

# Presence of duodenal diverticula in cadaveric study

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## SUMMARY

The duodenal diverticulum is a common entity, being the second in frequency among digestive tract and mostly asymptomatic. It could be found during endoscopic or surgical procedures, making procedures on the biliary tract more difficult. The objective of this study is to assess the prevalence of duodenal diverticula in cadaveric material and compare findings with the reviewed literature. An observational descriptive study was carried out. 70 in-situ and ex-situ duodenum-pancreatic blocks were dissected from human adult corpses previously fixed in formaldehyde solution. The presence of duodenal diverticula was studied by establishing its prevalence, number, location in relation to the duodenal parts and edges, and the relationship with the major duodenal papilla (MDP).

Regarding the prevalence, 16 (22,8%) duodenal diverticula were found in the analysed cases. These predominated in the descending part of the duodenum (D2). All of them were unique and were located on the mesenteric edge. Regarding their relationship with MDP, there was a predominance of the intradiverticular papilla. The duodenal diverticulum is a frequent entity and the prevalence reported in literature is different within each type of study (cadaveric, ERCP and CT). Our results evidence the highest prevalence

if compared to other cadaveric studies analysed. In our study, as well as in the reviewed literature, duodenal diverticula are mostly located in the D2, in relation to MDP.

**Key words:** Duodenal diverticula – Periampullary diverticula – Duodenal papilla

## INTRODUCTION

Duodenal diverticula were initially described in the 18th century by Chomen (1710) and Morgagni (1761) as a finding during cadaveric dissections, without understanding yet their clinical implications. The first reports on the living were made after 1912 in the course of surgery and duodenal radiological examinations (Gru, 1954).

Duodenal diverticula are a frequent entity, being the second in frequency among the digestive tract. Their approximate prevalence varies between 5% and 27% in cadaveric population and through endoscopic studies, knowing that they are found in lower proportion when assessed by imaging studies (Mahajan et al., 2004; Brunicardi et al., 2010; Acuña et al., 2002).

They are defined as a sacculum composed of different layers of the duodenal wall that herniate due to a parietal defect. There are two types: congenital and acquired.

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Congenital diverticula are evaginations of the duodenal wall that form during embryologic development. They are made up of all layers of duodenum.

Acquired diverticula can arise by traction (adhesions to other organs) or by propulsion (parietal weakness on the point of passage of the vessels and excretory ducts through the muscular layers). These are the most frequent and are formed by mucosa and submucosa, being predisposed to perforation (Valencia, 2014).

They are mostly asymptomatic; when symptomatic, biliopancreatic symptoms are most frequent and are related to their location, representing a challenge on their diagnosis. Most frequent complications are: obstructive jaundice, perforation, duodenal obstruction and digestive bleeding (Brinucardi et al., 2010; Mathis and Farley, 2007). Diverticula can be found during endoscopic or surgical procedures and their presence implies a more complex procedure, with greater morbidity.

The aim of this study is to search for duodenal diverticula in cadaveric material, assess their prevalence and compare our findings with the reviewed literature.

## MATERIAL AND METHODS

An observational descriptive study was carried out. It consisted in the dissection in-situ and ex-situ of 70 duodenum-pancreatic blocks from human adult corpses previously fixed in formaldehyde solution. The age of corpses was in the range from sixty-five to seventy-five years old. Systematically, we dissected the common biliary duct and any biliary pathologies found during dissection were excluded from the sample. We were not able to identify the sex of each of the samples because we did ex-situ dissections, for which we were provided just with the duodenum-pancreatic block. Therefore, our data do not allow to consider differences between males and females.

The duodenum was opened longitudinally at its free edge and the presence of duodenal diverticula was assessed.

We recorded prevalence of duodenal diverticula, number (single or multiple), location and relation to duodenal parts and to its edges (mesenteric or antimesenteric). To assess the location, the duodenum was divided in four parts as described by classic authors. We also considered superior and inferior duodenal flexure (SDF and IDF respectively).

