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ผลในการมองเห็นหินปูนขนาดเล็กจากการมีภาพขยายของแมมโมแกรม

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Effect of Magnification Views for Detection of Microcalcifications in Digital Mammograms

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บทคัดย่อ

วัตถุประสงค์: เพื่อศึกษาประสิทธิภาพในการมองเห็นหินปูนขนาดเล็กจากการขยายของแมมโมแกรม เทียบกับการวิเคราะห์จากแมมโมแกรมแบบมาตรฐาน ในแง่ของอัตราการมองเห็น การให้คะแนนไบแรด และการเปลี่ยนแปลงของการจัดการกับหินปูนในทางคลินิก

วิธีการศึกษา: ผู้ป่วย 100 ราย มีหินปูนขนาดเล็กทั้งหมด 136 ตำแหน่ง ได้รับการตรวจด้วยเครื่องแมมโมแกรมแบบมาตรฐาน และมีภาพขยาย ในโรงพยาบาลมหาวิทยาลัยระดับตติยภูมิแห่งเดียวในภาคตะวันออกเฉียงเหนือระหว่างเดือนมกราคม 2561 ถึงธันวาคม 2561 รังสีแพทย์ด้านภาพวินิจฉัยเต้านมตรวจสอบภาพสองครั้งแยกกัน และระบุจำนวนของรอยโรค การให้คะแนนไบแรด และระดับความเชื่อมั่นในการวินิจฉัย แล้วจึงทำการวิเคราะห์ข้อมูล อัตราการตรวจจับ ความแตกต่างทางสถิติของการให้คะแนนไบแรด และระดับความเชื่อมั่นในการวินิจฉัย และการเปลี่ยนแปลงในการจัดการกับหินปูนในทางคลินิก

ผลการศึกษา: จำนวนรอยโรคในการตรวจแมมโมแกรมแบบมาตรฐาน และแบบมีภาพขยาย คือ 121 และ 136 รอยโรคตามลำดับ การมีภาพขยายเพิ่มอัตราการตรวจจับ ร้อยละ 12.39 การมีภาพขยายแสดงให้เห็นความแตกต่างอย่างมีนัยสำคัญทางสถิติของการให้คะแนนไบแรด ($p < 0.001$) ซึ่งร้อยละ 62.5 ของรอยโรคได้รับการให้คะแนนไบแรดที่แตกต่างกัน มีผลกระทบให้การจัดการกับหินปูนในทางคลินิกที่แตกต่างกันร้อยละ 21.33 ของรอยโรค การมีภาพขยายยังเกี่ยวข้องกับระดับความเชื่อมั่นที่สูงในการวินิจฉัย (ร้อยละ 81.6 ของรอยโรค, $p < 0.001$)

สรุป: การมีภาพขยายเพิ่มอัตราการตรวจจับ ระดับความมั่นใจในการวินิจฉัย และส่งผลให้เกิดการเปลี่ยนแปลงบางอย่างในการจัดการหินปูนขนาดเล็กเมื่อเทียบกับการตรวจแมมโมแกรมแบบมาตรฐาน

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Abstract

Objective: To study the efficiency of magnification views compared to standard digital mammograms (MMG) on the detection rate, BIRADS grading, and effects on management of microcalcification.

Methods: 100 patients with the total of 136 microcalcifications were retrospectively reviewed on MMG and the magnification view in a tertiary university hospital between January 2018 and December 2018**.** A breast radiologist reviewed the images on two separated occasions. The number of lesions, microcalcification grading by using the Breast Imaging Reporting and Data Systems (BIRADS), and diagnostic confidence levels were recorded. The detection rate, statistical difference of BIRADS grading and diagnostic confidence level, and changes in management were analysed.

Results: The number of lesions on MMG and magnification views were 121 and 136; magnification increased the detection rate by 12.39%. A comparison between MMG and magnification view showed a statistically significant difference of microcalcification grading by BIRADS ($p < 0.001$), in which 62.5% of the cases received different gradings. This difference in grading resulted in a change in management in 21.33% of the cases. The magnification view was also related to high diagnostic confidence levels (81.6% of the cases, $p < 0.001$).

Conclusions: Magnification increases the detection rate, diagnostic confidence level, and resulted in some changes in management compared to MMG.

