Major Duodenal Papilla and Its Normal Anatomy

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Ampulla · Major duodenal papilla · Papilla of Vater · Sphincter of Oddi

Abstract
The major duodenal papilla (papilla of Vater) is the point where the dilated junction of the bile and pancreatic ducts (ampulla of Vater) enter the duodenum. The ampulla is surrounded by the sphincter of Oddi, which not only controls the flow of bile and pancreatic juice into the duodenum, but also prevents the reflux of duodenal contents, bile and pancreatic juice into the bile and pancreatic ducts.

Gross Anatomy of the Major Duodenal Papilla

The major duodenal papilla is a slight elevation on the duodenal mucosa when observed through the lumen. It is usually located about 8 cm distal to the pylorus inside the descending limb of the duodenum [1]. According to the discussion of Lindner et al. [2] regarding the course of the common bile duct into the duodenum in 1,000 patients, the major duodenal papilla is mainly located in the descending part of the duodenum (82%), and occasionally in the transition between the descending duodenum and horizontal (12%) part or in the horizontal part (6%). When the major duodenal papilla is located in the horizontal part of the duodenum, the lower bile duct runs vertically. The major duodenal papilla projects <1 cm into the duodenum, although it varies among individuals [1].

When observed through an endoscope, the major duodenal papilla is a hemispherical or oval elevation. A circular fold at the oral side, called the hooding fold, often covers the duodenal papilla. A diagonally running long oral protrusion similar to a long mucous membrane is also located at the oral side, and the circular fold covers the elevated tissue at the oral side. A similar fold, called the frenulum, runs vertically at the anal side of the major duodenal papilla. If the major duodenal papilla is hidden under the duodenum, these vertical folds give a good in-
dication of its location during endoscopy. The longitudinal fold sometimes includes those at the oral side as well as the frenulum. A duodenal papilla sometimes does not have such folds and frenula. Intra- or peri-diverticular papillae are often located in the area of the major duodenal papilla.

Anatomic Variations in Pancreatic and Biliary Ducts at the Major Papilla

Pancreatic and bile ducts are located at the duodenal papilla along with the choledochal duct and about 70% of them form an ampulla [1]. The apertures of pancreatic and bile ducts can be classified as follows: multiple duodenal papillae in which the pancreatic and bile ducts are clearly separated, those that are joined to form a partition, and those that form a common duct. Multiple duodenal papillae are very rare and require a differential diagnosis from secondary choledochoduodenal fistula. The bile duct orifice is always located at the upper left of the pancreatic duct (or duct of Wirsung) orifice. Autopsy studies have revealed that 55–86% of individuals have a common duct (table 1) [1, 3–9].

Dowdy et al. [1] reported that the length of the common duct is 1–12 mm, and that 35% are <3 and >5 mm long, respectively, with an average length of 4.4 mm. The diameter of the common duct is 1–4 mm, with an average of 2.6 mm. Rienhoff and Rickrell [5] found that the length of the common duct was <2 mm in 92 (53%) of 173 patients, 3–5 mm in 62 and >6 mm in 19. The length of the common duct is influenced by the angle of the common duct into the duodenum wall. In a prospective study on the opening patterns of pancreatic and bile ducts in 354 patients treated with endoscopic retrograde cholangiopancreatography, the bile and pancreatic ducts were clearly separated in only 25 patients.

By contrast, using an indwelling cannula in the major duodenal papilla both the pancreatic duct and the bile

<table>
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<th>First author</th>
<th>No fusion %</th>
<th>Short common channel %</th>
<th>Long common channel %</th>
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<td>Dowdy [1]</td>
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<td>Dawson [6]</td>
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<td>Suda [7]</td>
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<td>Millbourn [9]</td>
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<td>Kamisawa [10]</td>
<td>7</td>
<td>56</td>
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No fusion = Pancreatic and bile ducts have not fused into one duodenal papilla; short common channel = pancreatic and bile ducts join to form a partition immediately below the duodenal papilla; long common channel = common tube is obvious.

