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The efficacy of 1 molar contrast material in the evaluation of breast lesions with MR imaging

Purpose

Although it is well known that breast magnetic resonance imaging (MRI) examinations should be performed with contrast use (1-5), the sensitivity and specificity of different contrast media in the detection of breast lesions and in image quality is not studied enough up to now. The aim of this study is to investigate the efficacy of 1 molar (containing 1 mol/ml gadobutrol) contrast material in the differentiation of malignant and benign breast lesions with MRI according to contrast uptake curves and patterns of lesion enhancement, with histopathologic correlation.

Methods and Materials

This prospective study was performed in Radiology Department of Yuzuncu Yil University Hospital between December 2008 and December 2009. Thirty-seven women (age range:22-77 years, mean:43,7 years) with a total of 76 breast lesions of BIRADS category III or higher based on mammographic or sonographic examination were included in this study.

MRI examinations were performed with a 1,5 Tesla system (Siemens Symphony, Erlangen, Germany). T2-weighted fatsat turbo spin echo, T1-weighted fatsat 3D FLASH, and axial pre-contrast and dynamic post-contrast images with 0,2 ml/kg gadobutrol (Gadovist^R, Schering) containing 1 mol/ml gadobutrol injection were obtained in all patients. Contrast material was injected by automatic injection system. Dynamic images were obtained as axial T1-weighted fatsat 3D FLASH, which was repeated 9 times with an interval of 60 seconds between the sequences. Contrast-time curves classified as Type I, Type II, and Type III were maintained in all lesions by post-processing (Figures 1-6). Also the enhancement patterns, as well as contrast-noise (C/N) ratio of the lesions were noted.

The lesions with a prediagnosis of malignancy based on MRI findings underwent tru-cut biopsy and histopathological results were obtained. The lesions thought to be benign according to MRI findings were followed up for 6 months, and they were regarded as benign in case no change in morphology or size was demonstrated.

With SPSS-13 programme, Chi-square test was used for the determination of the relation among categoric variables. The level of significance was accepted as 5%. Sensitivity, specificity, positive predictive value, and negative predictive value were calculated. Ethics committee approval has been obtained for the study.

Results

A total of 76 lesions in 37 women were observed on breast MRI examinations. Of the 76 lesions, 20 were malignant and 56 were benign based on MRI findings. Twenty-two of the benign lesions also had histopathologic diagnosis (3 granulomatous mastitis, 11 fibroadenoma, 3 adenosis, 2 papilloma, 1 intramammarian lymph node, 1 post-operative scar tissue and radiation necrosis (Tables 1 and 2).

Due to the analysis with Chi-square test, 55,4% of the benign lesions were displaying Type I, 33,9% Type II, and 10,7% Type III contrast-time curve, whereas 5% of the malignant lesions were displaying Type I, 50% Type II, and 45% Type III contrast-time curve. MR imaging findings were in harmony with histopathological results ($p < 0.01$). Sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of MR imaging with 1 molar contrast agent in detecting malignant lesions were 45%, 89,3%, 60%, 82%, and 77,63%, respectively.

Table 1: Distribution of contrast-time curves in benign lesions

Histopathology	Type-I contrast-time curve	Type-II contrast-time curve	Type-III contrast-time curve	Total
Fibroadenoma	15	14	1	30
Adenosis	6	1	-	7
Fat necrosis	5	-	-	5
Mastitis	1	1	1	3
Intramammarian lymph node	-	-	3	3
Papilloma	-	2	1	3
Scar tissue	2	-	-	2
Fibroadenolipoma	2	-	-	2
Infected cyst	-	1	-	1
Total	**31**	**19**	**6**	**56**

Table 2: Distribution of contrast-time curves in malignant lesions

Histopathology	Type-I contrast-time curve	Type-II contrast-time curve	Type-III contrast-time curve	Total
Invasive ductal carcinoma	1	10	8	19
Mucinous adenocarcinoma			1	1
Total	1	10	9	**20**

One malignant lesion (invasive ductal carcinoma) displayed Type-I contrast-time curve, which was accompanied by enhancement on the breast skin at the level of the lesion. Six benign lesions showed Type-III contrast-time curve (1 fibroadenoma, 1 granulomatous mastitis, 3 intramammarian lymph nodes, and 1 papilloma).

Of the lesions with Type-I contrast-time curve, 31 (96,9%) were benign, and 1 (3,1%) was malign. Of the lesions with Type-II contrast-time curve 19 (65,5%) were benign, 10 (34,5%) were malign. Of the lesions with Type-III contrast-time curve, 6 (40%) were benign, while 9 (60%) were malignant. There was significant correlation between the types of contrast-time curve and histopathologic results ($p<0.05$) (Graphic 1).