Keywords: magnification view, microcalcification, mammogram

Introduction

Breast cancer is the most common cancer in women worldwide and it is the leading cause of death among women.[1] Breast cancer screening can be performed by mammography (MMG). Microcalcification is one of the key factors to diagnose breast cancer, which can be found in one-third of invasive breast cancer cases.[2–5] With respect to the shape and arrangement of microcalcifications, magnification views are frequently used to enhance the detection and characterization of the microcalcifications.[6–9] Particularly for equivocal microcalcifications, magnification views can increase the diagnostic accuracy which is consistent with pathological diagnosis, and magnification images are better than the zooming method for images in terms of improved diagnostic accuracy, image quality and reliability in diagnosis.[7] Enhanced characterization of microcalcifications has the potential to facilitate the early detection of suspicious microcalcifications, thus providing considerable diagnostic benefits in the identification of ductal carcinoma in situ (DCIS). The zooming method cannot replace magnification since views have higher spatial resolution and better signal-to-noise ratio, especially when used for determining microcalcifications.[10] There are publications stating that magnified views can be replaced by digital zooming.[11GE]

To the best of current knowledge, there is no definite consensus if digital zooming on digital MMG or additional magnification views should be added in case of microcalcifications. Therefore, this study aimed to determine whether magnification views would produce any differences in diagnosis, grading, and management of breast calcifications compared to standard digital MMG.

Material and Methods

The local institutional ethics committee for Human Research approved this retrospective analytical study with a waiver of informed consent.

Target population

All patients who underwent standard digital mammograms with additional magnification from January 2018 to December 2018 were recruited. The duration between standard digital mammogram and magnification had to be less than 30 days. Age, sex, date of mammogram and magnification view, breast density, morphology and distribution of microcalcification, and BIRADS classification were recorded.

Image acquisition*:*

All digital mammography was performed by Amorphous selenium TFT-based direct capture technology with an 18 x 24 cm detector and 0.070 mm pixel size (Selenia Dimensions, Hologic, Marlborough, Massachusetts, US).

Magnification views were performed using a magnification factor of 1.80 with a magnification paddle with a diameter of 10 cm.

All images were reviewed on a SecurView DX Workstation, Hologic, Marlborough, Massachusetts, US, with 5 megapixel thin film transistor monitors (TFT monitors).

Image interpretation

One breast radiologist used visual analysis to evaluate MMG and magnification images on two separate occasions, one week apart. MMG can be zoomed up to 2 to 3 times. Recorded data included the number of lesions, morphology and distribution of microcalcifications classified by BIRADS, and a diagnostic confidence level.

Non-specific microcalcifications are small focal lesions with increased density in mammographic images that look like microcalcifications but with blurred visualization.

The confidence level that was used ranged from 1 to 5 for each lesion: 5, meaning absolute confidentce, 4. meaning very confident, 3. meaning somewhat confident, 2. meaning not too confident, and 1. meaning not at all confident.[12]

Statistical analysis

All data were analyzed with IBM SPSS statistics software version 19. Demographic data and imaging findings were interpreted by descriptive analysis. The numbers of lesions detected on MMG and magnification images were compared using paired t-tests. BIRADS classification was analyzed by a marginal homogeneity test. The diagnostic confidence level was compared using McNemar's test. The p-values of less than 0.05 indicate the statistical significance of all statistical tests.

Results

Of 110 patients who underwent digital mammograms with magnification views, the duration between MMG and magnification images were more than 30 days in 10 cases. Finally, 100 cases with 136 lesions were included.

All the patients were women. The mean age was 50.7 years (range 27-84 years). Breast densities were 0% of entirely fatty, 15.44% of scattered area of fibroglandular tissue, 69.85% of heterogenous density of fibroglandular, and 14.71% of extremely dense.

Detection of microcalcification

One hundred and twenty-one microcalcifications were detected with standard digital mammograms and 136 microcalcifications were detected with magnification views; overall the detection rate was increased 12.39%. Increased detection rate of microcalcifications were 14.57% for breasts with heterogenous densities of fibroglandular tissue and 16.67% for breasts with scattered areas of fibroglandular tissue. No increased detection rate was noted for extremely dense breasts. (Table 1 and Fig 1)

Microcalfication grading base on BIRADS classification.

