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Authors

Golia Pernicka, Jennifer S
Bates, David DB
Fuqua, James L
et al.

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Meaningful Words in Rectal MRI Synoptic Reports: How "Polypoid" May Be Prognostic

Jennifer S. Golia Pernicka, MD[1], **David D.B. Bates, MD**[1], **James L. Fuqua III, MD**[1], **Andrea Knezevic, MS**[2], **Joongchul Yoon, MD**[3], **Lorenzo Nardo, MD, PhD**[4], **Iva Petkovska, MD**[1], **Viktoriya Paroder, MD**[1], **Garrett M. Nash, MD**[5], **Arnold J. Markowitz, MD**[6], **Marc J. Gollub, MD**[1]

[1] Department of Radiology, Memorial Sloan Kettering Cancer Center, 530 East 74th Street, New York, NY 10065, USA

[2] Department of Epidemiology & Biostatistics, Memorial Sloan Kettering Cancer Center, 1275 York Avenue, New York, NY 10065, USA

[3] Department of Radiology, Hôpital Saint-Eustache, 520 Boulevard Arthur-Sauvé, Saint-Eustache, QC J7R 5B1, Canada

[4] Department of Radiology, University of California–Davis, 4860 Y Street, Sacramento, CA 95817, USA

[5] Department of Surgery, Memorial Sloan Kettering Cancer Center, 1275 York Avenue, New York, NY 10065, USA

[6] Department of Medicine, Memorial Sloan Kettering Cancer Center, 1275 York Avenue, New York, NY 10065, USA

Abstract

Purpose: This study explored the clinicopathologic outcomes of rectal tumor morphological descriptors used in a synoptic rectal MRI reporting template and determined that prognostic differences were observed.

Methods: This retrospective study was conducted at a comprehensive cancer center. Fifty patients with rectal tumors for whom the synoptic descriptor "polypoid" was chosen by three experienced radiologists were compared with ninety comparator patients with "partially circumferential" and "circumferential" rectal tumors. Two radiologists re-evaluated all cases. The

Corresponding Author: Jennifer S. Golia Pernicka, MD, Body Imaging Service, Department of Radiology, Memorial Sloan Kettering Cancer Center, David H. Koch Center for Cancer Care, 530 East 74th St., Suite 07118, New York, NY 10021, (646) 608-1817, goliapej@mskcc.org.

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outcome measures were agreement among two re-interpreting radiologists, clinical T staging with MRI (mrT) and descriptive nodal features, and degrees of wall attachment of tumors (on MRI) compared with pathological (p)T and N stage when available.

Results: Re-evaluation by two radiologists showed moderate to excellent agreement in tumor morphology, presence of a pedicle, and degree of wall attachment (k=0.41–0.76) and excellent agreement on lymph node presence and size (ICC=0.83–0.91). Statistically significant lower mrT stage was noted for polypoid morphology, wherein 98% were mrT1/2, while only 7% and 2% of partially circumferential and circumferential tumors respectively were mrT1/2. Pathologic T and N stages among the three morphologies also differed significantly, with only 14% of polypoid cases higher than stage pT2 compared to 48% of partially circumferential cases and 60% of circumferential cases.

Conclusion: Using a "polypoid" morphology in rectal cancer MRI synoptic reports revealed a seemingly distinct phenotype with lower clinical and pathologic T and N stages when compared with alternative available descriptors.

Precis:

"Polypoid" morphology in rectal cancer confers a lower clinical and pathologic T and N stage and may be useful in determining whether to proceed with surgery versus neoadjuvant treatment.

Keywords

rectal cancer; rectal polyp; rectal MRI; polypoid rectal tumor; partially circumferential rectal tumor; circumferential rectal tumor

Introduction

Structured reports are widely used in diagnostic radiology because they improve report consistency, standardize language and content, and promote guideline-based care [1, 2]. Several subspecialized radiology groups such as the Society of Abdominal Radiology (SAR)[1] Rectal and Anal Cancer Disease Focused Panel (DFP) and the European Society of Gastrointestinal and Abdominal Radiology advocate the use of synoptic reporting and have published sample templates [3, 4]. Some structured radiology reports are also *synoptic*, presenting pre-defined diagnostic terms in a picklist. Synoptic reports have demonstrated their value through superior inclusion and communication of key information pivotal to treatment decisions, resulting in greater satisfaction among referring surgeons [5–7]. Some terms in these reports are quantitative, such as distance to the anal verge or tumor length; other terms are subjective and their significance, if any, is unknown [8, 9].