In terms of diagnosing benign pathology, Type-I contrast-time curve had a sensitivity of 55%, specificity of 95%, positive predictive value of 96%, negative predictive value of 56%, and accuracy rate of 65%.

In terms of diagnosing malignant pathology, Type-II contrast-time curve had a sensitivity of 50%, specificity of 66%, positive predictive value of 34%, negative predictive value of 21%, and accuracy rate of 61%, whereas these values for Type-III contrast-time curve were 45%, 89%, 60%, 18%, and 77%, respectively.

In terms of diagnosing benign pathology, sensitivity, specificity, positive predictive value, negative predictive value, and accuracy rate of homogenous contrast enhancement were 54%, 75%, 86%, 63%, and 60%, respectively ($p=0.059$).

Positive predictive value of peripheral ring-like contrast enhancement to determine malignancy was found to be 41%.

Table 3: Histopathologic correlation of increased vascularity in the involved breast

Increased vascularity	Histopathologically malignant	Histopathologically benign
present	11 (91%)	5 (20%)
absent	1 (8,3%)	20 (80%)

When increased vascularity was evaluated in terms of diagnosing malignancy, its sensitivity was 91%, specificity 80%, positive predictive value 68%, and negative predictive value 95% ($p < 0.05$).
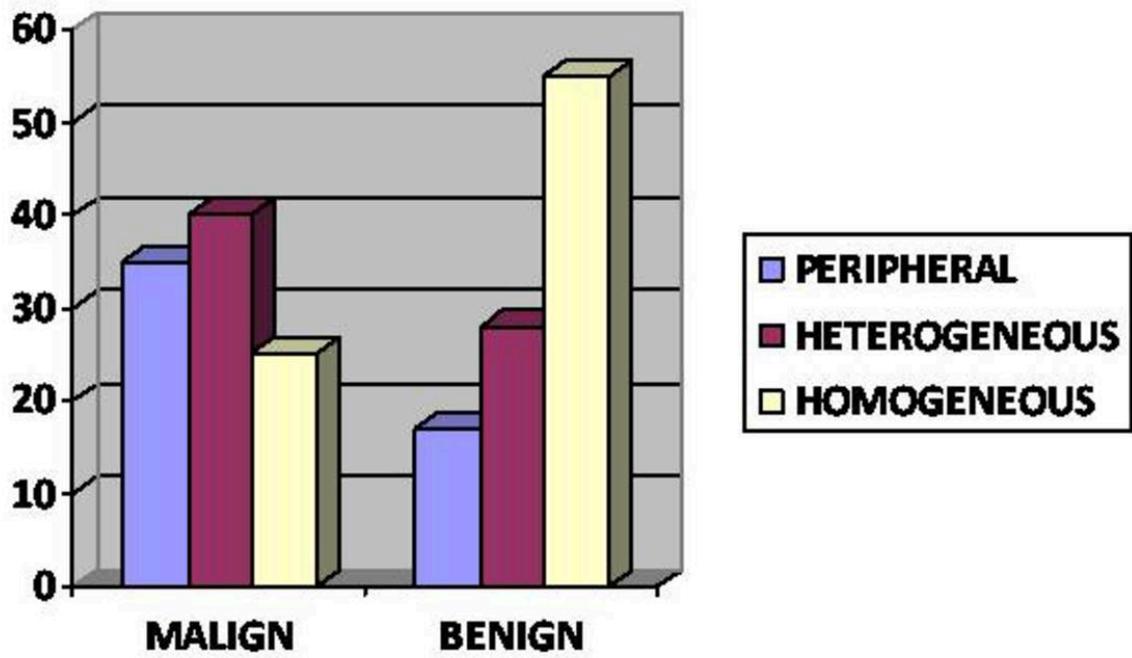
The mean increase in contrast-noise ratio (CNR) was significantly higher in malignant lesions (450%) than in benign lesions (60%) ($p < 0.05$).
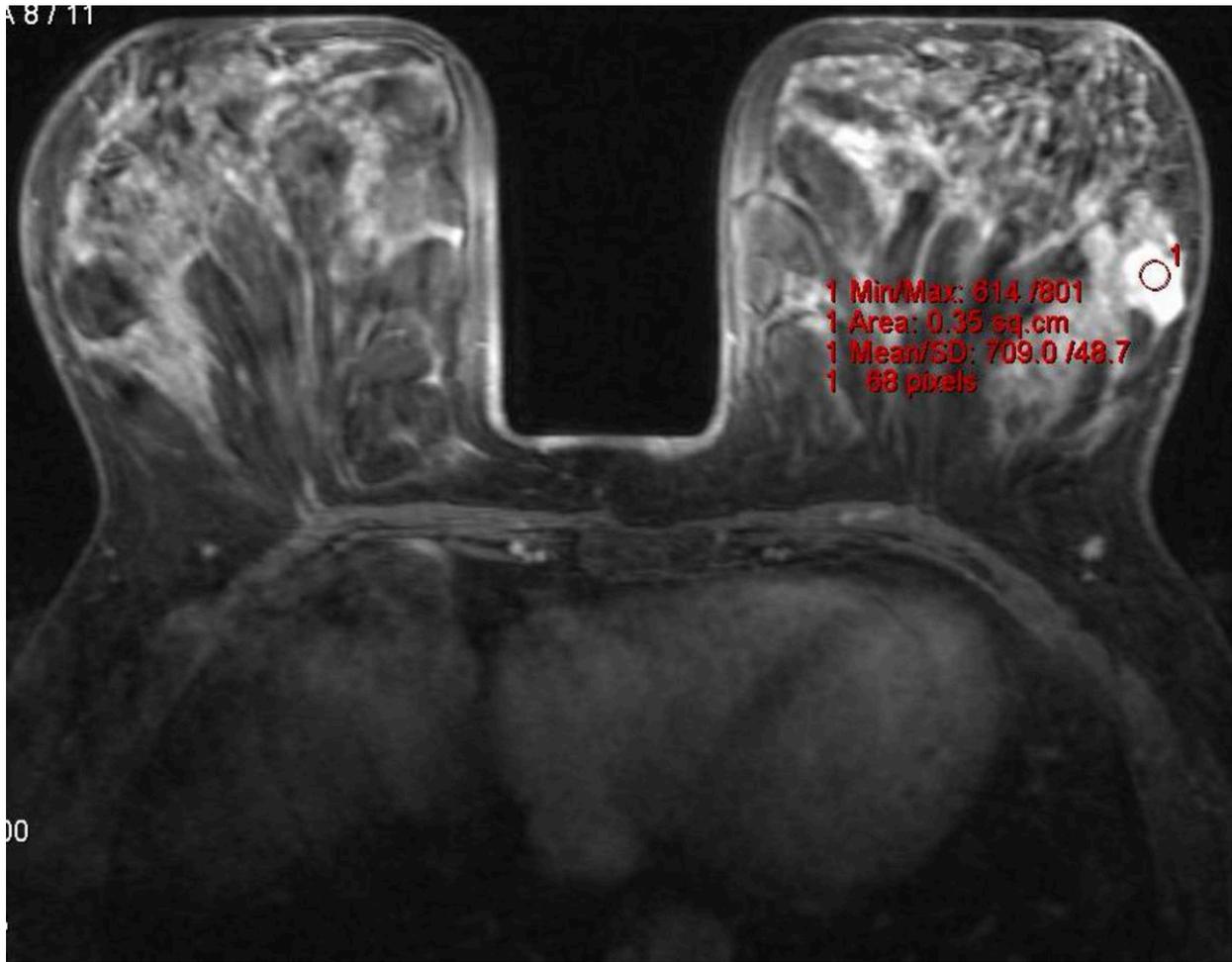
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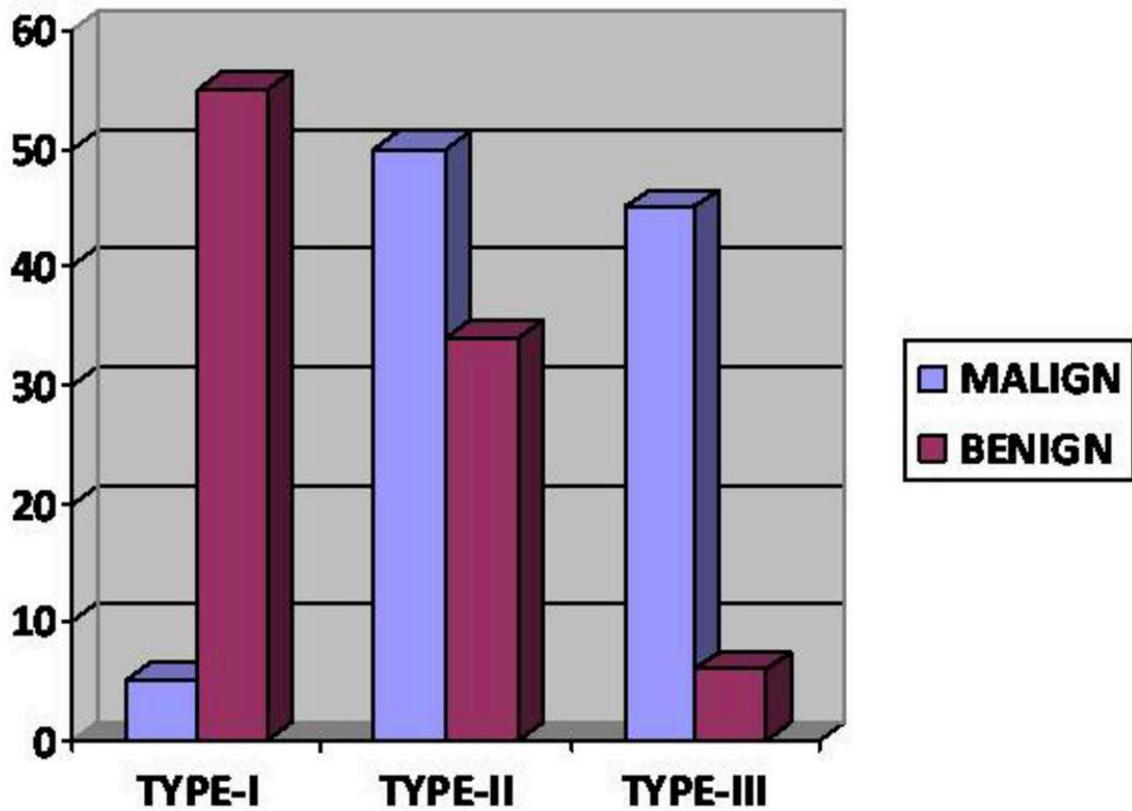
Fig. 0: The percentages of histopathologically malignant and benign lesions correlated with types of contrast-time curves.

