Positive predictive value for additional synchronous breast lesions in whole-breast sonography at the diagnosis of breast cancer:

Clinical and imaging factors

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Clinical and imaging factors

Directed by Professor Min Jung Kim

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<TABLE OF CONTENTS>

LIST OF FIGURES

LIST OF TABLES

ABSTRACT

Positive predictive value for additional synchronous breast lesions in whole-breast sonography at the diagnosis of breast cancer: Clinical and imaging factors

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Purpose: To evaluate the positive predictive value (PPV) of bilateral whole-breast ultrasonography (BWBS) on detection of synchronous breast lesions on initial diagnosis of breast cancer and evaluate factors affecting PPV of BWBS according to variable clinical and imaging factors.

Methods: Total 75 patients who had synchronous lesions with pathologic confirmation at the initial diagnosis of breast cancer during Jan 2007 and Dec 2007 were included. Clinical factors of the patient such as age, history of breast cancer and menopause status was evaluated. One observer retrospectively reviewed mammography and BWBS images of the index breast cancer lesion and the synchronous lesion. The PPV for additional biopsy was calculated for BWBS and variable clinical and imaging factors affecting the PPV for BWBS was evaluated.

Results 97 synchronous breast lesions were included. Overall PPV for additional biopsy was 21.6%. The PPV for synchronous lesions detected only on mammography, detected both on mammography and BWBS, detected only on BWBS was 11.1%, 76.9% and 14.3% respectively. There was no clinical factor affecting the PPV for BWBS. Among the imaging factors ipsilateral location of the synchronous lesion to the index lesion ($p=0.06$) showed marginal statistical significance for synchronous breast lesion to be malignant. Mass with calcification mammography presentation ($p <0.01$), presence of calcification among the ultrasonography findings ($p <0.01$) and high BI-RADS final assessment ($p<0.01$) were imaging factors of the additional synchronous lesion with statistical significance for the synchronous lesion to be malignant.

Conclusions: BWBS can be a useful adjunct to mammography for detection of additional synchronous malignancy at the diagnosis of breast cancer with a relatively high PPV, especially when mammography findings are correlated with sonography findings.

Key words: Breast cancer, synchronous lesion, mammography, bilateral whole breast sonography (BWBS) positive predictive valve (PPV)

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I. INTRODUCTION

As a result of greater awareness of breast cancer by the physician and the patient with expansion of breast cancer screening, more of these tumors are detected in the earlier stages [1]. Women who require surgical treatment of early stage breast cancer may prefer to undergo breast-conserving therapy as oncologic breast surgery can have a profound impact on a woman's body image and sense of self. Detection of synchronous breast cancers on initial diagnosis is critical for determining the eligibility of breast conserving surgery [2].

Mammography is the only proven efficacious radiographic screening technique for detection of breast cancer, however the sensitivity of

mammography has been reported to be lower in women with dense breasts than in women with primarily fatty breasts (62.2% vs 88.2%) [3,4]. Furthermore, detection of synchronous malignancy is more challenging because the additionally detected breast cancer lesions are known to be smaller and less suspicious than the index cancer [5]. Bilateral whole-breast sonography (BWBS) has been used to overcome these limitations of mammography and has been reported to be an efficacious imaging modality in identifying mammographically occult breast cancer in preoperative staging [6]. Hence, the roles of various other imaging modalities are under study for detection of breast cancer lesions not detected on mammography or clinical breast examination [7]. To our knowledge, there has been no published study regarding the positive predictive value (PPV) of BWBS in detection of synchronous breast lesions in a large population.

The purpose of our study was to evaluate the PPV of bilateral whole-breast ultrasonography (BWBS) on detection of synchronous breast lesions on initial diagnosis of breast cancer and also evaluate factors affecting PPV of BWBS according to variable clinical and imaging factors.

II. MATERIALS AND METHODS

Our institutional review board approved our research study and waived the informed consent requirement because this was a retrospective study.

1. Patient

Between January 2007 and December 2007, 346 patients were newly diagnosed with breast cancer at our institution by biopsy and 348 patients underwent BWBS with a known diagnosis of breast cancer from another hospital. All patients underwent mammography before BWBS. The patients with additional breast lesions with suspicious radiological findings other than the primary breast cancer lesion that underwent imaging guided biopsy or surgical resection after imaging guided localization were reviewed in the study.

