Review Article

Biliary Stent Migration: A Review of the Literature

Seyed Alireza Taghavi[1], Fardad Ejtehadi[1], Ramin Niknam[1] , Gholam Reza Sivandzadeh[1], Masoud Tahani[2] , Alireza Aminisefat[2], Fateme Sharafi[2], Iraj Shahramian[1*]

[1] Gastroenterohepatology Research Center, School of Medicine, Shiraz University of Medical Sciences, Shiraz, Iran.

[2] Pediatric Gastroenterology and Hepatology Research Center, Zabol University of Medical Sciences, Zabol, Iran.

ABSTRACT

With Currently, Endoscopic retrograde cholangiopancreatography (ERCP) has evolved as a therapeutic intervention for treating disorders related to the biliary system and plays an important role in treating benign and malignant strictures of the biliary system. The placement of biliary stents is a frequent and useful procedure to decompress the biliary system, and endoscopic biliary stenting seems relatively simple. However, in some cases, it can lead to several complications. Distal or proximal migration of endoscopically placed biliary stents is one of the known complications of ERCP and can affect up to 6-10% of patients.

Several factors, including those related to the patient, endoscopy, or stent, are involved in stent migration. When migration occurs, it is necessary to remove or replace endoprosthesis to prevent recurrent biliary complications and more severe consequences such as cholangitis and sepsis.

This review explores the frequency, etiology, risk factors, complications, and management strategies pertaining to biliary stent migration, consolidating diverse management approaches for informed decision-making.

Keywords: Biliary stent, Stent migration, Bile ducts, Literature review, ERCP

please cite this paper as:
Taghavi SA, Ejtehadi F, Niknam R , Sivandzadeh GR, Tahani M, Aminisefat AR, Sharafi F, Shahramian I. Biliary Stent Migration: A Review of the Literature. *Govaresh* 2024; 29: 24-31.

Corresponding author:
Iraj Shahramian, MD
Professor of Pediatrics Gastroenterology, Department of Pediatrics,
School of Medicine, Shiraz University of Medical Science, Shiraz, Iran
Tel: + 98 9151917652
Email: ir_buper@yahoo.com

Received: 17 Jan. 2024
Revised: 28 Mar. 2024
Accepted: 29 Mar. 2024

1. INTRODUCTION

Today, many therapeutic methods are used in the treatment of benign and malignant strictures of the biliary system. Since most surgical interventions, especially in malignant cases, are associated with a high rate of complications. Therefore, methods based on endoscopic and percutaneous biliary interventions are preferred (1-4). In this regard, today, endoscopic retrograde cholangiopancreatography (ERCP) is used predominantly as a therapeutic intervention in the management of disorders related to the biliary system and plays an important role in the removal of common gallstones and obstructive jaundice.

Allows the passage of devices through the pancreatic and biliary channels (5), endoscopic placement of the biliary stent is recognized as a safe and less invasive approach to treating biliary illnesses such as choledocholithiasis, and its use has expanded considerably in the last ten years (6). This approach has been extremely helpful and effective in addressing postoperative bile leakage and avoiding surgical treatments (7).

Various types of stents are available depending on size, design, and material (plastic, polyethylene, Teflon, or metal). Placement of biliary stents is a useful and powerful procedure for decompressing the biliary system, and endoscopic biliary stenting seems relatively simple. However, in some cases, it can be accompanied by several complications (7) (Table 1).

The relatively common side effects of stenting include occlusion, cholangitis, bleeding, and pancreatitis. Conditions such as dislocation and migration of biliary stents and related life-threatening complications are less common.

Migration of endoscopically placed biliary stents is a known complication of ERCP, and it is necessary to suspect it in patients with abdominal pain with a history of previous ERCP and biliary stenting (8-11).

Several factors, including factors related to the patient, endoscopic, or stent, determine and contribute to stent migration.

Evidence has shown that the risk of stent migration is higher in benign biliary strictures than in malignant biliary strictures. Furthermore, patients with multiple stents will have significantly lower rates of migration (12). Stent migration can be proximal or distal. Different studies have shown that distal or proximal stent migration affects 6-10% of patients. This can be especially true in patients with benign diseases with plastic biliary stents (9).

Most biliary prostheses pass through the intestine without any problems, and the person may be asymptomatic. However, when the stent passes through the intestine, life-threatening complications such as penetration, perforation, peritonitis, intestinal obstruction, sepsis, and fistula formation may occur (13). The present review study discussed the frequency, cause, risk factors, complications, and management of biliary stent migration.

