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## **Effect of implementing a regional referral network on surgical referral rate of benign polyps found during a colorectal cancer screening program: A population-based study.**

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## **Abstract**

### **INTRODUCTION**

Surgical management is too often performed as the first-line treatment for large, benign colorectal polyps. We report the management of benign lesions detected by organised colorectal cancer (CRC) screening.

### **METHODS**

Population-based study in 2012, 2016, and 2017, analyzing the evolution of surgical management of benign polyps of  $\geq 2$  cm diameter discovered in the context of organised CRC screening after the implementation of a regional referral network for the management of superficial colorectal lesions.

### **RESULTS**

A total of 1,571 patients underwent colonoscopy following a positive test during the study period, among which 981 colonoscopies yielded at least one lesion. The adenoma detection rate was lower in 2012 (Guaiac test) than in 2016 and 2017 (fecal immunochemical test) (40% vs. 60% vs. 57%,  $p < 0.0001$ ). The surgery rate for benign lesions decreased from 14.6% in 2012 to 7.7% in 2016 and 5% in 2017 ( $p = 0.017$ ). The risk factors for surgery for benign lesions were year 2012 (odds ratio [OR] = 3.35,  $p = 0.022$ ), high-grade dysplasia (OR = 2.49,  $p = 0.04$ ), *in situ* carcinoma (OR = 5,  $p = 0.003$ ), size  $\geq 20$  mm (OR = 17.39,  $p < 0.0001$ ), and private sector (OR = 6.6,  $p = 0.0002$ ). The morbidity rate of surgery for benign polyp  $\geq 2$  cm was 20.4% at 1 month and its cost was sixfold higher than that of endoscopy.

### **CONCLUSION**

The establishment of a regional referral network for the management of large colorectal polyps reduces the rate of surgical management of such lesions.

**Keywords:** Colorectal Cancer; ESD; EMR; Colorectal Surgery.

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## **INTRODUCTION**

A colorectal cancer screening program by faecal occult blood testing followed by colonoscopy in cases of positivity results in decreased mortality from colorectal cancer [1]. Endoscopic resection is the gold standard for treating precancerous lesions and decreasing the incidence of colorectal cancer. However, despite the availability of guidelines based on a growing body of evidence on the benefits of endoscopic resection over surgery, endoscopic resection is limited for large complex superficial lesions due to a lack of expert referral centres. Surgery for benign polyps is associated with a higher morbidity, mortality risk, and higher cost compared to endoscopic resection, whether complex endoscopic mucosal resection (EMR) [2,3] or endoscopic submucosal dissection (ESD) [4,5] is performed. A recent large French population-based study found a high rate of surgical referral as a result of a colorectal cancer screening program [6]. By contrast, repeat colonoscopy at an expert centre has a clearance rate of 71% of lesions without biopsy-proven cancer [7]. The European guidelines recommend referring large complex non-malignant lesions to an expert referral centre [8]. However, expert referral centres are rare, whereas the number of benign complex lesions has increased as a result of colorectal screening programs based on fecal immunochemical test (FIT), which increases both parallel participation and the adenoma detection rate [9,10]. This important clinical and economic issue was emphasised by a Dutch report on a high rate of surgical referral for benign polyps without attempted endoscopic resection; the rate was stable over an 11-year period (2005–2015) [11].

The number of expert referral centres in France is growing due to an important offer of hands-on training for endoscopic resection techniques (EMR and ESD) for these large complex lesions.

The goal of this study was to analyse the evolution of the surgical referral rate for benign lesions detected due to a colorectal cancer screening program before and after implementation of a regional referral network.

## **METHODS**

### **Description of the administrative area, medical resources, and experts in endoscopic resection**

We collected the necessary information to carry out this study from the databases of the SDDC 87 (Structure de Dépistage Des Cancers en Haute Vienne; Cancer Screening Facility in

Haute Vienne) from the Caisse Primaire d'Assurance Maladie (Primary Health Insurance Fund), which has been validated by the Commission Nationale de l'Informatique et des Libertés (the French Data Protection Authority).

