



Universiteit
Leiden
The Netherlands

Referrals for surgical removal of polyps since the introduction of a colorectal cancer screening programme

Bosch, D.; Leicher, L.W.; Vermeer, N.C.A.; Peeters, K.C.M.J.; Cappel, W.H.D.T.N.; Westreenen, H.L. van

Citation

Bosch, D., Leicher, L. W., Vermeer, N. C. A., Peeters, K. C. M. J., Cappel, W. H. D. T. N., & Westreenen, H. L. van. (2020). Referrals for surgical removal of polyps since the introduction of a colorectal cancer screening programme. *Colorectal Disease*, 23(3), 672-679. doi:10.1111/codi.15413

Version: Publisher's Version
License: [Creative Commons CC BY 4.0 license](https://creativecommons.org/licenses/by/4.0/)
Downloaded from: <https://hdl.handle.net/1887/3185339>

Note: To cite this publication please use the final published version (if applicable).



ORIGINAL ARTICLE

Referrals for surgical removal of polyps since the introduction of a colorectal cancer screening programme

Dianne Bosch¹ | Laura W. Leicher² | Nina C.A. Vermeer³ | Koen C.M.J. Peeters³ | Wouter H. de Vos tot Nederveen Cappel² | Henderik L. van Westreenen¹

¹Department of Surgery, Isala, Zwolle, The Netherlands

²Department of Gastroenterology and Hepatology, Isala, Zwolle, The Netherlands

³Department of Surgery, Leiden University Medical Centre, Leiden, The Netherlands

Correspondence

Laura W. Leicher, Department of Gastroenterology and Hepatology, Isala, Dokter van Heesweg 2, 8025 AB Zwolle, The Netherlands.
Email: l.w.leicher@isala.nl

Abstract

Aim: Implementation of the Dutch national bowel screening programme in 2014 led to an increased rate of detection of polyps. In general, polyps should be removed endoscopically. However, if the size and location of the polyp make endoscopic removal technically difficult, or if there is a suspicion for early (T1) cancer, surgery is the preferred method for removal. An increasing number of these patients are being treated with minimally invasive surgical procedures instead of segmental resection. The aim of this study was to assess the number of referrals for surgery and the type of surgery for polyps since the introduction of the Dutch national bowel screening programme.

Method: A retrospective cohort study was performed. Patients who underwent surgery for colorectal polyps between January 2012 and December 2017 were included. Patients with histologically proven carcinoma prior to surgery were excluded. Primary outcomes were the number and type of surgical procedures for polyps.

Results: A total of 164 patients were included. An annual increase in procedures for colorectal polyps was observed, from 18 patients in 2012 to 36 patients in 2017. All the procedures before implementation of the screening programme were segmental resections, and 58.8% of the patients underwent organ-preserving surgery after implementation of the screening. The overall complication rate of organ-preserving surgery was 16.3%, compared with 44.3% for segmental resections ($P = 0.001$). Overall, invasive colorectal cancer was encountered in 23.8% of cases.

Conclusion: The number of referrals for surgical resection of colorectal polyps has doubled since the introduction of the Dutch national bowel screening programme with a substantial shift towards organ-preserving techniques.

KEYWORDS

colorectal cancer screening programme, colorectal surgery, complications, polyps, organ-preserving surgery

DB and LWL contributed equally to this manuscript.

© 2020 The Association of Coloproctology of Great Britain and Ireland

INTRODUCTION

Colorectal cancer (CRC) is the second most common malignancy in the Netherlands, with an incidence of 14 258 in 2017 [1]. Approximately 95% of CRCs will evolve from an adenomatous polyp or sessile serrated lesion (SSL) [2]. Adenomatous polyps are the most common polyps and account for approximately two thirds of all colonic polyps [3]. Despite their dysplastic character, only 5% of all adenomatous polyps progress to CRC. Endoscopic screening studies in an asymptomatic population show an overall prevalence of adenoma of 25–30% at the age of 50 years [2–7].

In order to reduce the incidence as well as the mortality rate of CRC, the Dutch National Institute for Health and Environment (RIVM) introduced a national bowel screening programme in January 2014. All men and women aged between 55 and 75 years receive a faecal immunochemical test (FIT) biennially, followed by colonoscopy in case of a positive FIT result [8]. In a recent systematic review summarizing the results for 6442 patients, endoscopic resection of large colonic polyps (≥ 20 mm) was successful in 92% of cases. Despite advanced techniques of endoscopic resection, such as endoscopic mucosal resection and endoscopic submucosal dissection (ESD), colorectal surgery was required in the remaining group [9]. In certain cases, surgery is preferred, for instance if the size and location of the polyp make endoscopic removal technically difficult or if macroscopic inspection implies a suspicion for early cancer (T1). In these cases, an *en bloc* resection is the best treatment option.

