fertilization. Research has demonstrated that even small doses of radiation can be detrimental to the fetus within 10 to 12 days post-fertilization of the egg.

5.1. Pregnancy and Radiation: It is recommended that pregnant women avoid diagnostic imaging procedures during pregnancy unless there is a compelling medical reason to proceed with radiographic imaging. Diagnostic X-rays of the abdominal-pelvic region may be performed on women of reproductive age at the onset of menstruation, as the likelihood of pregnancy is lower during this time.

In the case of a pregnant patient requiring medical imaging with X-rays, it is the responsibility of both the radiologist and the attending physician to reassess the necessity of the procedure. Medical imaging should only be performed when the pelvic region is adequately protected with a lead apron. The radiation dose to the fetus is determined based on the X-ray parameters, specifically kilovolt peak (kVp), milliampere-seconds (mAs), and irradiation time. If the calculated dose falls within the acceptable reference range, the patient is informed that the current radiation exposure is unlikely to adversely affect the fetus.

In situations where the pregnancy status is uncertain, it is crucial to assess the radiation dose to the fetus during diagnostic X-ray imaging of the pelvic region. In these cases, factors such as the type of imaging examination, the number of film repetitions, and the kilovolt (kV) and mAs parameters are considered when calculating the estimated fetal dose. If the estimated fetal dose exceeds 150 mGy, the option of terminating the pregnancy should be evaluated, taking into account the associated dose-related risks and the gestational age.

6. Radiation Dose Reduction Methods

Medical devices must be calibrated regularly and undergo quality control tests when they emit ionizing radiation (13). Promoting the consistent use of PPE, such as lead aprons, among radiation workers would be beneficial. Providing in-service training to improve the knowledge and awareness of healthcare workers exposed to ionizing radiation may be an effective strategy for reducing radiation doses. One effective method for decreasing patient radiation exposure is the implementation of radiation signage within the unit. This approach can help minimize unnecessary medical imaging procedures and enhance the understanding of radiation protection among medical imaging technicians.

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Case Report

Isolated Hydatid Cyst of the Breast

Memenin İzole Kist Hidatik Hastalığı

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hydatid cyst
mammography
ultrasonography

Abstract
The occurrence of primary breast hydatid cysts is exceedingly rare, even in endemic regions, and reported prevalence rates are infrequent. Although classified as a benign condition, it represents a significant health concern caused by the parasitic tapeworm Echinococcus granulosus. Hydatid cyst disease can manifest in various anatomical locations throughout the body, ranging from the head to the extremities. Diagnosis typically involves imaging studies, such as ultrasound, which can reveal the characteristic features of the cyst. Additionally, serological tests may be conducted to detect specific antibodies against Echinococcus. This report aims to present the imaging findings of an exceptionally rare case of an isolated breast hydatid cyst in a 74-year-old female patient.

Anahtar Kelimeler
meme
kist hidatik
mamografi
ultrasonografi

Özet
Primer meme hidatik kistlerinin oluşumu, endemik bölgelerde bile son derece nadirdir ve bildirilen yaygınlık oranları seyrektir. İyi huylu bir durum olarak sınıflandırılmasına rağmen, parazitik tenya Echinococcus granulosus'un neden olduğu önemli bir sağlık sorunudur. Hidatik kist hastalığı, baştan ekstremitelere kadar vücudun çeşitli anatomik yerlerinde ortaya çıkabilir. Tanı genellikle kistin karakteristik özelliklerini ortaya çıkarabilen ultrason gibi görüntüleme çalışmalarını içerir. Ek olarak, ekinokoklara karşı spesifik antikorları tespit etmek için serolojik testler yapılabilir. Bu vaka sunumunda, 74 yaşında bir kadın hastada son derece nadir görülen izole meme hidatik kistinin görüntüleme bulguları sunulmuştur.

Introduction

Echinococcosis is a parasitic disease that predominantly affects the liver and lungs (1). However, it can also manifest in other organs, with a prevalence of 2.5% in the kidneys, 2.5% in the heart and pericardium, 2% in the bones, 1.5% in the spleen, 1% in the muscles, and 0.5% in the brain (2). Primary involvement of the breast in echinococcosis is exceedingly rare, even in endemic regions, with a reported prevalence of only 0.27% (3). Patients typically present to healthcare facilities with a painless, progressively enlarging palpable mass (3,4). The diagnosis of hydatid disease is based on enzyme-linked immunosorbent assay (ELISA) findings for echinococcus antigens, with positive results observed in approximately 85% of infected individuals. The diagnostic process encompasses a comprehensive medical history, physical examination, imaging techniques, and serological testing (5).

