Anastomotic stricture after liver transplantation: It is not Achilles’ heel anymore!

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A B S T R A C T

Biliary-tract complications, such as biliary strictures, anastomotic leaks, choledocholithiasis, and biliary casts, can occur after liver transplantation (LT). Of these complications, biliary strictures are regarded as an Achilles’ heel. Recently, treatment of anastomotic biliary stricture (ABS) has transitioned from conventional surgical revision to a nonsurgical treatment modality. Endoscopic serial balloon dilatation and/or multiple plastic stent replacements are highly effective and are now regarded as the first-line treatments. However, if the patient has undergone anastomosis by means of a hepaticojejunostomy, percutaneous treatment is performed. With recent technological advances and the rendezvous method, the clinical success rates of endoscopic and percutaneous ABS treatments have increased, but these methods fail in some patients who have total obstruction of anastomotic stricture. For these patients, magnetic compression anastomosis (MCA) has been suggested as an alternative method. Animal and human studies have demonstrated the safety and efficacy of MCA, and advancements in these nonsurgical methods have increased the clinical success rate of ABS. This review focuses on ABSs that develop after LT and discusses the clinical results of various nonsurgical methods and future directions.

Keywords: Anastomosis; Bile duct obstruction; Complication; Liver transplantation; Stricture

Introduction

Although the incidence of complications after liver transplantation (LT) has decreased because of advancements in surgical techniques, organ preservation, and immunosuppressive management, biliary complications remain common. Of these, biliary stricture and leakage occur most frequently and are affected by various factors, including the type of graft, reconstruction technique, use of biliary stents, and other characteristics of the recipient and donor. Anastomotic biliary stricture (ABS) occurs because of ischemia at the end of the bile duct, causing a fibro-proliferative response and small bile leaks that induce perianastomotic fibro-inflammatory responses. The incidence of post-LT ABS is 5% to 10% in deceased-donor LT (DDLT) and 15% to 30% in living-donor LT (LDLT). Post-LT ABS is regarded as an Achilles’ heel, because often it is not resolved even by use of multiple treatment modalities. Treatment methods for ABS include both surgical and nonsurgical approaches, such as endoscopic or percutaneous procedures; nonsurgical management has recently become more popular. The use of magnetic compression anastomosis (MCA) for complete biliary obstruction or severe biliary benign strictures that cannot be treated by conventional nonsurgical methods has also been discussed, and its feasibility for post-LT ABS has been suggested. This review identifies effective treatment strategies for ABS by comparing the outcomes of the various methods.

Endoscopic Management

Endoscopic retrograde cholangiopancreatography (ERCP) has been attempted as the first-line treatment modality for post-LT biliary complications, particularly in patients undergoing LT with end-to-end anastomosis. Endoscopic treatment avoids liver puncture and enables access through a nondilated intrahepatic duct, making the procedure safe for patients with cirrhosis, ascites, or coagulopathy. Although endoscopic treatment for ABS can be successful in LT patients who receive Roux-en-Y choledochojejunostomy, it remains challenging, because of the anastomosis site must be approached using a balloon enteroscope or colonscope. Therefore, percutaneous therapy based on interventional radiology is usually performed for ABS that develops following...
LT in patients undergoing Roux-en-Y choledochojiunostomy. ABS treatment by ERCP involves balloon dilatation (BD), the placement of single or multiple plastic stents (MPS), and insertion of a retrievable self-expandable metal stent (SEMS). Standard endoscopic treatment can be summarized as the use of ERCP after sphincterotomy with various combinations of progressive pneumatic BD (from 4 to 10 mm) and/or plastic- or metal-stent insertion with periodic stent replacement.

**BD and/or plastic-stent insertion in patients with ABS after LT**

Although the optimal treatment strategy for ABS is unclear, multiple sessions of BD followed by endoscopic placement of multiple side-by-side plastic stents (BD with MPS) is the most common approach. These treatments have success rates of 70% to 100% in DDLT patients,10–12 and 60% to 75% in LDLT patients.

The incidence of recurrence is 0% to 20% and is usually managed by repeated endoscopic stent placement. Tables 1 and 2 summarize the results of BD with MPS in DDLT and LDLT patients.

