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Vacuum-Assisted Breast Biopsy (VAB): Diagnostic and Therapeutic Role

Biópsia Mamária Assistida por Vácuo: Papel Diagnóstico e Terapêutico

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Abstract

Background
Vacuum-assisted breast biopsy (VAB) plays a diagnostic and therapeutic role. This study aims to correlate imaging and anatomopathological features of lesions submitted to VAB.
Material and methods
We carried out a retrospective study, which included 221 BAV (guided by stereotaxis or ultrasound) performed at Portuguese Institute of Oncology in Lisbon (IPOLFG) during 15 months. We reviewed the imaging characteristics of the lesions, the respective anatomopathological diagnoses in VAB and in available surgical specimens.
Results / Discussion
Imaging characteristics: microcalcifications (60,2%); nodules (33%); architectural distortion (4.5%) and density asymmetries (2.3%). Anatomopathological diagnosis: benign lesions (44.8%); lesions of uncertain malignant potential/B3 lesions(22.2%), including 23 papillomas(10.4%); ductal carcinoma in situ/ DCIS (23.5%); DCIS(38-54.3%); invasive carcinoma not otherwise specified/IC (9.5%). Cases submitted to surgery at IPOLFG=31.3% with the respective VAB diagnosis: benign lesions(2,8%); B3 lesions(15.7%); DCIS(54.3%); CI(27.1%). In benign and B3 lesions we didn`t found upgrade in surgical specimens. Of the 19 papillomas with follow-up, only 1 was not completely excised with BAV. Of the DCIS, 5.2% had no residual lesion in the surgical specimen and we identified upgrade in 21,1%, half for microinvasive carcinoma and half for IC, one with a 3 mm axillary metastasis. When coexistence of IC and CDIS in BAV, we registered downgrade in 14.3% (no invasion in surgical specimen).
Conclusions
The low percentage of cases submitted to surgery post-VAB proves its efficacy in the management of benign lesions and B3 lesions. In DCIS submitted to surgery at IPOLFG, we verified no residual tumor in 5.2% and upgrade in 21,1% of the cases, in half for microinvasive carcinoma.

Keywords

Breast lesions; Microcalcifications; Vacuum assisted biopsy.

Resumo

Introdução
A biópsia mamária assistida por vácuo (BAV) pode ter intenção diagnóstica e/ou terapêutica. Este estudo tem como objetivo correlacionar as características imagiológicas e anátomo-patológicas de lesões submetidas a BAV.
Material e Métodos
Realizámos um estudo retrospetivo, que incluiu 221 BAV (guiadas por estereotaxia ou ecografia) efetuadas no Instituto Português de Oncologia de Lisboa/IPOLFG, num período de 15 meses. Avaliámos as características imagiológicas e os respetivos diagnósticos anátomo-patológicos na BAV e na peça operatória.
Resultados/Discussão
Características imagiológicas: microcalcificações (60,2%); nódulos (33%); distorção arquitetural (4,5%); assimetrias de densidade (2,3%). Diagnósticos anátomo-patológicos: lesões benignas (44,8%); lesões de potencial maligno incerto/lesões B3 (22,2%), incluindo 23 papilomas (l0,4%); carcinoma ductal in situ/ CDIS (23,5%); carcinoma invasivo sem tipo especial/CI (9,5%). Casos com cirurgia no IPOLFG=31,3%, com os seguintes diagnósticos em BAV: lesões benignas (2,8%); lesões B3 (15,7%); CDIS (54,3%); CI (27,1%). Nas lesões benignas e B3 não observámos upgrade nas peças operatórias. Dos 19 papilomas com follow-up, apenas 1 não foi completamente excisado na BAV. Dos CDIS, 5,2% não tinham lesão residual na peça operatória e verificámos upgrade em 21,1%, metade para carcinoma microinvasivo e metade para CI, 1 com metástase axilar com 3 mm. Nos CI com CDIS na BAV, registámos downgrade em 14,3%, por ausência de invasão na peça operatória.
Conclusões
A baixa percentagem de casos submetidos a cirurgia pós-BAV comprova a sua eficácia na abordagem de lesões benignas e lesões B3. Nas peças operatórias dos CDIS, verificámos ausência de lesão residual em 5,2% e upgrade em 21,1% casos, em metade destes para carcinoma microinvasivo.