The BIRADS gradings were recorded for MMG and magnification views. Fifty-one microcalcifications (37.5%) have the same grading from both MMG and the magnification view. Of them, 17.65% were BIRADS 3 and 16.91% were BIRADS 4. (Fig 2)

There were 85 microcalcifications (62.5%) that have different gradings between MMG and magnification views, which were classified into three groups. First, the non-specific microcalcification (41.18%) was changed to BIRADS 2 (0.74%), BIRADS 3 (25%), BIRADS 4B (15.44%) after magnification. Second, the downgraded group (14.71%), most of them were changing from BIRADS 4B to 3. (Fig 1 and 3) Third, the upgraded group (6.62%) was changed from BIRADS 3 to 4. (Fig 4)

There was a statistically significant difference of microcalcification grading by BIRADS between MMG and the magnification view ($p < 0.001$). (Table 2)

Management changing

Due to changing in BIRADS grading, overall management of 21.33% of microcalcifications were changed. After magnification view, the management recommendation of 14.71% microcalcifications were changed from tissue diagnosis to short interval follow-up and 6.62% were changed from short interval follow-up to tissue diagnosis.

Diagnostic confident level

On MMG, 6.7% of microcalcifications were diagnosed with a high confidence level and 93.3% with a low confidence level. On the magnification views, there was increased high confidence level and decreased low confidence level to 81.6% and 18.4%, respectively.

There was a statistically significant difference of diagnostic confidence levels between MMG and the magnification view ($p < 0.001$). (Table 3)

Table 1 Detection rate between standard digital mammogram and magnification view.

	Standard MMG	Magnification
Total number of lesions	121	136
Breast density		
Entirely fatty	0	0
Scattered area of fibroglandular tissue	18	21
Heterogenous density of fibroglandular	83	95
Extremely dense	20	20

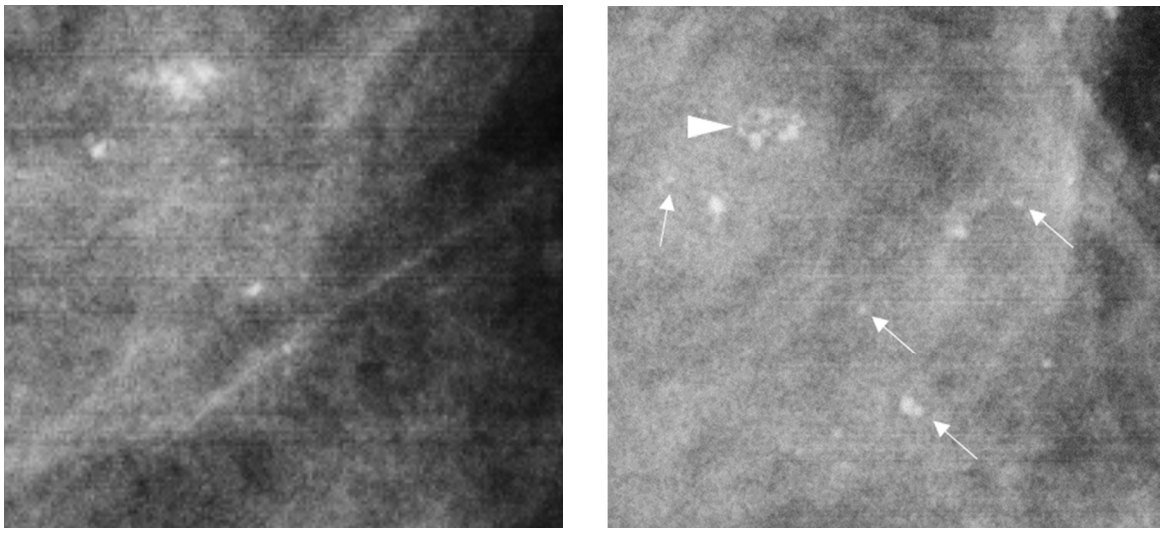

Fig 1 Downgrade group and increase number of visualized calcification. A group of amorphous calcification on MMG and regional amorphous calcification (right). On magnification view (left), the group of amorphous calcification (arrowhead) appears more well define and was interpreted as a group of round and punctate calcification and increase visualization of several round/oval shape calcification scattered in this area (arrows).

