Do Better with Less: Combining Ultrafast MRI with Artificial Intelligence for Breast Cancer Detection

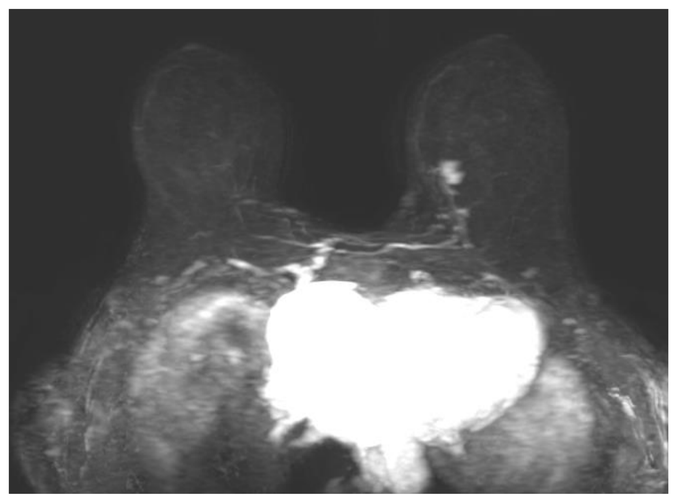
Belinda Lokaj, Jamil Zaghir, Daniel Keszthelyi, Christophe Gaudet-Blavignac, Hugues Turbé, Jean-Philippe Goldman, Mina Bjelogrlic, Karen Kinkel, Jérôme Schmid, Christian Lovis

INTRODUCTION

Breast cancer is the leading cause of death in women. Compared to mammography, **breast MRI** is more sensitive and not dependent of breast density. Therefore, MRI has been increasingly highlighted as a tool for breast cancer screening [1].
High costs and availability are the main limitations of this technique, therefore abbreviated protocols (e.g. ultrafast sequence) are investigated to enable wide utilization of breast MRI.

Kinetic parameters derived from 4D ultrafast sequence have shown significant **discrimination between benign and malignant** lesions [2].

OBJECTIVE : Exploit deep learning approach with ultrafast MRI sequence for breast lesion classification.



MIP reconstruction of ultrafast images with a lesion

METHODS

Dataset : MRI examinations from Clinique des Grangettes – Hirslanden performed with Philips Ingenia 3T were collected. A total of 415 lesions were identified and segmented.

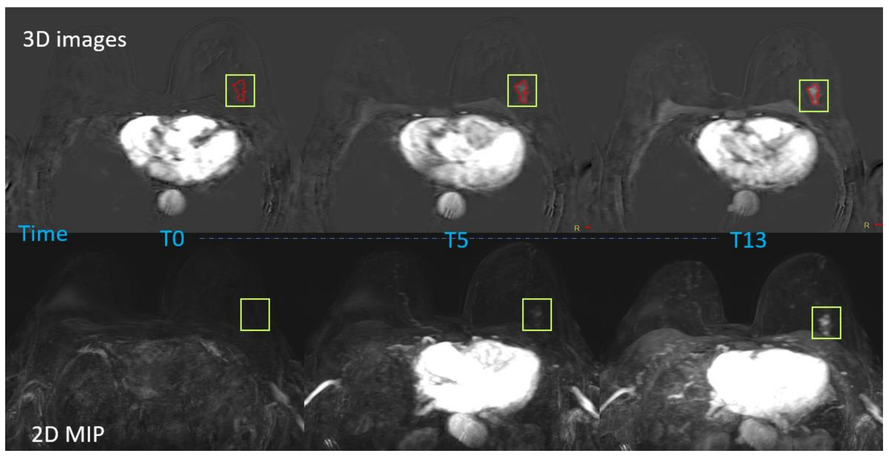
(Approved by Geneva Cantonal Ethics Committee (CCER) Project-ID: 2019-0716)

For the first experiments, classification of two kind of data prepared from the segmentations were assessed :

- 3D segmentations of the last phase of 4D ultrafast
- 3D MIP series stacks (each phase of 4D ultrafast)

ResNet-50 and DenseNet-121 models were tested with 3D segmentations data and 3D MIP stacks data.

- Datasets : train (80%), validation (20%), test (103 supplementary lesions)
- Geometric data augmentation
- Balanced sampling



RESULTS

DenseNet-121 performs better than ResNet-50.

Comparison between the two type of data shows almost similar performances regardless of the model architecture.

Results shows better performance compared with literature [3] that tested classification with MIP-like data and DenseNet. (AUC 0.884 vs 0.811).

3D segmentations (last phase only)						
model	**acc**	**auc**	**npv**	**ppv**	**se**	**sp**
ResNet-50	0.777	0.795	0.911	0.333	0.533	0.818
DenseNet-121	0.854	0.911	0.951	0.500	0.733	0.875
3D MIP stacks (each phase)						
model	**acc**	**auc**	**npv**	**ppv**	**se**	**sp**
DenseNet-121	0.835	0.884	0.961	0.462	0.800	0.841
ResNet-50	0.777	0.842	0.933	0.357	0.667	0.795

CONCLUSION

Preliminary investigations show **promising and reliable results**.

Currently, most studies using 4D ultrafast sequence with deep learning approaches apply techniques to reduce data dimensionality (e.g., MIP reconstructions).

However, it is expected that **fully exploitation of 4D nature (3D spatial + time)** of the sequence could improve classification performances.

This work is part of the SUBREAM project funded by the swiss cancer research (Project n° KFS-5460-08-2021-R)

1. C. K. Kuhl, "Abbreviated Magnetic Resonance Imaging (MRI) for Breast Cancer Screening: Rationale, Concept, and Transfer to Clinical Practice," Annu. Rev. Med., vol. 70, no. 1, pp. 501–519, Jan. 2019, doi: 10.1146/annurev-med-121417-100403.
2. R. M. Mann, R. D. Mus, J. van Zelst, C. Geppert, N. Karssemeijer, and B. Platel, "A Novel Approach to Contrast-Enhanced Breast Magnetic Resonance Imaging for Screening: High-Resolution Ultrafast Dynamic Imaging," Invest. Radiol., vol. 49, no. 9, pp. 579–585, Sep. 2014, doi: 10.1097/RLI.0000000000000057.
3. M. U. Dalmiş et al., "Artificial Intelligence-Based Classification of Breast Lesions Imaged With a Multiparametric Breast MRI Protocol With Ultrafast DCE-MRI, T2, and DWI.," Invest. Radiol., vol. 54, no. 6, pp. 325–332, Jun. 2019, doi: 10.1097/RLI.0000000000000544.

SIMED@HUG SIMED@UNIGE

krebsliga schweiz ligue suisse contre le cancer lega svizzera contro il cancro

Hes·so Haute Ecole Spécialisée de Suisse occidentale

UNIVERSITÉ DE GENÈVE FACULTÉ DE MÉDECINE

HUG Hôpitaux Universitaires Genève

SIMED