2. Image Evaluation and diagnostic strategy for additional lesions

Mammograms were obtained with dedicated equipment Selenia Full-Field Digital Mammography System (Lorad/Hologic). Standard craniocaudal and mediolateral oblique views were routinely obtained and additional mammographic views were obtained as needed. If recent mammograms

taken from another hospital were available at the time of BWBS, routine mammograms were not performed in our institution.

BWBS has been prospectively performed in the evaluation of a patient with a known breast malignancy or in the evaluation of a patient with a suspicion of breast cancer in our institution since 2000. BWBS was performed using ATL HDI 5000 and 3000 (Philips Medical Systems) sonography units with 10-MHz of linear array transducers by 4 full-time board-certified radiologists all having at least several years of experience in performing breast sonography. The radiologists performing BWBS knew the results of mammograms and previous sonograms if present. When there was a palpable lesion or mammographical abnormality, sonography was targeted first to the area with the abnormality, then to the remainder of the ipsilateral breast, next to the ipsilateral axilla, then to the contralateral breast and finally to the contralateral axilla. For screening examination of a dense breast, BWBS was performed according to the operator's preference. Sonography was performed with the patient in the supine position with the arms raised. If necessary, the patient was shifted into an appropriate contralateral posterior oblique position so that the lateral and inferior parts of the breasts could be scanned. Scanning was performed in the radial and antiradial planes, as well

as in the longitudinal and transverse planes[8]. Scanning of both axillas started from the lower part of the axilla and continued upward toward the axillary fossa. The examination took approximately 15 minutes (range, 10-20 minutes).

All additional synchronous breast lesions detected on ultrasonography with a BI-RADS category higher than 4 were sampled for biopsy with a US-guided 14-gauge automatic core-needle biopsy (CNB). When there were two or more suspicious synchronous breast lesions, the most suspicious lesion or the lesion that could alter the surgical method was selected for biopsy. All additional synchronous breast lesions detected only on mammography as suspicious calcifications not identified on ultrasonography were sampled for biopsy under mammography-guided localization.

3. Retrospective image review and data analysis

We defined the index lesion as the mass that was either detected by the patient as a palpable lump, the mass that was first detected by imaging modalities such as mammography, or that was categorized as the highest final assessment by BI-RADS when two or more lesions were detected simultaneously in screening BWBS in patient with dense breasts on mammogram. Synchronous lesion was defined as the lesion that showed

suspicious findings other than the index lesion detected in the same initial BWBS exam that appeared more than 2cm from the index lesion.

Clinical information of the patients was collected by retrospective chart review. The age of the patient at diagnosis of breast cancer, family history of breast cancer and menopause status was reviewed. The mammography and ultrasonography images of the index and synchronous lesion were retrospectively reviewed by one radiologist (KMJ). The mammography images were reviewed for evaluation of PPV according to various imaging modalities and were not included for evaluation of PPV of BWBS. The index and synchronous lesions detected on mammography was described as mass only, mass with calcification or calcification only. For ultrasonography images, the size of each lesion was measured along the widest dimension and the locations of the synchronous additional lesions were categorized into ipsilateral or contralateral to the index lesion. All index and additional synchronous lesions were described according to their shape as round, oval or irregular; according to their orientation as parallel or nonparallel; according to their margin as well-defined, microlobulated, ill-defined, or spiculated; according to lesion boundary as abrupt or echogenic halo; according to their echogenicity as anechoic, hyperechoic, complex, hypoechoic or isoechoic; according to calcification as no calcification, or

microcalcificaton in mass, according to their acoustic transmission as no posterior acoustic feature, enhancing, shadowing, or combined by BI-RADS lexicon[9]. The BI-RADS final assessment given for the index lesion and the additional lesion according to the mammographic and ultrasonographic findings were based on the category classifications of the original radiology reports. The original reports were not reread to rule out the possibility that foreknowledge of the correct cancer diagnosis might affect reinterpretation and to ensure that the results would reflect the accuracy of routine diagnostic work.

PPV was determined according to the clinicoradiologic features of index and additional lesions. Student's *t* test was used for comparison of continuous variables and Chi-square test was used for categorical data. Logistic regression was used to construct a multivariable model of independent factors associated with risk of additional synchronous breast lesion to be malignant. Statistical significance was assigned to p values less than 0.05. Data was analyzed using SPSS software package (version 12.0, SPSS).