Palavras-chave

Lesões da mama; Microcalcificações; Biópsia assistida por vácuo.

Introduction

Vacuum-assisted biopsy (VAB) of breast lesions plays an important diagnostic and therapeutic role, especially in benign lesions and B3 lesions, with indications in continuous expansion.[1,2,3] In recent years, advances in knowledge and development of this technique has allowed to optimize the procedure.[1]

The VAB device is essentially a larger gauge needle than the one used in microbiopsy ("core biopsy"), usually between 7 and 11 Gauge (G) instead of 14G, added to a suction chamber and rotating cutting blade. The most recent VAB devices allow obtaining multiple samples through a single access, without the need for re-insertion of the needle.[1,3]

VAB can be performed using different imaging methods used in the context of the study of the mammary gland, including mammography, ultrasound, tomosynthesis and magnetic resonance imaging (MRI).[1,4] Stereotactic-guided VAB is generally used in cases of suspicious microcalcifications[1] observed in mammographic studies.

The main advantage of VAB devices lies in their ability to extract large tissue samples, in some cases with complete excision of the lesion, with consequent optimization of sample representativeness. It can be used for re-evaluation in case of microbiopsy that is not representative of the imaged lesion, or in the evaluation of a possible upgrade in B3 lesions, and it implies a lower risk of disagreement with the anatomopathological diagnosis of the surgical specimen.[1,2,3]

An increasing role for VAB in the management of B3 lesions (lesions with uncertain malignant potential) diagnosed in microbiopsy has been recognized. B3 lesions are a heterogeneous group of lesions with different risks of malignancy, including flat epithelial atypia of columnar cells, papillary lesions, radial scar/complex sclerosing lesion (CSL), classic lobular neoplasia, phyllodes tumor and atypical ductal hyperplasia.[1,2] Current recommendations advocate VAB as the preferred assessment method (instead of the surgical excision option) for certain B3 lesions diagnosed on microbiopsy, including flat epithelial atypia, papilloma/papillary lesions without atypia, radial scar/complex sclerosing lesion (CSL) and classic lobular neoplasia.[2]

The carcinoma in situ, namely ductal carcinoma in situ (DCIS) incorporates a spectrum of lesions categorized on the basis of mammographic and anatomopathological characteristics such as the presence or absence of necrosis and nuclear grade.[6] Microcalcifications constitute the most frequent mammographic finding in cases of DCIS, although the radiological manifestation can also occur in the form of a nodule or architectural distortion.[5,6] On imaging, the extension of the DCIS is more accurately evaluated with MRI.[6] Several factors have been associated with histological underestimation, namely the presence of a palpable lesion, the lesion dimension, BI-RADS category, histological grade and the presence of necrosis.[7]

VAB increases the probability of detecting an eventually invasive component (IC) in a DCIS diagnostic context, resulting in rates of underestimation of the invasive component in VAB much lower than those recorded with microbiopsy.[1,3,5]

The present study aims to characterize lesions submitted to VAB at IPOLFG over a 15-month period, comparing the imaging pattern and the anatomopathological diagnosis.

We intend to evaluate imaging patterns, the respective anatomopathological diagnoses and the agreement between the anatomopathological diagnosis in the VAB and in the surgical specimen, especially in the papilloma and DCIS subgroups.

Material and Methods

We carried out a retrospective analysis of all stereotactic or ultrasound-guided VABs, performed between January 2018 and March 2019. Magnetic resonance-guided-VABs were not included. Cases in which both the radiological study and the anatomopathological diagnosis were performed at IPOLFG were included.

The study was approved by the Ethics Committee of IPOLFG (UIC/1348).

We evaluated clinical and epidemiological data (age, gender, personal history of breast carcinoma and ACR/American College of Radiology breast pattern), radiological data (mammography and ultrasound), namely the presentation form (microcalcifications, nodule, architectural distortion or asymmetry of density), characteristics of microcalcifications (morphology and distribution) and the assigned BI-RADS category. The anatomopathological diagnoses related to the evaluation of the VAB sample and of the surgical specimen (when the surgery was performed at IPOLFG) were reviewed.