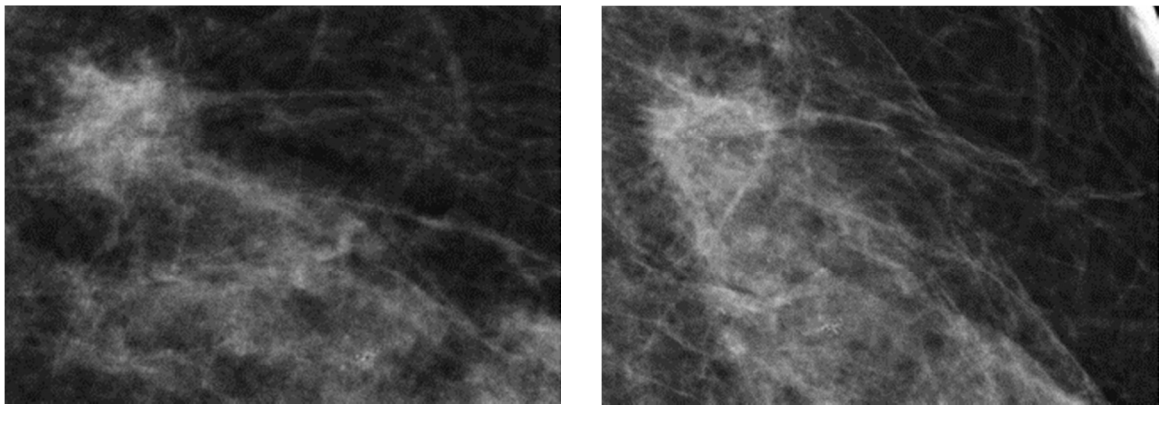

Fig 2 Calcification with spiculated mass (BIRADS 4C) by standard digital mammogram (right) and magnification view (left), there is unchanged BIRADS grading.

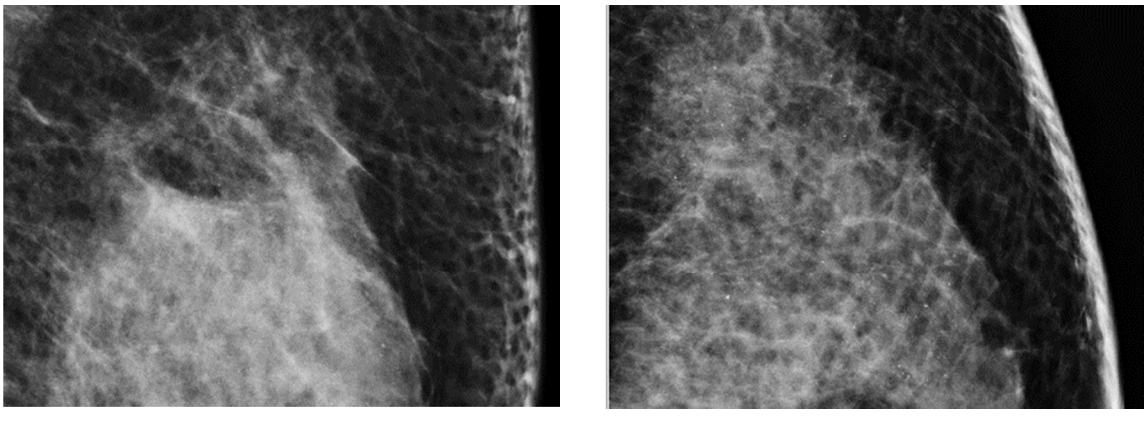

Fig 3 Downgrade group, group of amorphous calcification on MMG (right) and regional amorphous calcification on magnification view (left).

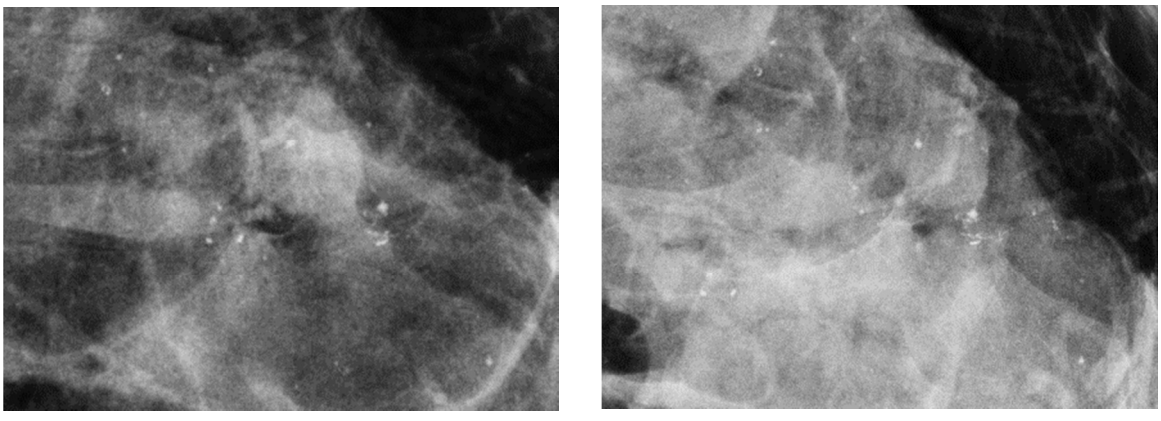

Fig 4 Upgrade group, regional punctate and amorphous calcification on MMG (right) and group of fine pleomorphic calcifications on magnification view (left). The patient underwent tomosynthesis-guided biopsy and pathology report showed chronic xanthomatous inflammation with fibrotic stroma.

