

The Diagnostic Efficacy of the Kaiser Score for Characterizing Breast Lesions Classified as BI-RADS IV -V on Dynamic Enhanced Breast MRI

Howidah Jabbar Hussein¹, Raad Hefdhi Abedtwfeq²

ABSTRACT:

BACKGROUND:

Baltzer et al. introduced the Kaiser score to aid the interpretation of enhancing breast MRI lesions, the score ranges from 1 to 11, reflecting an increased probabilities of malignancy.

OBJECTIVE:

To investigate whether the application of the Kaiser score, can improve the diagnostic performance in contrast enhancing lesions classified as BI-RADS4-5 on breast MRI.

PATIENTS AND METHODS:

Prospectively Data collected at oncology teaching hospital in medical city teaching complex in Baghdad, the study included 60 female patients with breast lesions classified as BI-RADS4-5 on DCE-MRI. The diagnostic efficacy of Kaiser score was evaluated according to the pathological results.

RESULTS:

The study included 60 females with 69 suspicious breast lesions categorized as BI-RADS 4-5 lesions on DCE-MRI, 45 lesions were malignant, 24 were benign, the results regarding the diagnostic performance of the Kaiser score, showed that it has high accuracy with AUC= 94.1%, high sensitivity of 92.3%, high specificity of 86.7%, and it was 88.4% accurate in diagnosis of breast malignancy.

CONCLUSION:

This study provides evidence that the Kaiser score can be used in improving the diagnostic performance of dynamic enhanced breast MRI in BI-RADS 4-5 lesions.

KEY WORDS: Breast cancer, Magnetic resonance imaging, Kaiser score.

¹M.B.Ch.B Baghdad Medical City /X-Ray Institute.

²M.B.Ch.B, D.M.R.D, F.I.B.M.S-Radiology Consultant Professor of Radiology ,Al-Yarmouk Teaching Hospital, Baghdad, Iraq.



INTRODUCTION:

Baltzer et al. ⁽¹⁾ introduced interesting classification flowchart tree (Kaiser score) for the assistance of the interpretation of lesions of breast that is enhancing in MRI, by including four major criteria (margins, curve type of dynamic enhancement, pattern of internal enhancement, and oedema), in summary, Kaiser score ranging from score 1 (the least score, the carcinoma very unlikely) to score 11 (the highest score, carcinoma is very likely) which reflects increasing possibilities of malignant disease) ⁽²⁾. in this thesis we investigate whether the application of this score increase the diagnostic ability of contrast enhanced MRI, of the breast for highly suspicious masses and lumps classified as BIRADS 4-5 lesions.

ANATOMY OF THE BREAST

The main structures in the breast consist of skin, fatty tissue, fascial layers, Cooper ligaments, fibro glandular tissue, lymphatic structures, and neuro-vascular structures ⁽³⁾, the base of the breast formed by pectoralis major muscle, the nipple is located superior to the creases situated inframammary and is found in the level of mid clavicular line ⁽⁴⁾.

Breast Blood supply ⁽⁵⁾:

The breast is supplied from the axillary, intercostal internal and mammary arteries. branches of the internal mammary artery are the main source. The remaining comes from 4 branches of the axillary artery, These arteries are accompanied by the corresponding veins to which venous blood is drained ⁽⁵⁾.

KAISER SCORE

Breast lymphatic drainage ⁽⁶⁾:

The breast lymphatic drainage occur alongside its blood supplying vessels, draining to internal mammary and axillary lymph nodes. There are three levels in the axillary nodes these are:

Level I: the lymph nodes that are lateral to pectoralis minor muscle.

level II: the lymph nodes that are posterior to pectoralis minor.

Level III : nodes that are medial to the pectoralis minor ⁽⁶⁾.

DIAGNOSING BREAST CANCER

Diagnosing Patients with breast cancer needs a three-step assessment consisting of clinical examination, imaging techniques, alongside with histopathological examination. the most widely used imaging technique is Mammography. yet, mammography in young women is not sensitive, in this situation breast ultrasonography can be used. Ultrasound is important in evaluating the size and consistency of breast lesions. Ultrasound is of great role in needle guided biopsy. MRI has good sensitivity in diagnosing soft tissue pathologies in the breast.