When the form of presentation translates into microcalcifications, the practice established in the Radiology Service at IPOLFG includes radiography of the obtained fragments in order to demonstrate the presence of microcalcifications and support a representative sampling (not necessarily including all microcalcifications). At the end of the procedure, a metallic clip is placed for reference.

In the DCIS subgroup, the imaging manifestation, characteristics of microcalcifications (morphology and distribution), extension (largest axis in mm, estimated in pre-operative magnetic resonance if available, or alternatively in mammography), as well as anatomopathological diagnostic data were analyzed, with emphasis on the nuclear degree (low, intermediate or high) and necrosis (present/absent).

In patients with surgery performed at IPOLFG, after correlating the anatomopathological diagnosis in the VAB and in the surgical specimen, we calculated the percentage of upgrade of B3 lesions and benign lesions to malignancy, as well as the percentage of upgrade from DCIS to microinvasive carcinoma and invasive carcinoma (IC).

We also evaluated the downgrade percentage in the sample, including cases where the lesion identified in the surgical specimen no longer showed the lesion diagnosed in the VAB.

Regarding the DCIS, we tried to measure variables with a possible significant association with the occurrence of upgrade, namely the largest estimated axis in Radiology, the nuclear grade and necrosis. The assessment of the results' statistical significance was performed using the "Fisher's exact test". A result was considered statistically significant if $p < 0.05$.

Some lesions were exemplified with iconography from the institution's Radiology and Pathological Anatomy Services.

Results

2.1 Overall Results

All samples were collected from female breasts. Regarding clinical characteristics, we observed a mean age of 57 years and a personal history of breast cancer in 27 cases (12.2%) (Table 1).

Most procedures were performed under stereotactic guidance (124-56.1%) and the remaining were ultrasound-guided (97-43.9%). More than 2/3 of the patients had an ACR (American College of Radiology) type b breast pattern (157-71%). Most biopsies targeted microcalcifications (n=133; 60.2%) and nodules (73-33.0%), and 10 biopsies were performed for architectural distortions (4.5%) and 5 for asymmetries of density (2.3%).

Regarding the BI-RADS categories, most lesions (155-70.1%) were classified as having a moderate suspicion index for malignancy (BI-RADS 4B) and malignancy has been documented in the pathological examination in 41 cases-31%. Of the remaining, 37 (16.7%) had a low suspicion level (BI-RADS 4A) and 28 (12.7%) had a high suspicion index (BI-RADS 4C), with malignancy rates of 1.4% and 82.1%, respectively. Only one lesion (with the anatomopathological diagnosis of IC) was categorized as BI-RADS 5, corresponding to 0.5% of the sample.

The vast majority of the calcifications were grouped (82.7%). Morphologically, more than half (74-55.6%) were amorphous and 35-26.3% were fine and pleomorphic.

Nodules represent 33% of the total sample. The mean size assessed by imaging was 12 mm, with 23 of all nodules corresponding to papillomas, 31 to other B3 lesions, 12 to fibroadenomas and 7 to CI.

The number of malignant lesions in the anatomopathological diagnosis was 73, including 52 DCIS and 21 CI (Figures 1 and 2). 49 B3 lesions were identified, which included papillomas (Figure 3), complex sclerosing lesions (CSL), atypical ductal hyperplasia (ADH) and lobular carcinoma in situ, being the remaining alterations benign (99), which included usual ductal hyperplasia, adenosis sclerosing, ductal ectasia,

Table 1 – Characteristics of the population (n=221) analyzed (clinical-epidemiological and radiological) and characteristics of the detected microcalcifications (n=133) (morphology and distribution according to the BI-RADS lexicon).