Location of the major duodenal papilla (MDP) in relation to the duodenal diverticulum (Dd) was also recorded, describing two types: intradiverticular (MDP within the diverticulum) or juxtadiverticular (MDP near the diverticulum). Duodenal diverticula not located in the same duodenal part as the MDP were excluded from this classification.

The material used to carry out this work was donated under a written consent to the Department of Anatomy.

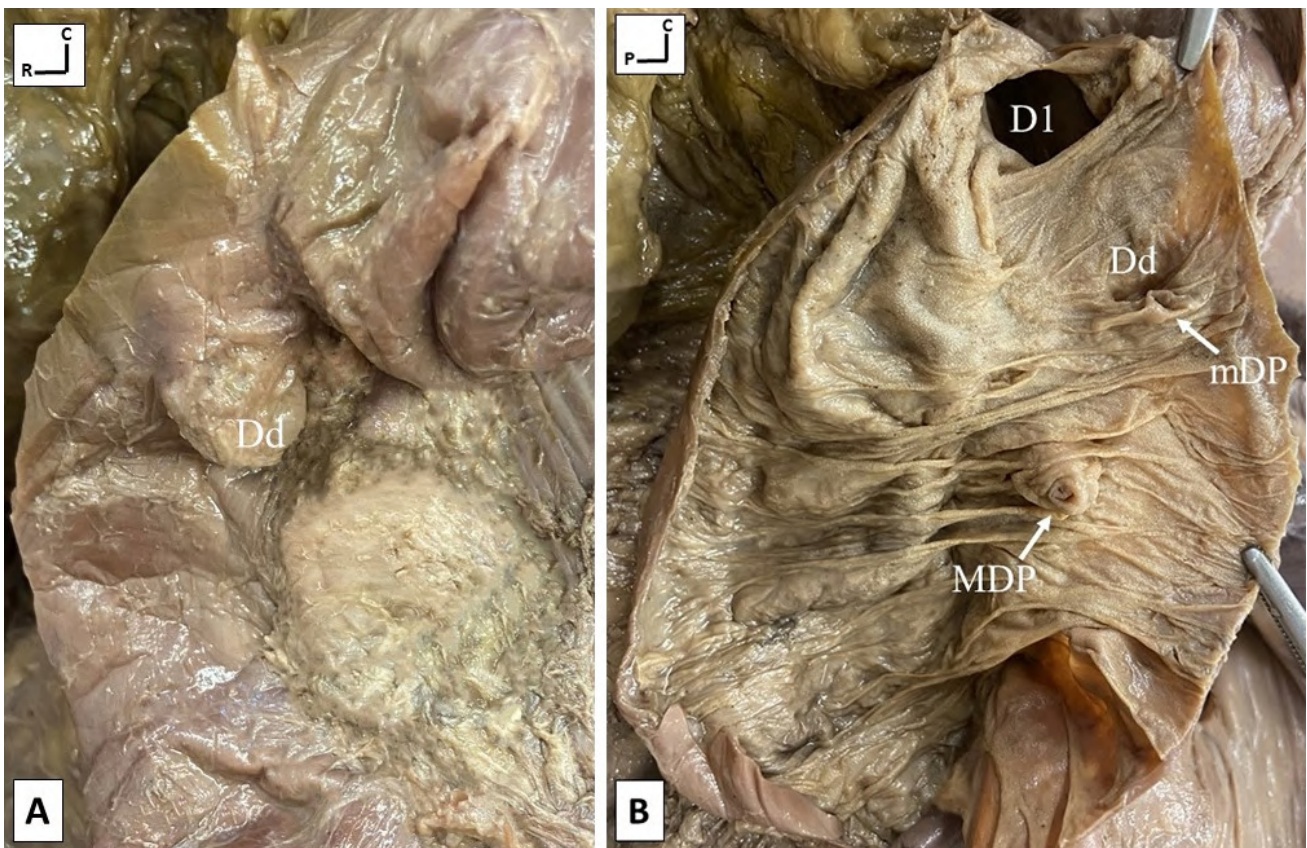
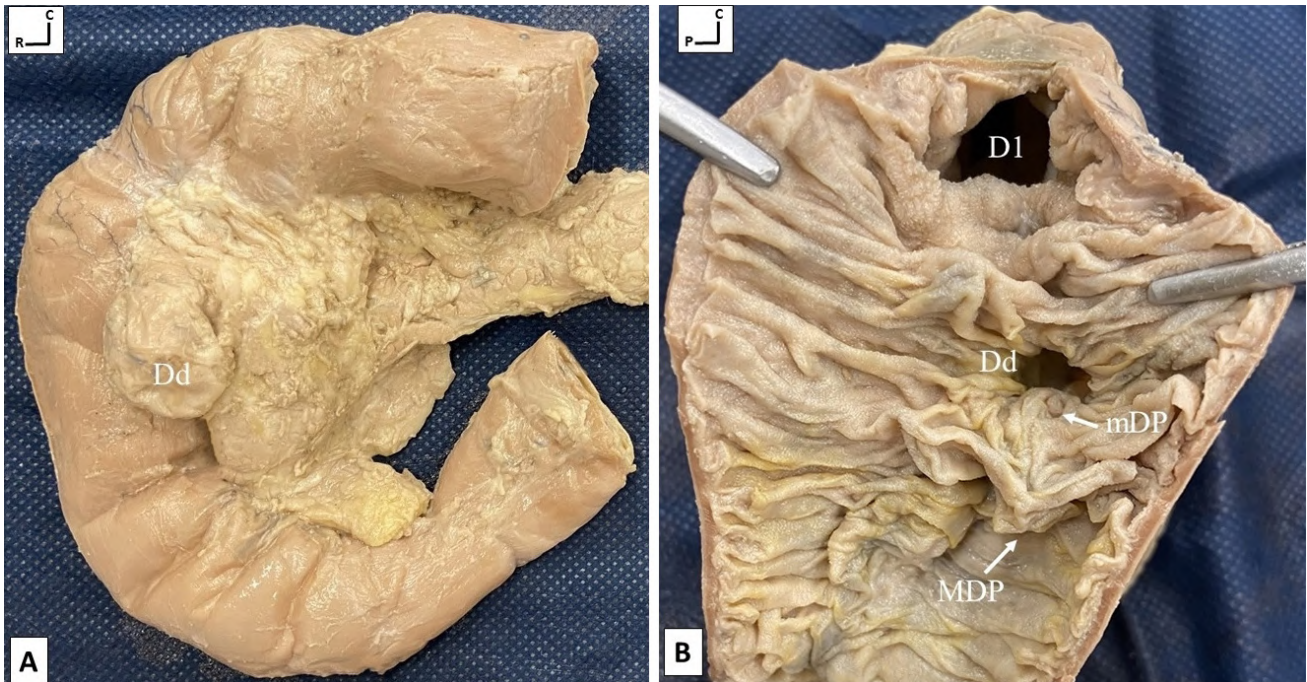
## RESULTS