Colorectal surgery is associated with significant morbidity and mortality. For malignant colorectal resections, all patient and procedure-related data are collected in the Dutch Colorectal Audit; however, the data for premalignant lesions are not registered. Literature reporting the number of surgical procedures performed for adenomas or SSLs is lacking. Also, it is unclear whether surgical procedures performed for polyps have the same morbidity and mortality rates as surgical procedures performed for CRC.

The aim of this study was to investigate the number of referrals for surgical resection of colorectal polyps. Furthermore, the type of surgery and its clinical outcome were studied.

MATERIALS AND METHODS

Study design and population

After approval by the institutional review board, a retrospective cohort study was performed. Written consent from patients was not required.

Patients who underwent surgical removal of colorectal polyps between January 2012 and December 2017 were included. The Dutch national bowel screening programme started in 2014.

Patients were included if they were referred for surgical removal of colorectal polyps that could not be endoscopically removed for technical reasons (size, position of the endoscope, location) or if, upon macroscopic inspection, cancer was suspected. If lesions in the

What does this paper add to the literature?

The introduction of the Dutch national CRC screening programme has led to a significant increase in the detection of colorectal polyps. In general, these polyps are removed endoscopically. However, despite advanced endoscopic treatments there is still a role for the colorectal surgeon who should attempt to use an organ-preserving technique.

left colon or rectum were suitable for removal by ESD they were referred to another hospital with experience with this. Exclusion criteria were histologically proven carcinoma prior to surgery and patients with a genetic predisposition to colorectal cancer (i.e. patients with Lynch syndrome, APC-related (attenuated-) adenomatous polyposis coli and serrated polyposis syndrome). Polyps were defined as histologically proven or macroscopically suspicious lesions or (advanced) adenomas, SSLs or early (T1) cancer. Patients who were referred from other hospitals for surgical treatment were also excluded.

Primary outcomes were the number and type of surgical procedures. Secondary outcomes were clinical and histological outcome. Clinical outcome was defined as 30-day or in-hospital morbidity, and mortality was graded according to the Clavien–Dindo classification (CDG) [10].

Procedures and definitions

All endoscopic examinations were carried out by or under the supervision of a certified gastroenterologist. For the national screening programme, all endoscopists and proceedings met the national quality requirements. If applicable, the 'lifting' sign was tested by submucosal injection of NaCl 0.9% with indigo carmine. Nonoptimal lifting of the polyp was stated as a positive nonlifting sign. An unsuccessful attempt at endoscopic resection was defined as partial removal of the polyp. Colonoscopies performed after a positive faecal occult blood test within the national bowel screening programme were defined as screening colonoscopies. Colonoscopies for all other reasons (surveillance following removal of adenomas or SSLs in the past or symptomatic patients) were defined as regular colonoscopies.

All patients were discussed at our weekly colorectal multidisciplinary team meeting. All surgical colorectal procedures were performed by or under the supervision of a specialized colorectal surgeon. The different types of surgery included segmental colon resection, low anterior resection, transanal endoscopic microsurgery (TEM) and limited endoscopic-assisted wedge resection (LEAWR). LEAWR is a type of combined endoscopic–laparoscopic surgery (CELS) where no anastomosis is created [11]. During laparoscopy, the involved part of the colon is mobilized to ensure LEAWR. A suture was placed laparoscopically with intraluminal endoscopic visualization through the base of the polyp. Traction was given on the suture to enable positioning

of the linear stapler. Before stapling off the polyp, the patency of the lumen and total inclusion of the polyp tissue were checked endoscopically. Both TEM and LEAWR were introduced to our hospital in 2015. LEAWR is not suitable if the polyp encompasses more than half of the circumference of the colon, in cases of diverticulosis or if polyps are located near or at Bauhin's valve. TEM is not suitable for polyps located more than 15 cm from the anal verge. Complications were graded according to the CDG of complications [10]. Major complications were defined as grade 3b or higher.

