

# Fatal outcomes of endoscopy: an analysis from the coroner's point of view



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## ABSTRACT

**Background and study aims** This study was designed to provide a profound analysis of fatalities associated with endoscopic procedures.

**Methods** Protocols of all autopsies performed within 20 years in a large Department of Forensic Medicine were retrospectively analyzed to identify all fatalities directly related to an endoscopic procedure. Data were further specified focusing on the type of endoscopy and the final cause of death.

**Results** Of 22,615 autopsies performed between January 2000 and September 2019, 86 deaths were identified as complications of an endoscopic procedure. The average age of these 86 patients was 70.9 years (66.4 (range, 26–89) in males (n=35) and 74.1 years (range, 22–94) in females (n=51)). Endoscopic procedures included 29 endoscopic retrograde cholangiopancreatographies (ERCPs), 27 colonoscopies, 18 percutaneous endoscopic gastrostomy (PEG) tube placements, six gastroscopies, two upper endoscopic ultrasonographies, and four transesophageal echocardiographies. ERCPs, colonoscopy and PEG procedures together accounted for 74 of 86 (86%) endoscopy-related deaths. Focusing on the single procedures, post-ERCP pancreatitis (14/29, 48%), colonoscopy-associated perforation (24/27, 89%), and peritonitis after PEG placement (16/18, 88%) were the most common causes of death.

**Conclusions** Even in the thought-to-be-safe and screening endoscopic procedures fatalities do occur. This study gives an overview of endoscopy-related fatalities, stressing the role of ERCP, colonoscopy, and PEG.

## Introduction

Every year, more than 4.5 million endoscopies are performed in Germany [1]. Fatalities after a medical intervention are rare, but always a catastrophe – for the patient, of course, for their loved ones and, last but not least, for the examiner. This study gives an insight into the different causes of endoscopy-related deaths, derived from a 20-year period of a large number of autopsies in an institute of forensic medicine.

## ABBREVIATIONS

<b>EGD</b>	Esophagogastroduodenoscopy
<b>EUS</b>	Endoscopic ultrasound
<b>EUS-FNA</b>	Endoscopic ultrasound-guided fine-needle-aspiration
<b>ERCP</b>	Endoscopic retrograde cholangiopancreatography
<b>PEG</b>	Percutaneous endoscopic gastrostomy
<b>PEP</b>	Post-ERCP-Pancreatitis
<b>TEE</b>	Transesophageal echocardiography

## Methods

This work was based on a total of 22,615 autopsies over 20 years, performed in the Department of Forensic Medicine at the University Medical Center Hamburg-Eppendorf from January 1, 2000 to September 30, 2019.

The autopsy protocols consisted of autopsies arranged:

- by the prosecutor
- for scientific purposes
- by a private person and
- by the health authority.

During the 20-year period, there were a minimum of 959 (in 2010) and a maximum of 1357 (in 2001) autopsies with an average of 1130 autopsies per year.

The autopsy protocols were digitally stored on the institute's intranet. Each autopsy protocol from the 22,615 autopsies was opened individually by the first author and evaluated for the cause of death. All autopsy protocols with endoscopy-related deaths were selected. In some protocols, the causes of death could only be assumed and not clarified. These protocols were excluded from analysis.

When an endoscopy-related cause of death was identified, data were examined according to following parameters:

- Type of autopsy (a–d, as defined above)
- Age and gender
- Type of endoscopy and interventions
- Final cause of death, as assumed from autopsy and medical history outlined in the autopsy protocol

Endoscopic procedures analyzed for this study were upper gastrointestinal endoscopy, colonoscopy, endoscopic retrograde cholangiopancreatography (ERCP), percutaneous endoscopic gastrostomy (PEG), endoscopic ultrasound (EUS) including endoscopic ultrasound-guided fine-needle aspiration (EUS-FNA) and transesophageal echocardiography (TEE).

## Results

Of 22,615 autopsies, 86 deaths (35 male, 51 female) occurred after an endoscopic intervention (~0.38% of all autopsies). The average age of these patients with an endoscopy-related death was 70.9 years (66.4 years [range, 26–89] in males and 74.1 years [range, 22–94] in female patients).

On average there were  $4.3 \pm 2.3$  fatal outcomes detected in an autopsy after an endoscopy per year [1–9 cases].

