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Management of large polyps in a colorectal cancer screening program with fecal immunochemical test: a community- and population-based observational study

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Authors

Bernard Denis[1,2], Isabelle Gendre[2,3], Philippe Perrin[2,3], Nicolas Tuzin[4], Mathieu Pioche[5]

Institutions

1 Department of Gastroenterology, Louis Pasteur Hospital, Colmar, France
2 ADECA Alsace, Colmar, France
3 CRCDC Grand Est, site de Colmar, Colmar, France
4 Department of Public Health, University Hospital of Strasbourg, Strasbourg, France
5 Department of Gastroenterology, Edouard Herriot Hospital, Lyon, France

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Corresponding author
Bernard Denis, Department of Gastroenterology, Louis Pasteur Hospital, 39 avenue de la Liberté, 68024, Colmar Cedex, France
bernard.denis@ch-colmar.fr

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ABSTRACT

Background and study aims The aim of this study was to analyze presentation, management, and outcomes of large polyps (LPs; ≥ 20 mm) detected in a colorectal cancer (CRC) screening program using a quantitative fecal immunochemical test (FIT).

Patients and methods This was a retrospective community- and population-based observational study of all LPs detected in patients aged 50 to 74 years between 2015 and 2019 during FIT-positive colonoscopies within the screening program organized in Alsace (France).

Results Among 13,633 FIT-positive colonoscopies, 1256 LPs (8.5 % malignant and 51.8 % nonpedunculated) were detected by 102 community gastroenterologists in 1164 patients (one in 12 colonoscopies). The sensitivity of optical diagnosis of malignancy was 54 % for nonpedunculated and 27 % for pedunculated T1 CRCs. The endoscopic resection rate was 82.7 % (95 % confidence interval [CI] 80.3–84.9) for benign LPs (70.2 % [95 % CI 66.4–74.1]) nonpedunculated, 95.2 % [95 % CI 93.4–97.1] pedunculated), varying from 0 to 100 % depending on the endoscopist. It was correlated with cecal intubation (Pearson $r = 0.49$, $P < 0.01$) and adenoma detection rates ($r = 0.25$, $P = 0.01$). Most endoscopists did not refer patients to more experienced endoscopists, and as a result, 60 % to 90 % of 183 surgeries for benign LPs were unwarranted. Endoscopic resection was curative for 4.3 % (95 % CI 0.9–12.0) of nonpedunculated and 37.8 % (95 % CI 22.5–55.2) of pedunculated T1 CRCs. Overall, 22 endoscopic submucosal dissections had to be performed to avoid one surgery.

Conclusions Compared with current recommendations, there is tremendous room for improvement in community endoscopy practices in the diagnosis and management of LPs. Detection and polypectomy competencies are correlated and highly variable among endoscopists. Endoscopic resection is curative for 83 % of benign LPs and 16 % of T1 CRCs.

Introduction

Most colorectal cancers (CRCs) are preventable whatever the screening method used. Fecal occult blood test (FOBT), flexible sigmoidoscopy, and colonoscopy and polypectomy are effective at reducing CRC incidence and mortality [1].

Large polyps (LPs; ≥ 20 mm) are increasingly detected in FOBT-enriched colonoscopies. They are malignant in a significant proportion of cases and can be challenging to remove endoscopically. Several guidelines have been published on colorectal polypectomy and management of LPs along with systematic reviews and meta-analyses [2–9]. Some authors claim that all benign colorectal polyps can be removed by endoscopic resection (ER), using endoscopic mucosal resection (EMR), endoscopic submucosal dissection (ESD), or hybrid techniques. In a large meta-analysis, over 90 % of LPs could be removed endoscopically by experienced endoscopists [8]. Data from population-based studies are not so good, with referral rates for surgery of 21 % to 22 % for benign LPs [10, 11]. In 2015, the US recommendations proposed two research questions concerning LPs: How are they managed? and What is the success rate of ER of nonpedunculated LPs in community practice [12]? There is still no answer in 2021. An indirect disappointing answer is the high volume of surgery for benign colorectal polyps observed in several countries. In the United States, they represented 25 % of surgeries for colorectal neoplasia [13]. Yet the complication and mortality rates for surgery for benign polyps are significantly higher than those for ER [8, 14]. There are no data on the management of LPs in community practice and in population-based fecal immunochemical test (FIT) and colonoscopy screening programs. Precise data on the management and outcomes of LPs in an organized CRC screening program are of utmost importance for providing transparent information to the invited population.