Histological material was obtained preoperatively through endoscopically conducted biopsies and/or postoperatively from the surgically resected specimen. Polyps were categorized as hyperplastic, tubular adenoma, tubulo-villous adenoma, villous adenoma or SSL. Adenomas were further subdivided as low-grade dysplasia (LGD; mild to moderate dysplasia) or high-grade dysplasia (HGD; severe dysplasia). For staging invasive cancer, the TNM 5 classification system was used, according to the latest national guidelines. High-risk features for lymph node metastasis in case of a T1 CRC were defined as poorly differentiated tumour, (lymph)angio-invasive growth and a resection margin of <1 mm. A low-risk T1 CRC was defined as a moderate/good differentiated tumour, no (lymph)angio-invasive growth and a free resection margin of 1 mm or more [12].

Data management and analysis

For data collection and analysis, both Research Manager[®] (Cloud9 Software) and IBM SPSS Statistics, version 25.0 (IBM Corp.) were used. Continuous variables were presented, according to the distribution, as median values with the interquartile range (IQR). Continuous data were compared between groups using the Mann-Whitney *U*-test, and categorical data were compared using Fisher's exact test or the Fisher-Freeman-Halter. *P*-values of <0.05 were considered statistically significant.

RESULTS

A total of 2169 patients were identified who underwent colorectal surgical procedures between January 2012 and December 2017. From this group, 2005 patients were excluded and 164 patients who were operated on for benign polyps were included (Figure 1).

The total number of colonoscopies conducted after implementation of the screening programme ranged between 5141 and 5517 per year, compared with 5555 colonoscopies in 2012 before implementation of the screening programme.

The majority of patients were male (57.3%) with a median (IQR) age of 69 (range 63–74) years (Table 1). The majority (76.2%) of patients were referred for surgery because of polyps that were technically unresectable endoscopically due to size, location and/or nonlifting sign (Table 2). In total, 45.5% of encountered polyps were sessile, with a median size of 3.5 cm. The majority of polyps (54.9%) were located in the right colon and showed LGD preoperatively (62.5%). In 33 cases

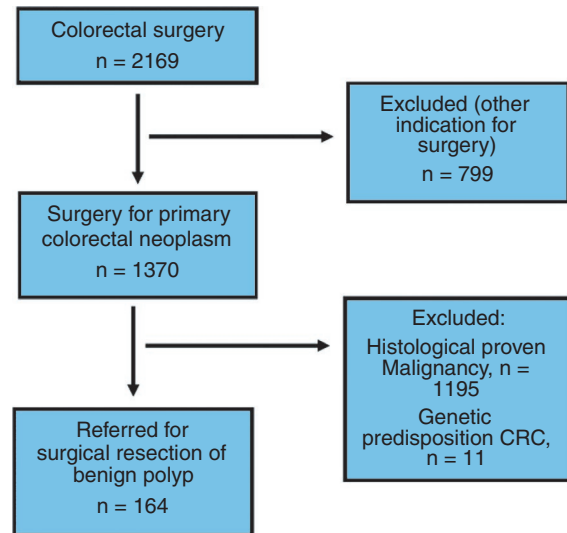


FIGURE 1 Flowchart of the patient selection process

(20.1%) one or more attempts were made at endoscopic removal (Table 1). In 29 of these 33 patients, no malignancy was suspected. Out of 55 polyps that were suspicious for an invasive tumour, 20 were malignant (positive predictive value 36.3%). Of the 109 suspected benign polyps, 19 were carcinomas (negative predictive value 82.6%). Of the 49 patients who underwent organ-preserving surgery, 15 (30.6%) were suspected of having a malignancy. Of the 115 patients who underwent major surgery, 18 (15.7%) patients had a polyp that was suspicious for an invasive tumour. In 51 out of 55 suspect malignant cases (92.7%) no attempts at endoscopic resection were made.

The main surgical procedure was a segmental colectomy (70.1%); the remaining group of 49 patients (29.9%) underwent a TEM ($n = 22$) or LEAWR ($n = 27$). The procedures were performed laparoscopically or transanally in 80.5% ($n = 132$) with a conversion rate of 4.3% ($n = 6$; Table 2).

Before implementation of the Dutch national screening programme in 2014, the annual number of patients who underwent surgical removal of polyps was 18 (2012) and 17 (2013) (Figure 2). Since programme implementation, the absolute number of surgical procedures increased annually to 36 in 2017. The percentage of patients who were referred for surgery after a positive FIT result increased from 16.7% in 2014 to 50% in 2017.

From 2012 to 2014, all surgical procedures were major surgical procedures. In the following years, the number of organ-preserving surgeries increased to 21 out of 36 (58.3%) procedures in 2017, resulting in an average of 41.2% organ-preserving surgeries after implementation of the screening programme.