	Characteristics	Results
Characteristics in the overall sample (clinical-epidemiological and radiological), n=221	Age	Average = 57 years old
	Sex	Female: n= 221 (100%) Male: n= 0(0%)
	Personal history of breast cancer	Yes: n= 27 (12,2%) No: n= 194 (87,8%)
	Breast Composition	ACR type a: n= 18 (8.2%) ACR type b: n= 157 (71.0%) ACR type c: n= 42 (19.0%) ACR type d: n= 4 (1.8%)
	Imaging method guiding the VAB	Stereotactic: n= 124 (56.1%) Ultrasound: n= 97 (43.9%)
	Radiological presentation	Microcalcifications: n= 133 (60.2%) Nodule: n= 73 (33.0 %) Architectural distortion: n= 10 (4.5%) Asymmetry: n= 5(2.3%)
	BI-RADS	4A: n= 37 (16,7%) 4B: n= 155 (70,1%) 4C: n= 28 (12,7%) 5: n= 1 (0,5%)
Characteristics of microcalcifications (n=133)	Microcalcifications morphology	Amorphous: n= 74 (55.6%) Punctiform/round: n= 3 (2.3%) Coarse heterogeneous: n= 6 (4.5%) Fine pleomorphic: n= 35 (26.3%) Fine linear: n= 13 (9.8%) Fine linear branching: n= 2 (1.5%)
	Microcalcifications distribution	Grouped: n= 110 (82.7%) Segmental: n= 7 (5.3%) Regional: n= 15 (11.3%) Diffuse: n= 1 (0.7%)

VAB: vacuum assisted biopsy; ACR: American College of Radiology; Breast patterns: type a (predominantly adipose), type b (dispersed fibroglandular densities), type c (heterogeneously dense), type d (extremely dense); BI-RADS: Breast Imaging-Reporting and Data System – BI-RADS 4: suspect (4A: low suspicion for malignancy; 4B: moderate suspicion for malignancy; 4C: high suspicion for malignancy), BI-RADS 5: highly suspected of malignancy

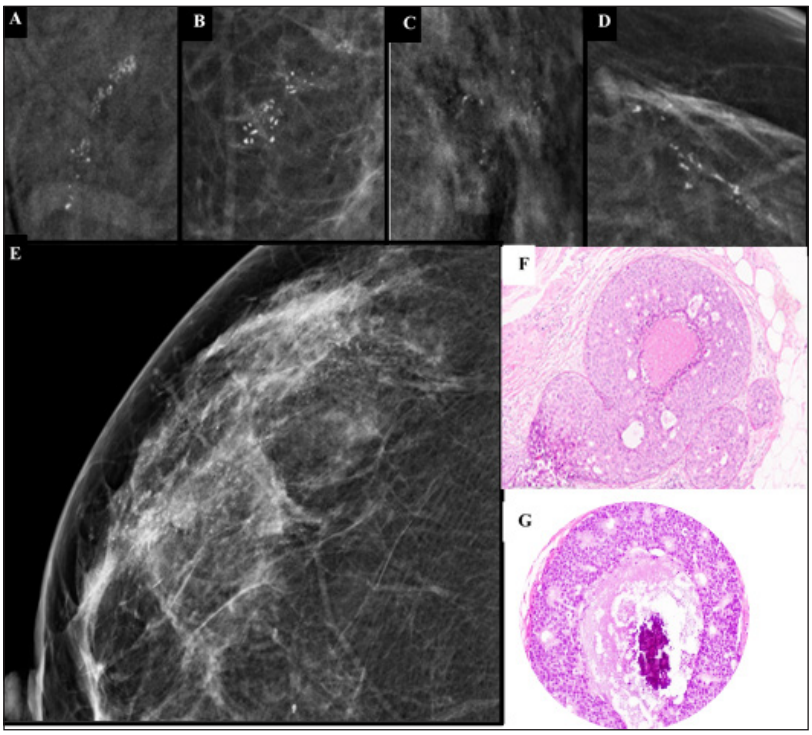


Figure 1 (A-G) – Examples of suspicious microcalcifications submitted to stereotactic-guidance vacuum-assisted biopsy: A- pleomorphic microcalcifications with linear distribution, B-clustering pleomorphic microcalcifications, C-clustering of amorphous microcalcifications, D-fine linear microcalcifications, E- amorphous microcalcifications with linear distribution. After surgery, the final anatomopathological diagnosis was, in all these cases, compatible with ductal carcinoma in situ (exemplified in F - Hematoxylin-Eosin staining and in G - ductal carcinoma in situ with microcalcifications).