► **Table 1** gives an overview of endoscopy-related deaths, according to the endoscopic procedure and cause of death. ERCP, colonoscopy and PEG procedures together were clearly the interventions with the highest absolute number of fatalities, accounting for 74 of 86 (86%) endoscopy-related deaths. A detailed analysis of the different endoscopic procedures yielded the following results:

► **Table 1** Type of endoscopic procedures.

Endoscopic procedure	Total amount	Cause of death	No. cases
ERCP	29	Post-ERCP pancreatitis	14
		Duodenal perforation	11
		Bleeding	2
		Others	2
Colonoscopy	27	Sigmoid perforation	11
		Rectal perforation	5
		Cecal pole perforation	1
		Colon perforation without precise localization	7
		Bleeding	1
		Others	2
PEG	18	Peritonitis	16
		Bleeding	2
Gastrosopy	6	Esophageal perforation	4
		Stomach perforation	1
		Pancreatitis	1
EUS/FNA	2	Stomach perforation	1
		Mediastinitis	1
TEE	4	Esophageal perforation	4
Total	86		86

ERCP, endoscopic retrograde cholangiopancreatography; PEG, percutaneous endoscopic gastrostomy; EUS, endoscopic ultrasonography; FNA, fine-needle aspiration; TEE, transesophageal echocardiography.

### ERCP

The most common lethal complication of ERCP was post-ERCP pancreatitis causing almost 50% (14/29) of ERCP-related deaths. Eleven deaths were caused by procedure-related duodenal injury with consecutive fatal peritonitis. One of the two fatal cases of hemorrhage was due to bleeding from the pancreas; the other one was caused by an injury to esophageal varicose veins due to liver cirrhosis with portal hypertension.

### Colonoscopy

The most frequent perforation site was the sigmoid colon (11 of 24 cases), with the rectum being the second most common region of perforation (n = 5).

In seven other cases, the perforation site was not described in detail or could not be determined more precisely by the autopsy. These cases are summarized under "Colon perforation without precise localization."

It appears worth mentioning that in the subtype "other diagnoses," a traumatic brain injury following a fall from the examination table is included.

## PEG

With 18 procedure-related deaths, PEGs were among the top three endoscopic procedures resulting in lethal complications. Sixteen of 18 deaths (88.8%) were caused by peritonitis after PEG placement. Two patients died from bleeding.

The 16 peritonitis cases can be subdivided into 12 misplacements and dislocations of the PEG and four infections. In the 12 misplacements/dislocations of the PEG, the PEG system leaked into the free abdominal cavity in eight cases. In the remaining four cases, there was a gastric perforation without covering into the free abdominal cavity.

In one case, the patient developed sepsis despite a properly inserted PEG probe. The reason was a purulent infection of the epidermis at the entry site, abscessing into the subcutaneous fatty tissue. Another patient developed peritonitis due to “buried bumper syndrome.”

## Upper gastrointestinal endoscopy (esophagogastroduodenoscopy)

There were six deaths after an esophagogastroduodenoscopy (EGD), four of them due to esophageal perforation. In these four cases, the ultimate causes of death were mediastinitis (n = 2), peritonitis (n = 1), and pneumonia (n = 1) due to a fistula formation between the esophagus and the right lower pulmonary lobe. In one case there was a gastric perforation with the formation of a pneumoperitoneum. One patient died due to pancreatitis after an accidental papillectomy in an intended duodenal polypectomy.

## TEE

All four TEE-related deaths were initially caused by esophageal perforation, with two of the patients ultimately dying from pneumonia (► Fig. 1), the other two succumbing to mediastinitis and a septic infection.

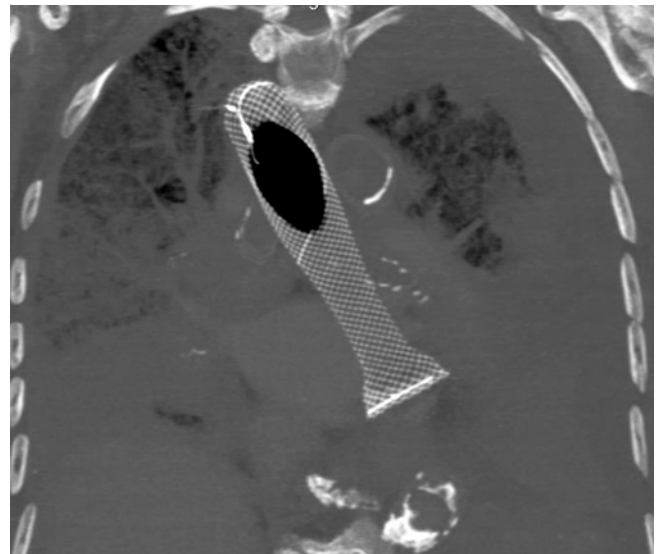
## Endoscopic ultrasound/FNA

One patient in this group died from gastric perforation caused by the endoscope. The other one from a progressive duodenal perforation with consecutive fatal peritonitis after FNA of a pancreatic head carcinoma.