Clinical and pathological outcome

The overall complication rate was 36.0%, which were mostly minor complications. Only 8 out of 164 patients (4.9%) presented with

TABLE 1 Baseline characteristics

	Total (n = 164) (%)
Age (years)	
Median	69
IQR	63–74
Gender	
Female	70 (42.7)
Male	94 (57.3)
BMI (kg/m ²)	
Median	26.6
IQR	24.3–29.5
CCI score	
Median	3
IQR	2–4.8
Morphology	
Sessile	51 (31.1)
Flat	43 (26.2)
Pedunculated	18 (11)
Unknown	52 (31.7)
Size (cm)	
Median	3.5
IQR	2.5–4.5
Location	
Right colon	90 (54.9)
Transverse colon	9 (5.5)
Left colon	37 (22.6)
Rectum and rectosigmoid	28 (17.1)
Preoperative histology	
No dysplasia	4 (2.4)
LGD	90 (54.9)
HGD	50 (30.5)
Unknown	20 (12.2)
Nonlifting sign	
Positive	31 (18.9)
Negative	22 (13.4)
Not performed	111 (67.7)
Endoscopic resection attempts	
One or more attempts	33 (20.1)
No attempts	131 (79.9)
Gastroenterologist's assessment	
Suspect malignant	55 (33.5)
Not suspect	109 (66.4)

Abbreviations: BMI, body mass index; CCI, Charlson comorbidity index; HGD, high-grade dysplasia; IQR, interquartile range; LGD, low-grade dysplasia.

one or more major complications; in seven patients these occurred after segmental resection. One patient presented with a major complication after an organ-preserving procedure, a post-TEM

TABLE 2 Surgery characteristics

	Total (n = 164) (%)
Indication for surgery	
Endoscopically unresectable	125 (76.2)
Nonradical polypectomy	20 (12.2)
Recurrence in scar tissue	11 (6.7)
Multiple polyps	5 (3.0)
Other	3 (1.8)
Duration of surgery (min)	
Median	95
IQR	70–129
Type of surgery	
Ileocaecal resection	9 (5.5)
Right hemicolectomy	63 (38.4)
Left hemicolectomy	9 (5.5)
Transverse colon resection	4 (2.4)
Sigmoid resection	18 (11.0)
LAR	12 (7.3)
TEM	22 (13.4)
LEAWR	27 (16.5)
Approach	
Open	23 (14.0)
Laparoscopic/transanal	135 (80.5)
Conversion ^a	6 (4.3)

Abbreviations: IQR, interquartile range; LAR, low anterior resection; LEAWR, limited endoscopic-assisted wedge resection; TEM, transanal endoscopic microsurgery.

^aPercentage of total number of intended laparoscopic surgeries.

haemorrhage treated surgically. There were no serious complications after LEAWR. In 4 out of 115 segmental resections (3.5%) an anastomotic leakage occurred. Postoperative mortality was zero. A significantly lower overall complication rate (16.3%) was seen after organ-preserving surgery compared with segmental resection (44.3%) ($P = 0.001$; Table 3).

Overall invasive CRC was encountered in 23.8% of the referred polyps. Fifty per cent of the resected polyps appeared to contain HGD and 45% of the resected polyps contained LGD (Table 4).

A CRC was found in eight patients who underwent organ-preserving treatment for a polyp. An additional oncological resection was indicated in four out of these eight patients due to high-risk features for lymph node metastases; this number represents only 8.2% of all patients who received organ-preserving surgery. The remaining four patients had a low-risk pT1 CRC. No major complications occurred within 30 days after additional oncological surgery.

DISCUSSION

Since the introduction of the Dutch CRC screening programme in 2014, the number of referrals for surgical resection of polyps has

doubled in our hospital. Thirty per cent of these patients were treated using an organ-preserving technique and CRC was found in 24% of these patients.

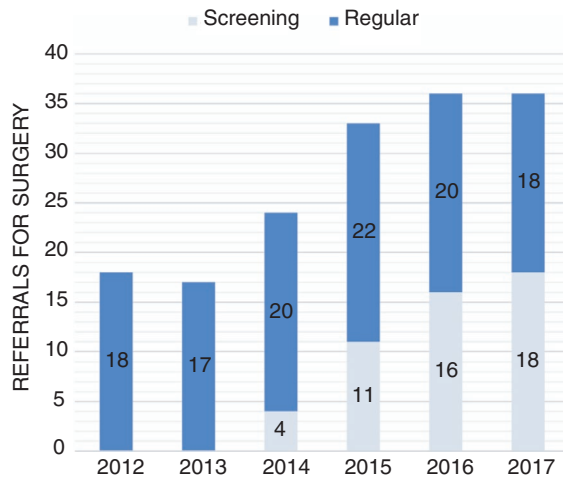


FIGURE 2 Annual volume of surgical procedures. 'Regular' indicates the number of patients who were referred for surgery after colonoscopy due to reasons other than a screening colonoscopy. 'Screening' indicates the number of patients who were referred for surgery after colonoscopy in the Dutch national screening programme