A common term for tumor morphology in rectal cancer synoptic MRI reporting templates is "polypoid," which the SAR Rectal and Anal Cancer DFP lexicon defines as a "morphological description of tumor which may have a pedicle or stalk with or without obvious vessels; and with tumor tissue extending from the stalk to protrude into the rectal lumen; polyps may also be sessile in configuration" [9]. We hypothesized that, in addition to being a purely descriptive term, according to the "adenoma-carcinoma sequence" first described by Cho et al. [10], a lesion described as "polypoid" may be an adenoma

or very early stage cancer; thus, “polypoid” may be a semantic term with prognostic significance [10]. Such phenotypic quantifications and semantic annotations have previously been demonstrated to be predictive of patient outcomes [11].

When properly chosen and standardized, terms used in synoptic reports could further strengthen a report’s clinical value. The purpose of the present study was to explore the clinicopathologic outcomes of rectal tumor morphological descriptors used in a synoptic MRI reporting template and determine if prognostic differences were observed. More specifically, we focused on establishing the criteria from T2-weighted (T2W) magnetic resonance (MR) images that would define a lesion as “polypoid” and determine whether or not this morphologic subtype of rectal cancer demonstrates clinical prognostic behavior different from other commonly used descriptors such as “partially circumferential” and “circumferential” (Figure 1).

Materials and Methods

Patient Selection

In this institutional review board approved and HIPAA-compliant study, we selected the first 50 consecutive patients with the synoptic tumor morphology field choice of “polypoid” from our rectal MRI database (total of 4,326 reports) between December 2010 and January 2017. These 50 patients were then compared with randomly chosen patients with the field choice “circumferential” or “partially circumferential” from the same patient cohort and called the “control” group.

MR Technique and Reader Experience

MR images were obtained from various GE Healthcare System platforms (Discovery MR750, Optima MR450w, Signa EXCITE, and Signa HDxt; Waukesha, WI) at either 1.5T or 3T using a phase-array coil and the dedicated high-resolution protocol described in Supplemental Table 1. T2-weighted images were reviewed retrospectively by two readers with experience reading approximately 1,000 and 200 rectal MRIs, respectively.

MR Image Analysis

Initially, two radiologists re-analyzed 50 consecutive polypoid tumors for agreement in the MRI T-stage and nodal features (including presence of nodes [yes/no] over 3 mm, number of nodes, largest short axis nodal diameter, location [mesorectal, superior rectal, obturator, and common iliac], and heterogeneous signal and/or irregular borders [yes/no]) [12]. Re-analysis of mrT stage at this juncture also addressed whether radiologists agreed on mrT1 vs. mrT2, an area not usually addressed due to the known limitations of MRI for this pathologic distinction. Finally, the degree of attachment of the tumor to the bowel wall (one or a sum of several linear tangents at interface of mass with wall) was measured.

Subsequently, to allow for statistical significance in testing for differences in mrT stage distribution between the three synoptic choices available in the template (polypoid, partly and fully circumferential), the statisticians estimated that 50 cases of nonpolypoid tumors were needed. Thus, a comparator group of non-polypoid tumors was randomly extracted

from the cohort to include 25 partly circumferential and 25 fully circumferential tumors. The mrT and mrN stages for these non-polypoid cases, which were recorded in the official report, were used to confirm the likelihood of higher mrT stages.

Finally, a post-hoc analysis was performed due to recognition of high interobserver agreement in wall attachment size and a desire to derive a more granular definition that would better separate polypoid from partly circumferential descriptors, an otherwise arbitrary distinction (i.e., circumferential is a defined as 360 degrees of attachment, but partly circumferential from 359 degrees to a lower unspecified number). Towards that end, two radiologists explored an arbitrary definition of ¼ circumference attachment (WC) (i.e., 90 degrees) (Figure 2) based on our senior author's rectal MR experience and observation that beyond ¼ WC, masses begin to lose any semblance of polypoid morphology and become more bulky, mass-like and broad-based, and tested agreement between readers in a 50 patient cohort comprising all tumor morphologies. It was also reasoned that polyps may or may not have a stalk, but that circumferential and partly circumferential tumors were not likely to contain a stalk, so the presence or absence of a stalk was also tested for agreement among the two readers.

