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EDITORIAL

Endoscopic ultrasound-guided pancreatic fluid collection drainage: Where are we?

Anupam Kumar Singh, Manish Manrai, Rakesh Kochhar

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Anupam Kumar Singh, Department of Gastroenterology, Postgraduate Institute of Medical Education and Research, Chandigarh 160012, India

Manish Manrai, Department of Gastroenterology, Command Hospital, Lucknow 226002, India

Rakesh Kochhar, Department of Gastroenterology, Paras Hospital, Panchkula 134109, India

Corresponding author: Manish Manrai, FRCPE, MBBS, MD, Professor, Department of Gastroenterology, Command Hospital, Lucknow Cantt, Lucknow 226002, India. manishmanrai@yahoo.com

Abstract

Pancreatic fluid collections (PFCs) result from injury to the pancreas from acute or chronic pancreatitis, surgery, or trauma. Management of these collections has evolved over the last 2 decades. The choice of interventions includes percutaneous, endoscopic, minimally invasive surgery, or a combined approach. Endoscopic drainage is the drainage of PFCs by creating an artificial communication between the collection and gastrointestinal lumen that is maintained by placing a stent across the fistulous tract. In this editorial, we endeavored to update the current status of endoscopic ultrasound-guided drainage of PFCs.

Key Words: Pancreatic fluid collections; Endoscopic ultrasound-guided drainage; Endoscopic necrosectomy; Lumen apposing metal stent; Review

Core Tip: Pancreatic fluid collections can be challenging to manage during acute or chronic pancreatitis. In the presence of established indications of drainage, especially infected collections, the modalities include per-cutaneous, endoscopic, minimally invasive surgery, or a combined approach. There has been a subtle shift towards endoscopic drainage as the emerging modality in certain situations. We highlighted the methodology and complications of this modality of therapy for drainage of pancreatic fluid collections.

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INTRODUCTION

Pancreatic fluid collections (PFCs) result from injury to the pancreas from acute or chronic pancreatitis, surgery, or trauma. Management of these collections has evolved over the last 2 decades. The interventional armamentarium for tackling these collections includes percutaneous, endoscopic, minimally invasive, or a combined approach[1-3]. Despite the availability of multiple drainage routes, no single route or approach is perfect and the choice depends upon multiple factors including duration of disease, clinical condition of the patient, anatomical ease of access to the collection, and the available expertise in the house.

Endoscopic drainage of PFCs is accomplished by creating an artificial communication between the collection and gastrointestinal lumen. This communication is maintained by placing a stent across the fistulous tract. With technical advancements, endoscopic internal drainage is preferred for its lower risk of secondary infection of PFC and eliminated risk of external pancreatic fistulas[4]. However, these benefits come in exchange for potential risks associated with anesthesia required during the procedure. In this editorial, we summarized the current status of endoscopic drainage of PFCs.

INDICATIONS OF DRAINAGE OF PFC

Most PFCs are asymptomatic and do not require any invasive intervention. The classic indications of drainage include infected collections, clinical worsening, or pressure symptoms[5]. Table 1 elaborates the indications of drainage of PFCs in patients with pancreatitis.

During acute pancreatitis, these collections can be drained with a percutaneous or endoscopic approach, taking into consideration factors like clinical condition of the patient, the anatomy of the collection, and the availability of expertise. When the patients are clinically stable and collections are well-defined, these are preferably drained *via* an endoscopic approach.

TIMING OF DRAINAGE OF PFC

The exact time frame of endoscopic drainage remains a matter under investigation. Most of the guidelines and experts suggest that collections with a well-defined wall (> 4 wk from the onset of disease) should be drained by an endoscopic approach[5,6]. However recent studies have shown that early endoscopic drainage for (peri-)pancreatic collections can be performed safely with a similar outcome as delayed drainage. Trikudanathan *et al*[7] showed that endoscopic drainage of necrotic collections within 4 wk of disease onset is an acceptable strategy for stable patients. Similarly, Oblizajek *et al*[8] and Chantarojanasiri *et al*[9] demonstrated the safety and effectiveness of endoscopic drainage for (peri-)pancreatic collections in the initial 3-4 wk of illness.