Imaging of hydatid cysts in the breast generally reveals a lesion of variable size with sharply defined contours that is not adherent to the surrounding breast tissue. These cysts may present as dynamic, solid, or mobile nodules and can occasionally exhibit calcification. If the cyst remains intact, it typically does not provoke inflammatory responses or lymphadenopathy. In approximately 5% of cases, the cyst may become infected, presenting as poorly defined and pseudo-tumoral, which can mimic an abscess or a malignant tumor (6). The recommended treatment for hydatid cysts in the breast is total cystectomy. The significance of primary breast involvement lies in its potential to be misdiagnosed as malignancy (6).

In the current study, we aim to present a case of an isolated hydatid cyst located in the breast, which may be misdiagnosed as other types of breast masses.

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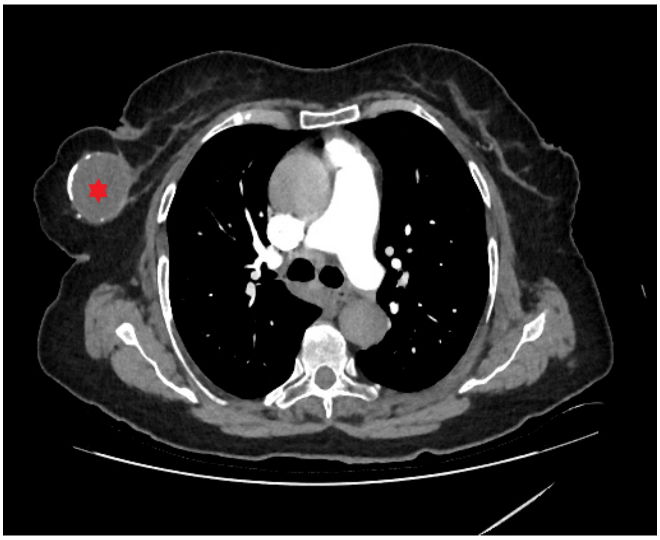

Figure 1: A well-circumscribed hypodense mass lesion with wall calcification located in the upper outer quadrant of the right breast, as observed on thoracic computed tomography (red star).

Case Report

A seventy-four-year-old female patient presented to the emergency department with complaints of dyspnea. Upon examination, a painless, mobile mass measuring 3 cm in diameter was identified in the upper outer quadrant of the right breast. This mass exhibited well-defined borders and a soft consistency. The integrity of the adjacent skin was preserved, and there were no signs of mastalgia or local inflammation in the right breast. Furthermore, there was no evidence of axillary or supraclavicular lymphadenopathy, nor was there any nipple discharge. Laboratory analysis revealed hypercalcemia.

A thoracic computed tomography (CT) scan conducted in the emergency department confirmed the presence of a mass in the right breast (Figure 1). Following this, mammography and breast ultrasound (USG) were performed for further assessment. The results of the mammography indicated a lesion characterized by calcified, well-defined heterogeneous opacity located in the upper outer quadrant of the right breast (Figure 2). The sonographic examination identified a mass lesion exhibiting a well-circumscribed heterogeneous echo, composed of intertwined echogenic and hypoechoic rings with calcified walls (Figure 3). The classification system established by the World Health Organization (WHO) guidelines is the current standard for hydatid cyst classification. In this instance, the lesion was classified as CE5 according to the WHO classification system, due to the presence of thin-wall calcification and a heterogeneous solid appearance on USG. It was categorized as Breast Imaging Reporting and Data System (BI-RADS) category 2.

In non-mammary organs, hydatid cysts were not identified. A tru-cut biopsy was performed on the mass, which had been radiologically assessed as a hydatid cyst due to its composition of necrotic scolices and the absence of anaphylactic risk. The procedure was completed without complications. The pathology report revealed the presence of an acellular lamellar cuticular membrane, consistent with the typical characteristics of a hydatid cyst (Figure 4).

