Management of complex bile duct injuries.

Authors:
Eduardo de Santibañes.
Victoria Ardiles.
Juan Pekolj.

Department of Surgery and Liver Transplant Unit.
Hospital Italiano de Buenos Aires.
Argentina.

Correspondence to:
Eduardo de Santibañes
Esmeralda 1319 4to piso, 4to cuerpo. CP 1007
Buenos Aires.
Argentina
TEL: (54-11) 4981-4501 FAX: (54-11)4981-4041
eduardo.desantibanes@hospitalitaliano.org.ar; e.desantibanes@gmail.com

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Abstract:

Background:
At present, laparoscopic cholecystectomy is the treatment of choice for gallbladder stones. From the beginning this approach was associated with a higher incidence of biliary injuries compared with the open procedure. The injuries produced during the laparoscopic approach seem to be more complex. A complex biliary injury represents an intricate disease difficult to diagnose and eventually treat. We considered complex injuries: 1) those that involve the confluence; 2) those that have had previous failures in repair attempts; 3) any bile duct injury associated with a vascular injury; 4) or any biliary injury in association with portal hypertension or secondary biliary cirrhosis. The present paper evaluates our experience in the treatment of these complex biliary injuries and analyzes the international literature in the management of these patients.

Key words: complex bile duct injuries, associated biliary lesion, liver transplantation for bile duct injuries.
INTRODUCTION

At present, laparoscopic cholecystectomy is the treatment of choice for gallbladder stones. From the beginning, this approach was associated with a higher incidence of biliary injuries compared with the open procedure. The incidence ranged between 0.3% and 1.3% in the 90’s, establishing itself around 0.6% at present [1-3]. The injuries produced during the laparoscopic approach seem to be more complex than the ones produced during the open procedure due to the more proximal location of the injury in the biliary tree, its frequent association with a vascular injury, and the thermal mechanism usually involved [4,5]. Besides, a high percentage of these injuries coexist with biliary fistula, a fact that conditions the small caliber of the bile duct [6-8]. This obscure picture can worsen if the surgeon performing the operation does not take the correct decision once the bile duct injury is produced.

For a non-specialized HPB surgeon, most of bile duct injuries should be considered complex [9] (Table 1). Surgeons specialized in HPB surgery obtain better results in the treatment of this pathology than the non-specialized ones. Thus, this unpleasant situation for patients and doctors could be avoided if the HPB specialists treated the patient primarily. In order to best treat these complex injuries the approach should be multidisciplinary, i.e. joint work of surgeons, interventional radiologists and endoscopists [10].

A complex biliary injury represents an intricate disease, difficult to diagnose and eventually to treat. Our aim is to analyze the management of complex bile duct injuries.
Management and treatment:

Inadequate management of these complex injuries may cause severe complications, such as biliary peritonitis leading to systemic sepsis and multiple organ failure in the early stages, or secondary biliary cirrhosis (SBC) eventually leading to the need for liver transplantation in the long-term follow-up [11-14]. Although results published by highly acknowledged centers show more than 90% of success in the treatment of these severe injuries, the quality of life of these patients at five years appeared to be severely impaired, both physically and mentally, when compared with patients that underwent laparoscopic cholecystectomy and had no biliary injuries [10].

Diagnosis and treatment of different complex bile duct lesions will be discussed as follows:

A) Injuries that involve the hepatic duct confluence

Initial management depends on the moment of diagnosis and on the type of lesion. The algorithm we used for the management of this type of injuries is represented in Figure1 [15].