Differentiating distal and proximal migration by stent type: In the context of biliary stent migration, distinguishing between distal and proximal migration based on the type of stents is crucial for understanding and managing complications effectively. Distal migration, where the stent moves away from the insertion site towards the distal end of the biliary tree, and proximal migration, where the stent moves towards the proximal end or back into the biliary system, present distinct challenges and risks associated with each type of stent. For instance, plastic stents may exhibit a higher risk of both distal and proximal migration compared with metal stents, while the complications arising from migration, such as pancreatitis or intestinal obstruction, may vary depending on the migration direction and the material of the stent. By categorizing migration types based on stent material, clinicians can tailor their management strategies more effectively, thereby enhancing patient outcomes and reducing the risk of severe complications associated with biliary stent migration.

Table 1. Complications of different types of biliary stents

Stent type	complications	Risk of migration	Other complications
Plastic	Migration Occlusion Cholangitis Bleeding	High	Pancreatitis Perforation
Metal	Migration Pancreatitis Perforation	Moderate	Occlusion Sepsis
Polyethylene	Migration Intestinal obstruction	Low	Bleeding Fistula Formation Peritonitis
Teflon	Migration Fistula Formation Peritonitis	Moderate	Pancreatitis Intestinal obstruction

2. Incidence

In general, evidence shows that biliary stent migration can occur in 1.7-10% of patients (8,14-21). However, this frequency can vary according to the type of stent, distal

or proximal displacement, location of the stent, underlying disease, and other factors related to the patient.

3. Cause

Several factors are effective in causing migration of the biliary stent, including factors related to the patient's condition, endoscopy, and stent. Generally, biliary stents migrate due to a dilated common bile duct (CBD), wide sphincterotomy, and dilation of the biliary balloon. Additionally, the use of wide and straight stents, which are inserted for more than a month, increases the chance of migration. Intraluminal stents can migrate into the CBD, duodenum, or colon (22).

Thus, the endoscopist must assess the size and form of the stent in each patient to reduce the likelihood of stent migration. It may move easily because there is nothing to keep a straight biliary stent in place. However, direct plastic stent implantation can lessen the risk of migration when paired with lateral flaps (23). Furthermore, a too-long stent might press on the duodenum wall, leading to tissue necrosis and perforation. However, curved (Amsterdam) or twin pigtail stents are less likely to migrate or perforate (8,24,25).

Kawaguchi and colleagues reported that the placement of multiple stents may be effective in the rate of stent migration. The insertion of multiple stents (inserting more than two stents) causes the biliary stricture to be tightened, the multiple stents are held tighter, and the friction between them reduces the movement. All these factors prevent the migration of the stent (25).

In addition, studies have shown that the underlying etiology of the biliary problem is also influential in stent migration. Benign biliary strictures are more prone to migration than malignant strictures due to the mildness of the stricture (12,25).

According to evidence, the length of the stent above the proximal end of the stricture affects how quickly the stent migrates to the distal side. If the stent is excessively long (more than 2 cm), it can be forced down and migrate to the distal side, increasing the risk of duodenal injury. As a result, since the length of the stent outside the papilla is easily adjustable, adequate assessment of the stenosis site and selection of the appropriate length of the stent are required to adjust the length of the stent above the proximal end of the stenosis and sufficient precision in this field can reduce the likelihood of distal migration (26,27).

4. Risk factors

4.1. Patient factors

4.1.1. Diseases (benign or malignant)

Biliary stricture due to benign diseases such as chronic pancreatitis and autoimmune pancreatitis is one of the mostsignificant risk factors for the migration of the biliary stent. According to studies, migration occurs more frequently in benign than in malignant instances of biliary strictures (13.7% vs 5.3%). Therefore, benign biliary strictures may be considered substantial risk factors, especially in distal migration (12,25,26). In reality, data has indicated that the cause for the higher frequency of stent migration in benign instances can be attributed to a greater increase in the width of the biliary system in benign cases and a faster resolution of inflammation after stenting (12). However, the severity of biliary system stenosis in malignant cases is usually higher than in benign cases, which the difference in the level of local inflammation can cause. Therefore, the tight cover of the stents by malignant tissue and tumor growth causes the stent to stick and fix, preventing migration (10,25). In general, papillary strictures are related to stent migration outside the CBD and malignant strictures are related to their proximal migration (8).

4.1.2. Cases undergoing endoscopic sphincterectomy

There is little information on the effect of endoscopic sphincterectomy (EST) before biliary stenting on migration frequency, and the results are contradictory. Studies have shown that performing EST can increase stent migration (22). In contrast, some reports have shown that EST does not significantly affect the migration rate (28,29). However, another study has shown an increase in the migration rate in the group without EST compared with the group with EST (30). The evidence shows that the EST probably does not significantly affect the migration rate, and the presence of various risk factors is effective in performing or not performing the migration.