III. RESULTS

Among the 694 patients diagnosed with breast cancer, 75 patients (10.8%) had 97 additional breast lesions that underwent further pathologic confirmation through US-guided CNB (n=70) and MMG-guided localization and excision biopsy (n=27). Twenty-one lesions (21.6%) were diagnosed as malignant and 76 (78.4%) as benign; the overall PPV for additional biopsy was 21.6%.

1. Positive predictive value of synchronous lesions according to variable imaging modalities

Among the 97 synchronous breast lesions, 27 (27.8%) lesions seen only on mammography as calcifications, were biopsied under mammographic guidance. Three (11.1%) lesions were pathologically confirmed as malignant and 24 (88.9%) lesions as benign, with a PPV for biopsy of 11.1% for synchronous lesions biopsied under guidance with mammography (Figure 1). The remaining 70 cases were biopsied with US-guided CNB, revealing 18 (25.7%) malignant lesions, showing a PPV for biopsy of 25.7% for synchronous lesions biopsied under US-guided CNB. Thirty-nine synchronous breast lesions were found ipsilateral to the index lesion and 31

lesions were found contralateral to the index lesion; PPV for ipsilateral and contralateral lesions were 35.9% and 12.9% respectively (Figure 2). Among 70 lesions, 13 lesions were seen in both US and mammography with a PPV for biopsy of 76.9% (10/13), 49 (70%) were detected only in US with PPV of 14.3% (7/49) and the remaining 8 lesions could not be correlated with mammography because there were no available mammograms.

Figure 1. Diagram of pathologic diagnosis of synchronous lesions according to variable imaging modalities

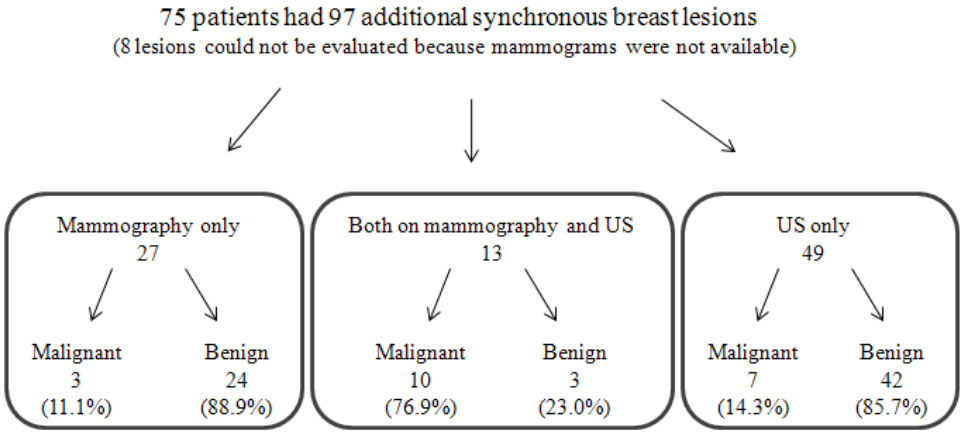
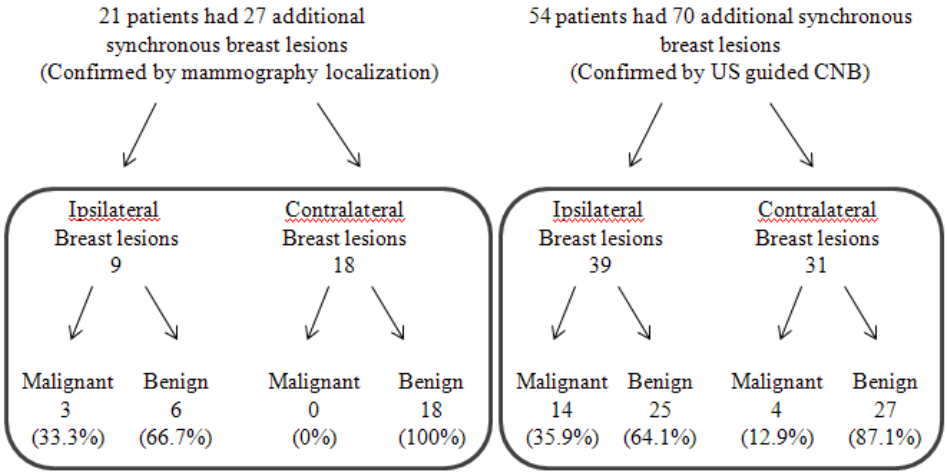


Figure 2. Diagram of pathologic diagnosis of additional synchronous lesions according to location to index lesion



2. Factors affecting PPV of BWBS according to variable clinical and imaging factors

The 27 lesions seen only in mammography were excluded for evaluation of factors affecting PPV of BWBS. Finally, a total of 70 additional synchronous lesions detected on ultrasonography in 54 patients with breast cancer were included.

