MR- BIRADS 5th
Benefits and Controversials

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MRI report should include

1. Indication (Clinical history)
2. Comparison to previous examinations
3. MRI technique (kind of weighting/ contrast dose/ postprocessing techniques)
4. Breast Tissue: Amount of fibroglandular tissue (FGT)
   Background Parenchymal Enhancement (BPE) (Level/ symmetric or asymmetric)
5. Findings: Focus/ Mass/ Non-Mass Enhancement/ intamammary lymphnodes/ skin lesions/ non-enhancing findings/ associated features

An additional contrast MRI can optimize the extent of locoregional disease in special cases and improve the therapeutical decision making in following cases:

- unclear locoregional extent after performing conventional diagnostics
- lobular carcinoma
- suspicion of multicentricity
- cancer of unknown primary (CUP) and positive lymphnodes
- high genetic risk
- women with breast implants
- women less than 40 years of age
- response assessment of neoadjuvant chemotherapy
- high breast density
- diagnostics of local recurrence
3. Amount of fibroglandular tissue (FGT)

Descriptive - Not as percentage (T1 with and without FS):

- a. Almost entirely fat
- b. Scattered fibroglandular tissue
- c. Heterogeneous fibroglandular tissue
- d. Extreme fibroglandular tissue

If not evenly distributed → description of the part with the most fibroglandular tissue

Categorization in „a to d“ reasonable → translatable into every language
3. Amount of fibroglandular tissue (FGT)

Amount of fibroglandular tissue

→ **No criterion for MRI assessability** (likelihood of missing sth.)
→ Amount of fibroglandular tissue + degree of Background Enhancement do not correlate with each other
→ could **at most indicate the breast cancer risk**
  (higher mammographic breast density is associated with higher breast cancer risk)

**Essential for Assessability of MRI:**

Degree of Motion artifacts + Background Enhancement (BPE)
Pixel shift artifact on subtraction images due to patient motion → misinterpretations

due to pixelshift: “pretended enhancement”: false positive

due to pixelshift: “missed enhancement”: false negative
3. Amount of fibroglandular tissue (FGT)

Amount of fibroglandular tissue  →  No criterion for MRI assessability (likelihood of missing sth.)

Essential for assessability of MRI: Degree of Motion artifacts  +  Background Enhancement (BPE)

In case of Motion Artifacts (pixelshift)  →  false positive  +  false negative findings pretended

Motion artifacts should be described in degrees
Impression: how valid/assessable the examination is
Numerical classification (1-4): less mistakable than verbal descriptions

classification of motion artifacts still not included in BRARDS 5th
4. Background Enhancement (BPE)

**Description:** Symmetric or asymmetric
Volume and Intensity of Enhancement
on first-contrast images ~ 90s

**Annotation:** Phase of menstrual cycle / hormonal replacement

- Increased BPE: more BIRADS 3 findings ↑
  - Minimal BE: 27% BIRADS 3 ↑
  - Mild – marked BE: 45-58% BIRADS 3 ↑

- Increased BPE: more false positives ↑
  (BIRADS 4 and 5)

- Increased BPE: associated with ↑ risk of CA

**Problem with BPE terms:**
for each language → translation necessary
essential to find a uniform terminology → danger of confusion relatively high

**German Classification (WOBI)**

- Minimal (minimal)
- Mild (mild)
- Moderate (moderate)
- Marked (marked)

**References:**
- Hambly; AJR 2011
- Baltzer; Röfo 2011
- King; Radiology 2011
- Pike; Ann Oncol. 2013
- Hambly; AJR 2011
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  - *Hambly; AJR 2011*

- increased BPE: more false positives ↑
  - (BIRADS 4 and 5)
  - *Baltzer; Röfo 2011*

- increased BPE: associated with ↑ risk of CA
  - *King; Radiology 2011*
  - *Pike; Ann Oncol. 2013*

**Problem with BPE terms:**
- for each language → translation necessary
- essential to find a uniform terminology → danger of confusion relatively high

Generally: less problems if all classification systems would have

an additional numerical classification (e.g. Level 1-4 for BPE)
- translatable into every language
- less mistakable
4. Background Enhancement (BPE)

**BIRADS 3 + Background Enhancement (BE) according to BIRADS 5th:**

- BPE should not be described as **BIRADS 3**
- If questionable whether BPE → short-time follow-up after 2-3 months possible (≈BIRADS 3)
  - in premenopausal women follow-up should be performed in the 2nd week of menstrual cycle
  - in postmenopausal women + HRT → hormones should be discontinued
- If finding is smaller and less prominent: benign

