

# Enteroscopy in the Elderly: Review of Procedural Aspects, Indications, Yield, and Safety

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## Keywords

Enteroscopy · Elderly · Safety · Efficacy · Yield

## Abstract

**Background:** As human longevity continues to increase, age-related diseases are more common, which leads to a higher use of gastroenterology services. Endoscopic procedures are generally considered to be of higher risk in the elderly with multiple comorbidities. However, some endoscopic techniques have already been proved to be well tolerated in the elderly. **Summary:** Enteroscopy enables the nonsurgical diagnosis and therapeutic management of a wide variety of small bowel diseases. Although it has been shown to be safe and effective, with high diagnostic yield and therapeutic success rate in the general population, its safety and efficacy in the elderly is largely unknown, and there are still some concerns about its use in these patients. **Key Messages:** This review will focus on enteroscopy in elderly people, taking into account patient and procedure characteristics, indications, findings, yield, and complication rate.

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## Enteroscopia nos idosos: revisão de aspetos processuais, indicações, rentabilidade e segurança

## Palavras-chave

Enteroscopia · Idosos · Segurança · Eficácia · Rentabilidade

## Resumo

**Introdução:** À medida que a longevidade humana continua a aumentar, as patologias relacionadas com a idade tornam-se mais prevalentes, o que conduz a um maior uso dos serviços da gastroenterologia. Os procedimentos endoscópicos geralmente acarretam maior risco nos idosos com múltiplas comorbidades, porém algumas técnicas endoscópicas já foram consideradas bem toleradas nestes pacientes. **Sumário:** A enteroscopia permite o diagnóstico e terapêutica de uma ampla variedade de doenças do intestino delgado. Apesar de ter sido demonstrada a sua eficácia e segurança na população geral, com elevada rentabilidade diagnóstica e terapêutica, a sua eficácia e segurança nos idosos é desconhecida, e ainda

permanecem dúvidas em relação ao uso deste exame nestes indivíduos. **Mensagens-chave:** O objetivo desta revisão é avaliar o uso da enteroscopia nos idosos, tendo em conta as características dos doentes e do procedimento, as indicações, os resultados, a rentabilidade e as complicações.

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## Introduction

The small bowel (SB) has been a relatively difficult area to examine until the beginning of this millennium. The introduction of capsule endoscopy (CE) in 2000 allowed an easier and more effective diagnostic approach to the SB, being the first-line noninvasive SB investigative modality [1]. Enteroscopy enables the nonsurgical diagnosis and therapeutic management of a wide variety of diseases of the SB [2], and it is divided into push, deep, and intraoperative enteroscopy. Push enteroscopy is a rapid technique, but only allows limited access to the proximal SB [3]. Intraoperative enteroscopy used to be a modality to investigate and treat the SB; however, it requires general anesthesia and is associated with a higher morbidity and mortality rate [4]. Nonetheless, it continues to have an important role in limited indications [5]. Deep enteroscopy (DE) uses specialized platforms to pleat the bowel over the scope in order to increase insertion depth and permit SB visualization.

DE is the technique of choice for obtaining mucosal biopsies and performing therapeutic interventions in the SB [2]. The commercially available platforms for DE include single-balloon enteroscopy (SBE), double-balloon enteroscopy (DBE), and spiral enteroscopy (SE). Balloon enteroscopy (SBE and DBE) follows the push-and-pull technique to advance deeper into the SB, whereas the SE principle uses rotating motion to gather the SB [6]. DBE was first introduced in Japan by Yamamoto in 2001 and in Western countries by May in 2003. SBE was introduced in 2007, as a simplified balloon enteroscopy system because the preparation and handling of the DBE were complex. Spiral enteroscopy was first introduced in 2006, and in addition to the advantage of a shorter small-bowel examination time, it is more stable within the bowel, thus allowing controlled examination of the intestinal mucosa and therapy [6]. Compared to SBE and DBE, SE is the least studied and utilized DE platform.

Age cutoffs of older than 65 and older than 80 years have been used to designate elderly status and advanced

age, respectively [7]. As human longevity continues to increase, age-related diseases grow, and in this patient population there is a higher prevalence of comorbidities, specifically anemia and obscure gastrointestinal bleeding (OGIB), which leads to a higher use of gastroenterology services [8, 9].