1) Injuries identified during laparoscopic cholecystectomy

Only 15% to 30% of biliary injuries are diagnosed during the surgical procedure [16]. In the current series of bile duct injuries treated in the Hospital Italiano, only 23% of the lesions were adverted during the cholecystectomy. Only 21% of these patients had undergone intraoperative cholangiography, and the lesion was identified due to the existence of a bile leak or due to an abnormal cholangiogram.
If the injury is immediately identified during the laparoscopic procedure, the surgeon should carefully consider his skills and experience to repair such injury. Conversion to open laparotomy should be immediate, and the injuries repaired primarily by an experienced HPB surgeon. This will reduce morbidity, will shorten hospital stay and will decrease hospital costs [17]. An inadequate primary repair may increase the incidence of biliary stenosis and of other complications that will need new therapeutic procedures. Every failure to repair these complex injuries is associated with a loss of biliary tissue, and every attempt to repair the injuries goes up in the biliary tree, destroying duct confluence with the possibility of isolating right and left hepatic ducts [9,18]. When the lesion is identified and the surgeon performing the operation cannot repair it, the hepatic pedicle and subphrenic space have to be adequately drained and the patient should be referred to a tertiary center. The ligature of the ducts to allow dilatation should be avoided because of the high risk of cholangitis and bile leak with peritonitis for late slippage of ligature.

There are some guidelines that HPB surgeons should follow:[15,19-21] (Table 2).

The use of intra-anastomotic stents is controversial [4,22,23]. Some authors use them when the bile duct caliber is less than 3 or 4 mm [10,24].

2) Injuries diagnosed in the post-operative course

Most biliary injuries are not identified during laparoscopic cholecystectomy and they become symptomatic weeks, months or years later. When they are diagnosed in the early post-operative period, the definitive treatment should exceptionally be performed immediately. It should be carried out in stages,
combining interventional radiology and endoscopic procedures (treatment of abscesses, bilomas, cholangitis) at the beginning, deferring definitive surgical treatment for 6 to 8 weeks, when local inflammatory phenomena have decreased.

Only if cholangitis or biliary fistula exist do we employ percutaneous transhepatic biliary drainage (PTBD) in order to stabilize the patient and to improve local conditions. Some schools use PTBD as a routine procedure previous to any surgical approach and, after the bilio-enteric continuity is performed, they change the stent for a sylastic softer one, internalizing it in the same procedure [4].

Hilar and subphrenic collections should be ruled out with an abdominal ultrasound. A contrast-enhanced computed tomography (CT) sometimes has the capacity of defining the injury level as well as vascular injuries and parenchymal atrophy [23].

Biliary anatomy should be thoroughly investigated before any attempt at surgical repair. Nowadays, if any doubt exists we complete the (CMRI) with a PTC performed when the patient is in the operating room for the definitive surgical procedure [25].

In Stewart and Way’s communications, operations performed to repair bile duct injuries were unsuccessful in 96% of the patients when cholangiograms were not obtained preoperatively, and they were unsuccessful in 69% of the patients when cholangiographic data were incomplete [9].

If a vascular injury is suspected either because of some abnormality of the previous studies or because of a bleeding accident during the laparoscopic cholecystectomy, performance of an abdominal angiography should be
prompted in order to define the hepatic artery and portal vein anatomy integrity (Figure 2).

As it has already been mentioned, while some authors defer the definitive surgical treatment for 6 to 8 weeks after the bile injury has occurred [4,11], others defer the definitive treatment only if the patient is unstable. They argue that the waiting time increases the complication rate due to drainage obstructions or displacement, and that the deferred treatment is difficult to maintain in the outpatient setting. With this strategy, they are able to perform the bile reconstruction with a median of 2 days after the patient’s admission, resulting in an average length of stay of eleven days (median: 9 days) compared with a 32-day average reported by other authors that defer the treatment [26].

In our opinion, a very important advantage of the management is that, if we take into account that the laparoscopic biliary injuries very often have a thermal mechanism, the 6 or 8 weeks previously mentioned allow the lesion to progress to the last stage before repair [15,25].

As many other surgeons, we approach the left hepatic duct as it has been described by Hepp and Couinaud, in order to obtain normal tissue with good vascularization, so as to perform a wide anastomosis [25,27,28]. Bismuth Type E3 lesions are ideal to be repaired with this technique. When the ducts are isolated, in Bismuth Type 4 or 5 lesions, the left hepatic duct can be approached using the previously mentioned technique. If the right duct does not have a good exposure, it can be approached by performing a hepatostomy in the gallbladder fossa direction as it has been described by Jarnagin and Blumgart, and by Strasberg et al. [19,29]. The same tactics can be used when
the lesion is Bismuth type 5 or Strasberg type E5. In these cases, the preoperative placement of a PTBD can be extremely useful not only to have a biliary map but also to localize a small right posterior duct during the surgical repair. Sometimes, it is necessary to catheterize both ducts in the right side, one for the anterior and the other for the posterior sector.