We found 16 (22,8%) duodenal diverticula in the total of analysed cases (Table 1). All of them were located at the mesenteric edge, mainly in the descending part of duodenum (D2) (Figs. 1 and 2).

**Table 1.** Analysed variables and results are expressed as absolute frequency and percentual relative frequency. D2: Descending part of duodenum; IDF: Inferior duodenal flexure; D3: Horizontal part of duodenum; D4: Ascending part of duodenum; MDP: Major duodenal papilla.

VARIABLE	N = 70
Prevalence	16 (22,8%)
Unique/multiple	Unique: 100%
Location:	
<i>In relation to duodenum</i>	D2: 13 (81,25%) IDF: 1 (6,25%) D3: 1 (6,25%) D4: 1 (6,25%)
<i>In relation to duodenal edge</i>	Mesenteric edge: 100%
Location of MDP in relation to diverticula	Intradiverticular: 8 (62%) Juxtadiverticular: 5 (38%)

Of the 13 diverticula situated in D2, the MDP was located in 8 cases (62%) intradiverticular and in 5 (38%) cases juxtadiverticular.



**Figs. 1 and 2.-** Duodenum-pancreatic block. Fig. **1A** and **2A**: Anterior view of the duodenum-pancreatic block. A duodenal diverticulum is observed in the descending part of duodenum and mesenteric edge. Fig. **1B** and **2B**: Longitudinal opening of duodenum was made through the antimesenteric edge of the descending part of duodenum. Orifice of duodenal diverticulum and its relationship with major and minor duodenal papilla can be observed. Dd: Duodenal diverticulum; D1: Superior part of duodenum; MDP: Major duodenal papilla; mDP: Minor duodenal papilla.

## DISCUSSION

Prevalence of duodenal diverticula varies according to different types of studies (cadaveric, ERCP and CT), and also in each type of study (Table 2).

Regarding the prevalence of duodenal diverticula in corpses (Baldwin, 1911; Boileau, 1935; Ackermann, 1943; Poppel and Jacobson, 1956; Dowdy et al., 1962; Sakthivel et al., 2013), there are differences in the reviewed literature, our study showing the highest prevalence. Considering that prevalence increases with age (Boileau, 1935; Motta-Ramírez et al., 2010), our results may be explained because of the age of the corpses. Cadaveric studies that report the age of corpses (Baldwin, 1911; Boileau, 1935; Sakthivel et al., 2013) have a wide age range, including young subjects. This could explain their lower prevalence.

The bibliography that studies duodenal diverticula with ERCP or CT have biggest series, but also reports different prevalence.

In ERCP, the prevalence described is among 11%-38% (Acuña et al., 2002; Boix et al., 2006; Ospina Nieto, 2007; Ozogul et al., 2014;). This method is biased, because it does not evaluate the entire duodenum, so duodenal diverticula located distal from MDP may be not reported.

Concerning prevalence observed in CT studies (Wiesner et al., 2009; Motta-Ramírez et al., 2010; Rekha et al., 2016; Yilmaz et al., 2019), it is lower than the other types of studies reviewed. This can be explained because visualization of duodenal diverticula with CT is difficult, increasing diagnostic sensitivity with the use of oral and intravenous contrast (Esteban et al., 2014; Rangan and Thomas Lamont, 2020). However, using contrast does not assure their visualization (Stone et al., 1989). Stone et al. (1989) found 10 duodenal diverticula in 14 abdominal CT with oral and intravenous contrast in patients that had a previous diagnosis of duodenal diverticula with upper gastrointestinal barium examination.

In the discussed literature, most diverticula were unique (Table 3) and located predominantly in D2 (Table 4), at least half of them being juxtapapillary (Boileau, 1935; Dowdy et al., 1962; Ozogul et al., 2014; Rekha et al., 2016).

ERCP studies do not assess the entire duodenum, so this could be a bias while registering the presence of unique or multiple diverticulum and location of diverticula in the duodenum.

Concerning the location of diverticula in relation to the duodenal edge, both in the literature review (Rekha et al., 2016; Ackermann, 1943; Sakthivel et al., 2013; Skandalakis, 2013) and in our results, these were located in the mesenteric edge. Boileau

**Table 2.** Prevalence of duodenal diverticula. ERCP: Endoscopic retrograde cholangiopancreatography; CT: Computed Tomography.