## Discussion

Mortui vivos docent. What can the gastroenterologist and endoscopist learn from lethal outcomes of procedures they perform every day?

First of all, fatalities do occur. Considering the several thousand endoscopies performed every year in the region covered by the Institute for Forensic Medicine, an average of 4.3 procedure-related deaths per year does not seem to be that much. On the other hand, each death after a routine procedure considered to be safe and methodologically sound inevitably raises questions from relatives, colleagues, possibly the prosecutor – and definitely the investigator himself, often accompanied by feelings of guilt and heavy self-doubts. Similarly, from the coroner’s point of view, about four of 1000 autopsies have to be



► Fig. 1 Autopsy protocol of the Department of Forensic Medicine at the University Medical Center Hamburg-Eppendorf (Case number S1036–18). Approx. 13,5 cm long stent in the esophagus after esophageal perforation during a TEE. The patient died from pneumonia (post-mortem CT scan).

performed because something went fatally wrong in endoscopy. Looking at it from the clinician’s point of view, a recently published study identified 28 fatal endoscopic events in 146.010 gastrointestinal endoscopies over a 9-year period (procedure-related fatality rate = 0.018%), with EGDs being the most common endoscopic procedure leading to fatal outcome (n = 11) [2].

Again, let us have a closer look at the different endoscopic procedures in our post-mortem study, focusing on the ones most often responsible for a lethal outcome.

Though definitely much less performed than EGD or colonoscopy, not surprisingly in our cohort, ERCP accounted for the highest number of fatalities. ERCP-related complications happen at a constant rate, the majority being mild-to-moderately severe [3].

The most often quoted and most feared complication of ERCP, post-ERCP pancreatitis (PEP), however, somewhat surprisingly accounted for less than half of ERCP-related deaths in our cohort. According to literature, the incidence of PEP varies between 2% to 24% depending on the patient’s comorbidities, the indications for ERCP, experience and qualification of the investigator, and previously taken preventive measures [4].

A study from the United States reported on 35 autopsies after a previously performed ERCP over a 13-year period and documented 14 lethal ERCP-related outcomes in this cohort, with acute pancreatitis being the most common lethal complication (n = 7) [5].

Surprisingly, however, the second most common complication in our study was duodenal perforation with 11 fatalities, indicating that the number of deaths caused by perforation is only slightly below that of PEP. Literature quotes a perforation rate of ERCP of less than 1% [6]. Malignancy, age > 80 years,

and sphincterotomy in the pancreatic duct were identified to significantly increase lethal outcome after an ERCP-related perforation [7].

Besides papillotomy, the sometimes-difficult passage of the duodenal bulb with the side-viewing endoscope, and possibly, retroflexed pressure with the endoscope to the wall opposite of the papilla may be the relevant risk factors for this complication. Unfortunately, the autopsy protocols were not exact enough to precisely describe the location of duodenal perforation to substantiate these speculations. Thus, the investigator should not only be prepared to scrupulously apply all measures for PEP prevention but also be aware of the risk of fatal perforation, even in absolute figures twice as frequent than in the much more often performed EGD.

Based on these results, ERCP remains the endoscopic procedure with the highest risk of mortality. Current guidelines limiting ERCP to only therapeutic indications have taken this into account.

As expected, in colonoscopy, perforation was the by far most common cause of death. In literature, perforation rate vary between 0.1% and 0.2% depending on whether a diagnostic or a therapeutic colonoscopy is performed [8]. Perforation, of course, is usually not lethal if recognized and managed in time. Unfortunately, the data from our autopsy protocols were not precise enough to document the time lag between occurrence and recognition/management of perforation.

Compared to fatal perforations, fatal hemorrhage has been relatively rare in our cohort. Literature quotes a rate of colonoscopy-associated hemorrhage of 0.1% to 0.6% [9].

