Review article

Sphincter of Oddi Dysfunction

K. K. Maudar*

Abstract
Sphincter of Oddi dysfunction (SOD) manifests with biliary and or pancreatic pain with or without cholecystectomy. Modern diagnostic techniques and various modalities of management have greatly improved the results of treatment of SOD. This review article presents the current diagnostic and therapeutic approach to the management of SOD.

Key Words
Sphincter of Oddi dysfunction.

Introduction
Sphincter of Oddi Dysfunction (SOD) is a clinical syndrome characterised by biliary type of pain or pancreatic type of pain. It is believed to be caused by mechanical or functional abnormalities of Sphincter of Oddi (SO). SOD has been described by a multitude of terms like biliary spasm, papillary stenosis, sclerosing papillitis, biliary dyskinesia and postcholecystectomy syndrome. Broadly, two types of SOD are described as SO stenosis and SO dyskinesia due to anatomical and functional abnormalities respectively (1-2).

Functional Anatomy of SO
Musculature: SO was described by Oddi in 1887 as a circular and longitudinal muscle controlling flow of bile into the duodenum. It consists of a common sphincter - 6 mm in length, composed of thick, circular, semi-circular, and longitudinal fibres with numerous glands; common bile duct (CBD) sphincter - 10 mm in length; and specific sphincter of the pancreatic duct - 6 mm in length. SO is divided into three zones: (a) a superior occlusive sphincter; (b) a middle sphincter which can be dilated; and (c) an inferior sphincter, which is around the papilla. This sphincteric complex is situated in the duodenal window (3).

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Fig. 2: Microphotograph showing intramural part of CBD and PD with their independent sphincter musculature.

Fig. 3: Microphotograph showing a common sphincter musculature at the duodenal window.

Fig. 4: Microphotograph showing longitudinal and circular muscle fibres of sphincter of Oddi with abundant nerve fibres and ganglia.

Fig. 5: Microphotograph showing sphincter of Oddi musculature, sclerosis, inflammatory cells, centrifugal proliferation of mucous glands and heterotopia.

**Neural Control Mechanism**
SO is innervated by postganglionic fibres from the coeliac ganglion and preganglionic parasympathetic fibres from the vagus nerve. (4). In addition, SO contains neurotransmitters like nitric oxide (NO), substance P, and gastrin releasing peptide. (5). NO is non-adrenergic and non-cholinergic transmitter in the SO. Inhibition of NO synthase increases SO motility. (6). In guinea pig SO, interstitial cells of Cajal (ICC) are believed to be responsible for spontaneous activity of SO. Receptors for acetylcholine, tachykinins, vasoactive intestinal polypeptide, adenosine triphosphatase and NO are located on ICC in guinea-pig generate spontaneous activity in the gut (7). SO as pump under low pressure (< 3 mm Hg) and as resistor at higher pressure (> 3.5 mm Hg) in CBD has been demonstrated in animal experiments. (8).

**Pathophysiology**
SOD is generally caused by biliopancreatic disease. SO is damaged by gall stones, fibrosis, bile stasis and non-functioning gall bladder. About 20% of patients complain of abdominal pain after cholecystectomy. Endoscopic retrograde cholangiopancreatography (ERCP) in such patient may reveal stenosis of SO. SO dyskinesia is a functional disturbance of the SO, resulting in intermittent biliary or pancreatic obstruction. Spasm of the sphincter induced by various pharmacologic agents that affect smooth muscle function has been hypothesized as the mechanism of dyskinesia. (9-11).

**Clinical Presentation and Investigations**
Patients who present with biliary SO dysfunction typically experience severe, recurrent biliary type of pain often 4-5 years after
cholecystectomy, and are mostly female. Pancreatic SO dysfunction presents as recurrent episodes of pancreatitis without an obvious cause, and these patients are often given the diagnostic label of idiopathic recurrent pancreatitis. Similar to the patients with biliary SO dysfunction the majority of these patients are female. Cholecystectomy is often performed as an empirical treatment for pancreatitis on the assumption or demonstration of microlithiasis, however despite this the episodes of recurrent pancreatitis persist. (12-14).

The patients with SOD are classified as per criteria proposed by Hogan and Geenen. (Table I and II). Findings of dilated CBD after cholecystectomy, increase in diameter of CBD following fatty meals test or cholecystokinin octapeptide administration and paradoxical increase in diameter of CBD more than 2 mm indicate SOD. Rome III criteria for the diagnosis of functional SOD, functional pancreatic sphincter and functional gallbladder disorders are proposed based on the expert consensus. (15-18). These criteria are essential indications for ERCP and other invasive procedures.

<table>
<thead>
<tr>
<th>Table 1. Milwaukee Biliary Group Classification (Hogan-Geenen classification) of biliary SOD (17)</th>
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<tr>
<td><strong>Type I (Biliary stenosis)</strong></td>
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<tr>
<td>Biliary-type pain</td>
</tr>
<tr>
<td>Abnormal liver function tests (&gt; 2 times normal)</td>
</tr>
<tr>
<td>Dilated common bile duct &gt; 12 mm</td>
</tr>
<tr>
<td>Delayed drainage of ERCP contrast &gt; 45 minutes</td>
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</table>

| **Type II** |
| Biliary-type pain and 1 or 2 of the following : |
| Abnormal liver function tests (> 2 times normal) |
| Dilated common bile duct > 12 mm |
| Delayed drainage of ERCP contrast > 45 minutes |

| **Type III** |
| Biliary-type pain only |

**Non-invasive Investigations of SOD** have very low specificity and sensitivity. Ultrasound (US) abdomen is diagnostic in 3-4% of cases. However, fatty meal US abdomen is more specific and useful investigation. Pancreatic duct is well delineated by abdominal US in 55% - 99% of the patients but it has limited value in acute pancreatitis. However, secretin-stimulated
endoscopic ultrasound (EUS) is more useful modality of investigation of SOD. Scintigraphy poorly correlates with SO manometry (SOM) in confirming SOD. It has sensitivity of 25%-38%, specificity of 86% - 89%, positive predictive value of 40% - 60% and negative predictive value of 75% - 79% (19-21).