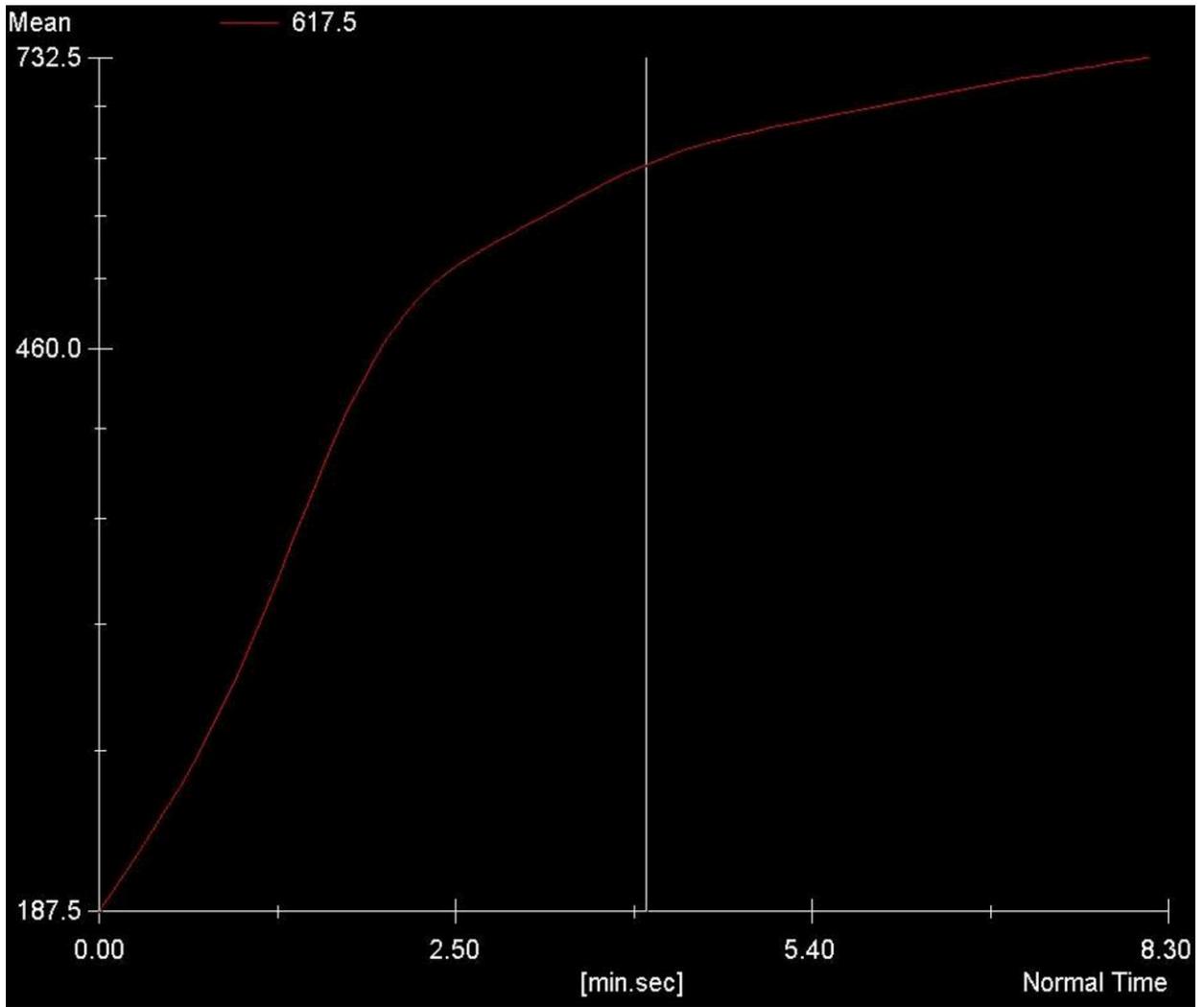© Radiology, Yüzüncü Y#l University Medical Faculty - Van/TR

