



ORIGINAL REPORT

## Breast MR imaging changes after neoadjuvant chemotherapy: Correlation with molecular subtypes<sup>☆</sup>

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### KEYWORDS

Breast cancer;  
Breast magnetic  
resonance imaging;  
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Molecular subtypes

### Abstract

**Objective:** MRI is an imaging technique that is best suited for evaluating the response to neoadjuvant chemotherapy for locally advanced breast cancer. We aimed to (a) quantify the response in the molecular subtypes, (b) describe the morphological and dynamic variation, and (c) determine whether the molecular phenotype changes after chemotherapy.

**Material and methods:** This is a retrospective study of 75 carcinomas in 69 patients who underwent MRI both before and after neoadjuvant chemotherapy. The response to treatment was classified as (a) complete response, (b) major partial response, (c) minor partial response, or (d) no response. We quantified the response in each molecular subtype (luminal A, luminal B, Herb 2+, and triple negative). The morphological changes were classified as (a) concentric reduction, (b) fragmentation, (c) ductal enhancement, or (d) necrosis. The dynamic changes affected the maximum intensity peak and the post-initial enhancement.

**Results:** In the 4 molecular subtypes, 4 types of response were seen. The response was good in 84.6% of the triple negative subtype, in 76.9% of the luminal B subtype, in 75.6% of the luminal A subtype, and in 69.2% of the Herb 2+ subtype. The predominant morphological change was concentric reduction (75%). The predominant dynamic change was a decrease in the maximum intensity peak (<100% in 64.2%), and type I or II curves were seen in 85.7%.

**Conclusions:** The triple negative subtype responded best to neoadjuvant chemotherapy. The most common changes were concentric reduction and a decrease in the maximum intensity peak, with fewer washout curves. We observed a change in the molecular phenotype between the specimen at diagnosis and the final study in 12.2% of cases.

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**PALABRAS CLAVE**

Cáncer de mama;  
 Quimioterapia  
 neoadyuvante;  
 Resonancia  
 magnética;  
 Subtipos moleculares

## Resonancia magnética de mama: cambios en la imagen del cáncer tratado con neoadyuvancia. Correlación con subtipos moleculares

**Resumen**

**Objetivo:** La RM es la técnica de imagen que mejor valora la respuesta a la quimioterapia neoadyuvante en el cáncer de mama localmente avanzado. Los objetivos son: primero, cuantificar la respuesta en los subtipos moleculares; segundo, describir las variaciones morfológicas y dinámicas, y tercero, valorar si el fenotipo molecular se modifica tras la quimioterapia.

**Material y métodos:** Estudio retrospectivo de 75 carcinomas, en 69 pacientes con quimioterapia neoadyuvante. Se realizó RM pre y post-tratamiento. La respuesta se clasificó en: respuesta completa; respuesta parcial mayor; respuesta parcial menor y sin respuesta, cuantificando cada una en cada subtipo molecular (luminal A, luminal B, Herb 2+ y triple negativo). Los cambios morfológicos fueron: reducción concéntrica, fragmentación, realce ductal y necrosis. Los cambios dinámicos afectaron al pico de intensidad máxima y al realce post-inicial.

**Resultados:** En los 4 subtipos moleculares se observaron los 4 tipos de respuesta. El triple negativo tuvo 84,6% de buenas respuestas, seguido del luminal B (76,9%), luminal A (75,6%), y Herb 2+ (69,2%). El cambio morfológico que predominó fue la reducción concéntrica en el 75% y el dinámico fue la disminución del pico de intensidad máxima, <100%, en el 64,2%, con predominio de curvas tipo I y II en el 85,7%.

**Conclusiones:** El subtipo triple negativo es el que mejor respondió a la quimioterapia neoadyuvante. Los cambios más frecuentes fueron la reducción concéntrica y la disminución del pico de intensidad máxima con menos curvas de lavado. El cambio del fenotipo molecular fue del 12,2%, entre la muestra al diagnóstico y el estudio final.

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**Introduction**

The introduction, at the end of the nineties, of neoadjuvant chemotherapy (NC) as an initial treatment of locally advanced breast cancer (LABC) has provided the following important advantages: (a) assessment of tumor chemosensitivity; (b) reduction in tumor size, improving the surgical outcome, and (c) early treatment of micrometastases.

The major disadvantage is, in case of poor response, the delay in surgery.

Compared with conventional techniques, magnetic resonance (MR) imaging has proven to be the most accurate technique<sup>1-3</sup> to evaluate the response to NC.

NC is given on the basis of the immunohistochemical analysis of estrogen receptor (ER), progesterone receptor (PR) and epidermal growth factor receptor 2 (Herb 2+). Recent studies suggest that breast cancer is a group of distinct neoplasms<sup>4,5</sup> that can be classified according to the molecular phenotype as luminal A, luminal B, basal-like or triple negative, and Herb 2+ subtypes (Fig. 1).

We aim to quantify the response to NC in the molecular subtypes, describe the morphological and dynamic variations undergone by the tumor after NC, and quantify changes in the molecular phenotype in those patients with immunohistochemical studies available before and after NC.

**Material and methods**

Descriptive retrospective study was conducted between 2003 and 2009, of 75 carcinomas in 69 patients (68 females and 1 male) treated with NC. The age range was 31–74 years (mean 53.4 years), 44% of patients were <50 years and 2 had

pregnancy associated breast cancer detected during the first two months of lactation.

All patients underwent an MRI examination before and after the NC.

From 2003 to 2006, the MRI examinations were performed with a GE Signa scanner using FSE T1 (375/14) sequences, T2 (2975/85) sequences with fat saturation, and one axial dynamic 3D sequence, with 6 phases of 90s (5 with contrast and 1 without). From 2006 to 2009, all MRI examinations were performed with a GE Excite scanner using FSE T1 (600/10) sequences, sagittal T2 (4000/85) sequences with fat saturation, and one dynamic 3D VIBRANT sequence with 6 phases of 90s (5 with contrast and 1 without). The dose of gadolinium was 0.15 mmol/kg.

The morphological and dynamic pattern of enhancement was classified according to BI-RADS as mass and non-mass enhancement (diffuse, regional, focal area and ductal enhancement). In the dynamic assessment, the initial enhancement during the first 2 min was evaluated and considered as moderate when <100% and intense when >100%. The post-initial enhancement was classified as persistent (curve I), plateau (curve II), and washout (curve III). The most suspicious curve was selected in all cases.

Tumor volumes were estimated using the 3D MIP images of the MRI examinations performed before and after the NT, with 4 types of response:

- (1) Complete response (CR): absence of enhancement or reduction in the volume of enhancement >99%.
- (2) Major partial response (MPR): reduction in the volume of enhancement >50%.
- (3) Minor partial response (mPR): reduction in the volume of enhancement <50%.

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