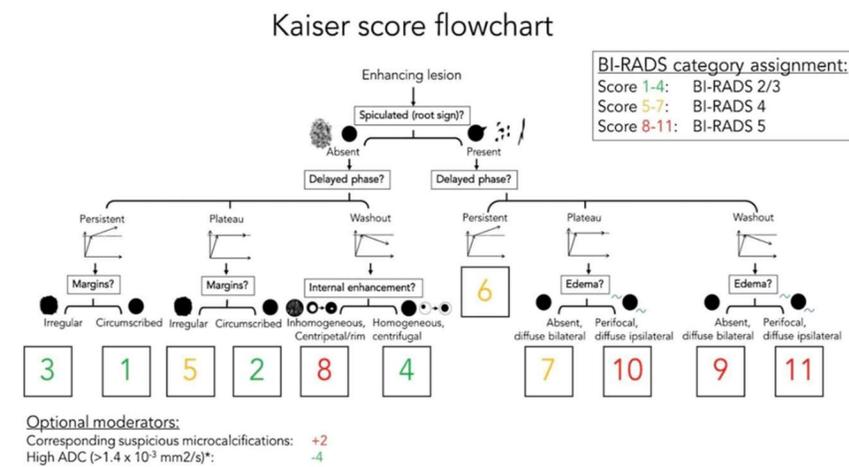


Figure 1: The flowchart of Kaiser score (7).

MRI of the breast: The patient examined by MRI using magnetic field, a radio frequency wave is used to form high contrast images, contrast agent is used in dynamic contrast enhanced-MRI before the images are taken.

Kaiser score classification system:

Baltzer et al. proposed a simple classification system to complement and to increase the specificity of the ACR BI_RADS lexicon, in differentiation of malignant versus benign breast lumps by MRI. The score is a flowchart guiding the radiologist through a stepwise assessment of the lesions, depending on 4 independent BI_RADS lexicon diagnostic criteria, these criteria are: margins of the lesion, signal intensity -time curve type, pattern of internal enhancement and the presence of oedema, figure (1.5). The result is a score that reflects increasing malignant lesions possibilities, starting from score 1 to score 11, the scores that are more than four, will require a

histopathological assessment. The score is calculated by using a flow chart starting from high to low, which permit the radiologist looks for the positivity or negativity of 4 criteria, these are: the margins of lesion, signal intensity -time curve type, internal enhancement pattern, and presence of edema, the result will be associated with the increase probability of malignant disease (starting from 1 to 11), the corresponding BI_RADS categorization as follows:

- 1-4: least risk of breast malignancy (BI-RADS 2-3).
- 5-7: moderate risk of breast malignancy (BI-RADS 4).
- 8-11: highest risk of breast malignancy (BI-RADS 5).

Optional criteria can be included, these are: presence of suspicious micro calcifications (+2) and increase ADC values (-4).

KAISER SCORE

AIM OF THE STUDY:

To investigate if the application of the Kaiser score, can increase the diagnostic performance in lesions that is contrast enhancing, classified as BI_RADS IV-V on MRI of the breast. in order to decrease the number of unnecessary biopsy and invasive surgical intervention.

PATIENTS AND METHODS:

study design, settings, and data collecting time

This is a prospective cross section study that, did at Oncology teaching hospital in the center of Baghdad Medical city teaching complex during a period of 8 months between April 2022 until December 2022.

Study patients and sample size

The study included 60 female patients with 69 breast lesions, 9 patients with bilateral breast lesions. Those patients were referred due to suspicious breast lesions classified as BI-RADS4-5 in preoperative DCE- breast magnetic resonance imaging. the MRI findings was assessed by using the Kaiser score, With pathology results as the gold standard.

Inclusion criteria: All Female patients above 18 years with suspicious lesions of the breast, classified as BIRAD 4-5 in CE – breast MRI was included.