Endoscopic procedures are generally considered to be of higher risk in the elderly with multiple comorbidities [8]. Some endoscopic techniques, mainly upper endoscopy [10–12], colonoscopy [10, 12–14] and endoscopic retrograde cholangiopancreatography [12, 15–18] have already been proved to be well tolerated in the elderly. Although DE has been shown to be safe and effective, with high diagnostic yield and therapeutic success rate in the general population [19], the safety and efficacy of DE in the elderly are largely unknown, and there are still some concerns about its use [8]. Because of procedural complexity and extended procedure time, certain providers may be discouraged from using DE. This issue is important, as in one multicenter survey evaluating 1,411 DE procedures (DBE, SBE, and SE), over 40% were elderly patients. In this paper, we review enteroscopy series focusing in elderly patients (Table 1), taking into account patient and procedure characteristics (Table 2), indications (Table 2), findings (Table 3), diagnostic and therapeutic yield (Table 3), and complication rate (Table 3).

### Patient Characteristics

In older patients, the proportion of patients with age-related diseases/comorbidities, class III of the American Society of Anesthesiologist (ASA), and with anticoagulation and antiplatelet agent use is significant [20–22]. This proportion could be higher than the younger counterpart, as has been seen in previous studies [23–26]. According to Davis-Yadley et al. [25], with increasing age, there was a progressive increase in the Charlson Comorbidity Index (CCI) with all older age groups. In addition, according to one study, elderly patients tended to undergo enteroscopy within 24 h of presentation (emergency setting) more often than younger patients ( $p < 0.05$ ) [26].

### Procedure Characteristics

The procedure time was not significantly different between elderly and younger patients [23, 24, 27]. In some series, elderly patients were more likely to undergo the anterograde approach [25, 26], and in another series, the completion rate did not vary across different ages [28]. Hegde et al. [23] described no significant differences in

**Table 1.** Characteristics of the different studies

Study	Country	Year	Study methodology	Type of enteroscopy	Patients, <i>n</i>	Procedures, <i>n</i>	Time evaluated	Cohort age, years
Hegde et al. [23]	USA	2010	Retrospective	DBE	170 (110 younger, 60 elderly)	216 (137 younger, 79 elderly)	1 year (August 2007–August 2008)	<75 and ≥75
He et al. [20]	China	2012	Retrospective	DBE	59 (only 1 patient ≥80 years)	81	8 years and 6 months (January 2003–July 2011)	All ≥65
Byeon et al. [21]	USA	2012	Retrospective	DBE	167 (22 >85 years); prior to inclusion, in 4 patients DBE was canceled because of poor medical conditions, in 2 patients it was canceled because of inadequate indications	214	5 years and 10 months (November 2004–September 2010)	All ≥75
Sidhu et al. [27]	UK	2013	Prospective	DBE	111 ( <i>NA number of patients in each group</i> )	148 (108 younger, 40 elderly)	6 years and 4 months (July 2006–November 2012)	<70 and ≥70
Choi et al. [24]	Republic of Korea	2014	Retrospective	DBE	158 (124 younger, 34 elderly)	218 (177 younger, 41 elderly)	9 years and 11 months (September 2003–August 2013)	<65 and ≥65
Cangemi et al. [22]	USA	2015	Retrospective	DBE	130	215	6 years and 7 months (January 2006–September 2012)	All ≥80
Chen et al. [34]	China	2016	Retrospective	DBE	674 (308 younger, 272 middle-aged, 94 elderly)	729 ( <i>NA number of procedures in each group</i> )	8 years and 10 months (January 2007–November 2015)	11–44, 45–65 and 66–88
Davis-Yadley et al. [25]	USA	2016	Retrospective	SBE	366 (101 ≥75 years, 119 65–74 years, 90 55–64 years, 118 <55 years)	428 ( <i>NA number of procedures in each group</i> )	±4 years (2010–2014)	≥75 65–74 55–64 <55
Chang et al. [26]	Taiwan	2017	Retrospective	SBE	168 (112 younger, 56 elderly)	265	6 years and 10 months (December 2009–October 2016)	<65 and ≥65
Pinho et al. [19]	Portugal	2016	Multicentric retrospective	DAE	–	1,411: (16 pediatric, 828 adults, 567 elderly)	10 years	<18 18–65 ≥65
Lin et al. [35]	Taiwan	2016	Retrospective	SBE	128	200	5 years and 3 months (September 2009–December 2014)	<30 30–65 >65
Pattni et al. [28]	UK	2017	Retrospective	DAE	202	215	6 years and 2 months (September 2008–November 2014)	<75 and ≥75
Tao et al. [36]	China	2017	Retrospective	SBE	186	196	5 years and 11 months (January 2009–December 2014)	14–45 46–59 60–74 75–89 >90

NA, not available; DBE, double-balloon enteroscopy; SBE, single-balloon enteroscopy.

