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ORIGINAL ARTICLE

Importance of Resection Margins in the Treatment of Rectal Adenomas by Transanal Endoscopic Surgery

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Abstract

Background Polypectomy is the gold standard for treating colorectal adenomas up to 2 cm in size. For larger lesions, various procedures ranging from endoscopy to transanal surgery can be performed and achieve varying results for en bloc resection and recurrence. There are no clear guidelines for dealing with involved resection margins. We assess the recurrence of rectal adenomas operated using TEM with full-thickness wall excision with or without free resection margins and define optimal endoscopic follow-up.

Method Observational study with prospective data collection, including patients undergoing TEM between 6/2004 and 11/2017, with definitive diagnosis of rectal adenoma. Data on epidemiological, preoperative, surgical, postoperative, pathological, and follow-up variables were recorded. Univariate analysis, follow-up risk function, and multivariate logistic regression analysis were performed to detect risk factors for recurrence.

Results TEM was indicated in 736 patients; 481 adenomas were identified in the preoperative biopsy, of which 95 were infiltrating adenocarcinomas (19.8%) in the definitive pathology study. With a minimum follow-up of 1 year, 372 patients were included. Pathology study showed free margins in 324 (87%). Recurrences were recorded in 15 patients (4%), up to 18 months in the free margins group and up to 24 months in the involved margins group. Thirteen patients with recurrence (86.6%) were treated with TEM. No predictors of recurrence were found in the multivariate analysis.

Conclusion TEM is the technique of choice for treating rectal adenomas and recurrences, achieving a low relapse rate. Follow-up must be adapted to resection margins and should be extended to 24 months.

Keywords TEM · Rectal adenomas · Recurrence rectal adenomas · Follow-up rectal adenomas

Introduction

Tumors located in the middle and upper third of the rectum with an indication of local excision are not easily accessible, and so they have traditionally been treated by abdominal surgery. The introduction of transanal endoscopic microsurgery (TEM) by Buess in the 1980s allowed local excision of rectal tumors up to 20 cm from the anal verge through a rectoscope.[1] Today, TEM is widely used for the excision of rectal adenomas and incipient rectal carcinomas (pT1).[2]

Endoscopic polypectomy is the gold standard for treatment of colorectal adenomas up to 2 cm in size. For the excision of larger rectal adenomas, the techniques used include piecemeal endoscopic mucosal resection (PEMR), endoscopic mucosal resection (EMR),[3] endoscopic submucosal dissection (ESD),[4] endoscopic full-thickness resection (FTR),[5] transanal

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excision, and TEM.[6] Many studies advocate endoscopic techniques such as PEMR, EMR, and ESD for colonic polypectomies.[3, 4] In the rectum, because of the high incidence of infiltrating adenocarcinoma (18.8%),[7] our group favors the use of TEM with full-thickness wall excision, a technique that provides excellent vision and allows surgeons to obtain wide margins and a single piece resection.

There are currently no standardized criteria or clinical guidelines for the follow-up of patients operated on for rectal adenoma with TEM with involved resection margins in the final pathology report. (Henceforth in the manuscript, the term "involved" is used to refer both to positive margins, and to margins in close contact with the lesion (< 1 mm) and/or a piecemeal excision).

The main objective of the present study was to assess the effect of involved resection margins on the risk of recurrence of rectal adenomas after full-thickness wall resection using TEM. Secondary objectives were (1) to identify the variables associated with the excision with involved margins and (2) to define the optimal endoscopic follow-up for all the different groups of patients and to determine the best way to approach recurrences.

Methods

This is an observational study with prospective data collection including all patients undergoing TEM between June 2004 and November 2017, treated at the coloproctology unit of Parc Taulí University Hospital. All patients with rectal tumors who were candidates for TEM were assessed and treated by the same team of five expert surgeons in coloproctology. Patients underwent a preoperative evaluation in accordance with our previously described protocol[8] and were classified into one of the five preoperative indication groups (I to V). Group I: with curative intention (benign tumors which, after ultrasound (u) and magnetic resonance imaging (MRI), were staged as u-MRI T0-1 and u-MRI N0); group II: with curative intention (low-grade adenocarcinomas, u-MRI T0-1 and u-MRI N0); group III: consensus indication (low-grade adenocarcinomas, u-MRI T2 and u-MRI N0 who reject radical surgery); group IV: palliative indication (adenocarcinoma of any stage not supporting radical surgery); and group V: atypical indications.[9]

