April 30, 2021

PharmacologyOnLine

Special issue • 2021 • vol.1 • 166-174

AUTOMATIZED BREAST ULTRASONOGRAPHY WILL REPLACE HAND-HELD ULTRASONOGRAPHY?

Graziella Di Grezia 1, Gianluca Gatta 2, Teresa Iannaccone 3
1 Radiology Division, "G. Criscuoli" Hospital, S. Angelo dei Lombardi Av, IT
2 Radiology Department, University of Campania "L. Vanvitelli", Naples, Italy
3Department of Medicine, Surgery and Dentistry, University of Salerno, Salerno, Italy

graziella.digrezia@gmail.com

Abstract

Imaging has a significant role in diagnosing, treating, and monitoring breast cancer. Advances in this field are having a great impact in the clinical management of this disease. In the last years, automatized breast ultra-sound (ABUS) has been developed to overcome hand-held ultrasonography main limitations.

ABUS allows to visualize large sections of the breast from the skin surface to the chest wall. The time saved should be used to further investigations for suspicious lesions.

Keywords: *kBreast cancer, imaging, ultrasonography, ABUS*

Introduction

The significant reduction in breast cancer mortality in the population is attributable to improvements in treatment, but even more so to the increasingly accurate and timely diagnosis of the disease.

In the last years, automatized breast ultrasound (ABUS) has been developed to overcome hand-held ultrasonography main limitations: operator dependence, non-reproducibility and inability to store three-dimensional breast volumes [1].

ABUS was introduced more than about ten years ago and it has evolved and improved until the new models are disseminated; from old generation equipped with low frequency (4-7 MHz) transducer to modern scanners with high-frequency (6-15 MHz), the quality has improved.

These high frequency, large (15-17cm) reverse-curved or linear-array transducers acquire entirely the breast; images are reconstructed coronally and viewed at a dedicated workstation; these reconstructions

not only to improve lesion detection and characterization, but are useful for pre-operative planning.

ABUS scanner of new generation can acquire until 2000-5000 images and some of these equipments can also do 3D reconstructions; despite the width of the probe (from 12 to 26 cm), in some cases of large breasts, more than one scan could be necessary. The time of the execution of the exam is about 15 minutes, less than the time necessary for handle breast ultrasonography (about 19 minutes) [2] [**Fig. 1**].

Gel pad application for automated breast sonography is easy and provides significant pain relief, with the scan coverage expanded, and the image quality maintained. Each sectional plane of the saved volume can be visualized, thereby avoiding the investigator- dependent and non-standardized documentation. It takes a proficient radiologist 3–10 minutes to interpret a case of ABUS results, depending on the complexity The main application of ABUS is in dense breasts [3], especially in addition to FFDM (full field digital mammography)/DBT (digital breast tomosynthesis) during breast cancer screening programs (age range 45-69 or 74 yo) [4].

Other applications include post-neoadiuvant chemotherapy evaluation or second-look exams (after MRI, PET-CT).

Breast dense tissue is quite common, with over half of all premenopausal women, as do at least one third of elderly women having either heterogeneously dense C (visually estimated as >50 <75% glandular tissue) or extremely dense D (visually estimated as >75% glandular tissue) breasts.

ABUS allows to visualize large sections of the breast from the skin surface to the chest wall and to store entire breast volumes on a picture archiving and communication system, and to compare current studies with relevant prior studies.

The execution needs a dedicated training for radiology technicians, but the procedure is simplified, especially if the equipment is available in the same space of mammography (e.g. screening programs, with a consequently reduction of patient anxiety) [5].

The time saved should be used to further investigations for suspicious lesions and for interventional procedures conducted by the breast radiologist [**Fig 2, 3**].

