University of Pisa

DIPARTIMENTO DI RICERCA TRASLAZIONALE E DELLE NUOVE TECNOLOGIE IN MEDICINA E CHIRURGIA

Scuola di Specializzazione in Radiodiagnostica
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Tesi di Specializzazione

Diagnostic and Interventional Radiology in a breast centre

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INDICE

1. ABSTRACT

Topic of the thesis is the analysis of three key aspects of diagnostic and interventional radiology in a Breast Center: 1 - monitoring of the radiation dose delivered by mammography; 2 – integrated diagnostic approach conducted together by radiologists and surgeons (joint CORD); 3 - interdisciplinary meetings.

Radiation dose monitoring

Mammography is still considered the most effective imaging technique for the early detection of breast cancer and for mortality reduction. The parameter for estimating the absorbed dose is the average glandular dose.

The purpose of this section of the thesis is to present the data collected from three mammography units in the period from January 1 to May 31 2014.

A dose monitoring software (TQM) was used that was able to automatically detect relevant indices from X-ray equipments and to analyze the data in terms of variability of dosimetric behaviours.

The "joint CORD"

In the period from January 16 to April 11, 2014 a weekly session handled by a junior breast surgeon and a senior Radiology resident (joint CORD) was established.

The aim of this session was to optimize the path within the Breast Centre of the patients with urgent referral and nonspecific symptoms. In fact, for these patients it is likely that the final diagnosis can be already reached with a clinical breast examination and a breast ultrasonography.

Twelve sessions of joint CORD were performed, that included 95 patients (average: 7.9 patients for each session).

Of the 95 patients who had access to this service, 33 had an examination performed elsewhere with detection of suspicious nodules or were controls at 6 months of multiple fibroadenomatosis; 20 came for palpable lumps; 16 for unilateral or bilateral breast pain; 5 for mastitis; 5 for swelling / hyperemia or collection after QUART; 4 for secretion (milky); and 12 for various reasons (axillary swelling, screening prior hormonal therapies, skin nodule, adenoma of the nipple).

Of the 95 patients, besides ultrasound and clinical breast examination, 24 (25.2%) underwent mammography, 6 (6.3%) underwent MRI, and 2 (2, 1%) underwent stereotactic biopsy.

US-guided cytological examinations were performed in 23 subjects (24.2%): in 21 cases of nodules and in 2 cases of mammary secretions.

The results of cytology were: 15 C2 (benign findings) with the conclusion of the diagnostic iter; 2 C3 (probably benign findings); 4 C1 (inadequate sampling).
The joint CORD allowed patients to finish their diagnostic workup in a single access, thus dramatically reducing the time they spent in the breast imaging center.

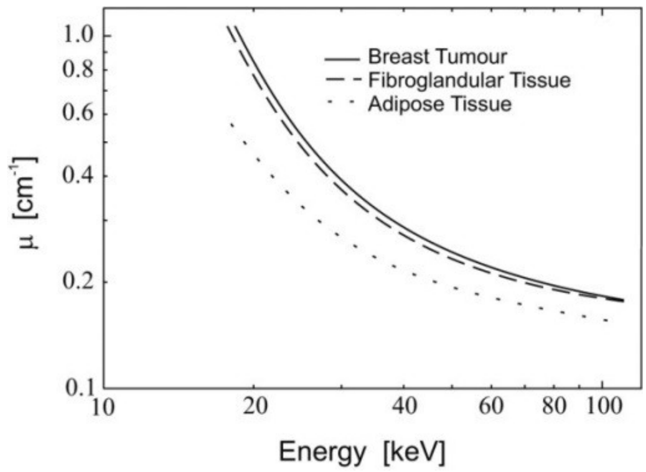
Interdisciplinary meetings

Interdisciplinary meetings (with breast radiologists and surgeons) were conducted on a weekly basis starting from January 17, 2014.
This section of the thesis analyzes the period from January 17 to March 27, 2014.
The cases discussed were tabulated to analyze the most frequent causes of problems, possible solutions and improvements for clinical practice.
Eleven meetings were held, discussing a total of 48 cases (average: 4.36 cases discussed per meeting).
Of the 48 cases discussed, 11 (22.9%) did not reach a cyto-histological conclusive diagnosis, 9 (18.7%) had an underlying lack of communication between radiologists and surgeons, 8 (16.6%) required a further biopsy, 6 (12.5%) had an inappropriate use of MRI , 5 (10.4%) required additional MRI, 3 (6.25%) required a shared decision between radiologists and surgeons, 2 (4.1%) had a PET inappropriately performed, 2 (4.1%) were considered inappropriate for surgical evaluation, and 1 (2.07%) required a new mammography.

2. INTRODUCTION

Mammography is an imaging technique that uses ionizing radiation to produce a mammogram, a 2D projection of the breast. It is the main diagnostic tool to identify breast cancers and it is used for two main purposes, screening and clinical use. Breast cancer is the most prevalent cancer in the female population of industrialized countries. Is very important an early diagnosis of this disease.

A normal breast is composed of adipose tissue and glandular tissue, whose abundance weight percentage varies depending on the subjects and age. These tissues are characterized by poor natural contrast and mammograms should have high quality, to reveal any micro calcifications with size ≈ 100 mM. The main problem is due to the fact that the attenuation of X-rays by a pathological tissue is very similar compared to that of a healthy breast tissue (Fig.1) and the differences between them are of the order of 4% to 15 keV, decreasing to 1% at 25 keV.



Tissue	Source	μ (cm^{-1})
Adipose	H, mean	0.512
	H, range	0.487–0.557
	W, mean	0.546
	W, mean $\pm\sigma$	0.502–0.590
	J, mean	0.456
	J, range	0.441–0.476
Gland	H, mean	0.794
	H, range	0.740–0.828
	W, mean	0.713
	W, mean $\pm\sigma$	0.613–0.819
	J, mean	0.802
	J, range	0.791–0.816

Fig. 1 (Left) Comparison between the linear attenuation coefficient of the carcinoma tissue and adipose tissue fibroghiandolare. It is seen that with increasing energy the three curves are getting closer and closer. (Right) values of the linear attenuation coefficients for adipose tissue and glandular tissue at 20 keV measured experimentally by several authors (H: Hammerstein et al., W: Woodard and White, J Johns and Yaffe). [3] J Johns and Yaffe) [3].

To get a good contrast resolution on the pictures it is important to work with low kV values, typically between 25 kV and 40 kV.

2.1 HOW'S MADE A MAMMOGRAPHY

Mammography is X-ray equipment dedicated and specialized for the study of the breast and is made by the following basic elements (Fig. 2):

- X-ray tube
- compression plate
- removible grate
- Digital detector

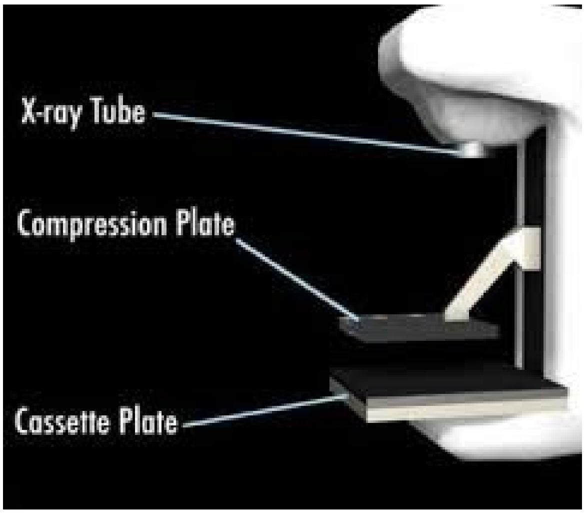


Fig. 2 Principali elementi di un mammografo, montati su di un braccio rotante a forma di C.

The X-ray tube is constituted by two electrodes, the cathode and the anode. Between them is kept a constant potential difference (in mammography typically on the order of tens of kV). The cathode consists of a tungsten filament wound in a spiral from which electrons are emitted by thermionic effect. These are accelerated towards the anode due to the potential difference between the two electrodes and the impact of the beam of accelerated electrons causes the generation of X-rays due to the phenomenon of Bremsstrahlung. The X-ray tube anode can be fixed with suitable cooling systems, or rotating anode in order to spread the heat load over a larger area.

The spectrum of radiation produced by an X-ray tube is constant (Fig. 3) and is constituted by photons of different energy, from a few keV up to a maximum value numerically equal to the potential difference applied to the tube: $E_{max} = kVp$. At the bremsstrahlung spectrum overlaps the characteristic radiation: when an electron inside of the anode material is ionized, it is ejected from his orbital and the gap is filled by a reorganization of the higher energy levels. This process is associated with the emission of a photon of energy equal to the energy difference between the two levels of transition. It takes the name of characteristic radiation because it is typical of every element and depends on the type of material of which is made the anode . The characteristic radiation covers about 20-30% of the total radiation emitted by the tube.

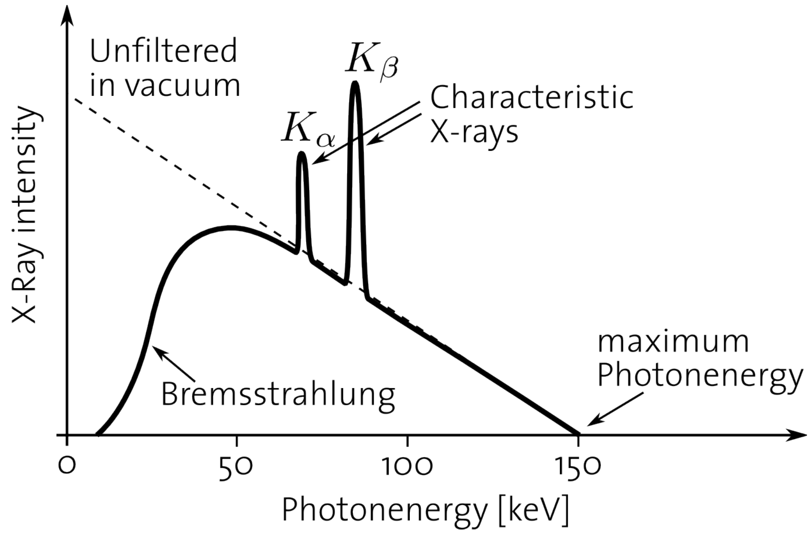


Fig. 3 Radiation spectrum of an x-ray

Before hitting the object to scan the beam is filtered with additional metallic materials in order to retain the low energy photons, those less penetrating that may be completely absorbed by the object target contributing to the dose that it receives, but does not give usefull information for the image formation.

The compression device of the breast has a rectangular shape and is generally composed of plastic material. It is used to immobilize and compress the breast in order to make the thickness thinner and uniform. The compression of the breast tissue must be the greatest possible to obtain a thickness of the breast approximately uniform, but at the same time tolerated by the patient. There is an optimal value for the force, but it is important to check the compression applied, and the accuracy of his measure. All scanners must be equipped with engine driven compressor.

The mobile/anti-scatter grid, is composed of lead lamellae alternate to radiolucent spaces and has the purpose to absorb the scattered photons. It is designed to let pass only those X-ray whose direction is on the line perpendicular to the plane of the detector and absorb photons directed obliquely. The grid is equipped with a mechanism for the movement designed to prevent the display of the lead slats on the mammogram.

The detection system used in mammography is based on the use of Full Field Digital Mammography (FFDM), and according to the revelation of the machinery can be direct or indirect. The direct digital detection systems (eg Giotto Image MD) using flat panel detectors coupled with a photoconductive amorphous selenium (a-Se), which transforms X-rays directly into an electric signal. The detection systems digital indirect (eg GE Senographe DS) instead convert the X-rays in the first light signal and then into electric charge. A layer of crystals of thallium activated cesium iodide (CsI: Tl) with columnar structure converts X-rays into visible light which is then absorbed by the array of photodiodes with technology to amorphous silicon (a-Si) and converted into electric charge.