Any additional imaging performed concurrently, such as staging computerized tomography (CT) of the chest, abdomen, and pelvis or fluorodeoxyglucose (FDG) PET/CT scans, was also assessed for the presence of metastatic disease. The electronic medical record was also searched for rectal tumor pathology and, when available, the pathologic (p)T and N stages were recorded as well as whether the pathology specimen was post-neoadjuvant chemotherapy and/or radiation treatment.

Statistical Methods

Fifty polypoid rectal tumor cases from the study period were identified to be included in this analysis. Imaging features and preoperative clinical T and N stages of the 50 polypoid tumor cases were measured by two readers (JSGP and JY) on radiologic review and were assessed for inter-reader agreement using the kappa statistic for binary measures and the weighted kappa for ordinal measures. For continuous measures, the nonparametric interclass correlation coefficient (ICC) was calculated to assess agreement [13]. Values of agreement measures were interpreted as excellent (> 0.75), moderate (0.40–0.75), or poor (< 0.40) [14].

Data from the radiologic review of the more experienced reader (reader 1) was used to compare lymph node characteristics of 50 polypoid tumor cases across clinical T stages using the Fisher's exact test for categorical variables and the Kruskal-Wallis test for continuous variables. Characteristics of polypoid tumor cases were compared to 90 randomly selected circumferential and partially circumferential rectal cancer controls; two-group comparisons were performed using Fisher's exact test for categorical variables and the Wilcoxon rank-sum test for continuous variables.

To show the frequency of a limited number of imaging features in polypoid tumor cases vs. circumferential or partially circumferential controls, 25 randomly selected polypoid cases and 25 randomly selected circumferential or partially circumferential controls were selected and reviewed by two radiologists and were assessed for attachment to wall circumference (≤

¼ or > ¼ circumference) and visible pedicle (yes/no). Inter-reader agreement was assessed using the kappa statistic and difference in frequency of the features between case type was assessed using Fisher's exact test.

All statistical analysis was performed using SAS version 9.4 (Cary, NC) except calculation of nonparametric interclass coefficient, which was performed using the nopaco package in R [13].

Results

Agreement on characteristics of polypoid rectal tumors (Table 1).

Evaluation of polypoid tumors by two readers showed excellent agreement on lymph node presence and size (ICC = 0.83–0.91). T stage and node location showed poor to moderate agreement (κ = 0.06–0.55).

Comparison of T and N stages among polypoid, partly circumferential, and circumferential rectal tumors (Tables 2 and 3).

There were statistically significant differences in the clinical (MRI) T stage with lower clinical T stage seen in the polypoid category: 98% of polypoid tumors were T1/T2, whereas only 7% were T1 in the partially circumferential and 2% were T1 in the circumferential categories (Table 2). Additionally, MRI assessment of lymph nodes showed statistically significant differences in lymph nodes > 3 mm short axis, including the number of nodes and their median size. No difference was noted among these morphologic groups for heterogenous nodes. Although few differences were noted in nodal location, polypoid tumors were far less likely to spread to proximal (superior rectal) nodes (Table 2).

Comparison of pathologic T and N stages among the three morphologies revealed further statistically significant differences. Only 14% of polypoid cases were higher than T2 compared to 48% of partially circumferential cases and 60% of circumferential cases. Only 10–14% of polypoid tumor cases were node positive compared to 30–33% of partially circumferential cases and 50% of circumferential cases. Similarly, negative nodal pathology was much more common among polypoid tumors (86%) than among partially circumferential tumors (67%) and circumferential tumors (50%) (Table 3).

Exploring more distinctive descriptors between polypoid and other tumors (Table 4).