Fig. 0: Enhancement patterns of malignant and benign lesions

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Fig. 0: Homogeneously enhancing solid mass (fibroadenoma) on the outer quadrant of left breast.

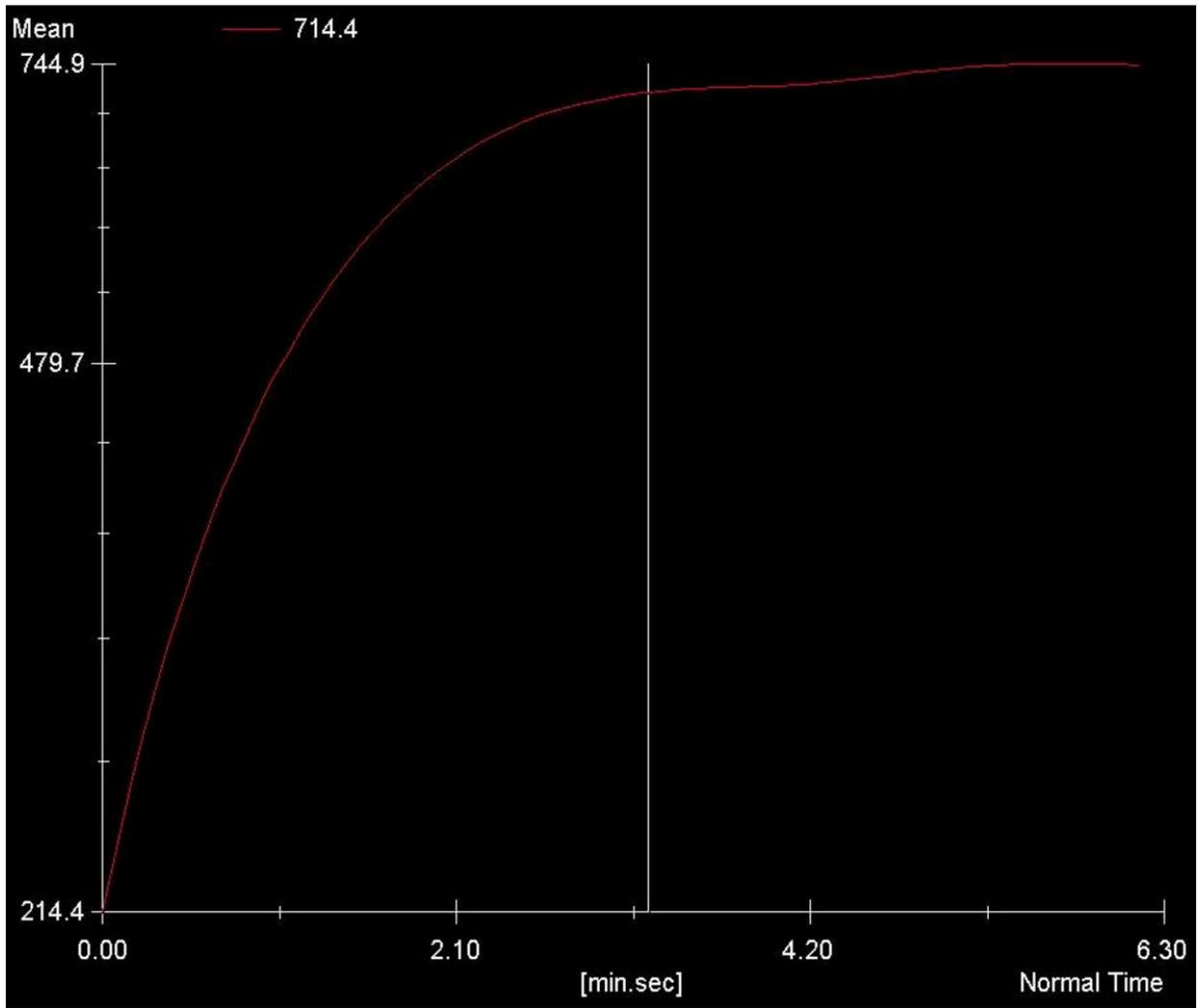© Radiology, Yüzüncü Y#l University Medical Faculty - Van/TR