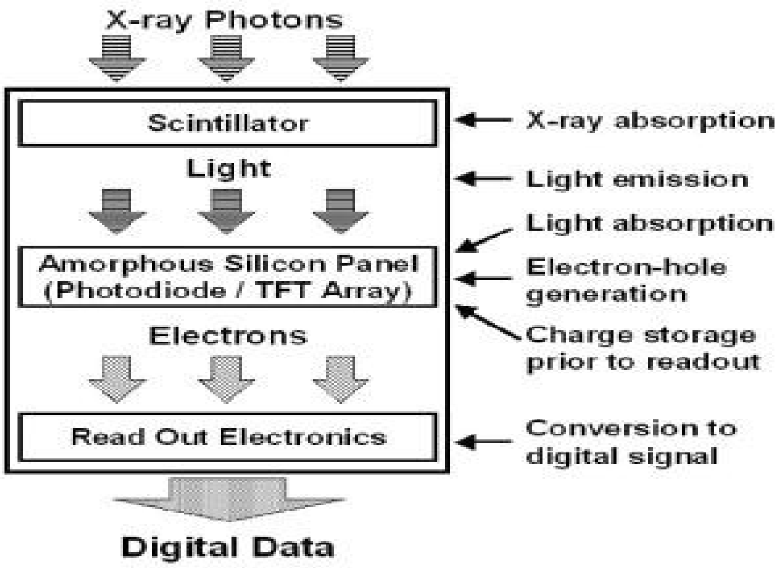


Fig. 4 Photon detection chain with the indirect conversion method. The charge of each pixel is read through an electronic chain, digitized and sent to the computer. The digital image is produced directly on the monitor in the work station and readily

The feature that differentiates different types of mammography is the anode-filter coupling. The anode of a mammography is usually made in molybdenum (Mo, Z = 42) because the characteristic radiation produced from it generates two peaks in the spectrum at 17.6 keV and 19.7 keV that is in a range of useful energy for mammograms. The molybdenum anode has limits on breast of high thickness and density for which you prefer to use an anode that produces a "harder" beam as the Rhodium (Rh, Z = 45), whose characteristic radiation has two peaks to higher energies with respect to molybdenum (fig. 5).

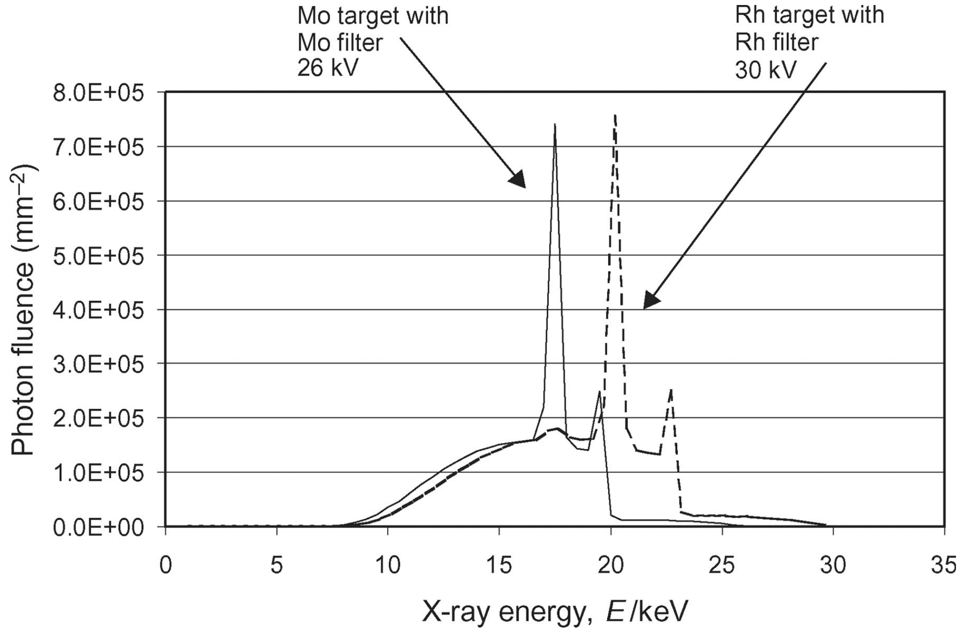


Fig. 5 Radiation spectrum for two different anodes made by molybdenum and rodium

Another material often used for the anode is the tungsten (W, Z = 74).

Beam's filtration is obtained by thin thicknesses of molybdenum, rhodium or aluminum. To better adapt to the characteristics of the breast tissue, the current mammography have several pairs anode-filter: Mo / Mo, Mo / Rh, Rh / Rh, Rh / Mo, W / Al, W / Rh, Rh / Al manually or automatically selectable in function of the thickness of the compressed breast and of its constitution (abundance percentage of glandular tissue and adipose).

Suitability of the beam of photons to cross the breast is expressed by the value of the Half Value Layer (HVL), function of the peak voltage. In radiology emivalent thickness of a beam of X-rays is the thickness of absorbing material required to reduce the intensity of X-rays to half of its initial value and is evaluated by measuring the attenuation of the beam produced by thin aluminum filters. With the combination anode / filter Mo / Mo and with peak voltage equal to or lower than 30 kVp the SEV must be between 0.26 and 0.32 mm of Aluminium.

2.2 Dosimetric Units in mammography

Breast is a highly radiosensitive organ and it is necessary to take into account the risk that you present a radiation-induced cancer following exposure to X-rays linked to mammographic procedure. In the new European Directive EURATOM 59/2013 the weighting factor wT for breast used to calculate the effective dose was raised to 0.12 compared to the value 0.05 of the previous Directive EURATOM 43/1997.

Protocols for dosimetry and quality control in mammography imaging systems are of paramount importance for the estimation of dose to the breast and to minimize the risk associated with radiological procedure.

The dose in mammography depends mainly on the quality of the radiation beam and the thickness and composition of the breast. Is important that the radiation is more monochromatic and with low energy as possible in order to define and identify small structures and to obtain a good contrast between the tissues, as seen in Fig.7. The compression of the breast is of fundamental importance as it allows the reduction of the thickness and therefore the exposure time and the dose of radiation administered. According the author Fife, range for the compressed breast is between 2.5 cm and 8.6 cm with an average value equal to 5.2 cm. The other element of variability is represented by the composition of the breast, which is formed mainly by adipose tissue in childhood, which is formed mainly by glandular tissue during puberty; and which glandular tissue is gradually replaced by fat in adulthood. The age is not a sufficient indicator of glandularity and there are significant variations within a population and in relation to the size of the breast. Geise and Palchevsky in a work of 1996 have estimated the glandularity breast cancer in a sample of 417 patients and found average values of 68%, 42%, 26% and 16% for a thickness of the compressed breast, respectively, equal to ≤ 3 cm, 3-5 cm, 5-7 cm and ≥ 7cm.

The dosimetric index chosen as a parameter to indicate the dose to the glandular tissues of the breast is the average glandular dose (AGD = Average Dose Gladular or MGD = Mean Glandular Dose), commonly accepted as representative of the risk originated from ionizing radiation as a result of irradiation breast. Significant fractions of the energy absorbed from the breast in fact are deposited in the skin, fatty tissue and connective tissues, but it is believed that is the glandular tissue the one with the highest risk of radio-induced malignancies. The average glandular dose is the amount recommended by the ICRP (International Commission on Radiological Protection) and is used in many protocols as the reference in mammography, as in the European protocol "European protocol on dosimetry in mammography" EUR 16263 and in Protocol "European guidelines for quality assurance in breast cancer screening and diagnosis".

In fact it is very difficult or impossible to measure the average glandular dose in a direct way for each and every single breast examination; the most simple and direct measurement to be made is that of the air kerma (ESAK = Entrance Surface Air Kerma) without the contribution of the backscattering, at a point corresponding to the input surface of the breast. It is necessaire use conversion factors based on models and simulations that relate the input air kerma at the surface with the average glandular dose. The air kerma in free air must be measured at the entry point of the breast and for different values of kV and couplings anode / filter available in the system. To calculate the AGD is necessary to know the parameters of exposure and the thickness of the compressed breast.

Conversion factors that are used today are those obtained from Monte Carlo simulations by Dance and its employees with a simple model of the breast and mammography imaging system. According to this theory the average glandular dose is calculated using the formula: D = ESAK · g · c · s

Where the ESAK is the kerma in free air incident on the upper surface of the breast, and g is the conversion factor between kerma and average glandular dose in a breast with glandularity 50%, c is the correction factor for a glandularity different compared to 50 % es is the correction factor for the quality of the beam that takes account of different materials of the anode and the filter.

To calculate the correction factors by the method of Monte Carlo simulation the compressed breast was simulated with a cylinder to said semicircular section (puppet of standard breast) of PMMA (polymethylmethacrylate) often 4.5 cm in diameter and 16 cm (Fig. 6 left).

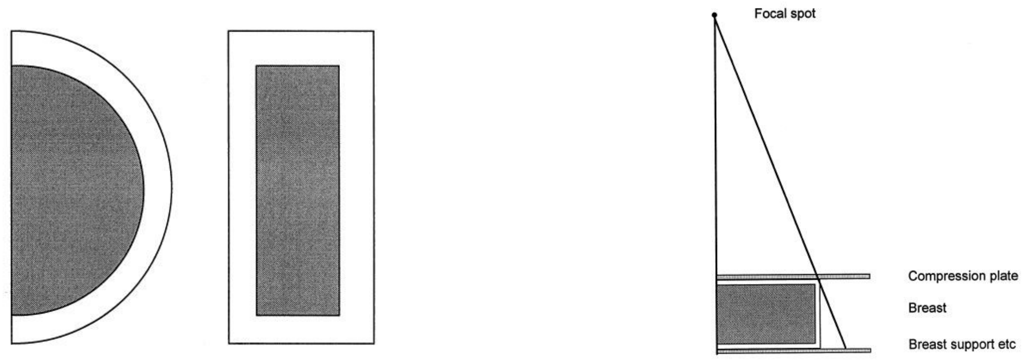


Fig. 6 (Left) Standard phantom for breast, cranio-caudal projection of the phantom and cross-sectional section perpendicular to the detector plane. (Right). Irradiation geometry used in the Monte Carlo silumation by Dance at al. The central region mimics a uniform (50 %-50 %) mixture of fat and glandular tissue, whereas the white outer layer represents a 0,5 cm thick adipose tissue surrounding the central region from all sides expect the chest wall. In this model the photon pathway is traced starting from tube up to the detector and this distance is assumed to be 60 cm. The energy delivered in the central mammary region is split between adipose and glandular tissue according to the probabilities of interaction of photons with the 2 types of tissue.

The g factor (mGy / mGy) converts the air kerma free in average glandular dose and is valid for a breast with glandularity 50%; it depends on the thickness of the compressed breast that used by the couple anode filter and kV. To simplify, the g factor was tabulated as a function of the thickness of the beam emivalente (HVL = Half Value Layer) expressed in mm of Al in such a way as to have a single table for different pairs anode / filter and kV used. In Figure 7 are shown the values of g calculated for different thicknesses of the compressed breast, from 2 cm to 11 cm, and for beams with HVL in the range 0.30-0.60 mm Al [4]. The highest value relates breasts factor 2 cm factor irradiated with higher energy beams; the values on the diagonal end of the table are approximately 0.3 and this means that about a third of the air kerma incident on the free surface of the breast contributes to the value of the dose absorbed by the glandular tissue. We also note that for the same beam quality, more the breast is compressed, more the g value increases. In Fig 8 is shown the trend of the conversion factor g as a function of the thickness for beams of different quality and it shows how this decreases as the thickness of the breast in agreement with data reported in the table.