All patients with definitive diagnosis of adenoma in the resection specimen after TEM were included. All lesions were advanced colorectal adenomas (ACA),[10] defined by at least one of the following criteria: diameter ≥ 2 cm, villous component, and high-grade dysplasia. Patients with preoperative adenocarcinoma biopsy, those with adenomatous lesions but a follow-up of less than 1 year, and those with atypical indications were excluded. The day before surgery, all patients underwent mechanical preparation of the colon and thromboembolic prophylaxis. During anesthetic induction, they were given antibiotic prophylaxis for colorectal surgery, in accordance with the hospital's protocol. As the surgical technique, TEM (Richard Wolf, Knittlingen, Germany) was used from the beginning, and in 2008, TEO (Transanal Endoscopic Operation, Karl Storz GmbH, Tüttlingen, Germany) was incorporated.[11] Since then, both techniques have been used interchangeably. All patients underwent a full-thickness excision of the rectal wall using a harmonic scalpel (Ultracision, Ethicon Endo-Surgery, Cincinnati, OH), without gross vision of any residual lesion. The defect was closed by a long-term resorbable running monofilament suture. In the event of tension in the suture, the proximal defect was partially closed. The resection specimen was mounted on a cork base and kept in place with needles. In patients with multiple polyps, the largest polyp was selected for the analysis. If the patient had no previous polyp history, follow-up by sigmoidoscopy was performed at 4–6, 12, and 24 months. A complete colonoscopy was performed 3 and 5 years after the intervention, in accordance with the consensus protocol.[8]

The study variables (epidemiological, preoperative, surgical, postoperative, pathology, and follow-up) are presented in detail in Tables 1 and 2. The lesions were classified using the definition of Scala et al.: small (< 3 cm), large (3–5 cm), and giant (> 5 cm).[12] With regard to surgeon's experience, Barendse et al. criteria were followed: surgeon 1 was the one with the most experience (> 150 cases performed); surgeons 2, 3, and 4 had average experience (35–150 cases), and surgeon 5 had the least experience (< 35 cases).[13]

Overall morbidity at 30 days and morbidity according to the Clavien-Dindo classification[14] are shown separately. Recurrence was defined in the pathology report as the presence of adenomatous tissue in the areas of resection or scarring, following the criteria of Higaki et al.[15]

The study was approved by the local Institutional Ethics Committee (CEIC: 2017/597) and complied with the criteria of the Declaration of Helsinki. The STROBE guidelines for observational studies were followed.

Statistical Analysis

The SPSS statistical package version 23 was used. The prospective collection of data allowed analysis without missing any values. Quantitative and categorical variables were described in accordance with standard statistical regulations. The univariate analysis of the quantitative variables was carried out using the Student's t test, providing its application conditions were fulfilled; otherwise, the Mann-Whitney U test or Kruskal-Wallis test was applied. For categorical variables, Pearson's X^2 test or Fisher's exact statistic test were used. A p value < 0.05 was considered statistically significant.

The follow-up of adenoma recurrence was analyzed with the Kaplan-Meier estimation method and the log-rank test.

Table 1 Descriptive analysis of the variables of the study

Variables			Patients ($n = 372$)	Patients (%)
Epidemiological	Age (y)*		71 (IQR 17) (91–31)	
	Sex	Male	222	59.7
		Female	150	40.3
Preoperative	Tumor size (cm)*		4 (IQR 2) (1–12)	
	Tumor size (cm)	Small (< 3 cm)	36	9.7
		Medium (3–5 cm)	194	52.1
		Large (> 5 cm)	142	38.2
	Distance anal verge (cm)*		7 (IQR 5) (1–22)	
	Distance proximal margin tumor to anal verge (cm)*		11 (IQR 5) (1–25)	
	ASA	I	11	3
		II	215	57.8
		III	125	33.6
		IV	21	5.6
	Biopsy type of adenoma	Villous	185	49.7
		Tubulovillous	163	43.8
		Tubular	24	6.5
	Biopsy grade of dysplasia	High	195	52.4
		Medium	29	7.8
		Low	148	39.8
Surgical	Surgical equipment	TEM	192	51.6
		TEO	180	48.4
	Pieces of the specimen	En bloc	358	96.2
		Fragmentation	14	3.8
	Surgeon experience	> 150	176	47.3
		150–35	166	44.6
		< 35	30	8.1
	Surgical time (min)*		70 (IQR 50) (240–20)	
	Depth of wall excision	Full	369	99.2
		Partial	3	0.8
	Perforation into abdominal cavity	Present	23	6.2
		Absent	349	93.8
	Suture of the defect	Complete	329	88.4
		Incomplete	42	11.29
		Absent	1	0.3
	Tumor location (quadrant)	Anterior	99	26.6
		Right-lateral	71	19.1
		Left-lateral	103	27.7
		Posterior	99	26.6
Postoperative	Overall morbidity		82	22
	Morbidity (Clavien-Dindo)	0	290	78
		I	54	14.5
		II	12	3.2
		IIIa	5	1.3
		IIIb	7	1.9
		IVa	3	0.8
		V (mortality)	1	0.3