4.1.3. Bile duct diameter

In circumstances where the diameter of the bile duct is larger, an increase in the frequency of migration is anticipated since, generally speaking, more space is needed for migration in the proximal bile duct. In this sense, research revealed that patients with bile duct diameters > 10 mm had a significantly higher migration rate than patients with bile duct diameters> 10 mm (25).

4.2. Stent factor

4.2.1. Duration of stent placement

Various reports show that the chance of stent migration increases with increasing the duration of stenting. Kawaguchi and colleagues (25) reported that patients with a stenting duration of more than one month had significantly more stent migration than patients whose stenting duration was less than one month. Furthermore, Yuan and others have reported stenting for more than three months as a risk factor for distal stent migration (26).

4.2.2. Stent shape

The use of straight stents is associated with an increase

in migration frequency, while pig-tailed or curved (Amsterdam) stents are associated with a lower probability of migration. Direct stents, when used with side flaps or barbs, also reduce the frequency of migration (25). However, Gregorios and co-workers (31) showed that double-pigtail stents are a risk factor for stent migration. In summary, in cases of long-term use, the probability of migration is high, especially in younger patients. The anti-migratory advantage of these stents compared with straight stents was insignificant in this study.

4.2.3. Stent diameter

Using stents with a larger diameter increases the probability of proximal migration. The diameter of the stent is related to the frequency of migration. Kawaguchi and colleagues showed that the migration frequency in patients with 10-Fr stents was significantly higher than in patients with 7-Fr stents. Healing of bile duct strictures in patients with thicker stents appears to play an influential role in causing migration (25).

4.2.4. Stent length

It is necessary to choose a stent with the appropriate length and according to the type and location of the biliary stricture to reduce the frequency of migration. The length of the used stent is related to the frequency of migration. Short and long stents are both risk factors for migration (32). Gromski and others showed that all migrated stents were large (9 cm). This study found that larger stents had a greater capacity for complications (perforation) and migration (24). Arhan and others (10) showed that in patients with benign biliary strictures, shorter stents migrate proximally, and larger stents migrate distally. However, since a longer part of large stents is fixed in the common bile duct, proximal movement is limited, and the risk of proximal migration is expected to be lower.

5. Complications

In most cases, foreign objects introduced into the intestine pass through without significant problems. However, patients with underlying disorders such as diverticular disease, hernia, or intra-abdominal adhesions due to weakness of the intestinal wall and increased resistance during intestinal movement will be exposed to many complications (33,34). Biliary stent migration can be asymptomatic or manifestwith life-threatening complications such as perforation, intestinal bleeding, obstruction, peritonitis, and preparation for the development of intra-abdominal or retroperitoneal abscesses (13).

The numerous complications caused by stent migration can be divided into three general categories: penetration, intestinal perforation, and obstruction. Penetration requires adhesion between the pierced organs and can eventually cause a fistula without causing severe contamination (35). There have been many reports of colovesicular (36), colocutaneous (37), colovaginal (38), biliocolic (39), and pelvic abscess formation (40) in the context of migration of the biliary stent. There is also a case report of bronchopleurobiliary fistula following the migration of the biliary stent (41).

One of the most important complications related to stent migration is intestinal perforation. Generally, migration of biliary stents affects the duodenum primarily compared with other parts of the small intestine and colon (13). There are many reports of colon perforation in the field of migration of biliary stents in patients with straight plastic stents (42,43,33). There is also a case report of necrotizing fasciitis following colon perforation (44). Perforation of the duodenum after migration of the biliary stent has also been mentioned as a less common complication in many reports (45-47).

Compared with pancreatic stents, biliary stents have a higher incidence of duodenal perforation complication, which may be due to the angle at which biliary stents exit being more perpendicular to the opposing duodenal wall and the use of external plastic pigtail stents in the pancreatic ducts (24).

6. Managements

Symptomatic or not, migrated biliary stents should be removed immediately (48). Endoscopic recovery is usually a suitable treatment option for migrated stents, except in cases where surgical removal of the stent is the only treatment option. Urgent surgical interventions, including intestinal perforation, obstruction, and generalized abdominal pain, are required in emergency cases. In benign cases of biliary lesions, removal or replacement of the stent is necessary to prevent the risk of secondary complications and obstruction (7).

In cases where the biliary stent migrates into the bile duct, various treatment methods can be used, including simple grasping forceps, balloon catheters, electro-hydraulic lithotripsy, or extracorporeal shock wave lithotripsy. However, in cases where removal is not possible, a surgical method is recommended (49).