Ramai *et al*[10] in a meta-analysis included six studies and showed similar technical and clinical success for endoscopic drainage performed early (< 4 wk) or delayed (≥ 4 wk). The study noted similar rates of adverse events in both groups. Recently, Shah *et al*[11] compared the outcomes in a large series of 101 patients. They noted that early drainage required higher endoscopic necrosectomy (57.1% *vs* 27.3%; P = 0.003) and percutaneous drainage (31.4% *vs* 12.1%; P = 0.018) with similar procedure-related complication rates. The authors also noted that early endoscopic drainage could be performed even in patients with incompletely walled-off collections.

These recent studies have shown encouraging results regarding the safety of early endoscopic drainage. It is noteworthy that most of these early endoscopic drainages were performed in clinically stable patients with a single or no organ failure. Additionally, a subset of these patients also required percutaneous drainage. Thus, a generalized approach to endoscopic drainage cannot be recommended at present. In a selected group of patients requiring drainage of collections and hemodynamic stability, early endoscopic drainage can be considered. More studies are needed before a clear preference for early endoscopic drainage can be recommended.

STEPS OF ENDOSCOPIC ULTRASOUND-GUIDED DRAINAGE

The pre-procedure checklist includes a review of indications of drainage and imaging. Imaging assessment can be done with contrast-enhanced computed tomography or magnetic resonance imaging. Pre-procedure imaging assesses the adequacy of wall encapsulation and gives an idea of the appropriate site of puncture, *i.e.* stomach or duodenum. Additionally, magnetic resonance imaging tells the amount of liquid and solid content of the collections. Immediately

Table 1 Indications of drainage of pancreatic fluid collections[3]

Indication	Description
Clinical suspicion or documented infected pancreatic collection	
Persistent or new onset organ failure	
Pressure symptoms	Gastric outlet obstruction; intestinal obstruction; biliary obstruction; persistent symptoms (*e.g.*, pain, "persistent unwellness"); and disconnected pancreatic duct (*i.e.* full transection of the pancreatic duct) with ongoing symptoms
Other relative indications	Persistently increasing size on follow-up; and poor appetite secondary to collection

before the procedure, an endoscopic ultrasound (EUS) assessment for vessel-free approach, proper puncture site, and location should be done. The procedure should be performed in a left lateral position under conscious sedation in a fluoroscopy-equipped endoscopy unit. Intubation should be considered in patients with large collections, acute lung injury, and old age to prevent the risk of aspiration. Proper drainage sites should be identified with a linear array EUS. The use of real-time color Doppler at the puncture site avoids the risk of vessel injury.

With advancements in endoscopic accessories, several modifications have been described. We will describe the standard approach in detail with modifications as suggested (Figure 1). In the standard approach, the PFC is first punctured with a 19-gauge aspiration needle. The needle stylet is then removed, and 5-10 mL of cyst fluid is aspirated to confirm the position and for biochemical analysis of the fluid. In cases of hemorrhagic aspirate, inadvertent vessel injury or a preexisting pseudoaneurysm should be ruled out with cross-sectional imaging before proceeding further. After puncturing the cyst, an endoscopic retrograde cholangiopancreatography guidewire (0.025-0.035 inches) is inserted through the needle under fluoroscopic guidelines. The guidewire should be coiled two to three times into the cavity. The needle is then removed carefully, maintaining the position of the guidewire in the cavity. During this exchange, the EUS position of the puncture site should be maintained. The fistula tract is then dilated with electrocautery or a balloon dilator over the guidewire. When the self-expanding metal stent placement is planned, the fistulous tract can be dilated with an 8.5 Fr cystotome directly or sequentially with a 6 Fr cystotome followed by a 4 mm balloon.

The metal stent is then deployed over the guidewire. The distal flange is then opened under EUS and fluoroscopic vision. Once the distal flange is opened and confirmed, the proximal end is deployed in two ways. In the first method, the endoscopic vision is established, and the proximal end is deployed under vision after identifying the endoscopic marker. In the second method, the proximal end is deployed inside the EUS scope channel and pushed outside under endoscopic vision[12]. The fluid can be seen coming out through the stent. Placement of a plastic stent requires a larger balloon dilation of 10-12 mm. Obliteration of the waist during the balloon dilation ensures adequate dilation. After tract dilation, a second guidewire can be placed with re-cannulation with sphincterotome/cannula and guidewire or using a wide bore catheter over the first guidewire. The use of wide-bore catheters has the benefit of preventing inadvertent loss of the fistulous tract. Over the first guidewire, a 7 Fr double pigtail (DPT) plastic stent is placed under fluoroscopy and endoscopic vision. Over the second guidewire, another DPT stent or a nasocystic tube is placed.