**Table 2.** Patient characteristics, indications, and type of procedure in the different studies

Study	Patient characteristics	Indications	Procedure
Hedge et al. [23]	Cardiac disease: elderly – 46.7%; younger – 28.2% ( $p = 0.02$ ) Anticoagulation therapy: elderly – 26.7%; younger – 11.8% ( $p = 0.02$ )	Main indication – OGIB: all – 85%; elderly – 96%; younger – 79.6% ( $p = 0.0008$ ) Abnormal findings on a previous radiologic imaging study: elderly – 3.8%; younger – 14.6% ( $p = 0.01$ )	No significant differences in the mean number of procedures per patient, the percentage of upper/lower DBE procedures, procedure time, and depth of enteroscope insertion between the 2 age groups
He et al. [20]	Age-related diseases – 50% 49.2% ( $n = 29$ ) had blood transfusion	Main indication – overt OGIB (36/51) Others: abdominal pain (15/51), diarrhea (3/51)	
Byeon et al. [21]	Significant chronic diseases such as ischemic heart disease or COPD – 97.2% ASA class III – 70.6% Anticoagulants or antiplatelet – 42.1%	Main indication – OGIB (82.7%)	Mean DBE procedure time – $131 \pm 51$ min
Sidhu et al. [27]	Median dose of midazolam: elderly – 4.5 mg; younger – 6 mg ( $p < 0.001$ ) Median dose of fentanyl: elderly – 50 $\mu$ g; younger – 75 $\mu$ g ( $p = 0.02$ ) Transfusion requirements (number of patients): 10 ( $<70$ ) vs. 22 ( $\geq 70$ )	The only indications were OGIB (74% occult and 26% overt) Occult OGIB was the most frequent indication in both groups	Procedure time was not significantly different between the groups ( $p = 0.45$ )
Choi et al. [24]	Comorbidities: elderly – 67.6%; younger – 33.9% ( $p = 0.001$ ) ASA class III: elderly – 20.6%; younger – 2.4% ( $p = 0.001$ ) NSAID, anticoagulant, or antiplatelet agent use: elderly – 29.4%; younger – 11.3% ( $p = 0.015$ ) Mean midazolam dose: elderly – 2.61 mg; younger 3.85 mg ( $p < 0.001$ )	Main indication – OGIB: all – 56.3%; elderly – 67.6%; younger – 56.3% ( $p = 0.17$ )	No difference in mean total procedure time
Cangemi et al. [22]	Comorbidities – 89.2% ASA class III or IV – 90.8%	Main indication: OGIB (94.9%)	Mean procedure time – $81.1 \pm 29.7$ min
Chen et al. [34]		Main indication – OGIB (36.6%) Next common indication – abdominal pain (29.7%) ( <i>NA data of each group</i> )	
Davis-Yadley et al. [25]	ASA class III: all – 80.9%; $\geq 75$ – 69.3%; 65–74 – 66.4%; 55–64 – 68.9%; $<55$ – 72% ( <i>NA statistical significance</i> ) CCI: Progressive increase with all older age groups compared with the younger group ( $p < 0.01$ ) Aspirin and anticoagulant use: all – 41.5%; $\geq 75$ years – 47.6%; 65–74 – 48.8%; 55–64 – 38.9%; $<55$ – 9.3% (between all older groups and the youngest group, $p < 0.05$ ) Transfusion requirements comparing to the $<55$ group with 22% $\rightarrow$ 55–64 33.3% ( $p = 0.04$ ); 65–74 26.1% ( $p = 0.37$ ) and $\geq 75$ 19.1% ( $p = 0.95$ )	Main indication – OGIB: all – 96.4%; $\geq 75$ – 94.1%; 65–74 – 90.8%; 55–64 – 90%; $<55$ – 58.5% (between all older groups and the youngest group, $p < 0.01$ ) Other indications: all – 20.5%; $\geq 75$ years – 5.9%; 65–74 – 9.2%; 55–64 – 10%; $<55$ – 41.5% (between all older groups and the youngest group, $p < 0.001$ )	Anterograde SBE: older patients 93–96%; younger – 83.1% ( $p < 0.05$ ) Retrograde SBE: older patients 5–8.9%; younger – 22% ( $p < 0.05$ )
Chang et al. [26]	Comorbidities and ASA class III higher in elderly patients ( $p < 0.05$ ) Elderly patients tended to undergo SBE within 24 h of presentation (emergency setting) ( $p < 0.05$ )	Main indication – OGIB: all – 52.4%; elderly patients – 83.9%; younger – 36.6% ( $p < 0.001$ ) Unexplained abdominal pain: all – 26.8%; elderly – 8.9%; younger – 35.7% ( $p < 0.001$ ) Suspicious small-bowel tumor: all – 12.5%; elderly – 3.6%; younger – 17% ( $p = 0.01$ )	Anterograde SBE: elderly – 33.9%; younger – 17.0% ( $p = 0.01$ ) Both approaches: elderly – 46.4%; younger – 63.4% ( $p = 0.04$ ) Complete SB evaluation: elderly – 45%; younger – 56.5% ( $p = 0.37$ )
Pinho et al. [19]		Main indication – OGIB (43.3%) ( <i>NA data of each group</i> )	
Lin et al. [35]		Main indication – OGIB (62.5%) ( <i>NA data of each group</i> )	
Pattni et al. [28]	Mean midazolam dose: elderly – between 3.7–5.5; younger – 4.6–6.1 ( $p < 0.001$ )	Main indication – OGIB (63.8%) ( <i>NA data of each group</i> )	Completion rates did not vary across different ages of patient ( $p = 0.238$ )
Tao et al. [36]		Main indication – OGIB (34.4%) ( <i>NA data of each group</i> )	