The majority of patients with ABS undergo BD and long-term stenting by ERCP at three-month intervals for 12 to 24 months to prevent clogging, cholangitis, and stone formation. This method involves passing a guidewire across the stricture, after which 8.0- to 11.5-Fr plastic stents are inserted following BD to 6 to 8 diameters. If possible, the stent diameter or the number of stents is increased at each session. Although this technique usually requires sphincterotomy of the papilla, similar ABS success rates can be achieved without sphincterotomy by placing the stent above the sphincter of Oddi. The clinical success rate of BD alone is less than 50%, whereas that of BD with MPS is 75% to 100% in DDLT patients, and 60% to 75% in LDLT patients. Dual or multiple stents yield better results than a single stent by ensuring greater dilatation of the stricture. Zoepf et al reported that BD with maximal plastic-stent insertion is more effective and has a lower recurrence rate than does BD alone.

In endoscopic treatment, differences in causes and treatment outcomes can be seen based on when stricture occurs. Generally, post-LT ABS is caused by an improper surgical technique, including excessive use of electrocoagulation, tension at the level of the anastomosis, and inappropriate bile duct dissection, as well as by small-caliber bile ducts, localized ischemia, infections, or fibrotic healing, with most cases occurring within 12 months after LT. ABS that occurs one or two months after LT may result from transient narrowing caused by postoperative edema and inflammation. This type of early ABS has a good response to BD with temporary stent placement. However, in contrast to early narrowing, treatment is more difficult in late strictures, which occur in most patients, because the strictures are more fibrotic and inherently more difficult to dilate than are early strictures because of fibrotic scarring from ischemia in the donor or recipient bile duct near the anastomosis. Therefore, late ABS is managed more aggressively, with ongoing ERCP sessions every two or three months, longer stent durations, and/or a greater number of stents inserted in situ for 12 to 24 months. The recurrence rate of ABS following BD with MPS is 18%, and the mean time for recurrence is 110 days. Because there is a negligible difference between BD alone and BD with MPS in early ABSs that develop within two months after LT, even BD alone can be effective. However, BD with MPS would likely be more effective than BD alone for late ABS.

The procedure-related complication rate in BD with MPS is 0% to 24%, and the complications tend to be minor to moderate, e.g., leakage cholangitis, pancreatitis, and bleeding related to sphincteroplasty. The success rate is based on the time of onset of the stricture, the complexity of the deformity at the anastomosis, and the number of stents placed during the initial procedure. In DDLT patients, a longer stent duration and greater maximal diameter versus a greater total number of stents per patient in MPS are associated with a greater likelihood of a successful outcome. The stricture resolution rate was 97% and 78% for MPS durations of < 12 and ≥ 12 months, respectively. More stents at initial ERCP and more total stents per patient are predictive of stricture resolution.

The outcomes of endoscopic treatment differ with the type of graft in which the stricture occurred. ABS is more common in LDLT patients than in DDLT patients, and treatment rates range from 60% to 75%, because the response to BD with MPS treatment is diminished. In most post-LDLT ABSs, the stricture resolution rate is lower than that for post-DDLT ABSs, because BD alone or BD followed by insertion of a single PS was performed. That is, in LDLT, the donor bile duct and strictures are smaller and anatomically more challenging, with generally more strictures in LDLT patients than in DDLT patients. Moreover, the risks of cholangitis and stent occlusion are higher in LDLT patients than in DDLT patients.

In one study, no differences in the clinical success, failure, complication, or recurrence rates were observed in patients with post-DDLT ABSs treated with BD alone and those treated with BD with endoprosthesis. However, that study lacked a well-designed randomized and controlled evaluation of BD alone and BD with MPS for post-DDLT ABS; so definitive conclusions could not be drawn, because of the small number of enrolled patients. However, such studies emphasize the need for further investigation of the utility of several sessions of BD with MPS.

**SEMS insertion in patients with ABS after LT**

A major disadvantage of endoscopic BD with MPS treatment is the need for multiple procedures over an extended period and the risk of cholangitis resulting from stent occlusion. Although endoscopic BD with MPS management is less invasive and has a high success rate, its disadvantage is that ERCP must be repeated every three or four months for up to two years. Early ABS (< six months post-LT) usually has a good response to a single endoscopic therapy session, but late ABS requires longer treatment, because it is associated with ischemic injury in bile-duct anastomosis. Consequently, frequent replacement and an increasing number of plastic stents are needed because of the development of occlusions within three to six months; thus, BD and plastic stent placement must be performed four or five times at three-month intervals.

