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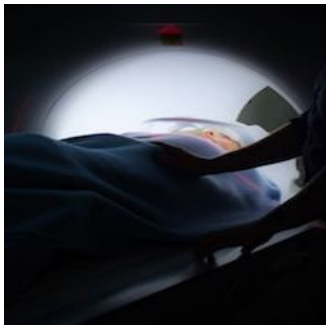
# Radiomics in magnetic resonance imaging: the need for standardisation



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Radiomics is a hot topic in radiology. A steadily increasing number of researchers across the globe is engaging in radiomics and applying it to a large number of imaging data. “Radiomics” means the extraction of a large number of quantitative imaging features from routinely acquired imaging data (e.g, x-ray, ultrasound, CT, MRI, PET) in order to allow for subsequent data mining and model building. Various studies have shown so far the great potential of radiomics for diagnostic decision making, therapy monitoring and outcome prediction, given its ability to detect imaging findings which remain imperceptible to the human eye.

Despite all these encouraging results and the ongoing hype concerning radiomics, several crucial steps must be taken now in order to allow for a further and reliable translation of radiomics to clinical routine. Recently, the Imaging Biomarker Standardization Initiative has been founded, including researchers from several imaging disciplines and from all over the world. This initiative currently is taking the lead in the important step of radiomic imaging biomarker standardisation, although mainly focusing on CT and PET imaging. They aim at a standardised way for radiomic feature extraction by e.g. defining mathematical functions, which then might (and should) be adopted by the various open-source and commercial software solutions, which are currently available.

While such a standardisation appears relatively straightforward for CT and PET imaging, both based on quantitative imaging parameters such as Hounsfield Units and Standardized Uptake Values, MRI poses larger problems when it comes to radiomic image analysis. Radiomics includes—amongst others—the analysis of image texture (‘texture analysis’), consisting of a large number of features basically derived from the analysis of pixel-to-pixel neighbourhoods and the relation of one (or several) pixels to another. Thus, given the mostly qualitative nature of MRI with non-standardised pixel-values and large variations of signal intensities depending on scanner type, selected sequence, coil, field strength and so on, a standardised extraction of quantitative imaging features remains extremely challenging across different institutions and even amongst different scanners of the same vendor. Consequently, the generalisability and robustness of diagnostic radiomics approaches across institutions—which is the basis for a translation to clinical routine—at least remains questionable.

While many studies nowadays are available investigating the robustness of CT-derived radiomics features and delivering interesting insights into the reliability (or non-reliability) of certain features for future clinical studies, little is known on MRI-derived radiomics features. It appears likely

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that MRI-derived radiomics features—at least those based on histogram and various grey-level matrices—will not be robust at all and thus might not be well-suited for being integrated in diagnostic or prognostic models. At least some studies are currently ongoing, which might shed some light on these questions in the near future.

Although this statement might be somewhat frustrating, there might be newer, quantitative MRI techniques such as mapping, ADC or DCE-MRI which have the potential to deliver more robust radiomic features based on their quantitative, absolute pixel-values. However, this is one of my personal hypotheses, which of course has to be investigated in future studies.

So, what is the conclusion of my critical thoughts on standardisation in radiomic MR research? MRI is much more difficult for the field of radiomics than CT or PET imaging and a natural scepticism is recommended when it comes to the analysis of diagnostic or prognostic radiomic MRI signatures in clinical trials. Future and ongoing studies will shed more light on the robustness and applicability of radiomics for standard MR imaging. Quantitative MR technique might represent interesting alternatives for radiomics analyses, which should be further investigated. Besides this, radiomics remains an extremely interesting trend in radiology, moving towards a concert with other 'omics' fields such as genomics, proteomics, metabolomics etc. in a 'multi-omics' approach and finally leading the way towards precision medicine for better patient outcome.

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