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Adherence to Barrett's esophagus surveillance guidelines and its impact on progression: a multicenter prospective study

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Adherence to surveillance recommendations for Barrett's esophagus (BE) has been little studied. This study evaluated adherence to current guidelines in Spain, factors associated with deviations from recommendations, and the impact on progression. It was a prospective, observational, multicenter study of patients with BE between January 2016 and December 2022. 375 patients (80.5% males, age 55 ± 13 years) were followed for 50 (IQR 34–61) months and underwent 556 gastroscopies, 505(90.8%) for surveillance. Among these, only 206(40.8%) were performed within the recommended intervals and 254(50.3%) were early endoscopies. Risk factors for early endoscopy were short BE length (< 3 cm 59.5% vs. ≥ 3 cm 42.2%, OR 2.01(1.35–2.98)) and endoscopy referred by a surgeon (7.2% vs. 2.8%, OR 2.99(1.19–7.52)), whereas use of the Seattle protocol (68% vs 79.9%, OR 0.51(0.32–0.8)) was protective. BE progression was confirmed in 13 patients (3.4%): 7 low-grade dysplasia, 5 high-grade dysplasia or in-situ adenocarcinoma, and 1 invasive adenocarcinoma. The median time from BE diagnosis to progression was 48 months (IQR 28–59). Early endoscopy did not significantly increased detection of BE progression (3.1% vs 2%, p = 0.41). The only independent risk factor for progression was BE length (OR 9.39 (2.02–43.78)). In conclusion, adherence to BE surveillance guidelines in Spain is low and the tendency to early endoscopy is notable. Improving adherence could reduce unnecessary procedures without compromising patient outcomes.

Keywords Barrett's and adenocarcinoma, Guidelines, Surveillance, Quality management

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Barrett´s esophagus (BE) is a condition where the squamous epithelium of the distal esophagus is replaced by at least 1 cm of columnar epithelium with specialized intestinal metaplasia[1]. It is considered the main precursor of esophageal adenocarcinoma (EAC). The development of EAC is a gradual process in which metaplastic epithelium without dysplasia evolves to low-grade dysplasia (LGD), high-grade dysplasia (HGD) and EAC, although the risk of progression to HGD or EAC is low (0.33—0.78% per year)[2–4]. For this reason, endoscopic surveillance in patients with BE is recommended in order to detect dysplastic changes or cancer at an early stage, prevent progression and promote potentially curative therapies. This strategy is supported by findings suggesting improved survival from EAC in patients with adequate surveillance[5,6]. However, surveillance intervals recommended in guidelines are merely indicative and have changed over time due to the low-quality of scientific evidence.

Intervals of endoscopic surveillance are usually determined by the extent of BE and the presence and grade of dysplasia. Several scientific societies have modified and published their own surveillance recommendations. In an effort to unify European guidelines, the European Society of Gastrointestinal Endoscopy (ESGE) published a consensus guideline in 2017[1] and this has recently been updated[7]. However, independently of the guidelines used, the main indicator of their utility is physicians' adherence to their recommendations.

Few studies have evaluated adherence to BE surveillance guidelines in clinical practice. Most describe low adherence to recommendations but adherence among studies is heterogeneous. While some studies report over-surveillance, others report under-surveillance. Furthermore, most studies to date are from the United States[8–12] and reports from Europe are scarce[13,14].

For the above reasons, we aimed to determine clinical adherence to surveillance intervals recommended in the current guidelines among patients with BE in Spain and to identify factors associated with inappropriate use of these guidelines. Additionally, we aimed to ascertain whether oversurveillance correlates with an increased risk of disease progression detection.

Materials and methods

Study design

Prospective, observational and multicenter registry of consecutive patients with BE in Spain, including public and private institutions and university and non-university hospitals (Supplementary Table 1).

The registry was approved by the Ethics Committee at each hospital (EC15/267/4389). The study was conducted according to the principles of the Declaration of Helsinki and all patients included provided informed written consent to participate in the study.

Patients

All patients over 18 years and diagnosed with BE, defined as the presence of at least 1 cm of histologically confirmed intestinal metaplasia in place of the squamous epithelium of the esophagus were eligible for the study. Exclusion criteria were: 1) BE with previous endoscopic or surgical treatment; 2) presence of confirmed low-grade dysplasia, HGD or EAC at index endoscopy or diagnosed within 6 months after inclusion; 3) lack of follow-up after inclusion in the registry, defined as at least one follow-up endoscopy or one year of clinical follow-up; and 4) unwillingness to sign the informed consent.