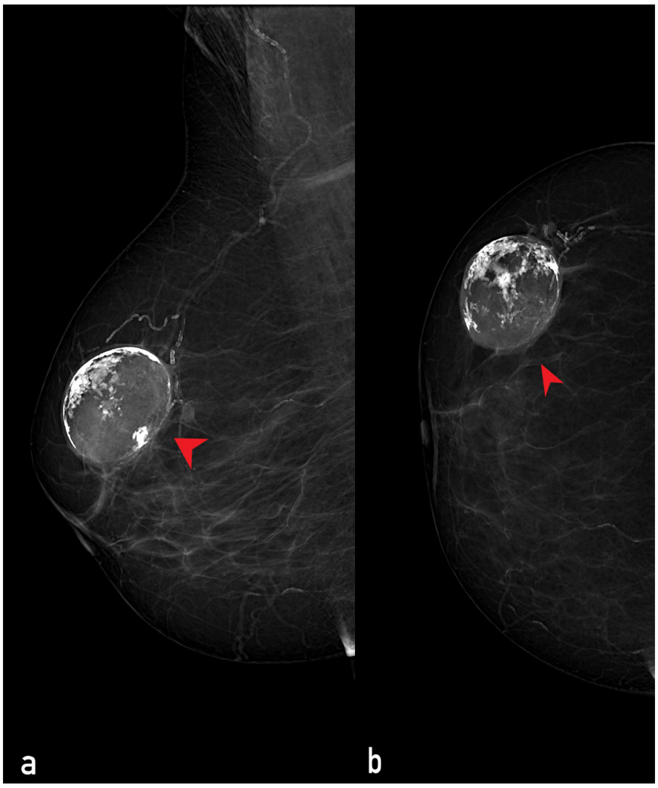

Figure 2: The mammographic findings in the right breast, particularly in the upper outer quadrant, are presented. **(a)** The mediolateral oblique (MLO) view and **(b)** the craniocaudal (CC) view illustrate an opacity lesion characterized by calcifications. This lesion is well-circumscribed and is indicated by arrowheads.

Discussion

The first documented case of hydatid cysts in the breast was reported by Haen in 1770 (7). Mammary hydatid cysts are generally regarded as primary in origin and disseminate to the breast via the bloodstream. In rare cases, they may also reach the breast through the bile ducts, which can occur as a result of trauma or surgical procedures involving the liver or

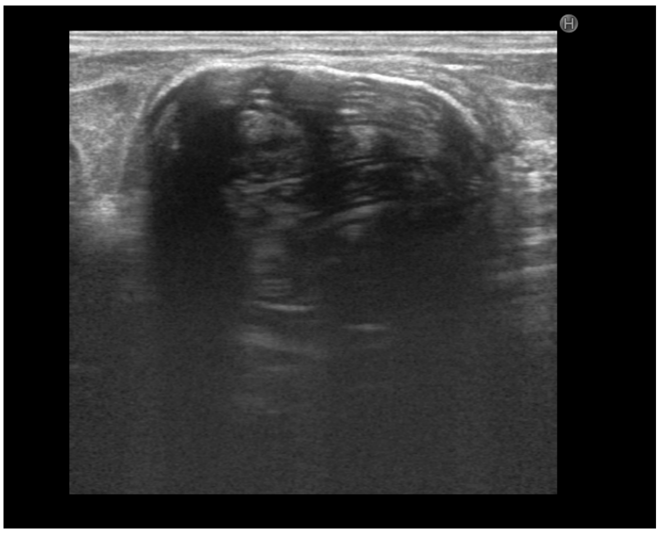

Figure 3: An ultrasound examination has identified a mass lesion characterized by a posterior shadow, which is likely due to calcification. The lesion displays a heterogeneous internal structure, featuring hypoechoic formations organized in circular lamellae, situated in the upper outer quadrant of the right breast.

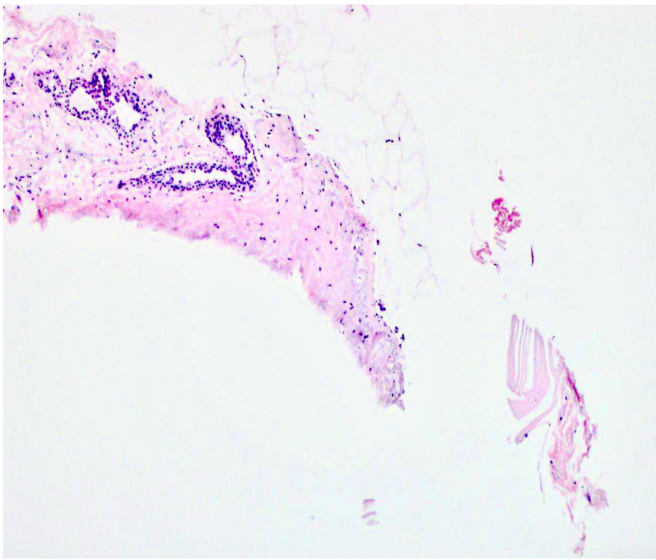

Figure 4: The histological examination of a hydatid cyst reveals the presence of an acellular lamellar cuticular membrane structure located adjacent to the breast tissue (H&E x 100).

other organs.

Hydatid cysts of the breast are predominantly diagnosed through postoperative pathological examination, as the radiological findings associated with this condition lack specificity (8). The main laboratory techniques employed to confirm diagnoses include serological tests such as agglutination methods, immunoelectrophoresis, skin tests, and ELISA (9). Additional serological assessments include the Casoni skin test, complement fixation (Weinberg) test, indirect hemagglutination (IHA) test, and Western blot (WB) test. While positive serological results provide valuable information, negative results do not definitively exclude the presence of hydatid cysts. These serological evaluations are particularly important during patient follow-up (10).