Our aim was to analyze presentation, management, and outcomes of colorectal LPs detected in the French CRC FIT screening program.

Patients and methods

We conducted a population-based retrospective observational study of prospectively collected data. We analyzed data concerning all LPs detected from 2015 to 2019 in residents undergoing colonoscopy for a positive FIT within the CRC screening program organized in Alsace, part of the French national program. This study was approved by the institutional review board of the Hospices Civils de Lyon.

FIT screening program

A guaiac-based FOBT (gFOBT) CRC screening program was initiated in 2003 in Alsace. Its design has been previously described [15, 16]. People with serious illness, recent CRC screening, or high CRC risk were excluded. Residents aged 50 to 74 years (0.57 million individuals) were invited by mail every other year to participate. The gFOBT was replaced by a quantitative FIT (OC-Sensor) in 2015. The FIT positivity threshold was set at 30 µg hemoglobin per gram (µg/g) feces. People with a positive FIT were referred for colonoscopy.

Colonoscopies

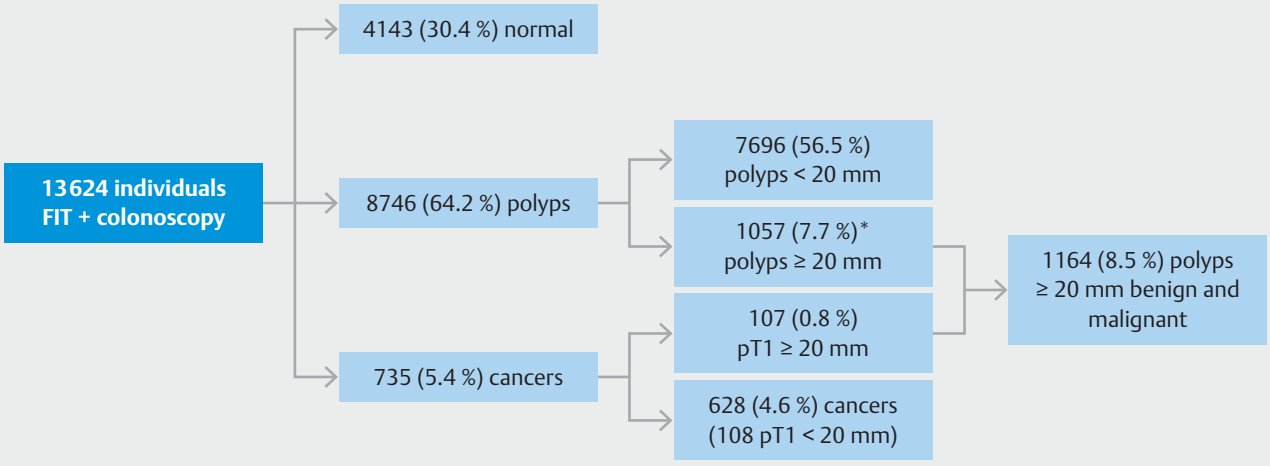
In France, almost all colonoscopies are performed by certified gastroenterologists, their certification process including the performance of 200 colonoscopies and 50 polypectomies. There is no certification maintenance rule related to the practice of endoscopy in general, and of colonoscopy in particular. All certified gastroenterologists participated in the program. Most colonoscopies were performed with sedation/anesthesia provided by an anesthesiologist. The ER technique was left to the endoscopists' discretion. There are no French guidelines about colorectal polypectomy such as those existing in other countries [2–6]. Because there is no certification system for expert endoscopists in France, experts were defined by ER success rates of benign LPs ≥ 90 % and regular referral of patients from other endoscopists (> 10 patients during the study period). All colonoscopy and pathology reports were prospectively collected as part of routine practice.

Colorectal polyps

LPs were defined as polyps measuring ≥ 20 mm. In most cases, polyp size was ascertained from the pathology report, or failing that, from the endoscopist's evaluation recorded in the colonoscopy report. The pathological examination of polyps was performed as usual by community general pathologists. In situ and intramucosal carcinomas were classified as high-grade dysplasia. T1 CRC (malignant polyp) was defined as carcinoma invading the submucosa through the muscularis mucosa, but not beyond. T1 CRCs were considered superficial when submucosal invasion was ≤ 1 mm and deeply invasive when it was > 1 mm. They were divided into T1 CRCs with low risk of lymph node metastasis (LNM), i. e. with submucosal invasion ≤ 1 mm without lympho-vascular involvement, tumor budding and poor differentiated component, and high-risk T1 CRCs in the other cases [3]. In case of several LPs in a single patient, the management of the worst-prognosis lesion was considered (per-patient analysis). The colonoscopy and pathology reports for all T1 CRCs were further analyzed concerning the description of an optical suspicion of malignancy, the resection technique, the outcomes of resection (success, i. e. complete ER, or failure), the number of pieces (en bloc vs piecemeal resection), and the pathology risk factors for LNM. The proximal colon was defined as proximal to the splenic flexure. Correlations between ER success rate for LPs and established quality indicators were determined among endoscopists having performed > 10 colonoscopies and having encountered more than one LP during the period.