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**Problem:**

"if **BE has to be monitored** " → **BE is mostly some kind** Non-Mass Enhancement (morphology)

**But** according to BIRADS 5th ed.: **not allowed** to describe **Non-Mass-Enhancement as BIRADS 3**
<table>
<thead>
<tr>
<th>Focus</th>
<th>Morphology</th>
<th>Kinetics</th>
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<td>Initial phase</td>
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<td>Internal enhancement characteristics</td>
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<td>Non-mass enhancement (NME)</td>
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**Changes compared to BI-RADS 4th edition**

- **Focus-Foci= multiple Foci → described as BE** Reasonable!
- **Lobulated → eliminated** No further consequence!
- **Smooth (glatt) → displaced by circumscribed (umschrieben)** No further consequence!
- **Enhancing int. septations → eliminated**
- **Central dot sign → eliminated** Important criteria disappeared!
- **Ductal became → linear** Reasonable!
- **Symmet./ asymmetric NME → Symmet./ asymmetric BE** Reasonable!
- **Stippled Enhancement → described as BE** Reasonable!
- **Reticular Enhancement → eliminated** Important criterion disappeared!
Color maps and/or manually generated curves or CAD

Color maps give a better impression of the lesion's heterogeneity than manually generated curves (provides a more realistic visualization of the dynamic behaviour)

Kinetic analysis is possible

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Color map:
- green = plateau
- blue = persistent curve shape
- red = washout

No changes compared to BIRADS 4th edition
BI-RADS® 5th ed. Kinetics

No changes compared to BIRADS 4th edition

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Color- map with initial fast enhancement postintial: blue = Persistent
green = Plateau
red = Washout

**Significance of dynamics?**

If LN + Fibroadenoma often washout: „malignant kinetic curve“
CA also persistierent curve: „benign kinetic curve“
Kinetics less significance compared to Morphology

Although breast cancers may more frequently show early rapid and delayed washout enhancement than benign breast lesions, there remains substantial overlap in the kinetics of malignant and nonmalignant lesions of the breast.\textsuperscript{15} It has

Malignant lesions: kinetic behaviour depends on

- Histology
- Lesion grade/Aggressivity (G1/G2/G3 - Ki-67)
- Microvessel density

Benign and malignant lesions: large spectrum of initial enhancement + postinitial curve shapes

Kinetics less significance:

A “benign/persistient” curve shape does not rule out cancer!!
Morphology:
central enhancement septations + central dot sign
→ Essential criteria of malignancy
(but no longer included in BIRADS 5th)

1. Subtraction
2. Subtraction
3. Subtraction

BI-RADS® 5th ed. Kinetics - less significance of internal enhancement
Observing the dynamic behaviour

Centrifugal (growing) enhancement
Observing the dynamic behaviour
Centrifugal (growing) enhancement
Observing the dynamic behaviour
Centrifugal (growing) enhancement

BI-RADS® 5th ed. Kinetics - less significance of internal enhancement
Observing the dynamic behaviour
Centrifugal (growing) enhancement
Observing the dynamic behaviour

Centrifugal (growing) enhancement

→ Essential criterion of benign lesions
→ Less vulnerable to errors than color-maps
  (no motion-artifacts / no artificial software corrections)

But not included in BIRADS 5th!
T2 Imaging - with and without Fat Suppression (FS)

- **T2 without FS:** Chemical shift effect (e.g. typical of LN)
- **T2 without FS:** Morphological information (lesion's margin/ surrounding retraction)

Whenever possible use **T2 with FS + without FS**

**T2 with FS (e.g. SPAIR/ TIRM): better visualization of T2**

**High T2 Signal:**
- Cysts
- Ductectasia
- Mucoid Fibroadenoma
- Edematous Changes
- Lymphnode
- Mucinous Carcinoma
- Higher aggressive CA
- Peritumoral Edema

**T2 Signal intermediate (to parenchyma):**
- Vast majority of carcinomas

**Ballesio et al.; EJR 2009**

Breast MRI: Are T2 IR sequences useful in the evaluation of breast lesions?