Study endpoints

The main endpoint was to evaluate adherence to recommended surveillance time intervals as indicated by current clinical guidelines. Prior to 2017, physicians followed either the American Gastroenterology Association Guideline[15] or the British Society of Gastroenterology Guideline[16]. For non-dysplastic Barrett, the former guidelines recommended 3–5 years surveillance while the latter differentiated between 3–5 years for segments of less than 3 cm and 2–3 years for those of 3 cm or larger. From 2017, new ESGE guidelines[1] were adopted by all institutions, recommending 5 years for BE between 1 and < 3 cm, and 3 years for BE ≥ 3 and < 10 cm. It was also recommended that patients with BE ≥ 10 cm should be referred for surveillance endoscopies to a BE expert center and surveilled yearly. Recommendations are summarized in Supplementary Table 2. Additionally, at the time of performing the surveillance endoscopies, the endoscopists answered the specific question of whether the gastroscopy was performed at the appropriate time and the reason for any early or delayed timing. In case there was not a reason (technical or clinical) for advancing the endoscopy, it was considered an oversurveillance.

Secondary endpoints were: 1) to describe the type and reasons for deviation from surveillance guidelines; 2) to assess risk factors associated with early endoscopy and oversurveillance); 3) to describe BE progression to dysplasia or cancer; and 4) to assess risk factors for progression to dysplasia or cancer.

Data and study variables

Data analyzed were age, sex, body mass index (BMI), date of BE diagnosis, tobacco and alcohol consumption, symptoms of gastroesophageal reflux disease (GERD) and related therapies, type of medical center where the endoscopy was performed (tertiary, secondary, primary or private), specialty of the referring physician (gastroenterologist, general surgeon, general physician, or other), endoscopic features (BE length according to the Prague classification, signs of esophagitis according to the Los Angeles criteria, mucosal and vascular pattern, presence of nodular lesions), use and type of sedation with propofol, technical characteristics of the endoscope used, number and site of esophageal biopsies, histological assessment (presence dysplasia or cancer), and date and indication of endoscopy (surveillance or treatment). We defined two types of progression: 1) BE progression to dysplasia or cancer defined as the histological detection of confirmed LGD, HGD or EAC at follow-up endoscopies; 2) BE progression to advanced neoplasia as progression to HGD or cancer. LGD was always confirmed in two consecutive endoscopies. Histological diagnosis was performed at each hospital by local pathologists.

Study data were collected and managed using REDCap (Research Electronic Data Capture) data capture tools hosted at Asociación Española de Gastroenterología (AEG; www.aegastro.es)[17]. This is a secure, web-based application designed to support data capture for research studies and promote independent investigation driven research.

Guidelines deviation criteria

Surveillance interval deviations were considered significant if they exceeded or fell short of the guideline recommendations by more than 6 months for non-dysplastic BE, or by more than 2 months for dysplastic BE.

All reasons for these deviations from clinical guidelines were documented.

Statistical analysis

Quantitative data were tested using the Kolmogorov–Smirnov test for normality and presented as mean ± standard deviation in case of normal distribution or median and interquartile range (IQR) otherwise. Qualitative data were shown as absolute number and percentage. Comparisons between groups were analyzed using the Chi-squared test or the Fisher exact test for qualitative variables, and t-student test or the Mann–Whitney test in case of quantitative variables, as appropriate.

Binary logistic regression was conducted to identify independent risk factors for oversurveillance and for BE progression. Candidate variables for inclusion in the model were those achieving a p value ≤ 0.1 in the univariate analysis. Odds ratios (ORs) and associated 95% confidence intervals (CIs) were used to quantify the level of association.

A p-value < 0.05 was considered statistically significant. The analysis was conducted using SPSS Statistics (IBM Corp. Released 2023. IBM SPSS Statistics for Windows, Version 29.0.2.0 Armonk, NY: IBM Corp).