The study protocol conformed to the ethical guidelines of the 1975 Declaration of Helsinki and was approved by the Ethical Committee of Limoges University Hospital Centre on September 12, 2019.

The populations screened in our administrative area were 115,028 people in 2012, 121,190 in 2016, and 122,921 in 2017.

Two physicians specialising in interventional endoscopy including resection of complex superficial colorectal lesions completed their training and introduced piecemeal colonic EMR and rectal ESD for large superficial lesions in the academic centre of the administrative area since 2013. Because of the satisfactory results by the expert team, a regional care network was set up in 2015 with direct access by phone and e-mail to all gastroenterologists in the department, whether to send patients or to request advice on photographs and videos on the resectability of superficial lesions detected. Regular meetings (at least twice a year) with all physicians of the department about characterisation, indications, pre-therapeutic evaluation, and results have been held since the end of 2015.

This period also corresponded to a modification in faecal occult blood testing in France with the FIT that replaced the guaiac-based test national screening program for colorectal cancer. We selected the years 2012, 2016, and 2017 for analysis because 2012 was the last year in which the *Hemoccult II* test was performed; two endoscopists expert in complex resections arrived in our department in 2013. The year 2016 was the first full year in which the FIT was performed (started in April 2015) after implementation of the referral regional network in 2015.

Over the period analysed, 26 gastroenterologists performed all of the colonoscopies in public (academic and non-academic) and private hospitals after a positive test.

### **Characteristics of the study population**

The population studied corresponded to inhabitants of the Haute-Vienne administrative area, aged 50–74 years, with a medium risk for colorectal cancer during 2012, 2016, and 2017, who were invited by the National Health Insurance to participate in the screening program.

The patient data collected were sex, date of birth, age at the time of testing, and dates of the test and colonoscopy.

We also evaluated the Institut National de la Statistique et des Études Économiques (INSEE; National Institute of Statistics and Economic Studies) participation rate for the study period.

### **Polyp characteristics**

We noted the number of polyps after colonoscopy and the location of the lesions with the most severe histology. The lesions were classified as adenoma, adenocarcinoma, hyperplastic polyp, serrated and colloid carcinoma, and other than colorectal cancer. Dysplasia was classified according to the Vienna classification for superficial lesions and according to the TNM classification for cancerous lesions.

### **Characteristics of the colonoscopy**

The screening facility database prospectively collects the following data: completeness of the colonoscopy (defined by caecal intubation), presence or absence of a lesion, number of lesions, date of colonoscopy, lesion treatment modality, practitioner's establishment of practice.

The colonoscopies were performed by 26 gastroenterologists (17 in the public sector, six in the private sector, and three practitioners in both sectors depending on the year).

The public sector was divided into the academic tertiary public hospital (the referral centre) and the primary care public hospitals. All but one of the gastroenterologists of the public sector worked at least half-time in the referral centre.

The adenoma detection rate was defined by the proportion of colonoscopies with at least one adenomatous lesion or colon cancer and was calculated for the entire population and for each gastroenterologist.

The cancer detection rate (proportion of colonoscopies with at least one colon cancer) and advanced adenoma detection rate (adenoma  $\geq 1$  cm and/or with villous contingent  $\geq 25\%$  and/or high-grade dysplasia) were also calculated.

### **Analysis of data for benign polyps $\geq 2$ cm**

The management of benign lesions (low-grade dysplasia, high-grade dysplasia, and *in situ* carcinoma)  $\geq 20$  mm, representing endoscopically resectable lesions considered complex

according to the European Society of Gastrointestinal Endoscopy (ESGE) and American Society for Gastrointestinal Endoscopy (ASGE) guidelines [8][12], was analysed anonymously. Colonoscopy, histology, therapeutic management (endoscopy or surgery), hospitalisation, and 30-day follow-up data were analysed.

Postoperative complications were assessed according to the Clavien–Dindo classification:

- Grade I: Any undesirable postoperative event not requiring medical, surgical, endoscopic or radiological treatment; for example, ileus or abdominal wall abscess.
- Grade II: Complication requiring medical treatment; for example, thrombophlebitis or blood transfusion.
- Grade III: Complication requiring surgical, endoscopic, or radiologic treatment.
- Grade IV: A life-threatening complication requiring intensive care.
- Grade V: Death.