7. Methods of endoscopic removal

7.1.Grasp forceps or simple biopsy forceps

According to the technical description, the distal end of the stent is directly gripped with forceps or biopsy forceps in this retrieval approach. Straight or pig-tailed thin stents can be implanted using this technique.

Clinical Applications: According to Kawaguchi and colleagues (25), this approach was used and effective in 56.1% of patients with migration of the biliary stent, and in 60% of these cases, the stents in question were 7-Fr pigtail stents. The biopsy-forceps approach is a helpful procedure

for endoscopic recovery of distally migrated and affected biliary metallic stents, according to Matsushita and others (Figure 1) (50).

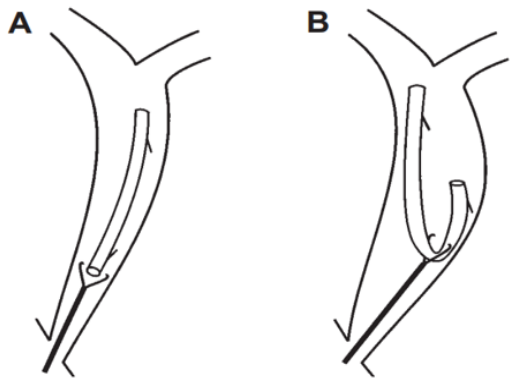

Figure 1. Diagram of the forceps method. Using a pair of rat-toothed forceps, remove a proximally migrating stent by grabbing its distal end or shaft (options A or B) (51).

7.2.Snare

Technical description: This technique can be used if the distal end of the migrated stent is close to the ampullary orifice. The distal end of the stent is captured with a snare, and the migrated stent is recovered (14).

Clinical applications: Various studies have shown that snares have been used successfully to retrieve proximally migrated stents (52).

7.3. Dormia basket

Technical description: The distal end of the migrating stent is passed through a closed Dormia basket placed into the bile duct. As soon as the distal end of the stent is placed between the strings of the basket after the basket has been opened and pushed up and down, it is closed and dragged directly down from the ampullary orifice (14).

Clinical applications: Chaurasia and others (51) showed that using the Dormia basket technique as a useful and simple method in patients with proximal stent migration is successful in most cases.

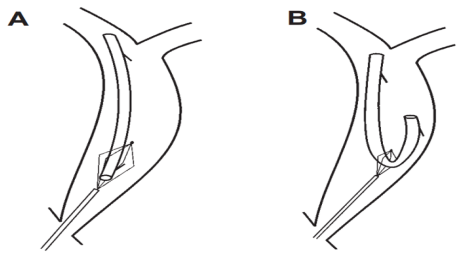

Figure 2. An illustration of the Dormia basket method for recovering proximally migrating stents. A, A Dormia basket is opened, the wires are engaged by the distal end of the migrating stent, and the stent is dragged straight down. B, The proximally migrating stent is folded back on itself after being recovered and gripped at its shaft with a Dormia basket (51).

Katsinelos and co-workers (53) have also recommended using various techniques, including a Dormia basket, to retrieve migrated biliary stents (Figure 2).

7.4. Balloons.

Technical description: The migrating stent is inflated adjacent to or above the stone extraction balloon in the procedure described above, and the balloon catheter is then lowered to allow the distal end of the stent to exit the ampullary orifice (Figure 3) (14).

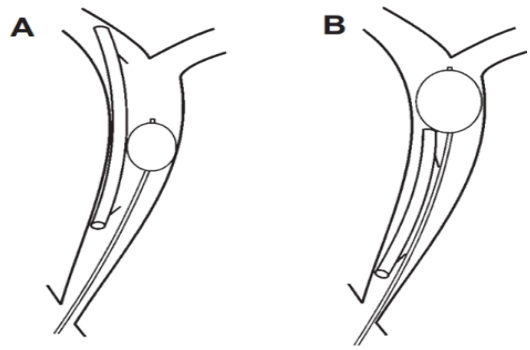

Figure 3. Illustration of a balloon catheter not used in a stent procedure. A balloon was placed next to the stent. B, A balloon perched on top of a stent (51).

Clinical applications: Lahoti and others have demonstrated that the balloon approach successfully recovers proximally migrating biliary stents (Figure 4) (54).