Table 1 (continued)

Variables			Patients ($n = 372$)	Patients (%)
Pathology	Type of adenoma	Villous	199	53.5
		Tubulovillous	15	40.6
		Tubular	21	5.6
	Grade of dysplasia	High	277	74.5
		Low	95	25.5
	Resection margins	Free	324	87.1
		In contact	32	8.6
		Positive	3	0.8
		Fragmentation	13	3.5
Follow-up	Recurrence		15	4

Y years, *CM* centimeters, *MIN* minutes, *IQR* interquartile range, *TEM* transanal endoscopic microsurgery, *TEO* transanal endoscopic operation, *ASA* American Society of Anesthesiology physical status classification system, *(median-IQR-range)

The actuarial mortality tables method was used to calculate the recurrence risk index for each semester, based on the involved margins factor. Multivariate logistic regression analysis was carried out to detect risk factors related to the excision of lesions without free margins. The variables with statistical significance, or a trend towards significance with a p value of < 0.25, were introduced in the multivariate analysis. Recurrence of adenomas was not included in the multivariate analysis due to the low number of cases.

Results

During the study period TEM/TEO was indicated in 736 patients. Among these patients, 481 patients had an adenoma in the preoperative biopsy, 386 (80.2%) of which were shown to be adenomas and 95 (19.8%) as infiltrating adenocarcinomas in the final pathology report. Fifty-nine (62.1%) patients with adenocarcinoma were pT1, and so surgery was considered to be curative in this group. The other 36 patients (24 pT2, 12 pT3), were rescued with radical surgery (Fig. 1).

Descriptive Analysis

As it is shown in Table 1, 372 patients with a minimum follow-up of 1 year were included. In reference to tumor size, 90.3% (336/372) were medium-sized or large. In the preoperative biopsy, 49.7% (185/372) were villous adenomas, and 52.4% (195/372) were high-grade dysplasia lesions. En bloc surgical resection was obtained in 96.2% (358/372) of the cases, a full-thickness wall resection in 99.2% (369/372), and complete closure of the defect in 88.4% (329/372). The 22% (82/372) of patients showed postoperative morbidity, according to Clavien-Dindo's classification of surgical complications, and was grade I in 14.5% (54/372) of them. In 12.9% (48/372) of patients, involved margins (in contact, positive, and/or fragmentation) were reported in the resection specimen.

During a median follow-up of 60 months (range 12–144), 15 patients (4%) presented recurrence (Fig. 2a).

Univariate and Multivariate Analysis

Table 2 displays the univariate analysis of groups according to involved margins and recurrence.

The presence of involved resection margins was the only variable significantly associated with recurrence, recorded in 6/48 (12.5%) of patients with involved margins and in 9/324 (2.8%) of patients with free resection margins, with a p value of 0.007. Neither the pathological characteristics of the lesion (high-grade dysplasia, villous morphology), nor lesion size, nor surgeon's experience exerted any influence.

In the univariate analysis of the patients with involved resection margins, the variables that were found to be statistically significant were age, tumor size, distance from the anal verge, en bloc resection, surgical time, presence of perforation into the peritoneal cavity, complete defect suture, and recurrence.

In the multivariate analysis, no predictive factor of recurrence was found in this group.

Follow-Up Analysis

Figure 2 presents the follow-up of these patients in a Kaplan-Meier graph. Figure 2a shows that there is a risk of recurrence during the first 24 months after surgery. Figure 2b shows statistically significant differences in survival between the two groups (involved/free resection margins), with recurrence being recorded in the first 24 months after surgery in both groups.