For operated polyps  $\geq 20$  mm, we obtained from the individual colonoscopy reports the reason for the gastroenterologist's decision to perform direct surgical management.

An economic analysis of the cost of hospitalisation from the point of view of the paying agency (Social Security) was also carried out. Diagnosis-related group values were recorded for this economic analysis.

## **Outcomes**

The primary outcome was the rate of surgical management for benign lesions before and after the development of a regional care network for managing superficial colorectal lesions.

The secondary outcomes were:

- The surgical management rate according to the institution.
- Risk factors for surgical management of benign polyps.
- The results and costs of surgical and endoscopic management of polyps  $\geq 2$  cm.
- The performance of the guaiac test (*Hemoccult II*) and the FIT.

## **Statistical analysis**

The statistical analysis was performed by a professional and independent non-gastroenterologist statistician (SK). Quantitative data are expressed as medians and interquartile range. Qualitative data are presented as percentages. Univariate qualitative data were compared using Fisher's exact test, and the Wilcoxon rank test was used for

quantitative data. A multiple logistic regression on a per-patient analysis was applied to identify clinically relevant predictive factors of direct surgery for benign colorectal lesions. The univariate analyses involved known risk factors for surgery for benign colorectal lesions for which we had data, and which were clinically relevant. The multivariate analysis involved parameters found to be significant in univariate analyses.

A  $P$ -value  $< 0.05$  was considered significant, and open-source R version 3.0.2 (2013-09-25) and LATEX, on the i386-w64-mingw32 platform, were used for the analysis.

## RESULTS

### Participation in a screening program and population characteristics (*Figure 1*)

In the year 2012, the INSEE participation rate was 25.15% (14,462 tests performed on half of the INSEE population of 57,514 people) and 2.07% of the tests were positive; in 2016 the rate was 35.59% (21,566/60,595) with 4.72% positive, and in 2017 it was 21.30% (13,089/61,460) with 4.27% positive.

Among the positive tests, 90% led to colonoscopy in 2012 and 2016, compared to 80% in 2017.

The study included 1,571 patients who had positive tests followed by colonoscopy during the 2012, 2016, and 2017 campaigns. The median age of the patients was 63 years, and 57% were men.

About 69% of the colonoscopies were performed in the private sector compared to 31.06% in the public sector; 97.9% of colonoscopies were considered complete.

These colonoscopies were performed by 26 gastroenterologists (17 in the public sector, 6 in the private sector, and 3 practitioners who were in both sectors depending on the year), and the median age of the gastroenterologists was 51 years.

A total of 981 (63%) colonoscopies revealed at least one lesion, the majority of which were located in the sigmoid colon. The average size of the lesions (all histological types combined) was 10 mm, and almost 20% of the lesions were  $\geq 20$  mm. The characteristics of the study population, the colonoscopies, and the gastroenterologists are listed in *Table 1*.

### Primary outcome: Surgical management for benign polyps (*Table 2*)

The surgical management rate for benign lesions decreased significantly after the implementation of a regional referral network, from 14.6% in 2012 to 7.7% in 2016 and 5% in 2017 ( $P = 0.017$ ).

### **Secondary outcomes**

#### **Public/private comparison of the surgical management rate for benign polyps (Table 3)**

Surgical management was significantly more important for benign lesions discovered in the context of organised screening carried out in the private sector (10.1% vs. 2.8%,  $P = 0.0001$ ). This difference was only significant for polyps  $\geq 20$  mm (public 22.22% vs. private 62.82%;  $P = 0.0003$ ).

We identified a significant decrease in the surgical management of benign polyps in the private sector (2012: 21.8%; 2016: 10.16%; 2017: 5.96%;  $P = 0.004$ ) but not in the public sector.

#### **Risk factors for surgical management of benign lesions**

After univariate and multivariate analyses (Table 4) we identified risk factors for surgical management of benign lesions found during colonoscopies performed following a positive faecal occult blood test in our population. The following risk factors were significant in the multivariate analysis:

- The year 2012: odds ratio (OR) 3.35, 95% confidence interval (CI) [1.20–9.40],  $P = 0.022$ . The proportion of surgical management then decreased in 2016 and 2017.