Statistical methods

Quantitative variables were expressed using mean and standard deviation (SD) while categorical variables were expressed as numbers and percentages with 95 % confidence intervals (CIs). The chi-square test was used to test for statistical significance by comparisons of proportions. Student's *t* test was used to compare difference in group means. Pearson's correlation coef-



▶ **Fig. 1** Flowchart.

▶ **Table 1** Endoscopically-removed polyps (n = 22,933): distribution by size and malignancy.

Polyp size (mm)	0–9	10–19	20–29	30–39	≥40	Total
Total number (%)	17,140 (74.7)	4537 (19.8)	807 (3.5)	287 (1.3)	162 (0.7)	22,933 (100)
Malignant polyps (%)	15 (0.1)	97 (2.1)	53 (6.6)	27 (9.4)	27 (16.7)	219 (1.0)

ficient (*r*) was used to evaluate correlations between variables. All statistical tests were two-sided. The significance threshold was set at 0.05. Statistical analyses were performed using R software version 3.6.0.

Results

Colonoscopies and polyps

A total of 13,633 colonoscopies were performed in 13,624 individuals by 102 endoscopists, including four experts (▶ **Fig. 1**). The overall cecal intubation rate (CIR) was 97.8 % (84.2 %-100 % depending on the endoscopist) and adenoma detection rate (ADR) was 58.6 % (28.6 %-78.6 %). Overall, 22,933 polyps were removed (▶ **Table 1**). Among them, 1256 LPs (5.5 %) were managed in 1164 patients (mean age 63.3 years; SD 6.7; 67.7 % men) and analyzed by 38 pathologists. The LP detection rate was 4.2 per 1000 individuals screened with FIT. The positive predictive value of FIT for LPs was 8.5 % (95 % CI 8.1–9.0). Their characteristics are presented in ▶ **Table 2**. Half were nonpedunculated (51.8 %) and situated in the distal colon (52.4 %). The overall rate of T1 CRCs was 8.5 %. It increased significantly with polyp size ($P<0.001$) (▶ **Table 1**), nonpedunculated shape ($P<0.01$) (▶ **Table 2**), and distal location (17.3 % in rectum, 8.9 % in sigmoid colon and 5.4 % in left and proximal colon, $P<0.001$). In comparison with pedunculated LPs, nonpedunculated LPs were significantly larger, more often proximal, with high-grade dysplasia or malignancy, with morphological features suggestive of malignancy, and biopsied (▶ **Table 2**).

Management of pedunculated and nonpedunculated polyps

Among 563 individuals harboring pedunculated LPs, 10 (1.7 %) had morphological features suggestive of malignancy that were actually pT1 CRCs, and were all managed surgically (**Supplementary Fig. 1a**). Among the other 553 individuals, with LPs initially assessed as benign, 38 (6.9 %) were managed surgically (**Supplementary Fig. 1b**). Among 601 individuals harboring nonpedunculated LPs, 68 (11.3 %) had morphological features suggestive of malignancy and 38 were actually T1 CRCs. Of them, 57 (83.8 %) were finally managed surgically (**Supplementary Fig. 1c**). Among the other 533 individuals, 168 (31.5 %) were managed surgically (**Supplementary Fig. 1d**).

Benign polyps

The overall success rate for ER of benign LPs was 82.7 % (95 % CI 80.3–84.9): at initial colonoscopy (67.4 %) or during a second procedure, performed by the same endoscopist (7.6 %) or another one, expert (6.4 %) or nonexpert (1.3 %) (▶ **Table 3**). It increased significantly from 78.3 % in 2015 to 2016 to 85.9 % in 2017 to 2018 ($P=0.002$). It varied from 0 % to 100 %, according to the endoscopist (mean 68.2 %, SD 29.9 %, median 72.0 %). It was ≥ 90 % for 24.8 % of endoscopists and < 80 % for 58.4 % of them. It was 91.3 % for experts (91.8 % for first-line and 90.9 % for referral colonoscopies). It was significantly correlated with CIR (Pearson coefficient $r=0.49$, $P<0.001$), ADR ($r=0.25$, $p=0.02$), proximal serrated lesion detection rate ($r=0.26$, $P<0.05$), and annual LP volume ($r=0.29$, $P=0.003$). It was not cor-

▶ **Table 2** Characteristic features of 1256 large polyps, overall and according to polyp shape (per-polyp analysis).