Attachment to wall circumference was > ¼ for most partially circumferential and circumferential controls (96% and 88% for reader 1 and 2, respectively). Attachment to wall circumference was ≤ ¼ in 52% of polypoid cases read by reader 1 and 80% of polypoid cases read by reader 2 (Table 4). A visible pedicle was not seen in almost all partially circumferential and circumferential controls (96% of cases for both readers) and was seen in approximately half of the polypoid cases (44% and 52% of cases for readers 1 and 2, respectively) (Table 4).

Discussion and Conclusions

In this retrospective study of 50 patients with “polypoid” rectal tumor morphology recorded on synoptic pelvic MRI, distinguishing characteristics of polypoid masses were attachment to ≤ ¼ wall circumference and presence of a visible pedicle in significantly more polypoid cases than partially circumferential and circumferential rectal cancer controls. Additionally, lower clinical and pathologic T and N stages, a smaller size of the largest node, and fewer number of nodes greater than 3 mm were more significantly associated with polypoid morphology than were controls. Inter-reader agreement for MRI-based T-stage and for node locations was quite limited which is similar to other published studies comparing rectal cancer T-stage on T2 weighted sequences [15] although the majority of cases were judged to be mrT1 and mrT2 by both readers. Reproducibility was fair to moderate for assessment of degrees of attachment to the wall and presence of a visible pedicle, suggesting the need to improve and revise definitions of the terms “polypoid,” “partially circumferential,” and “circumferential.”

We interpret our findings as confirmation of our hypothesis that rectal tumors with polypoid morphology are more likely to reflect early stage cancer or premalignant adenoma and by extension that [10] rectal lesions with polypoid characteristics have low metastasis to regional lymph nodes. While not all colon adenocarcinomas follow the adenoma-carcinoma pathway [16], the vast majority do, and progressively greater wall involvement increases the circumference of the tumor, its depth of invasion, and access to lymphatics, leading to nodal involvement. These different growth patterns have not been adequately explored as imaging biomarkers and further investigation is warranted.

To our knowledge, this study is the first to elucidate polypoid rectal tumor morphology on MRI and to attempt to refine a definition of the term “polypoid” and compare this synoptic descriptor to the alternatives “partially circumferential” and “circumferential.” Our review of the literature revealed a comparable study of the performance of endoscopic ultrasound (EUS) and MRI in local staging of rectal cancer that demonstrated polypoid tumor morphology to be inversely correlated with the accuracy of T staging on MRI [17]. The authors found that most polypoid tumors were pathologically proven to be T1, as in our study, and that most polypoid tumors are lower stage than other tumor morphologies. That study, however, attempted to compare EUS and MRI rather than to specifically investigate features of polypoid tumor morphology. Additionally, a recent study published by the Dutch ColoRectal Audit Group investigated the diagnostic accuracy of detection of early stage (T1 and T2) rectal cancers by MRI; however, the study did not specifically evaluate polypoid tumor morphology [18]. Another study of polypoid tumors showed that this morphology on MRI was an indicator of KRAS mutation [19], which we did not explore in this study. Our results, which demonstrate low rates of lymph node positivity in T1/T2 rectal cancers, align with other published studies [20–22]; however, these studies did not specifically consider tumor morphology. Lastly, while the Paris classification scheme describes polyp morphology for superficial neoplastic lesions, this scheme is based on polyps throughout the gastrointestinal tract (specifically the esophagus, stomach, and colon) and relies upon the tumor shape seen on endoscopy [23, 24]. This is in contradistinction to our focus on rectal tumors using MRI.