Results

Study population

Between January 2016 and October 2018, 500 patients with BE in 15 hospitals were eligible for the study, with follow-up extending until December 2022. After excluding 125 patients (Fig. 1), 375 were analyzed. Baseline demographic and endoscopic characteristics of the patient population are shown in Table 1. Most patients were male (302; 80.5%) and mean age at diagnosis was 55 ± 13 years. A history of smoking, either as current or former smokers, was reported in 202 participants (53.9%), and alcohol use was reported in 149 (39.7%). Additionally, 253 (67.5%) had a hiatal hernia, and 213 (56.8%) had experienced reflux symptoms. Most patients (330, 88%) were under proton pump inhibitor treatment. Fifty-one (13.6%) had prior anti-reflux surgery. Median length of BE at inclusion was 2 cm (IQR 1–5).

Endoscopic procedures performed during follow-up

A total of 556 upper gastrointestinal endoscopies were performed during the study period, 505 (90.8%) being surveillance endoscopies. The characteristics of the 505 surveillance endoscopies are summarized in Table 2. Most of these were referred by gastroenterologists (436; 87.2%) and performed by a senior endoscopist (485; 96.2%) at a tertiary hospital (317; 63.1%). Sedation was administered by the endoscopist in 323 (64.2%) cases, in 262 (52.1%) with propofol alone. The Seattle protocol was followed in 358 (70.9%), accounting for 81.2% of the 441 endoscopies with biopsies.

Adherence to surveillance guidelines

Two-hundred and six of the 505 surveillance endoscopies (40.8%) were performed within the recommended interval, 254 (50.3%) were performed earlier, and 45 (8.9%) later. Among these 254 early endoscopies, which accounted for 84.9% of the inadequate interval endoscopies, a possible reason was found in 97 cases (38.2%) (Table 3), leading to a rate of oversurveillance of 31% (157 out of 505).

On the other hand, the main cause for delay was scheduling issues 25 (55.5%). Other reasons are shown in Supplementary Table 3.

Progression during follow-up

Patients were prospectively followed-up for a median of 50 months (IQR 34–61). As some patients had been diagnosed of BE prior to inclusion in the registry, the median time from BE diagnosis to last follow-up was 81 months (IQR 54–133). BE progression to dysplasia or cancer was confirmed in 13 patients (cumulative progression rate 3.5% or 0.83% yearly progression rate). Seven (1.9%) of the 13 patients progressed to LGD, 5 (1.3%) to HGD/EAC in-situ, and 1 (0.3%) to invasive EAC. Thus, 6 patients progressed to HGD or cancer, which represents a BE cumulative progression rate to advanced neoplasia of 1.6% (0.38% per year). The patient with invasive EAC was diagnosed with a stage IV adenocarcinoma and it was the only BE related death during the study. The median time from BE diagnosis to progression was 48 months (IQR 28–59) (Supplementary Fig. 1).

Early endoscopy did not increase the detection of BE progression to dysplasia or cancer: 8/254 cases (3.1%) compared to 5/251 (2%) in the group with adequate or delayed follow-up (p = 0.41). Early scheduling of the endoscopy was justified in 4 of the 8 cases with progression (2 without Seattle protocol performed in the previous gastroscopy, 1 with non-HD endoscopy and 1 follow-up for esophagitis). Therefore, progression to dysplasia or cancer in the group with oversurveillance was not different (2.5%; 4/157).

Risk factors associated with BE early endoscopy, oversurveillance and progression

In the univariate analysis of risk factors among the 254 patients undergoing early endoscopy, short-segment BE (< 3 cm; 59.5% vs. 42.2%, p < 0.01) and referral for endoscopy by a surgeon rather than a gastroenterologist or other physician (7.2% vs. 2.8%, p = 0.03) were significant. In contrast, certain markers of high-quality endoscopy