→ **High T2:** 80% benign lesions
  → **Low T2:** 80% malignant lesions

- Sens 82%, Spec 77%, PPV 80%, NPV 80%

**High T2:** does not exclude Carcinoma **but quite important criterion**

- More reliable than dynamics + and even applicable in small lesions (< 5mm)
**T2 Imaging - with and without Fat Suppression (FS)**

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  (e.g. typical of LN)

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  (lesion's margin/ surrounding retraction)

Whenever possible use **T2 with FS + without FS**

**T2 with FS (e.g. SPAIR/ TIRM): better visualization of T2**

- **T2 with FS:** Signal within the lesion  
  benign lesions: ↑ T2, malignant lesions intermediate T2  
  *Ballesio et al.; EJR 2009*

- **T2 with FS:** Signal of the surroundings  
  peritumoral/ prepectoral und subcutaneos edema  
  suspicious signs of malignancy:  
  *Uematsu; Breast Cancer 2015*

- **T2 with FS:** Visualization of milkducts  
  helpful for localization of intraductal lesions  
  *Duct obstruction due to cancer*  
  *filling defect due to papilloma*  
  *Example Uematsu*  
  *Cancer with peritumoral and prepectoral edema*
T 2 Imaging - with and without Fat Suppression (FS)

Subtraction

- Clustered ring enhancement

T2 with FS: SPAIR

- No small cysts on T2 + intermediate T2 signal

- Highly suspicious of DCIS

Biopsy: DCIS
T2 Imaging - with and without Fat Suppression (FS)

Subtraction

T2 with FS: SPAIR

clustered ring enhancement

several small cysts with high T2 signal

less likely to be DCIS: Biopsy → cystic ductectasia
**Statement in terms of BIRADS 5th:**

Some helpful **differentiation criteria** have been **eliminated**

+ **others never been included**  
  (meaning of T2)

nevertheless **essential to apply them** for lesion assessment

- clustered ring enhancement

less likely to be DCIS:
  
**Biopsy → cystic ductectasia**
Problems with MR assessment

Different enhancement categories

Mass

Focus (< 5mm)

Non - Mass (NME)

BIRADS- classification based on **Morphology + Kinetics**

**Weighting** of the morphologic + dynamic criteria is different
(in case of Focus + NME dynamics are of less significance)

**Management** different (different significance of Second look US/
different recommendations on follow-up etc.)
Significance of Assessment Criteria

- **Mass**
  - Morphology *highest significance* +++
  - Kinetics (dynam. observation) important ++
  - Sec. Look US important ++
  - Follow-up easily assessable +++
  - (Size/Intensity of Enhanc.)
  - Diffusion *interm. significance* +(+)

- **Fokus (< 5mm)**

- **Non- Mass (NME)**

Problems with MR assessment
Problems with MR assessment

Significance of Assessment Criteria

Mass

Focus (< 5mm)

Non-Mass (NME)

Morphology **highest significance** +++
Kinetics (dyn. observation) **important** ++
Sec. Look US **important** ++
Follow-up **easily assessable** +++
Diffusion **interm. significance** +(+)

Morphology **less significane** +
Kinetics dangerous (Partial volume) –
Sec. Look US **intermed. signific.** +(+)
Follow-up **highest significane** +++

(C. KurtzRadiologie - Luzerner Kantonsspital)
**Focus**

Def: < 5mm; solitary + with contrast against the BE
too small to be accurately assessed (margin/ internal enhancement)
too small for reliable kinetics (partial volume of surrounding tissue)

**Criteria for benign:**
- high signal on T2 (T2/ STIR) + not unique
- possibly fatty hilum (=LN)
- persistent kinetics (postinitial)
- stable compared to prior examination

**Criteria for suspicious** (definitive biopsy)
- unique + distinct from the BPE
- no fatty hilus
- washout- kinetics
- new or increased in size

If not hyperintense on T2

\[\rightarrow\] benign or malignant
\[\rightarrow\] Follow-up or Biopsy

**Screening- Situation**
Follow-up with acceptable risk (< 5mm)

**Preoperative Situation** → individual decision
If lesion is neglected (biological relevancy) or
greater surgical excision (lesions adjacent to index tumor) or
pre-operative MR-Vacuum biopsy

However in reality → assessment only possible in context with the clinical setting
**BIRADS 3 - Follow-up**

Likelyhood of malignancy ≤ 2%

**Major problems**

- **Application intuitive** (no precise definition what is exactly BIRADS 3/ hardly any publications)
- **No robust data** on unproblematic application (contrary to mammography)
- **BIRADS 3 possible** in certain casee of focus / mass → should not be applied to NME