Data about surgical referrals for complex polyps are scarce. In one cohort study, the number of patients referred for laparoscopic colorectal resection for nonmalignant polyps almost tripled after the introduction of the national screening programme [13]. The screening colonoscopies conducted after a positive FIT resulted in a higher number of surgical resections compared with those conducted in symptomatic patients. This is related to a higher number of endoscopically detected polyps during screening colonoscopies, which is consistent with results of earlier research in which the prevalence of adenoma in the screening population was higher than in symptomatic patients [14].

In our hospital, the increase in surgical referrals for removal of colorectal polyps led to the development of a less invasive surgical technique. This technique (LEAWR), in which laparoscopy and endoscopy are combined, was developed in 2015. One of the great benefits of this minimally invasive technique is that no anastomosis is created. No complications were observed in a pilot study [11].

Our study shows a substantial morbidity related to segmental colon resections for polyps. These results are comparable with large cohort studies reporting a reoperation rate of 7.8% and readmission rate of 3.6% after surgery for nonmalignant colorectal polyps [15,16]. Over time, there is a reduction in surgery-related morbidity [16]. Morbidity rates for benign lesions are comparable to those for surgery for CRC [17].

	Total (n = 164) (%)	Organ-preserving (n = 49) (%)	Segmental resections (n = 115) (%)	P value
Overall complication rate	59 (36.0)	8 (16.3)	51 (44.3)	0.001 ^c
CDG				
≤3a	51 (31.1)	7 (14.3)	44 (38.3)	1.000 ^c
≥3b	8 (4.9)	1 (2.0)	7 (6.1)	
Anastomotic leakage	4 (3.5 ^b)	-	4 (3.5)	a
Mortality	-	-	-	a
(Re)laparotomy	7 (4.3)	-	7 (6.1)	0.200 ^c
Stoma creation at re-intervention				
Temporary	2 (1.2)	-	2 (1.7)	a
Permanent	1 (0.6)	-	1 (0.9)	
Length of stay (days)				
Median	5	2	5	<0.001 ^d
IQR	3–6	2–3	4–8	
Readmission	11 (6.7)	2 (4.1)	9 (7.8)	0.508 ^c
Length of readmission stay (days)				
Median	6	6	6	0.808 ^d
IQR	5–21	5–7	5–22.5	

Abbreviations: CDG, Clavien–Dindo classification; IQR, interquartile range.

^aStatistical analysis could not be performed.

^bPercentage of total primary anastomoses (n = 115).

^cFisher's exact test.

^dMann–Whitney U-test.

TABLE 3 Clinical outcomes

TABLE 4 Postoperative pathology

	Total (n = 164) (%)	Organ-preserving (n = 49) (%)	Major surgery (n = 115) (%)
Benign	125 (76.2)	41 (83.7)	84 (73.0)
High-grade dysplasia	61	16	45
Low-grade dysplasia	55	20	35
No dysplasia	5	3	2
Unknown	4	2	2
Malignant	39 (23.8)	8 (16.3)	31 (27.0)
Low-risk pT1	4	4	–
High-risk pT1	4	4	–
TNM >pT1	31	–	31

In the organ-preservation group, seven patients (14.3%) had a minor complication. Only 1 out of 49 patients (2.0%) who underwent minor surgery presented with a major complication, this concerned a post-TEM haemorrhage that required surgery. LEAWR did not lead to major complications. A recent study reporting on short- and long-term results of TEM observed similar rates of minor complications in 12 patients (8.8%) and major complications in 2 out of 135 patients (1.5%) [18]. Three retrospective studies investigating postoperative complications after different types of CELS observed no complications [11,19,20]. These studies were limited by their small sample sizes, ranging from 3 to 23 patients, which makes comparison difficult. A prospective study by Wilhelm et al. [21] analysed 146 patients who underwent CELS, of whom 82% underwent local excision and 18% received endoscopy-assisted segmental colon resection. The overall complication rate was 25% and the major complication rate was 3%. These results are very comparable to our overall complication rate of 36.0% and occurrence of major complications in 4.9% of patients, especially when in our study 70% of surgeries were segmental resections. Considering that a significantly lower overall complication rate was encountered in the organ-preservation group, this therapy should be the first choice if surgical treatment of colon polyps is necessary.