Table 2 Microcalcification grade base on BIRADS between MMG and magnification view.

		Magnification					
	BIRADS	Benign calcification, BIRADS 2	Probably benign calcification, BIRADS 3	Suspicious calcification, BIRADS 4B	Suspicious calcification, BIRADS 4C	Suspicious calcification, BIRADS 5	Non-specific microcalcifi-cation
MMG	Benign calcification, BIRADS 2	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
	Probably benign calcification, BIRADS 3	0 (0)	24 (17.65)	8 (5.88)	1 (0.74)	0 (0)	0 (0)
	Suspicious calcification, BIRADS 4B	0 (0)	19 (13.97)	23 (16.91)	0 (0)	0 (0)	0 (0)
	Suspicious calcification, BIRADS 4C	0 (0)	1 (0.74)	0 (0)	2 (1.47)	0 (0)	0 (0)
	Suspicious calcification, BIRADS 5	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
	Non-specific microcalcifi-cation	1 (0.74)	34 (25)	21 (15.44)	0 (0)	0 (0)	2 (1.47)
	p-value of marginal homogeneity test	<0.001					

Table 3 Diagnostic confidence level between MMG and magnification view.

		Magnification	
	Diagnostic confidence level	**High**	**Low**
MMG	High	8 (5.93)	1 (0.74)
	Low	103 (76.30)	23 (17.04)
	p-value of McNemar's test.	**<0.001**	

Discussion

According to this study, magnification helps increase the detection rate and there are statistically significant differences in diagnosing calcifications when grading by BIRADS between MMG and magnification views leading to changes in treatment and also enhancing diagnostic confidence.

The study has found that magnification helps increase the detection rate by 12.39% in heterogeneous density of fibroglandular tissue and scattered fibroglandular tissue. Since it is difficult to identify the breast tissue background and microcalcifications, magnification can differentiate between calcification and micro objects more clearly. Similarly, according to Sickles.[10], magnification improves the quality of images due to increased resolution and reduced noise, hence clearer calcifications, more sharp margins of lesions and breast background images are obtained. The sharper images, in two patients with cancer lesions were found compared to using MMG and were also useful in distinguishing malignant from benign breast disease.

The quality of magnification views is better than MMG images for breast cancer diagnosis. Statistically, there are significant differences in diagnosing microcalcifications according to BIRADS when compared to MMG images in terms of the detailed characteristics of calcifications, especially non-specific microcalcifications. In this present study, 62.5% of microcalcifications changed BIRADS classification following magnification views because of better image quality, i.e. higher spatial resolution and better signal-to-noise ratios, resulting in sharper images for identification of micro lesions more effectively.

This satisfies the study of Fallenberg, et al[9], in that magnification views are important for detecting and correct categorizing calcifications in terms of quantities and characteristics, which are better than MMG images. Additionally, in the study of Sickles[7] there were 117 pathologically proved cases for which concurrent convential contact (1X, microcalcifications have improved visibility, improved diagnostic accuracy for 55%, and reduced the number of biopsies for benign breast lesions in patients whose conventional mammograms were interpreted as equivocal. As same as the study of Moraux-Wallyn et al.[13], magnification images are better than zoomed images in terms of sensitivity, specificity, positive predictive values and negative predictive values, but no statistical differences are found, which may be due to the small number of lesions in the study, i.e. 88 lesions.

With regard to treatment, there were changes in the management that accounted for 21.33% in this study. The downgrade group of patients results from probably more visible calcifications and hence an increased amount of calcification, including the arrangement of calcifications such as in group to regional distribution. The upgraded group of patients results from a more noticeable group of microcalcifications in the large number of calcifications in wide regions. From the fact that calcifications are more distinct in magnification views, including an increased diagnostic confidence level, which satisfies the work of Kim et al.[14] that magnification views can provide better diagnostic performance in terms of image quality and confidence rate for diagnosis than zoomed images. In this study, there were no differences between BIRADS diagnosis and treatment for those who have calcifications together with masses.