NA, not available; SB, small bowel; DBE, double-balloon enteroscopy; SBE, single-balloon enteroscopy; OGIB, obscure gastrointestinal bleeding; ASA, American Society of Anesthesiologists CCI, Charlson Comorbidity Index; NSAID, nonsteroidal anti-inflammatory drug.

**Table 3.** Findings, diagnostic and therapeutic yield, and complications in the different studies

Study	Findings	Diagnostic yield	Therapeutic yield	Complications
Hedge et al. [23]	Main finding – angiodysplasia: all – 28.7%; elderly – 39%. younger – 23% ( $p = 0.01$ ) Polyps/mass lesions were the next most common finding (13.1%), then small-bowel erosions/ulcers (11.7%); no significant differences between groups	All: 53.2%; elderly – 55.7%; younger – 51.8% ( $p = 0.8$ )	Endoscopic therapy: all – 35.7%; elderly – 46.8%; younger – 29.2% ( $p = 0.01$ ) Therapeutic success: all – 85.7%; elderly – 86.5%; younger – 85% ( $p > 0.5$ )	Immediately after the procedure and on the basis of follow-up telephone calls 24–48 h after the procedure Complication rate: all – 0.9%; elderly – 0%; younger – 1.4% with transient hypoxia or arrhythmia ( $p = 0.5$ ) No deaths were observed
He et al. [20]	Main finding – primary or metastatic tumors (15/51) Others: diverticula – 7/51; single ulcer – 5/51; angiodysplasias – 4/51; erosions – 2/51	64.4% DY for SB diseases of 60.8%	TY = 34% (endoscopic therapy in 20 patients) Surgical in 23 and intra-operative enteroscopy in 1	Severe complications were not found during and after DBE Levels of systolic and diastolic blood pressure decreased slightly after DBE
Byeon et al. [21]	Main finding – angiodysplasia (30.8%) Next common findings – ulcer and/or erosion of nonspecific etiology (7.0%)	60.3%	38.8%	Complication rate general – 3.7% Pancreatitis: 1.4% Hypoxia after DBE procedures: 1.4% Aspiration pneumonia: 0.9% and treated with antibiotics Small amount of peritoneal free air after DBE ERCP: 0.5% No inadvertent perforation as a result of the DBE procedure Levels of systolic and diastolic blood pressure decreased slightly after DBE
Sidhu et al. [27]	Main finding – angiodysplasia: all – 25.7%; elderly – 47.5%; younger – 17.6% (NA statistical significance) Normal: all – 52.7%; elderly – 37.5%; younger – 58.3% (NA statistical significance)	All: NA; elderly – 53%; younger – 35% ( $p = 0.06$ ) Increasing age ( $p = 0.008$ ) and positive CE findings ( $p = 0.010$ ) associated with a higher yield	All: 45% treated vascular lesions (APC) Management changed: all – 50%; elderly – 50%; younger – 28% ( $p = 0.01$ ) Increasing age ( $p = 0.006$ ) and positive CE findings ( $p = 0.016$ ) predicted a change in management	Elderly: no complications or procedure-related deaths at 30 days Younger: respiratory arrest occurred in 1 patient in DPOC (type 2 respiratory failure) (NA statistical significance)
Choi et al. [24]	Most common diagnosis: all – mucosal lesions: elderly – 33.3%; younger – 60.9% ( $p = 0.002$ ) > The most common and detailed final diagnosis: elderly – drug-induced enteropathy younger – CD or tuberculosis Second common diagnosis: all – tumor lesions; elderly – 30.8%; younger – 14.1% ( $p = 0.005$ )	All: NA; elderly – 92.3%; younger – 86.5% ( $p = 0.422$ )	Endoscopic therapy: all – 15.2%; elderly – 23.5%; younger – 12.9% ( $p = 0.17$ ) Interventional therapy (endoscopic + surgery): all – 29.7%; elderly – 50%; younger – 24.2% ( $p = 0.006$ ) Medical therapy: all – 70.3%; elderly – 50%; younger – 75.8% ( $p = 0.006$ ) Therapeutic success: elderly – 100%; younger – 87.5% ( $p > 0.05$ )	Complication rate: all – 1.8%; elderly – 2.6%; younger – 1.8% ( $p = 0.548$ ) elderly – transient hypoxia 0.5% younger – intervention-related bleeding 0.9%; pancreatitis 0.5% No perforations or deaths related to DBE were reported in both groups
Cangemi et al. [22]	Main finding – nonbleeding angiodysplasia (43.7%) Next common finding – bleeding angiodysplasia (17.2%)	77.2% Diagnostic yield for OGIB – 76.5%	59.5% APC – 99.2% of the therapeutic procedures and 59.1% of all procedures	No immediate postprocedural complications noted within 48 h
Chen et al. [34]	Main finding: all – Crohn's disease (33.4%); elderly – tumor (73.4%); younger – Crohn's disease (48%) (NA statistical significance) Next common finding: all – tumor (18.8%); elderly – angiodysplasia (24.5%); younger – tumor (10.4%) (NA statistical significance)	All: 70.9%. elderly: 78.6%; middle-aged: 71.2%; younger: 73% (NA statistical significance)	All – 8.23% (60/729) hemostasis – 28.3%; polypectomy – 25% (NA data of each group)	Complication rate: all – 0.96% (3 patients with perforation, 2 patients with postprocedural hemorrhage, and 1 patient with aspiration pneumonia) (NA data of each group)