Figure 3 illustrates the risk of recurrence per semester, limited to the first 60 months. Patients in the involved margin group had a much higher risk of recurrence, but only during

Table 2 Univariate analysis of groups according to involved margins and recurrence

Patients ($n = 372$)			Involved margins ($n = 48$)		Recurrence ($n = 15$)		
Variables			*N* (%)	*p*	Variables	*N* (%)	*p*
Epidemiological	Age (years)*	Involved margins Free margins	74.5 (IQR 13) 70 (IQR 17)	**0.027**	Recurrence Non-recurrence	70 (IQR 20) 70 (IQR 17)	0.466
	Sex	Male Female	27/222 (12.2%) 21/150 (14%)	0.638	Male Female	7/222 (3.2%) 8/150 (5.3%)	0.298
Preoperative	Tumor size (cm)*	Involved margins Free margins	6 (IQR 2.7) 4 (IQR 2)	**< 0.001**	Recurrence Non-recurrence	4 (IQR 3) 4 (IQR 2)	0.582
	Tumor size (small-medium-large)	Small (< 3 cm) Medium (3–5)	2/36 (5.6%) 13/194 (6.7%)	**< 0.001**	Small (< 3 cm) Medium (3–5)	2/36 (5.6%) 6/194 (3.1%)	0.621
		Large (> 5 cm)	33/142 (23.2%)		Large (> 5 cm)	7/142 (4.9%)	
	Distance anal verge (cm)*	Involved margins Free margins	6 (IQR 5) 7 (IQR 5)	**0.037**	Recurrence Non-recurrence	5 (IQR 7) 7 (IQR 5)	0.189
	Distance proximal margin tumor to anal verge (cm)*	Involved margins Free margins	11 (IQR 5) 11 (IQR 5)	0.596	Recurrence Non-recurrence	10 (IQR 6) 11 (IQR 5)	0.281
	ASA	I II	0/11 (0) 25/215 (11.6%)	0.385	I II	0/11 (0%) 9/215 (4.2%)	0.671
		III	20/125 (16%)		III	6/125 (4.8%)	
		IV	3/21 (14.3%)		IV	0/21 (0%)	
	Biopsy type of adenoma	Villous Tubulovillous	32/185 (17.3%) 16/163 (9.8%)	**0.017**	Villous Tubulovillous	5/185 (3.2%) 10/163 (6.1%)	0.156
		Tubular	0/24 (0%)		Tubular	0/24 (0%)	
	Biopsy grade of dysplasia	High Medium	26/195 (13.3%) 9/29 (31%)	**0.005**	High Medium	10/196 (5.1%) 5/33 (15.2%)	0.835
		Low	13/148 (8.8%)		Low	0/143 (0%)	
Surgical	Surgical equipment	TEM TEO	25/192 (13%) 23/180 (12.8%)	**1**	TEM TEO	10/192 (5.2%) 5/180 (2.8%)	0.296
	Pieces of the specimen	En bloc Fragmentation	34/358 (9.5%) 14/14 (100%)	**< 0.001**	En bloc Fragmentation	13/358 (3.6%) 2/14 (14.3%)	0.104
	Surgeon experience	> 150 150–35	24/176 (13.6%) 22/166 (13.2%)	0.565	> 150 150–35	9/176 (5.1%) 4/166 (2.4%)	0.333
		< 35	2/30 (6.6%)		< 35	2/30 (6.7%)	
	Surgical time (min)*	Involved margins Free margins	95 (IQR:68) 70 (IQR:45)	**0.001**	Recurrence Non-recurrence	105 (IQR:70) 70 (IQR:50)	**0.012**
	Depth of wall excision	Full Partial	47/369 (12.7%) 1/3 (33.3%)	0.340	Full Partial	14/369 (3.8%) 1/3 (33.3%)	0.116

Table 2 (continued)