	Overall number (%)	Pedunculated number (%)	Non-pedunculated number (%)	*P*
Polyps	1256	606 (48.2)	650 (51.8)	
Size				<0.001
▪ 20–29 mm	808 (64.3)	484 (79.9)	324 (49.8)	
▪ 30–39 mm	286 (22.8)	96 (15.8)	190 (29.2)	
▪ ≥40 mm	162 (12.9)	26 (4.3)	136 (20.9)	
Location[1]				<0.001
▪ Rectum	179 (14.3)	63 (10.4)	116 (17.9)	
▪ Distal colon	657 (52.3)	473 (78.0)	184 (28.4)	
▪ Proximal colon	418 (33.3)	70 (11.6)	348 (53.7)	
Histology				<0.001
▪ Conventional adenoma	1206 (96.0)	597 (98.5)	609 (93.7)	
▪ Sessile serrated adenoma/polyp	29 (2.3)	2 (0.3)	27 (4.2)	
▪ Hyperplastic	6 (0.5)	2 (0.3)	4 (0.6)	
▪ Non-adenomatous non-serrated	15 (1.2)	5 (0.8)	10 (1.5)	
Dysplasia				<0.001
▪ T1 CRC	107 (8.5)	37 (6.1)	70 (10.8)	
▪ High grade – pTis	354 (28.2)	154 (25.4)	200 (30.8)	
▪ Low grade	763 (60.7)	408 (67.3)	355 (54.6)	
▪ No dysplasia	32 (2.5)	7 (1.2)	25 (3.8)	
Suspicious for T1 CRC	78 (6.2)	10 (1.7)	68 (10.5)	<0.001

CRC, colorectal cancer.
[1] Two missing data.

▶ **Table 3** Management of 1057 individuals harboring benign large polyps, overall and according to polyp shape (per-patient analysis).

	Overall number (%)	Pedunculated number (%)	Non-pedunculated number (%)	*P*
Patients	1057 (100)	526 (49.8)	531 (50.2)	–
Endoscopic resection 1st attempt n (%)	712 (67.4)	461 (87.6)	251 (47.3)	<0.001
Endoscopic resection 2nd attempt n (%)	162 (15.3)	40 (7.6)	122 (23.0)	<0.001
Same endoscopist	80 (7.6)	22 (4.2)	58 (10.9)	<0.001
Other non-expert endoscopist	14 (1.3)	6 (1.1)	8 (1.5)	0.6
Other expert endoscopist	68 (6.4)	12 (2.3)	56 (10.5)	<0.001
Endoscopic resection (overall)	874 (82.7)	501 (95.2)	373 (70.2)	<0.001
Surgery from outset	180 (17.0)	24 (4.6)	156 (29.4)	<0.001
Surgery (overall)	183 (17.3)	25 (4.8)	158 (29.8)	<0.001

related with annual colonoscopy volume ($r=0.17$, $P=0.1$). Of 232 patients that initial endoscopists could not manage themselves, 34.5 % were referred to a more experienced endoscopist and 65.5 % to a surgeon. Referral rate to another endoscopist varied from 0 % to 100 % depending on the endoscopist. Of the 59 endoscopists with an ER success rate < 80 %, 54.4 % did not refer any patient (likewise for 70.6 % of 17 endoscopists having an 80 %-90 % ER success rate). ESD was performed in 16 cases

▶ **Table 4** Characteristic features of 107 malignant large polyps, overall and according to polyp shape (per-polyp and per-patient analysis).