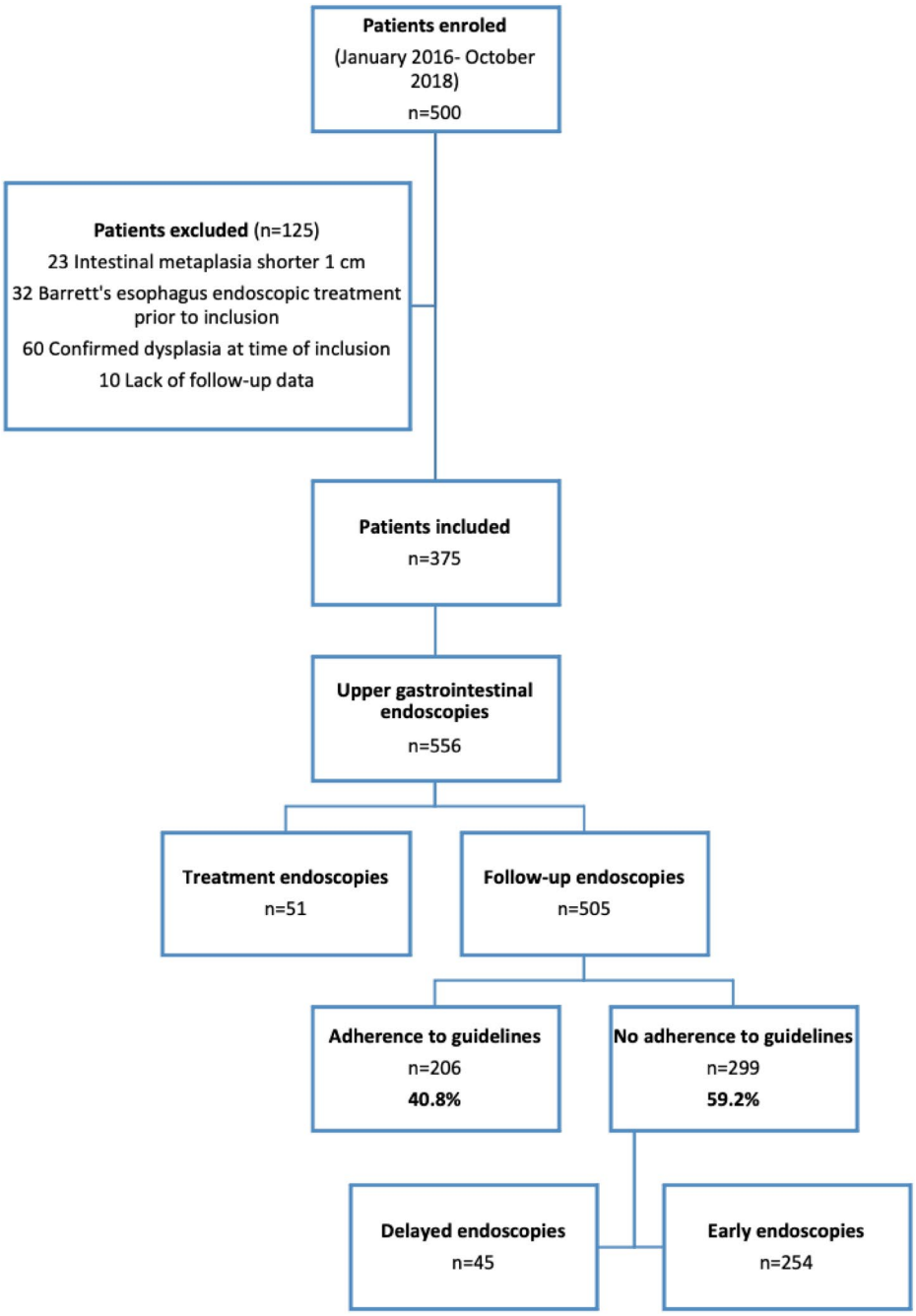

Fig. 1. Flow-chart of the study population.

protected against early endoscopy: the use of the Seattle biopsy protocol (68.0% vs. 79.9%, $p < 0.01$), of high-definition endoscope (61.3% vs. 70.9%, $p = 0.02$), and dye-based or electronic chromoendoscopy (22.1% vs. 30.9%, $p = 0.03$; and 38.1% vs. 49.4%, $p = 0.01$). In the multivariate analysis, short-segment BE (OR 2.01, 95%CI 1.35–2.98) and surgeon-indicated endoscopy (OR 2.99, 95%CI 1.19–7.52) were independent risk factors for early endoscopy, whereas adherence to the Seattle protocol remained a protective factor (OR 0.51, 95%CI 0.32–0.80). Full analysis of early endoscopy factors is presented in Table 4.

When considering only the 157 patients who were oversurveilled, the univariate risk-factor analysis showed again short-segment BE (< 3 cm; 57.3% vs. 47.8%, $p = 0.049$), and surgeon-indicated endoscopy (11% vs. 2.3%, $p < 0.01$) significantly associated with early endoscopy. In the multivariate analysis surgeon-indicated endoscopy (OR 4.97, 95%CI 2.09–11.82) was the only independent risk factors for oversurveillance. Full analysis of oversurveillance factors is presented in Table 5.