Patients ($n = 372$)			Involved margins ($n = 48$)		Recurrence ($n = 15$)		
Variables			*N* (%)	*p*	Variables	*N* (%)	*p*
	Perforation into abdominal cavity	Involved margins	7/48 (14.6%)	**0.019**	Recurrence	1/23 (4.3%)	0.623
		Free margins	16/324 (4.9%)		Non-recurrence	14/349 (4%)	
	Suture of the defect	Complete	35/329 (10.6%)	**< 0.001**	Complete	14/315 (4.4%)	0.827
		Incomplete	12/42 (28.6%)		Incomplete	1/42 (2.3%)	
		Absent	1/1 (100%)		Absent	0/1 (0%)	
	Tumor location (quadrant)	Anterior	10/99 (10.1%)	0.762	Anterior	5/99 (5.1%)	0.594
		Right-Lateral	11/71 (15.4%)		Right-lateral	4/67 (5.6%)	
		Left-Lateral	14 /10 (13.6%)		Left-lateral	2/103 (1.9%)	
		Posterior	13/99 (13.1%)		Posterior	4/100 (4%)	
Postoperative	Overall morbidity	Involved margins	14/48 (29.2%)	0.197	No	9/290 (3.1%)	0.109
		Free margins	68/324 (21%)		Yes	6/82 (7.3%)	
	Morbidity (Clavien-Dindo)	0	34/290 (11.7%)	**0.032**	0	9/290 (3.1%)	0.299
		I	8/54 (14.8%)		I	5/54 (9.3%)	
		II	1/12 (8.3%)		II	0/12 (0%)	
		IIIa	1/5 (20%)		IIIa	0/5 (0%)	
		IIIb	3/7 (42.9%)		IIIb	1/7 (14.3%)	
		IVa	0/3 (0%)		IVa	0/3 (0%)	
		V (mortality)	1/1 (100%)		V	0/1 (0%)	
Pathology	Type of adenoma	Villous	32/199 (16%)	0.056	Villous	6/199 (3%)	0.556
		Tubulovillous	16/151 (10.6%)		Tubulovillous	8/151 (5.3%)	
		Tubular	0/22 (0%)		Tubular	1/22 (4.5%)	
	Grade of dysplasia	High	39/277 (14.1%)	0.164	High	11/277 (3.9%)	0.878
		Low	9/95 (9.5%)		Low	4/95 (4.2%)	
	Resection margins				Free	9/324 (2.8%)	**0.008**
					In contact	4/32 (12.5%)	
					Positive	0/3 (0%)	
					Fragmentation	2/13 (15.3%)	
Follow-up	Recurrence	Involved margins	6/48 (12.5%)	**0.007**			
		Free margins	9/324 (2.8%)				

Bold entries are statistically significant *P* values

IQR interquartile range, *TEM* transanal endoscopic microsurgery, *TEO* transanal endoscopic operation, *Mann-Whitney *U* Test

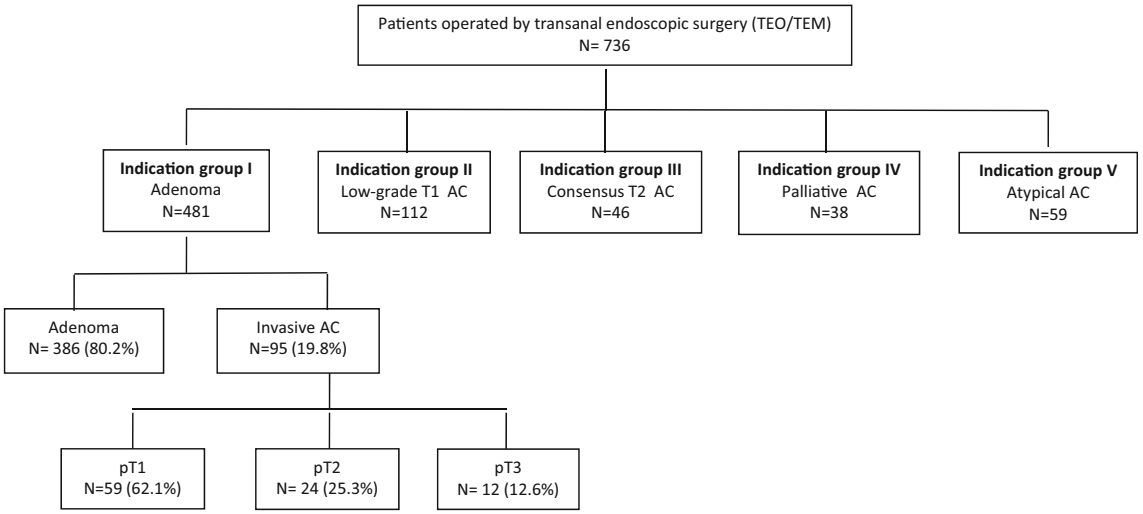
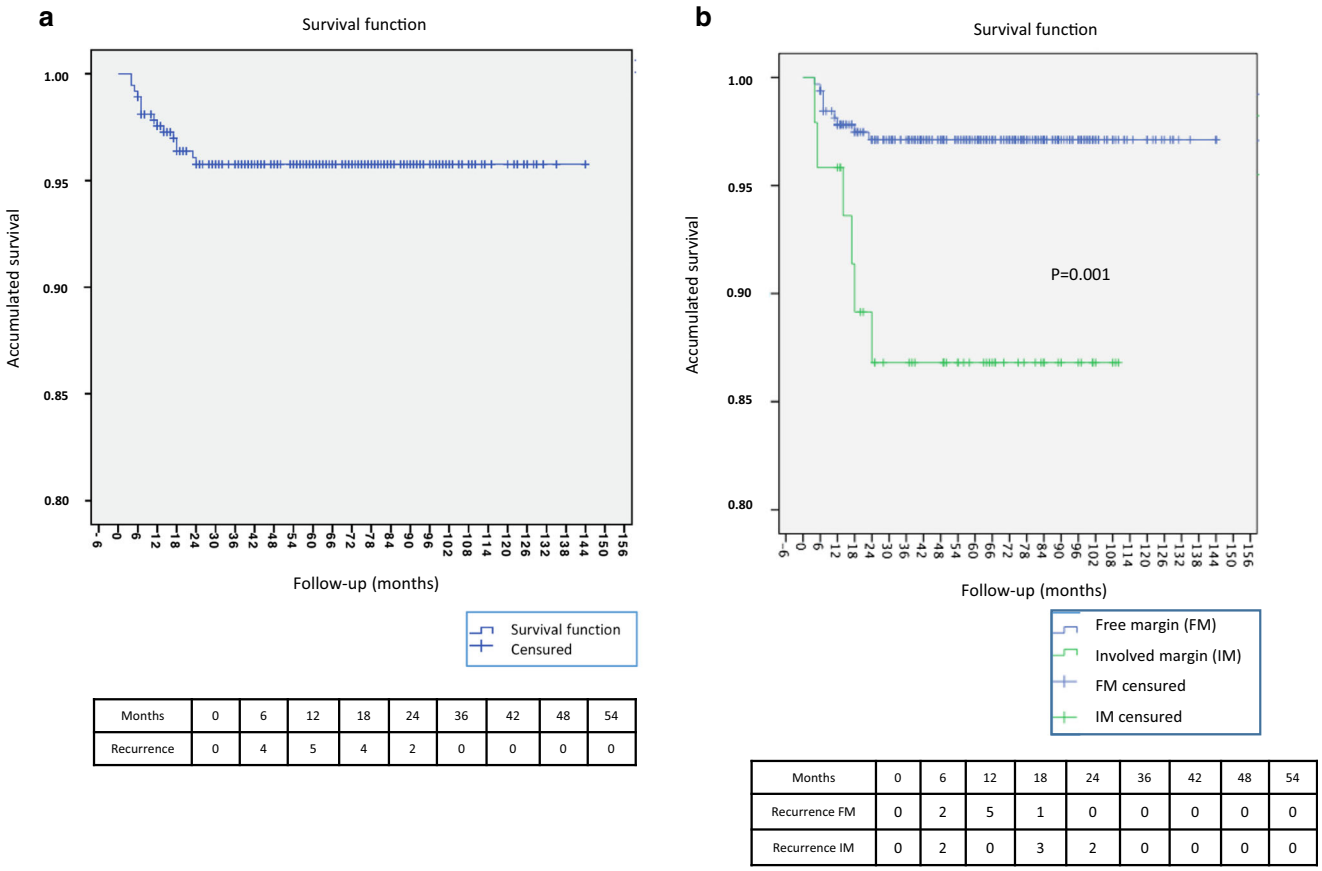