	Overall number (%)	Pedunculated number (%)	Non-pedunculated number (%)	*P*
T1 CRC	107 (8.5)	37 (6.1)	70 (10.8)	<0.001
▪ Low-risk T1 CRC	19 (17.8)	10 (27.0)	9 (12.9)	
▪ High-risk T1 CRC	53 (49.5)	22 (59.5)	31 (44.3)	
▪ Unknown T1 CRC	35 (32.7)	5 (13.5)	30 (42.9)	
Optical diagnosis of T1 CRC				–
▪ Sensitivity % [95 % CI]	48/107 44.9 [35.4–54.3]	10/37 27.0 [12.7–41.3]	38/70 54.3 [42.6–66.0]	
▪ Specificity % [95 % CI]	1027/1057 97.2 [96.2–98.2]	526/526 100 [100–100]	501/531 94.4 [92.4–96.3]	
▪ PPV % [95 % CI]	48/78 61.5 [50.7–72.3]	10/10 100 [100–100]	38/68 55.9 [44.1–67.7]	
▪ NPV % [95 % CI]	1027/1086 94.6 [93.2–95.9]	526/553 95.1 [93.3–96.9]	501/533 94.0 [92.0–96.0]	
Biopsy sample during colonoscopy	59 (55.1 %)	8 (21.6)	51 (72.9)	<0.001

CRC, colorectal cancer; NPV, negative predictive value; PPV, positive predictive value.

▶ **Table 5** Management of 107 individuals harboring malignant large polyps, overall and according to polyp shape (per-patient analysis).

	Overall number (%)	Pedunculated number (%)	Non-pedunculated number (%)	*P*
Patients	107 (100)	37 (34.6)	70 (65.4)	–
Endoscopic resection 1st attempt n (%)	40 (37.4)	26 (70.3)	14 (20.0)	<0.001
Endoscopic resection 2nd attempt: other non-expert endoscopist **n (%)**	5 (4.7)	2 (5.4)	3 (4.3)	0.8
Endoscopic resection 2nd attempt: other expert endoscopist **n (%)**	8 (7.5)	1 (2.7)	7 (10.0)	0.2
Endoscopic resection (overall)	53 (49.5)	29 (78.4)	24 (34.3)	<0.001
En bloc endoscopic resection	26 (24.3)	18 (48.6)	8 (11.4)	<0.001
Curative endoscopic resection	17 (15.9)	14 (37.8)	3 (4.3)	<0.001
Surgery from outset	54 (50.5)	8 (21.6)	46 (65.7)	<0.001
Adjuvant surgery for high-risk T1 CRC	36 (33.6)	15 (40.5)	21 (30.0)	0.3
Surgery (overall)	90 (84.1)	23 (62.2)	67 (95.7)	<0.001

CRC, colorectal cancer.

(2.7 % of nonpedunculated LPs) and hybrid technique in six cases (1.0 %), for benign LPs in 21 cases (95.5 %). ESD or hybrid technique were en bloc in 16 (72.7 %) cases.

Malignant polyps

Of 735 CRCs, 232 (31.6 %) were T1 CRCs, 107 of them being LPs (▶ **Table 4**, ▶ **Table 5**). Overall, the endoscopist mentioned optical suspicion of T1 CRC for 78 (6.7 %) LPs, 48 of them being true positive T1 CRCs. The overall sensitivity and the negative predictive value (NPV) of the optical diagnosis of T1 CRC were 44.9 % (95 %CI 35.4–54.3) and 94.6 % (95 %CI 93.2–95.9), respectively. Endoscopic biopsies were performed in 55.1 % of cases, the result of which being: absence of neoplasia (3.4 %), low-grade dysplasia (28.8 %), high-grade dysplasia (27.1 %), in situ carcinoma (17.0 %), and invasive carcinoma (23.7 %). An ER was performed in 53 cases (49.5 %), 60.4 % for 20– to 29-mm T1 CRCs and 39.6 % for ≥ 30 mm T1 CRCs ($P = 0.04$).

The pathology report was complete, analyzing all risk factors for LNM, in 30 % of cases of surgery and 56.6 % of cases of ER (Sm or Haggitt stage 79 %, differentiation degree 98 %, lymphovascular invasion status 91 %, tumor budding status 77 %, deep margin status 94 %). The reason for classifying 31 nonpedunculated LPs as high-risk T1 CRCs was Sm > 1 in 19 cases (61.3 %), deep resection margin involved or not evaluable in seven

▶ **Table 6** Characteristics of patients and large polyps classified by final therapeutic modality.