Fig. 0: The mass in Figure 3 displays Type-I contrast-time curve.

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Fig. 0: A solid mass on the right breast with spiculated contour (intraductal carcinoma) showing marked enhancement.

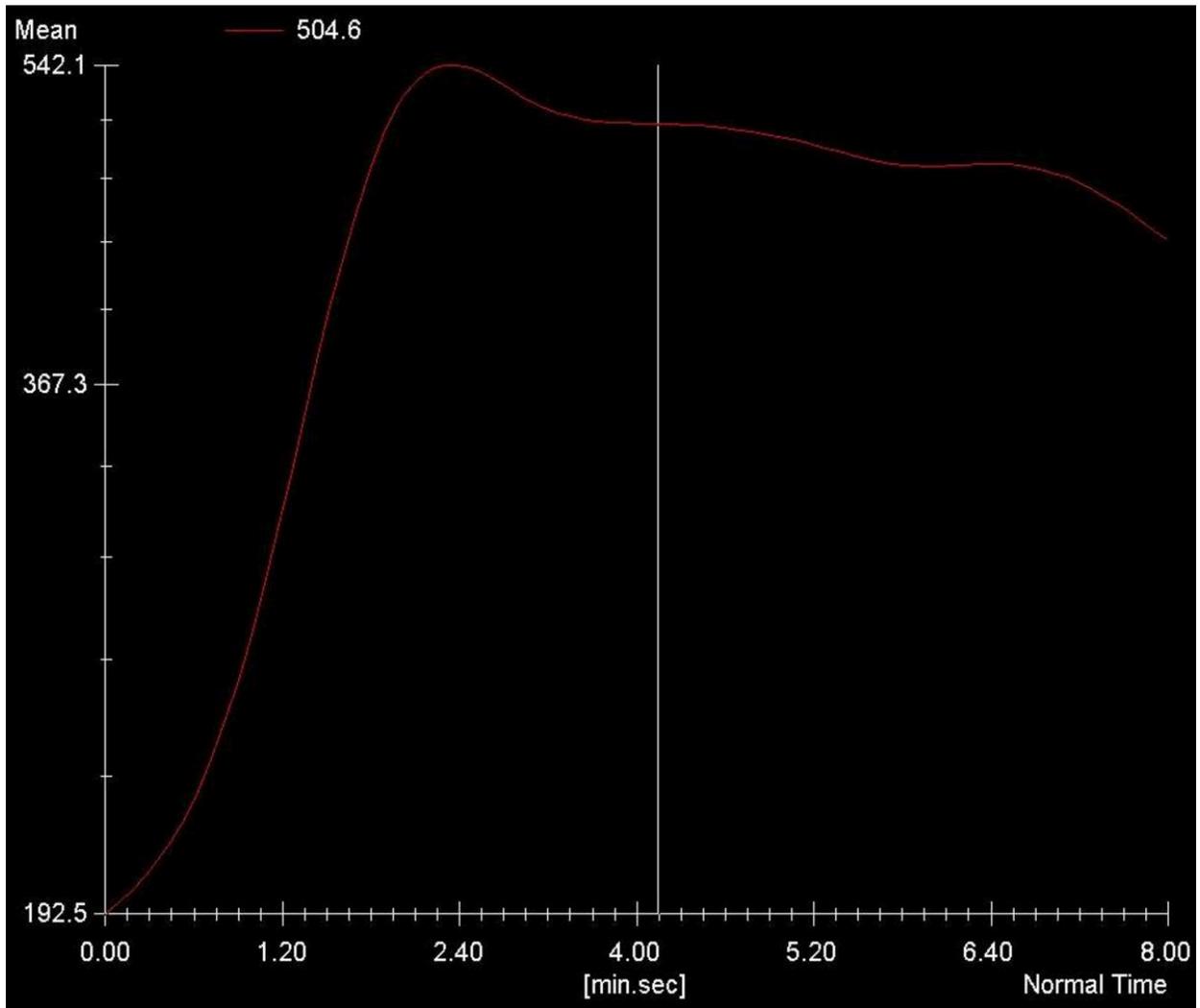© Radiology, Yüzüncü Y#l University Medical Faculty - Van/TR

Fig. 0: The mass in Figure 5 displays Type-II contrast-time curve.