With regards to BE progression, univariate analysis showed a significant association with BE length (6.4 ± 3.4 vs. 3.4 ± 3 cm; $p < 0.01$), older age at diagnosis (62 ± 11 vs. 54 ± 13 years OR 1.05 (1.0–1.1), $p = 0.03$), and longer follow-up time (59 ± 17 vs. 46 ± 23 months, OR 1.03 (1.0–1.06), $p = 0.04$). Multivariate analysis revealed BE

	N = 375
Age (years) (mean ± SD)	55 ± 13
Sex (Male / Female)	302 (80.5%) / 73 (19.5%)
BMI (Kg/m^2) (mean ± SD)	27 ± 4
Smoking	
Yes	202 (53.9%)
No	165 (44%)
Unknown	8 (2.1%)
Alcohol use	
Yes	149 (39.7%)
No	217 (57.9%)
Unknown	9 (2.4%)
Reflux symptoms	
Yes	213 (56.8%)
No	160 (42.7%)
Unknown	2 (0.5%)
Hiatal hernia	
Yes	253 (67.5%)
No	120 (32%)
Unknown	2 (0.5%)
PPI use	
Yes	330 (88%)
No	43 (11.5%)
Unknown	2 (0.5%)
Antireflux surgery	
Yes	51 (13.6%)
No	324 (86.4%)
Type of hospital	
Tertiary	207 (55.2%)
Secondary	123 (32.8%)
Primary	26 (6.9%)
Private	19 (5.1%)
Barrett's segment length (cm) median (IQR)	
Circumferential extent	1 (0–3)
Maximum extent	2 (1–5)
Prospective follow up (months) median (IQR)	50 (34–61)

Table 1. Patient's baseline general characteristics SD: Standard deviation; PPI: proton pump inhibitor; IQR: interquartile range.

length (OR 9.39 95%CI 2.02–43.78) as the only independent risk factor for progression. A full analysis of BE progression factors is summarized in Table 6.

Discussion

In this study, adherence to BE clinical guideline recommendations in Spain was low, with only 40.8% of endoscopies being performed within the recommended interval and 50.3% performed earlier than recommended, with a consequent increase in the number of surveillance endoscopies performed.

Clinical guidelines are designed to reduce variation in patient management and enhance the quality of care, but several studies[9–11,18] have highlighted their inappropriate use in routine practice, raising questions about their true effectiveness. Several retrospective cohort studies from the US have reported low adherence rates, ranging from 12 to 23%[9–11]. Our results align with these findings showing low adherence to clinical guidelines. Three other US studies, however, have reported higher adherence rates, of between 54 and 70%[12,18,19]. Two of these were based on endoscopy quality registry data[12,19] and the third was based on a meta-analysis[18]. An improvement from 54%[12] to 70%[19] was detected in only 5 years between these studies by the same study group. This was attributed to the increased awareness and adoption of guidelines among endoscopists, driven by the emphasis on quality measures endorsed by gastroenterology professional societies in recent years.

Early endoscopy accounted for 50.3% of all procedures. This finding is consistent with findings from the US and Denmark (30–65%)[8,11–13]. The high number of surveillance endoscopies performed earlier than recommended has potential cost implications. Previous cost-effectiveness analyses have shown that shortening surveillance intervals increases healthcare costs without providing meaningful clinical benefit. Gordon et al.[20]

	N = 505 (%)
Referral physician	
Gastroenterologist	436 (87.2%)
Surgeon	25 (5%)
General Physician	29 (5.8%)
Others	10 (2%)
Endoscopist	
Senior	485 (96.2%)
Fellow	19 (3.8%)
Type of hospital	
Tertiary	317 (63.1%)
Secondary	123 (24.5%)
Primary	37 (7.4%)
Private	25 (5%)
Sedation	
Endoscopist with propofol	262 (52.1%)
Endoscopist with other medications	61 (12.1%)
Anestesiologist	171 (34%)
No sedation	9 (1.8%)
High-definition endoscope	388 (77.4%)
Dye chromoendoscopy	140 (28.2%)
Electronic chromoendoscopy	236 (47.1%)
Biopsies	441 (87.3%)
Seattle protocol (n = 441)	358 (81.2%)
Adherence to guidelines	206 (40.8%)

Table 2. Characteristics of surveillance endoscopy.