	Endoscopy n (%)	Surgery n (%)	*P*
Population (per-patient analysis)			
Number	**891**	**273**	–
Mean age (SD) years	63.0 (6.8)	64.6 (6.2)	<0.001
Men n (%)	606 (68.0)	182 (66.7)	0.7
Polyps (per-polyp analysis)			
Mean size (SD) mm	26.0 (7.7)	33.7 (12.1)	<0.001
Location[1]			<0.001
▪ Rectum	135 (75.4)	44 (24.6)	
▪ Distal colon	563 (85.7)	94 (14.3)	
▪ Proximal colon	257 (61.5)	161 (38.5)	
Morphology			<0.001
▪ Pedunculated	548 (90.4)	58 (9.6)	
▪ Non-pedunculated	408 (62.8)	242 (37.2)	
Location[1] **and morphology**			0.1
▪ Rectum non-pedunculated	77 (66.4)	39 (33.6)	
▪ Distal colon non-pedunculated	124 (67.4)	60 (32.6)	
▪ Proximal colon non-pedunculated	206 (59.2)	142 (40.8)	
Histology			0.2
▪ Conventional adenoma	913 (75.7)	293 (24.3)	
▪ Sessile serrated adenoma/polyp	26 (89.7)	3 (10.3)	
▪ Hyperplastic	6 (100)	0 (0)	
▪ Non-serrated non-adenomatous	11 (73.3)	4 (26.7)	
Dysplasia			<0.001
▪ T1 high-risk CRC	5 (9.4)	48 (90.6)	
▪ T1 low-risk CRC	11 (57.9)	8 (42.1)	
▪ T1 unknown risk CRC	1 (2.9)	34 (97.1)	
▪ High-grade dysplasia	238 (67.2)	116 (32.8)	
▪ Low-grade dysplasia	676 (88.6)	87 (11.4)	
▪ Non-dysplastic	25 (78.1)	7 (21.9)	

(22.6%), and poor differentiation, budding or lymphovascular invasion in five (16.1%). Among 24 nonpedunculated T1 CRCs removed endoscopically, an EMR was performed in 23 cases and an ESD in one case optically suspicious for malignancy (pT1 Sm1 low-risk). One patient (1.9%) had surgery because of doubt on R0 resection linked to uncertain pathology related to piecemeal EMR. Overall, ER was curative in 17 patients (15.9%; 95% CI 9.5–24.2), three (4.3%; 95%CI 0.9–12.0) with nonpedunculated T1 CRCs and 14 (37.8%; 95%CI 22.5–55.2) with pedunculated ones.

Surgery

The characteristics of patients and LPs managed surgically are presented in ▶**Table 6**, in comparison with those managed endoscopically. The reasons for surgery, from the outset or secondarily, are detailed in ▶**Table 7**. Three of four surgeries (202/273) were performed from the outset, one in four (51/202) for T1 CRC suspicion. Overall, the reason for surgery was ER not attempted or failed in two-thirds of cases (179/273).

▶ **Table 7** Reasons for surgery.

	Total	Pedunculated	Non-pedunculated	*P*
From the outset	**202 (17.4)**	**29 (5.2)**	**173 (28.8)**	**<0.001**
▪ T1 CRC suspicion	51 (25.2)	5 (17.2)	46 (26.6)	0.3
▪ ER failure	8 (4.0)	0 (0)	8 (4.6)	0.2
▪ ER not attempted	142 (70.3)	24 (82.8)	118 (68.2)	0.1
▪ Polyposis	1 (0.5)	0 (0)	1 (0.6)	0.7
Secondary	**71 (6.1)**	**19 (3.4)**	**52 (8.7)**	**<0.001**
▪ Adjuvant surgery	39 (54.9)	16 (84.2)	23 (44.2)	<0.01
▪ ER failure	29 (40.9)	3 (15.8)	26 (50.0)	<0.01
▪ ER complication	3 (4.2)	0 (0)	3 (5.8)	0.5
Total surgery	**273 (23.5)**	**48 (8.5)**	**225 (37.4)**	**<0.001**

CRC, colorectal cancer; ER, endoscopic resection.

Discussion

This is the first population- and community-based study about LPs to be published, and the first embedded in an organized CRC screening program with FIT. Compared with current recommendations, our results indicate that there is a tremendous amount of room for improving community endoscopy practices for the diagnosis and management of LPs in the real world [3–6].

