

Radiomics, radiogenomics and artificial intelligence in musculoskeletal radiology

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Thesis submitted to fulfill the requirements for the
degree of 'Doctor of Health Sciences'

Academic year 2023-2024

SUMMARY

This PhD thesis has introduced the main principles of artificial intelligence, machine learning, deep learning, radiomics, radiogenomics and its applications in musculoskeletal radiology, with a focus on haematological disorders (multiple myeloma and precursors, Erdheim-Chester disease and solitary plasmacytoma of bone), musculoskeletal bone tumours (osteosarcomas, giant cell tumours of bone and central cartilage tumours) and rheumatic diseases. Alongside modern multiparametric imaging techniques, these new postprocessing and analysis solutions allow for deeper insights regarding diagnosis, differential diagnosis, opportunistic screening, therapy response monitoring and clinical outcome prediction. In general, automatic parameter or feature extraction, segmentation, lesion detection, classification or categorisation and prediction of clinical outcomes can assist researchers and clinicians to provide higher quality and personalised care to patients. In the mentioned technical and clinical domains, this PhD thesis provides a solid basis for further research. In this way, earlier and more tailored (differential) diagnostic and therapeutic pathways can be established in a patient-centred way to deliver personalised care, performed by clinicians that are informed by both clinical and technical parameters and that are assisted by high-end software solutions to gain deeper insights.

SHORT CURRICULUM VITAE

EDUCATION

2019-present	Master of Science in Specialist Medicine, Radiology, Ghent University
2019	Radioprotection and Use of X-rays, Ghent University
2016-2017	Patient Care in French, Ghent University
2016	Introduction in Electrocardiography, Ghent University
2016	International and Global Development in Patient Care, Ghent University
2015-2019	Master of Science in Medicine, Ghent University
2015	Medical English, Ghent University
2013-2015	Honours Program in Life Sciences, Ghent University
2012-2015	Bachelor of Science in Medicine, Ghent University
2010-2012	Bachelor of Science in Civil Engineering, Royal Military Academy Brussels

PROFESSIONAL AND RESEARCH EXPERIENCE

2023-present	Co-Founder and CMO RheumaFinder BV
2019-present	Radiology Resident and PhD Researcher, Ghent University (Hospital)

AWARDS AND GRANTS

2024	Research Award, University Foundation
2023	Innovation Project Award, VLAIO
2023	Invest in the Youth Award, ESR
2022	Faculty Mobility Fund, Ghent University
2022	Best Oral Presentation Award, ESSR Congress Rostock
2022	Young Researcher Grant, ESSR
2021-2022	Xavier Rogiers Research Award, Ghent University

PUBLICATIONS (*shared first authorship)

GM Kalisvaart*, RE Evenhuis*, W Grootjans, **T Van Den Berghe** et al.

Relative wash-in rate in dynamic contrast-enhanced magnetic resonance imaging as a new prognostic biomarker for event-free survival in 82 patients with osteosarcoma: a multicentre study. *Cancers* 2024

T Van Den Berghe*, B Verberckmoes*, N Kint et al.
Predicting cytogenetic risk in multiple myeloma using conventional whole-body MRI, spinal dynamic contrast-enhanced MRI, and spinal diffusion-weighted imaging. *Insights Into Imaging* 2024

T Van Den Berghe*, F Delbare*, E Candries et al.
A retrospective external validation study of the Birmingham Atypical Cartilage Tumour Imaging Protocol (BACTIP) for the management of solitary central cartilage tumours of the proximal humerus and around the knee. *European Radiology* 2024

T Van Den Berghe, M Lejoly, D Dorleijn et al.
Which imaging features give the best positive/negative predictive value for differentiating an enchondroma from an ACT/chondrosarcoma? *BOOM World Consensus* 2024

T Van Den Berghe, M Lejoly, D Dorleijn et al.
Can chondrosarcoma be safely diagnosed by radiology alone using radiology classifications e.g., BACTIP, RAS? *BOOM World Consensus* 2024

GM Kalisvaart*, **T Van Den Berghe***, W Grootjans et al.
Evaluation of response to neoadjuvant chemotherapy in osteosarcoma using dynamic contrast-enhanced MRI: development and external validation of a model. *Skeletal Radiology* 2023

T Van Den Berghe, D Brack, A De Clercq et al.
Plasmacytoma. *Medical Radiology – Diagnostic Imaging* 2023

A Baur-Melnyk*, **T Van Den Berghe***, KL Verstraete
Plasma cell dyscrasias: multiple myeloma and precursors. *Musculoskeletal Imaging*, 3rd edition 2023

M Lejoly, **T Van Den Berghe**, D Creytens et al.
Diagnosis and monitoring denosumab therapy of giant cell tumour of bone: radiologic-pathologic correlation. *Skeletal Radiology* 2023

T Van Den Berghe, D Babin, M Chen et al.
Neural network algorithm for detection of erosions and ankylosis on CT of the sacroiliac joints: multicentre development and validation of diagnostic accuracy. *European Radiology* 2023

T Van Den Berghe, E Candries, N Everaert et al.
Erdheim-Chester disease: diffusion-weighted imaging and dynamic contrast-enhanced MRI provide useful information. *Skeletal Radiology* 2023

M Chen, K Yu, X Hu, **T Van Den Berghe** et al.
Proton density fat fraction (PDFF) maps aid fat metaplasia evaluation in the sacroiliac joints in addition to T1WI: improved diagnostic accuracy in axial spondyloarthritis. *European Journal of Radiology* 2022

T Van Den Berghe, L Lapeire, M Lejoly et al.
Imaging findings and value of CT and (DCE-)MRI in monitoring denosumab therapy of giant cell tumours of bone. *Seminars in Musculoskeletal Radiology* 2022

FE Lecouvet, M-C Vekemans, **T Van Den Berghe** et al.
Imaging of treatment response and minimal residual disease in multiple myeloma: state of the art WB-MRI and PET/CT. *Skeletal Radiology* 2021

T Van Den Berghe, KL Verstraete, FE Lecouvet et al.
Review of diffusion-weighted imaging and dynamic contrast-enhanced MRI for multiple myeloma and its precursors (monoclonal gammopathy of undetermined significance and smouldering myeloma). *Skeletal Radiology* 2021

Funding

Department of Diagnostic Sciences, Ghent University
Department of Radiology, Ghent University Hospital
Research and Development Project, VLAIO
European Society of Musculoskeletal Radiology
European Society of Radiology

Doctoral School of Life Sciences and Medicine

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