The availability of cautery-enhanced metal stents, *i.e.* Hot-axios, Hot-spaxus, and Hot-Nagi, makes this procedure even easier[13]. These accessories avoid the cumbersome step of tract dilation and save time. Furthermore, these accessories can be used with a free-hand technique by directly puncturing the cyst and avoiding the initial step of needle puncture and guidewire placement. In expert hands, these newer lumen-apposing metal stents (LAMS) can be placed even without the need for fluoroscopy[12].

WHICH STENT TO CHOOSE: PLASTIC OR METAL OR BOTH?

Endoscopic drainage of PFCs could be performed with either DPT plastic stents or metal stents. Metal stents can be divided into two types: Biflanged metallic stents or LAMS. Table 2 describes the available metal stents for drainage of PFCs. Historically, plastic stents formed the backbone of endoscopic drainage. However, their placement is demanding and time-consuming, especially when multiple stents are required. The placement of metal stents for such collections saves time and ensures a much broader fistula for drainage. The wider tract provides a more effective way of drainage compared to multiple plastic stents when solid content is present. It also allows the endoscope to access the collection to perform direct endoscopic necrosectomy (DEN). Table 3 enumerates the benefits and limitations of both plastic and metal stents.

For the pseudocysts that have homogeneously hypoechoic fluid without a significant amount of solid content, a metal stent does not provide any benefit except for less procedure time. The longer indwelling of DPT plastic stents could reduce the risk of recurrence in cases of pancreatic duct leak and should be preferred. However, the case is not similar for walled-off necrosis (WON). Both retrospective and observational studies have suggested that metal stents perform better than plastic stents for draining WON[14-17]. However, recent observational studies suggest similar clinical success with both plastic and metal stents[18-20]. Three randomized controlled trials also showed similar clinical efficacy with multiple plastic and metal stents for WON[21-23]. Table 4 summarizes the studies on the outcome of endoscopic drainage with plastic and metal stents. A meta-analysis also concluded no difference in clinical success and adverse events between LAMS and multiple plastic stents for symptomatic WON[24]. The equivocal data and higher complications due to metal

Table 2 Technical specifications of the available metal stents used for endoscopic drainage

Stent	Company	Lumen diameter, mm	Length of stent, cm	Deployment sheath diameter, Fr
Hot Axios	Boston Scientific, MA, United States	6/8/10/15/20	1-3	9.0/10.8
Niti-S Hot Spaxus	Taewoong Medical, South Korea	8/10/16	2	10.0
Niti-S Hot Nagi	Taewoong Medical, South Korea	10/12/14/16	1-3	10.0
Niti-S Nagi	Taewoong Medical, South Korea	10/12/14/16	1-3	10.0

Table 3 Advantages and disadvantages of metal and plastic stents for drainage of pancreatic fluid collections

Circumstance	LAMS/biflanged metal stent	Plastic stent
Advantage	One-step procedure	Low cost
	Short procedure time	No need for removal
	No need for fluoroscopy guidance	Prevents the recurrence of pseudocyst in pancreatic leak when left indefinitely
	Rapid access into the cavity with easy treatment of complications	
Disadvantage	Higher cost	Multi-step procedure
	Needs removal (in all) and replacement with plastic stent (in selective cases)	Longer procedure time
		Need for fluoroscopy guidance
		High migration rate

LAMS: Lumen-apposing metal stent.