Fig. 1 Patients' flow chart. AC, adenocarcinoma. Group I: rectal lesions with biopsy revealing adenoma and staged T0-N0 by endorectal ultrasound (u) and/or pelvic magnetic resonance (mr). Group II: adenocarcinomas [either well (G1) or moderately differentiated (G2)], and staged u-mrT0-1, u-mrN0. Group III: indication by consensus, adenocarcinomas [either well (G1) or moderately differentiated (G2)], staged u-mrT2, u-mrN0. Group IV: palliative indications. Group V: atypical indications

the first 24 months; while in the free margins group, the risk of recurrence was evident only in the first 18 months.

Among the 15 patients who presented recurrence after TEM, 9 had free margins, 14 had a full-thickness wall excision, and 5 did not present high-grade dysplasia. In six patients, the first sigmoidoscopy performed after 6 months follow-up was normal. In two patients, the recurrence was small and could be controlled endoscopically. The remaining



Months	0	6	12	18	24	36	42	48	54
Recurrence	0	4	5	4	2	0	0	0	0

Months	0	6	12	18	24	36	42	48	54
Recurrence FM	0	2	5	1	0	0	0	0	0
Recurrence IM	0	2	0	3	2	0	0	0	0

Fig. 2 Follow-up of rectal adenomas. **a** Kaplan-Meier survival curves of cumulative probability of recurrence of rectal adenomas after TEM. **b** Log-rank curves of cumulative probability of recurrence of rectal adenomas after TEM in patients with and without free resection margins

