

Appendix 1 Key staging elements with direct impact on patient treatment decisions in MRI rectal cancer staging assessment.

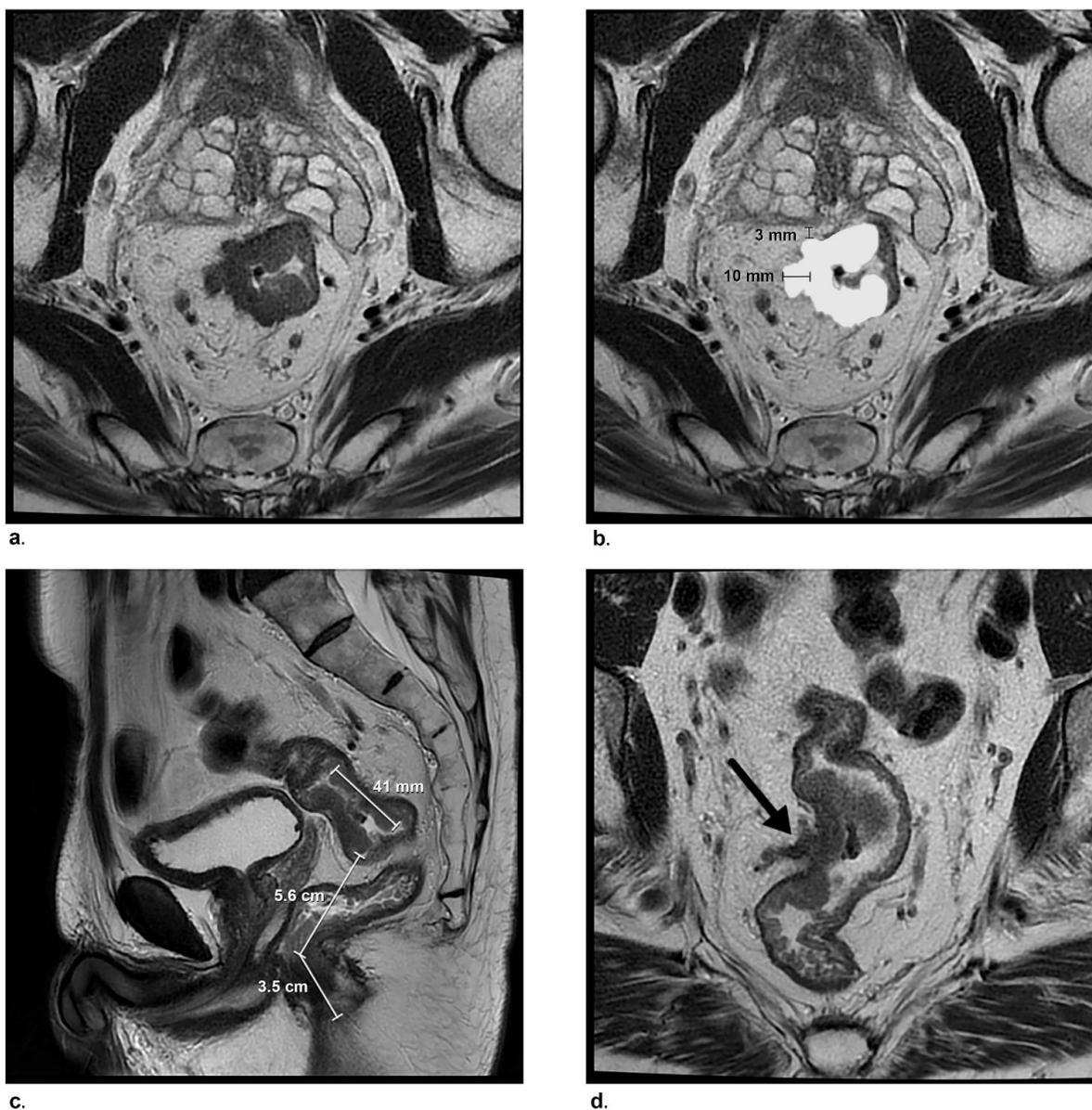
Cause of staging failure	Impact on patient treatment decision	Training point
Suboptimal-quality MR images	Under- or overstaging T stage and under- or overuse of chemoradiotherapy.	<p>Knowledge of standard rectal cancer MRI protocol including:</p> <ul style="list-style-type: none"> • Patient preparation • Coil positioning • Sequences • Acquisition techniques with appropriate angulation
Suboptimal scan planes	Under- or overstaging T stage and under- or overuse of chemoradiotherapy.	<ul style="list-style-type: none"> • Achieving good routines in the use of the various scan planes. • Appreciation of possible partial volume effect with blurring of the muscularis propria in cases with tissue distortion caused by the tumour or by a naturally tortuous rectum
Lack of appreciation of normal rectal and pelvic anatomy	Incorrect treatment decisions regarding the extent of surgery and/or the use of chemoradiotherapy.	<p>Appreciation of the MRI appearance of key anatomic landmarks including:</p> <ul style="list-style-type: none"> • The layers of the rectal wall • The contents of the mesorectum • The mesorectal fascia, the peritoneal reflection, levator muscles and sphincter complex • The adjacent structures and pelvic organs.
Misjudgement of the tumour height	Incorrect treatment decisions regarding the extent of surgery and/or the use of chemoradiotherapy.	Learning the principles for measuring the distance from the inferior border of the luminal tumour to the inferior border of the subcutaneous part of the external sphincter representing the anal verge.
Lack of appreciation of the invasive border.	Overstaging T stage and overuse of chemoradiotherapy	<p>Assessment of the T stage based on the identification of</p> <ul style="list-style-type: none"> • The axial location of the tumour • The tumour morphology • The central invasive border in rectal cancer
Misjudgement of the the distance to the mesorectal fascia	Risk of overestimating involvement of the MRF and overuse of chemoradiotherapy.	<ul style="list-style-type: none"> • Learning the principles for measuring the depth of the extramural invasion and the distance between the tumour and the mesorectal fascia. • For low rectal tumours appreciating the TME surgical plane at the levator muscles/sphincter complex. • Appreciation of the relationship between the central invasive border of the tumour and the MRF in cases with little or asymmetrical mesorectal padding.