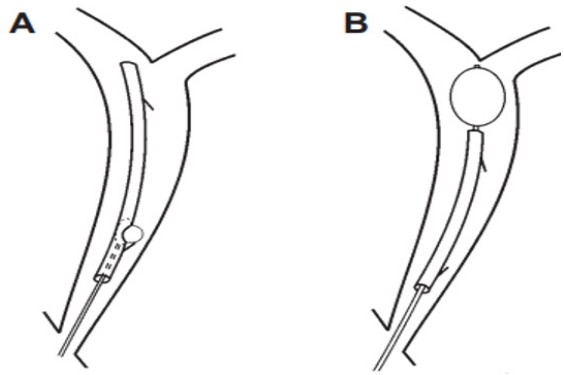

Figure 4. The diagram shows a balloon catheter within a stent approach. In the stent, there is a balloon. B, A balloon perched on top of a stent (51).

7.5. Lasso technique or snare over in stent wire guide technique.

In this method, the biliary channel should be cannulated

first using a guidewire that passes through or near the migrating stent. Next, a polypectomy snare is gently placed into the bile duct while being dragged over the guidewire to protect the duct. The snare is opened and moved to encapsulate the stent and recover it after being placed at the distal end of the stent (55).

Clinical applications: Sherman and others first suggested this method, which involved cannulating the stent with a guidewire (56). In most cases, Vila and colleagues also stressed the value and simplicity of the Lasso technique in retrieving proximal pancreatic stent migration (55).

7.6. Cholangioscopy.

The biliary system can be seen with an imaging technique called percutaneous transhepatic cholangioscopy (PTCS), which can be used for diagnostic and therapeutic reasons. Electrohydraulic lithotripsy for intrahepatic or common bile, photodynamic or laser palliative treatment for cancers, and other catheter-driven therapies are examples of PTCS therapeutic approaches. The normal diameter and length of a cholangioscope used for percutaneous procedures are 4.8 to 6.0 mm and 35 to 70 mm, respectively. For the passage of additional treatment tools, such as lithotripsy fibers, baskets, forceps, balloon dilators, and guidewires, there is also a rather large lateral channel of 2.0 to 2.6 mm. Snares, forceps, and other tools are used to retrieve stents (57-59).

Clinical applications:

There have been many reports of successful recovery of proximal migration using cholangioscopy, but the high costs in this field make this method only used in cases of unsuccessful attempts to recover migrated stents (61-63).

In general, migrating plastic or metallic stents can be removed using single-operator digital cholangioscopy (with spy basket, retriever snare, and spy bite biopsy forceps) (61).

Direct capture of the stent using a wire basket, trap, forceps, or indirect traction with a balloon in patients with dilated ducts is typically effective and beneficial (19). Through endoscopy, most migrated biliary stents can be removed using these techniques. Most patients with non-dilated or minimally dilated choledochus undergo balloon procedures. The use of Dormia baskets is recommended in situations of dilation of the choledochus because the inflated balloon cannot adequately cover the lumen, and the stent can be easily removed from it.

The benefit of the basket over the snare also comes from the fact that it includes more wires, increasing the probability of obtaining the stent compared with the snare's single loop (14). Pig-tailed or thin straight stents can be successfully grasped with a basket or trap. However, thick and straight stents can be inserted using the guidewire cannulation approach (25).

Although the pancreatic duct is tiny, it can be difficult to employ the lasso technique or the snare in the stent wire guide approach to remove proximally migrated pancreatic duct stents (63).

7.7. Soehendra Stent Retriever

Technical description: The Soehendra stent retriever is a device designed to facilitate the exchange of biliary stents. Exchange of the biliary stent typically involves removing the occluded stent and placing a new one. However, in complicated cases, stricture recannulation can be challenging. The Soehendra stent retriever was developed to overcome this difficulty and ensure successful stent replacement. Recent modifications to the device have addressed the issue of inserting the guide wire and advancing the retriever over it. Cannulation of the obstructed stent and insertion of the guide wire has been significantly improved by including a curved plastic tip. The stent can be readily removed so that a fresh one can be inserted by coupling and screwing the retriever into the distal end of the stent. It is crucial to remember that an 11.5 French retriever must be used to remove a 10-French polyethylene stent. The modified stent retriever has been used successfully in 20 procedures to replace occluded biliary stents, even by trainees (60).

8. CONCLUSIONS

Biliary stent migration is known as one of the complications of ERCP, and managing it can be challenging. Its important risk factors include the patient's underlying etiology (malignant or benign biliary disease), the size, shape, and diameter of the stent, and the duration of stent placement. In most cases, it is possible to remove the stent with the help of endoscopy. However, in cases with complications, surgery may be required.

Consent for publication:

The authors agreed to publish their work in this journal.

Competing interests:

The authors state that they have no competing of interests.

Funding:

No funding was received.