Anatomy of the Major Duodenal Papilla

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duct were visualized in only 131 patients [10]. Therefore, the presence and length of a common duct are closely associated with the symptoms of reflux of pancreatic juice into the biliary tract [11].

**Normal Anatomy and Histopathology of the Major Duodenal Papilla**

Obviously, the mucosae of the duodenal papilla and common duct consist of different papillary structures and the elevation of the duct from the duodenal mucosa along with smooth muscle. A proptosis from the mucous membrane, termed papillary fold, in the lumen of the duodenal papilla prevents the reflux of duodenal contents. This fold develops in the area between the common duct and the bile duct of the duodenal papilla (fig. 1). The duodenal papilla lacks muscularis mucosae and a submucosal layer like the gallbladder and bile duct. The SO consists of a thin smooth muscle and is located at the distal end of the pancreatic and bile ducts. The SO muscle acts independently of the muscularis propria of the duodenum, and most of it is distributed under the mucous membrane from the unique muscle layer, although variations exist according to Suda et al. [7].

Boyden [12] divided the SO roughly into the sphincter choledochus, the sphincter pancreaticus and the sphincter ampullae. According to Suda et al. [7], the sphincter choledochus is best developed and regulates the outflow of bile and prevents free communication between the bile and pancreatic ducts.

In pancreaticobiliary maljunction defined as a junction of pancreatic and bile ducts located outside the duodenal wall, the action of SO does not functionally affect the junction, and two-way regurgitation occurs. Since the pressure is generally higher in the pancreatic duct than in the bile duct, reflux of pancreatic juice occurs [11].

**Vascular Supply of the Duodenal Papilla**

The plexus of arteries of the duodenal papilla mostly comprises those in the stomach and back sides that are separated from the duodenal artery (53%); 25% arise from the back side and 8% from the stomach side. Another 8% arise mainly from the back (25%). The average length from the opening of the duodenal papilla to the duodenal artery is 36.5 mm, and in 5% of patients, it runs within the endoscopic sphincterotomy (EST). Maximum diameter of the arteries of the plexus is 1.6 mm (average: 1 mm) and the risk of hemorrhage of the duodenal papilla due to EST is very low, but may be increased in the week following EST [13].

**Innervation of the Biliary Tract**

The biliary tree is basically controlled by the autonomic nervous system and the celiac ganglion and vagal nerve, which are parts of the sympathetic and parasympathetic nervous systems, respectively. A nerve that branches from the hepatic nerve plexus formed by the sympathetic and vagal nerves is distributed to the gallbladder, bile duct and duodenal papilla and controls the biliary tree. A nerve branch from the superior mesenteric plexus derives from the pancreatic nerve plexus in the nervous system that controls the lower side of the bile duct and duodenal papilla.

**SO Function in the Duodenal Papilla**

The basic SO pressure is 4–5 mg Hg higher than that of the bile duct. The SO controls the flow of bile from the bile duct into the duodenum and egests bile into the duodenum by peristaltic contraction. The flow of bile is affected by the total volume of bile secreted by the liver, gallbladder contraction and SO pressure. Moreover, the SO prevents the reflux of duodenal and pancreatic juice as well as bile into the cystic and pancreatic ducts [1]. Cholangiography can visualize the movement of the sphincter peristalsis. First the upper part, the sphincter choledochus, opens from above downwards, the contrast enters the ampulla. Then the sphincter choledochus contracts, again from above downwards, isolating a small portion of contrast in the ampulla. The distal sphincter opens and the systolic volume falls into the duodenum (opening phase). Thereafter the sphincter contracts again, this time from below upwards – an antiperistaltic movement. First the distal sphincter is closed, flowed by the sphincter choledochus. When the contraction is complete, no contrast is seen in the intramural part and the contracted muscle produces a convex stop of the contrast in the lower common duct (closing phase) [14].
References