**Table 3** (continued)

Study	Findings	Diagnostic yield	Therapeutic yield	Complications
Davis-Yadley et al. [25]	Main finding – angiodysplasia: all – 34.7%; ≥75 y – 39.6%; 65–74 y – 37%; 55–64 y – 30%; <55 y – 13.6% (between all older groups and the youngest group $p < 0.01$ ) Tumors: all – 3%; ≥75 y – 2%; 65–74 y – 0.8%; 55–64 y – 1.1%; <55 y – 5.9% (between all older groups and the youngest group $p > 0.05$ )	All – 67.5%; ≥75 years – 66.3%; 65–74 – 59.7%; 55–64 – 55.6%; <55 – 50% (only $p < 0.05$ between the oldest group and the youngest group)	All – 44.2%; ≥75 years – 47.5%; 65–74 – 42%; 55–64 – 44.4%; <55 – 20.3% (between all older groups and the youngest group $p < 0.05$ )	Minor complications (bradycardia, supraventricular tachycardia and mild bleeding): all: 1.4%; ≥75 years – 1%; 65–74 – 0; 55–64 – 1.1%; <55 – 2.5% (between all older groups and the youngest group, $p > 0.05$ ) Major complications (hemodynamic instability, bowel perforation and balloon trauma): all: 1.4%; ≥75 years – 2%; 65–74 – 2.5%; 55–64 – 1.1%; <55 – 0 (NA statistical significance) Overall complication rate: all: 2.8%; ≥75 years – 2%; 65–74 – 2.5%; 55–64 – 2.2%; <55 – 2.5% (between all older groups and the youngest group, $p > 0.05$ )
Chang et al. [26]	Main finding – Mucosal lesions: 41.7% Next finding tumor lesions: 36.9% Angiodysplasia: all – 17.8%; elderly – 37.5%; younger – 8% ( $p < 0.001$ ) Diverticulum: all – 10.7%; elderly – 25%; younger – 3.6% ( $p < 0.001$ ) Ulcer/erosion: all – 36.9%; elderly – 23.2%; younger – 43.8% ( $p = 0.01$ ) IBD: all – 4.8%; elderly – 0; younger – 7.1% ( $p = 0.04$ )	All – 59.5%; elderly – 75%; younger – 51.8% ( $p = 0.004$ )	All – 26.2%; elderly – 39.3%; younger – 16.9% ( $p = 0.001$ )	Complication rate: all – 3.6%; elderly – 5.4%; younger – 2.7% ( $p = 0.37$ )
Pinho et al. [19]	Main finding – angiodysplasias (25.8%). Next common finding: tumor/polyps and Crohn's disease (NA data of each group)			Anesthetic complications requiring interruption of the procedures were reported in 9 (0.6%) patients, all under deep propofol sedation, 6 of them aged 65 or older ( $p > 0.05$ )
Lin et al. [35]	Main finding: all – angiodysplasia (15.2%) <30 years – Meckel's diverticulum (17.7%) 30–65 years – non-specific ulcer (26.9%) >65 years – angiodysplasia (27%) (NA statistical significance)			
Pattni et al. [28]	Main finding: all – angiodysplasia (25.6%)	Older patients were more likely to have an abnormal examination (mean age normal examination 60.3 vs. abnormal examination 67.9 years, $p < 0.001$ )	Elderly – 78.5%; younger – 37.9% ( $p < 0.001$ )	Procedure was better tolerated in older patients ( $p = 0.001$ ) 0.4% complication rate related to sedation in an elderly patient (80 years)
Tao et al. [36]	Main finding: all – mucosal lesions (17.2%) elderly: vascular malformations younger (<45 y): small intestinal diseases except for lymphoma, protuberant lesions, vascular malformations, and undetermined bleeding			