A. Clinical factors of patients vs the pathology of synchronous lesions

The 54 patients in the study ranged in age from 30 to 74 years. The patients with additional benign synchronous breast lesions had a mean age of 44.7 years (range, 30-74 years) and patients with additional malignant synchronous breast lesions had a mean age of 45.4 years (range, 30-74 years) (Table 1). There was no statistical significance between the patients age and PPV for additional synchronous malignant lesions (p=0.63). 6 patients among 54 patients had a family history of breast cancer; 3 patients had a family history of their sisters with breast cancer, 2 in their mothers, and 1 patient in her aunt. 2 patients with a family history of breast cancer had additional synchronous malignant breast lesions, however there was no statistical significance between patient's family history and PPV for additional synchronous malignant lesions (p= 0.79). Correlation between menopause status of the patient and additional synchronous malignant lesion also did not show statistical significance (p= 0.30).

Table 1. Clinical factors of 54 patients according to the pathology of synchronous lesions

Clinical factors	Histopathological outcome		
	Patients with additional synchronous benign breast lesion (n=38)	Patients with additional synchronous malignant breast lesion (n=16)	*p* value
Age (range)	44.7 years ± 9.10 (30 – 74 years)	45.4 years ± 9.97 (30 – 74 years)	0.63
Family history of breast cancer			0.79
	4	4	
Menopause			0.30
Premenopause	30	11	
Postmenopause	5	5	
Unknown	3	3	

B. Imaging factors of index lesions vs the pathology of synchronous lesions

Imaging factors of 54 index lesions according to the pathology of 70 synchronous breast lesions did not show any statistically significant imaging factor of the index lesion when correlating the pathology of synchronous breast lesion (Table 2), and only ipsilateral location showed marginal significance (p=0.06).

Table 2. Imaging factors of 54 index lesions according to the pathology of 70 additional synchronous breast lesions

Characteristics of index lesion	Histopathological outcome		*p* value
	Additional synchronous benign breast lesion (n=52)	Additional synchronous malignant breast lesion (n=18)	
Mean size (range)	20mm ± 9.8 (4-40mm)	17mm ± 9.5 (5-41mm)	0.23
Location related to index lesion			0.06
Ipsilateral	25	14	
Contralateral	27	4	
MMG Presentation			0.46
Negative	7	2	
Mass only	24	8	
Mass with calcificaiton	11	5	
Calcification only	1	2	
Not available	9	1	
US Finding			
Shape			0.93
Round	6	3	
Oval	13	4	
Irregular	31	10	
Oreientation			0.84
Parallel	14	5	
Non-parallel	36	12	
Margin			0.17
Well-circumscribed	4	4	
Indistinct	4	3	
Angular	7	0	
Microlobulated	20	5	
Spiculated	15	5	

Characteristics of index lesion	Histopathological outcome		*p* value
	Additional synchronous benign breast lesion (n=52)	Additional synchronous malignant breast lesion (n=18)	
Boundary			0.42
Abrupt	31	13	
Echogenic halo	19	4	
Echogenicity			0.44
Anechoic	0	0	
Hyperechoic	2	1	
Complex	0	0	
Hypoechoic	36	12	
Isoechoic	12	4	
Acoustic attenuation			0.87
None	38	12	
Enhancement	8	3	
Shadowing	4	2	
Calcification			0.39
None	20	6	
With calcification	30	11	
Final Assessment			0.63
Category 4a	6	2	
Category 4b	10	2	
Category 4c	15	3	
Category 5	19	10	
Category 6	2	1	

(US imaging features of 3 index breast lesion was not included because it was previously excised)