The overall postoperative malignancy rate of 23.8% is in line with malignancy rates between 6.9% and 44.3% of surgically resected colorectal polyps reported in the literature [22–27]. A plausible explanation for the different percentages is selection bias, as polyps that were endoscopically deemed suspicious for early cancer were included in several studies.

In our study, we observed a high percentage of right-sided polyps. According to multiple retrospective studies, colorectal polyps predominantly exhibit a proximal colonic distribution [28,29]. Another explanation for the high proportion of right-sided polyps referred for surgery is due to the higher risk for complications such as perforation and bleeding associated with the removal of right-sided polyps [28].

In the majority of the included patients no attempt was made at endoscopic removal. This was mainly due to unfortunate polyp characteristics such as large size, difficult location, nonlifting sign and/or the suspicion of early (T1) carcinoma. In 51 out of the 55 patients

in whom no attempt at endoscopic removal of the polyp was made there was a suspicion of a malignancy with deep invasion. In such cases an *en bloc* resection is advised, which is not always possible by endoscopy [29–32].

In recent years, endoscopic treatment options have expanded, with the introduction of ESD and endoscopic full thickness resections enabling local excision of pT1 tumours. The use of these techniques may reduce referrals for surgery. Our hospital participates in a network with in which all these endoscopic techniques are available. A French study showed a reduction of referrals after the implementation of a regional referral network; however, all included patients were screen-detected [33]. Therefore, the influence of a national bowel screening programme on referral numbers was not investigated. Prior to referral for surgical excision, it is recommended that experts on endoscopic treatment are consulted. Repeated colonoscopy before surgery in an expert centre can also reduce the rate of surgical referrals by 71% [34]. For rectal lesions, the choice for ESD or TEM has still to be established by a multicentre study (TRIASSIC study), which is currently still including patients [35].

There were a few limitations in our study, mainly due to its retrospective design. First, a clear definition of an unresectable polyp was difficult to establish and this definition changed over time with the development of endoscopic expertise in our clinic. The therapeutic strategies were based on endoscopic assessment by different gastroenterologists, which can lead to interobserver variability. In the final years of the study period, complex polyps were extensively discussed with experienced endoscopists. Furthermore, total numbers and success rates of endoscopic treatments (polypectomies) and referrals for ESD to other hospitals during the studied time interval were not available. The increase in surgical referrals due to the implementation of the screening programme led to the development of a less invasive technique (LEAWR), which may have reduced the threshold for surgical referrals. In addition, if all referred patients, despite their complexity, had been discussed with more experienced endoscopists the number of patients who underwent surgery could possibly have been lower. Despite increasing endoscopic possibilities and techniques over time, an increase in referrals for surgery was still observed. However, this study might reflect the consequences of a bowel screening programme for daily clinical practice in a large teaching hospital.



In conclusion, the number of referrals for surgery for colorectal polyps has doubled since the introduction of the CRC screening programme with a substantial shift towards organ-preserving techniques.

ACKNOWLEDGEMENTS

None.

CONFLICT OF INTEREST

Not applicable.

AUTHOR CONTRIBUTIONS

DB: data acquisition, statistical analysis, drafting and critical revision of the manuscript. LWL: interpretation of data, drafting and critical revision of the manuscript. NCAV: interpretation of data, critical revision of the manuscript. KCMJP: interpretation of data, critical revision of the manuscript. WHdVtNC: interpretation of data, critical revision of the manuscript. HLvW: interpretation of data, drafting and critical revision of the manuscript.

ETHICAL APPROVAL

We had approval of the institutional review board.

CONSENT TO PARTICIPATE

No written consent from the patients was needed.

CONSENT FOR PUBLICATION

All authors give their final approval of this version to be published and find agreement to be accountable for all aspects of the work.

CLINICAL TRIAL REGISTRATION

Not applicable.

DATA AVAILABILITY STATEMENT

Data available on request from the authors.