FIT is the CRC screening tool with the highest advanced neoplasia yield. Endoscopists had to manage an LP in one of every 12 FIT-positive colonoscopies, i. e. 10 times more frequently than in the Polish colonoscopy screening program (1/113) [17]. Our ER rate for benign LPs was similar to those observed in the gFOBT English Bowel Cancer Screening program (BCSP) and in Brittany (France) [10, 11]. It was 46.9 % at detection, intermediate between rates observed in the English BCSP (64.8 %) and in non-BCSP patients (34.2 %) [18]. The ER rate for benign LPs was < 80 % for almost 60 % of our endoscopists. ER rates are heterogeneous and lower in community-based studies than in expert series [8]. Furthermore, despite the higher morbidity-mortality rate of surgical resection, when the first-line endoscopists could not remove benign LPs themselves, they referred patients to a surgeon twice as often as to a more experienced endoscopist [8, 14]. This led to a significant volume of surgeries for benign LPs, avoidable in 32 % to 74 % of cases if patients had been referred to expert endoscopists [13, 14]. Surgery was definitely unwarranted in more than 60 % of our benign LP patients who underwent surgery, i. e. all those with pedunculated LPs and nonpedunculated LPs measuring 20 to 35 mm. It can even be reasonably stated that all surgeries performed for benign LPs were unwarranted in the absence of prior ER failure by an experienced endoscopist. Screening program reports never mention the rate of referral to experienced endoscopists. It reached 7.3 % in our FIT program, six times higher than in the gFOBT program in Brittany (1.3 %) [11]. Overall, one in six patients harboring benign LPs were not given the best possible chance as their colonoscopies were performed by endoscopists who had low ER rates and did not refer to more experienced endoscopists.

Agreed quality indicators assessing polypectomy competency are lacking. The US guidelines "suggest measuring and reporting the proportion of patients referred to surgery for benign colorectal lesion management" [5]. We would advise measuring the endoscopist's ER rate for benign LPs instead of the rate of referral to surgery because the latter is actually a combination of two indicators: the ER rate and the rate of referral to an experienced endoscopist. Only the first evaluates the endoscopist's polypectomy competency, whereas the second one reflects the endoscopist's behavior when encountering an LP exceeding self-perceived LP ER competency. By contrast, the rate of patients referred to surgery for benign colorectal lesion management should be added to the existing quality indicators of CRC screening programs. It is almost never specified and has no established benchmark. In our FIT program, it was 1.7 % (95%CI 1.4–1.9) overall (all sizes polyps) and 17.3 % (95 %CI 15.0–19.6) for LPs (4.8 % for pedunculated LPs). It decreased significantly for benign-appearing nonpedunculated LPs from 33.6 % in 2015 to 2016 to 24.0 % in 2017 to 2018, compared with 34.3 % in 2006 to 2009 in the English gFOBT BCSP [10].

The ER rate for benign LPs varied dramatically between endoscopists and was moderately but significantly correlated with CIR, ADR, proximal serrated lesion detection rate, and annual LP volume, the highest correlation being with CIR. By contrast, a small single academic center study did not find any correlation between polypectomy competency and ADR or withdrawal time [19]. The literature about this subject is poor. Our results indicate that some endoscopy skills are actually linked, mainly manual skills such as completeness of the procedure and polyp resection. The assessment of the correlation between manual and visual skills needs further studies.

The European and US guidelines recommend that "large sessile and laterally spreading or complex polyps should be removed by an appropriately trained and experienced endos-

copist" [3, 5]. Given the high incidence of LPs in FIT-positive colonoscopies and the insufficient rate of referral to experienced endoscopists, one might wonder whether FIT-positive colonoscopies should be performed by accredited gastroenterologists only, as in English and Dutch BCSPs [10, 20]. Likewise, given the difficulties of interpretation, the moderate performance of community pathologists, and the decisional challenge, i. e. the indication (or not) for adjuvant surgery, endoscopically-removed T1 CRCs should be analyzed, or at least reviewed, by gastrointestinal expert pathologists, as recommended by the European Society of Gastrointestinal Endoscopy (ESGE) [3].

Malignancy (i. e. submucosal invasion) was suspected in only one-half of nonpedunculated T1 CRCs and one-quarter of pedunculated ones. These results are similar to those obtained by screening-certified endoscopists in the Dutch BCSP [20]. They are far from the ideal situation where endoscopists could predict accurately the absence of malignancy and perform EMR (piecemeal if necessary), estimate a nonnegligible risk of superficial malignancy (nongranular pseudodepressed or granular with mixed-sized nodules) and perform en bloc EMR or ESD, and diagnose deeply invasive cancer to refer for surgery [2]. For the moment, the NPV of optical diagnosis of T1 CRC was around 95 %, enough to systematically propose an EMR for LPs without suspected malignancy. Likewise, for LPs with suspected malignancy, because ER of high-risk T1 CRCs has no deleterious effect on long-term outcomes, EMR could be systematically attempted as first-line treatment, adapting the ultimate treatment to the pathology analysis of the resected specimen [21]. Our results confirm that biopsy samples cannot diagnose LP malignancy accurately and should not be used to choose the adequate resection technique. In any case, optical diagnosis of lymphovascular invasion, tumor budding, and poor differentiation, which were the only reasons for classifying LPs as high-risk T1 CRCs in 16 % of cases, seems impossible.