Features misinterpreted as extramural tumour invasion	Overstaging T stage and overuse of chemoradiotherapy	Learning to distinguish nodular or broad-based bulging extensions in continuity with the intramural portion of the tumour representing an infiltrating tumour margin. Avoid overstaging benign features as <ul style="list-style-type: none">• Fine, reticular extensions radiating from the rectal wall are due to desmoplastic reaction/peritumoural fibrosis rather than tumour• Disruption of the muscularis propria by penetrating small vessels is not the same as tumour
Lack of appreciation of EMVI	Risk of underestimating involvement of the MRF and underuse of chemoradiotherapy.	Learning to look for tumour along perirectal vessels as expanded vessels with contiguous tumour extension or tumour deposits along a vascular bundle.
Lack of appreciation of lymph node disease	Overstaging N stage	Understanding that lymph node staging at MR has no prognostic impact.

Appendix 2 Overview of the proforma template content for MRI rectal cancer staging assessment.

Key MRI findings and features in local staging of primary rectal cancer
Tumour location and morphology Distance from the inferior border of the luminal tumour to the anal verge (cm) Length of the tumour (mm) Circumferential location of the tumour in the rectal wall (o'clock position) Mucinous tumour (yes/no)
Tumour category T stage (T1, T2, T3, T4) Circumferential location of the central invasive border (o'clock position) ^a Maximum depth of extramural spread (mm) ^a Minimum distance from the extramural spread to the mesorectal fascia/levator muscle (mm) ^a Invasion of the surrounding organs, incl. the peritoneal reflection (with the indication of which) ^b Invasion of the levator muscles (yes/no) ^b Invasion of the sphincter complex (internal sphincter, intersphincteric plane, external sphincter) Early (T1, T2, T3 with ≤5 mm extramural spread) or advanced tumour (T3 with >5 mm extramural spread, T4)
Lymph nodes Suspicious lymph nodes (yes/no) Suspicious lymph nodes within 1 mm of the mesorectal fascia (yes/no)
Extramural venous invasion (EMVI) EMVI (yes/no) EMVI within 1 mm of the mesorectal fascia (yes/no)
Tumour deposits Tumour deposits (yes/no) Tumour deposits within 1 mm of the mesorectal fascia (yes/no)

^a For T3 and T4 tumours^b For T4 tumours



Appendix 3. Patient in his 60s with a T3 tumour of the midrectum. **(a)** Oblique axial T2-weighted high-resolution MR image perpendicular to the long axis of the tumour. **(b)** MR image with morphologic features of the tumour shows tumour growth between the 4-o'clock and 1-o'clock positions and invasive tumour border between the 5-o'clock and 11-o'clock positions infiltrating up to 10 mm beyond the muscularis propria at 9-o'clock position. The shortest distance (3 mm) from tumour penetration to the anticipated circumferential resection margin (mesorectal fascia) is present at the 11-o'clock position. Intact muscularis propria is seen at 11- to 5-o'clock positions. No concern is needed for the short distance between the rectum and the mesorectal fascia at the 1-o'clock position (due to the asymmetrical position of the rectum in the mesorectum), as this is at a good distance from the invasive border. **(c)** Sagittal T2-weighted MR image with measurements of the distance from the inferior border of the luminal tumour to the anal verge (9.1 cm) and the length of the tumour (41 mm). **(d)** Oblique coronal T2-weighted MR image parallel to the long axis of the tumour shows direct tumour invasion into a perirectal vein (extramural venous invasion, EMVI).