- Histology for high-grade dysplasia (OR 2.49, 95% CI [1.04–5.97],  $P = 0.04$ ) and carcinoma *in situ* (OR 5, 95% CI [1.73–14.45],  $P = 0.003$ ).

- The size of the lesion, for lesions  $\geq 20$  mm: OR 17.39, 95% CI [5.50–54.99],  $P < 0.0001$ .

- A private establishment was also a significant risk factor: OR 6.59, 95% CI [2.41–18.01],  $P = 0.0002$ .

- The rectal location of the lesions was a protective factor for surgical management: OR 0.13, 95% CI [0.003–0.56],  $P = 0.006$ .

An analysis of the colonoscopy reports leading to surgical management of benign lesions  $\geq 20$  mm yielded the following reasons why physicians chose to refer benign lesions for direct surgical management:

- Large size: 25/55 (45.5%)
- Inaccessibility: 8/55 (14.5%)
- Endoscopic suspicion of malignancy: 16/55 (29.09%)
- Endoscopic resection failure: 6/55 (10.91%)

Lesion size or erroneous characterisation were the reasons for direct surgical management in 75% of the cases (45% lesion size and 30% endoscopic suspicion of malignancy).

### **Surgical and endoscopic management for benign lesions $\geq$ 20 mm and costs**

Of the 105 benign polyps  $\geq$  20 mm analysed, 50 were treated by endoscopy (47.62%) and 55 by surgery (52.38%). Among the lesions treated by endoscopy, 33 (66%) were treated with *en bloc* EMR, 7 (14%) with piecemeal EMR, and 9 (18%) with ESD. The majority of the surgical resections were performed by laparoscopy (47 of 55 or 85.45%), 5 by laparotomy (9.09%), and 3 (5.45%) by transanal resection.

We observed minor complications during endoscopic resection in 15 patients (30%); all were bleedings and were resolved by endoscopic haemostatic therapy. No peri-procedural perforation occurred; three (6%) postprocedural bleeding episodes required endoscopic haemostatic therapy.

Two of the patients who underwent endoscopic resection (4%) required additional surgery. In one, the need for surgery was because of deep carcinomatous invasion (classified as Haggitt 4), and in the other because of piecemeal EMR with the section limits passing into an intramucosal carcinoma.

Among the patients in the surgery group, we experienced only one perioperative complication (volvulus and tearing of the meso of the terminal ileum) during surgical management. Surgical complications were observed in 11 patients (20% of those operated on), three with Clavien–Dindo level I (pain managed with an analgesic), six with Clavien–Dindo level II (infection, fistula treated with antibiotic therapy, haematoma), one patient with a level III complication (anastomotic fistula requiring Hartmann surgery), and one patient presented with circulatory collapse and severe respiratory distress requiring emergency transfer to the intensive care unit (Clavien–Dindo level IV).

No deaths were reported within 30 days in either the endoscopy or surgery group.

*Table 5* compares lesions and hospitalisation data for benign lesions  $\geq 20$  mm in the endoscopy and surgery groups. No significant differences in patient age, patient sex, or topography of the resected lesion were observed between the two groups.

The histology was less severe in the endoscopy group than in the surgery group, with more low-grade dysplasia lesions and fewer *in situ* carcinomas.

Morbidity at 30 days was higher in the surgery group, with 20% morbidity compared to 6% in the endoscopy group ( $P = 0.044$ ).

The median length of stay was significantly longer in the surgery group (10 days [9, 12] vs. 2 days [1, 3],  $P < 0.0001$ ) as was the cost of care for social security (on average  $7.198 \pm 3.018$  € in the surgery group vs.  $1.129 \pm 354$  € in the endoscopy group,  $P < 0.0001$ ).