Breast thickness (cm)	HVL (mm Al)						
	0.30	0.35	0.40	0.45	0.50	0.55	0.60
2	0.390	0.433	0.473	0.509	0.543	0.573	0.587
3	0.274	0.309	0.342	0.374	0.406	0.437	0.466
4	0.207	0.235	0.261	0.289	0.318	0.346	0.374
4.5	0.183	0.208	0.232	0.258	0.285	0.311	0.339
5	0.164	0.187	0.209	0.232	0.258	0.287	0.310
6	0.135	0.154	0.172	0.192	0.214	0.236	0.261
7	0.114	0.130	0.145	0.163	0.177	0.202	0.224
8	0.098	0.112	0.126	0.140	0.154	0.175	0.195
9	0.0859	0.0981	0.1106	0.1233	0.1357	0.1543	0.1723
10	0.0763	0.0873	0.0986	0.1096	0.1207	0.1375	0.1540
11	0.0687	0.0786	0.0887	0.0988	0.1088	0.1240	0.1385

Fig. 7: Values of conversion factor g (mGy/mGy) for breast thickness between 2 and 11 cm and HLV ranging between 0.30 mm Al and 0.60

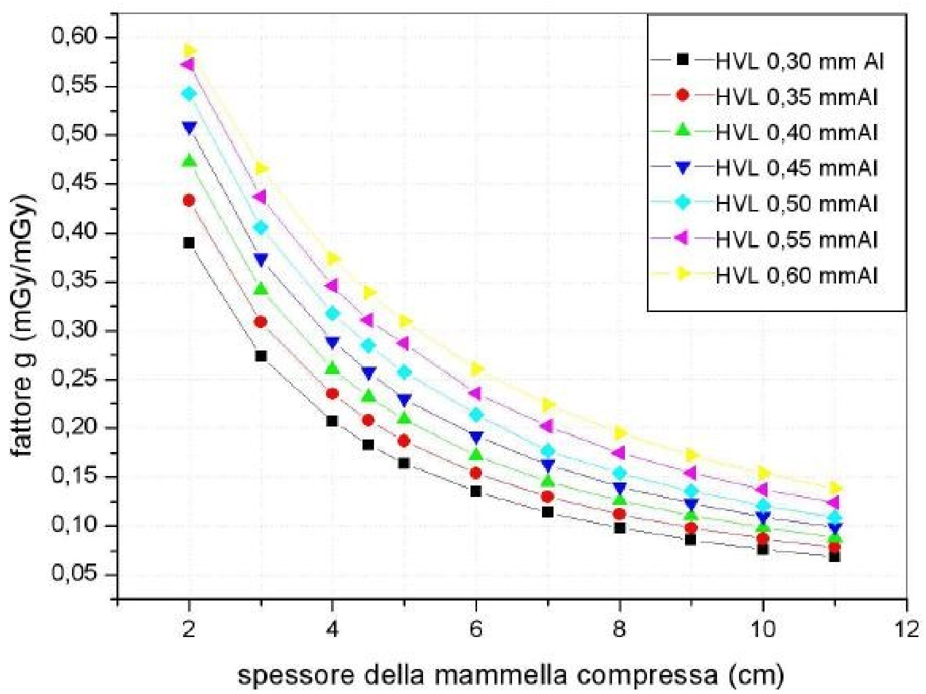


Fig. 8: The value of g as a function of breast thickness stratified according to different Half Value Layer between 0,30 mm and 0,60 mm

The s-correction factor consideres the different anode/filter pairs used. For calculations have been used the following combinations of anode material and filtration: molibdeno/30µm molybdenum (Mo / Mo), molibdeno/25µm rhodium (Mo / Rh), rodio/25µm rhodium (Rh / Rh), rhodium / 1mm aluminum (Rh / Al), tungsteno/50µm rhodium (W / Rh). For each of them have been used five values of tube voltage: 25 kV, 26 kV, 28 kV, 30 kV and 32 kV. The results are shown in Fig 8 and for simplicity has been assigned a single s factor for each combination anode/filter, regardless HVL and the thickness of the breast. The right column shows the maximum value of the error that you do with this simplification. Also in the Protocol EUREF OF 2006 [6] estimated the value of the correction factor for the coupling s tungsten anode and aluminum filter (W / Al) and found to be equal to 1.05.

Spectrum	*s*-factor	Maximum error (%)
Mo/Mo	1.000	3.1
Mo/Rh	1.017	2.2
Rh/Rh	1.061	3.6
Rh/Al	1.044	2.4
W/Rh	1.042	2.1

Fig. 9: Different correction factor values s for different anode/ filter coupling used

C-factor corrects for breast glandularity which is not 50%. A composition of the standard breast with 50% of adipose tissue and 50% of glandular tissue is not real and it varies according to the thickness of the breast and the age of the patient. A study on populations of women between 40-49 years and 50-64 years in the UK shows how the glandularity varies according to the thickness of the breast in these two groups (Fig.10). In Fig.10 are shown the values of the composition of the breast that vary between 99.9% and 0.1% of the adipose tissue of glandular tissue up to a maximum of 100% of glandular tissue. The same results are shown in the tables of Fig.11.

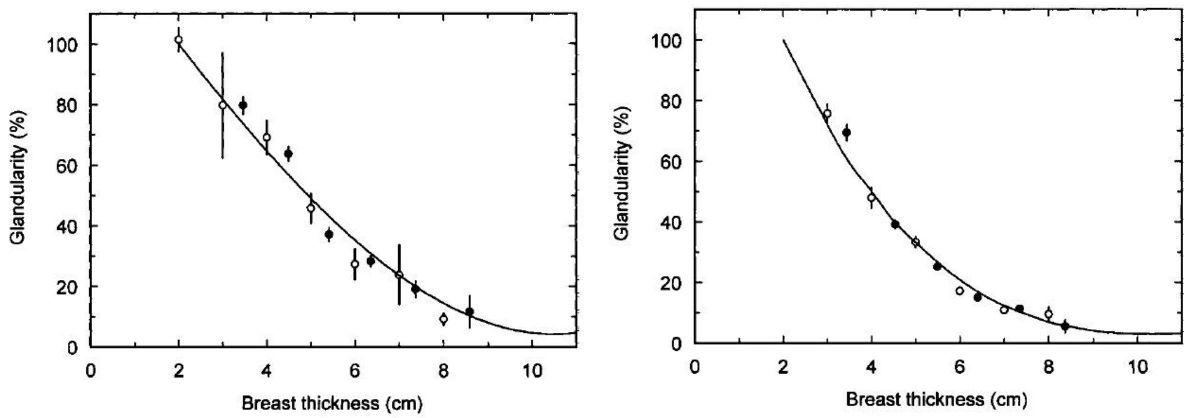


Fig. 10: Estimation of the average composition of the breast for different values of the thickness of the compressed breast for women aged between 40 and 49 years (left) and women aged between 50 and 64 years[4].

Compressed breast thickness (cm)	Glandularity age 40–49 (%)	Glandularity age 50–64 (%)
2	100	100
3	82	72
4	65	50
5	49	33
6	35	21
7	24	12
8	14	7
9	8	4
10	5	3
11	5	3

Fig. 11: Average composition of the breast with 2 different compressions

In light of these results, in order to calculate the average glandular dose c factors were calculated for typical breasts in the two different age groups, 40-49 years and 50-64 years as shown in Fig.12. For thicknesses less than or equal to 4 cm, the c-value is less than or equal to 1, and this corresponds to a value of glandularity greater than 50% (Fig. 11). For thicknesses greater than 4 cm, the c-factor is greater than 1 and this factor contributes to increase the final value of the average glandular dose. As noted for the group of women aged between 50 and 64 years and for a thickness of compressed breast equal to 4 cm the composition of the breast is equal to 50% of glandular tissue and 50% of adipose tissue and the factor c is equal to 1 (ie no correction). In Fig 13 is shown the trend of the c factor as a function of the thickness of the compressed breast for five different values of glandularity.

Breast thickness (cm)	HVL (mm Al) 0.30	0.35	0.40	0.45	0.50	0.55	0.60
2	0.885	0.891	0.900	0.905	0.910	0.914	0.919
3	0.894	0.898	0.903	0.906	0.911	0.915	0.918
4	0.940	0.943	0.945	0.947	0.948	0.952	0.955
5	1.005	1.005	1.005	1.004	1.004	1.004	1.004
6	1.080	1.078	1.074	1.074	1.071	1.068	1.066
7	1.152	1.147	1.141	1.138	1.135	1.130	1.127
8	1.220	1.213	1.206	1.205	1.199	1.190	1.183
9	1.270	1.264	1.254	1.248	1.244	1.235	1.225
10	1.295	1.287	1.279	1.275	1.272	1.262	1.251
11	1.294	1.290	1.283	1.281	1.273	1.264	1.256

Breast thickness (cm)	HVL (mm Al) 0.30	0.35	0.40	0.45	0.50	0.55	0.60
2	0.885	0.891	0.900	0.905	0.910	0.914	0.919
3	0.925	0.929	0.931	0.933	0.937	0.940	0.941
4	1.000	1.000	1.000	1.000	1.000	1.000	1.000
5	1.086	1.082	1.081	1.078	1.075	1.071	1.069
6	1.164	1.160	1.151	1.150	1.144	1.139	1.134
7	1.232	1.225	1.214	1.208	1.204	1.196	1.188
8	1.275	1.265	1.257	1.254	1.247	1.237	1.227
9	1.299	1.292	1.282	1.275	1.270	1.260	1.249
10	1.307	1.298	1.290	1.286	1.283	1.272	1.261
11	1.306	1.301	1.294	1.291	1.283	1.274	1.266

Fig.12: Estimates of correction factor c as a function of thickness of compressed breast and of the half-value for the groups of women with age range between 40-49 (left) and 50-64

The impact of the c-factor on the final calculation of the average glandular dose is shown in Fig 14. As can be seen the estimate of the average glandular dose considering the c-factor c is greater than the estimate without the multiplicative factor c for the udder with a thickness greater than 4 cm, and this difference becomes more significant as the thickness increases.

In summary then, it is possible to obtain an automatic procedure that allows the calculation of AGD in real time for each exposure for single patient once you have available measures air kerma of the source for different kV values and for different anode coupled / filter, and the thickness of the compressed breast.

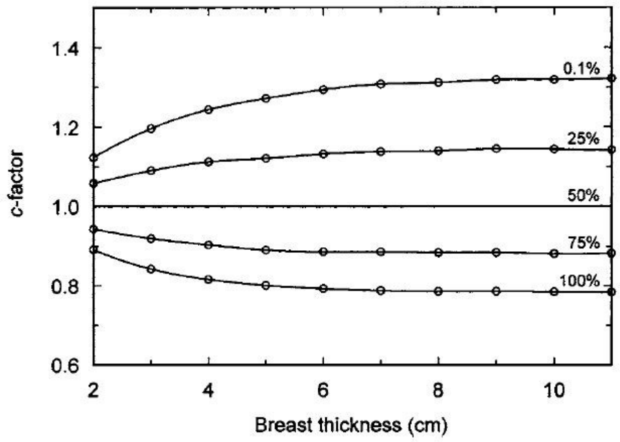


Fig. 13: Variation of correction factor c as a function of the compressed breast thickness with different values of HVL and *glandularity* of 0,1%, 25%, 50%, 75% e 100%

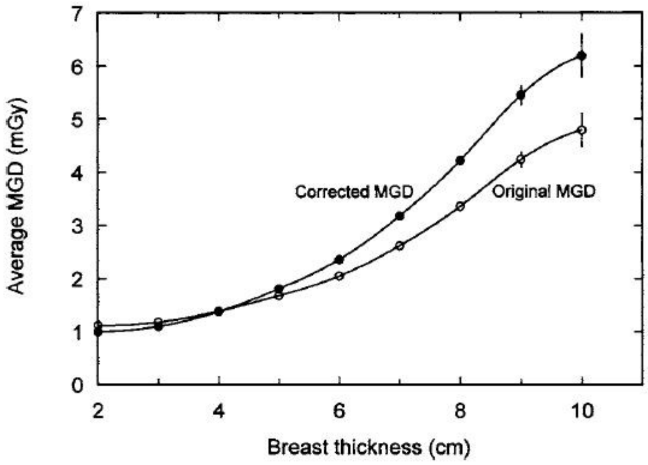


Fig. 14: Effects of estimates of mean glandular dose obtained by applying correction factor c. ADG corrected values are less than original ADG for thicknesses up to 4 mm, and superior for higher thickness values. up to values 30 % higher

2.3 INFORMED CONSENT

Actually in Radiology Breast Imaging the patient signs informed consents relating to the processing of personal data for inclusion in the examination RIS-PACS system connected with the air wide, to rule out pregnancy in the event of diagnostic procedures or interventional procedures using ionizing radiations, and before undergoing interventional procedures.

However, it would be useful and important to introduce a disclosure / consent (currently only verbal) concerning mammography in accordance with the recommendations of the European Society of Breast Imaging (EUSOBI) 2011.

Such consensus should clarify, after a brief description of the overall objective of undergoing regular mammograms, or to obtain an early diagnosis of breast cancer,the best time of the menstrual cycle (7-12 th day) to perform the test and the cadence with which mammography should be performed. It also seems necessary to explain the importance to bring any previous X-ray examinations, as some cancers can be diagnosed only on the basis of changes from a previous exam.

A good informed consensus should contain a brief description of mammography, how it is performed, and the fleeting feeling of pain associated, proven by some of the women who undergo the procedure in relation to breast compression, but it is a necessary element for a optimization of the examination in terms of radiation dose mammography and legibility, and it is important not cause motion artifacts in the brief moment of capture. It is also important to invite the patient to relax and focus on the benefits that the compression generates.

Mention should be made of the risks from exposure to ionizing radiation in relation to the reduction of mortality obtained by the test, the risk of overdiagnosis (approximately 5-20% of cancers diagnosed in asymptomatic patients would have remained idle for a lifetime, but It is not possible to distinguish these from those that are not treated then fatal) and the fallibility of the test may not detect approximately one third of cancers particularly in perimenopausal age and in dense breasts. For this it is necessary to highlight that even in case of a negative mammogram is important not to underestimate any breast symptoms (especially new-onset nodules, skin or nipple retraction, nipple alterations) even if insurgents at a short distance from a negative breast examination.