There have been attempts to overcome the limitations of periodic plastic-stent replacement by placing temporary single-session SEMSs. Post-DDLT ABS has the following characteristics: (1) ABS at a high level, (2) an acute-angled bile duct, and (3) a narrow lumen of the intrahepatic duct above the ABS. Because of these characteristics of post-DDLT ABS, MPS insertions can be technically difficult within the limited space in the intrahepatic duct and because of the high rate at which plastic stents migrate when the proximal rather than the central portion of the plastic stent is placed at the stricture. SEMS has shown promise in post-LT patients. In benign biliary diseases, uncovered SEMSs are susceptible to reactive hyperplasia and consequence secondary stone formation above the stent, as well as difficult removal six to nine months after placement. Because of these limitations, partially covered or fully-covered SEMS (FCSEMS) is used for benign biliary stenosis. Recently, FCSEMS has been
Table 1 Outcomes of Endoscopic Treatment of ABS in Deceased-Donor LT

| Author (year)     | No. of patients | Type of report | Interval of ABS after LT | Technique | No. of procedures per patient | Technical success rate (%) | Interval of stenting (wk) | Ratio of stent insertion (%) | Stent-free follow-up (mo) | Clinical success rate (%) | Recurrence rate (%) | Complication (%) | Recurrence treatment |
|-------------------|-----------------|----------------|--------------------------|-----------|------------------------------|---------------------------|---------------------------|-----------------------------|--------------------------|---------------------------|----------------------|---------------------|-----------------------|
| Mahajani et al (2000) | 30 R            | 6.9 wk         | BD ± stent               | BD        | 2                           | 100                        | 14                        | -                          | 17.9                     | 100                       | 10                   | 6.4                 | T-tube, PTBD         |
| Schwartz et al (2000) | 15 R            | 19.9 wk        | BD                       | BD        | 1.87                        | 73.3                       | -                         | -                          | 25.2                     | 80                        | 27.7                | 17.4                | Surgery, ERCP        |
| Chabini et al (2001)  | 22 R            | -              | BD + stent               | BD        | -                           | 100                        | 3–4 mo                    | 12                         | 68.8                     | 9                         | 13.6                | -                   |                      |
| Morelli et al (2003)  | 25 R            | 7.8 wk         | BD + stent               | BD        | 3.1                         | 88                         | 13                        | -                          | 54                       | 80                        | 0                   | 3.7                 | None                 |
| Graziedi et al (2006) | 65 P            | -              | BD ± stent               | BD        | 4.1                         | 89.2                       | 4 mo                      | 71                         | 42.2                     | 76.9                     | -                   | 1.2                 | -                    |
| Akay et al (2006)    | 20 R            | -              | BD ± stent               | BD        | 1.65                        | 75                         | 3 mo                      | 73.3                       | 22                       | 53.3                      | 10                  | 20                  | Surgery, ERCP        |
| Holt et al (2007)    | 53 P            | -              | BD + stent               | BD        | 3.2                         | 92                         | -                         | 100                        | 18                       | 69                        | 3                   | 20.7                | Surgery              |
| Pasha et al (2007)   | 25 R            | 2 mo           | BD + stent               | BD        | 3.5                         | 88                         | 2–3 mo                    | 100                        | 21.5                     | 91                        | 18.1                | 5                   | Surgery, ERCP        |
| Elmi and Silverman (2008) | 15 R        | 29 days        | Stent ± BD               | BD        | 3.5                         | 100                        | -                         | 73.4                       | 17.5                     | 87                        | 6.7                 | 33.3                | -                    |
| Barriga et al (2008) | 22 R            | 53 mo          | BD + stent               | BD        | 3.6                         | 95.5                       | 2–4 mo                    | 100                        | 24                       | 67                        | 13.6                | 4.2                 | Surgery              |
| Morelli et al (2008) | 38 P            | 88.9 days      | BD + stent               | BD        | 3.45                        | 100                        | 2 wk                      | 100                        | 11.8                     | 87                        | 13.1                | 5.2                 | Surgery, ERCP        |
| Tabibian et al (2010) | 83 R            | 20 mo          | BD + stent               | BD        | 3                           | 83.1                       | 3 mo                      | 100                        | 11                       | 94                        | 3                   | 5.7                 | ERCP                 |
| Sanna et al (2011)   | 34 R            | -              | BD ± stent               | BD        | -                           | 90.7                       | -                         | -                          | -                        | 64.7                      | 17.6                | -                   | Surgery              |
| Cai et al (2012)     | 38 R            | 6.73 mo        | BD + stent               | BD        | 4.86                        | 83.9                       | 3 mo                      | 100                        | 10                       | 83.9                      | 27.7                | 16.1                | -                    |
| Poley et al (2013)   | 31 R            | -              | BD + stent               | BD        | 5                           | 100                        | 3 mo                      | 100                        | 28                       | 80.6                      | 19.3                | 67.7                | Surgery, FCSEMS      |
| Albert et al (2013)  | 47 R            | 16.25 mo       | BD ± stent               | BD        | 4.2                         | 100                        | -                         | 57.4                       | 37.5                     | 95.7                      | 34                  | 16                  | ERCP                 |
| Faleschini et al (2015) | 79 R           | -              | BD + stent               | BD        | 3                           | 100                        | 2–3 mo                    | 100                        | -                        | 68                        | -                   | 4                   | -                    |
| Tringali et al (2016) | 51 R            | 6.8 mo         | Additive stenting        | BD        | 4                           | 100                        | 4 mo                      | 100                        | 5.8 yr                  | 98                        | 6                   | 5.4                 | -                    |
| Tal et al (2017)     | 58 RCT          | 5.4 mo         | FCSEMS                   | BD        | 7.4                         | 95.8                       | 6–12 wk                   | 100                        | 17.1                     | 95.8                      | 20.8                | 4.1                 | -                    |
| Barakat et al (2018) | 32 P            | -              | Additive stenting        | BD        | 4.1                         | 100                        | 2.5–3 mo                  | 100                        | 6                        | 96.9                      | 1.1                 | 3.1                 | -                    |
| Martins et al (2018) | 32 RCT          | 7.7 mo         | FCSEMS                   | BD        | 7.4                         | 95.8                       | 6 mo                      | 100                        | 36.4                     | 83.3                      | 23.3                | 32                  | -                    |
| 32 RCT              | 9.3 mo          | MPS            | 4.9                      | 100                        | 12 mo                      | 100                        | 32.9                       | 36.4                      | 83.3                      | 23.3                      | 32                  | -                    |