### **Performance of the guaiac test and FIT**

The cancer detection rate (*Table 6*) was 9.8% and did not differ between the *Hemoccult II* period and the FIT period. In contrast, the overall adenoma detection rate was 57%, and was significantly lower in 2012 (*Hemoccult II*) at 40%, compared to 62% and 57.5% in 2016 and 2017, respectively (FIT) ( $P < 0.0001$ ). The detection rate for advanced adenomas was 24.26%; this rate was also lower in 2012 at 18% ( $P = 0.024$ ).

### **DISCUSSION**

This study is the first to demonstrate a direct effect of implementing a regional referral network on the number of surgical treatments for superficial colorectal lesions.

The network is effective for detecting polyps  $< 20$  mm in size, for which there was almost no surgical management in 2016 and 2017. The number of surgical procedures also tended to decrease, albeit non-significantly, for lesions  $\geq 20$  mm; however, they remained at high rates, particularly in the private sector.

In an American study in 2014 [7], when all non-cancerous lesions that were initially referred to a surgeon were given a second prior colonoscopy by an expert endoscopist, 71% were treated with curative endoscopic resection. If these results were applied to our study, 109 patients would not have been operated on, with a social security savings of more than 660,000 euros.

The difference in the use of surgery between the public and private sectors must be nuanced. First, the two endoscopy experts in the region worked in the public sector at the

Limoges University Academic Hospital. All but one of the gastroenterologists in the public sector worked at least part-time at the academic hospital. There, they were in contact with the two experts and could share data with them on large or difficult colorectal polyps, or discuss doubts regarding cancer invasion. Access to their expertise in real time facilitates appropriate decision-making. This efficient network can be further improved for private practitioners by providing photography and video-recording systems and rapid transmission systems to obtain expert advice and optimise patient care. Almost three-quarters of the screening colonoscopies were carried out in the private sector and an effective and rapid response is essential considering the high patient turnover.

The characterisation difficulties encountered in our administrative area are not an isolated problem.

In a 2019 Dutch meta-analysis [13], overdiagnosis caused by characterisation errors was responsible for the decision to perform direct surgical management in 20 to 30% of cases of benign polyps.

In a large population-based study from the prospective nationwide Dutch Pathology Registry (based on the PALGA database) [11], characterisation errors leading to overdiagnosis were responsible for the decision to perform direct surgical management in 25.9% of cases.

Underdiagnosis leading to inappropriate endoscopic management is also problematic in the presence of signs of deep cancer invasion, which is a contraindication for endoscopic resection. For example, a Dutch randomised study of piecemeal EMR and transanal endoscopic microsurgery for non-degenerated adenomatous rectal lesions showed that 13% of invasive cancer lesions were misclassified as benign [14].

In our study, high-grade dysplasia and *in situ* carcinoma were risk factors for surgery, emphasising the difficulty of distinguishing deep from superficial invasive carcinomas [6,15].

In future, artificial intelligence may overcome this difficulty [16]. A preliminary Japanese study showed that artificial intelligence using a neural network system with machine-learning capability had >97% accuracy for differentiating an adenomatous polyp from a hyperplastic lesion [17]. Another Japanese study showed that artificial intelligence coupled with endocytoscopy enabled the detection of invasive carcinoma with a sensitivity similar to that of an expert endoscopist and better than that of a non-expert gastroenterologist [18].

Lesion size was the most important risk factor for surgery but does not preclude ESD or large piecemeal mucosectomy. This data is a well-known risk factors for surgical management of benign lesions [6,19].

The SMSA score, which is based on lesion size, morphological characteristics, location, and accessibility [20], allow physicians to assess the difficulty of resecting benign colon polyps [21]. The SMSA score is easy to implement in clinical practice, and it enables the selection of benign lesions for referral to an expert centre (SMSA 4) for first-line treatment [8].

The patient age, patient sex, topography of the lesion, number of polyps by colonoscopy, and the experience of the gastroenterologist were not identified as surgical risk factors in our study.

It is conceivable that a generation of gastroenterologists may still have doubts about the real benefits of endoscopic management of complex benign lesions. Our results concur with known data on the morbidity of surgery compared to endoscopic treatment for benign lesions. Our surgical results are consistent with a recent meta-analysis of 26 studies on the subject, published in *Endoscopy* [13], which estimated a 1-month morbidity of 24% after surgical resection of benign polyps (20.4% in our study) and mortality of 0.7% at 1 month (0% in our case, but in a smaller population).

