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Construction of mammographic findings simulators to study the interference of silicone implants in the diagnosis of breast cancer

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Abstract

Introduction: Breast cancer is the most prevalent malignant neoplasm among women, presenting itself, in 99% of cases, in females. Augmentation mammoplasty is the most performed aesthetic surgical intervention in the world. **Objective:** This study aims to improve the search for biomaterials compatible with mammographic findings suggestive of malignancy, to further study the interference of silicone implants in mammography exams. **Methods:** To make the simulators of mammographic findings, a bibliographic study of possible biomaterials that presented compatibility with the breast tissue and with possible neoplastic findings was carried out. The validation process of the simulators made in this work was carried out in two stages. **Results:** The result found was a density variation between 2.54 and 2.57 (dimensionless unit). For the second plate, the individual optical density of each material was analyzed. The results found for fiberglass ranged between 1.95 and 2.63. For chicken eggshells between 0.59 and 0.80. For the glycerin suppository, values between 1.43 and 2.29 were found. And for plastic PVC film 1.78 to 2.53. **Conclusion:** Given the above, it is observed that the first plate as a whole is compatible with mammographic studies. However, on the second plate, when the materials were analyzed separately, it was observed that fiberglass and plastic PVC film were the closest to compatibility with the commercial phantom, being compatible materials to simulate breast neoplasms in possible further studies.

Keywords: Breast cancer. Neoplastic findings. Biomaterials.

Introduction

Breast cancer is the most prevalent malignant neoplasm among women, presenting itself, in 99% of cases, in females [1]. Such pathology, if detected early, in most cases, has a favorable prognosis, with a survival rate of almost 100% [2]. Currently, Brazil follows the recommendations of the World Health Organization and countries that adopt mammography as the exam of choice for screening for breast cancer, since mammography enables the detection of small and early findings suggestive of malignancy [3].

In the current scenario, augmentation mammoplasty is the most performed aesthetic surgical intervention in the world. Added to this, several studies show that this procedure can interfere in the search for early findings, and thus make the diagnosis of breast cancer difficult [4].

Thus, this study aims to improve the search for biomaterials compatible with mammographic findings suggestive of malignancy, to further study the interference of silicone implants in mammography exams.

Methods

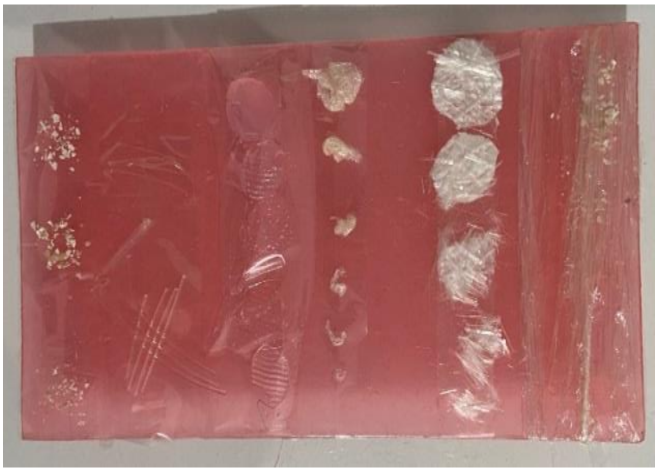
To make the simulators of mammographic findings, a bibliographic study of possible biomaterials that presented compatibility with the breast tissue and with possible neoplastic findings was carried out.

Thus, as a basis for the first simulator, a number 7 dental wax plate measuring 15 cm long and 7.5 cm wide was used and the mammographic findings were placed in it. To simulate breast microcalcifications, crushed hen's eggshells composed of calcium carbonate ($CaCO_3$) and magnesium, with diameters around 1 mm, were used. To simulate malignant neoplasms, a glycerin suppository was used. Finally, 20 mm nylon fibers were used to simulate the breast tissue [5]. The findings board is exposed as shown in **Figure 1**.

Subsequently, a second findings plate was made, improving these materials and adding fiberglass and plastic PVC film, these materials being arranged in different diameters to also simulate malignant neoplasms [6]. Finally, the 20mm nylon threads are replaced by 40mm threads, arranged in a parallel and transversal way, to simulate the breast parenchyma. The improved findings board is displayed as shown in **Figure 2**.

Figure 1. Plate simulating 14x7 cm mammographic findings.

Figure 2. Improved findings board.



All these materials were chosen from the characterization of their attenuation coefficients, using optical density, and the chosen ones were those that obtained better compatibility with those found in the breast tissue, using the commercial acrylic phantom as a parameter.

The validation of these simulators was obtained through the Speedmaster model SM-12 densitometer equipment to identify the optical density of the materials used. The validation is done using the optical density values of the commercial simulator findings plate and compared with the values obtained from the simulators made in this work. The assembly of the experimental apparatus was performed by placing the findings plates on acrylic plates (which are radiotransparent) and this apparatus was exposed on the mammography compression tray.

The radiographic parameters used to generate the image were 28 kV and 80 mAs using the Automatic Exposure Control-AEC mode of the mammography equipment.

Results and Discussion

The validation process of the simulators made in this work was carried out in two stages. First, optical density measurements were taken of the first plate made, not evaluating the materials individually. The result found was a density variation between 2.54 and 2.57 (dimensionless unit). For the second plate, the individual optical density of each material was analyzed.

The results found for fiberglass ranged between 1.95 and 2.63. For chicken eggshells between 0.59 and 0.80. For the glycerin suppository, values between 1.43 and 2.29 were found. And for plastic PVC film 1.78 to 2.53. The nylon threads could not be analyzed because the device did not identify values compatible with them.

The validation was carried out using the optical density values of the commercial simulator findings plate and compared with the values obtained from the simulator made in this work. In the commercial simulator, a value of 2.59 was found for optical density.

Conclusion

Given the above, it is observed that the first plate as a whole is compatible with mammographic studies. However, on the second plate, when the materials were analyzed separately, it was observed that fiberglass and plastic PVC film were the closest to compatibility with the commercial phantom, being compatible materials to simulate breast neoplasms in possible further studies.

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Data sharing statement
No additional data are available.

Conflict of interest

The authors declare no conflict of interest.

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