lack of specificity can delay early detection and treatment of recurrent lesions [8]. The ultrasound examination is used as a complementary follow-up imaging modality of the treated breast, especially in radiodense breasts. This examination does have high sensitivity if performed at regular intervals, because of the detection of hypoechoic nodules within fibrous hyperechoic tissue [3]. The sensitivity of ultrasound is user dependent, however, and it is limited when evaluating small or noninvasive lesions, especially in fatty breasts.

For these reasons, MRM is considered a useful additional examination in patients with suspicion of recurrence [7,8]. Progress in breast MRI has been limited by a lack of standardization in the acquisition and interpretation of MRM images, with some studies focusing on morphology (spatial resolution) [19] and other studies stressing kinetics (temporal resolution) [20,21].

In the present study, the multifactorial evaluation protocol proposed by Fischer and colleagues [1] was used to evaluate enhancing lesions on the site of prior lumpectomy, based both on their morphologic and kinetic characteristics, in an attempt to standardize their evaluation. The number of true-negative cases confirmed by histology (12 lesions) demonstrates that 12 unnecessary biopsies could have been avoided using this multifactorial protocol.

The dynamic enhancement pattern, combined with morphology, on contrast-enhanced MRI of breast masses, allows reproducible lesion characterization [22], and it is useful to differentiate between benign and malignant lesions [21,23]. A review of the literature has reported a sensitivity of more than 90%, and 85–100% specificity, for MRM to detect recurrence [7,10,24-26]. In the present study MRM correctly detected 8/9 lesions on the surgical scar, all being infiltrating carcinomas.

The sole false-negative lesion was an infiltrating mucinous carcinoma. The lesion showed well-defined margins, regular shape and homogeneous contrast enhancement, with a moderate initial increase and a steady increase in later sequences (graded as Fischer 2 and BI-RADS II). Other cases of infiltrating mucinous breast cancer not detected by MRM have been described [27,28]. The large amount of mucus slows the diffusion of contrast medium through the entire tumor [27,29], and thereby induces gradual enhancement curves [30,31]. T2-weighted images have been considered useful because of the very high signal intensity on these sequences compared with other histologic types [29]. In this case, the T2-weighted sequence would probably have been helpful in detecting the mucinous lesion. Nevertheless, this type of sequence is not routinely performed in our institution because of the low rate of this histological type (1–4%) [29].

MRM in the present study found seven false-positive cases, although all examinations were performed at least 6 months after treatment. Other studies have demonstrated difficulties in differentiating a recurrent tumor from postoperative changes within 6 months after surgery [32] and within 12 months after radiation therapy [33]. In the seven false-positive cases described herein, the mean time between treatments and MRM was 13 months, and only in two of these cases was the time between the end of radiotherapy and MRM shorter than 12 months (6 months and 8 months, respectively).

The high sensitivity in detection of multifocality, in particular for lesions located far from the scar, has influenced the type of repeat surgery (quadrantectomy versus mastectomy). These results are comparable with other studies [9] performed on smaller numbers of patients.

Of particular relevance is the very high negative predictive value of MRM (98.7%), which indicates a very low likelihood of new malignancy if MRM defines the lesion as benign. These results suggest that lesions graded by MRM as Fischer I–II (BI-RADS I–II) can be safely monitored with the usual yearly follow-up. A repeat MRM examination after 6 months is recommended for lesions graded as Fischer III (BI-RADS III), if there is no clinical suspicion of recurrence before 6 months. For lesions graded higher than Fischer IV (BI-RADS IV–V), further cytological or histological evaluation is mandatory.

One limitation of this study is the lack of *in situ* ductal carcinoma in our series. Ductal carcinoma *in situ* is considered one of the most common causes of false-negative results at MRM [34], and this can decrease the diagnostic accuracy of the technique. In the present series we found no ductal carcinoma *in situ*, and this does probably justify the 93.8% overall sensitivity with only one false-negative case. Another limitation was that imaging examinations were evaluated by a single reviewer. We therefore did not assess the interobserver variability in the use of this multifactorial protocol.

Conclusion

This series demonstrates the high sensitivity and high specificity of MRM in confirming or excluding recurrence at the prior lumpectomy site, after conservative surgery and radiation therapy, when recurrence was already suspected either by mammography (including the associated clinical examination) or by ultrasonography. MRM has shown an overall high negative predictive value (98.8%) in the detection of breast cancer, including lesions not related to the surgical scar.

Despite the high accuracy of MRM in detecting recurrence on the site of lumpectomy, its cost and low availability limit its use for the routine follow-up of treated patients. In some conditions, however, as in the presence of radiodense breasts and/or structural post-treatment changes, MRM represents an important diagnostic modality in support of the other traditional imaging modalities, and it can be considered conclusive when showing negative findings.