3) The isolated right posterior hepatic duct injury

We consider it a complex lesion due to its difficult diagnosis and its many repair failures after treatment. The reason for these failures is the small caliber of the posterior hepatic segmental duct, which, when injured, is isolated high up in the hilum [30]. The tactics used for its diagnosis depends on whether the isolated hepatic duct has been ligated or not (Strasberg type B or C injury). In type B, as both ends of the duct have been ligated, most of the times the patient is asymptomatic and the hepatic lobe becomes atrophied without any other sequelae. Although the ERCP can seem normal in type C, the lesion must be suspected because of the existence of a biliary fistula, and because the posterior segment of the right hepatic duct does not appear in the cholangiography. In these circumstances, a HIDA scintigraphy or a percutaneous transhepatic cholangiography (PTC) can also show the disconnected duct [31] (Figure 3).

There is some controversy regarding the management of the lesion of 2- or 3-mm. ducts when they are identified during the laparoscopic cholecystectomy. If the duct has not been manipulated, some authors prefer to ligate it without performing anastomosis. In this case, we perform an intraoperative cholangiography of the injured duct, and if the area that this duct drains is large
enough, we always carry out a Roux-en-Y hepatojejunostomy no matter how thin the duct is. If during the long-term follow-up, a stenosis occurs, dilatation through interventional radiology is our option because bilio-enteric continuity already exists. If this technique fails and the patient is symptomatic, hepatic resection has to be performed [32] (Figure 4).

Indications for liver resection are biliary confluence destruction associated with portal lesion and destruction of right anterior or posterior collectors with severe lobar atrophy. In a series of 77 patients with biliary injuries, Sauvanet et al. used hepatic resection in 15% of the cases [33].

In our series, 3 patients with Strasberg Type C and E5 lesions were treated after failure of hepaticojejunostomy with balloon dilatation (one of these 3 patients had an associated vascular injury). This method failed in all the patients and we performed a hepatic resection with good outcome.

B) High stenosis with previous repair attempts failures.

Patients in whom several attempts at repair have failed represent complex cases and a surgical challenge. They should be thoroughly studied to avoid a new failure. The work-up must always include an abdominal angiography because a vascular associated injury can be the reason for failure. Koffron et. al. reported that 61% of patients with biliary injuries, in which primary repair attempts had failed, had vascular associated lesions. The higher the stenosis was, the greater the incidence of vascular associated lesions was; 71% in Bismuth Type 4, 63% in Bismuth Type 3 and 33% in Bismuth Type 2 [34].

Generally, these repeated failures in biliary repair cause a long period of cholestasis due to poor bilio-enteric drainage. Prolonged biliary obstruction may
lead to progressive hepatic fibrosis and secondary biliary cirrhosis with portal hypertension. The latter is considered an ominous predictive sign of morbidity and mortality. Its diagnosis prior to a therapeutic decision is crucial [19,35,36]. In a recent study of biliary stenosis, hepatic histopathologic changes were found in most patients: grade I hepatic fibrosis in 47% of patients, grade II in 34%, and grade III in 11% [37].

If the patient does not have severe portal hypertension and the stenosis is either extrahepatic or limited intrahepatic, the surgical approach is used. We perform a wide bilio-enteric anastomosis 1 cm above the stenosis. If the stenosis has an associated lobar atrophy, or if it is too long inside the liver and it is associated with cholangitis, we carry out ipsilateral liver hepatectomy and perform a hepatico-jejuno anastomosis with the opposite duct. Hepatic resection was performed in 3 patients of our series (2 right and 1 left) due to destruction of the hepatic confluence and high-up stenosis inside the liver parenchyma.