Type of study	Authors (year)	Nº	Prevalence
Cadaveric	Baldwin (1911)	105	14 (13,3%)
	Boileau (1935)	133	15 (11,3%)
	Ackermann (1943)	50	11 (22%)
	Poppel (1956)	100	4 (4%)
	Dowdy (1962)	100	10 (10%)
	Sakthivel (2013)	120	5 (4,2%)
ERCP	Acuña (2002)	100	11 (11%)
	Boix (2006)	400	131 (38%)
	Ospina (2007)	508	122 (24,4%)
	Ozogul (2014)	2327	274 (11,7%)
CT	Wiesner (2009)	1010	33 (3,3%)
	Motta-Ramírez (2010)	12704	50 (0,5%)
	Rekha (2016)	565	47 (8,3%)
	Yilmaz (2019)	2910	157 (5,4%)

et al. (1935) found 1 of the 15 diverticula in the antimesenteric edge.

Regarding the location of MDP in relation to duodenal diverticula, we observed in the reviewed literature that there is a slight predominance of

juxtadiverticular MDP (Acuña et al., 2002; Boix et al., 2006; Ospina Nieto, 2007; Ozogul et al., 2014;). In contrast, our study showed a predominance of MDP located intradiverticularly (Table 1). This may have clinical implications in procedures that involve MDP.

**Table 3.** Unique or multiple diverticula reported in the reviewed literature. ERCP: Endoscopic retrograde cholangiopancreatography; CT: Computed Tomography.

Variable	Type of study	Authors	Results (%)
Unique/multiple diverticula	Cadaveric	Baldwin (1911)	Unique: 93%
			Multiple: 7%
		Ackermann (1943)	Unique: 72,7%
			Multiple: 27,3%
	ERCP	Acuña (2002)	Unique: 81,8%
			Multiple: 18,2%
		Ospina (2007)	Unique: 83%
			Multiple: 17%
	CT	Motta-Ramírez (2010)	Unique: 86%
			Multiple: 14%
Rekha (2016)		Unique: 89,3%	
		Multiple: 10,7%	

**Table 4.** Location of duodenal diverticula. ERCP: Endoscopic retrograde cholangiopancreatography; CT: Computed Tomography. SDF: Superior duodenal flexure; D2: Descending part of duodenum; IFD: Inferior duodenal flexure; D3: Horizontal part of duodenum; D4: Ascending part of duodenum.

Type of study	Authors	Nº of diverticula	Location
Cadaveric	Baldwin (1911)	15 (14 specimens)	D2: 9 (60%)
			D3: 5 (33,3%)
			D4: 1 (6,7%)
	Boileau (1935)	20 (15 specimens)	SDF: 1 (5%)
			D2: 14 (70%)
			IDF: 2 (10%)
			D3: 3 (15%)
	Ackermann (1943)	14 (11 specimens)	D2: 5 (35,7%)
			IFD: 1 (7,1%)
			D3: 5 (35,7%)
D4: 3 (21,5%)			
Dowdy (1962)	10	D2: 10 (100%)	
Sakthivel (2013)	5	D2: 3 (60%)	
		D3: 2 (40%)	
ERCP	Acuña (2002)	11	D2: 11 (100%)
	Ozogul (2014)	274	D2: 274 (100%)
CT	Rekha (2016)	52 (47 patients)	D2: 47 (90,4%)
			D3: 5 (9,6%)

We highlight that we found 2 duodenal diverticula in relation to minor duodenal papilla which were located on the edge of the diverticulum (Figs. 1B and 2B). Baldwin (1911) also found in 1 specimen 2 diverticula in relation to minor duodenal papilla.

As for the limitations, we were not able to identify the sex of each of the samples, and our data do not allow to consider differences between both sex. We emphasize that greater series have been made in living subjects, with the bias that ERCP and CT have, previously commented.

## CONCLUSIONS

Duodenal diverticula are a frequent entity. Prevalence differs according to different types of studies (cadaveric, ERCP and CT). Our results evidence the highest prevalence compared to cadaveric studies reviewed. In our study, as well as in the reviewed literature, they are mostly located in D2 in relation to MDP, with a similar distribution of intradiverticular/juxtapapillary MDP.

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