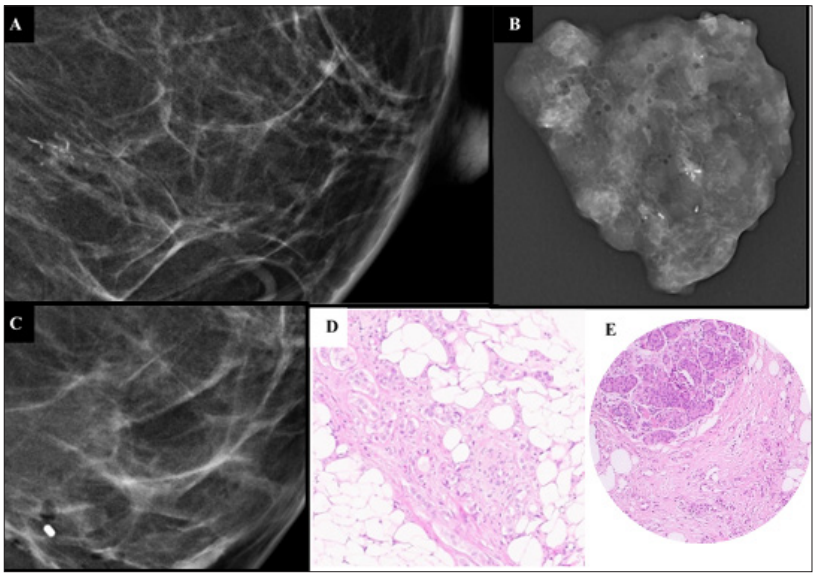


Figure 2 (A-E) - Mammography (A – cranio-caudal view) shows a cluster of microcalcifications, some with a fine linear morphology, located at the union of the internal quadrants of the left breast, measuring 16 mm (longest axis). Stereotactic-guidance vacuum-assisted biopsy was performed, with radiography of the fragments (B) and placement of a clip (C). The anatomopathological diagnosis (D, E) showed invasive carcinoma of no special type associated with an extensive component of high-grade ductal carcinoma in situ with necrosis and microcalcifications (photo E showing the two components – in situ and invasive).

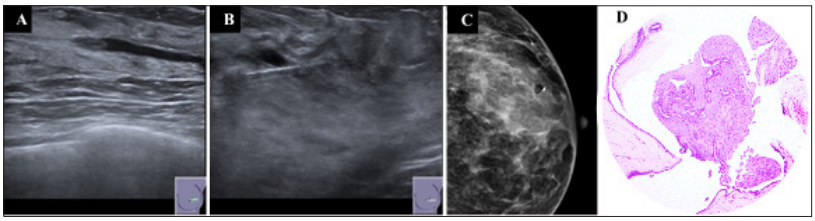
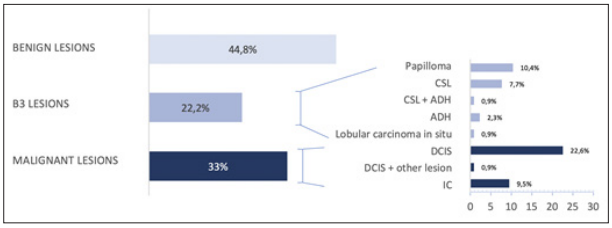


Figure 3 (A-D) – Breast ultrasound (A) shows a ductal ectasia with an intraductal nodularity measuring 8 mm, at the junction of the external quadrants of the right breast, in the peri-areolar region. An ultrasound-guided vacuum-assisted biopsy (B) was performed, with complete macroscopic removal of the lesion. Four fragments were obtained, the largest measuring 15 mm. A metallic reference clip was placed at the biopsy site after the procedure (C). The anatomopathological diagnosis was consistent with the imaging characteristics, revealing an intraductal papilloma without malignant neoplasm tissue (Photo - D).

cysts, hamartomas, fibroadenomas, fibroadenomatous hyperplasia of the breast lobes and alterations in normal development and involution ("ANDI")(Graph 1).
The percentage of carcinomas is globally within the expected ranges according to the BI-RADS classification, with the exception of the results for category 4A, which were slightly lower(Table 2).

Graph 1 – Anatomopathological results obtained from the analysis of 221 vacuum-assisted biopsies, specifying the B3 lesions and malignant lesions detected.