<table>
<thead>
<tr>
<th>N=</th>
<th>Collective</th>
<th>Frequency BIRADS 3</th>
<th>Malignitäts-Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Kuhl; Radiology 2000</strong></td>
<td>192</td>
<td>BRCA 1 and 2 carriers</td>
<td>10 % (19/192)</td>
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<tr>
<td><strong>Lberman Cancer 2003</strong></td>
<td>367</td>
<td>women with increased risk</td>
<td>24 %</td>
</tr>
<tr>
<td><strong>Sadowski; J Magn Reson Imaging 2005</strong></td>
<td>473</td>
<td>unclear Mx/ US finding</td>
<td>17 %</td>
</tr>
<tr>
<td><strong>Eby; J Magn Reson Imaging 2007</strong></td>
<td>809</td>
<td>heterogeneous</td>
<td>20 % (160/809)</td>
</tr>
<tr>
<td><strong>Weinstein; Radiology 2010</strong></td>
<td>969</td>
<td>Contralateral breast in women with breast cancer (no anti-hormonal therapy)</td>
<td>11 % (106 von 969)</td>
</tr>
</tbody>
</table>

**BIRADS 3 NME more frequently used by inexperienced diagnosticians** (assurance)

14-34 % of all patients (every 3rd patient) → Costs + Uncertainty in patients ↑

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*C. Kurtz Radiologie - Luzerner Kantonsspital*
BIRADS 3 NME - Definitions

Mass

Fokus (< 5mm)

Non- Mass (NME)

Official BIRADS 5th Statement

BIRADS 3 possible, if questionable Background Enhancement (2 months control)
BIRADS 3 should not be used for Non-Mass Enhancement

„Data are not sufficient robust“

But: Background Enhancement ist mostly some kind of NME
Why is it difficult to unambiguously classify \textit{NME} as BIRADS 2 ?

Chen; Magn Reson Imaging 2008. \textit{N=31}

Fibrocystic changes were evaluated

\to when applying either \textit{morphologic} or \textit{kinetic criteria}

\to 29 \% classified as suspicious of malignancy

Why is it difficult to perform follow-ups of \textit{NME} ?

- 3 dimensional enhancement \to deformation by different breast compression
- Dynamics (difficult to monitor) \to NME often some kind of background enhancement with
  \textit{\triangle} intensity of enhancement (7th or 14th day of menstrual cycle)
- DCIS (especially low grade): can be constant in size over a longer time period

\textit{identical NME with CC und LM compression} \to \textit{different shape}
For final BIRADS classification (BIRADS 2 /3 /4 or 5): **further criteria essential**

<table>
<thead>
<tr>
<th>Imaging criteria</th>
<th>+</th>
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<tbody>
<tr>
<td>T2 criteria (intra/ peritumoral)</td>
<td>Complaints/ Age of the patient</td>
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<tr>
<td>Morphologic criteria</td>
<td>Risk situation (familial/ genetic high risk or only increased risk)</td>
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<tr>
<td>Observing kinetic enhancement (z.B. cine-loop)</td>
<td>Previous biopsies with suspicious findings</td>
</tr>
<tr>
<td>Diffusion ....</td>
<td>Already confirmed cancer (likelihood of another cancer in ipsilateral breast ↑)</td>
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<td>Pathologic nipple discharge</td>
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<td>Previous findings at conventional imaging</td>
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<td>Habits of your institution/ MR-team (follow-up or biopsy)</td>
</tr>
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</table>

Caution: Be careful of using BIRADS **just based on Imaging Features** ！！！！！

For „adequate classification“ the factors mentioned above have to be taken into account

Basis: certain experience and close reference to the clinical situation

Each attempt to define BIRADS 3 **just by Imaging Features** → unwanted ↑↑ BIRADS 3
Conclusion: New BIRADS 5th - What is good - What is controversial?

- clearer in terms of classification features (e.g. BPE)
- more helpful in lesion assessment (especially Focus)

When a report is addressed to a referring physician → „How valid/assessable is this report“?

Described by 2 components: **Background Enhancement + Motion Artifacts**

(Not by the amount of fibro glandular tissue FGT)

To describe the degree of BPE + motion artifacts → alphanumeric descriptions generally less unmistakable (e.g. Level 1 - 4)

**Reasonable Approach for MRI Assessability**
Be aware, that using the current BIRADS 5th Lexicon criteria might not be sufficient.

Also consider essential criteria we had before even if they are not mentioned in the report.

Consider other criteria still not included in BIRADS 5th Lexicon criteria.

Central dot sign → predominantly malignancy
Central enhancing septations → predominantly malignant
Reticular enhancement → frequently in lobular cancer

T2 without FS: chemical shift + morphological information
T2 with FS: signal within the lesion + signal of surroundings there might be even more criteria.....

Final conclusion: Use the BIRADS 5th lexicon criteria + additional reasonable criteria.
Thank you for your attention.