Exclusion criteria:

- Examinations with no, benign or low suspicious findings (BI-RADS 1,2,3).
 - Biopsy proven malignant breast lesions (BIRADS 6).
 - Improper examination results due for example to patient movement.
 - Common contraindication to MRI (presence of non-safety pacemakers or claustrophobia).
- operating characteristic (ROC), specificity, sensitivity, and likelihood ratios were calculated and divided to 11 assignment categories, a cutoff value of >5 indicates malignancy. A p value equal to or less than 0.05 is considered significant statistically.

EQUIPMENT AND TECHNIQUES

Breast MRI is done using a 1.5 Tesla Siemens system (Magnetom Aera; Siemens Health, Germany) with wide pore and a dedicated bilateral sixteen channel fixed breast coil.

The application of Kaiser score system translating it into BI-RADS categories: The Kaiser score flow chart was applied to each lesion categorized as BIRADS4-5, The result of the chart from above to below is a score with increasing risk of malignancy, moderators were applied, these are:

- The presence of suspicious micro calcifications upgrades the score by 2 points.
 - High (greater than 1.4×10^{-3}) corresponding ADC values downgrades the score by 4 points.
- For Each lesion, Kaiser score was calculated, and in comparison to histopathological results which is the gold standard in this study, the score diagnostic efficacy was tested.

Administrative approvals: approvals from The Council of Iraqi Board for Medical Specialization. And the Oncology Teaching Hospital in the center of Baghdad Medical City.

Ethical considerations and official approvals

Verbal permission was obtained for every patient prior to data collection and also, the information was anonymous and data was used exclusively for the research purposes.

Statistical analysis

The data collected, using Microsoft Excel, version 2016 then analyzed by using Statistical Package for Social Sciences (SPSS), version 26 software. The data presented as mean, standard deviation and ranges, the evaluation of diagnostic ability of Kaiser score using Receiver

RESULTS:

PATIENT DEMOGRAPHICS

Patients' age ranged from 27 to 73 years with a mean of 44.91 ± 10.78 years (Figure 2)

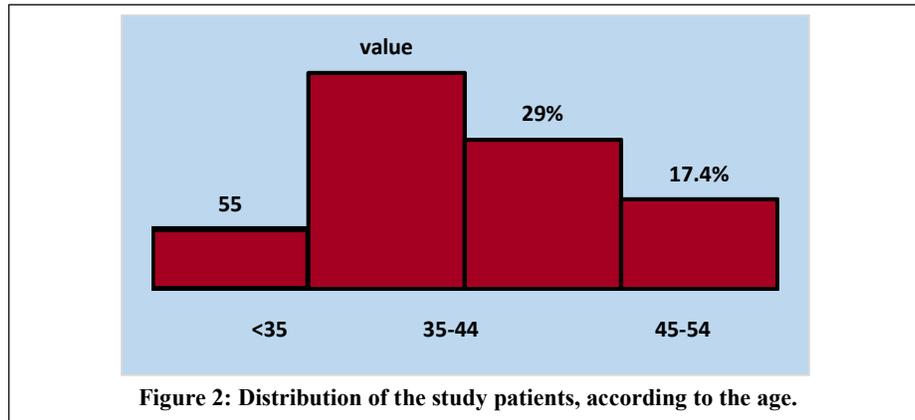


Figure 2: Distribution of the study patients, according to the age.

histopathological results:

According to the histopathological examination, 45

lesions (65.2%) were malignant and the remaining 24 lesions (34.8%) were benign (Figure 3).