REFRENCES:

1. Mueller PR, Ferrucci JT Jr, Teplick SK, vanSonnenberg E, Haskin PH, Butch RJ et al. Biliary stent endoprosthesis: analysis of complications in 113 patients. *Radiology*. 1985;156(3):637–9.
2. Smith AC, Dowsett JF, Russell RC, Hatfield AR, Cotton PB. Randomised trial of endoscopic steriting versus surgical bypass in malignant low bileduct obstruction. *Lancet*. 1994;344(8938):1655-60.

3. Barth KH. Percutaneous biliary drainage for high obstruction. *Radiol Clin North Am*. 1990;28(6):1223-35.
4. Devière J , Devaere S, Baize M, Cremer M. Endoscopic biliary drainage in chronic pancreatitis. *Gastrointest Endosc*. 1990;36(2):96-100.
5. Adler DG, lieb JG, Cohen J, Pike IM, Park WG, Rizk MK, et al. Quality indicators for ERCP. *Gastrointest Endosc* 2015;81:54-66.
6. Culnan DM , Cicuto BJ , Singh H, Cherry RA. Percutaneous retrieval of a biliary stent after migration and ileal perforation. *World J Emerg Surg*. 2009:4:6.
7. Namdar T , Raffel AM, Topp SA, Namdar L, Alldinger I, Schmitt M, et al. Complications and treatment of migrated biliary endoprostheses: a review of the literature. *World J Gastroenterol* . 2007;13(40):5397-9.
8. Johanson JF, Schmalz MJ, Geenen JE. Incidence and risk factors for migration of biliary and pancreatic stents. *Gastrointest Endosc* 1992;38:341-6.
9. Cano-Hoz M , Carrascosa MF , Pérez AD , Ramos-Martín R. Migrated biliary stent. *Lancet Gastroenterol Hepatol*. 2018;3(4):288.
10. Arhan M , Odemiş B, Parlak E, Ertuğrul I, Başar O. Migration of biliary plastic stents: experience of a tertiary center. *Surg Endosc*. 2009;23(4):769-75.
11. Chaurasia OP , Rauws EA, Fockens P, Huibregtse K. Endoscopic techniques for the retrieval of proximally migrated biliary stents: the Amsterdam experience.*Gastrointest Endosc*. 1999;50(6):780-5.
12. Alkhawaldeh IM, Shattarah O, AlSamhori JF, Abu-Jeyyab M, Nashwan AJ. Late small-intestinal perforation from a Migrated Double Plastic Biliary Stent: A Case Report and a Review of the Literature of 85 Cases from 2000 to 2022. *Clin Case Rep*. 2023;11(11):e7425.
13. Siaperas P, Ioannidis A, Skarpas A, Angelopoulos A, Drikos I, Karanikas I . A rare cause for Hartmann procedure due to migration of the biliary stent: A case report. *Int J Surg Case Rep*. 2017:31:83-85.
14. Duman AE, Hülagü S. Management of plastic biliary stents migrated in patients with benign biliary diseases. *Laparosc Endosc Surg (LESS)* 2022;29(1): 29-35.
15. Kang J, Park YT, Kim HJ, KIM JS. Delayed hemobilia caused by penetration of biliary plastic stent into the portal vein. *Korean Journal of Pancreas and Biliary Tract*. 2022;27(3):135-9.
16. Bagul A, Pollard C, Dennison AR. A review of the problems after the insertion of biliary stents illustrated by an unusual complication. *Ann R Coll Surg Engl*. 2010;92(4):W27-31.
17. Vila JJ, Marcos K, Manuel PM. Retrieval of proximally migrated pancreatic stents. *Video J Encycl GI Endosc*.2013;1.2:584-7.
18. Lammer J. Biliary endoprostheses: plastic vs. metal stents. *Radiol Clin North Am* 1990;28:1211-22.