Naturally, both hemorrhage and perforation rates may increase up to seven times if polypectomy is performed [10]. A Danish study investigated adverse events of colonoscopy, showing that the sigmoid colon, as in our study, was the most common site of perforation from shearing force (11/24 in our study vs. 11/30), while the cecum was the most common perforated site after polypectomy (18/30) [11]. In a Dutch national colorectal cancer screening program out of 112,634 fecal immunochemical test-positive patients who underwent colonoscopy, 10 colonoscopy-associated lethal outcomes were documented, showing a colonoscopy-related mortality of 0.89 per 10.000 [12].

In summary, even in the thought-to-be-safe procedure of colonoscopy, a small but not negligible risk of a lethal outcome must be kept in mind. However, the investigator might find it difficult or even impossible to translate this message to patients, as of course, the overall benefits of a procedure such as screening colonoscopy still very much outweigh the possible risks.

PEG placement and feeding is still the most effective option for patients with a functioning digestive system and an impaired or diminished swallowing ability [13].

Depending on the definition of a complication, the complication rate for PEG varies widely from 16% to 70%. However, it is agreed that the minor complications (e.g. pneumoperitoneum or wound infection) are much more frequent than the more serious complications (e.g. necrotizing fasciitis, aspiration pneumonia or buried bumper syndrome) [14].

The incidence of a buried-bumper syndrome (a typical complication that occurs when the internal fixation device grows into the gastric mucosa) is a rare complication, reported in less than 1% [15]. Nevertheless, a buried-bumper syndrome is considered as a handling mistake due to the failure to loosen the external fixation device regularly and a lethal outcome resulting from a buried-bumper syndrome may be forensically relevant.

More than in other endoscopic procedures, complications of PEG are not only related to and caused by the intervention itself but at least the same by the postprocedural care. The relatively and somewhat surprisingly high number of fatalities in our cohort (especially considering the relatively much lower numbers of procedures compared to EGDs or colonoscopies) underscores that PEG insertion is a potentially dangerous procedure which should not be completely delegated to junior endoscopists (as it is often practiced). Furthermore, uncomplicated establishment of a PEG is largely dependent on a good communication with well-practiced nursing staff who are responsible for aftercare.

As shown by our data, infectious complications, often triggered by misplacement or handling problems, are the most relevant causes of PEG associated fatalities. A high level of scrutiny and suspicion with early detection of complications and immediate therapy are the most important requirements for prevention.

Six of 86 deaths occurred after EGD, together with colonoscopy the by far most frequently performed endoscopic investigation. Not surprisingly, five of six deaths were due to perforation, mostly in the esophagus.

Contrary to the trend reported in literature with a higher risk of perforation in therapeutic gastroscopy, four of five perforations in our cohort occurred during diagnostic gastroscopies [16].

Similar to EGD, esophageal perforation was the leading cause of death in TEE. Due to the lack of an endoscopic lens, esophageal perforations may be difficult to recognize during the TEE procedure itself, possibly leading to delayed diagnosis and treatment.

## Conclusions

In conclusion, contrary to other studies focusing on a clinician's point of view, our data show causes of endoscopy-attributed deaths in a large cohort of autopsies from the perspective of forensic medicine.

This perspective allowed analysis of a relatively high number of fatalities, stressing the important role of deaths caused by ERCP (PEP/duodenal perforation), colonoscopy (mainly perforation) and PEG (mainly infection).

However, we cannot report on figures concerning sedation, of course the most relevant other endoscopy-related risk, because this was not the focus of our data. Furthermore, the autopsy protocols were not precise enough to allow a detailed analysis of the endoscopic intervention and possibly failed or omitted therapeutic measures.

Although the analyzed endoscopic procedures are thought to be safe, it should be kept in the patient's, and especially doc-

tor's mind that fatal complications may occur during the procedure.

This study underscores the importance of proper patient education about the upcoming procedure, including perforation, bleeding, and infection with possible lethal outcome.

Given the often advanced age of patients who undergo endoscopy, preoperative staging of a patient's condition and planning of the procedure is important to avoid fatal outcomes. Every endoscopy unit and every endoscopist should have a clearly structured plan for how to prevent, diagnose and manage potentially severe and fatal complications.

Autopsy pathologists, on the other hand, must be well informed about possible complications of endoscopic interventions so that they can provide useful information to the endoscopists and families when the tragedy of a lethal outcome occurs following an intervention.

### Competing interests

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The authors declare that they have no conflict of interest.

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