C. Imaging factors of synchronous lesions vs the pathology of synchronous lesions

Among imaging factors of 70 synchronous breast lesions, mass with calcification mammography presentation ($p < 0.01$), presence of calcification among the ultrasonography findings ($p < 0.01$) and high BI-RADS final assessment ($p < 0.01$) were imaging factors with statistical significance for the additional synchronous lesion to be malignant (Table 3). On multivariable logistic regression analysis, these factors showed statistical significance; mass with calcification mammography presentation (odds ratio 2.95, confidence interval 0.11-8.32), presence of calcification (odds ratio 3.36, confidence interval 0.14-82.92) and higher BI-RADS assessment of the synchronous additional lesion (Odds radio 6.30, 95% confidence interval 0.70-55.01) were associated to be statistical significant independent factors for the synchronous lesion to be malignant.

Table 3. Imaging factors of 70 additional breast lesions according to the pathology of these lesions

Characteristics of additional synchronous breast lesion	Histopathological outcome		*p* value
	Additional synchronous benign breast lesion (n=52)	Additional synchronous malignant breast lesion (n=18)	
Mean size (range)	7.8mm ± 3.9 (4-21mm)	8.7mm ± 3.8 (4-17mm)	0.36
MMG Presentation			**<0.01**
Negative	42	7	
Mass only	1	1	
Mass with calcificaiton	0	5	
Calcification only	2	4	
Not available	7	1	
US Finding			
Shape			0.22
Round	12	8	
Oval	23	6	
Irregular	17	4	
Oreientation			0.32
Parallel	32	8	
Non-parallel	20	10	
Margin			0.53
Well-circumscribed	4	1	
Indistinct	12	4	
Angular	7	0	
Microlobulated	23	10	
Spiculated	6	3	

Characteristics of additional synchronous breast lesion	Histopathological outcome		*p* value
	Additional synchronous benign breast lesion (n=52)	Additional synchronous malignant breast lesion (n=18)	
Boundary			0.40
Abrupt	47	18	
Echogenic halo	5	0	
Echogenicity			0.82
Anechoic	0	0	
Hyperechoic	1	0	
Complex	0	0	
Hypoechoic	27	9	
Isoechoic	24	9	
Acoustic attenuation			0.53
None	48	18	
Enhancement	4	0	
Shadowing	0	0	
Calcification			**<0.01**
None	50	10	
With calcification	2	8	
Final Assessment			**<0.01**
Category 4a	46	9	
Category 4b	4	2	
Category 4c	2	6	
Category 5	0	1	

IV. DISCUSSION

Breast conservation therapy is the preferred method of treatment for women with stage I or II breast cancer against mastectomy and conservation surgery with radiation therapy [10]. Holland et al [11] found a total of 43% (121 out of 282) additional tumor foci in mastectomy specimens more than 2cm away from the index cancer. Moreover, contralateral synchronous breast cancers are known to lower the survival rate compared to unilateral breast cancer [12,13]. Therefore, exact characterization of synchronous lesions other than the primary cancer lesion at the time of initial diagnosis is crucial for surgical planning as well as establishing the prognosis of the patient [2]. Although, mammography is the only proven efficacious radiographic screening technique for detection of breast cancer, whole breast sonography is being considered an adjunct to mammography in the preoperative staging of breast cancer [13]. Previous study by Buchberger et al. showed results verifying the role of sonography in detection of mammographically and clinically occult carcinoma with 28 additionally found malignant lesions only seen on sonography in a total 103 malignancies [14]. The purpose of this study was to evaluate the role of sonography in the preoperative staging of patients with

breast cancer in identifying any synchronous breast lesions for accurate breast cancer staging and optimize treatment planning.

Additional biopsies were performed only in 10.8% of the total cancer patients in this study. This biopsy rate showed lower results compared to the study by Moon et. al[13] and we believe that factors such as retrospective nature of the study and additional lesions within 2cm of the index cancer did not undergo further biopsy contributed to these values.