On the other hand, there were no statistically significant differences between zoomed images and magnification views when used for a level of suspicion of breast cancer according to Kim et al.[14] which consisted of digital magnification mammograms (MAGs The number of subjects in that study was small,

and two-thirds of radiologists in the research team worked at the same hospital as the patients; therefore, they might have seen the data. But, based on statistics in this study, magnifications views are significantly better than zoomed image in terms of image quality and confidence level.

The limitations of this study are that it is a retrospective study. There is a small number, and the data of patients who have had biopsies which may have resulted in a false negative diagnosis.

The suggestion of this research is that lesions with calcifications are more clearly noticeable in magnification views, particularly the patients who have a large number of calcifications and a group of calcifications in a thick breast background.

Conclusion

Magnification views significantly increased the detection rate resulting in 21.33% changes in management recommended according to the BIRADS classification. Additionally, magnification views increased the diagnostic confidence level.

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References

1. Tan PH, Ellis I, Allison K, Brogi E, Fox SB, Lakhani S, et al. The 2019 World Health Organization classification of tumours of the breast. Histopathology 2020;77(2):181–5. doi.org/10.1111/his.14091
2. Weigel S, Decker T, Korsching E, Hungermann D, Böcker W, Heindel W. Calcifications in digital mammographic screening: improvement of early detection of invasive breast cancers? Radiology 2010;255(3):738–45. doi.org/10.1148/radiol.10091173
3. Sripaiboonkij N, Thinkamrop B, Promthet S, Kannawat C, Tangcharoensathien V, Ansusing T, et al. Breast cancer detection rate, incidence, prevalence AND interval cancer-RELATED mammography screening times AMONG thai women. Asian Pac J Cancer Prev 2016;17(8):4137–41.
4. Muttarak M, Paramagul C, Ng KH. Diagnostic mammography in breast imaging. In: Diagnostic and Therapeutic Applications of Breast Imaging, 2012:85–119.
5. Wiwanitkit V. Prevalence of abnormal mammogram among working Thai women. Indian J Cancer 2014; 51(4):486. doi.org/10.4103/0019-509X.175349
6. Sickles EA. Mammographic detectability of breast microcalcifications. AJR Am J Roentgenol 1982;139(5):913–8. doi.org/10.2214/ajr.139.5.913
7. Sickles EA. Further experience with microfocal spot magnification mammography in the assessment of clustered breast microcalcifications. Radiology 1980;137(1 Pt 1):9–14. doi.org/10.1148/radiology.137.1.7422866
8. Oestmann JW, Kopans DB, Linetsky L, Hall DA, McCarthy KA, White G, et al. Comparison of two screen-film combinations in contact and magnification mammography: detectability of microcalcifications. Radiology 1988;168(3):657–9. doi.org/10.1148/radiology.168.3.3406394
9. Fallenberg EM, Dimitrijevic L, Diekmann F, Diekmann S, Kettritz U, Poellinger A, et al. Impact of magnification views on the characterization of microcalcifications in digital mammography. Rofo 2014;186(3):274–80. doi.org/10.1055/ s-0033-1350572
10. Sickles EA, Doi K, Genant HK. Magnification film mammography: image quality and clinical studies. Radiology 1977;125(1):69–76. doi.org/10.1148/125.1.69
11. Fischer U, Baum F, Obenauer S, Funke M, Hermann KP, Grabbe E. Digital full field mammography: comparison between radiographic direct magnification and digital monitor zooming. Radiologe 2002;42(4):261–4. doi.org/10.1007/s00117-002-0733-2

12. Min Jung K, Eun-Kyung K, Jin Young K, Eun Ju S, Ji Hyun Y, Seon Hyeong C, et al. Characterization of microcalcification: can digital monitor zooming replace magnification mammography in full-field digital mammography? Eur Radiol 2009;19(2)310-7. doi.org/10.1007/s00330-008-1135-2
13. Moraux-Wallyn M, Chaveron C, Bachelle F, Taieb S, Ceugnart L. Comparison between electronic zoom and geometric magnification of clusters of microcalcifications on digital mammography. J Radiol 2010;91(9 Pt 1):879–83. doi.org/10.1016/S0221-0363(10)70129-3
14. Kim MJ, Youk JH, Kang DR, Choi SH, Kwak JY, Son EJ, et al. Zooming method (x 2.0) of digital mammography vs digital magnification view (x 1.8) in full-field digital mammography for the diagnosis of microcalcifications. Br J Radiol 2010;83(990): 486–92. doi.org/10.1259/bjr/16967819

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