Hand-held ultrasonography systems have broad-band high frequency probes (6-16 MhZ) with high multidimensional imaging level; three dimensional ultrasonography allows the study in three orthogonal planes. A composed imaging reduces shadowing artifacts and avoids overlapping scans; it allows to visualize the lesion in more than one plans, thanks to the rotation of the y-axis, with the availability of more standardized images such as in coronal plane and to have the more accurate measure of the long axis; in adjunct the volume evaluation is possible. Four dimensional breast ultrasonography is able to demonstrate the elasticity of the lesion elasticity, thanks to movement of compression and decompression of breast tissue.
HHUS is a first level exam that can distinguish cystic from solid masses and is a valid help to guide interventional procedures, such as US-guided fine needle cytology or biopsies [6,7,8]; is a cheap, non-invasive, quick and safe diagnostic tool used as a complementary exam in over forty women and as the main exam in

under forty patients, both male and female [9,10].

However, the main limitation of breast ultrasonography is operator dependent nature and its low specificity, leading to a high rate of false positive results.

In the last decades, many software here have been developed to improve the sensibility and specificity of the method, even if the guide of interventional procedures makes the exam irreplaceable [11].

Tissue harmonic imaging is an automatized tissue optimization that enhances contrast to optimize the image quality and improves the visualization of the needle against fatty background during breast interventional procedures. Even if the tissue imaging plays a role in fatty breasts, *compound imaging* improves lesion echo texture assessment.

The development of *Colour Doppler Flow Imaging* (CDFI) consists in the detection of very small or micro blood flow states, the SMI that use an algorithm that allows the visualization of minute vessels with slow velocity without using an ev contrast media.

Elastosonography can measure the degrees of stiffness in different tissues; a varying pressure applied to tissue surface generates shear deformation as well as longitudinal propagation. Shear-wave elastography (SWE) uses acoustic radiation force to obtain real-time 2D or 3D quantitative shear-wave speed images.

High mean stiffness values in shear-wave elastography have been shown to have a statistically significant positive association with the invasive size, high histologic grade, lymph-node involvement, tumor type, and vascular invasion for invasive breast cancer, and which suggests that higher mean stiffness values have poorer prognostic features [12].

*Contrast-enhanced ultrasound (CEUS)*utilizes intravenously injected gas microbubbles in order to improve backscattering from the vasculature (Calliada, et al. 1998). Enhancement patterns in the early phase and contrast medium persistence in the late phase differ in benign and malignant breast lesions. The features of malignancy include early and fast enhancement in the early phase, centripetal filling, claw-shaped enhancement, higher maximum intensity, and contrast medium accumulation in the late phase

The EFSUMB Guidelines of CEUS for the breast remains an important topic for research, but has not been recommended for routine clinical use [13].

Very High Frequency Ultrasonography (HFU)(until 70 MHz) allows an evaluation within the first centimeter of the skin surface with high spatial resolution although reduced the low depth of penetration with a good assessment of skin, first order ducal involvement and nipple-area complex; also allows also the evaluation of dermatologic diseases of the breast, the skin thickness, the retraction assessment, papillary lesions, inflammatory carcinoma or Paget disease and could have a role in the assessment of nipple discharge.

Functional imaging

Nuclear medicine imaging uses small amounts of radioactive material to diagnose, evaluate or treat a variety of diseases. [14-16] These include many types of cancers [17-19], metabolic [20,21] , gastrointestinal [22,23], endocrine [24] or neurological disorders [25,26] and other abnormalities. Because nuclear medicine exams can pinpoint molecular activity, they have the potential to identify disease in its earliest stages. They can also show whether a patient is responding to treatment. [27]

In breast cancer, functional techniques which do not depend on the anatomical appearances of the breast, like scintimammography, may have a role in this clinical setting, and could be an useful complement to radiological imaging. The utilization of PET for prediction of treatment response to primary chemotherapy is an area of active research. [28]

Conclusions

In conclusion, ABUS can not replace HHUS in clinical senology, but should be useful in breast cancer screening, in second look evaluation or, in selected cases, in post-neoadiuvant chemotherapy exams [**Tab 1**].