Our results show the overall PPV of biopsies for additional synchronous lesions in patients with breast cancer as 21.6% and the PPV for lesions detected only on ultrasonography as 14.3%. These results are lower than previously reported PPV values of 30-40% for sonographic screening in high-risk patients [14,15]. These results could be explained by that we routinely performed preoperative ultrasonography for breast cancer patients in clinical practice. Because we were aware that BI-RADS category 3 nodules in breast cancer patients show malignancy through our own experience and previous literature as about 11.4% [2], meticulous evaluation of the remaining breast lesions was inevitable and any subtle but suspicious findings leaded the operator to consider the lesion as suspicious findings and perform biopsy for pathologic confirmation with the long-term experience of preoperative

ultrasonography. This could play a role to lower the PPV, compared with the results in other study with high risk patients[7]. The PPV according to final assessment was 16.4% (9/55), 33.3% (2/6), 75.0% (6/8) and 100.0% (1/1) for category 4a,b,c and 5 lesions, which are consistent with previous report based on sonographic findings[16]. However, we did not reclasssify the sonographic findings of additional nodules to check how many cases would have undertaken biopsy or follow-up in routine screening patients.

The clinical factors of the patients did not show statistical significance in detection of additional synchronous malignancy in patients with breast cancer. The age of the patient, family history of breast cancer and menopause status were evaluated as clinical factors. Advanced age of the patient, family history of breast cancer and natural menopause after age 45 are well known risk factors of breast cancer [17]. However, our results showed that these clinical risk factors are not related to synchronous additional breast cancer lesion; as our study population is too small and further investigation with a larger population is needed.

The different imaging findings of the index lesions were evaluated and ipsilateral location of the synchronous lesion to the index lesion showed marginal statistical significance for detection of additional synchronous

malignancy. Previous studies also showed a higher PPV for additional lesions in ipsilateral location[2], therefore the threshold for category 4 should be set more sensitive than usual risk patients when additional lesions are found ipsilaterally to the index lesion. However, for contralateral additional lesions, this threshold may be set as usual risk patients to avoid too many unnecessary biopsies in breast cancer patients. In this study, none of the other imaging findings of the index lesion helped suggest malignancy of the synchronous lesion and thorough inspection of the synchronous lesion itself should be most important.

The PPV of biopsy for additional synchronous lesions detected both on mammography and ultrasonography was very high, 76.9% while the PPV for lesions detected only on ultrasonography was low, 14.3% . Also the incidence of additional synchronous malignant lesions detected only on ultrasonography was 35.0% (7/20). These results are lower than previous reported incidence of 90.7% for mammographically occult synchronous cancers among synchronous additional malignant lesions in patient with breast cancer[2]. At our institution, ultrasonography is performed on the same day after review of the mammogram, and the mammogram and sonograms are interpreted together. The radiologist did not need to report the

mammographic finding prior to performing the sonogram. We think that this process could affect the interpretation of sonograms and mammograms. Although the radiologist who reviewed the mammogram did not find any abnormality prospectively, the radiologist might have searched for any subtle abnormality on the mammogram when a sonographic lesion was detected. As missed cancers on the mammogram have been well known to be detected in about half during retrospective review[18], in cases showing mammographic abnormality on retrospective review after sonogram, even a subtle abnormality could be mentioned. Only in cases showing no abnormality on the mammogram even during retrospective review, the mammogram was diagnosed as negative. Likewise, careful inspection of the area where abnormality was detected on mammography was conducted on sonography by the radiologist. This clinical practice in our institution may have resulted in a relatively low incidence and low PPV of mammographically occult synchronous cancers detected only on ultrasonography.

Our study results showed that the PPV for additional lesions seen only on ultrasonography (14.3%) was higher than lesions detected only on mammography (11.1%), although statistical evaluation for significance was not performed. The PPV for lesions detected on mammography was lower

than the Bi-RADS recommendation rate of 20%. These lesions correspond to synchronous additional lesions seen as calcifications on mammography which was not detected on sonography and similar lower PPV has been reported previously for lesions only seen on mammography as calcifications [13]. The PPV for lesions detected only on sonography also did not meet the biopsy recommendation rate by BI-RADS and large number of category 4a lesions with only subtle findings could have attributed to these results. The PPV of 14.3% for additional lesions seen only on sonography, although the threshold for category 4 was set sensitivity since the operator was aware of the index cancer, suggest preoperative BWBS as a clinical significant imaging modality additional to mammography for detection of additional lesions in breast cancer patients.