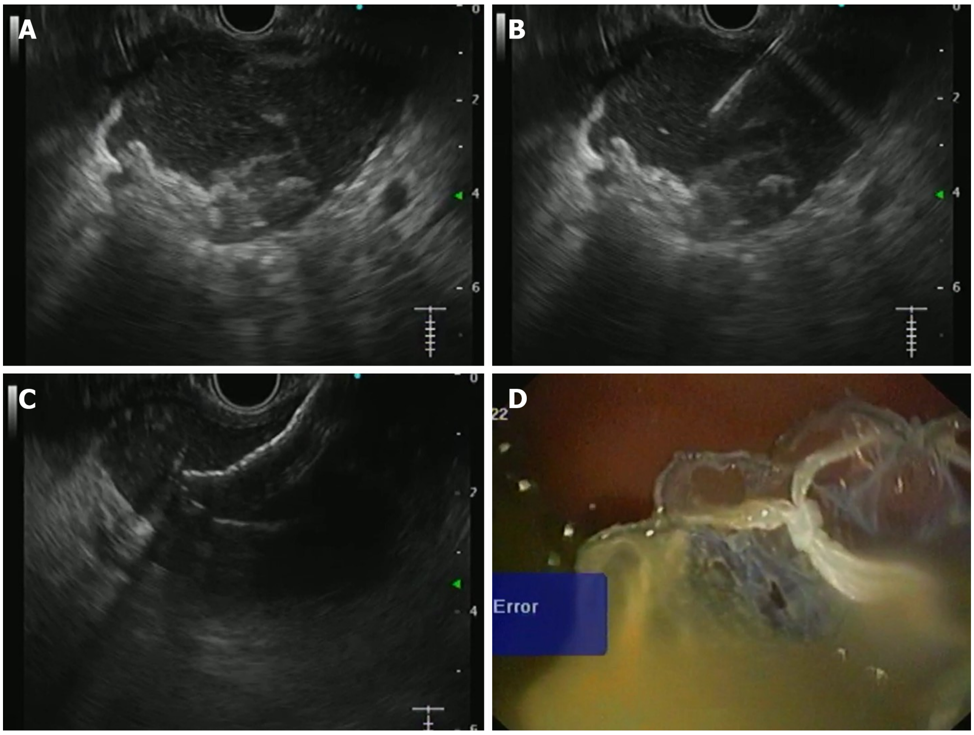

Figure 1 Endoscopy. A: A walled-off collection with hyperechoic necrotic contents; B: The collection was punctured with a 19-gauge needle; C: Proximal flange of the metal stent was deployed under endoscopic ultrasound vision; D: Distal flange of the stent was deployed under endoscopic vision.

Table 4 Outcomes of endoscopic drainage of pancreatic collection with various types of stents

Ref.	Collection	*n*	Clinical success	Adverse events	Conclusion
Lee *et al*[21], 2014	WON and Pseudocyst	PS = 25, FCMS = 25	PS: 90.0%, FCMS: 87.0%	PS: 8.0%, FCMS: 0%	Efficacy, AE, and reintervention rates were equal
Mukai *et al* [39], 2015	WON	PS = 27, BFMS = 43	PS: 90.6%, FCMS: 97.7%	PS: 18.5%, FCMS: 7.0%	Efficacy and AE were equal; reintervention rates more with PS
Siddiqui *et al* [14], 2017	WON	PS = 106 FCMS = 121, LAMS = 86	PS: 81.0%, FCMS: 95.0%, LAMS: 90.0%	PS: 7.5%, FCMS: 1.6%, LAMS: 9.3%	Efficacy was higher with FCMS and LAMS than with PS
Bapaye *et al* [15], 2017	WON	PS = 61, BFMS = 72	PS: 73.7%, BFMS: 94.0%	PS: 36.1%, BFMS: 5.6%	Efficacy was higher with BFMS than with PS; AE and reintervention rates were lower with BFMS
Bang *et al*[22], 2019	WON	PS = 29, LAMS = 31	PS: 96.6%, LAMS: 93.5%	PS: 6.9%, LAMS: 32.3%	Procedure duration was shorter with LAMS; stent-related AEs and procedure costs were higher with LAMS
Shin *et al*[19], 2019	WON and pseudocyst	PS: 17, LAMS: 10	PS: 88.2%, LAMS: 100.0%	PS: 25.0%, LAMS: 20.0%	Clinical success, technical success, and AE were similar; procedure time was higher with PS
Ge *et al*[18], 2020	WON	PS: 78, LAMS: 34	PS: 92.1%, LAMS: 94.1%	PS: 7.7%, LAMS: 41.2%	LAMS had higher AEs than PS
Muktesh *et al* [17], 2022	WON	PS = 45, BFMS = 53	PS: 81.8%, BFMS: 96.2%	PS: 8.8%, BFMS: 5.6%	Efficacy higher with BFMS; AE and reintervention rates were lower with BFMS
Boxhoorn *et al* [20], 2023	WON	PS: 51, LAMS: 53	-	-	Need for endoscopic necrosectomy, AEs, and mortality were similar between the plastic and metal stent
Kakadiya *et al* [23], 2023	WON	PS = 24, BFMS = 24	PS: 83.3%, BFMS: 87.5%	PS: 28.7%, BFMS: 4.1%	Clinical and technical success were similar; procedure time and AE were higher with PS