ABUS thanks to the standardize technique, the reproducibility, and the operator –

independence, can minimize the number of recalls in mammography screening [29-31], even if a second handle breast ultrasonography could be necessary for the BI-RADS judgment and to guide interventional procedures, such as fine needle aspiration or core biopsies.

Table 1 – advantages and disadvantages of HHUS (hand-held ultrasonography) and ABUS (automatized breast ultrasound) - Legend * CEUS: contrast-enhanced ultrasonography

	HHUS	ABUS
OPERATOR DEPENDANCE	yes	no
AVAILABILITY	yes	yes/no
COMPARISON WITH PREVIOUS EXAM	yes/no	yes
DOPPLER, ELASTOGRAPHY, CEUS*	yes	no
INTERVENTIONAL PROCEDURES GUIDE	yes	no
DEDICATED TECHNICIANS TRAINING	-	yes
FEASIBILITY DURING SCREENING MAMMOGRAPHY	no	yes

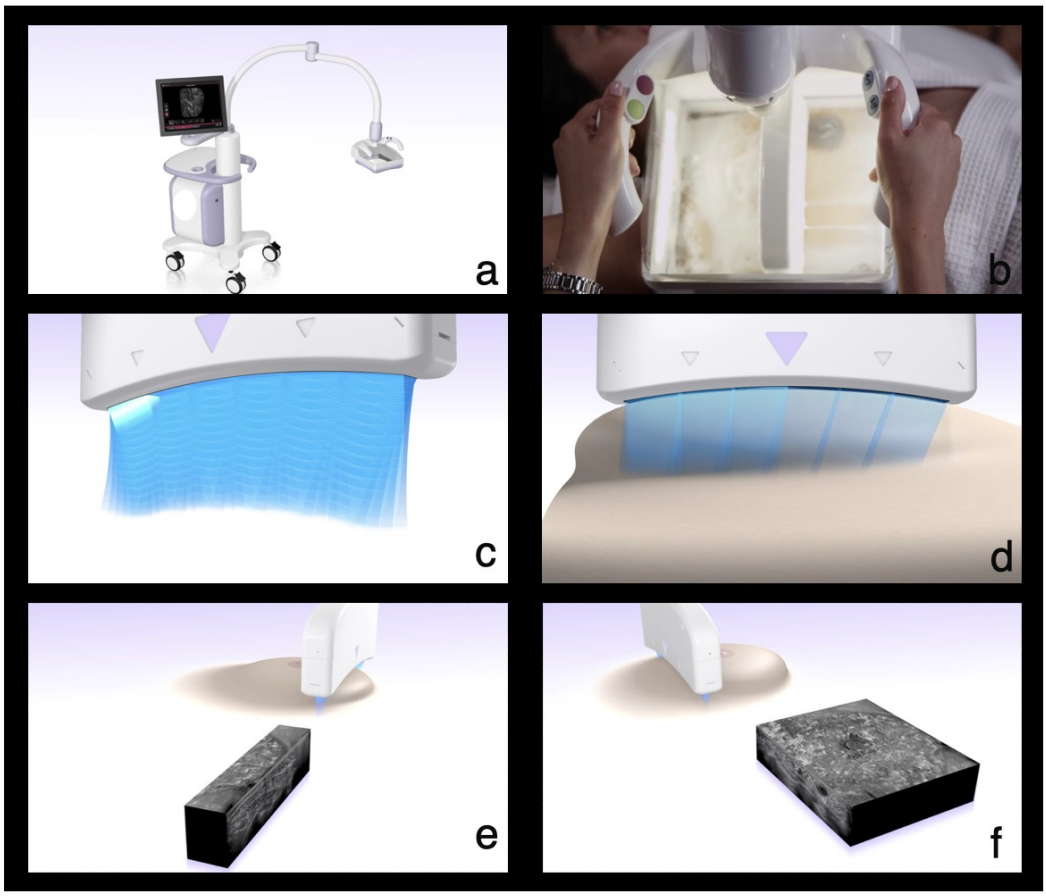

Figure 1. shows a) a model of automatized breast ultrasonography (ABUS), b) the dedicated probed the positioning, c) the probe extension on the breast (d) and the slab (e) and volume (f) acquisition in post-processing