Magnetic resonance imaging (MRI) can be another adjunct imaging modality in detection of additional synchronous malignancy in patients with breast cancer. Annual MRI is recommended in addition to mammography to women at very high risk of breast cancer in the United States with a high sensitivity in detection of malignancy [19,20] . However, there was a limited number of patients who actually performed breast MRI in our study and the high cost, requirement of contrast injection, limited availability are main

reasons why MRI is not a well established imaging modality. Further study is needed for evaluation of the role of MRI in detection of additional synchronous malignancy in patients with breast cancer and the role of BWBS and MRI should be compared in order to use these imaging modalities as a screening tool in patients with breast cancer.

There were some limitations to our study. First, our study population with additional breast lesions that was pathologically confirmed in newly diagnosed breast cancer patients was small. Second, the study was conducted at a single site with only a limited number of radiologists mainly in Asian women. Third, the clinical and imaging factors were only evaluated in synchronous lesions detected on ultrasonography. Other imaging modalities such as mammography and MRI were not evaluated according to clinical and imaging factors. Also, negative predictive value (NPV) was not evaluated. Furthermore, we did not suggest a standard for category 4 lesions to prevent unnecessary biopsies.

Our results along with those of other investigators demonstrate the feasibility of using BWBS of the breast as a screening role, specifically to evaluate other synchronous malignant lesions in patients with newly diagnosed breast

cancer. However, cost-effectiveness analysis should be performed to determine if the cost-benefit ratio is favorable and identification of patient population at highest risk for synchronous breast cancer should be investigated.

V. CONCLUSION

Bilateral whole-breast ultrasonography can be a useful adjunct to mammography for detection of additional synchronous malignancy at the diagnosis of breast cancer with as acceptable PPV, especially when mammography findings are correlated with ultrasonography findings.

REFERENCES

1. Perez CA. Breast conservation therapy in patients with stage T1-T2 breast cancer: current challenges and opportunities. Am J Clin Oncol 2010;33:500-10.
2. Kim SJ, Ko EY, Shin JH, Kang SS, Mun SH, Han BK, et al. Application of sonographic BI-RADS to synchronous breast nodules detected in patients with breast cancer. AJR Am J Roentgenol 2008;191:653-8.
3. Robertson CL. A private breast imaging practice: medical audit of 25,788 screening and 1,077 diagnostic examinations. Radiology 1993;187:75-9.
4. Pinsky RW, Helvie MA. Mammographic breast density: effect on imaging and breast cancer risk. J Natl Compr Canc Netw 2010;8:1157-64; quiz 65.
5. Kim MJ, Kim EK, Kwak JY, Park BW, Kim SI, Oh KK. Bilateral synchronous breast cancer in an Asian population: mammographic and sonographic characteristics, detection methods, and staging. AJR Am J Roentgenol 2008;190:208-13.
6. Gordon PB, Goldenberg SL. Malignant breast masses detected only by ultrasound. A retrospective review. Cancer 1995;76:626-30.
7. Kim MJ, Kim EK, Kwak JY, Park BW, Kim SI, Sohn J, et al. Sonographic surveillance for the detection of contralateral metachronous breast cancer in an Asian population. AJR Am J Roentgenol 2009;192:221-8.
8. Stavros AT, Thickman D, Rapp CL, Dennis MA, Parker SH, Sisney GA. Solid breast nodules: use of sonography to distinguish between benign and malignant lesions. Radiology 1995;196:123-34.
9. Liberman L, Menell JH. Breast imaging reporting and data system (BI-RADS). Radiol Clin North Am 2002;40:409-30, v.
10. Winchester DP, Cox JD. Standards for diagnosis and management of invasive breast carcinoma. American College of Radiology. American College of Surgeons. College of American Pathologists. Society of Surgical Oncology. CA Cancer J Clin 1998;48:83-107.
11. Holland R, Veling SH, Mravunac M, Hendriks JH. Histologic multifocality of Tis, T1-2 breast carcinomas. Implications for clinical trials of breast-conserving surgery. Cancer 1985;56:979-90.

