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Reconsidering the 1 mm Rule: Contextualising R1 Margin Status in Rectal Cancer

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Abstract

The 1 mm rule for circumferential resection margin (CRM) involvement in rectal cancer is deeply embedded in international practice, defining R1 resection as tumour at or within 1 mm of the resection margin. While this threshold has strong evidence in major resections for primary rectal cancer, its universal application is increasingly questioned. Advances in imaging, surgical technique and pathological understanding suggest that R1 status may require context-specific interpretation across three distinct clinical settings: encapsulated nodal involvement in locally advanced rectal cancer (LARC), locally recurrent rectal cancer (LRRC) and locally excised early rectal cancer (LERC).

This opinion article reviews current literature, international datasets and emerging evidence to challenge the uniformity of the 1 mm definition. It draws upon The International Collaboration on Cancer Reporting (ICCR) dataset, Royal College of Pathologists (RCPath) guidance and recent large cohort and registry analyses to explore the biological and clinical relevance of close margins in these scenarios.

Evidence indicates that the prognostic value of the 1 mm rule varies by anatomical and pathological context. In LARC, a lymph node metastasis abutting the CRM without extracapsular extension behaves biologically as R0 and should not be upstaged. For LRRC, narrow but clear margins (>0 mm) confer equivalent outcomes to wider margins, supporting the use of a 0 mm R1 definition. In LERC, a ≤1 mm margin may be oncologically acceptable in the absence of high-risk histological features. The current evidence supports a tailored approach to R1 definition, preserving rigour while aligning classification with modern oncological, anatomical and pathological realities.

Introduction

The circumferential resection margin (CRM) has long been recognised as a pivotal prognostic factor in rectal cancer. CRM involvement, conventionally defined as tumour at or within 1 mm of the inked surgical margin, correlates strongly with local recurrence and poorer survival (1,2) . This "1 mm rule", adopted by TNM staging, the Royal College of Pathologists and numerous national and international guidelines, has shaped surgical and pathological standards for the past three decades. However, the one-size-fits-all interpretation of this rule may no longer reflect the diversity of rectal cancer biology or surgical technique. Three clinical contexts: locally advanced rectal cancer (LARC) with nodal involvement at the CRM, locally recurrent rectal cancer (LRRC) following exenteration and locally excised early rectal cancer (LERC) each demonstrate distinct anatomical and pathological considerations that warrant a reassessment of what constitutes a R1 resection.

Locally Advanced Rectal Cancer (LARC) and Encapsulated Nodal Involvement

Since its introduction, total mesorectal excision (TME) has transformed rectal cancer outcomes by ensuring *en bloc* removal of the rectum and its surrounding mesorectal envelope, containing rectal blood vessels, lymphatics and lymph nodes, which may contain microscopic tumour deposits (3) . The completeness of mesorectal excision and CRM clearance remain the strongest determinants of local control (4) . CRM involvement traditionally encompasses direct tumour spread, discontinuous deposits, and invasion through lymphatic, venous or perineural channels. However, less emphasis has been placed on CRM involvement by lymph node metastases. Several cohort studies suggest that when tumour within a lymph node abuts the mesorectal fascia but remains encapsulated, recurrence rates mirror those of CRM-negative resections. This contrasts with extracapsular extension, which indicates loss of containment and correlates with both local recurrence and distant metastasis (5–7) . This nuanced interpretation reflects biological rather than purely geometric risk. Based on this, The International Collaboration on Cancer Reporting (ICCR) specifies that CRM involvement by an intact lymph node should not be classified as R1,

provided the capsule remains intact, although the pathology report should be annotated to reflect this specific interpretation (8). In the UK, The Royal College of Pathologists acknowledge the growing evidence to redefine R0 status in LARC but based on the relatively small number of "redefinable" cases within each dataset, they advocate a more cautious approach (9). However, further evidence has since emerged in a large Dutch TME cohort, which showed that lymph node related CRM involvement without extracapsular spread conferred survival equivalent to R0 resections (10). Consequently, we argue that UK reporting practice should align with ICCR standards, classifying such cases as R0 while annotating the finding for clarity. Pathologists should record whether extracapsular spread is present, its proximity to the CRM (to the nearest 0.1 mm) and mesorectal fascial integrity in the area to enable future audit and research correlation.