It is understood that any disclosure / consent signed and delivered at the time of the waiting room may not in any way replace the necessary oral communication between TSRM / doctor and the patient who would rather collect the feed-back received informational message.

It is merely an added value and more detailed aims to disseminate accurate information to a population too often uninformed.

It is not, however, write up a simple information that is clear, accurate, relevant and therefore effective.

3 RADIATION DOSE MONITORING (DESCRIPTION OF TQM DATA).

Determination of the average glandular dose is of paramount importance in order to calculate an estimate of the risk associated with each exam, related to the risk of radio-induced carcinogenesis associated with mammographic examination,

It 'also important that the dosimetric data are collected and monitored (as required by the new European Directive EURATOM 59/2013) laying down basic safety standards for the protection against the dangers arising from exposure to ionizing radiation. In that legislation requires states that the information relates to the exposure of the patient to be part of the report of the radiological procedure and the equipment used for diagnostic radiology are fitted with a device to inform the radiologist of the relevant parameters for the evaluation of the dose to the patient; Such equipment shall also provide the ability to transfer this information in the registration exam. The Directive also addresses the issue of the right to information of the patient and is required for the first time to the member states that the patient receives adequate information about the risks and benefits associated with the radiation dose delivered radiological examination before the exposure takes place.

In view of these major changes, several companies have recently put on the market for computer systems acquisition and automatic analysis of dosimetric data. The monitoring of the dose can be a great help during all phases of the radiodiagnostic examination and one of their important functions is to display the technical parameters of the acquisition of all the tests carried out. This can result in an optimization tool because the radiologist, medical physicist and technologist can evaluate how to reduce dose while maintaining image quality appropriate to the diagnostic question. At the end of the procedure radiological monitoring systems allow you to make an assessment of the performance: after a short period of time statistics are available on the dose delivered during a single test that can be compared with other procedures with the same Study Description, or about the same area of the body. This information allows the rapid detection of incorrect behaviors and dosimetric verification that they meet the Diagnostic Reference Levels (DRLs). The software for the monitoring of the dose is installed on the computer network of Radiology, the same one that connects the methods, database RIS / PACS workstations and reporting. The data collection is done by exploiting some characteristics of the DICOM standard, in particular the header, the RDSR (Radiation Dose Structured Report) and the MPPS (Modality Performed Procedure Step).

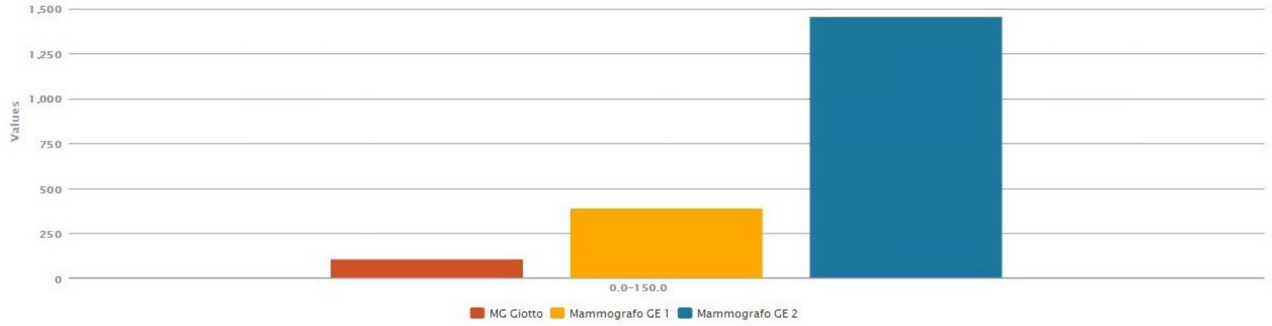
In this section of the thesis work was used the software Total Quality Monitoring (TQM) and dosimetric data were collected from the three mammography present within the premises of Radiology Breast Imaging PACS through interrogation. The Mammographs of the unit features are: a mammography Giotto Image MD whose use is limited to large breasts, mammography and two (GE1 and GE2). On Giotto mammography is used exclusively anode of tungsten and rhodium filter. The mammography mammography GE1 and GE2 have three possible pairs anode / filter: molybdenum / molybdenum, molybdenum / rhodium or rhodium / rhodium that are used respectively for increasing thickness of the compressed breast.

We analyzed data on bilateral mammography examinations RX made by 01/01/2014 to 05/31/2014 at the U. O. Breast of the University Hospital of Pisa. In this period of time were performed in all examinations in 1960, of which 110 mammography exams on the Giotto Image MD, 393 tests on mammography exams 1457 GE1 and GE2 on mammography (Table 1).

study description	device name	count	relativeCount	min	mean	max	median
Biopsia RX stereotassica della mammella	MG Giotto	1	0,62%	0.00	0.00	0.00	0.00
Biopsia RX stereotassica della mammella	Mammografo GE 1	5	0,81%	8.70	19.92	29.84	20.39
Biopsia mammaria stereotassica retroasp.	MG Giotto	41	25,47%	0.00	0.37	8.00	0.00
Biopsia mammaria stereotassica retroasp.	Mammografo GE 1	32	5,16%	13.39	26.38	42.90	25.71
Consulenza Radiologica	Mammografo GE 1	1	0,16%	2.79	2.79	2.79	2.79
Consulenza Radiologica	Mammografo GE 2	2	0,10%	4.33	4.38	4.44	4.38
Ecografia Cute e Tessuto Sottocutaneo	Mammografo GE 2	1	0,05%	4.83	4.83	4.83	4.83
Ecografia Mammaria Bilaterale	Mammografo GE 2	1	0,05%	3.72	3.72	3.72	3.72
RX Galattografia Monolaterale DX	Mammografo GE 1	2	0,32%	2.30	2.92	3.54	2.92
RX Galattografia Monolaterale DX	Mammografo GE 2	2	0,10%	0.97	2.82	4.67	2.82
RX Galattografia Monolaterale SN	Mammografo GE 1	1	0,16%	2.19	2.19	2.19	2.19
RX Galattografia Monolaterale SN	Mammografo GE 2	1	0,05%	8.41	8.41	8.41	8.41
RX Mammografia Bilaterale	MG Giotto	110	68,32%	0.17	9.15	19.10	8.90
RX Mammografia Bilaterale	Mammografo GE 1	393	63,39%	0.04	3.57	10.38	3.39
RX Mammografia Bilaterale	Mammografo GE 2	1457	74,53%	0.98	4.51	16.27	4.50
RX Mammografia Monolaterale DX	MG Giotto	4	2,48%	0.00	1.62	3.10	1.70
RX Mammografia Monolaterale DX	Mammografo GE 1	63	10,16%	0.51	1.78	6.08	1.62
RX Mammografia Monolaterale DX	Mammografo GE 2	139	7,11%	0.67	2.90	23.84	2.17
RX Mammografia Monolaterale SN	MG Giotto	5	3,11%	1.90	3.14	4.30	3.10
RX Mammografia Monolaterale SN	Mammografo GE 1	83	13,39%	0.36	2.34	20.16	1.71
RX Mammografia Monolaterale SN	Mammografo GE 2	178	9,10%	0.59	2.77	14.73	2.15
RX Pezzo Operatorio	Mammografo GE 1	24	3,87%	0.46	1.79	5.42	0.82
RX Pezzo Operatorio	Mammografo GE 2	35	1,79%	0.47	3.93	16.56	2.90
Reperaggio stereotassico mammella	Mammografo GE 1	12	1,94%	6.69	15.35	40.66	10.38
Reperaggio stereotassico mammella	Mammografo GE 2	2	0,10%	12.54	13.98	15.42	13.98
Visita specialistica radiologica	Mammografo GE 1	4	0,65%	2.42	3.34	4.04	3.46
Visita specialistica radiologica	Mammografo GE 2	136	6,96%	0.71	4.30	7.62	4.42

Table 1: Comparison of different instruments and different procedures in each of them.

Bilateral mammography examinations represent 76.18% of all procedures performed and the three machines have workloads very different from each other.(Fig 5) The average delivered dose is 9.15 mGy for mammography Giotto (that analyzed the more voluminous breasts and has the fixed coupling anode-filter is fixed with tungsten anode and rhodium filter), 3.57mGy for mammography and GE1 4.51 mGy for mammography GE2.



DOSE STATISTICS

NAME	COUNT	RELATIVECOUNT	MIN	MEAN	MAX	MEDIAN
▾All entries	2573	100.00 %	0.04	4.82	19.10	4.33
▾RX Mammografia Bilaterale	1960	76.18 %	0.04	4.58	19.10	4.37
MG Giotto	110	100.00 %	0.17	9.15	19.10	8.90
Mammografo GE 1	393	100.00 %	0.04	3.57	10.38	3.39
Mammografo GE 2	1457	100.00 %	0.98	4.51	16.27	4.50

Fig. 15: Workload distribution in the 3 mammographs of U. O. Senologia of Azienda Ospedaliero Universitaria di Pisa and dose values (min,max, mean, and median) delivered by each instrument

The different number of exams performed on the three mammography and the dose delivered by them is also shown in Fig 16.

Fig. 16:Display of the number of exam per hour in each day of the week (size of the dot) combined with the information on the delivered average dose

In each of these is shown on the horizontal axis the time of the day (0-23h) and on the ordinate the days of the week. The size of the symbols is indicative of the number of examinations carried out: a "dot" indicates that few exams are performed at that precise moment of the day, mind a large "cue ball" means that the machine worked great. color is

rather indicative of the average dose delivered between all the tests carried out at that precise time period: starting from the purple color that indicates a low AGD, to red for the highest. From these graphs we see that all three mammography work from Monday to Saturday, from 7:00 a.m.to about 7 p.m. Between noon and 2p.m., the activity is reduced on average compared to other times of day.
TQM allows to examine the performance dell'AGD (mGy) in function of time for each device.

Another interesting type of analysis that provides TQM is the trend over time dell'AGD relative to every single examination done in the period of interest and distributed on different intervals AGD marked with different colors (Fig. 17). At the center of each of these graphs is a horizontal black line indicates the average value of AGD dispensed from the machine in question. The two bands of bright green above and below the black line represents the region in which concentrates 80% of the examinations carried out and the green less intense bands represent regions of AGD of the other exams.