19. Tarnasky PR, Cotton PB, Baillie J, Branch MS, Affronti J, Jowell P, et al. Proximal migration of biliary stents: attempted endoscopic retrieval in 41 patients. *Gastrointest Endosc*. 1995;42(6):513-20.
20. Naggar E, Krag E, Matzen P. Endoscopically inserted biliary endoprosthesis in malignant obstructive jaundice-a review of the literature. *Liver* 1990;10:321-4.
21. Walta DC, Fausel CS, Brant B. Endoscopic biliary stents and obstructive jaundice. *Am J Surg* 1987;153:444-7.
22. Emara MH, Ahmed MH, Mohammed AS, I Radwan MI, Mahros AM. Biliary stent migration: why, how, and what? *Eur J Gastroenterol Hepatol*. 2021;33(7):967-973.
23. Barton RJ. The migrated double pigtail biliary stent causes small bowel obstruction. *J Gastroenterol Hepatol*. 2006;21(4):783-4.
24. Gromski MA, Bick BL, Vega D, Easler JJ, Watkins JL, Sherman S, et al. A rare complication of ERCP: duodenal perforation due to migration of the biliary stent. *Endosc Int Open*. 2020;8(11):E1530-E1536.
25. Kawaguchi Y, Ogawa M, Kawashima Y, Mizukami H, Maruno A, Ito H, et al. Risk factors for proximal migration of biliary tube stents. *World J Gastroenterol*. 2014;20(5):1318-24.
26. Yuan XL, Ye LS, Liu Q, Wu CC , Liu W, Zeng XH, et al. Risk factors for distal migration of biliary plastic stents and related duodenal injury. *Surg Endosc*. 2020;34(4):1722-1728.
27. Lee YN, Moon JH, Choi HJ, Choi MH, Lee TH, Cha SW, et al. Effectiveness of a newly designed metal antireflux valve stent to reduce duodenobiliary reflux in patients with unresectable distal malignant biliary obstruction: a randomized, controlled pilot study (with videos). *Gastrointest Endosc*. 2016;83(2):404-12.
28. Giorgio PD, Luca LD. Comparison of treatment outcomes between biliary plasttic stent placements with and without endoscopic sphincterotomy for inoperable malignant common bile duct obstruction. *World J Gastroenterol*. 2004;10:1212–1214.
29. Güitrón A, Adalid R, Barinagarrementera R, Gutiérrez-Bermdez JA, Martnez-Burciaga J. Incidence and relation of endoscopic sphincterotomy to proximal migration of biliary prostheses. *Rev Gastroenterol Mex*. 2000;65:159–162.
30. Margulies C, Siqueira ES, Silverman WB, Lin XS, Martin JA, Rabinovitz M, et al. Effect of endoscopic sphincterotomy on acute and chronic complications of biliary endoprostheses. *Gastrointest Endosc*. 1999;49:716–9.
31. Paspatis GA, Papastergiou V, Mpitouli A, Velegraki M, Nikolaou P, Fragkaki M, et al. Distal biliary stent migration in patients with irretrievable bile duct stones: long-term comparison between straight and double-pigtail stents. *Dig Dis Sci*. 2022;67(9):4557-4564.
32. Katsinelos P, Kountouras J, Paroutoglou G, Chatzimavroudis G, Paikos D, Zavos C, et al. Migration of plastic biliary stents and endoscopic retrieval: experience of three referral centers. *Surg Laparosc Endosc Percutan Tech*. 2009;19(3):217-21.
33. Klein U, Weiss F, Wittkugel O. Migration of a Tannenbaum biliary stent with perforation of the sigmoid diverticulum. *Rofo*. 2001;173(11):1057.