ESD was marginally used in our community-based study (3.7 % of nonpedunculated LPs) and mostly misused (95.5 % for benign LPs). Our results bring further community-based evidence demonstrating the marginal role of ESD for colorectal lesions: only one of 22 patients benefited from ESD, and thus avoided surgery. ESD low-effectiveness was caused by poor case selection. The number of LPs needed to be treated by ESD to avoid one surgery was 16 in a review of ESDs performed in tertiary care centers [22]. In three of four of our cases, adjuvant surgery was motivated by histological LNM risk factors, such as Sm invasion > 1 mm (61 %) and/or lymphovascular invasion, tumor budding, or poor differentiation (16 %). Deep resection margin involved or not evaluable was encountered in 23 % of cases. ESD enables a more precise pathologic diagnosis of the depth of invasion and the margin status than piecemeal EMR. However, piecemeal EMR does not prevent all pathology diagnoses, although the exact rate of missed information due to piecemeal EMR is not known [23]. Today, ESD seems to have a limited place for colorectal lesions, virtually nil for benign-appearing nonpedunculated LPs, and requires further evaluation for those suspicious of superficial malignancy. Overall, we would state that: 1) endoscopists encountering LPs they are unable to remove personally must refer their patients to experienced endoscopists, not to surgeons; and 2) experienced endoscopists should remove these LPs endoscopically using the ER method they do best: EMR, ESD or hybrid technique.

As previously reported, the rate of malignancy was threefold and two-fold higher for LPs located in the rectum and sigmoid, respectively, compared with the rest of the colon [24]. It suggests that appropriate treatment might be different between recto-sigmoid and more proximal LPs. ESD could be restricted to rectal LPs, as suggested by the ESGE, and eventually sigmoid LPs, while waiting for a demonstration of its interest in the rest of the colon [4].

As others, we found that 8.5 % of LPs were T1 CRCs (6.1 % of pedunculated LPs, significantly lower than 10.8 % of nonpedunculated) [24]. Of them, 9.3 % were N1 (5.4 % for pedunculated LPs, significantly lower than 11.4 % for nonpedunculated) and 15.9 % were cured by ER (37.8 % of pedunculated LPs, significantly lower than 4.3 % of nonpedunculated).

Our study is not without weaknesses. The size measurement was approximate in most cases, so that some LPs measuring around 20 mm could have been wrongly included or excluded. We had no information about difficulty of site access, subtypes of laterally spreading tumors, and use of advanced endoscopic imaging, such as narrow band imaging. The ER technique could be analyzed for malignant polyps only. We did not assess the performances of the optical diagnosis between low-risk and high-risk T1 CRCs, and between superficial and deeply invasive T1 CRCs. The Sm stage was specified in one-quarter of surgical cases only, so that it was impossible to compare the invasiveness of T1 CRCs removed endoscopically and surgically. There was no centralized histological review of T1 CRCs. The adverse events (AEs) from treatments have not been analyzed. We reported elsewhere the AEs of colonoscopies performed in our CRC screening program with FIT [25]. In any case, the higher morbidity and mortality of surgery over endoscopy is well demonstrated [10, 11, 14]. We did not analyze late follow-up and the occurrence of residual or recurrent neoplasia. Last, the generalizability of our results is questionable: A quick reading might suggest that French endoscopists' performance is poor and that our alarming message is French CRC screening program-specific. Such is probably not the case, as high rates of surgery for benign LPs are common and population- and community-based data about LP management are absent from the literature [13, 26]. All these data illustrate the huge gap between tertiary-center and real-world performance, as well as the urgent need for training and dissemination of modern techniques for optical diagnosis of superficial and deeply invasive malignancy, polypectomy, and quality control. Locoregional multidisciplinary meetings are needed, along with established referral pathways for the management of LPs.

Conclusions

In the French CRC screening program with FIT, only three of four LPs were cured endoscopically, four of five benign LPs, and one of six malignant LPs. Polypectomy competency was notably endoscopist dependent, correlated with CIR and ADR. Most surgeries for benign LPs could have been avoided if endos-

copists with lesser polypectomy competency had referred the patients they could not manage personally to experienced endoscopists instead of surgeons.

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Competing interests

Dr. Pioche has received personal fees from Olympus and Norgine.

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