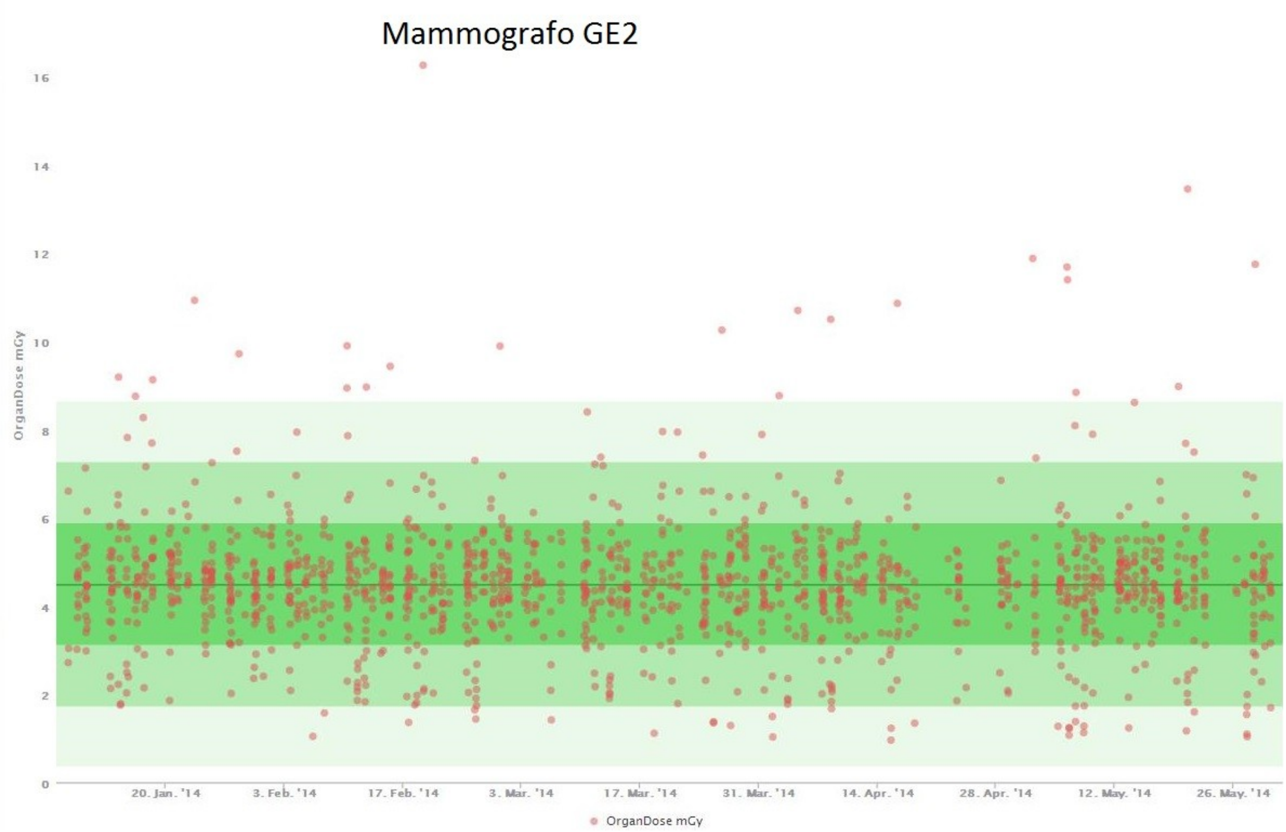
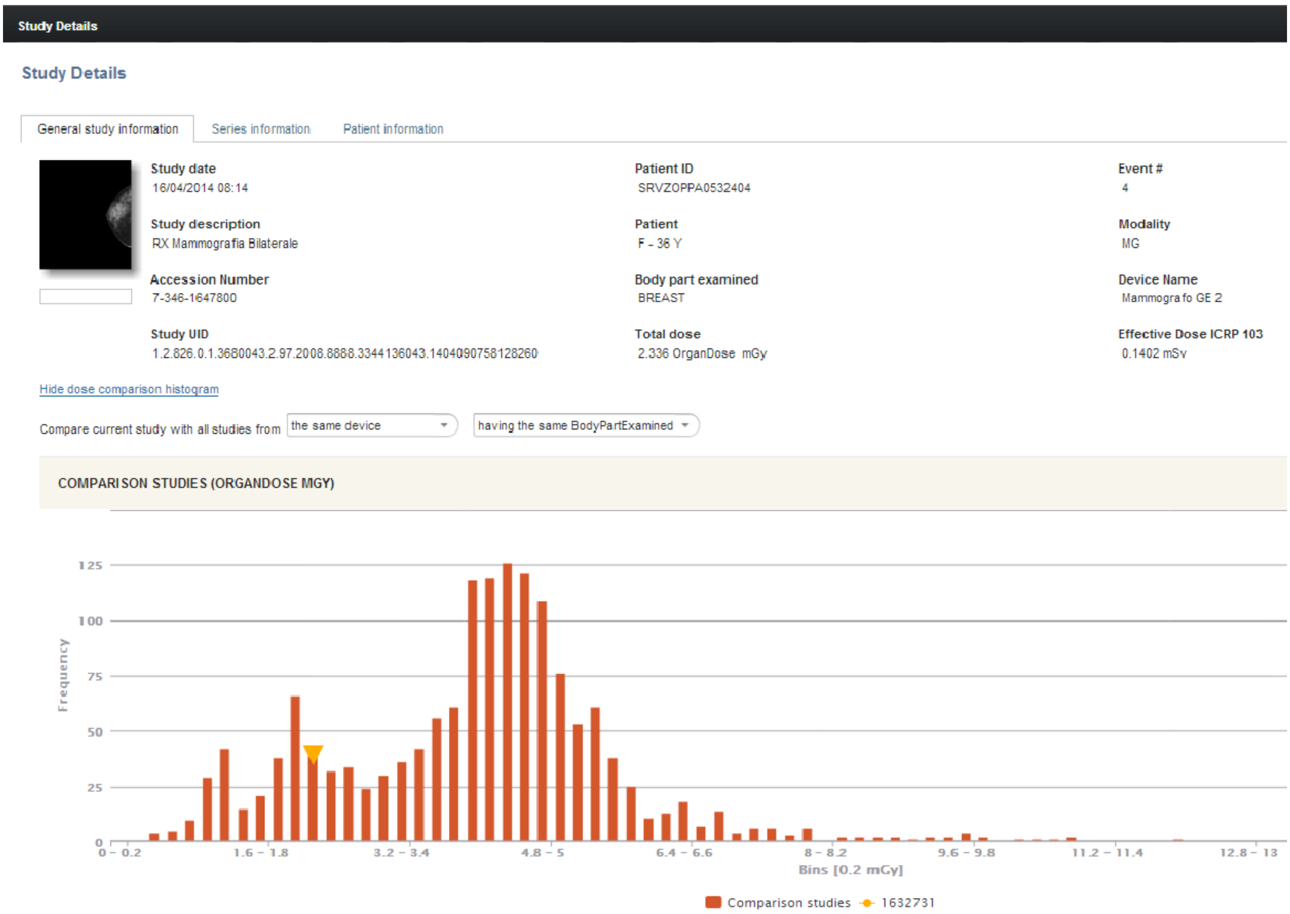


Fig. 17: Temporal trend of AGD per exam in the examined time window. In the y-axis, different dose intervals with different colors. The black horizontal line is the average delivered dose of the machine

This type of chart allows you to instantly locate examinations carried out with high dose values, and possibly investigate the reason. Is possible to select any of the red "dots" to see more details of a specific study. The window that opens is the one shown in Figure 18 where you can read all the information regarding the examination including the age of the patient, the number of projections made, the dose to the breast. Interesting is also the histogram in red which represents the frequency with which tests were performed for each dose range. A yellow arrow show where the study in question is placed and then compare it with the others. Finally, it is also possible to access the specific examination and in the table below i (Figure 18) we can read for each of the four projection made (RCC LMLO, RMLO, LCC) the parameters used: kV, mAs, compressive strength, thickness of the compressed breast.

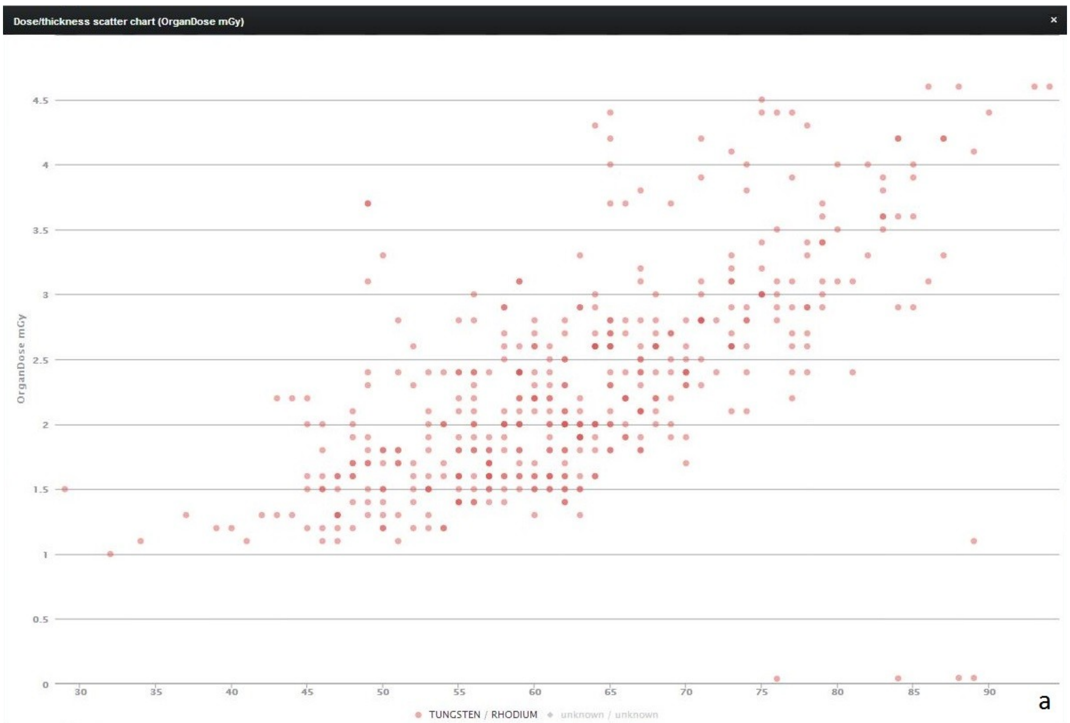


General study information | Series information | Patient information

SERIES DATETIME	SERIES DESCRIPTION	KV	MAS	COMPRESSION FORCE [N]	THICKNESS [MM]	ORGAN DOSE [MGY]	VIEW	LATERALITY
2014-04-16 08:16:13	FCR0309-02	26.0	25.0	80.0	27.0	0.527	RCC	R
2014-04-16 08:16:13	FCR0309-02	26.0	28.0	100.0	28.0	0.562	LMLO	L
2014-04-16 08:16:13	FCR0309-02	27.0	30.0	70.0	36.0	0.664	RMLO	R
2014-04-16 08:16:13	FCR0309-02	26.0	29.0	80.0	29.0	0.583	LCC	L

Fig. 18: Details regarding a specific study completed on 16/04/2014 with GE2 mammograph .

With TQM it can be seen for each equipment which are the most used settings in terms of coupling anode / filter and kV, and it can be seen for each of them shows the number of projections made, the value of minimum dose, maximum, mean and median, standard deviation and the average thickness of the compressed breast. It's also possible to have an overview of the different pairs anode / filter used in each of the individual projections and the dose value related to those as shown in Fig 19. Each symbol on the graphs a, b and c refers to a different choice of 'coupling anode / filter; in the abscissa is shown the thickness of the compressed breast expressed in mm and in ordinate the value of AGD relative to each of the projections of all the examinations considered. On mammography Giotto (Fig.19a) is used exclusively the tungsten anode and the filter of rhodium. The mammography GE1 and GE2 have three possible pairs anode / filter: molybdenum / molybdenum, molybdenum / rhodium or rhodium / rhodium that are used respectively for increasing thickness of the compressed breast. This is because materials with different atomic number Z create different radiation spectrum; a greater thickness of the breast in fact requires a harder beam in terms of energy and this can be achieved varying the material of which is made the anode and the material with which the beam of photons is filtered output to the tube.