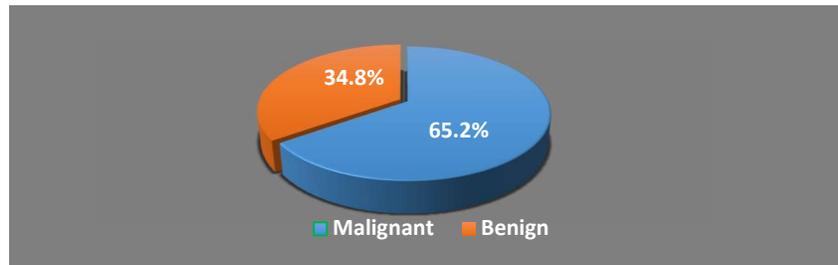


Figure 3: Histopathological results of the biopsied lesions.

distribution of study patients by characteristics is summarized by at (Table 1). histopathological diagnosis and certain lesion

Table 1: Distribution of patients by histopathological diagnosis and certain lesion characteristics.

Lesion Characteristics	Histopathological Diagnosis		Total (%) n= 69	P- Value
	Malignant Lesion (%) n= 45	Benign Lesion (%) n= 24		
Type of Lesion				
Mass Lesion	21 (55.3)	17 (44.7)	38 (55.1)	0.056
Non- mass Lesions	24 (77.4)	7 (22.6)	31 (44.9)	
ADC Value				
High	4 (22.2)	14 (77.8)	18 (26.1)	0.001
Low	41 (80.4)	10 (19.6)	51 (73.9)	
Micro-calcification				
Yes	7 (87.5)	1 (12.5)	8 (11.6)	0.049
no	38 (62.3)	23 (37.7)	61 (88.4)	
BI-RADS				
IV	32 (57.1)	24 (42.9)	56 (81.2)	0.003
V	(100.0) 13	(0) 0	13(18.8)	

KAISER SCORE

Diagnostic performance of kaiser score
that Kaiser score was significantly higher in the

cancerous lesions than in the benign lesions (8.56 vs 4.20, P= 0.001) (Figure 4) and (Table 2).

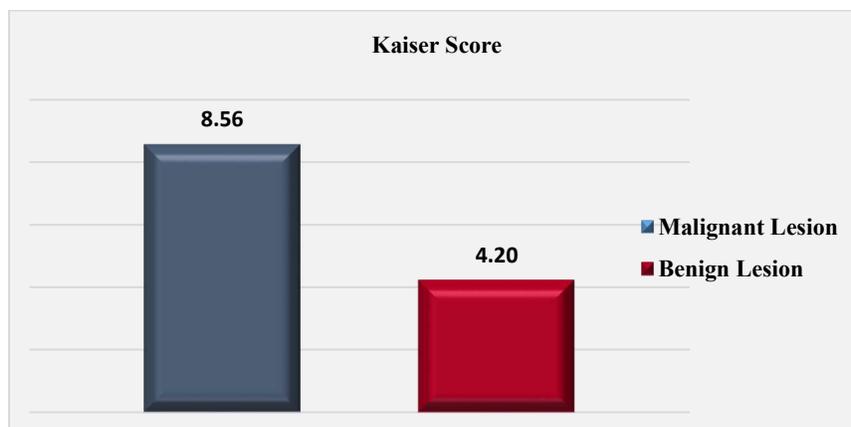


Figure 4: Distribution of the lesions by using Kaiser score.

Table 2: Comparison between breast lesions using Kaiser score.

Clinical Parameter	Histopathological Diagnosis		P - Value
	Malignant Lesions Mean ± SD	Benign Lesions Mean ± SD	
Kaiser Score	8.56 ± 1.74	4.20 ± 1.90	0.001

DIAGNOSTIC ACCURACY OF KAISER SCORE IN PREDICTIONS OF MALIGNANT LESIONS OF THE BREAST:

Receiver operating characteristic (ROC) curve analysis was constructed for Kaiser score as predictors of malignant breast lesions. The cut point of Kaiser score was 5. Hence, Kaiser score > 5 is a predictor for malignant lesions of breast, as a huge and significant (area that is under the curve)

(AUC= 94.1%) mean that there is a significantly association between the higher Kaiser score and malignant lesions. Kaiser score was 92.3% sensitive, 86.7% specific, and 88.4% accurate in diagnosis of malignant breast lesions, with PPV and NPV of 85.7% and 88.9% respectively (Figure 5) and (Table 3).