34. Ruffolo TA, Lehman GA, Sherman S, Aycock R, Hayes A. Biliary stent migration with diverticular colon impaction. *Gastrointest Endos*c. 1992;38:81–83.
35. Mady RF, Niaz OS, Assal MM. Migrated biliary stent causing perforation of the sigmoid colon and pelvic abscess. *BMJ Case Re*p. 2015:2015:bcr2014206805.
36. Wilhelm A, Langer C, Zoeller G, Nustede R, Becker H. Complex colovesicular fistula: A severe complication caused by migration of the biliary stent. *Gastrointest Endosc*. 2003;57:124–126.
37. Figueiras RG, Echart MO, Figueiras AG, González GP. Colocutaneous fistula relating to migration of a biliary stent. *Eur J Gastroenterol Hepatol*. 2001;13:1251–1253.
38. Blake AM, Monga N, Dunn EM. Biliary stent causing colovaginal fistula: case report. *JSLS* 2004; 8: 73-75
39. Fiori E, Mazzoni G, Galati G, Lutzu SE, Cesare A, Bononi M, et al. Unusual breakage of a plastic biliary endoprosthesis causing an enterocutaneous fistula. *Surg Endosc* 2002; 16: 870.
40. Anderson EM, Phillips-Hughes J, Chapman R. Sigmoid colonic perforation and pelvic abscess complicating biliary stent migration. *Abdom Imaging*. 2007;32:317-9.
41. Dasmahapatra HK, Pepper JR. Bronchopleurobiliary fistula: a complication of migration of the intrahepatic biliary stent. *Chest*. 1988; 94(4):874-5.
42. Liebich-Bartholain L, Kleinau U, Elsbernd H, Büchsel R. Biliary pneumonitis after migration of the proximal stent. *Gastrointest Endosc* 2001;54:382-4.
43. Basile A, Macri A, Lamberto S, Caloggero S, Versaci A, Famulari C. Duodenoscrotal fistula secondary to retroperitoneal migration of an endoscopically placed plastic biliary stent. *Gastrointest Endosc* 2003;57:136-8.
44. Marsman JW, Hoedemaker HP. Necrotizing fasciitis: fatal complication of the migrated biliary stent. *Australas Radiol*. 1996;40:80–83.
45. Issa H, Nahawi M, Bseiso B, Al-Salem A. Migration of a biliary stent causing duodenal perforation and biliary peritonitis. *World J Gastrointest Endosc*. 2013;5(10):523-6.
46. El Zein MH, Kumbhari V, Tieu A, Saxena P, Messallam AA, Azola A, et al. Duodenal perforation as a consequence of biliary stent migration can occur regardless of the type or duration of the stent. *Endoscopy*. 2014:46 Suppl 1 UCTN:E281-2.
47. Hean Lo C, Chung S, Bohmer RD. A devastating complication: duodenal perforation due to migration of the biliary stent. *Surg Laparosc Endosc Percutan Tech*. 2008;18(6):608-10.
48. Diller R, Senninger N, Kautz G, Tubergen D. Stent migration necessitating surgical intervention. *Surg Endos*c. 2003;17:1803–7.
49. Morimachi M, Ogawa M, Yokota M, Kawanishi A, Kawashima Y, Mine T. Successful endoscopic removal of a biliary stent with stent-stone complex after long-term migration. *Case Rep Gastroenterol*. 2019;13(1):113-117.
50. Matsushita M, Takakuwa H, Nishio A, Kido M, Shimeno N. Open biopsy forceps technique for endoscopic removal of distally migrated and impacted biliary metallic stents. *Gastrointestinal Endosc*. 2003;58(6):924-7.
51. Chaurasia OP, Rauws EA, Fockens P, Huibregtse K. Endoscopic techniques for the retrieval of proximally migrated biliary stents: the Amsterdam experience. *Gastrointestinal Endosc*. 1999;50(6):780-5.
52. Tarnasky PR, Cotton PB, Baillie J, Branch MS, Affronti J, Jowell P, et al. Proximal migration of biliary stents: attempted endoscopic retrieval in forty-one patients. *Gastrointestinal Endosc*. 1995;42(6):513-9.
53. Katsinelos P, Kountouras J, Paroutoglou G, Chatzimavroudis G, Paikos D, Zavos C, et al. Migration of plastic biliary stents and endoscopic retrieval: an experience of three referral centers. *Surg Laparosc Endosc Percutan Tech*. 2009;19(3):217-21.
54. Lahoti S, Catalano MF, Geenen JE, Schmalz MJ. Endoscopic retrieval of proximally migrated biliary and pancreatic stents: experience of a large referral center. *Gastrointestinal Endosc*. 1998;47(6):486-91.
55. Vila JJ, Marcos K, Manuel PM. Retrieval of proximally migrated pancreatic stents. *Video J Encycl GI Endosc*. 2013;1(2):584-7.
56. Sherman S, Hawes RH, Uzer MF, Smith MT, Lehman GA. Endoscopic stent exchange using a guide wire and a minisnare. *Gastrointestinal Endosc*. 1993;39(6):794-9.
57. Chin MW, Byrne MF. Update on cholangioscopy and biliary strictures. *World J Gastroenterol*. 2011;17(34):3864-9.
58. ASGE Technology Committee, Shah RJ, Adler DG, Conway JD, Diehl DL, Farraye FA, et al. Cholangiopancreatoscopy. *Gastrointest Endosc*. 2008;68(3):411-21.
59. Ahmed O, Mathevosian S, Arslan B. Biliary interventions: tools and techniques of the trade, access, cholangiography, biopsy, cholangioscopy, cholangioplasty, stenting, stone extraction, and brachytherapy. *Semin Intervent Radiol*. 2016;33(4):283-290.
60. Seitz U, Seewald S, He X, Akaraviputh T, Thonke F, Soehendra N. The new Soehendra stent retriever makes stent exchange much easier. *Endoscopy*. 2003 Jan;35(01):98.
61. Weaver MJ, Mullady DK. Endoscopic retrieval of a proximally migrated biliary stent with single-operator cholangioscopy and minisnare. *VideoGIE*. 2020;6(3):131-133.
62. Bills G, Brown J, Gabr M. Cholangioscopy-guided removal of a proximally migrated biliary stent using a modified standard polypectomy snare. *VideoGIE* 2021;6:316–8.
63. Bhandari S, Sharma A, Bathini R, Maydeo A. Endoscopic management of internally migrated pancreatic duct stents (with video). *Indian J Gastroenterol* 2016;35:91-100.