The clinical implications of our study align with efforts recently described by the Significant Polyps and Early Colorectal Cancer (SPECC) initiative, which promotes improved precision in preoperative assessment of significant polyps and early rectal cancer to guide personalized therapy and treatment decisions. As the initiative emphasizes, approximately one-third of rectal cancers are limited to the bowel wall without local spread, yet many patients undergo major surgery with a permanent ostomy or a low anastomosis with significant bowel dysfunction and/or incontinence when less radical options could be considered [25]. Our results indicate that key imaging findings may enhance our definition of polypoid tumor morphology—namely ≤ ¼ wall circumference attachment and a visible pedicle, which will define "polypoid" tumors in our practice as we aim to further refine this definition and validate our findings. These features, when seen on MRI, may indicate lower stage rectal cancer amenable to local excision or organ-conserving treatment to avoid overtreatment with radical resection [26–28]. On a practical level, accurately assessing lymph nodes on MRI is frequently challenging, but is particularly pivotal if a patient has less than a clinical T3 (cT3) tumor (in the USA) wherein neoadjuvant therapy will be administered irrespective of nodal stage for tumors cT3 or above. A radiologist faced with a mrT1/2 tumor and indeterminate nodes should consider our findings, which point to a lower pre-test probability of positive nodes, when issuing a report on equivocal nodes. Further investigation and refinement of the description of polypoid lesions on MRI would further the efforts of the SPECC initiative to promote personalized treatment decisions, organ preservation, decreased side effects from overtreatment, and improved quality of life [25]. We propose that the rectal tumor morphological term "polypoid" be included in the impression of the synoptic rectal MRI report, as it bears clinical prognostic significance.

Our study has several limitations. First, upon staging these lesions on T2W images, the readers may have presumed all lesions to be cancerous and may not have considered that the lesions could be premalignant adenoma, as patients were referred to our tertiary cancer care center. Indeed, our data collection form neglected to offer T0 as an option. Secondly, inter-reader agreement for mrT stages of polypoid tumors was disappointing, possibly due to the inexperience of one radiologist who was a fellow. Nonetheless, the majority of polypoid lesions (≥ 80%) clinically staged by the fellow were still mrT1/2, supporting our hypothesis that these are usually early and non-advanced. Thirdly, we did not have access to pathology from all cases because, as we are a tertiary cancer center, some patients did not continue their care at our institution, and treatment varied among other patients according to standard of care for locally advanced rectal cancer (for instance, 14/29 polypoid cases underwent neoadjuvant treatment prior to resection). We were therefore unable to compare our clinical assessment of all cases of polypoid lesions on MRI with the pathologic gold standard. Lastly, our assessment of ¼ circumferential wall involvement was arbitrary and subjective rather than objectively determined using an angle/tool or mathematical formula. This warrants further investigation and validation in an independent data set.

In this retrospective study of synoptic rectal MRI reports, our data indicated that primary "polypoid" rectal neoplasms represent a distinct phenotype with lower pathologic T and N stages than circumferential and partly circumferential rectal tumors. If our definition of "polypoid" is validated, this synoptic term may be more than descriptive, and could enhance patient and surgeon decision-making in sphincter-preserving treatment of rectal cancer.

Observing polypoid morphology on MRI, however, should not encourage lesion excision without adhering to sound oncologic principles.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Highlights

- Rectal MRI synoptic reporting contains “polypoid” as a morphologic descriptor
- Polypoid morphology of rectal cancer may confer a lower T and N stage
- Partially circumferential & circumferential rectal cancers mean higher T & N stage
- Polypoid rectal cancers may benefit from surgery rather than neoadjuvant treatment