In terms of morbidity-mortality and cost, endoscopic treatment has proven its superiority over surgery in many studies, whether EMR [2,3] or ESD [4,5], with similar benefits, although few studies are available on this subject, and most are retrospective.

Treating a benign polyp with direct surgery costs the paying agency (Social Security) sixfold more (cost of stay  $1,128.6 \pm 354$  € for endoscopy vs.  $7,197 \pm 3,018$  € for surgery). These data are important in a poor economic context and should encourage public authorities to promote gastroenterologists and structures that avoid direct surgical management of endoscopic resectable lesions. Indeed, complex endoscopic resection has no dedicated reimbursement (no dedicated DRG = diagnosis related group) in France and many other Western countries.

Finally, our findings also concur with the known data about superiority of FIT over the guaiac test. Detection of advanced adenomas and adenomas is significantly higher, confirming once again the improved sensitivity of a test that is simple to perform.

Few studies are currently available on the detection rate of adenomas found after a positive FIT. In 2017, Pr. Bernard Denis was the first in France to show that the adenoma detection

rate increased by 19% to 56.5% with the transition to the immunochemical test [22]. This value was confirmed in a 2017 American review [10] and in our study, with post-FIT adenoma detection rates of 62% and 57.5% in 2016 and 2017, respectively. These results validate the adenoma detection rate objectives recently published by the French Society of Digestive Endoscopy ( $\geq 25\%$  for all colonoscopies and  $\geq 45\%$  for screening colonoscopies) [23].

However, several limitations should be highlighted.

Although derived from a prospective population database, data on endoscopic and surgical management of polyps  $\geq 2$  cm were collected retrospectively.

In addition, we do not have data on the comorbidities of patients who may have influenced the choice of surgical or endoscopic treatment (although it has been demonstrated in the past that these are not surgical risk factors [15]), nor on the use of antiplatelet or anticoagulant medication that may have influenced the occurrence of complications, particularly bleeding.

Our administrative area is one of the smallest in France and has a low rate of participation in colorectal cancer screening. This raises the question of the representativeness of our results, which were based on a small number of subjects. However, there is only one private centre in the same city as the expert centre. This proximity of the private centre should theoretically favour the efficiency of the network.

The patients included in this study were selected based on the results of two tests, with different performances. The adenoma and invasive cancer detection rates of FIT were higher than, and similar to, respectively, those of the Guaiac test. However, these data are unlikely to influence the rate of surgery for benign polyps because the difference affects the absolute number of lesions found and surgically removed but not the rate of surgery for benign polyps.

In conclusion, establishing a specialised care network based on the availability of an expert centre for endoscopic resection enabled a significant reduction in the surgical management of benign lesions detected following a positive FIT, in particular for polyps  $< 2$  cm. The rate of direct surgical referral for polyps  $\geq 2$  cm is still excessive. As issues related to the size and characterisation of lesions are the two main risk factors for direct surgical management, improvement will require implementing technological tools that allow experts to visualise

photos or videos of all lesions for which deep degeneration is doubtful, or that are large in size, to avoid more morbidities and costly surgical management. Surgical teams should also be aware of these results and not hesitate to seek a second opinion for any lesion for which histology does not prove the presence of cancer.

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## TABLES

Category	Variable	N	Stat
Patients age	(years)	1571	63 [57;69]
Patients sexe	Male	896	57,03%
	Female	675	42,97%
Number of colonoscopy by year	2012	258	16,42%
	2016	885	56,33%
	2017	428	27,24%
Complete colonoscopy	Yes	1537	97,90%
	No	33	2,10%
	Unknown	1	
Presence of at least one lesion	Yes	981	63,13%
	No	573	36,87%
	Unknown	17	
Histology	Adenoma	685	71,80%
	Adenocarcinoma	151	15,83%
	Hyperplastic	92	9,64%
	Other polyp	21	2,20%
	Colloid carcinoma	3	0,31%
	Other type of cancer	2	0,21%
	Unknown	27	
Location	Rectum	138	14,50%
	Rectosigmoid junction	81	8,51%
	Sigmoid colon	402	42,23%
	Left colon	63	6,62%
	Splenic flexure	42	4,41%
	Transvers colon	49	5,15%
	Hepatic flexure	45	4,73%
	Right colon	81	8,51%
	Cecum	51	5,36%