AE: Adverse event; BFMS: Biflanged metal stents; FCMS: Fully-covered metal stent; LAMS: Lumen-apposing metal stent; PS: Plastic stent; WON: Walled-off necrosis.

stent-induced injury on the contralateral wall have reduced the enthusiasm for metal stents. The ease of placement, short procedure time, fewer number of necrosectomies, and early resolution of collections should dictate the use of metal stents in selected patients.

Patients who are sick enough to undergo long procedures with large amounts of necrotic content should be considered for the metal stent to facilitate faster recovery with less need for necrosectomy. Until more data is available, all the collections can be drained with the use of either of the stents depending on the choice of the patient and the endoscopist.

WHEN TO REMOVE THE STENTS

After the resolution of PFCs with endoscopic drainage, the stents need to be removed. Plastic stents do not need removal as they migrate by themselves. Also, the long dwelling time could prevent the recurrence of pseudocyst formation when a leak is suspected from the pancreatic duct. Removal is important when a metal stent is used initially for drainage to prevent stent-related complications. Conventionally, metal stents are removed at 3-6 wk after the drainage procedure once complete drainage is documented[25]. No study has investigated the appropriate timing of metal stent removal. Bang *et al*[22] identified that stent-related complications were significantly higher when stent removal was delayed beyond 3 wk. Ahmad *et al*[26] also noted that early removal of LAMS prevented delayed bleeding.

Thus, metal stents should be removed at 3-4 wk after drainage procedure. When a longer time is expected for complete drainage of the collection, a coaxial plastic stent should be placed to avoid metal stent-related complications[27].

HOW AND WHEN TO PERFORM DEN

DEN is a step-up approach in the process of endoscopic drainage of PFCs. The word “direct” refers to accessing the collection and its necrotic content directly by the endoscope through the stomach or duodenal wall. It involves the process of entering the cavity through the cystoenterostomy tract and the removal of solid material (Figure 2). The first successful DEN was described by Seifert *et al*[28]. Since then, it has become a standard step-up endoscopic approach in the management of PFCs.

The timing of DEN also remains ambiguous. In early studies, DEN was delayed to allow the cystoenterostomy tract to maturate[6,29]. However, with the availability of LAMS with larger diameters, DEN could be performed during the same session[30,31]. In a large retrospective study, Yan *et al*[31] found that DEN could be performed safely in the same session of endoscopic drainage without increasing the risk of adverse events. The study also noted that the immediate DEN