Locally Recurrent Rectal Cancer (LRRC)

The prognostic significance of CRM status in locally recurrent rectal cancer (LRRC) remains uncertain. Unlike primary disease, where TME provides a standardised anatomical plane, pelvic exenteration for LRRC entails extra-anatomical dissection through irradiated and fibrotic tissue planes (11,12). The historical 1 mm rule lacks validation in this setting and as such there is no agreed UK-based or international definition of a safe resection margin. Evidence from international collaborative datasets (PelvEx) demonstrate wide variation in definitions and reporting, impeding meaningful comparison of R1 rates across centres (13,14). Aiba *et al* (2022) observed that margins of 0.1–1 mm were associated with outcomes similar to direct involvement (0 mm) involvement (15). However, their cohort combined primary and recurrent cases, as well as incorporating intra-operative radiotherapy, thereby limiting its generalisability. In contrast, Koh *et al* (2022) analysed a large, prospectively collected LRRC cohort and demonstrated that a 0 mm threshold best discriminated between R0 and R1 status. Specifically, narrow but clear margins (>0 mm) conferred improved survival compared to R1 resections, and extending the clearance wider (>0.5 mm) presented no additional benefit (16). These findings support redefining R1 in

LRRC as tumour directly at the resection margin (0 mm), while margins>0 mm, even if ≤1 mm, should be considered clear. The precise distance and mechanism of spread should nevertheless be reported, allowing future refinement through multicentre prospective datasets. Such an approach better reflects the technical realities of exenterative surgery, acknowledging that wider margins are often anatomically impossible yet still oncologically adequate when microscopically clear. It is also recommended that the lymph node rule described above for LARC should also be applied to LRRC in all nodal stations, i.e. involved nodes at the margin that have an intact capsule should be considered R0.

Locally Excised Early Rectal Cancer (LERC)

Organ-preserving strategies for early rectal cancer have advanced through the adoption of local excision techniques such as transanal minimally invasive surgery (TAMIS), transanal endoscopic microsurgery (TEM) and advanced flexible endoscopic resection platforms. In well-selected T1 lesions without high-risk features, including: lymphovascular invasion, poor differentiation or high-grade tumour budding, local excision offers equivalent oncological safety to radical resection (17,18). Current Western practice defines R1 as ≤1 mm, which is extrapolated from TME data. Yet several studies, including the Scottish Screen-detected Polyp Cancer Study, have shown that incomplete excision and lymphovascular invasion rather than close margin distance predicts residual disease or lymph node metastasis in subsequent segmental resection specimens (19). Gijsbers *et al* (2022) demonstrated that margins of 0.1–1 mm yielded recurrence and metastasis rates comparable to >1 mm where adverse histological features were absent. For endoscopically resected malignant polyps, low rates of locoregional recurrence have been observed in resection margins ≤1 mm but without direct tumour invasion at the margin or within the coagulation artefact (20). Japanese guidelines define a safe margin as>0 mm, reflecting their extensive dataset showing lymph node metastasis rates below 2% in T1 cancers with submucosal invasion>1 mm but no additional risk factors (21). While longer follow-up data are required, these findings collectively support a reappraisal of the 1 mm rule in LERC. We advocate for a

pragmatic approach to retain resection margin as an important consideration, but not as an absolute indication for further radical surgery where all other criteria indicate low or acceptable risk. Pathologists should record the exact margin (to the nearest 0.1 mm) and report diathermy involvement, enabling multidisciplinary teams to individualise decisions.

Conclusion

The 1 mm CRM involvement threshold has provided clarity and quality assurance in rectal cancer surgery for over three decades. However, its universal application across diverse clinical scenarios risks misclassification and potential overtreatment. In locally recurrent disease, a 0 mm definition of R1 more accurately predicts outcomes; in early locally excised tumours, ≤1 mm margins are oncologically safe when high-risk features are absent; and in locally advanced disease, an encapsulated lymph node abutting the CRM should not be regarded as R1 without extracapsular spread. These distinctions emphasise a transition from rigid geometric measurement to biologically and contextually informed assessment. Future standardisation should harmonise UK practice with ICCR principles, incorporating structured synoptic reporting that distinguishes margin mechanism and anatomical context. Such a refined approach aligns pathology, surgery and oncology with modern multidisciplinary rectal cancer management and supports better international comparability of outcomes and we encourage a conversation between speciality associations over optimum implementation.

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