	Unknown	29	
Polyp size	(mm)	843	10 [6;16]
Polyp size	≥ 20mm	185	19,23%
	<20mm	777	80,77%
	Unknown	19	
Number of polyps		850	2 [1;3]
Resection method	Endoscopic	799	83,84%
	Surgical	154	16,16%
	Unknown	28	
Establishment	Public	488	31,06%
	Private	1083	68,94%
Gastroenterologist age	(years)	1571	51 [38;59]

Table 1 : Characteristics of the population, colonoscopies and gastroenterologists.

	GLOBAL	2012	2016	2017	p-value
Surgery rate for benign polyp	66/(870-14NA) (7,71%)	13/(94-5NA) (14,61%)	41/(538-6NA) (7,71%)	12/(238-3NA) (5,11%)	0,017
Surgery rate for benign polyp <20mm	11/751 (1,46%)	3/73 (4,11%)	4/463 (0,86%)	4/215 (1,86%)	0,075
Surgery rate for benign polyp ≥20mm	55/105 (52,38%)	10/16 (62,5%)	37/69 (53,62%)	8/20 (40%)	0.381

Table 2 : Management of benign lesions according to the years

	GLOBAL	2012	2016	2017	p-value
Surgery rate for benign polyp	<b>Public</b> : 8/(298-12NA) (2,80%) <b>Private</b> : 58/(572-2NA) (10,18%) <b>p</b> = 0,0001	<b>Public</b> : 1/(38-4NA) (2,94%) <b>Private</b> : 12/(56-1NA) (21,8%) <b>p</b> = 0,014	<b>Public</b> : 4/(173-5NA) (2,38%) <b>Private</b> : 37/(365-1NA) (10,16%) <b>p</b> = 0,001	<b>Public</b> : 3/(87-3NA) (3,57%) <b>Private</b> : 9/151 (5,96%) <b>p</b> = 0,55	<b>Public</b> 0,88 <b>Private</b> 0,004
Surgery rate for benign polyp <20mm	<b>Public</b> : 2/259 (0,77%) <b>Private</b> : 9/492 (1,83%) <b>p</b> = 0,347	<b>Public</b> : 0/30 (0%) <b>Private</b> : 3/43 (6,98%) <b>p</b> = 0,264	<b>Public</b> : 1/154 (0,65%) <b>Private</b> : 3/309 (0,97%) <b>p</b> = 1	<b>Public</b> : 1/75 (1,33%) <b>Private</b> : 3/140 (2,14%) <b>p</b> = 1	<b>Public</b> 0,647 <b>Private</b> 0,029
Surgery rate for benign polyp ≥20mm	<b>Public</b> : 6/27 (22,22%) <b>Private</b> : 49/78 (62,82%) <b>p</b> = 0,0003	<b>Public</b> : 1/4 (25%) <b>Private</b> : 9/12 (75%) <b>p</b> = 0,118	<b>Public</b> : 3/14 (21,43%) <b>Private</b> : 34/55 (61,82%) <b>p</b> = 0,014	<b>Public</b> : 2/9 (22,22%) <b>Private</b> : 6/11 (54,55%) <b>p</b> = 0,197	<b>Public</b> 1 <b>Private</b> 0,62

Table 3 : Management of benign lesions according to the years and establishments.