CSL: Complex sclerosing lesion; ADH: Atypical ductal hyperplasia; DCIS: ductal carcinoma in situ; IC: invasive carcinoma of no special type

2.2 Imaging and anatomopathological correlation in the DCIS subgroup

Considering the cases in which the DCIS component in the VAB was exclusive (n=50), the radiological manifestation of DCIS was essentially in the form of microcalcifications (98%), mostly grouped (82%), predominantly fine and pleomorphic (43%).
Of the cases with fine and pleomorphic microcalcifications, about 61% had necrosis in the anatomopathological diagnosis and 39% had high-grade lesions.
The morphology classically associated with greater radiological suspicion (fine linear or fine linear branched microcalcifications, corresponding to BI-RADS 4C, n=9) was associated with the presence of necrosis in 78% of the cases and high nuclear grade in 56% of the cases.

Table 2 – Comparison of the percentage of malignancy in this study with the probability of malignancy according to the BI-RADS classification.

BI-RADS Category/ subcategory	Malignancy at this sample	Probability of cancer according to ACR BI-RADS (5th edition)
4A	1,40 %	> 2% a ≤ 10%
4B	31 %	10% a ≤ 50%
4C	82,1 %	> 50% a < 95%
5	100%	≥ 95%

2.3 Diagnostic agreement in VAB and surgical specimen

Of the total VABs included in this study, 70 (31.3%) were subsequently submitted to surgery at IPOLFG, corresponding to a previous BAV-diagnosis of a benign lesion (2-2.9%), B3 lesion (11-15.7%); CDIS (38-54.3%) and of IC (19-27.1%).
When the VAB result was a benign lesion or a B3 lesion, there was no documented upgrade to malignancy, reflecting diagnostic agreement in all cases.
Among the cases initially diagnosed with DCIS, upgrade was demonstrated in 8 cases (21.1%): 4 cases for microinvasive carcinoma - pTmi and 4 for invasive carcinoma - 1 case pT1a, 2 cases pT1b, 1 case pT1c and pN1a (dimension of metastasis 3 mm). In four DCIS (50%) the dimension in the anatomopathological diagnosis was ≥ 20 mm and 2 cases were multifocal (Table 3).
In all these cases the nuclear grade of DCIS was intermediate or high. Nuclear grade (low versus intermediate/high) and necrosis (present versus absent) did not show a significant

Table 3 – Upgrade in DCIS

Case	VAB No. fragments	VAB No. fragments with tumor	Surgery dimension in situ	Surgery invasive dimension	Surgery pT	Surgery pN
1		13	50mm	7mm	pT1b	pN0
2	4	4	2 foci, the largest 20mm	3 foci, the largest: 3mm	pT1a	pN0
3	15	6	15mm	< 1mm	pTmi	x
4	24	6	2 foci, the largest 3mm	< 1mm	pTmi	pN0
5	20	6	50mm	12mm	pT1c	pN1a (3mm)
6	9	3	1mm	<1mm	pTmi	pN0
7	17	7	2mm	1mm	pTmi	pN0
8	9	9	50mm	4 foci, the largest: 7mm	pT1b	pN0

association with the occurrence of histological upgrade (p=1,000).
The median value of the DCIS dimension (largest axis estimated by imaging) was 16.5 mm in the upgraded group and 16 mm in the group without histological upgrade.
Considering two categories (CDIS length<20 mm versus CDIS length≥20 mm) there is no statistically significant association with the occurrence of upgrade (p=0.4485).
Two DCIS had no residual lesion in the surgical specimen.
We observed downgrade in 3 cases (4.3%) due to the coexistence of IC and DCIS in the VAB sample with no evidence of invasion in the surgical specimen.

