MSc project Bone Metastasis Detection & Segmentation

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Co-supervisor: Dr. Hans Peeters (Philips Healthcare MR)

The clinical problem

Breast and prostate cancer are primary cancers in women and men, and predominantly metastasize in bone. Fast and accurate detection of bone metastasis is needed, in order to diagnose its severity, to select and plan therapy and follow its effectiveness.

Current clinical practice

Magnetic resonance imaging (MRI) is often used for metastatic bone cancer screening as well as to assess therapy response. For this purpose, whole-body MRI acquisitions (WB-MRI) are used, which consist of multiple scans (in one examination), amongst others a T1-weighted mDixon and a DWIBS (diffusion weighted whole body imaging with background body signal suppression) scan. Since the human body is too large to be scanned at once, different parts are scanned separately and the resulting 3D images are later on merged (so-called multi-station MRI). Currently, the location and size of potential metastatic lesions are manually determined by clinical experts, which is very time consuming and prone to inter-clinician variation. Figure 1 shows a few example MR images.

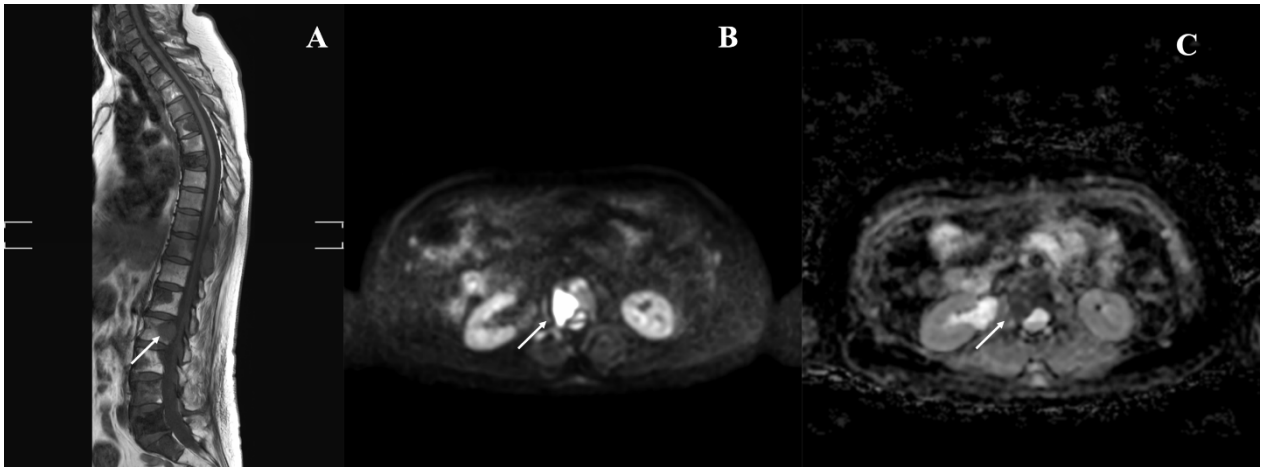

Figure 1*: Woman with bone metastatic breast cancer. Sagittal T1 weighted TSE MRI sequence (A) shows multiple low signal metastases in the spine. The metastases have high signal intensities on b800 diffusion weighted MR images (B). The corresponding Apparent Diffusion Coefficient (ADC) map (C) was used for quantitative measurements. The white arrow indicates the same metastasis.*

The required solution

A solution is needed for fully automatic, fast (few minutes) and accurate detection and segmentation of all metastasized bone cancer lesions, based on the multiple types of jointly acquired MRI data.

The MSc project

The goal of this MSc project is to develop and evaluate medical image analysis algorithms for the fully automatic detection and segmentation of metastatic bone cancer lesions. The project will consist of the following steps:

- **Image registration**: WB-MRI acquisitions consist of multiple image series, acquired at different time moments in the scan session, with different acquisition parameters. Patient motion and geometric distortion (due to MRI) first need to be compensated by flexible registration of all involved image series. After registration, all MR images should be sufficiently accurately aligned, and will serve as input for the subsequent lesion detection and segmentation steps.
- **Cancer detection**: In the first instance it is primarily of importance to detect the locations (e.g. center) of all bone cancer lesions. Conventional as well as more modern machine learning techniques like deep learning could be used to achieve this.
- **Lesion segmentation**: To be able to follow the effect of therapy over time, the lesion boundaries need to be accurately segmented, either with conventional or with machine learning approaches such as deep learning.
- **Accuracy evaluation**: The accuracy of the image registration, detection and segmentation needs to be quantitatively evaluated on image material that was not used during optimization of the algorithms. Before the start of the evaluation, a proper study design needs to be formulated.
- **Reporting**: A final report will be written in the form of a scientific article, using the IEEE scientific journal template. Potentially, an abstract about the performed research can be submitted to a scientific conference, and an adapted version of the final report can later on be offered for publication to a scientific journal.
- **Final presentation & defense**: The MSc project is concluded with a 25-min presentation and a 45-min defense session.

The project will be performed in cooperation with the MR Clinical Science department of Philips Healthcare in Best, with Senior Clinical Scientist Dr. Hans Peeters as co-supervisor. MR image data will be supplied by hospitals cooperating with Philips.

Expected skills and experience

- Medical image analysis (e.g. courses 8DC00, 2DMM10)
- Programming in Python, other languages (e.g. course BMB502417)
- Machine learning / deep learning (e.g. courses 8DM40, 8DM00)
- Experimental study design (course 8DM20)
- Written and oral communication in English

Contact

Are you interest in this project?

Do you want more information?

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