Variable	Univariable analysis			Multivariable analysis		
	Odd Ratio	95% CI	p-value	Odd Ratio	95% CI	p-value
Female sex	0,79	[0,47-1,33]	0,38			
Age	1,01	[0,97-1,04]	0,67			
Year 2012	2,31	[1,25-4,28]	0,007	3,35	[1,20-9,40]	0,022
Polyp location						
Rectum	0,38	[0,14-1,07]	0,066	0,13	[0,03-0,56]	0,006
Rectosigmoid junction	1,6	[0,73-3,50]	0,24			
Sigmoid colon	0,76	[0,46-1,25]	0,27			
Dysplasia						
Low grade	0,14	[0,08-0,24]	<0,0001			
High grade	5,41	[3,18-9,22]	<0,0001	2,49	[1,04-5,97]	0,04
Cancer	10,1	[5,41-18,8]	<0,0001	5	[1,73-14,45]	0,003
None	0,31	[0,10-1,01]	0,053			
Polype size	1,21	[1,17-1,25]	<0,0001	1,07	[1,01-1,13]	0,02
Benign polyp ≥20mm	75	[37,2-151,3]	<0,0001	17,39	[5,50-54,99]	<0,0001
Number of polyp per colonoscopy	1,08	[0,98-1,20]	0,1			
Private establishment	4,5	[2,13-9,53]	<0,0001	6,59	[2,41-18,01]	0,0002
Gastroenterologist >40 years old	2,29	[1,25-4,18]	0,007			

Table 4 : Uni- and multivariate analysis of surgical management risk factors for benign polyps.

Category	Variable	N	Stat	N	Stat	p-value
		50	<b>Endoscopy</b>	55	<b>Surgery</b>	
Patients age	Years	50	63 [58;68]	55	64 [58;69]	0,55
Test year	2012	6	12%	10	18,18%	0,41
	2016	32	64%	37	67,27%	
	2017	12	24%	8	14,55%	
Patients sex	Male	31	62%	37	67,27%	0,68
	Female	19	38%	18	32,73%	
Polyp location	Rectum	9	18%	4	7,27%	0,23
	Rectosigmoid junction	5	10%	5	9,09%	
	Simoid colon	22	44%	21	38,18%	
	Left colon	4	8%	3	5,45%	
	Splenic flexure	0	0%	4	7,27%	
	Transverse colon	1	2%	2	3,64%	
	Hepatic flexure	0	0%	3	5,45%	
	Right colon	2	4%	5	9,09%	
	Cecum	7	14%	8	14,55%	
Polyp size	mm	48	25 [20;30]	55	28 [24;38]	0,023
Vienna Classification	V1	0	0%	0	0%	0,022
	V2	0	0%	0	0%	
	V3	25	50%	15	27,27%	
	V4.1	17	34%	22	40%	
	V4.2	1	2%	0	0%	
	V4.3	0	0%	0	0%	
	V4.4	7	14%	18	32,73%	
Intermediate care hospitalisation	Yes	1	2,04%	44	81,48%	<0,0001
	No	48	97,96%	10	18,52%	
	Unknown	1		1		
New hospitalisation in the 30	Yes	2	4,08%	2	3,70%	1

days after resection						
	No	47	95,02%	52	96,30%	
	Unknown	1		1		
Morbidity at day 30	Yes	3	6%	11	20,37%	0,044
	No	47	94%	43	79,63%	
	Unknown	0		1		
Mortality at day 30	Yes	0	0%	0	0%	
	No	49	100%	54	100%	
	Unknown	1		1		
Length of hospitalisation	Days	49	2 [1;3]	54	10 [9;12]	<0,0001
global cost of hospitalisation (moy)	Euros	47	1128,6 (+/- 354)	53	7197,7 (+/- 3018)	<0,0001

*Table 5 : Comparison of results for benign lesions greater than 20mm and hospitalisation data in endoscopy and surgery groups.*

	GLOBAL	2012	2016	2017	p-value
Cancer detection rate	154/1571 (9,8%)	25/258 (9,69%)	90/885 (10,17%)	39/428 (9,11%)	0,84
Adenoma detection rate	888/(1571-17NA) (57,03%)	101/(258-4NA) (39,61%)	545/(885-7NA) (61,99%)	242/(428-6NA) (57,60%)	<0,0001
Advanced adenoma detection rate	377/(1571-17NA) (24,26%)	45/(258-4NA) (17,72%)	227/(885-7NA) (25,85%)	105/(428-6NA) (24,88%)	0,024

Table 6 : Test results by year.

**FIGURES**

Figure 1 : Flow chart of the study.