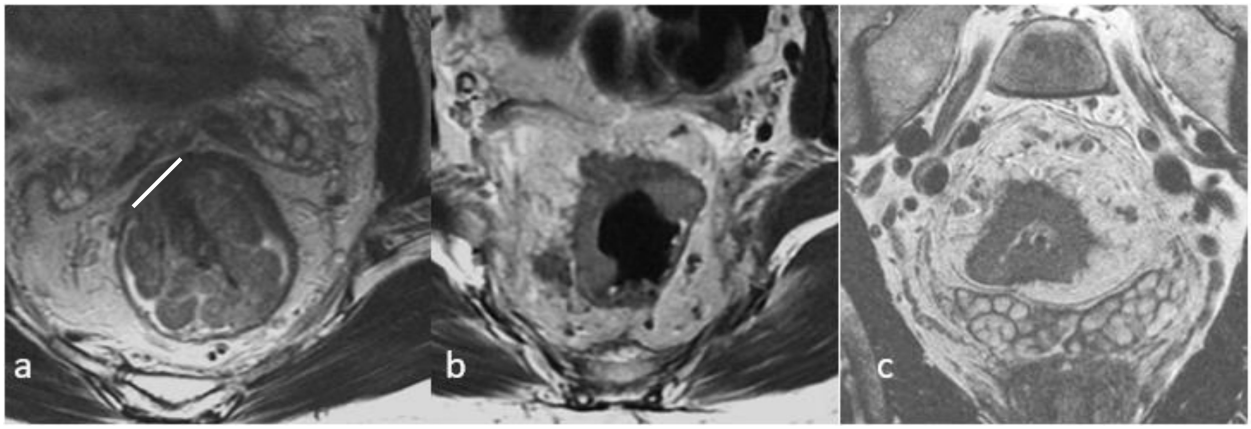

Fig. 1.

Comparison of T2W MR images for tumor morphology: (a) polypoid tumor in a 41 year old male with rectal cancer (white line demonstrating example of attachment size measurement), (b) partially circumferential tumor in a 64 year old female with rectal cancer, and (c) circumferential tumor in a 49 year old male with rectal cancer

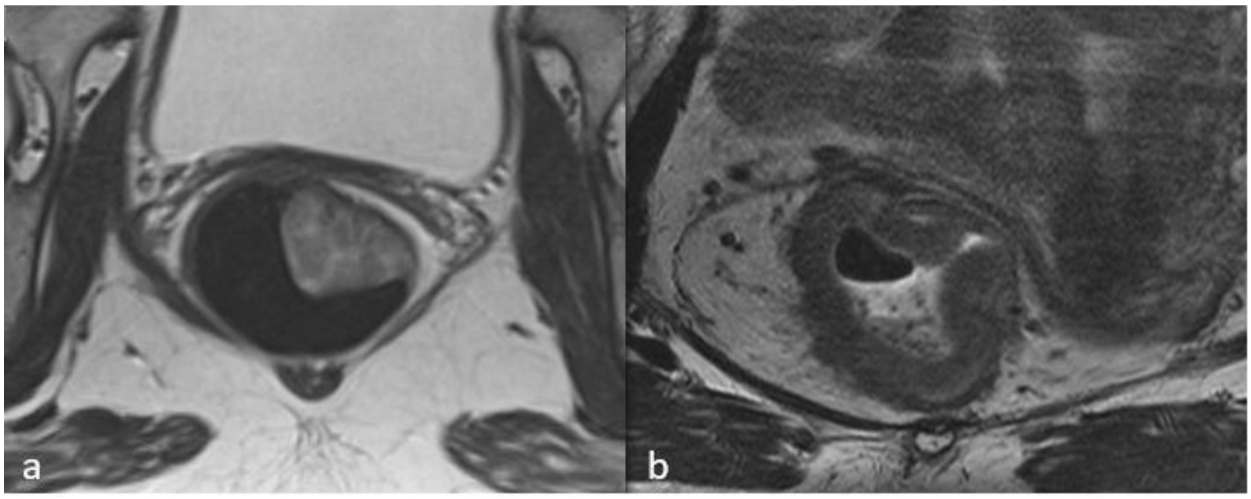

Fig. 2.

Image showing ≤ ¼ wall attachment for (a) polypoid tumor (pT1 N0) in a 60 year old male with rectal cancer compared to > ¼ wall attachment for (b) partially circumferential tumor in a 50 year old male with rectal cancer agreed upon by both radiologists

Table 1.

Characteristics of polypoid tumor from radiologic review of two readers ($n = 50$)

	Reader 1	Reader 2	Agreement*
mrT stage			0.17
1	27 (54%)	25 (50%)	
2	22 (44%)	15 (30%)	
3a	0	3 (6%)	
3b	0	4 (8%)	
3c	1 (2%)	2 (4%)	
4a	0	1 (2%)	
Attachment size, cm—median (range)	1.1 (0.5, 3.4)	1.1 (0.5, 3.4)	**0.76**
Any lymph nodes > 3mm	33 (66%)	31 (62%)	0.57
Number of nodes > 3mm—median (range)	2 (1, 9)	3 (1, 6)	**0.83**
Largest node short axis, cm—median (range)	0.5 (0.3, 1.8)	0.5 (0.4, 1.8)	**0.91**
Node location			
Mesorectal	24 (73%)	28 (90%)	0.32
Superior rectal	14 (42%)	11 (35%)	0.55
Obturator	2 (6%)	7 (23%)	0.44
Common iliac	0 (0%)	3 (10%)	†
Heterogenous/irregular borders	27 (82%)	21 (68%)	**0.06**

*Kappa statistic reported for binary measures, weighted kappa reported for ordinal measures, and nonparametric ICC reported for continuous measures

†Kappa statistic not calculated because of zero frequency for reader 1

Table 2.