Interventional radiology has become a therapeutic option for many of these patients in which morbidity and mortality can be increased due to portal hypertension. It is also useful to dilate long thermal intrahepática stenoses that have progressed high inside the liver and are very complex to be approached surgically. The sole condition is that bilio-enteric continuity exists [38,39]. S. Misra et al. treated 51 patients with this approach, 50 (98%) of which were stent-free at a mean follow-up of 76 months. The success rate of percutaneous management was 58.8%, needing no subsequent intervention [40].

For the management of complex biliary stenosis we use the algorithm described in Figure 5.
C) Bile duct injuries associated with vascular lesion

As a result of the close relationship between the common hepatic duct and the right hepatic artery, it is not unusual to injure this artery during laparoscopic cholecystectomy if a bile duct injury occurs. In an autopsy study of cholecystectomized patients with open procedure, the incidence of vascular lesions was 7% [41]. After laparoscopic cholecystectomies this incidence can be as high as 12% or 39% [9]. In 27 life-threatening complex biliary injuries (Bismuth type III, IV and V), J Buell et al. found associated arterial injuries in 26% of the cases [42]. Such arterial lesions were more frequent when the biliary lesion was more proximal [34,42].

Although hepatic artery ligation can be well tolerated, there are some factors that can condition this tolerance [43,44]. Normal portal blood flow and the continuity of the liver collateral circulation have to remain intact when the hepatic artery or one of its branches has been ligated. In some circumstances, this arterial ligation is not well tolerated, leading to ischemic infarction of the liver tissue.

The biliary duct is extremely sensitive to arterial blood supply deprivation and cannot tolerate surgical manipulation [45]. There are arterial bridges between the left and right hepatic arteries at the level of the hilar plate called hilar plexus. The knowledge of its existence is crucial when a biliary injury is being repaired, since its attrition, as a consequence of an excessive dissection, can result in a poor outcome.

When a biliary injury occurs just below the hepatic confluence and the right hepatic artery is also injured, the blood supply to the right hepatic duct is
maintained through the hilar plexus, which is fed from the left hepatic artery [46]. Surgeons must identify all arterial branches in the hepatic hilum and must not ligate potentially useful collaterals such as a left hepatic branch coming from the left gastric artery or other collateral branches during liver exploration.

There still exists some controversy regarding the consequences and implications that the association of a bile duct injury and an arterial injury may have. Alves et al. state that 19 out of 43 patients with biliary injuries had an associated right hepatic arterial lesion. All these patients underwent a Roux-en-Y hepaticojejunostomy. The authors found no differences regarding intraoperative management, blood consumption, post-operative complications, outcome in the long-term follow-up (mean time: 56 +/- 23 months) in patients with or without vascular injuries [7].

Koffron et al. have reported the failure to repair 18 consecutive cases with biliary injuries that were referred to a tertiary center. In 61% of the cases they identified associated vascular injuries. They concluded that arterial disruption may affect the outcome of primary management of bile duct injuries [34].

J Buell et al. found that an associated arterial injury is an independent predictor of mortality (38% with vs. 3% without arterial injury p<0.001) [42].

In a comprehensive review, Shallaly et al. advise to assess arterial compromise in all biliary injuries, since management and outcome are influenced by the absence of arterial blood flow [47]. The vascular lesion has to be suspected when a bleeding accident during laparoscopic cholecystectomy occurs, when there is a sudden rise in ALT during early post-operative course, or if there are multiple metallic clips on plain film images of the abdomen. In these cases, an
abdominal angiography is always indicated to rule out any arterial or portal venous damage.

We never use Doppler ultrasound in the above mentioned cases, as other authors have described, due to the existence of collateral circulation that produces false positive results [34].

If a vascular and biliary associated lesion is identified during the intra-operative procedure, the immediate reconstruction of both lesions has to be accomplished, thus avoiding a possible hepatic necrosis, a hepatico-jejunostomy anastomotic fistula or a bile duct stricture in the long term follow-up [46,48]. The technique for arterial reconstruction will depend on the type of lesion. A direct anastomosis can be done if there is no loss of arterial tissue and if the sectioned ends are not attritioned. If the hepatic artery has been resected, an inferior mesenteric artery is the preferred interposition graft to be used.