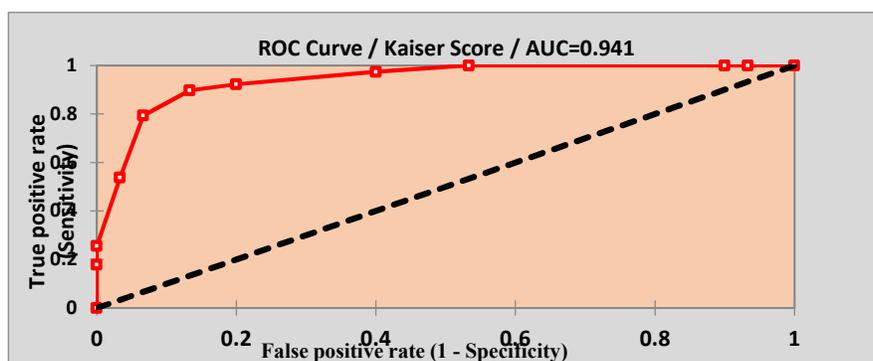


Figure 5:

curve of Kaiser score in diagnosis of malignant breast lesions.

ROC

KAISER SCORE

Table 3: Kaiser score Diagnostic accuracy in predictions of malignant breast lesions

Clinical Parameters	Cut-off value	SN	SP	PPV	NPV	Accuracy
Kaiser Score	5	92.3%	86.7%	85.7%	88.9%	88.4%

CASE 1:

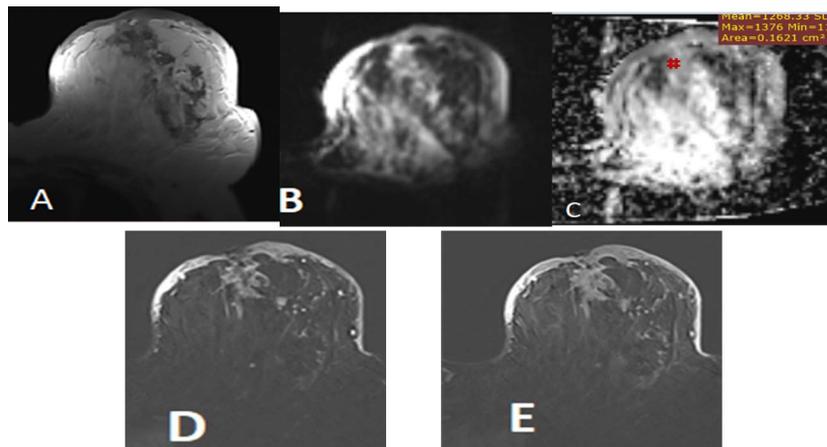


Figure 6: A women of 55 years old, presented with lump in her left breast, with skin retraction, DCE breast MRI, T2WI (A), DWI (B), ADC map (C), post contrast T1 subtraction images early (D) and delayed (E). there is irregular outline heterogeneously enhancing mass with speculated margin with type three enhancement curve and restricted diffusion. BI-RADS V, Kaiser score11, histopathology reveals invasive ductal carcinoma.

CASE 2:

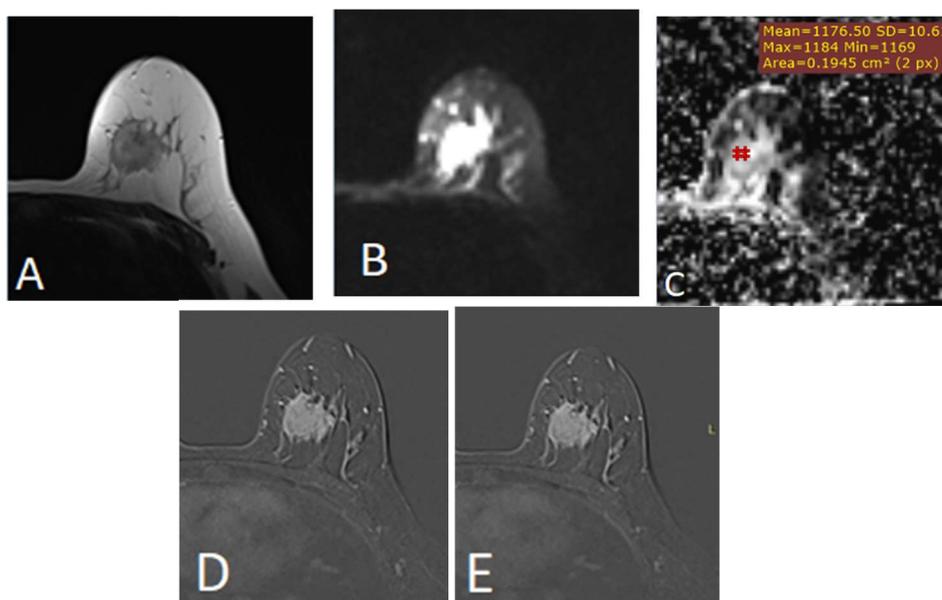


Figure 7: Women of 40 years old, presented with a mass in her left breast, Dynamic MRI is performed, T2 WI (A), DWI (B) ADC map (C), post contrast T1WI subtraction images early (D), and late (E). showing irregular outline speculated mass showing heterogeneous enhancement, with type III kinetic curve, restricted diffusion with ADC value of 1.1×10^3 . the lesion was assigned as BI_RADS category V, the Kaiser score given score of 11, biopsy was done, the result was (left breast lobular carcinoma).

KAISER SCORE

DISCUSSION:

The results of our study emphasize the diagnostic potential of the Kaiser score as a clinical diagnostic tool, in MRI contrast enhanced suspicious lesions (BI-RADS 4-5). The comparison of Kaiser score between the benign and malignant lesions as provided by histopathological results revealed that higher Kaiser scores (with cut point of 5) was significantly associated with malignant lesions with P value of 0.001. Hence, Kaiser score > 5 considered a predictor for malignant lesions of

breast, the score shows large area under the curve (AUC= 94.1%) and high sensitivity and specificity (92.3% sensitive, 86.7% specific), the application of the Kaiser score was 88.4% accurate in diagnosis of malignant lesions.

Since the introduction of the Kaiser score in 2013, it has been validated in studies including different patient populations. These studies summarize in (table 4)

Table 4: Summary of the studies that had studied the Kaiser score.

author	Year	Study group	Sensitivity of Kaiser score	Specify of Kaiser score	AUC
This study	2022	69	92.3%	86.7%	0.94
Marino <i>et al</i> ⁽⁸⁾	2016	121			0.889 - 0.943.
Wengert <i>et al.</i> (2)	2020	167	96.8-98.9%	58.3-65.3	0.968-0.989
Istomin. <i>et al.</i> ⁽⁹⁾	2021	697	98.5 % - 98.7 %	34.8 %-47.5 %	85.9- 87.6
Milos. <i>et al.</i> ⁽¹⁰⁾	2020	183	92.7%-97.6%	45.1 -72.5%	0.865–0.902
Jajodia . <i>et al.</i> ⁽¹¹⁾	2021	316	93.6%	49.4%	0.796
Woitek. <i>et al</i> ⁽¹²⁾	2017	469	80.6	82.5	0.873

Thus, in comparison to the previously mentioned studies, the results in our study lie within the reported ranges of (0.94) for the AUC, (92.3%) for sensitivity, yet our study shows increased specificity (86.7%) in comparison to other studies. This difference might be attributed to the difference in selected populations of patients, with a different ratios of malignant and benign breast lesions.

CONCLUSION:

Our study emphasizes that, the Kaiser score can be of important role in improving the diagnostic performance of dynamic enhanced breast MRI in BI-RADS IV-V lesions by providing a diagnostic strategy for BI-RADS classification system.

Recommendations:

We recommend the using of the Kaiser score as an additional tool in aiding the diagnosis of breast lesions in DCE breast MRI, the final recommendation of management must be given in combination with the BI_RADS categorization.

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