ORCID

Laura W. Leicher  <https://orcid.org/0000-0001-5943-1110>

Wouter H. de Vos tot Nederveen Cappel  <https://orcid.org/0000-0002-3956-1206>

REFERENCES

- Nederlandse Kankerregistratie [Internet]. Utrecht: IKNL. 2018. Incidentie darm; 2018 Jun 2. https://www.cijfersoverkanker.nl/selecties/incidentie_darm/img568b9b17f32f0. Accessed May 23 2019
- Fearon ER, Vogelstein B. A genetic model for colorectal tumorigenesis. *Cell*. 1990;61:759–67.
- Heitman SJ, Ronsley PE, Hilsden RJ, Manns BJ, Rostom A, Hemmelgarn BR. Prevalence of adenomas and colorectal cancer in average risk individuals: a systematic review and meta-analysis. *Clin Gastroenterol Hepatol*. 2009;7:1272–8.
- Rex DK, Lehman GA, Hawes RH, Ulbright TM, Smith JJ. Screening colonoscopy in asymptomatic average-risk persons with negative fecal occult blood tests. *Gastroenterology*. 1991;100:64–7.
- Rex DK, Lehman GA, Ulbright TM, Smith JJ, Pound DC, Hawes RH, et al. Colonic neoplasia in asymptomatic persons with negative fecal occult blood tests: influence of age, gender, and family history. *Am J Gastroenterol*. 1993;88:825–31.
- Rex DK. Colonoscopy: a review of its yield for cancers and adenomas by indication. *Am J Gastroenterol*. 1995;90:353–65.
- Pendergrass CJ, Edelstein DL, Hyland LM, Phillips BT, Iacobuzio-Donahue C, Romans K, et al. Occurrence of colorectal adenomas in younger adults: an epidemiologic necropsy study. *Clin Gastroenterol Hepatol*. 2008;6:1011–5.
- Committed to health and sustainability [Internet]. Bilthoven: RIVM. 2012 Jul 13. Bowel cancer screening programme. http://www.rivm.nl/en/Topics/B/Bowel_cancer_screening_programme. Accessed May 24 2018
- Hassan C, Repici A, Sharma P, Correale L, Zullo A, Bretthauer M, et al. Efficacy and safety of endoscopic resection of large colorectal polyps: a systematic review and meta-analysis. *Gut*. 2016;65:806–20.
- Dindo D, Demartines N, Clavien PA. Classification of surgical complications: a new proposal with evaluation in a cohort of 6336 patients and results of a survey. *Ann Surg*. 2004;240:205–13.
- Leicher LW, de Vos Tot Nederveen Cappel WH, van Westreenen HL. Limited endoscopic-assisted wedge resection for excision of colon polyps. *Dis Colon Rectum*. 2017;60:299–302.
- Colorectaalcarcinoom, Landelijke richtlijn. Utrecht: IKNL, Landelijke werkgroep Gastro Intestinale Tumoren. 2014 Apr 16. 229 p. Report no.: 3.0.
- Marres CCM, Buskens CJ, Schriever E, Verbeek PCM, Mundt MW, Bemelman WA, et al. The impact of the national bowel screening program in the Netherlands on detection and treatment of endoscopically unresectable benign polyps. *Tech Coloproctol*. 2017;21:887–91.
- Blumenstein I, Tacke W, Bock H, Filmann N, Lieber E, Zeuzem S, et al. Prevalence of colorectal cancer and its precursor lesions in symptomatic and asymptomatic patients undergoing total colonoscopy: results of a large prospective, multicenter, controlled endoscopy study. *Eur J Gastroenterol Hepatol*. 2013;25:556–61.
- Peery AF, Shaheen NJ, Cools KS, Baron TH, Koruda M, Galanko JA, et al. Morbidity and mortality after surgery for nonmalignant colorectal polyps. *Gastrointest Endosc*. 2018;87:243–50.
- Ma C, Teriaky A, Sheh S, Forbes N, Heitman SJ, Jue TL, et al. Morbidity and mortality after surgery for nonmalignant colorectal polyps: a 10-year nationwide analysis. *Am J Gastroenterol*. 2019;114:1802–10.
- Vermeer NCA, de Neree Tot Babberich MPM, Fockens P, Nagtegaal ID, van de Velde CJH, Dekker E, et al. Multicentre study of surgical referral and outcomes of patients with benign colorectal lesions. *BJS Open*. 2019;3:687–95.
- Lezoche G, Guerrieri M, Baldarelli M, Paganini AM, D'Ambrosio G, Campagnacci R, et al. Transanal endoscopic microsurgery for 135 patients with small nonadvanced low rectal cancer (iT1-iT2, iN0): short- and long-term results. *Surg Endosc*. 2011;25:1222–9.
- Lin AY, O'Mahoney PR, Milsom JW, Lee SW. Full-thickness excision for benign colon polyps using combined endoscopic laparoscopic surgery. *Dis Colon Rectum*. 2016;59:16–21.
- Yan J, Trencheva K, Lee SW, Sonoda T, Shukla P, Milsom JW. Treatment for right colon polyps not removable using standard colonoscopy: combined laparoscopic-colonoscopy approach. *Dis Colon Rectum*. 2011;54:753–8.
- Wilhelm D, von Delius S, Weber L, Meining A, Schneider A, Friess H, et al. Combined laparoscopic-endoscopic resections of colorectal polyps: 10-year experience and follow-up. *Surg Endosc*. 2009;23:688–93.
- Dulskas A, Kuliešius Ž, Samalavičius NE. Laparoscopic colorectal surgery for colorectal polyps: experience of ten years. *Acta Med Litu*. 2017;24:18–24.