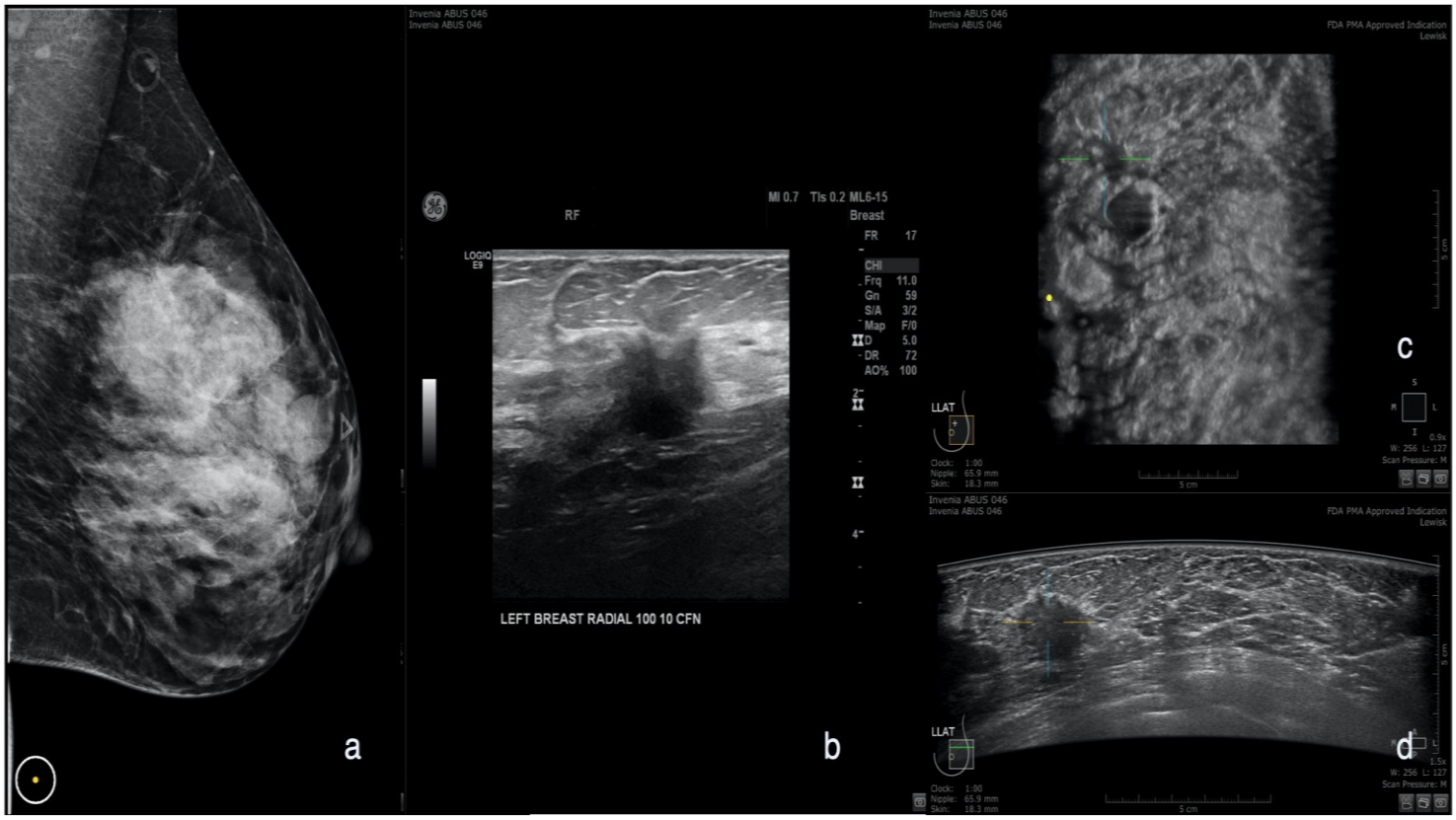

Fig. 2 F, 56 year old - a) left MLO mammography projection (breast density C class) - b) HHUS shows a suspicious focality with spiculated margins (Histological diagnosis: infiltrative ductal carcinoma) and ABUSwith coronal (c) and sagittal (d) plane showing and Incidental finding of a Lobular Carcinoma (5 mm)