	n = 97 (%)
Non-adherence to seattle protocol	24 (24.7%)
Gastroduodenal lesion or high-risk follow-up	15 (15.5%)
Digestive symptoms (reflux, dyspepsia, abdominal pain, vomiting, aerophagia, diarrhea)	15 (15.5%)
No high-definition endoscopy	12 (12.4%)
Other signs or symptoms (anemia, Suspicion gastrointestinal bleeding, Constitutional syndrome)	10 (10.3%)
Follow-up of other digestive conditions (esophagitis, esophageal ulcer, eosinophilic esophagitis)	7 (7.2%)
Other indication for the endoscopy (pre or post-surgical intervention of hiatal hernia, upper endoscopic ultrasound, portal hypertension)	6 (6.2%)
Not specified	8 (8.2%)

Table 3. Reasons of early endoscopies.

demonstrated that standard surveillance is unlikely to be cost-effective for the majority of patients, except for those at higher-risk. More recently, Deidda et al.[21] reported that surveillance every 2–3 years is not cost-effective when compared with less intensive approaches ($5309 vs $3182 in the 2-year surveillance and at-need arms, respectively). These and our findings reinforce that oversurveillance not only lacks clinical justification but also generates avoidable healthcare costs.

A possible justification for performing the endoscopy earlier than recommended was found in only 38.2% of cases. The most frequent justification for early scheduling was non-adherence to the Seattle protocol (24.7%). However, this accounted for less than 10% of all early endoscopies. Of note, the Seattle protocol was followed in more than 81% of the endoscopies with biopsies. In contrast, a previous meta-analysis reported a lower adherence rate to the Seattle protocol (49%)[18], although endoscopies performed in university hospitals or in specially established follow-up programs were associated with higher adherence. In our study, adherence to guidelines and to the Seattle protocol did not differ between the different types of hospitals, possibly because all participating institutions were similarly motivated. These results underscore the value of BE specialized programs and the clinical impact of performing high-quality endoscopy. In fact, the use of the Seattle protocol was the main reason that protected from early endoscopy, possibly indicating increased confidence by referring physicians. Similarly to the Seattle protocol, other indicators of high-quality endoscopy, such as the use of dye or electronic chromoendoscopy, also reduced premature endoscopies in the univariate analysis.

Oversurveillance occurred in 31% of all procedures and the main factor was endoscopy indicated by a surgeon. This may reflect a better knowledge of current guidelines among gastroenterologists. Interventions

	Early endoscopy	No early endoscopy	Univariate OR (95%CI) p	Multivariate OR (95%CI) p
Age	54 ± 13	54 ± 13	1 (0.99–1.01) 0.9	
Sex				
Male (n = 410)	199 (78.3%)	211 (84.1%)	0.69 (0.44–1.08)	
Female (n = 95)	55 (21.7%)	40 (15.9%)	0.1	
Length of Barrett				
< 3 cm (n = 257)	151 (59.5%)	106 (42.2%)	**2.03 (1.42–2.89)**	**2.01 (1.35–2.98)**
≥ 3 cm (n = 248)	103 (40.5%)	145 (57.8%)	**< 0.01**	**< 0.01**
Referral physician				
Surgeon (n = 25)	18 (7.2%)	7 (2.8%)	**2.67 (1.1–6.5)**	**2.99 (1.19–7.52)**
Gastroenterologist/other (n = 475)	233 (92.8%)	242 (97.2%)	**0.03**	**0.02**
Type of endoscope				
High-definition (n = 333)	155 (61.3%)	178 (70.9%)	**0.65 (0.45–0.94)**	0.74 (0.45–1.24)
No high-definition (n = 171)	98 (38.7%)	73 (29.1%)	**0.02**	0.25
Dye chromoendoscopy				
Yes (n = 132) No (n = 366)	55 (22.1%) 194 (77.9%)	77 (30.9%) 172 (69.1%)	**0.63 (0.42–0.95)** **0.03**	0.9 (0.55–1.46) 0.66
Electronic chromoendoscopy				
Yes (n = 220) No (n = 283)	96 (38.1%) 156 (61.9%)	124 (49.4%) 127 (50.6%)	**0.63 (0.44–0.9)** **0.01**	0.97 (0.56–1.67) 0.9
Visible lesion with negative biopsies				
Yes (n = 42) No (n = 456)	12 (4.9%) 235 (95.1%)	30 (11.9%) 221 (88.1%)	0.56 (0.32–1.08) 0.09	
Seattle protocol				
Yes (n = 346)	155 (68%)	191 (79.9%)	**0.53 (0.35–0.81)**	**0.51 (0.32–0.8)**
No (n = 121)	73 (32%)	48 (20.1%)	**< 0.01**	**< 0.01**

Table 4. Factors associated to early endoscopy. Bold values indicate statistical significance ($p < 0.05$).