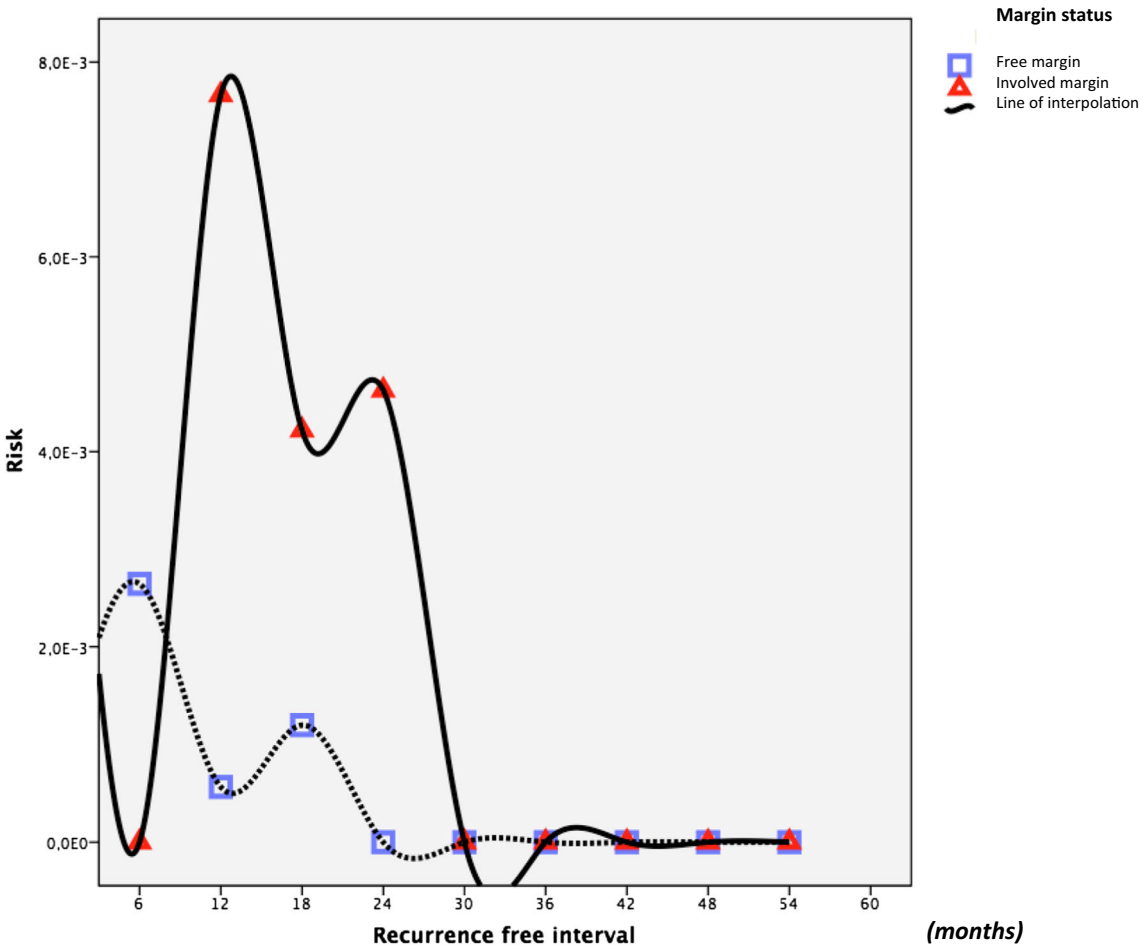


Fig. 3 Risk function chart between patients with and without free resection margins after TEM

13 patients underwent TEM. Of these, 2/13 experienced a second recurrence in the form of an adenocarcinoma (2/372, 0.5%) and received radical abdominal surgery (one abdominoperineal resection and one low rectal resection with a protective ileostomy).

Discussion

The treatment of large rectal tumors with biopsies indicating adenoma poses several questions: (1) Is this really a benign lesion? (2) What is the most curative and least aggressive treatment that we can offer? (3) What is the most appropriate follow-up? (4) What is the best line of action in the event of recurrence?