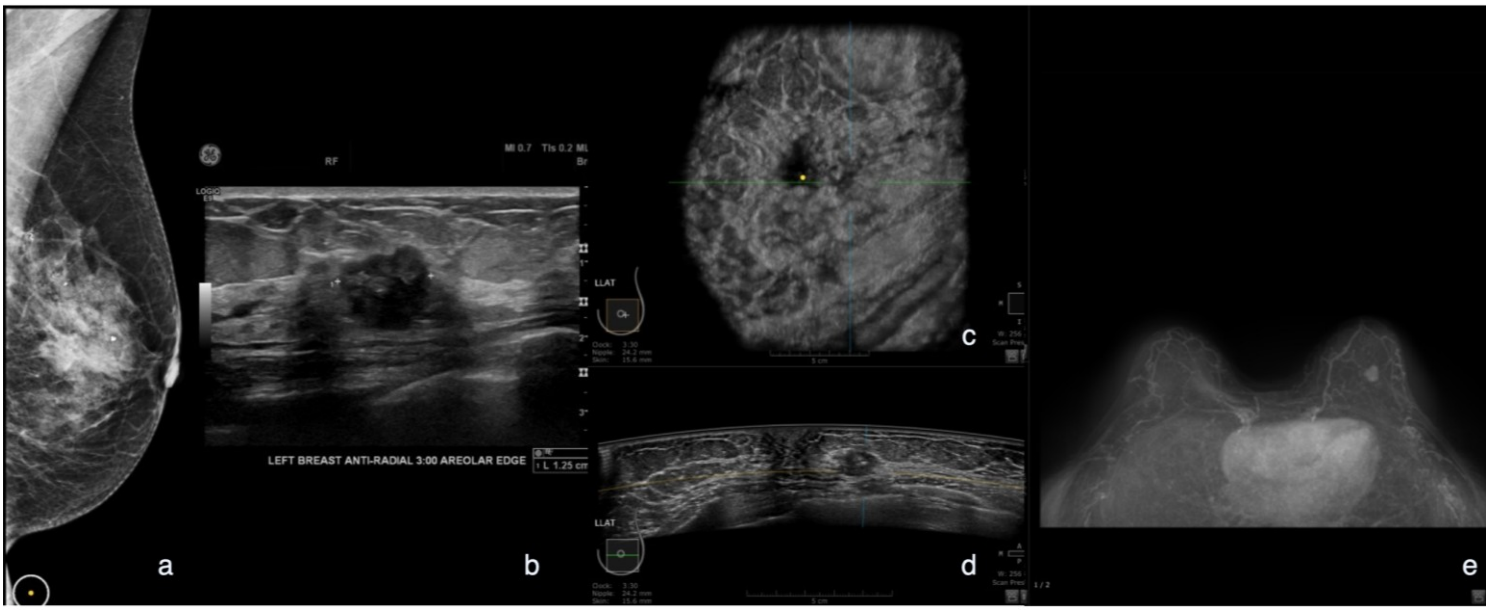

Fig. 3 - 56 year old – a) left MLO mammography projection (breast class density B) ; b) HHUS shows a suspicious lesion in inner periareolar region, confirmed during ABUS (c and d) in coronal and sagittal plane; e) Minimal Intensity Projection (MIP) reconstruction of Dynamic- Breast MRI that shows the focality. Histological diagnosis: infiltrative ductal carcinoma

REFERENCES

1 Vourtsis A. Three-dimensional automated breast ultrasound: Technical aspects and first results. Diagn Interv Imaging. 2019 Oct;100(10):579-592