12. Heron DE, Komarnicky LT, Hyslop T, Schwartz GF, Mansfield CM. Bilateral breast carcinoma: risk factors and outcomes for patients with synchronous and metachronous disease. Cancer 2000;88:2739-50.
13. Moon WK, Noh DY, Im JG. Multifocal, multicentric, and contralateral breast cancers: bilateral whole-breast US in the preoperative evaluation of patients. Radiology 2002;224:569-76.
14. Buchberger W, DeKoekkoek-Doll P, Springer P, Obrist P, Dunser M. Incidental findings on sonography of the breast: clinical significance and diagnostic workup. AJR Am J Roentgenol 1999;173:921-7.
15. Crystal P, Strano SD, Shcharynski S, Koretz MJ. Using sonography to screen women with mammographically dense breasts. AJR Am J Roentgenol 2003;181:177-82.
16. Yoon JH, Kim MJ, Moon HJ, Kwak JY, Kim EK. Subcategorization of ultrasonographic BI-RADS category 4: positive predictive value and clinical factors affecting it. Ultrasound Med Biol 2011;37:693-9.
17. Steiner E, Klubert D, Knutson D. Assessing breast cancer risk in women. Am Fam Physician 2008;78:1361-6.
18. Corsetti V, Ferrari A, Ghirardi M, Bergonzini R, Bellarosa S, Angelini O, et al. Role of ultrasonography in detecting mammographically occult breast carcinoma in women with dense breasts. Radiol Med 2006;111:440-8.
19. Stoutjesdijk MJ, Boetes C, Jager GJ, Beex L, Bult P, Hendriks JH, et al. Magnetic resonance imaging and mammography in women with a hereditary risk of breast cancer. J Natl Cancer Inst 2001;93:1095-102.
20. Saslow D, Boetes C, Burke W, Harms S, Leach MO, Lehman CD, et al. American Cancer Society guidelines for breast screening with MRI as an adjunct to mammography. CA Cancer J Clin 2007;57:75-89.

ABSTRACT(IN KOREAN)

유방암 진단 당시의 양측 유방 초음파의 진단적 수행 평가

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목적: 유방암 진단 당시 같은 시점에 동시에 존재하는 다른 유방 병변의 발견에 있어서 양측 유방 초음파의 양성예측도를 알아보고자 하였고 양측 유방 초음파의 양성예측도에 영향을 주는 다양한 임상적 및 영상 인자들을 알아보고자 하였다.

방법: 2007년 1월과 2007년 12월 사이의 환자 중 유방암 진단 당시 같은 시점에 발견된 조직학적으로 확진된 다른 유방 병변이 있는 총 75명의 환자를 대상으로 하였다. 환자의 임상적 인자로는 환자의 나이, 유방암의 과거력 그리고 폐경여부를 분석하였다. 한명의 영상의학과 전문의가 유방암 병변과 같은 시점에 발견된 다른 유방 병변의 유방촬영술 및 양측 유방 초음파 사진을 후향적으로 분석하였다. 다른 영상 검사들에 대한 추가 조직검사에 대한 양성예측도를 구하였고 양성 예측도에 영향을 주는 다양한 임상적 및 영상 인자을 분석하였다.

결과: 유방암 진단 당시 동시에 발견된 97개의 유방병변들이 포함되었다. 양측 유방 초음파의 추가 조직검사에 대한 전체 양성예측도는 21.6%였다. 추가로 발견된 병변들의 양성예측도는 유방촬영술에만 발견된 경우, 유방촬영술과 양측 유방 초음파 모두에서 발견된 경우 그리고 양측 유방 초음파에서 발견된 경우 각각 11.1%, 76.9% 그리고 14.3%이였다. 양측 유방 초음파의 양성예측도에 영향을 주는 임상적 요인은 없었다. 영상 인자 중에는 추가로 발견된 병변이 유방암 병변과 같은 측 유방에 위치할 경우 악성일 가능성이 통계학적으로 유의한 경향 (p=0.06)을 보였다. 또한 추가적인 유방 병변이 통계학적으로 유의하게 악성을 시사하는 추가병변에 대한 영상인자들은 유방촬영술에서 석회화를 동반한 종괴로 보일 경우 (p <0.01), 초음파 소견상 석회화가 동반될 경우 (p <0.01) 그리고 최종 BI-RADS 범주가 높을 경우 (p<0.01) 해당되었다.

결론: 양측 유방 초음파는 유방암으로 진단 받은 환자의 다른추가적인 악성 병변을 발견하는데 있어, 유방촬영술과 더불어 유용한 부가적 영상 방법이 될 수 있고, 특히 초음파와 유방촬영술 소견이 연관될 경우 높은 양성 예측도를 갖는다.

핵심되는 말: 유방암, 같은 시점에 발견된 병변, 유방촬영술, 양측 유방초음파, 양성예측도