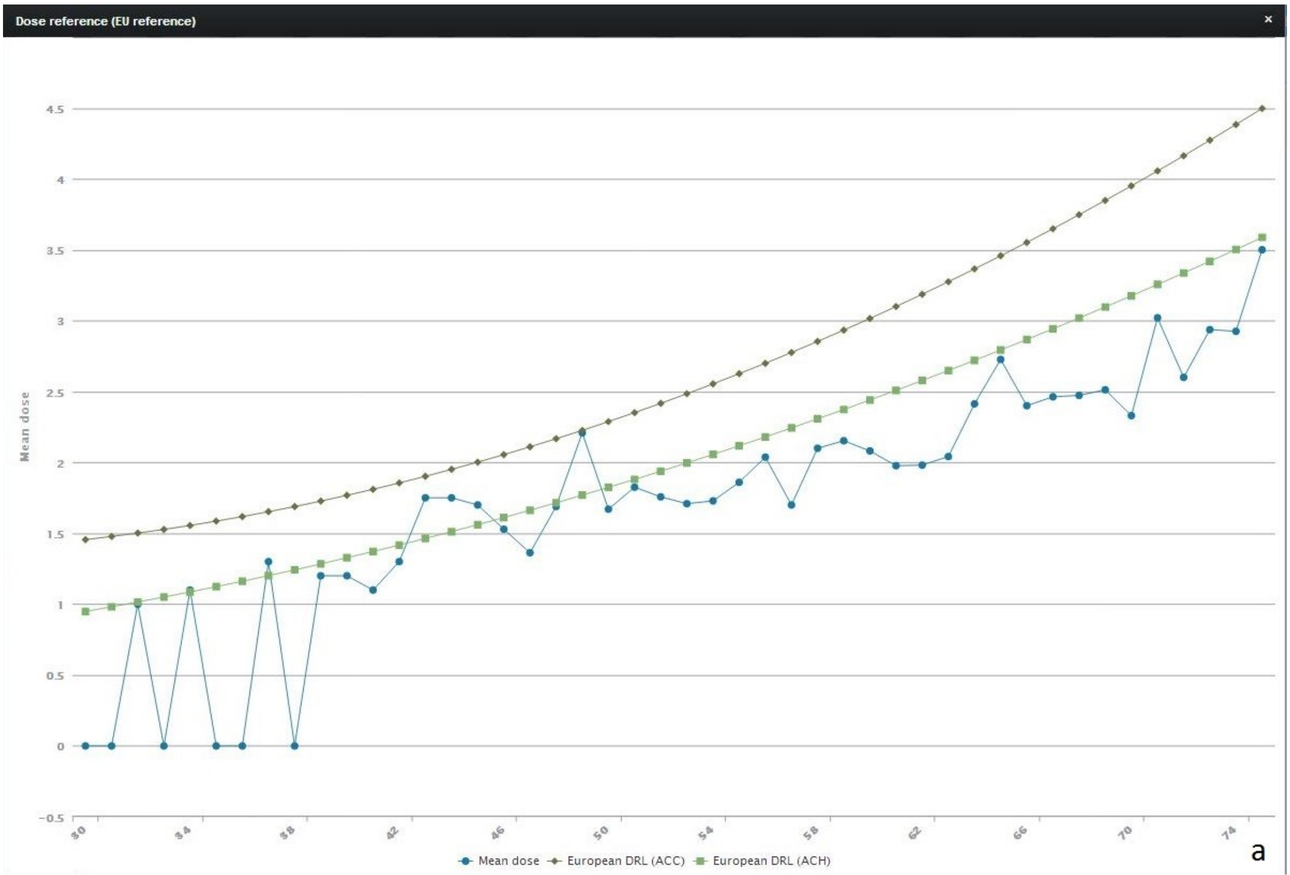
a

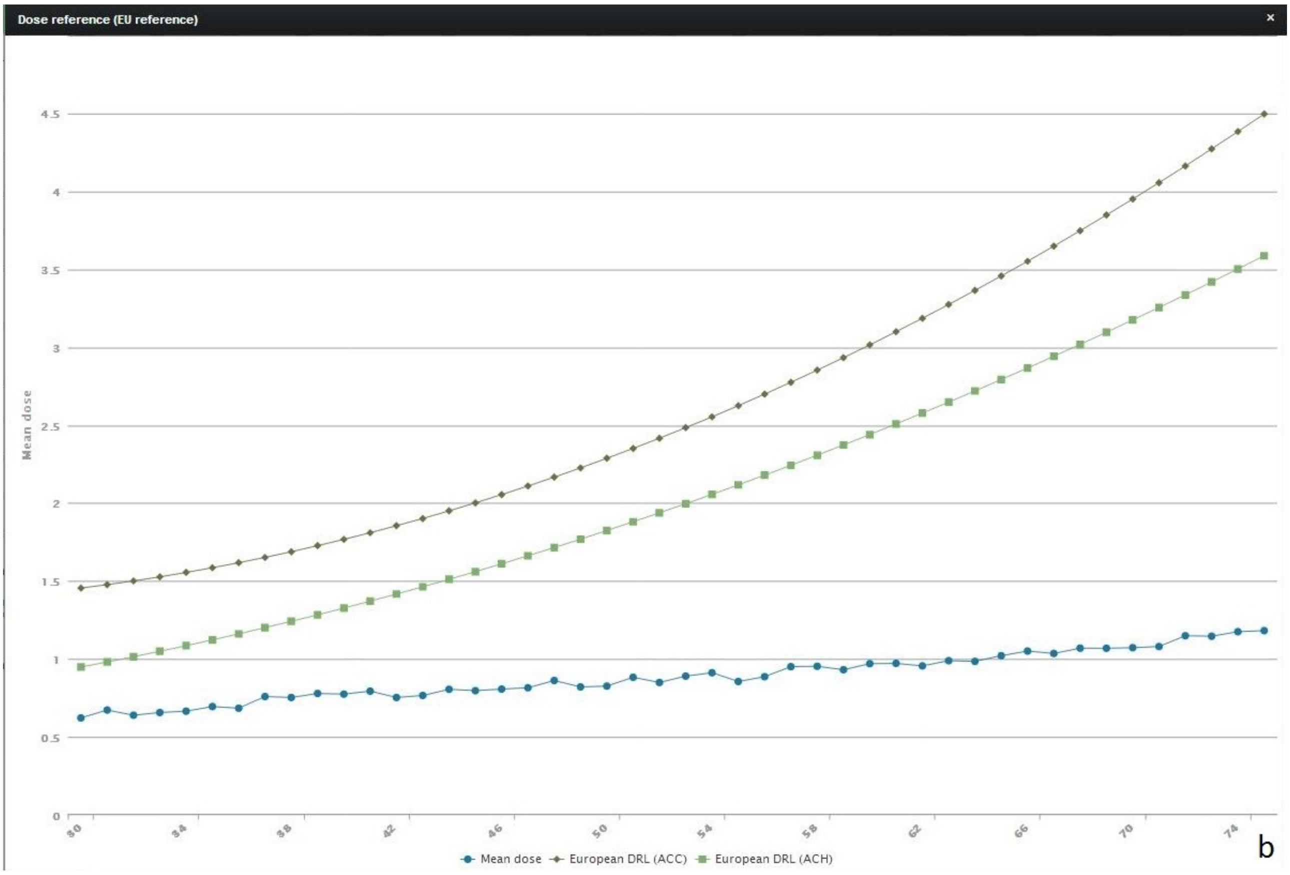
Fig. 19: Graphs showing the delivered dose in each projection for all exams as a function of the breast thickness and split according to different anode-filter coupling. Graphs (a), (b) and (c) refer to mammographs Giotto, GE1 e GE2 respectively.

How shown in these three graphs there is a trend of increasing type of the value of dose as a function of the thickness of the compressed breast, slightly more pronounced in the mammography Giotto.

The TQM software also offers the ability to view the compressive force applied expressed in Newtons and the thickness of the compressed breast by means of histograms.

The three graphs below show the plot of the mean AGD value according to the thickness of the compressed breast step of 1 mm, from 3.0 cm to 7.4 cm. In blue are the values for the data of the three devices while the two curves in gray and green represent European values of Dignostic Reference Levels (DRLs) respectively considered acceptable (ACC = acceptable) and desirable (ACH = achievable)





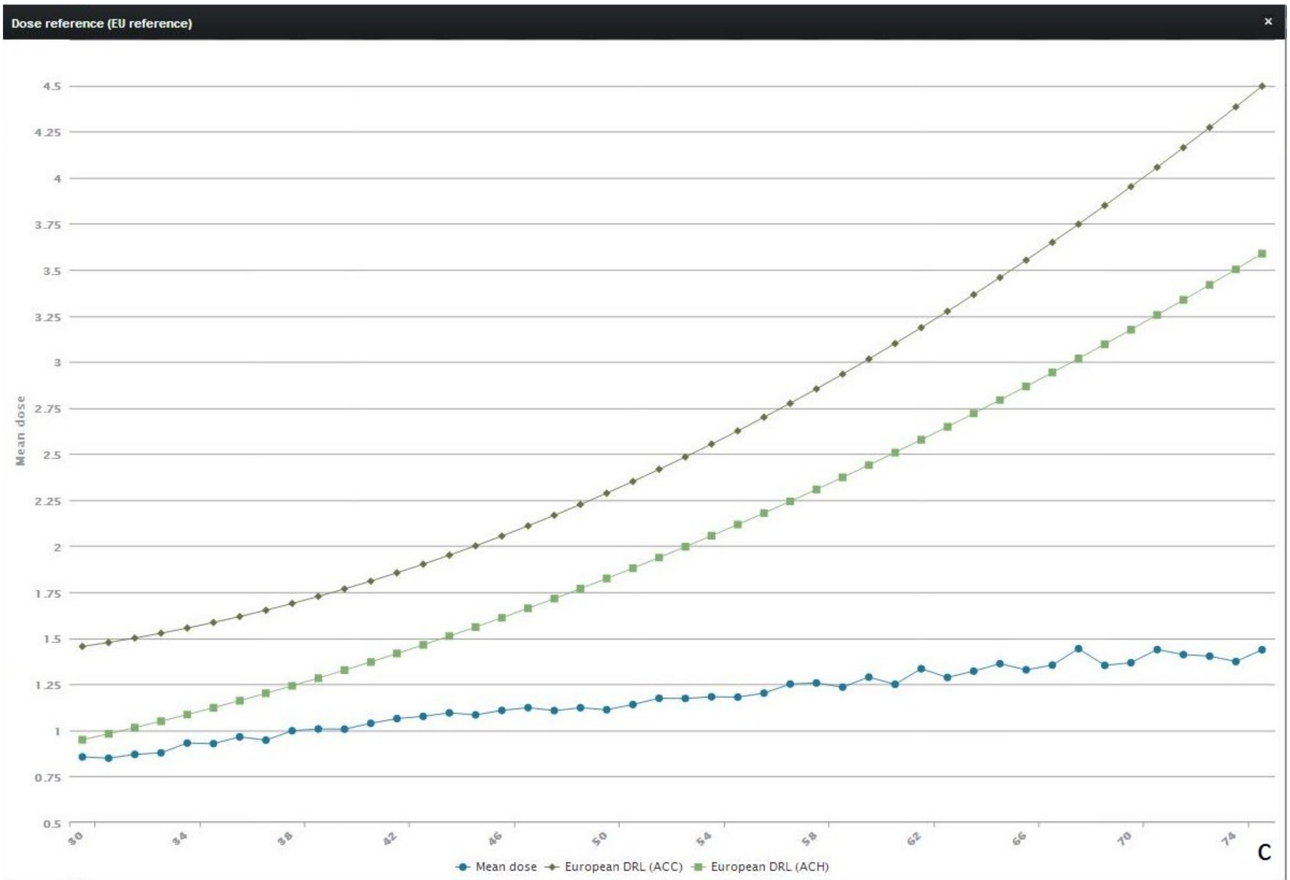


Fig.20 (a. Giotto, b.GE, c. GE) Mean AGD value as a function of the thickness of the compressed breast. GE mammographs show convenient values of mean AGD also for higher thickness values, possibly due to flexible multiple possibilities of anode-filter coupling modulated on the basis of breast thickness.

4. INTEGRATED DIAGNOSTIC APPROACH IN A BREAST CENTRE

4.1 The "joint CORD"

With the aim of optimizing the path within the Centre Senologico of those patients who access the path of urgency with nonspecific symptoms and may conclude in all probability their diagnostic iter with a breast ultrasound and a clinical breast examination, was established from 16th January to 11th April 2014 a weekly session of "joint CORD" where the session was handled by the cooperation of a junior breast surgeon and senior Radiology resident.

This allowed first to break down the waiting lists of the traditional radiological CORD (active 5 days a week with 8 patients per day for breast emergencies) that is able to concentrate on disposing of waiting lists of patients with symptoms more suspicious, and second to concentrate the accesses of patients with chronic non-specific symptoms but that would require, however, at least an ultrasound and a clinical breast examination to conclude theri diagnostic iter in a single day.

They had access to this service 95 patients, selected by the nursing staff that manages the lists of traditional work of CORD.Were performed 12 sessions of CORD JOINT with an average of 7.9 patients for session.

If patient had an age of 40aa and did not make a mammogram in the last year, or that there was a substantial clinical or ultrasound suspicion, a mammogram was performed and it was reported by a breast Radiologist (resident cannot report an instrumental examinations using ionizing radiations). If a fine-needle aspiration is required, it has been executed immediatly.

Further study using magnetic resonance imaging (MRI) or stereotactic biopsy were instead programmed due to organizational issues at our centerin another date.

Of the 95 patients who have had access to this service, 33 had an examination performed elsewhere with detection of suspicious nodules or were controls at 6 months of multiple fibroadenomatosis , 20 have palpable nodules, 16 have unilateral or bilateral breast pain, 5 mastitis, 5 for swelling / hyperemia or collection after QUART, 4 secretion (milky) and 12 others for various reasons (axillary swelling, prediction of hormonal therapies, skin nodule, adenoma of the nipple).

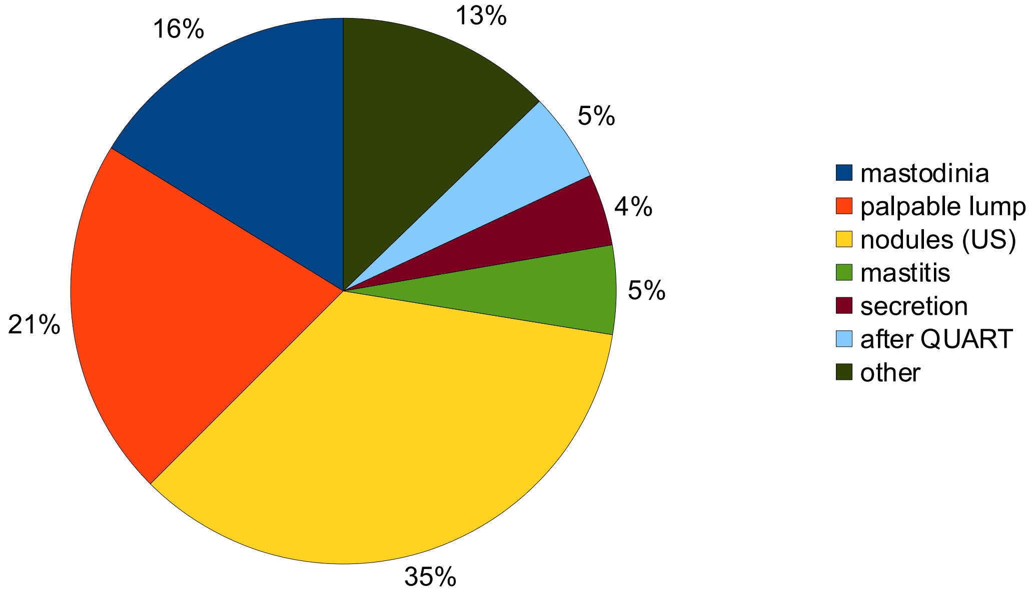


Fig 21 Reasons for access to the joint CORD service.