Imaging modalities generally demonstrate greater sensitivity than serological tests; therefore, USG, which reveals characteristic features of echinococcal cysts, or CT scans are recommended in cases where serological findings are negative. Upon identifying echinococcal disease, a comprehensive systemic examination should be conducted to assess the potential involvement of other organs, particularly the liver and lungs (11,12). The diagnosis of breast echinococcosis is often complicated by its frequent misidentification with other commonly encountered breast pathologies, such as benign cysts, chronic abscesses, fibroadenomas, phyllodes tumors, and even carcinomas, especially in older women. This diagnostic challenge is further exacerbated by the absence of specific precursors for the disease in its rare presentations and evaluations (13). USG is particularly preferred due to its ability to visualize floating membranes in entirely cystic lesions, as well as its effectiveness in identifying daughter cysts and vesicles. Furthermore, USG is superior in demonstrating pathognomonic features, such as hydatid sand (13).

The initial classification of hydatid cysts was established by Gharbi, who categorized them into five types primarily based on their USG characteristics (13). Subsequently, the World Health Organization (WHO) developed its own classification system. Both classification systems aim to guide the clinical management of hydatid cysts; however, the WHO system is more widely utilized on an international scale and provides greater detail, while the Gharbi system is predominantly employed in the regions where it was originally formulated (14). In the case presented, the cyst was classified as Type V according to the Gharbi system and as CE5 according to the WHO classification, with the USG findings consistent with the existing literature.

Mammography is capable of identifying well-defined lesions characterized by round-shaped structures within the mass (3). The ring-shaped structures observed within the lesion have previously been recognized as an unreported mammographic finding. This phenomenon may be attributed to variations in the density of the walls and the contents of the daughter cysts within a fluid-filled hydatid cyst. When a secondary infection occurs, differentiating between an echinococcal cyst and a breast abscess via mammography becomes challenging. In this case, mammography revealed typical rim-type calcification, suggesting the presence of a hydatid cyst. However, it is essential to acknowledge that similar rim-type calcified lesions can also be observed in the breast, and no definitive diagnostic conclusions were established (3).

Magnetic Resonance Imaging (MRI) is not definitive for diagnosing hydatid cysts; however, it can provide valuable diagnostic information (15). Hydatid cysts typically exhibit hypointensity on T1-weighted images, similar to other cystic lesions, and hyperintensity on T2-weighted images. A distinguishing characteristic of hydatid cysts is the consistently low signal intensity observed across all imaging sequences, as well as the presence of collapsed membranes (15). In the case under discussion, MRI was not performed.

Based on the USG and mammography findings, as well as the lamellar appearance and wall calcification of the cyst, we proceeded with a tru-cut biopsy due to the suspicion of a hydatid cyst. The use of fine needle aspiration biopsy (FNAB) in diagnosing echinococcal disease remains a contentious issue. It is generally discouraged because of the potential risk of inducing acute anaphylaxis or the dissemination of daughter cysts. Although this risk has garnered considerable attention in the literature, numerous studies indicate that FNAB is a cytologically safe procedure for diagnosing hydatid disease, with minimal associated complications. To date, only one case has been reported in which a cervical echinococcal cyst resulted in anaphylactic shock during FNAB. While occurrences of allergic reactions are infrequent, it is crucial to implement appropriate immediate measures to manage such events (16). In the current case, the initial diagnosis was established through USG imaging. However, considering the patient's preference against surgical intervention and the classification of the cyst as CE5 inactive, we opted to perform a biopsy to confirm the diagnosis.

Surgical excision of a cyst is regarded as the primary treatment for hydatid disease of the breast. In cases of cystic hydatid disease, the primary goal of radical treatment is to minimize recurrence rates and to prevent the need for unnecessary pharmacological interventions (2,10). Given the patient's expressed desire to avoid surgical intervention, no surgical procedure was planned.

Conclusion

Hydatid disease of the breast is a rare condition. Although it does not exhibit distinctive features and may mimic other mass lesions of the breast in imaging studies, it demonstrates specific diagnostic characteristics when evaluated through USG.

Ethical Approval and Consent: Written consent was obtained from the patient for the presentation.

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Conflict of Interest: The authors have no conflict of interest to declare.

Authors' Contributions: Project Administration: S.U.; Data Collection: S.U., N.O.E.;Literature Searching: S.U.; Data Analysis: S.U., Y.Y.B.; Methodology: S.U.; Writing: S.U.; Study Design: S.U.; Review and Editing: S.U., N.O.E., Y.Y.B.

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