ABS, anastomotic biliary stricture; LT, liver transplantation; R, retrospective; P, prospective; RCT, randomized controlled trial; BD, balloon dilatation; FCSEMS, fully-covered self-expandable metal stent; MPS, multiple plastic stents; PTBD, percutaneous transhepatic biliary drainage; ERCP, endoscopic retrograde cholangiopancreatography.
Table 2  Outcomes of Endoscopic Treatment of ABS in Living-Donor LT

| No. of procedures per patient (mean) | Technique of ABS after LT | Initial interval of stenting (mo) | Ratio of technical success rate (%) | Initial interval of follow-up (mo) | Clinical success rate (%) | Recurrence rate (%) | Complication rate (%) | Recurrence treatment |
|-------------------------------------|--------------------------|---------------------------------|-----------------------------------|-----------------------------------|--------------------------|---------------------|---------------------|---------------------|
| 1                                  | R + stent*               | 3                               | 77.8                              | 77.8                              | 100                      | 19.2                | 92.8                | Surgery             |
| 14                                 | 186 days                 | 6                              | 71                                | 71                                | 100                      | 31                  | 64.5                | ERCP                |
| 17                                 | 8.6 mo                   | 10                             | 73.3                              | 73.3                              | 100                      | 21.5                | 51                  | PTBD                |
| 26                                 | 0.5                      | 10                             | 57.6                              | 57.6                              | 100                      | 22                  | 45                  | ERCP                |
| 41                                 | 6.6 mo                   | 10                             | 85                                | 85                                | 100                      | 23                  | 45                  | ERCP                |
| 41                                 | 6.6 mo                   | 10                             | 52                                | 52                                | 100                      | 23                  | 45                  | ERCP                |
| 41                                 | 6.6 mo                   | 10                             | 46.7                              | 46.7                              | 100                      | 23                  | 45                  | ERCP                |
| 41                                 | 6.6 mo                   | 10                             | 56.8                              | 56.8                              | 100                      | 23                  | 45                  | ERCP                |
| 41                                 | 6.6 mo                   | 10                             | 55.8                              | 55.8                              | 100                      | 23                  | 45                  | ERCP                |
| 41                                 | 6.6 mo                   | 10                             | 79.7                              | 79.7                              | 100                      | 23                  | 45                  | ERCP                |
| 41                                 | 6.6 mo                   | 10                             | 90.1                              | 90.1                              | 100                      | 23                  | 45                  | ERCP                |
| 41                                 | 6.6 mo                   | 10                             | 99.9                              | 99.9                              | 100                      | 23                  | 45                  | ERCP                |
| 41                                 | 6.6 mo                   | 10                             | 9.9                               | 9.9                               | 100                      | 23                  | 45                  | ERCP                |
| 41                                 | 6.6 mo                   | 10                             | 18.8                              | 18.8                              | 100                      | 23                  | 45                  | ERCP                |

*Inside stent was placed within the choledochus above the sphincter of Oddi without performing endoscopic sphincterotomy.