Of the 95 patients, all of them have benefited of ultrasound and clinical breast examination. In 24 cases (25.2%) mammograms were performed for completion. In 6 cases (6.3%) was scheduled an MRI. In 2 cases (2, 1%) was requested a withdrawal under stereotactic guidance.

Twenty-three Cytological examinations were performed (24.2%), for 2 cases of mammary secretions and 21 cases a nodularity of the first response. Such cytology in 15 cases had reflected C2 (benign findings) with the conclusion of the process, in 2 cases C3 (probably benign finding) and was planned and carried out a histological sampling in both cases yielded B2 (benign finding, fibroadenoma), in 4 cases C1 (inadequate sampling) on which were planned and carried out 2 biopsies (B2), was a repeated cytology (about 8cm mass of mostly liquid), and a lady refused further investigations (the was attached a request for histological examination).

The CORD JOINT allowed patients to finish their process through a single access concentrating at the time they remain in the breast imaging center.

4.2 Interdisciplinary meetings

In 2000 Eusoma, the European Society of Breast Cancer Specialists, published a position paper “The Requirements of a Specialist Breast Unit”. This document represented the starting point towards accomplishing that quality assurance programmes for breast

services should become mandatoty.
Eusoma has decided to update and revise its paper taking into account advances in diagnosis and treatment and evidence based changes in practice that have occurred in recent years with respect to the organization of a Breast Centre. The main concepts continues to be the multidisciplinary approach to breast cancer care provided by health care professionals that are specialists in and dedicated to breast diagnosis, treatment and long-term care.
An suggested in this paper, were istituited weekly Breast Multidisciplinary case menagement meetings, to discuss diagnostic preoperative case as well as any other issue related to breast cancer patients which requires multidiscilinary discussion.
Were istutuite weekly meetings starting from January 17.
It was analyzed the period from January 17th to March 27th.
11 meetings were done with a total of 48 cases discussed and an average of 4.36 cases discussed per meeting.
At the meetings there were breast radiologists and breast surgeons, but the prospect is to extend participation in these meetings to all breast specialists (oncologists, pathologists, radiation oncologists, nuclear medicine).
The meetings were held on Friday from h13 to h14.30 in the meeting room of the breast surgery department, where there is a monitor (50 inch) connected with a computer and the RIS / PACS. The cases to be discussed were weekly prepared on slides to speed up the display of the same.
The cases could be selected by surgeons or radiologists without limit of number.
The cases discussed were tabulated to analyze the most frequent causes of problems, possible solutions and improvements traits for clinical practice.
Although it is essential and invaluable source of personal growth, it is not always easy cooperation and dialogue between two branches so similar but so different. Even find a space of time on a weekly basis that would allow a wider adherence to the specialists it was not easy, having to reconcile the radiological service marked by strict booking agendas and the most unpredictable activities of the surgery room.
As in all effective communication is required the capacity of listening to each other, and respect for professional specialist, in the awareness of the specialistic role of the other.
Of the 48 cases discussed, 9 (18.7%) had an underlying lack of communication / trust between radiologists and surgeons, 6 (12.5%) saw an improperly use of RM which then generated more questions than it has resolved ;in 5 cases (10.4%) was required MRI; in 3 cases (6.25%) was required greater accountability in the handling of the patient, in 11

cases (22.9%) the patient came at the end of the diagnostic iteror to surgery in the absence of conclusive cyto-histological diagnosis, in 8 cases (16.6%) was requested a further biopsy, in 2 cases (4.1%) a PET scan was performed and give a nonspecific breast uptake, in 1 case it was requested a new mammography (2.08%) and in 2 cases (4.1%) was evaluated not useful a request of surgical visit.

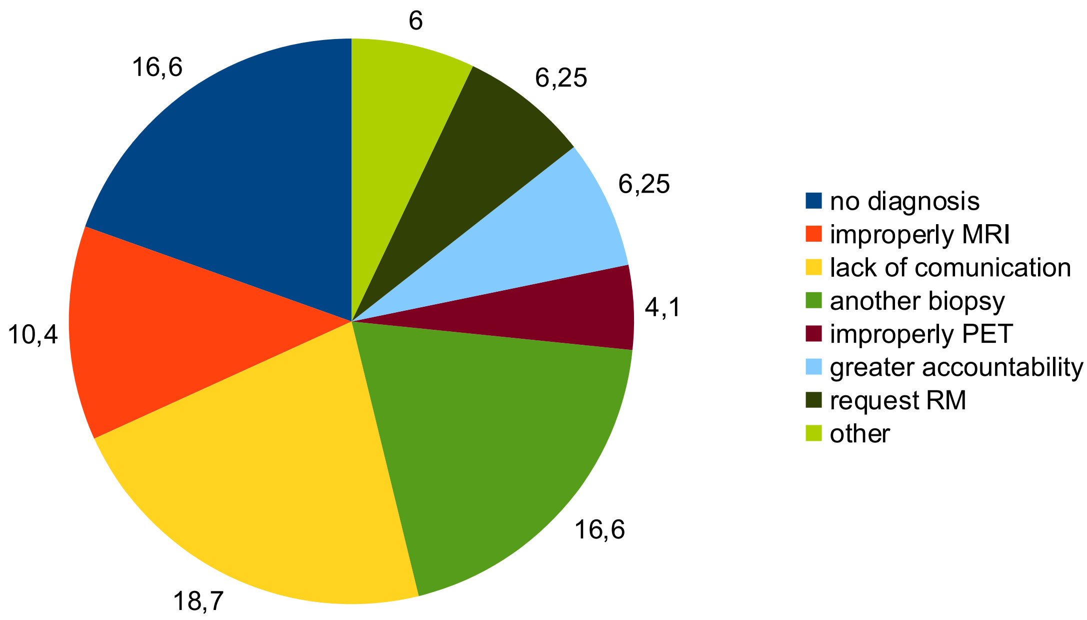


Fig.22. Interdisciplinary meetings outcome

From this meeting is therefore emerged as the main problems reside in the direct communication between the two departments, which too often takes place by what the patient reports, creating unnecessary confusion and on how too often surgeons do not cosideri concluded the diagnostic iter if there is a MRI with multiple enhancements and a negative second-look ultrasound, this problem widely known for the high sensitivity of MRI. It is necessary to adhere strictly to the instructions of the MR expressed in the guidelines of the 'American College of Radiology, reviewed in , 2013, even though sometimes we fall into the temptation to prescribe MRI examinations in more complex cases, often increasing the complexity of the case. RMI certainly does not provide a diagnosis of the nature. MRI if performed outside the guidelines, is likely to become a useless review. For this reason the 'American College of Radiology has produced guidelines for the use of this method.
The American College of Radiology, with more than 30,000 members, is the principal organization of radiologists, radiation oncologists, and clinical
medical physicists in the United States. The College is a nonprofit professional society

whose primary purposes are to advance the science of radiology,
improve radiologic services to the patient, study the socioeconomic aspects of the practice of radiology, and encourage continuing education for radiologists,
radiation oncologists, medical physicists, and persons practicing in allied professional fields.

Current indications for breast MRI include, but are not limited to:

1. Screening

   a. For high-risk patients – MRI can significantly improve the detection of cancer that is otherwise clinically, mammographically, and sonographically occult . Patients should be referred for screening breast MRI. Breast MRI may be indicated in the surveillance of women with more than a 20% lifetime risk of breast cancer (for example, individuals with genetic predisposition to breast cancer by either gene testing or family pedigree, or individuals with a history of mantle radiation for Hodgkin's disease). Although there is no direct evidence that screening with MRI will reduce mortality, it is thought that early detection by using annual MRI as surveillance, in addition to mammography, may be useful.

   b. For patients with a new breast malignancy - Screening of the contralateral breast with MRI in patients with a new breast malignancy can detect occult malignancy in the contralateral breast in at least 3% to 5% of breast cancer patients.

   c. For patients with breast augmentation **-** Breast MRI using contrast may be indicated in the evaluation of patients with silicone or saline implants and/or free injections with silicone, paraffin, or polyacrylamide gel in whom mammography is difficult. The integrity of silicone implants can be determined by noncontrast MRI.

2. Extent of disease

   a. Invasive carcinoma and ductal carcinoma in situ (DCIS) – Breast MRI may be useful to determine the extent of disease and the presence of multifocality and multicentricity in patients with invasive carcinoma and ductal carcinoma in situ (DCIS). MRI determines the extent of disease more accurately than standard mammography and physical examination in many patients. It remains to be shown conclusively, however, that this increased accuracy results in any reduction in recurrence rates following surgery, radiation, or systemic therapy.

   b. Invasion deep to fascia – MRI evaluation of breast carcinoma prior to surgical treatment may be useful in both mastectomy and breast conservation candidates to define the relationship of the tumor to the fascia and its extension into pectoralis major, serratus anterior, and/or intercostal muscles .

c. Postlumpectomy with positive margins – Breast MRI may be used in the evaluation of residual disease in patients whose pathology specimens demonstrate close or positive margins for residual disease.

d. Neoadjuvant chemotherapy – Breast MRI may be useful before, during, and/or after chemotherapy to evaluate treatment response and the extent of residual disease prior to surgical treatment.

3. Additional evaluation of clinical or imaging findings

a. Recurrence of breast cancer – Breast MRI may be useful in women with a prior history of breast cancer and suspicion of recurrence when clinical, mammographic, and/or sonographic findings are inconclusive.

b. Metastatic cancer when the primary is unknown and suspected to be of breast origin – MRI may be useful in patients presenting with metastatic disease and/or axillary adenopathy and no mammographic or physical Clinical trials demonstrate that breast MRI can locate primary tumor in the breast in over half of women presenting with metastatic axillary adenopathy and an occult primary. Breast MRI can also define the disease extent to facilitate treatment planning.

c. Lesion characterization – In rare cases, breast MRI may be indicated when other imaging examinations, such as ultrasound and mammography, and physical examination are inconclusive for the presence of breast cancer, and biopsy cannot be performed (e.g., possible distortion on only one mammographic view without a sonographic correlate). MRI should not replace ultrasound or diagnostic mammography to evaluate clinical focal signs or symptoms in the breast or to evaluate lesions identified on screening mammography.

d. Postoperative tissue reconstruction – Breast MRI may be useful in the evaluation of suspected cancer recurrence in patients with tissue transfer flaps.

e. MRI-guided biopsy – MRI is indicated for guidance of interventional procedures such as vacuum assisted biopsy and preoperative wire localization for lesions that are occult on mammography or sonography and demonstrable only with MRI.

B. Other Considerations

Screening of general population Screening breast MRI is not recommended for the general population of asymptomatic, average-risk women. False positives

Breast MRI may yield findings that are not evident clinically or on mammography or ultrasound. The findings may or may not be clinically significant. As with mammography or any other diagnostic test, false positive results can be expected, and the literature shows a wide range of specificity for breast MRI. The additional abnormalities detected on MRI may result in a follow-up examination or recommendation for biopsy. Published results for MRI directed biopsy are similar to those for mammography.

Treatment choices

Information from the MRI may change the planned treatment management. Caution should be exercised in changing management based on MRI findings alone without initial biopsy confirmation. Additional biopsies and/or correlation with other clinical and imaging information should be used together with clinical judgment. There is currently no evidence that identification of additional ipsilateral or contralateral occult malignancies improves patient outcomes.

4.Inappropriate uses of breast MRI

MRI should not supplant careful problem-solving mammographic views or ultrasound in the diagnostic setting. Because MRI will miss some cancers that mammography will detect, it should not be used as a substitute for screening mammograms. MRI should not be used in lieu of biopsy of a mammographically, clinically, and/or sonographically suspicious finding.

MRI does not always solve the problems.

Here an example of a woman of 37 years with a history family of breast cancer (mother and maternal grandmother) who has ultrasound examination in the retro-areolar (RA) area of epithelial hyperplasia with microcysts and internal hyperechoic spots related to precipitation of calcium salts within the microcysts (with corresponding Mammographic punctate and granular microcalcifications) in the context of cystic dysplasia and diffuse microcystic also dense in content.

