

MR imaging for rectal cancer staging

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Scientific Impact

Main aims and outcomes

MRI plays a key role in the diagnostic workup and therapeutic management of rectal cancer. Local tumour staging with MRI is used to identify prognostic risk factors, such as the extent of invasion beyond the bowel wall and the presence nodal metastases, which are used in clinical guidelines to stratify patients into low, intermediate and high-risk groups. While low risk patients typically undergo immediate surgical treatment, intermediate and high-risk patients require neoadjuvant radiotherapy or combined chemoradiotherapy to reduce the risk of a local recurrence. The local tumour stage as assessed on MRI also helps to guide further surgical and radiotherapy planning.

To ensure that the key factors that affect treatment planning are accurately reported, radiologists increasingly use structured reporting templates. These templates are largely based on the Tumour Nodes Metastases (TNM) staging manual, which is one of the most commonly used staging manuals in oncology. In addition to standard TNM parameters, current staging templates also include more recently introduced risk factors such as extramural vascular invasion (EMVI) and the subclassification of T3 tumours according to the depth of extramural invasion. Furthermore, the Dutch National guidelines on colorectal cancer recently added the 'sigmoid take-off' (STO) as a standard landmark to differentiate rectal from sigmoid cancer on imaging. Despite the increased availability and use of reporting guides and templates, there are still several challenges that can lead to uncertainties and variations in the radiological reporting of rectal cancer. With this thesis we set out to explore what are the main controversies that contribute to this variation and look for solutions to further optimize and harmonize the quality of radiological reporting.

One of our main findings was the fact that the experience level of radiologists has a major clinical impact. In [Chapter 3](#) we evaluated how well radiologists were able to apply STO to differentiate rectal from sigmoid cancers. We found good reproducibility ($\kappa 0.7-0.8$) for expert radiologists, but significantly poorer results for less experienced radiologists. In [Chapter 6](#) we performed a global survey involving 255 radiologists to identify what are the main problem areas when radiologists apply the TNM manual to stage rectal cancer on imaging. In several of the identified problem areas where there was huge variation between radiologists, this was mainly an issue for less experienced radiologists, and less so for the more dedicated experts among the survey respondents.

Second, we have learned that a good understanding of pelvic anatomy is an issue of major importance. In our TNM survey in [Chapter 6](#), we demonstrated that several of the identified problem areas were related to radiologists' insufficient understanding of the underlying anatomy, including for example the anatomical differentiation between mesorectal fascia (MRF) and peritoneum, and anatomical definitions to differentiate regional from non-regional pelvic lymph node stations on MRI. In [Chapter 3](#), we found that radiologists experienced difficulties in assessing the STO because they struggled with understanding normal and post-operative variations in pelvic anatomy. These issues indicate a need for more dedicated anatomy-based education and training. To this end, we developed the anatomy-focused MRI pictorial in [Chapter 2](#) to serve as a teaching reference.

A final important outcome of this thesis is that currently available guidelines such as the TNM staging manual may not be sufficiently applicable to the radiological staging setting. Several problem areas identified in [Chapter 6](#) were due to the fact that some definitions as outlined in the TNM staging manual are either ambiguous or difficult to apply for radiologists. Examples include the categorization of cT4b disease, the classification of mesorectal fascia involvement, and the differentiation between lymph nodes and tumour deposits. These are issues for which clear radiological definitions and supporting evidence are lacking, causing radiologists to struggle with them on a daily basis. A multidisciplinary team of experts provided consensus recommendations based on the currently available evidence combined with their own clinical experience. These recommendations may serve as a practice guide and support tool while awaiting further evidence.

In [Chapter 5](#) we assessed the impact of updated radiological guideline definitions (adopted in the 2014 Dutch Colorectal Guideline updates) on risk stratification and treatment planning in the Netherlands. When a dedicated expert radiologist applied these updated definitions on a historical patient cohort dating back from before 2014 to re-classify patients into high-risk versus low-risk diseases, this led to risk-downstaging in up to 18% of patients compared to the original reports using older guideline definitions. This shows that new radiological guideline definitions can have a substantial impact on risk stratification and consequently on therapeutic management. A similar observation was made for the STO that was introduced into the Dutch CRC guidelines in 2019. Although "colorectal cancer" is often reported as a single entity, recommended treatment strategies differ substantially between rectal and sigmoid cancer. For a long time, no uniform or widely accepted definitions were available to

discern rectal from sigmoid cancer. In [Chapter 3](#) we analyzed how applying the STO could have affected treatment management, compared to older guidelines when there were no consistent definitions available. We showed that in a retrospective cohort of 155 patients with tumours near the rectosigmoid junction that were previously treated as 'rectal cancer', 28% would be reclassified as sigmoid cancer using the STO, leading to a potential change in treatment management.

Relevance

The results of this thesis are relevant for radiologists and other clinicians involved in the diagnostic and therapeutic management of rectal cancer. The multidisciplinary expert recommendations from Chapter 6 can serve as a practice guide for radiologists when struggling how to best apply and translate the TNM staging manual to a radiological setting. Chapters 3 and 4 offer advice on how to improve consistency in applying the STO to differentiate sigmoid from rectal cancer on MRI. This can have a direct impact on treatment management as outlined above, but may also affect research outcomes, considering the arbitrary cut-offs points used in previous rectal cancer trials. Moreover, in The Netherlands where centralization has taken place and colorectal cancer centers are required to treat at least 20 rectal cancer patients per year, revised definitions that will result in a shift from rectal to sigmoid cancer in up to one fifth of cases may potentially lead to small volume centers losing its rectal cancer referral position. The anatomy tutorial in Chapter 2 can serve as quick reference for clinicians for anatomical considerations relevant for rectal cancer staging.

The results provided in this thesis are also relevant to develop future strategies to further improve the quality of radiological reporting. Our results support the use of structured reporting templates to promote more clear, concise and consistent reporting. Moreover, our results underline the importance of radiologists' experience when performing staging of rectal cancer, thus highlighting the importance of dedicated training and education as an integral part of guideline implementation strategies.

Target population

Our results are relevant for radiologists performing rectal cancer staging, as well as other clinicians, specifically surgeons, radiation oncologists, clinical oncologists, and pathologists, involved in rectal cancer management. Our findings highlight current concepts and areas of controversy in the imaging workup of rectal cancer that can affect

therapeutic management. We have provided guidance on how to handle some of the main problematic areas and developed support tools to improve the understanding of important anatomical concepts crucial for rectal cancer staging. These support tools can offer guidance for radiologists (and other clinicians) already involved in the multidisciplinary management of rectal cancer, especially those with less dedicated experience. Moreover they can serve as a teaching reference to help train residents in radiology, as well as trainees in surgery and other related clinical fields.

Activities

The results provided in this thesis have been published in peer-reviewed journals and presented to a wide audience at international conferences of both radiological as well as other clinical societies. The clinical recommendations derived from the different chapters have furthermore been disseminated via (online) radiological and clinical teaching courses, such as the rectal imaging workshop of the European Society of Gastrointestinal and Abdominal Radiology (ESGAR). The results were also embedded in the updated section on rectal cancer staging of the Radiology Assistant website (published online in 2021), which is one of the key educational reference sites for residents and radiologists worldwide, hosted by the Radiological Society of The Netherlands. The results of Chapter 6 were awarded as one of the best rated scientific abstracts in gastrointestinal cancer imaging during the annual congress of ESGAR in 2021. Finally, the results of this thesis may serve as a basis for future guideline updates.