The literature has not clearly stated what approach to take if the arterial occlusion is detected later. The controversy takes place because late arterial reconstruction will not avoid the already existing hepatic necrosis. However, the influence on the hepaticojejunostomy anastomosis remains unknown [46].

If an arterial injury is suspected in the immediate postoperative period, a complete abdominal angiography including portal vein evaluation has to be done. It is extremely important to identify the distal arterial end, and to find out if there is good retrograde flow through it during the surgical approach.

If the arterial occlusion has an attritioned distal end or has no retrograde flow that prevents reconstruction, but it coexists with good portal flow and lobar ischemia is not evident, a hepaticojejunostomy can be performed due to the fact that many patients have a good evolution. On the other hand, if arterial
reconstruction is impossible due to technical reasons and lobar ischemia is evident, hepatic resection is indicated together with a hepaticojejunostomy in the remaining duct [49-51]. Since the clearing function of the liver with the translocated intestinal bacteria is impaired after ischemia, it is important to maintain these patients with high antibiotic levels in blood just to avoid septic complications in the ischemic liver parenchyma [52,53].

D) Bile duct injury associated with portal hypertension or secondary biliary cirrhosis.

Successive failures of therapeutic procedures or inappropriate treatment of cholestasis and infection may lead to end-stage liver disease within few years after the injury [54,55]. In historical series of bile duct reconstruction, the incidence of portal hypertension and SBC was 8%[56]. Jonhson et al. stated that the development of hepatic fibrosis confirmed by liver biopsy was associated with a delay in the performance of the adequate treatment in patients with biliary stenosis [57]. The presence of cirrhosis during bile duct injury repair is also considered an ominous sign and the most important risk factor to predict morbidity and mortality increase [58]. In Chapman et al.'s series of bile duct injuries, 23 patients had portal hypertension and a high mortality rate during surgical reconstruction (26%). The mortality rate for patients with PH who underwent some surgical procedure was 23% (n=5). In contrast the mortality rate in patients without portal hypertension, who underwent some surgical procedure was only 2% (n=2) [18]. Also, the results of biliary reconstruction in patients with
cirrhosis are poor. Pellegrini et al. report only 25% of good results in patients with recurrent biliary stenosis associated with biliary cirrhosis [36]. SBC by itself has a poor prognosis and a high late mortality rate in spite of the patency of the hepaticojejunostomy [59].

The time required for the development of SBC after benign biliary stenosis has been reported to be 7.1 years, 4.6 years in those with common bile duct stones, and 0.8 years in patients with malignant biliary obstruction [60]. Recent studies describe the time of obstruction, basal ALT level, and time to normalization of ALT level after surgical repair as predictive factors in the development of hepatic fibrosis [37].

Patients with complex biliary injuries and portal hypertension who have biliointestinal continuity are treated by interventional radiology in our unit. If this continuity does not exist and the patient has some contraindication for liver transplantation, the bile duct is drained with a TPBD and portal hypertension is treated with a Transjugular Intrahepatic Portosystemic Shunt (TIPS) or a mesocaval shunt before bile duct repair. On three opportunities we treated patients with biliary stenosis associated with cavernomatous transformation of portal vein. These patients had undergone a mesocaval shunt previous to the hepaticojejunal anastomosis with a good outcome.

Most of the histologic changes produced in the early obstruction stages are reversible if the adequate treatment is performed in due time [61]. Unfortunately, many patients arrive at our unit late, after having undergone multiple unsuccessful treatments and with signs and symptoms of end-stage liver disease. To date there have been few publications about liver transplantation as a treatment for SBC [62-65].
In 2002 our experience was published [13]. In a ten-year period (1988-1998) 8 out of 14 patients with SBC were transplanted. The most evident proof of the severity of these 14 patients that were included in the transplant waiting list with SBC was the mortality rate (28.5% i.e. 4 patients). One of the patients had an injury of the right arterial and portal pedicle which led to complete atrophy of that lobe [13].