23. Lai JH, Ng KH, Ooi BS, Ho KS, Lim JF, Tang CL, et al. Laparoscopic resection for colorectal polyps: a single institution experience. *ANZ J Surg*. 2011;81:275–80.
24. Itah R, Greenberg R, Nir S, Karin E, Skornick Y, Avital S. Laparoscopic surgery for colorectal polyps. *JSL*. 2009;13:555–9.
25. Benedix F, Köckerling F, Lippert H, Scheidbach H. Laparoscopic resection for endoscopically unresectable colorectal polyps: analysis of 525 patients. *Surg Endosc*. 2008;22:2576–82.
26. Pokala N, Delaney CP, Kiran RP, Brady K, Senagore AJ. Outcome of laparoscopic colectomy for polyps not suitable for endoscopic resection. *Surg Endosc*. 2007;21:400–3.
27. Lo SH, Law WL. Laparoscopic colorectal resection for polyps not suitable for colonoscopic removal. *Surg Endosc*. 2005;19:1252–5.
28. Tholoor S, Tsagkournis O, Basford P, Bhandari P. Managing difficult polyps: techniques and pitfalls. *Ann Gastroenterol*. 2013;26:114–21.
29. Backes Y, Schwartz MP, ter Borg F, Wolfhagen FHJ, Groen JN, de Vos tot Nederveen Cappel WH, et al. Multicentre prospective evaluation of real-time optical diagnosis of T1 colorectal cancer in large non-pedunculated colorectal polyps using narrow band imaging (the OPTICAL study). *Gut*. 2019;68:271–9.
30. Backes Y, Moss A, Reitsma JB, Siersema PD, Moons LMG. Narrow band imaging, magnifying chromoendoscopy, and gross morphological features for the optical diagnosis of T1 colorectal cancer and deep submucosal invasion: a systematic review and meta-analysis. *Am J Gastroenterol*. 2017;112:54–64.
31. Overwater A, Kessels K, Elias SG, Backes Y, Spanier BWM, Seerden TCJ, et al. Endoscopic resection of high-risk T1 colorectal carcinoma prior to surgical resection has no adverse effect on long-term outcomes. *Gut*. 2018;67:284–90.
32. Backes Y, de Vos tot Nederveen Cappel WH, van Bergeijk J, ter Borg F, Schwartz MP, Spanier BWM, et al. Risk for incomplete resection after macroscopic radical endoscopic resection of T1 colorectal cancer: a multicenter cohort study. *Am J Gastroenterol*. 2017;112:785–96.
33. Rodrigues R, Geyl S, Albouys J, De Carvalho C, Crespi M, Tabouret T, et al. 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. *Clin Res Hepatol Gastroenterol*. 2020. <https://doi.org/10.1016/j.clinre.2020.06.014>.
34. Friedland S, Banerjee S, Kochar R, Chen A, Shelton A. Outcomes of repeat colonoscopy in patients with polyps referred for surgery without biopsy-proven cancer. *Gastrointest Endosc*. 2014;79:101–7.
35. Dekkers N, Boonstra JJ, Moons LMG, Hompes R, Bastiaansen BA, Tuynman JB, et al. Transanal minimally invasive surgery (TAMIS) versus endoscopic submucosal dissection (ESD) for resection of non-pedunculated rectal lesions (TRIASIC study): study protocol of a European multicenter randomised controlled trial. *BMC Gastroenterol*. 2020;20:225.

How to cite this article: Bosch D, Leicher LW, Vermeer NC, C.M.J. Peeters K, Vos tot Nederveen Cappel WH, Westreenen HL. Referrals for surgical removal of polyps since the introduction of a colorectal cancer screening programme. *Colorectal Dis*. 2021;23:672–679. <https://doi.org/10.1111/codi.15413>