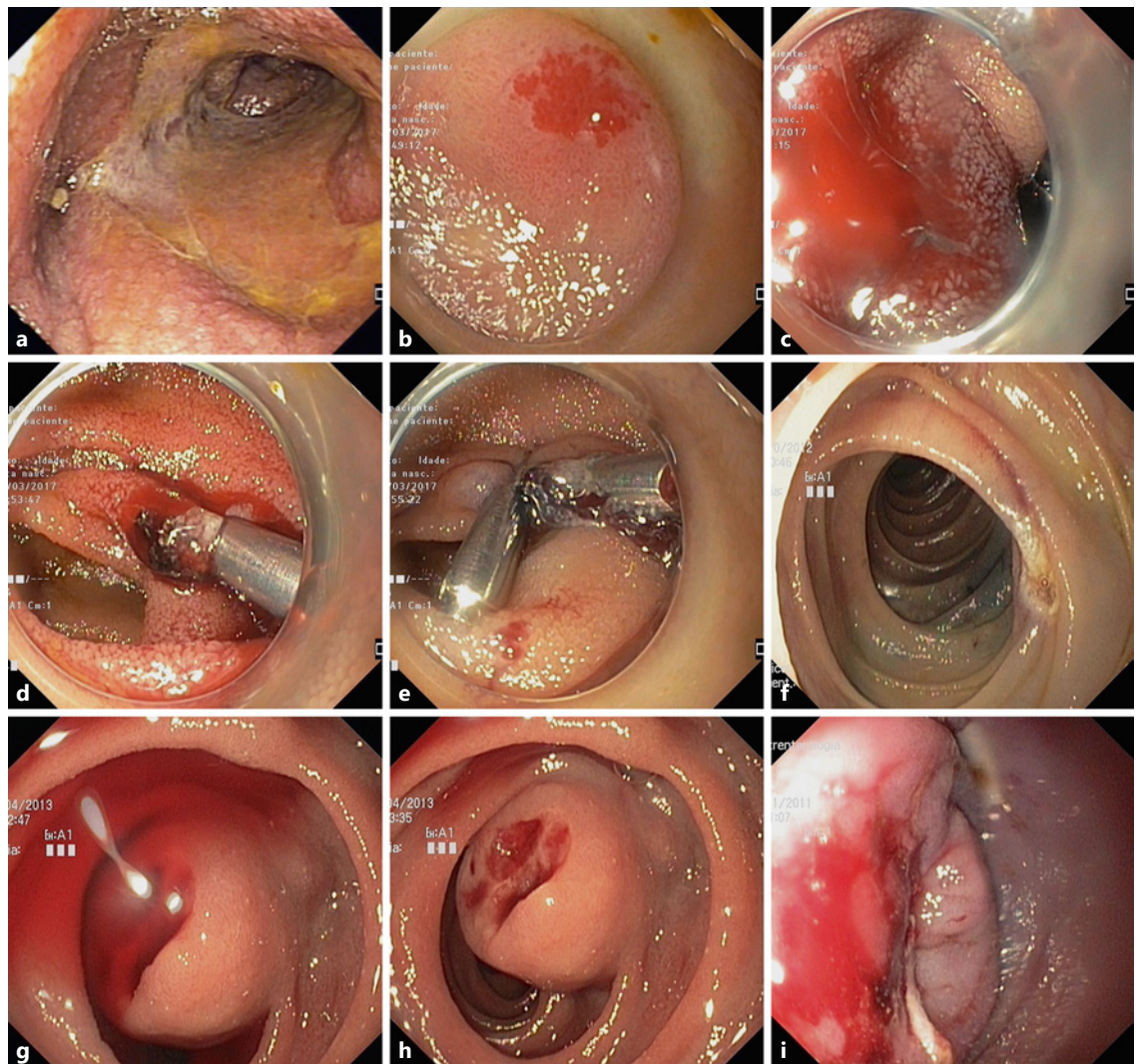
NA, not available; DY, diagnostic yield; TY, therapeutic yield; CE, capsule endoscopy; DBE, double-balloon enteroscopy; SBE, single balloon enteroscopy; APC, argon plasma coagulation; COPD, chronic pulmonary obstructive disease.