	Oversurveillance	No oversurveillance	Univariate OR (95%CI) p	Multivariate OR (95%CI) p
Age	54 ± 13	54 ± 13	1.01 (0.99–1.02) 0.41	
Sex				
Male (n = 410)	123 (78.3%)	287 (82.5%)	0.77 (0.48–1.23)	
Female (n = 95)	34 (21.7%)	61 (17.5%)	0.27	
Length of Barrett				
< 3 cm (n = 256)	90 (57.3%)	166 (47.8%)	**1.47 (1.00–2.14)**	1.43 (0.95–2.06)
≥ 3cm (n = 248)	67 (42.7%)	181 (52.2%)	**< 0.049**	0.09
Referral physician				
Surgeon (n = 25)	17 (11%)	8 (2.3%)	**5.24 (2.21–12.43)**	**4.97 (2.09–11.82)**
Gastroenterologist/other (n = 475)	137 (89%)	338 (97.7%)	**< 0.01**	**< 0.01**
Dye chromoendoscopy				
Yes (n = 132)	36 (23.1%)	96 (28.1%)	0.77 (0.5–1.19)	
No (n = 366)	120 (76.9%)	246 (71.9%)	0.24	
Electronic chromoendoscopy				
Yes (n = 220)	68 (43.6%)	152 (43.8%)	1 (0.68–1.45)	
No (n = 283)	88 (56.4%)	195 (56.2%)	0.96	

Table 5. Factors associated to oversurveillance. Bold values indicate statistical significance ($p < 0.05$).

such as extending educational initiatives to referring physicians across specialties, emphasizing multidisciplinary pathways, or the integration of decision-support tools in health IT systems might reduce unnecessary surveillance. Patients with a short-segment BE (< 3 cm) were also more frequently over-surveilled than those with longer segments. This suggests that physicians are hesitant to delay follow-up endoscopy beyond three

	Progression n = 13	Non-progression n = 362	Univariate OR (95%CI) p	Multivariate OR (95%CI) p
Sex				
Male	9 (69.2%)	293 (80.9%)	1.89 (0.57–6.31)	
Female	4 (30.8%)	69 (19.1%)	0,29	
Age at diagnosis (years)	62 ± 11	54 ± 13	**1.05 (1.0–1.1) 0,03**	1.05 (0.998–1.101) 0.06
BMI (kg/m^2)	26 ± 3	27 ± 4	0.95 (0.31–2.89)	
Smoking	7 (53.8%)	195 (55.1%)	0,93	
Symptoms of reflux	8 (61.5%)	205 (56.9%)	1.21 (0.39–3.77) 0,74	
PPI use	12 (92.3%)	318 (88.3%)	1.59 (0.2–12.5) 0,66	
Length of Barrett				
< 3 cm (n = 232)	2 (15.4%)	230 (63.9%%)	**9.73 (2.12–44.58)**	**9.39 (2.02–43.78)**
≥ 3 cm (n = 141)	11 (84.6%)	130 (36.1%)	**< 0,01**	**< 0.01**
Prague C	5,3 ± 3,6	2 ± 3	**1.23 (1.09–1.39) < 0,01**	-
Prague M	6,4 ± 3,4	3,4 ± 3	**1.19 (1.05–1.36) < 0,01**	-
Months of follow-up	59 ± 17	46 ± 23	**1.03 (1.0–1.06) 0,04**	1.03 (0.99–1.059) 0.07

Table 6. Patient's risk factors associated to Barrett`s esophagus progression detection Bold values indicate statistical significance ($p < 0.05$). BMI: body mass index; PPI: proton pump inhibitor.

years, as recommended for patients with BE < 3 cm. Nevertheless, in other two previous studies[11,12], a long Barrett's segment was associated with oversurveillance.

Undersurveillance was less frequent and occurred in only 8.9% of endoscopies in our study. In contrast, three studies from the United States showed a higher rate of undersurveillance or lack of surveillance, ranging from 46 to 87%[9–11]. The primary factors observed in those studies were the absence or the type of health insurance, male gender, long-segment BE and higher Charlson comorbidity index. In our series, however, the main reason was scheduling issues.