In biliary group the stenosis is in the biliary sphincter and for the pancreatic group it is either in both biliary and pancreatic sphincter or only in the pancreatic sphincter. Prospective studies have demonstrated the effectiveness of sphincterotomy in patients with elevated SO basal pressure (bile and/or pancreatic duct) with excellent long-term relief of symptoms in over 90% of patients with SO dysfunction of acute pancreatitis. (22).

SO Manometry carries a complication rate of pancreatitis of 3-30%. Functional study in guinea-pig SO revealed that fluid perfusion into the SO increases SO pressure which activates an intrasphincteric reflex to induce SO spasm. SO spasm can lead to acute pancreatitis. (23,24).

**Provocative Tests**

Fatty meal US, cholecystokinin, secretin and morphine-prostigmine provocative tests reproduce biliary or pancreatic pain, increase in pancreatic enzymes, dilatation of CBD by 2 mm or dilatation of pancreatic duct by 1.5 mm in patients with SOD. Positive morphine neostigmine test, pain induced by injection of contrast material at ERCP and delayed drainage of contrast material predict better results with sphincterotomy. SOM is the most sensitive and specific invasive investigation for the diagnosis of SOD. However, secretin MRC is evolving as noninvasive investigation for SOD. It is morphologic-functional test for studying the dynamic anatomy of SO. The accuracy of this test is comparable with SOM. The stimulation of pancreatic secretion during EUS improves dynamic imaging of pancreatic duct. Thus, the improved resolution of EUS provides more accurate examination of SO and predict benefit of sphincterotomy. (25-27).
Treatment
Stenting of biliary and pancreatic ducts carries high rate of morbidity due to stent induced pancreatitis. Moreover, it does not provide complete relief of symptoms. Endoscopic sphincterotomy and surgical sphincteroplasty and transampullary septectomy are currently recommended procedures. Transduodenal sphinctroplasty with or without transampullary septectomy is the procedure of choice for SOD diagnosed on SOM. However, 12% - 39% poor results in endoscopic sphinctectomy and 7% - 35% poor results following surgical sphincteroplasty are reported. Therefore, selection of patients for these procedure is mandatory. Relief of symptoms is reported in 90% of cases with biliary type of pain with raised basal pressure, following sphincterotomy.

Hypertensive pancreatic portion of SO carries high risk of pancreatitis following ERCP and sphincterotomy. Therefore, stenting of hypertensive pancreatic duct segment is useful after biliary sphinctectomy for SOD. (28-30).

A methodical approach to the management of postcholecystectomy pain is described in the flowcharts 1, 2.

FLOW CHARTS

1. POSTCHOLECYSTECTOMY PAIN

MANAGEMENT DEPENDS ON

LFTs

CBD STATE

ABNORMAL LFTs

DILATED CBD

A

ABNORMAL LFTs

OR

DILATED CBD

B

NORMAL LFTs

AND

NORMAL CBD

C
A. ABNORMAL LFTs AND DILATED CBD

ABNORMAL LFTs AND DILATED CBD
| ERCP
| STONE IN CBD OR BILE DUCT STRICTURE
| NO STONE OR STRICTURE
| TREAT
| DRAINAGE OF CONTRAST
| >15 MINUTES < 15 MINUTES
| SPHINCTEROTOMY MANOMETRY
| BASAL PRESSURE >40 MM Hg 
| < 40 mm Hg
| NIFEDIPINE OR NITRATES

B. ABNORMAL LFTs OR DILATED CBD

ABNORMAL LFTs OR DILATED CBD
| ERCP
| STONE IN CBD OR BILE DUCT STRICTURE
| NO STONE OR STRICTURE
| TREAT MANOMETRY
| BASAL PRESSURE > 40 mm Hg
| < 40 mm Hg
| SPHINCTEROTOMY
| NIFEDIPINE OR NITRATES
C. NORMAL LFTs AND NORMAL CBD

NORMAL LFTs
AND
NORMAL CBD
EVALUATE FOR OTHER CAUSES

<table>
<thead>
<tr>
<th>CAUSE FOUND</th>
<th>NO CAUSE FOUND</th>
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<tbody>
<tr>
<td>TREAT</td>
<td>TREAT</td>
</tr>
<tr>
<td>SYMPTOMATICALLY FOR FUNCTIONAL BOWEL DISEASE</td>
<td></td>
</tr>
<tr>
<td>IMPROVEMENT</td>
<td>NO IMPROVEMENT</td>
</tr>
<tr>
<td>STOP</td>
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<tr>
<td>BASAL PRESSURE &gt;40 mm Hg</td>
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<tr>
<td>SPHINCTEROTOMY</td>
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<tr>
<td>NIFDIPINE</td>
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<tr>
<td>OF NITRATES</td>
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<tr>
<td>BASAL PRESSURE &lt;40 mm Hg</td>
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</tr>
<tr>
<td>BILIARY ETOLOGY</td>
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Conclusion

SO functions under a complex neuroendocrinal control. SOD is caused by either organic obstruction or functional abnormality of SO. Current application of SOM for investigativaton and evaluation of SOD has been improved considerably. Endoscopic sphincterotomy or surgical sphinctertoplasty as guided by SOM is the procedure of choice for the successful management of SOD.

References

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