the mean number of procedures per patient, the percentage of upper/lower DBE procedures, the procedure time, and the depth of enteroscope insertion between the age groups.

### Indications

OGIB continues to be the main indication for DE [5, 29–31], although enteroscopy can be used for other indications such as the evaluation of SB obstruction and SB





**Fig. 1.** Enteroscopy images of ulcerated stenosis (**a**), angioectasia (**b**), bleeding angioectasia (**c**), clip to control bleeding (**d**), bleeding controlled after 2 clips (**e**), scar after argon plasma coagulation (**f**), bleeding subepithelial lesion (**g**), subepithelial lesion (**h**), and neoplasia (**i**).

tumors, management of Peutz-Jeghers patients [32], and accessing the pancreaticobiliary system in patients with surgically altered anatomy [29, 31, 33].

OGIB was the most common indication, independent of the age group, in all series reported in Table 2 [19–28, 34–36]. However, the proportion of patients performing enteroscopy for OGIB was significantly higher in elderly patients. Younger patients were more likely to undergo enteroscopy for other indications, such as abdominal pain, abnormal imaging, or suspicious small-bowel tumor [23, 25, 26]. This is in accordance with what has been established for CE [9].

### Findings

The distribution of positive findings seems to be different between Eastern and Western countries. Inflammatory lesions and SB mass lesions are primarily found in the east, whereas in the west, vascular lesions are more often diagnosed (Fig. 1) [31, 37–40].

As reported previously, elderly patients are more likely to have vascular lesions than younger patients in CE [9, 41]. In these studies, vascular lesions were also the most common finding in the elderly in Western countries [19, 21–23, 25, 27, 28], and these patients were more likely to present vascular lesions compared to younger patients

[23, 25–27, 35, 36, 42]. Despite that, Lin et al. [35], a group from Taiwan, reported that angiodysplasias were the main finding (contrary to what would be expected in an Asian population).

In Eastern series it seems that mass or mucosal lesions were the most common findings [20, 24, 26, 34, 36]. Mucosal lesions were more frequent in the younger group [24, 34–36] and tumor lesions in the older group [24, 34]. Choi et al. [24] reported that Crohn's disease or tuberculosis were the most common diagnoses in the younger group, with drug-induced enteropathy being the most common diagnosis in the elderly. Chen et al. [34] reported that associated with advancing age, the morbidity associated with tumors, angiodysplasias, tuberculosis, parasites, and nonsteroidal anti-inflammatory drugs, enteritis appeared to be increasing, and a decline occurred in the morbidity related to Crohn's disease, polyp, and Henoch-Schönlein purpura.

### *Diagnostic Yield*

DBE has a diagnostic yield comparable with that of CE in the evaluation of small-bowel disease [43, 44]. According to a meta-analysis by Teshima et al. [45], the diagnostic yield of DBE performed after a previously positive CE is higher when compared to DBE performed after a negative CE. Furthermore, CE performed prior to SBE has been shown to improve both the diagnostic and therapeutic yields [46]. Despite that, in some cases, DE could detect lesions missed by CE [47, 48]. BE comprises both DBE and SBE, and according to recent meta-analyses they both have similar diagnostic yield [49–51], although there is some evidence that the DBE technique has a longer insertion depth [52]. A diagnostic yield of around 40–80% for DBE [19, 31, 43, 49–51, 53] and around 36–66% for SBE have been reported [19, 39, 49–51]. Baniya et al. [6] compared BE with SE and found no significant differences in the diagnostic yield. In a recent meta-analysis, the diagnostic yield for OGIB, the main indication for DE, was 62.5% [31]

In the elderly, the reported diagnostic yield varied between 53 and 92% [20–27, 34], and when comparing with younger patients, it has a tendency to be higher in the elderly in some series [23, 24, 27, 34], being significantly higher in other series [25, 26]. Choi et al. [24] reported that increasing age and positive CE findings were found to be associated with a higher yield. Pattni et al. [28] observed that older patients were more likely to have an abnormal examination (mean age for normal examinations 60.3 years vs. mean age for abnormal examinations 67.9 years,  $p < 0.001$ ). The superior diagnostic yield in the elderly was also found in CE studies (50.7 vs. 41.2%) [9].