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Fig. 0: A smooth contoured small oval mass (intramammarian lymph node) on the right breast with homogeneous enhancement.

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Fig. 0: The mass in Figure 7 displays Type-III contrast-time curve.

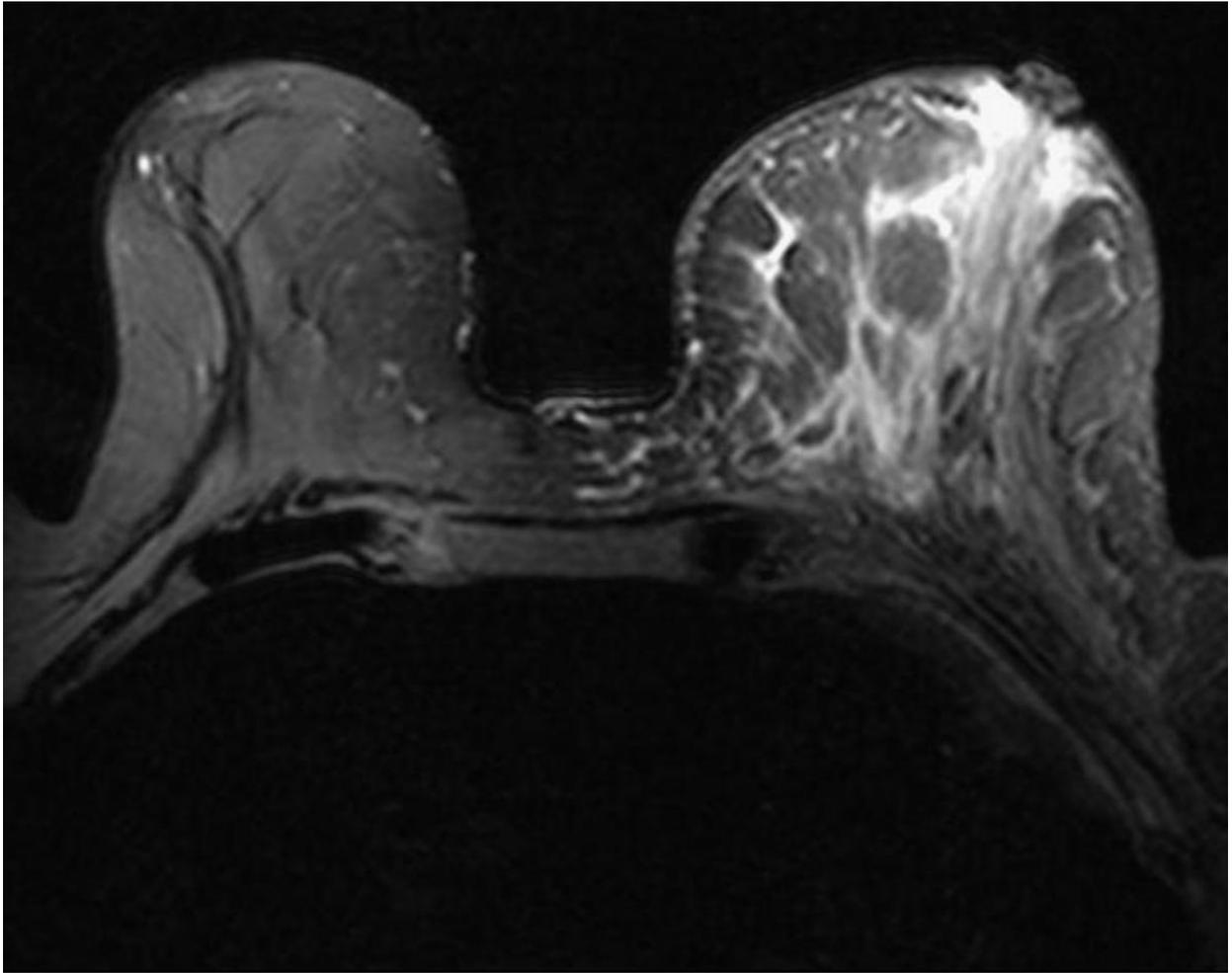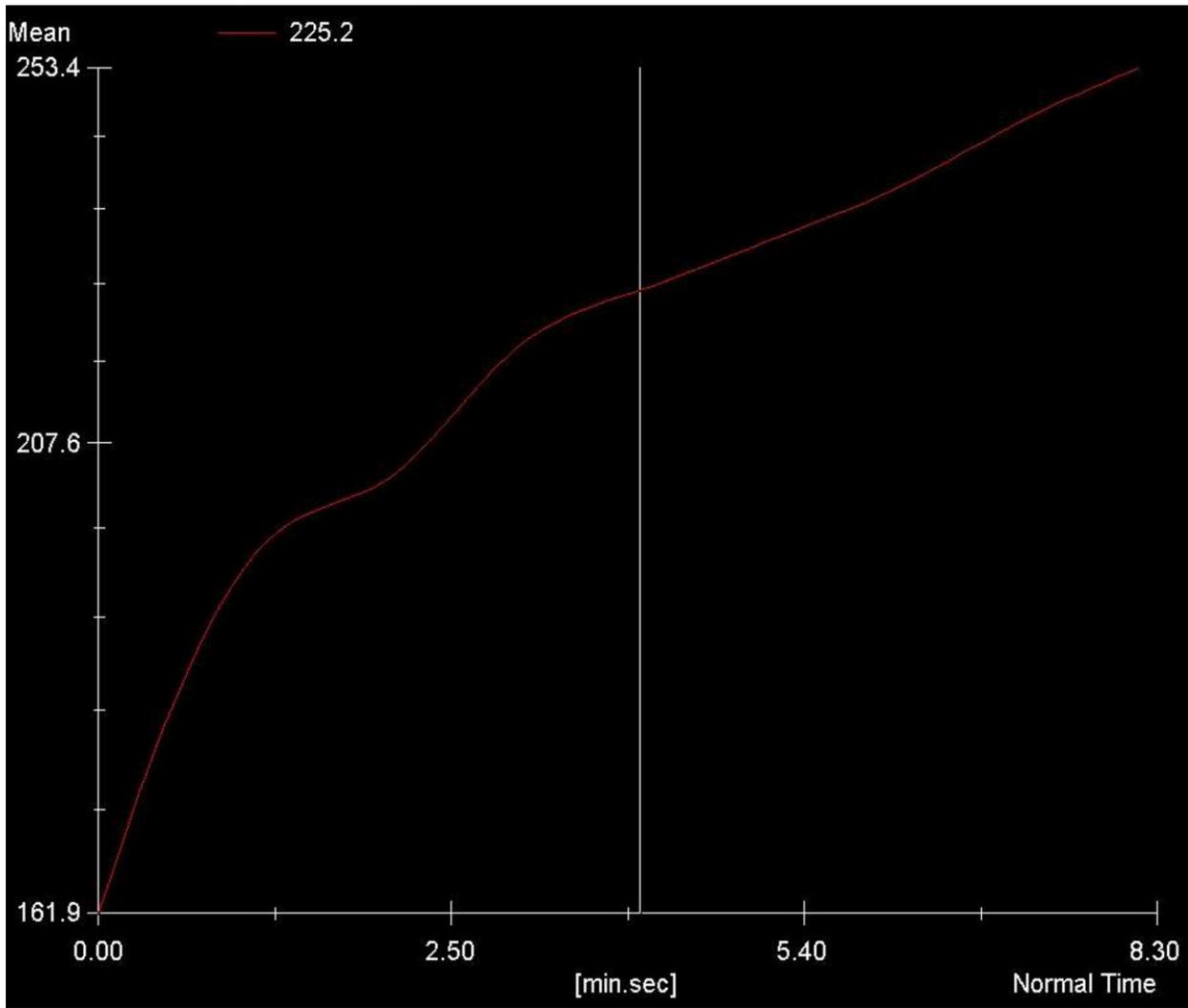© Radiology, Yüzüncü Y#l University Medical Faculty - Van/TR

Fig. 0: Heterogeneously enhancing area (granulation tissue) on the left breast.

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Fig. 0: The lesion in Figure 9 shows Type-I contrast-time curve.

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Conclusion

Our study with high dose (0,2 ml/kg) gadobutrol resulted in a high sensitivity of 95%, and a specificity of 55,4% in the diagnosis of malignant breast lesions (p=0.001), where decreased specificity (regarding enhancement pattern) can lead to an increase in false positive results.

As far as we are concerned, there is no study in the literature concerning CNR of breast lesions on MRI examinations. In our study using gadobutrol, the significant increase in CNR of malignant breast lesions can help in the diagnosis, even in small sized lesions. However, this idea needs further studies with other contrast materials containing gadolinium and also with lower doses of gadobutrol.

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