We stress the importance of performing correct preoperative staging, based mainly on endorectal ultrasound, which differentiates invasion in the submucosa,[16] and magnetic resonance. In the case of potentially benign lesions, the recommended treatment is local excision. Fragmented endoscopic resections such as PEMR have a high recurrence rate (17–43%).[17] Other therapeutic options are EMR and ESD, but both are complex techniques that require considerable experience and so can only be performed at reference centers.[18]

In the present study, most of the lesions were medium-sized or large and underwent an en bloc and full-thickness resection, and around 90% (324/372) of the excised lesions had free resection margins. As for morbidity, although the rate of 22% (82/372) may seem high, 66% (54/82) of these cases were Clavien-Dindo grade I complications. The majority of patients could be discharged at 24 h or could be included in an outpatient surgery program.[19]

Within the group of infiltrating adenocarcinomas found among potentially benign lesions, 61.1% were pT1 (59/95), and so, in these cases treatment was curative. In FTR, a full-thickness wall excision is performed, but this technique is limited by lesion size (< 30 mm). If we bear in mind the potential risks of abdominal surgery, these results can be considered satisfactory, with a gross resection rate of 90% but with a pathological complete resection rate of 76.9%.[20] In addition, Transanal Minimally Invasive Surgery (TAMIS) provides colorectal surgeons with a TEM-based alternative that probably achieves a similar quality of local excision, rate of fragmentation, and recurrence rates.[21]

Among its recommendations, the European Society of Gastrointestinal Endoscopy (ESGE)[22] proposes endoscopic follow-up between 2 and 6 months after the excision of colorectal adenomas with positive margins, either macroscopic or microscopic. If these tests are normal, the ESGE recommends repeating them every 5 years.[23]

There are no recommendations based on the results of follow-up of adenomas excised by TEM. Bun Kim et al. evaluated the long-term outcome and the adequate surveillance colonoscopy interval required for sessile and flat colorectal polyps (including adenomas, adenocarcinomas in situ and intramucosal cancer) larger than 20 mm, excised by means of EPMR.[24] They randomly performed a short-term or long-term surveillance colonoscopy (every 6 months or 12 months approximately) and reported a recurrence rate of 6.9% (14 patients). In the multivariate regression analysis, a polyp size greater than 40 mm was shown to be the only independent risk factor for local recurrence; neither piecemeal resection nor surveillance colonoscopy interval was found to exert an influence.

The recurrence of adenomas after classic transanal excision may be as high as 30%.[25] However, excision by TEM has a low recurrence rate (4%), as we report in our study. Since similar rates have been recorded by other experienced groups, we regard it as the technique of choice.[26] However, the TREND study, a recent multicenter randomized study comparing TEM and EMR,[27] found a recurrence rate after TEM of 11% and a complication rate of 26%—higher values than those previously described in the literature. Our team observed recurrences during the first 24 months after surgery (Fig. 2). The recurrence risk function of Fig. 3 shows a higher risk in patients with involved margins, which may appear up to 24 months post-surgery. In the group with free margins, this risk function is lower and is concentrated in the first 18 months.

We therefore suggest adjusting the controls depending on the margins, and performing endoscopic controls every 6 months, until 18 months if free margins are present or until 24 months otherwise. Subsequently, the routine tests suggested in the guidelines[22] should be carried out; even if the first test is normal, the recurrence may appear later (in fact, this was the case in 40% of the recurrences (6/15 patients) in our study).

There are few studies in the literature of predictors of adenoma recurrence after TEM.[28, 29] We identified the presence of involved margins as the most important factor. Interestingly, in our study, no morphological factors (size, high degree of dysplasia, villous component) were related to recurrence. In the multivariate analysis of possible risk factors for recurrence in the group of adenomas with involved margins, none of the factors emerged as significant, even though all the variables that had been significant in the univariate analysis were introduced in the model.

In the presence of an adenomatous recurrence, endoscopic resection is limited by the impossibility of lifting the lesion. One of the most frequently used techniques in this situation is coagulation with argon plasma (using electrocautery and biopsy forceps); however, the rate of recurrence with this technique can reach up to 50%.[30] FTR may be a good alternative, since it performs an en bloc excision of the full wall, but it is limited to lesions of up to 20 mm. In the rectum, we believe that TEM is the best therapeutic option for lesions larger than 20 mm. As we stated previously, in our series, 86.6% (13/15) of the recurrences were treated with a new TEM; 2/13 presented an infiltrating adenocarcinoma and were rescued by radical surgery.

The main limitation of the study is its retrospective nature, although the prospective introduction of the data ensured that none of the data were missing. Its main strength is the fact that it is a single-center study, with a wide case range, which addresses a situation that will become increasingly frequent with the implementation of screening programs for colorectal cancer all over the world.

In conclusion, as the recurrence rate of large rectal adenomas after TEM is low (4%), we believe that TEM is the technique of choice for its excision. Involved margins are the most important predictor of recurrence, and so a good surgical technique is essential. We have not found any predictive factors of relapse related to the depth of excision or the presence of free resection margins. As far as follow-up is concerned, a sigmoidoscopy should be performed every 6 months during the first 2 years, and standard controls should be carried out after this time.

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Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

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