### *Therapeutic Yield*

According to recent evidence, SBE and DBE were similar in their ability to provide endoscopic therapy (Fig. 1) [50, 51], with therapeutic yields ranging from 4 to 48% for SBE [19, 39, 40, 49–51] and from 9 to 92% for DBE [19, 29, 49–52, 54]. In the same meta-analysis of Baniya et al. [6], BE was similar to SE in the therapeutic yield reported.

The therapeutic yield in the elderly ranges between 23.5 and 59% [20–28]. Some studies reported that endoscopic therapy in the elderly was significantly higher [23, 25, 26, 28] than in younger patients, and endoscopic therapy and subsequent intervention after enteroscopy were more often applied in a significantly greater proportion of the former [24, 27]. On the other hand, medical therapy was administered to a higher percentage of younger patients than elderly patients [24]. Increasing age and positive CE findings were factors that predicted a change in management [27].

### *Complications and Safety*

There is increasing data demonstrating that BE is safe, with low complication rates. The complication rates reported range from 0.4 to 5% for DBE [19, 29, 31, 49–51, 55] and from 0.6 to 5.5% for SBE [19, 39, 49–51, 56]; when comparing both techniques, they did not show significant differences [49–51]. Perforation, pancreatitis, bleeding, aspiration pneumonia, intussusception, paralytic ileus, and intestinal necrosis are the main complications in patients undergoing DE [19, 29, 31, 55, 57].

In the elderly, several physiologic changes including increased body fat content and compromised renal and hepatic clearance make the body have higher sensitivity and poorer tolerance for drug administration leading to prolonged recovery and greater risk of oversedation [8]. In these patients, the lowest cumulative dose of sedation is used to minimize complications [29, 58]. The dose of sedation used in the elderly has been significantly lower [24, 27, 28].

Geriatric patients have a reduction in pharyngeal sensitivity leading to a greater risk of aspiration [8], and hypoxia associated with endoscopic procedures under sedation was reported to be more common in these patients [59].

In our review, the highest complication rate reported in the elderly was up to 5.4% [26]. In two studies with only elderly patients, levels of systolic and diastolic blood pressure decreased slightly after DBE [21, 23]. Byeon et al. [21], when evaluating patients older than 75 years of age, reported a complication rate of 3.7%, including pancreatitis, hypoxia and aspiration and pneumonia. Davis-



Yadley et al. [25] noted a major complication rate (hemodynamic instability, bowel perforation, and balloon trauma) of 2.25%, with no major complication in the younger group. Also, two other studies reported higher complication rates in the elderly patients, although not significantly different from the younger group [24, 26]. Pinho et al. [19] found that anesthetic complications requiring interruption of the procedures were reported in 9 (0.6%) patients, all under deep propofol sedation, where 6 of them were aged 65 or older ( $p > 0.05$ ). Conversely, there were some series in which no severe complications were found [20, 23, 27, 34]. In another series, enteroscopy was better tolerated in older patients, despite the fact that the same authors describe only one complication related to sedation in an elderly patient (80 years of age) [28].

## Conclusions

When comparing with a younger population, elderly patients usually have more comorbidities and higher use of anticoagulation and antiplatelet agents. Furthermore, they undergo enteroscopy within 24 h of presentation

(emergency setting [60, 61]) more often. However, enteroscopy seems to be a safe procedure in this group of patients, with studies reporting a similar complication rate to the general population.

According to this review, the main indication in the elderly for performing enteroscopy was OGIB, as is the case in the general population, but elderly patients have a higher proportion of procedures performed for this indication. This could be explained by the fact that elderly patients more often present angiodysplasia as the main finding in enteroscopy procedures.

There is some evidence that the diagnostic yield and therapeutic success rate of enteroscopy are higher in older patients, which proves that this modality is important and effective in this patient group.

For all these reasons, enteroscopy seems to be a safe and useful procedure in elderly patients, and age, per se, should not be viewed as a limitation for its use.

## Disclosure Statement

The authors declare no conflict of interest for this article.

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