The low rate of progression in the present study (3.5% for dysplasia or cancer and 1.6% for HGD/EAC) aligns with findings from other European series. A Dutch prospective cohort study reported a progression rate to HGD/EAC of 6.8% with a mean follow-up time of 7.8 years, corresponding to an annual progression risk of 0.78% per patient-year[3]. Similarly, an Italian study reported a 2.5% progression rate after a median follow-up of 40.2 months, establishing an incidence rate of 0.72 per 100 patient-years[22]. In our multivariate analysis, longer BE segment length was associated with progression. In the univariate analysis, additional factors such as older age at the time of BE diagnosis, and a longer follow-up period were also significant. A systematic review and meta-analysis including 20 cohort studies[23] identified similar risk factors, while also highlighting male sex and smoking as significant predictors of BE progression. However, consistent with a more recent cohort study[3], we did not find an association between sex or smoking habits and BE progression in our cohort. Interestingly, neither did we find a link between adherence to clinical guidelines and the risk of BE progression detection. This analysis has its limitations, as a short segment was the main factor for oversurveillance, and Barrett's length was the main risk factor for progression. Moreover, the study was not powered to perform this analysis, but the results suggest that oversurveillance is useless.

The consistently low progression rates reported across multiple studies, and its relation to BE length, raises the question of whether short-segment BE should still be classified and managed as a high-risk precancerous condition. Although the recent ESGE guidelines continue to recommend surveillance, emerging data suggest that some patient subgroups may have risks so low that surveillance might not be justified[24].

A key strength of this study is its prospective design as most studies assessing adherence to clinical practice guidelines are based on retrospective cohorts. Additionally, while other studies have evaluated adherence based on the endoscopist's recommendations after reviewing pathology results, they did not confirm whether surveillance endoscopies were performed at the appropriate time[12,19]. Therefore, our description of guideline adherence may better reflect real clinical practice. Furthermore, our study takes into consideration the different guidelines used during the study period. A second strength is that because we included both public and private hospitals, ranging from tertiary care centers to smaller institutions, our findings are more representative of current clinical practice in the country.

The main limitation of the study is the change in surveillance guidelines during the study period. Nevertheless, the registry explicitly documented whether surveillance endoscopy was conducted at the appropriate interval, regardless of the guideline followed. Moreover, only 30 of 505 (5.9%) of surveillance endoscopies were performed before the 2017 ESGE guidelines where adopted. Another limitation is that only 15 centers participated in the study. This may have introduced some bias in patient inclusion based on general characteristics or degree of dysplasia, potentially favoring the inclusion of higher-risk patients. Nonetheless, this does not impact the main

conclusion or objective and our results may overestimate real-world practices as the participating institutions were likely highly motivated to follow BE guidelines given that participation was voluntary. On the other hand, dysplasia was frequently diagnosed and confirmed by local pathologists at each participating hospital rather than by dedicated expert pathologists. However, we consider this a strength rather than a limitation, because our aim was precisely to capture real-world clinical practice. The true variability in pathological expertise is inherent to routine surveillance of Barrett's esophagus and reflects the context in which surveillance guidelines are applied. Regarding the number of patients included, it is relatively low compared to other cohort studies, thus limiting our ability to analyze factors associated with inappropriate surveillance and BE progression. Finally, the multivariate models included only variables with $p < 0.1$ in the univariate analysis. This approach may be methodologically suboptimal. However, given that there were only 13 progression events, including more variables in the model would lead to overfitting.

In conclusion, adherence to clinical guidelines for BE recommendations in Spain is low, with a notable tendency to oversurveillance. Given the low progression rates of BE in our country, improving guideline adherence and avoiding oversurveillance could help reduce healthcare costs and minimize the risks and burdens associated with unnecessary endoscopic examinations, without negatively affecting patient outcomes. Potential strategies to enhance guideline adherence, such as training programs or decision-support tools, should be evaluated to reduce oversurveillance.

Data availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Author contributions
GAC and FEG designed the study. All authors: data acquisition. GAC and MPM analyzed the data and wrote the original draft of the manuscript. FEG reviewed and edited the manuscript. All authors read and approved the final manuscript.

Competing interests
The authors declare no competing interests.

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