Although SEMSs are reportedly effective in patients who are refractory to plastic-stent treatment, there are arguments for its use as the initial method. Unfortunately, a comparative study on BD with MPS and SEMS lacked a large randomized and controlled trial directly comparing the two, and there are limitations in drawing conclusions from other existing studies because of the heterogeneity of the SEMSs used. In previous studies, SEMSs had a stricture-resolution rate very similar to that for MPS. However, because SEMSs have higher migration rates and differing results, their efficacy in patients with ABS compared to that of maximal plastic-stent therapy is unclear. The ABS resolution rate is 80% to 95% when SEMS patency is ≥3 months and 94% to 100% when dilatation and plastic-stent treatments last for 12 months.  

Although the clinical success rate of biliary stricture treatment using SEMS is 86.4% to 100%, the rates of migration rate (4%–37%) and complications (0%–41%) are high. The main concern in using covered SEMS is migration and the risk of occluding secondary branch ducts or the pancreatic duct, which could cause cholangitis and pancreatitis. SEMSs have a high rate of migration, and mucosal hyperplasia-induced stricture can occur at the proximal uncovered end of partially covered SEMSs. Moreover, SEMS removal is labor-intensive and can occasionally cause mucosal ulceration and bleeding because of the use of traumatic anti-migration systems (e.g., anchor fins). Therefore, a FCSEMS without a traumatic anti-migration system is recommended for treating BBSs, and new types of SEMSs are needed. For the treatment of post-LT ABS, although the efficacy of SEMS and MPS has been used in ABS after DDLT in place of an aggressive approach (MPS insertions with several sessions of ERCP).
evaluated, a large randomized and controlled trial and more data are needed to reach definitive conclusions about SEMSs as compared to BD with MPS in terms of deciding on the optimal stenting protocol, duration, indications, and cost-effectiveness, and whether they should be the primary or secondary treatment modality after MPS replacement.
Percutaneous Treatment

Endoscopic methods are generally accepted as the first-line treatment for post-LT biliary complications, although these treatments are virtually impossible in patients receiving LT with hepaticejunoanastomosis (HJ). Although endoscopic access to the HJ site has become possible with advances in small-bowel endoscopy and balloon endoscopy, its use is limited to hospitals because of the long case times, considerable operator expertise, consistent caseloads required, limited availability of balloon enteroscopes, smaller channel size, and fewer endoscopic accessories; furthermore, its efficacy has not yet been firmly established. In duct-to-duct anastomosis, recanalization using ERCP can fail if the anastomosis is pouch-shaped. Moreover, because the success rate of percutaneous treatment is 40% to 80%, like that of endoscopic treatment, it is considered an important treatment method for biliary complications. A meta-analysis of ABS in DDLT patients revealed no significant differences in the successful intervention rate (60% vs 59.3%; P = 1.00), time to recurrence after successful intervention (44.8 ± 7.4 months vs 41.9 ± 3.4 months; P = 0.47), or complication rate (24% vs 23%) between endoscopic treatment and percutaneous treatment. However, the number of intervention sessions was higher for percutaneous treatment (7.2 ± 0.6) than for endoscopic treatment (2.9 ± 0.6) (P < 0.01). A retrospective study of 498 patients who underwent percutaneous treatment for post-LD LT ABS reported a success rate of 98%, clinical success rate of 88.4%, and recurrence rates of 5% to 17.1%. The success rate of percutaneous treatment has increased because of advances in cannulation techniques, such as the conventional 0.035-inch guidewire, microcatheter, and rendezvous techniques. However, although percutaneous treatment yielded a success rate of 40% to 85%, the procedure is invasive and associated with complications, including hemorrhage, bile leakage, and significant morbidity. Cannulation is difficult if the intrahepatic ducts are not dilated sufficiently, and it involves a 2.2% risk of hepatic-artery injury. Furthermore, prolonged use of percutaneous drainage catheters can cause discomfort in patients; hence, percutaneous treatment can be considered a second-line option for post-LT ABS. For this reason, it is important to increase the treatment rate of ABS by performing percutaneous treatment in ABS patients who failed endoscopic treatment. The rendezvous technique, which combines percutaneous transhepatic biliary drainage and ERCP, involves support from an external drainage catheter. Its success rate is very high, and it is especially useful in angulated and twisted strictures. In a study using the rendezvous technique to treat ABS by means of an ordinary guidewire, such as the Kumpe® access catheter (Cook Medical, Bloomington, IN, USA), the procedural time was reduced. Therefore, in cases with technically difficult biliary access via an endoscopic approach, a percutaneous approach can be useful as an endoscopic and percutaneous/surgical method.