Discussion

VAB is of uppermost importance in the diagnostic and therapeutic approach of breast lesions. The therapeutic potential of VAB has reduced the need for surgical intervention in a large number of cases, making it the recommended procedure in the evaluation of certain B3 lesions diagnosed in microbiopsy. In this context, it is important to mention that papilloma excision was complete in almost all cases.
Globally, the percentage of carcinomas is in accordance with the expected ranges according to the BI-RADS classification, with the exception of the results for category 4A, which were slightly lower. This finding is likely to be related with the small fraction of the sample that fits into this category.
As described in the literature,[6,15] the radiological manifestation of DCIS was essentially in the form of suspicious microcalcifications, mostly observed as clusters of fine and pleomorphic microcalcifications.
The histological agreement between the anatomopathological diagnosis of VAB and the surgical specimen was complete for benign lesions and B3 lesions, illustrating the therapeutic potential of VAB in an appropriate context.
The therapeutic potential of VAB can even be applied to malignant lesions of small size, as demonstrated by the absence of residual DCIS in 2 of the cases.
The percentage of upgrade from DCIS to IC in the surgical specimen was within the range of values described in the literature.[3,5,7-15] Indeed, in studies that analyzed stereotactic-guided VAB, the percentage of reported IC underestimation varies between 10 and 29%.[3,8-12] In VAB under ultrasound control, there is greater variability in the percentage of underestimation, with values between 16 and 41% being recorded. [5,13,14]
The analysis of radiological (extension of DCIS) and histological (histological grade and necrosis) variables in possible association with upgrade to IC did not reveal significant results, probably in relation with the limited number of DCIS in the sample. In some previous studies, factors such as the presence of necrosis,[7,15,18] nuclear grade[7,16,17] and the maximum dimension of the lesion[7,16,18] demonstrated to be predictors of histological upgrade. However, there are other studies in which no statistically significant associations were documented for some of these variables.[15,16,18,19]
The heterogeneity of results in the various studies may be due to different methods and to the number of cases evaluated.[7,17]
There are some models that predict the risk of underestimation, but they still need further validation.[7,15,17]
The identification of cases with high risk of upgrading can change the therapeutic plan, including the assessment of the sentinel node during the procedure.[5,12,15,17] The field of radiomics is also being explored and could help guide the development and validation of risk models in the future.[20,21]
It should be noted, however, that half of the upgraded cases corresponded to microinvasive carcinomas and the presence of axillary metastasis was only detected in one case, with reduced dimensions and without characteristics that would determine axillary dissection.
The occurrence of downgrading situations, represented by the coexistence of both IC and DCIS in the VAB sample without evidence of tumor invasion foci in the histological analysis of the surgical specimen, can be explained by the small invasive component in the whole lesion. In cases of neoadjuvant therapy, complete IC remission can occur, with persistence of the in situ component only.
This study has several limitations, the most striking being the sample size, especially the small number of cases in which it was possible to compare the VAB result with the histology of the surgical specimen. Other limitations are its retrospective nature and the lack of follow-up period evaluation, particularly in cases of B3 lesions.

Conclusions

VAB play a key role in the diagnostic and therapeutic approach to breast lesions and has determined paradigm shifts, namely in the assessment of benign lesions and B3 lesions.

The correct radiological diagnosis has allowed the identification of the lesions that are best managed through VAB, thus significantly reducing the number of surgeries. This translates into benefits both for patients that undergo a less invasive procedure and for optimized surgical scheduling, in addition to the economic benefits.[1,3]

In DCIS excised by surgery at IPOLFG, we found an upgrade in less than 1/4 of the cases, and half of these to microinvasive carcinoma. We identified axillary metastasis in a small sentinel node in only 1 case, with no need for axillary dissection.

Ethical disclosures / Divulgações Éticas

Conflicts of interest: The authors have no conflicts of interest to declare.

Conflitos de interesse: Os autores declaram não possuir conflitos de interesse.

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Suporte financeiro: O presente trabalho não foi suportado por nenhum subsídio ou bolsa.

Confidentiality of data: The authors declare that they have followed the protocols of their work center on the publication of data from patients.

Confidencialidade dos dados: Os autores declaram ter seguido os protocolos do seu centro de trabalho acerca da publicação dos dados de doentes.

Protection of human and animal subjects: The authors declare that the procedures followed were in accordance with the regulations of the relevant clinical research ethics committee and with those of the Code of Ethics of the World Medical Association (Declaration of Helsinki).

Protecção de pessoas e animais: Os autores declaram que os procedimentos seguidos estavam de acordo com os regulamentos estabelecidos pelos responsáveis da Comissão de Investigação Clínica e Ética e de acordo com a Declaração de Helsínquia da Associação Médica Mundial.

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