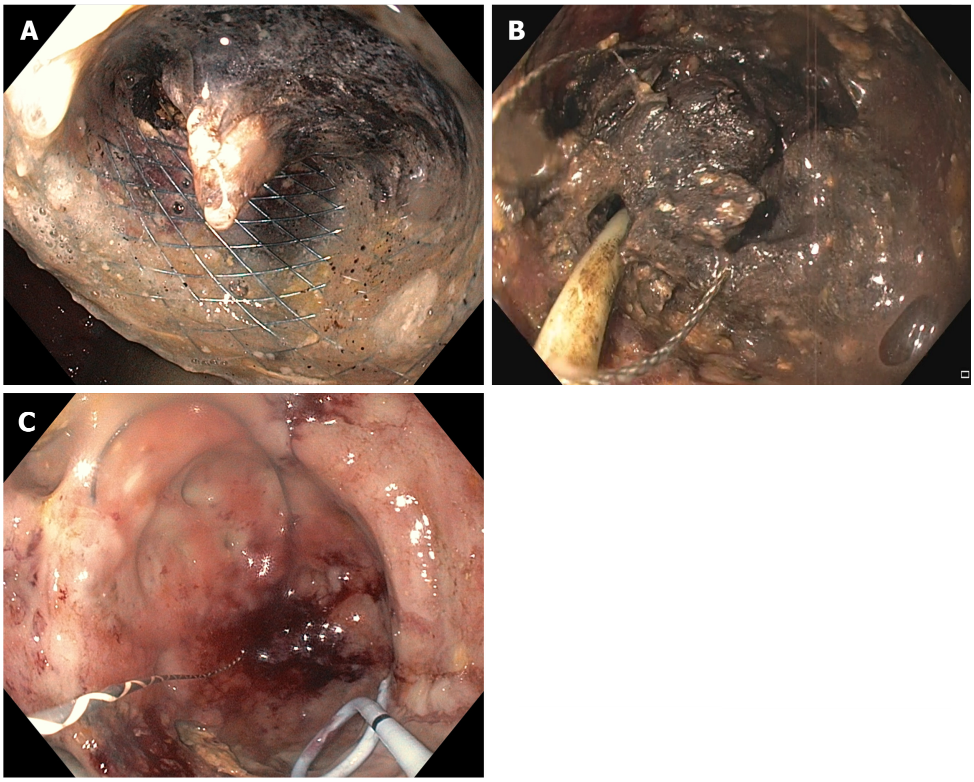

Figure 2 Process of entering the cavity through the cystoenterostomy tract and the removal of solid material. A: The metal stent was blocked due to the necrotic material; B: Debris was removed with direct endoscopic necrosectomy using a snare; C: A double pigtail plastic stent was placed to replace the metal stent.

group required a fewer number of necrosectomies than the delayed DEN group. A recently published randomized controlled trial (DESTIN trial) also confirmed these findings[32]. The study reported fewer reinterventions in the early DEN group compared to the delayed DEN group. Although the literature supports DEN in the same session of endoscopic drainage of PFCs, the ideal candidates for this intervention are not clearly defined. With the advent of metal stents with larger diameters, it is expected that a significant amount of necrotic material will be removed by itself. Thus, who should be considered for early DEN is not clear. Further studies are required to answer this question. However, when a LAMS with a larger diameter is used, DEN could be delayed in patients who are critically ill to allow spontaneous removal of solid necrotic debris and clinical stabilization. Meanwhile in clinically stable patients, early DEN can be performed.

Though the process of DEN is simple, it is time-consuming. Once the cavity is entered, the necrotic fluid and necrotic contents of the collection are aspirated through the working channel of the endoscope. Once the vision is clear and large adhered necrotic material is visualized, it is removed with the help of various devices and released into the stomach. Polypectomy snare, Dormia basket, Roth basket, stone removal baskets, or grasping forceps can be used to remove debris [33]. Before 2018, no specialized necrosectomy tools were available when Van Der Wiel *et al*[34] demonstrated the efficacy of the EndoRotor Powered Endoscopic Debridement System® (Interscope Medical, Inc., Worcester, MA, United States) in 2 patients with WON. A recent multicentric study demonstrated the safety and effectiveness of this device by decreasing the number of interventions and hospital stays[35].

COMPLICATIONS OF EUS-GUIDED PFC DRAINAGE

The era of EUS-guided interventions has opened a big basket of opportunities. However, these advanced procedures carry a considerable risk of adverse events. Siddiqui *et al*[25] reported an adverse event rate of 23% after EUS-guided transluminal interventions. The commonly reported adverse events were bleeding (1%-35%), stent maldeployment (2%-8%), infection (0%-10%), and perforation (0%-4%)[36-38]. Other rare complications include difficulty in stent removal due to tissue overgrowth and air embolism[39].

CONCLUSION

With the evolution of EUS interventions, internal drainage of PFCs has become the preferred approach. Though EUS guidance is the first choice in well-encapsulated collections and clinically stable patients, its utility in acute necrotic collections is still evolving. The choice of metal and multiple plastic stents remains a matter of investigation. The use of metal or plastic stents should be individualized for the clinical condition of the patient, size of the collection, anatomy of the collection, solid necrotic contents, cost concerns, and expertise available. Though having promising results, EUS-guided drainage is not free from complications, and a learning curve is needed to avoid procedure-related complications.

FOOTNOTES

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Country of origin: India

ORCID number: Anupam Kumar Singh 0000-0002-7610-1807; Manish Manrai 0000-0002-5805-033X; Rakesh Kochhar 0000-0002-4077-6474.

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