MCA in Patients with Totally Occluded ABS

Endoscopic and percutaneous procedures have high success rates in post-LT ABS. However, recanalization is impossible with conventional endoscopic and percutaneous methods in cases of a severe stricture or complete obstruction that prevents passage of the guidewire. In such cases, surgical revision must be performed, or external drainage catheters must be maintained. Surgical revision of BBSs has morbidity and mortality rates of 9.1% to 28% and 0% to 2.6%, respectively. Moreover, the rate of recurrent strictures requiring further interventions following surgical revision is 10% to 30%. Catheter-related complications can arise when percutaneous external drainage catheters are maintained, and the patient’s quality of life can be compromised. MCA was developed as a nonsurgical alternative for patients with BBSs in whom conventional endoscopic or percutaneous methods failed. The attractive force from the two magnets on both sides of the ABS creates compression, which induces ischemia in the ABS tissue. As the two magnets approach each other, complete necrosis of ABS tissues occurs, and a new fistula is formed to complete the recanalization (Fig. 3). An animal study of anastomoses formed by MCA and surgical hand-suturing revealed no differences in gross appearance, histology, functionality, or mechanical integrity. Histologically, MCA-formed anastomoses exhibited continuity of the serosal, submucosal, and mucosal layers, but neither ischemia nor necrosis. Thus, MCA is safe and equivalent or superior to anastomoses created by traditional suturing or stapling techniques. Overall, 22 MCA procedures for bili-biliary anastomosis and eight MCA procedures for bili-enteric anastomosis have been performed in patients with BBSs. One study observed a stricture resolution rate of 83.3% without complications after MCA performed in patients with post-LT ABS that was refractory to conventional methods, demonstrating the safety and feasibility of MCA. Another limitation is the lack of a noninvasive modality to evaluate the probability of success of MCA. Even if the length of the stricture is measured before MCA by computed tomography, magnetic resonance cholangiopancrea-
tography, and ERCP, MCA can fail if the distance is too great or the axes of the magnet are in parallel. The greater the distance between the magnets, the weaker the attractive power, and magnetic approximation may not occur. In one case, two magnets on the intrahepatic side were used to increase the attractive power, which resulted in successful MCA (Fig. 4). In MCA, various endoscopic and percutaneous methods, along with a surgically made fistula, are used to deliver the magnets. Endoscopic and percutaneous tracts are used primarily in post-LT ABS, but in other types of ABS, the delivery route appropriate for each case was used, indicating that no magnet-delivery system has been firmly established. Therefore, development of a pre-MCA assessment method for predicting outcomes, smaller and more powerful magnets, and an effective magnet-delivery system are needed, as are long-term follow-up data obtained from large-scale studies.

**Conclusion**

The proposed treatment modality for post-LT ABS is as follows (Fig. 5). The initial treatment modality is endoscopic for duct-to-duct anastomosis or percutaneous for HJ anastomosis. If endoscopic treatment fails for duct-to-duct anastomosis, one could try to convert to percutaneous treatment. If percutaneous treatment fails for HJ anastomosis, recanalization by an endoscopic procedure and/or the rendezvous method is a possibility, as they are for duct-to-duct anastomosis. In cases of failed endoscopic and percutaneous therapy for ABS, MCA is an alternative method. Application of these various modalities is expected to increase the success rate of ABS treatment.

For ABS occurring after LT, the clinical success rates of endoscopic and percutaneous methods have been increased by
novel ERCP techniques, advances in endoscopy, better guidewire techniques, and improvements in stent design. Moreover, use of the organic rendezvous technique, which encompasses these two methods, can increase the success rate in patients in whom one of the methods has failed. Furthermore, because MCA has been proposed as an effective and safer alternative for cases that cannot be treated by endoscopic and percutaneous methods, the treatment rate of ABS is expected to increase, whereas reliance on surgical modalities is expected to decrease. In conclusion, ABS after LT is no longer an Achilles’ heel, and adverse events are effectively manageable.

Conflicts of Interest

No potential conflict of interest relevant to this article was reported.

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