Mammography and the risk of thyroid cancer

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Recent press reports have suggested that an increase in the incidence of thyroid cancer in women could be due to x-ray exposure during mammograms.

These data have raised concerns among the population, giving rise to a large number of consults from patients who had been performed the mammographic *screening*, concerning possible ways to protect the thyroid gland.

These alarming claims about a relationship between the increase of thyroid cancer and the mammogram not only are unfounded, but that they are also potentially harmful, as they may dissuade women to stop performing their annual mammographic studies.

In the past 50 years, mammographic *screening* has become one of the most important advances for women's health. Since this annual check was started, the breast cancer death rate has been reduced by more than 30% [1].

From the Argentinian Society of Radiology (SAR) we believe that the dissemination of the actual doses the thyroid gland receives during a mammogram and the actual estimates of risk, based on these doses, help the radiological community appease and alleviate the concerns of patients about the risks that this study entails.

In 1995, the National Institute of Cancer in the United States conducted a study of almost 8000 patients who had been performed radiologic studies. Half of them had thyroid cancer and what it was intended to determine was whether they had received a higher dose [2]. The results indicated that the relative risk of thyroid cancer was not significantly associated with the estimated cumulative dose of the thyroid gland after radiological examinations.

In addition, in 2008, Dr. IoannisSechopoulos, of the School of Medicine of the University of Massachusetts, published in *Radiology* the results of his research about the radiation dose of received by the different organs of the human body human during a conventional mammogram with two events, using an anthropomorphic phantom and Monte Carlo simulations [3]. Their results pointed out that the radiation dose received by all the other tissues is extremely low, and even that the dose for the fetus during the first quarter is minimum. For space reasons the charts in this work only show the values of relative dose of those organs that had, at least, a 0.10%. In the case of the thyroid gland, these values were not included since they are insignificant.

In March 2012, due to the above-mentioned conjecture about the relationship between mammograms and the significant increase of thyroid cancer events, Doctor Sechopoulos himself published the organ related doses of the thyroid gland during mammograms in the *American Journal of Roentgenology*. He used the same methodology as for his work in 2008 [4]. These doses vary between 0,016% to 0,045% depending on the mammographic incidence obtained, and on the x-ray spectrum that is used.

In 2010, the American College of Radiology conducted a study on nearly 50,000 women, comparing the conventional mammography with digital mammography for *screening*[5]. In this study, it was determined that the average dose in mammary glands for a bilateral mammography with two incidents is of 3.7 mGy for a digital mammography and 4.7 mGy for the conventional one. With these data, and assuming a maximum organ-related dose for the thyroid gland of 0,045% - according to his work in 2008 [3] - Doctor Sechopoulos estimated in this year's publication [4] that during a bilateral mammogram with two incidents, the maximum average dose for the thyroid gland is 3.3 µGy for a digital mammography and 4.3 µGy for a conventional mammography.

Since the different organs and tissues have different sensitivity to the effects of radiation, the International Commission on Radiological Protection (ICRP) determined a weighting factor for each tissue in the calculations of the effective dose. Therefore, in order to calculate the effective dose, the values of the individual doses in the organs are multiplied by said weighting factor. In the case of the thyroid gland, the weighting factor is 0.04 [6].

Using this parameter, the exposure of the thyroid gland during a bilateral mammogram with two incidents has a maximum effective dose of 0.13 µSv for a digital mammography and of 0.17 µSv

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for the conventional one, which is considered an insignificant dose [4].

The 7th report on Biological Effects of Ionizing Radiation (BEIR VII) determined that the risk of suffering thyroid cancer induced by radiation is of 14 out of 100,000 women exposed to 0.1 Gy[7]. Therefore, if we consider the highest dose (mGy 4.7 in a conventional mammography), the risk of suffering from thyroid cancer induced by a screening examination for a 40-year-old woman is six per trillion. That is, 1 in 166.000.000 (one in 166 million). Even this risk decreases with age [4].

If we add the risk for multiple exams, the cumulative risk of having thyroid cancer caused by an annual mammographic screening between 40 and 80 years of age is approximately 56 per trillion. I.e., 1 in 17.800.000 (one in almost 18 million) [4].

Although thyroid protectors can provide patients with a bit of psychological well-being, they can also affect a proper positioning. In addition, in the event that a part of the protector stays within the field of the mammography x-rays, it can generate shadows on the breast tissue, forcing to repeat the study. This fact, which doubles the dose received by the patient, occurs in approximately 20% of the cases in which protective thyroid [1] is used. Even on modern computers with automatic exposure meter, the presence of the protector forces the automatic control of the exposure to use different parameters, thus resulting in a loss of contrast in the whole image [4]. This indicates that the use of thyroid protectors not only does not confer any benefit in terms of prevention of thyroid cancer, but it can also threaten the quality of the mammography and its benefits to save lives. At the same time, it could generate an unnecessary dose increase in the mammary gland, which would cause to repeat the test [1].

One way to quantify the radiation received in medical studies is to compare it with natural radiation. This is the radioactivity that exists in nature without human intervention, and to which we are all exposed every day. The average dose received by a human being is approximately 3 mSv per year [4], so, during a bilateral mammogram with two incidents, the thyroid gland receives the equivalent to 30 minutes of natural exposure. In other words, the thyroid gland receives 17,520 times more radiation in a year than the one it receives during a mammogram [1].

Finally, it should be pointed out that the incidence of thyroid cancer has significantly grown since 1998 to a same rate, both in women and men (who will not perform mammograms). This indicates that the increased incidence is actually linked to an improvement in diagnostic techniques, which have helped determine subclinical forms of this cancer in both sexes, and not to an increase in the radiation exposure of women who are performed mammographic exams [1.7].

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