2. Di Grezia G , Gatta G, Brunese L, Falco G State of the art in Integrated Breast Imaging BioMed Research International Volume 2019, Article ID 7596059

3. Sardu C, Gatta G, Pieretti G, Viola L, Sacra C, Di Grezia G Pre-Menopausal Breast Fat Density Might Predict MACE During 10 Years of Follow-Up: The BRECARD Study - J Am Coll Cardiol Cardiovasc Imaging. 2021 Feb, 14 (2) 426–438

4. Vestito A, Mangieri FF, Gatta G, Moschetta M, Turi B, Ancona A. Breast carcinoma in elderly women. Our experience. G Chir. 2011 Oct;32(10):411-6

5. Di Grezia G , Prisco V, Iannaccone T, Grassi R, Serra N, Gatta G Personality disorder and temperamental traits in patients with breast disease: preliminary results Minerva Psichiatrica 2016 Sept; 57(3):85-92

6. La Forgia D, et al Elite VABB 13G: a new ultrasound-guided wireless biopsy system for breast lesions. Technical characteristics and comparison with respect to traditional core-biopsy 14-16 G systems - Diagnostics 2020, 10(5), 291

7. Gatta G, Di Grezia G , Ancona A, Capodieci M, Coppolino F, Rossi C, Feragalli B, Iacomino A, Cappabianca S, Grassi R "Underestimation of atypical lobular hyperplasia and lobular carcinoma in situ at stereotaxic 11-gauge vacuum-assisted breast biopsy" European Journal of Inflammation 2013; 11(3): 825-835

8. Ancona A, Capodieci M, Galiano A, Mangieri F, Lorusso V, Gatta G. Vacuum-assisted biopsy diagnosis of atypical ductal hyperplasia and patient management. Radiol Med. 2011 Mar;116(2):276-91

9. Ferraro GA, Romano T, De Francesco F, Grandone A, D'Andrea F, Miraglia del Giudice E, Cataldo C, Gatta G Perrone L, Nicoletti G. Management of prepubertal gynecomastia in two monozygotic twins with Peutz-Jeghers from

aromatase inhibitors to subcutaneous mastectomy. Aesth Plast Surg Aesth Plast Surg 2013 Oct; 37(5):101

10. Di Grezia G , Romano T, De Francesco F, Somma F, Rea G, Grassi R, Gatta G – Breast ultrasound in the management of gynecomastia in Peutz-Jeghers Syndrome:a case report. Journal of Medical Case Report 2014 ; (18) 8:440

11. Di Grezia G , Somma F , Serra N , Reginelli A , Cappabianca S , Grassi R , Gatta G . Reducing Costs of Breast Examination: Ultrasound Performance and Inter-Observer Variability of Expert Radiologists Versus Residents. Cancer Invest. 2016 Jul 20:1-6

12 Barr RG. Breast Elastography: How to Perform and Integrate Into a "Best-Practice" Patient Treatment Algorithm. J Ultrasound Med. 2020 Jan;39(1):7-17

13. Cui Q, Dai L, Li J, Xue J. Accuracy of CEUS-guided sentinel lymph node biopsy in early-stage breast cancer: a study review and meta-analysis. World J Surg Oncol. 2020 May 29;18(1):112

14. Cuccurullo V, Di Stasio GD, Cascini GL. PET/CT in thyroid cancer - the importance of BRAF mutations. Nucl Med Rev Cent East Eur. 2020;23(2):97-102.

15. Briganti V, Cuccurullo V, Berti V, Di Stasio GD, Linguanti F, Mungai F, Mansi L. 99mTc-EDDA/HYNIC-TOC is a New Opportunity in Neuroendocrine Tumors of the Lung (and in other Malignant and Benign Pulmonary Diseases). Curr Radiopharm. 2020;13(3):166-176.

16. Cuccurullo V, Di Stasio GD, Cascini GL, Gatta G, Bianco C. The Molecular Effects of Ionizing Radiations on Brain Cells: Radiation Necrosis vs. Tumor Recurrence.Diagnostics (Basel). 2019 Sep 24;9(4):127.