MRI findings of polypoid vs circumferential and partially circumferential tumors

	Polypoid* (*n* = 50)	Partially circumferential (*n* = 45)	Circumferential (*n* = 45)	*p* †
Clinical mrT stage				**<0.001**
1	27 (54%)	0	0	
2	22 (44%)	3 (7%)	1 (2%)	
3a	0	6 (13%)	2 (4%)	
3b	0	26 (58%)	9 (20%)	
3c	1 (2%)	4 (9%)	12 (27%)	
3d	0	1 (2%)	3 (7%)	
4a	0	0	4 (9%)	
4b	0	5 (11%)	14 (31%)	
Any lymph nodes > 3mm	33 (66%)	39 (87%)	45 (100%)	**<0.001**
Number of nodes > 3mm—median (range)	2 (1, 9)	4 (1, 14)	5 (1, 17)	**<0.001**
Largest node short axis, cm—median (range)	0.5 (0.3, 1.8)	0.6 (0.3, 4.0)	0.7 (0.3, 2.3)	**<0.001**
Heterogenous/irregular borders	27 (82%)	32 (84%)	44 (97%)	0.19
Node location				
Mesorectal	24 (73%)	37 (95%)	39 (87%)	0.02
Superior rectal	14 (42%)	31 (79%)	43 (96%)	<0.001
Obturator	2 (6%)	9 (23%)	7 (16%)	0.09
Common iliac	0	0	3 (7%)	0.56
IMA	0	4 (10%)	3 (7%)	0.19
Ext iliac	0	0	5 (11%)	0.32
Inguinal	0	1 (3%)	4 (9%)	0.32

*Data from radiologic review of reader 1

†Two-group comparison (polypoid vs circumferential/partially circumferential) using Fisher's exact test for categorical variables and Wilcoxon rank-sum test for continuous variables

Table 3.

Pathological findings of polypoid vs circumferential and partially circumferential tumors

	Polypoid (*n* = 50)	Partially circumferential (*n* = 45)	Circumferential (*n* = 45)	Fisher's exact *p* *
Pathology performed	29 (58%)	33 (73%)	28 (62%)	
Pathologic T stage				**<0.001**
Tis	3 (10%)	1 (3%)	0	
0	3 (10%)	4 (12%)	4 (14%)	
1	13 (45%)	2 (6%)	1 (4%)	
2	6 (21%)	10 (30%)	6 (21%)	
3	4 (14%)	15 (45%)	13 (46%)	
4a	0	0	2 (7%)	
4b	0	1 (3%)	2 (7%)	
Pathologic N stage				**0.008**
0	25 (86%)	22 (67%)	14 (50%)	
1+	3 (10%)	10 (30%)	14 (50%)	
x	1 (4%)	1 (3%)	0	

* Two-group comparison (polypoid vs circumferential/partially circumferential)

Table 4.

Features of polypoid vs circumferential and partially circumferential tumors from radiologic review of two readers ($n = 50$)

	Reader 1			**Reader 2**			**Kappa**
	Polypoid (*n* = 25)	**Control (*n* = 25)**	**Fisher's exact *p***	**Polypoid (*n* = 25)**	**Control (*n* = 25)**	**Fisher's exact *p***	
Attachment to wall circumference							0.54
≤ ¼	13 (52%)	1 (4%)	**<0.001**	20 (80%)	3 (12%)	**<0.001**	
> ¼	12 (48%)	24 (96%)		5 (20%)	22 (88%)		
Visible Pedicle							0.38
No	14 (56%)	24 (96%)	**0.002**	12 (48%)	24 (96%)	**<0.001**	
Yes	11 (44%)	1 (4%)		13 (52%)	1 (4%)		