Fig 23 US image

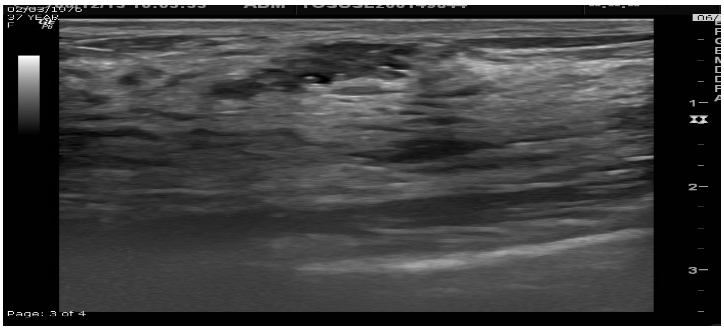


Fig 24: Right mammograms.

It is planned to complete diagnostic MRI and histological planned withdrawal of microcalcifications.
The MRI, however, showed multiple, bilateral nodules with a RA dx 4 nodularity and multiple focus enhancement bilaterally.

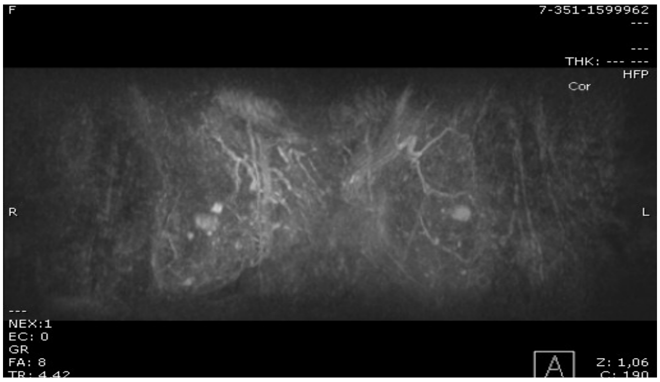
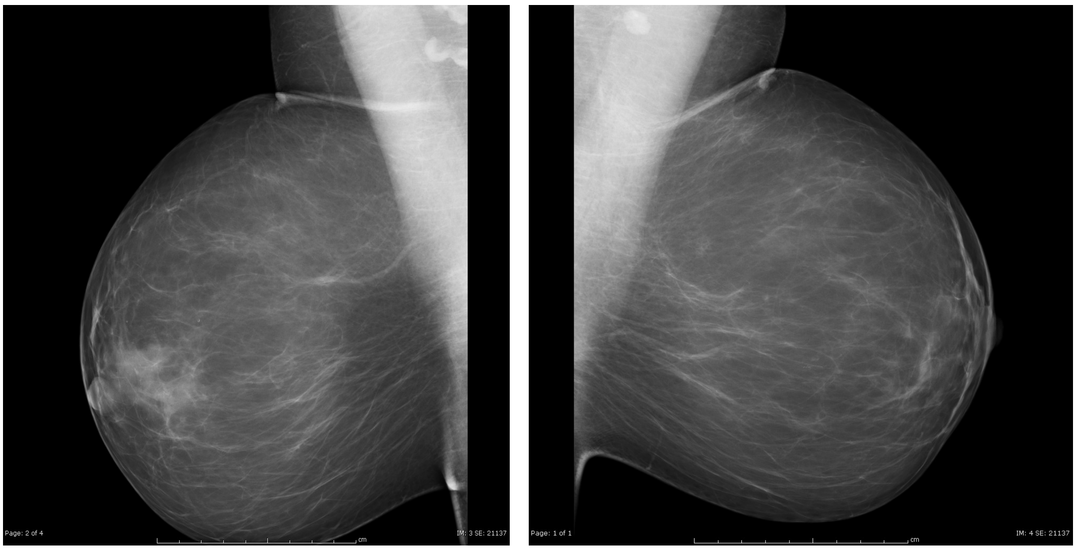


Fig 25 MRI

Follows US-guided biopsy of the region RA dx with a histological diagnosis of "atypical ductal hyperplasia, adenosis and small area with pseudopapillary aspects." The patient is then sent to the surgical visit for multinodular retroareolar area on the right (RM3, U4, R4b, B3) in a patient with bilateral complex breast R0-R3, R3 U3 also at h6 SIN.
It 'also important to establish clear diagnostic pathways to define which patients in staging should undergo preoperative MRI examination.
Is the example of the patient 47aa, which as a result of mammography performed (Fig.26) with highlights of microcalcifications R5 in the QIE SIN thenbenign at histologic sampling performed in stereotactic guidance, however, being recommended excision of the region for the suspicious appearance of microcalcifications, however, was deemed unfit for the execution of the preoperative MRI in relation to the structure of the mammary fat.



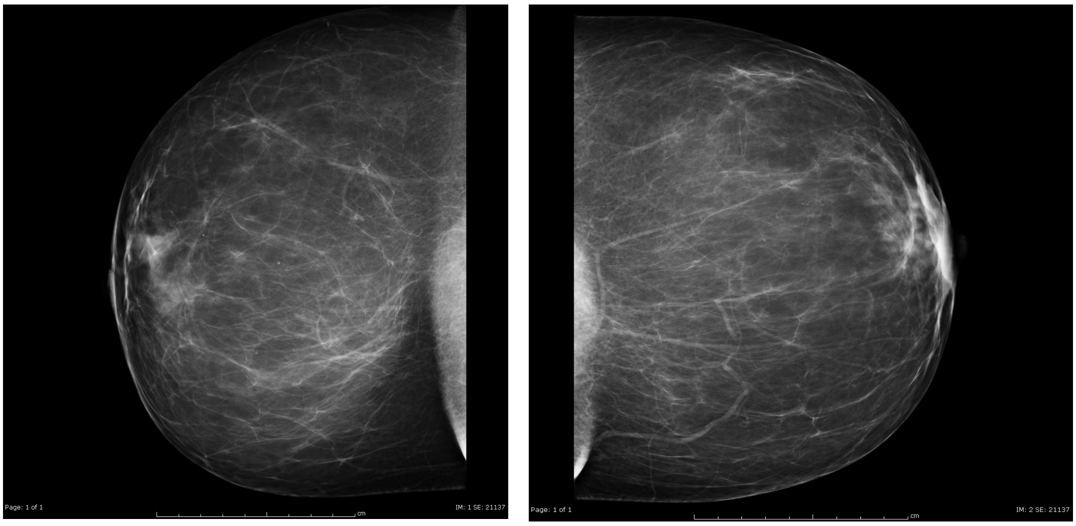


Fig 26 : Mammography showing microcalcifications

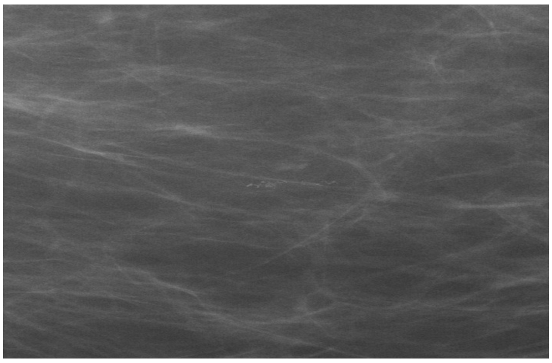


Fig 27 Mammography magnification showing microcalcifications

Another aspect that emerged is the assumptionof responsibility by radiologists and surgeons for the management of the patient, controversial for medico-legal issues. Two pratical examples follows.

Case 1: Lady of 45 years with thickening visible on mammography in charge of the left breast (R4a, U2, RM2, B2). Several ultrasound and mammographic controls idocumented stability of the left glandular plaque. MRI test required after 6 months

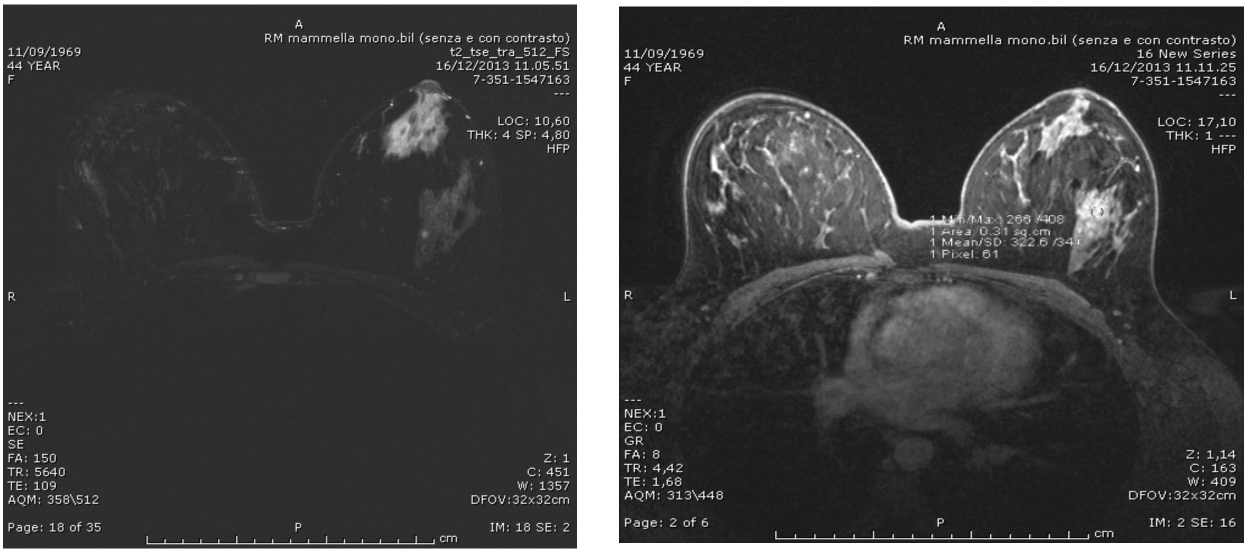


Fig 28 MRI breast scan (left, T2w; right T1w+contrast)

MRI performed after 6 months show dimensional, morphological plaque stability and the same type of enhancement. However It planned a stereotaxis biopsy with result of "replaced with fibrous mammary fat" (B1).

Although finding show stabilitylsince 2012, the radiologist suggest the possibility of a MRI guided biopsy or excision.

Case 2: Woman 36yrs. Familiarity for breast cancer. US findings show a nodule on the left QSE classified probably malignant (U4) which underwent two biopsies with outcome B1 in 2011. Cytology of axillary lymph nodes negative for malignant cells.

In May 2012, the patient's routine ultrasound finding which confirms the stability of the U4, 9.5 mm SIN QSE.

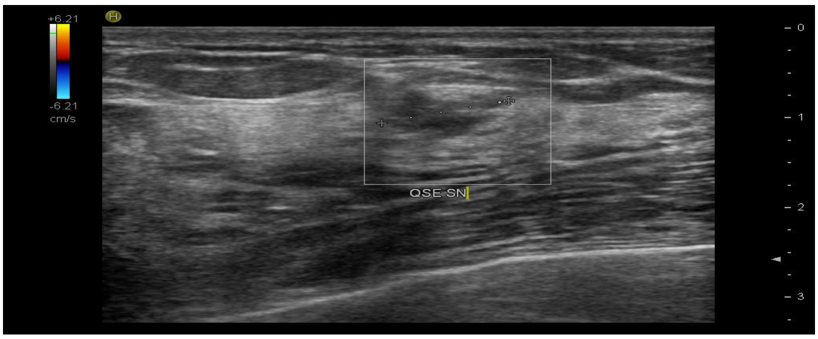


Fig 29 Ultrasound breast scan, U4 nodule.

Performs MRI in June 2012, which was negative.

Ultrasound scans November 2012 and July 2013, unchanged.

Visit breast surgery in November 2013, which assesses the tests performed, and concludes that although the findings are stable, having been the nodule at first classified as probably malignant, there is ample indication for resection.

5. CONCLUSIONS

Radiology is an essential step in the clinical management of the breast patient. The quality of the diagnostic service is crucial in ensuring timeliness and accuracy in clinical decisions, quickly bringing the planning surgical patients candidates for surgery.

The control of the dose and the diagnostic work-up optimization (e.g. number of accesses) is part of the quality checks to be carried out.

For a good functioning of the Breast Center, is necessary that radiologists derive maximum information content from the tests performed in order to conclude the process, and that there is a relationship of mutual trust with the surgeons.

Next steps in this direction will be the application for accreditation of multidisciplinary meetings and the drafting of a report on the same testimony and shared decision-making, in line with the requirements of the new Eusoma directive.

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