17. Cuccurullo V, Di Stasio GD, Mansi L. Physiopathological Premises to Nuclear Medicine Imaging of Pancreatic Neuroendocrine Tumours. Curr Radiopharm. 2019;12(2):98-106.

18. Cuccurullo V, di Stasio GD, Evangelista L, Ciarmiello A, Mansi L. Will 68Ga PSMA-radioligands be the only choice for nuclear medicine in prostate cancer in the near future? A clinical update. Rev Esp Med Nucl Imagen Mol. 2018 Mar-Apr;37(2):103-109.

19. Cuccurullo V, Di Stasio GD, Mazzarella G, Cascini GL. Microvascular Invasion in HCC: The Molecular Imaging Perspective. Contrast Media Mol Imaging. 2018 Oct 4;2018:9487938. doi: 10.1155/2018/9487938. PMID: 30402046.

20. Kitson SL, Cuccurullo V, Ciarmiello A, Mansi L. Targeted Therapy Towards Cancer-A Perspective. Anticancer Agents Med Chem. 2017;17(3):311-317.

21. Cuccurullo V, Di Stasio GD, Schillirò ML, Mansi L. Small-Animal Molecular Imaging for Preclinical Cancer Research: PET and SPECT. Curr Radiopharm. 2016;9(2):102-13.

22. Cuccurullo V, Di Stasio GD, Prisco MR, Mansi L. Is there a clinical usefulness for radiolabeled somatostatin analogues beyond the consolidated role in NETs? Indian J Radiol Imaging. 2017 Oct-Dec;27(4):509-516.

23. Cuccurullo V, Prisco MR, Di Stasio GD, Mansi L. Nuclear Medicine in Patients with NET: Radiolabeled Somatostatin Analogues and their Brothers. Curr Radiopharm. 2017;10(2):74-84.

24. Briganti V, Cuccurullo V, Di Stasio GD, Mansi L. Gamma Emitters in Pancreatic Endocrine Tumors Imaging in the PET Era: Is there a Clinical Space for 99mTc-peptides? Curr Radiopharm. 2019;12(2):156-170.

25. Ciarmiello A, Giovannini E, Meniconi M, Cuccurullo V, Gaeta MC. Hybrid SPECT/CT imaging in neurology. Curr Radiopharm. 2014;7(1):5-11.

26. Lupi A, Bertagnoni G, Borghero A, Picelli A, Cuccurullo V, Zanco P. 18FDG-PET/CT in traumatic brain injury patients: the relative hypermetabolism of vermis cerebelli as a medium and long term predictor of outcome. Curr Radiopharm. 2014;7(1):57-62.

27. Cistaro A, Cuccurullo V, Quartuccio N, Pagani M, Valentini MC, Mansi L. Role of PET and SPECT in the study of amyotrophic lateral sclerosis. Biomed Res Int. 2014;2014:237437. doi: 10.1155/2014/237437.

28. Cuccurullo V, Cascini GL, Mansi L. Structural, pathophysiological and clinical aspects of diagnostic imaging in breast recurrence: the breast after treatment. Q J Nucl Med Mol Imaging. 2013 Dec;57(4):322-31.

29. Huang CS, Yang YW, Chen RT, Lo CM, Lo C, Cheng CF, Lee CS, Chang RF. Whole-Breast Ultrasound for Breast Screening and Archiving. Ultrasound Med Biol. 2017 May;43(5):926-933

30. Gatta G, Pinto A, Romano S, Ancona A, Scaglione M, Volterrani L. Clinical, mammographic and ultrasonographic features of blunt breast trauma. Eur J Radiol. 2006 Sep;59(3):327-30.

31. Vestito A, Mangieri FF, Gatta G, Moschetta M, Turi B, Ancona A. Breast carcinoma in elderly women. Our experience. G Chir. 2011 Oct;32(10):411-6.