Intractable ascites, repeated episodes of variceal bleeding, repeated cholangitis, progressive jaundice, pruritus and poor quality of life are indicators for the need of liver replacement [66]. The hospital mortality rate of this series was 12.5% [13], similar to results reported in the literature [63]. The five-year survival rate of liver transplantation for benign diseases exceeds 80% with excellent quality of life. Up to now, we have transplanted 16 patients with an actuarial 1-year survival rate of 91.7%. On the other hand, we lost 4 patients who were on the waiting list.

Biliary injuries produced during laparoscopic cholecystectomy have proved to be more severe and complex. These lesions represent an intricate disease, difficult to diagnose and eventually to treat. Inadequate procedures, multiple interventions performed by inexperienced surgeons, and delayed referrals to specialized centers may result in late complications sometimes requiring liver transplantation as the only possible treatment.
References:


19-Jarnagin WR, Blumgart LH. Operative repair of bile duct injuries involving the hepatic duct confluence. Arch surg 1999; 134: 769-775


24-Mercado Miguel, Orozco H et al. To stent or not to stent bilio enteric anastomosis after iatrogenic injury: A dilemma not answered. Arch Surg 2001;1:60-63


29-Strasberg SM, Picus DD, Delvin JA. Results of a new strategy for reconstruction of biliary injuries having an isolated right sided component. Journal of Gastrointestinal Surg 2001;3:266-274

30-Suhocki,P V, Meyers W C. Injury to aberrant bile ducts during cholecystectomy. A common cause of diagnostic error and treatment delay. AJR. 1999;172:955-959


49- Schmidt SC, Langrehr J M, Raakow R, Klupp J, Steinmuller T, Nehaus P. Right hepatic lobectomy for recurrent cholangitis after


53-Schatlen WE. The role of intestinal bacteria in liver necrosis following experimental excision of the hepatic arterial supply. Surgery.1954;36:256-269).


Table 1. Criteria to define a complex bile duct injury.

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<td>a)</td>
<td>Injuries that involve the hepatic duct confluence, i.e. Bismuth class III, IV, V (combined or not with common bile injury); or in Strasberg classification Type E3, E4, E5. (13, 14, 15, 16).</td>
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<td>b)</td>
<td>High stenosis with previous repair attempts. (17)</td>
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<td>c)</td>
<td>Any biliary injury associated with a vascular injury. (14, 16, 18).</td>
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<td>d)</td>
<td>Biliary injuries associated with portal hypertension or secondary biliary cirrhosis (16, 19)</td>
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Figure 1. Algorithm for management of intraoperative diagnosed biliary injuries.

- **Biliary Injury**
  - **Intraoperative diagnosis**
    - **Partial section**
      - Without thermal lesion
        - Suture without t-tube
    - **Total section**
      - Without thermal lesion
        - T-T anastomosis with t-tube
      - **Biliary resection**
      - Thermal lesion
        - Experienced Surgeon
        - Inexperienced Surgeon
          - Hilar and subphrenic drainage
          - Roux-en Y hepato jejunostomy
Table 2. Guidelines for treatment of bile duct injuries

1. Exposure of damaged area avoiding too much dissection
2. The end of injured bile duct has to be free from burns and attritions
3. Intraoperative cholangiography in every bile leakage
4. Vascular integrity should be confirmed
5. Hepaticojejunostomy with an isolated Roux-en-Y
6. Opposition of both mucosas with reabsorbable suture
7. Use of magnification
Figure 2. Associated vascular injury. A. CT Scan with hipodense right liver lobe, B Angiography with injury of right hepatic artery and right portal branche.
PTBD: percutaneous transhepatic biliary drainage. ERCP: endoscopic retrograde cholangiopancreatography, PTC: percutaneous transparietal cholangiography; CMRI: cholangioRMI

Strasberg type C

ERCP can seem normal

But a fistula does exist!!

Not manipulated duct

Hepaticojejunostomy

Small territory

Suture

Stenosis

Hepatic resection

HIDA or PTC, CMRI

Manipulated duct

Strasberg type B

Both ends have been ligated

Cholangitis

PTBD

Most of the times the patient is asymptomatic and the hepatic lobe becomes atrophic

Hepaticojejunostomy

Figure 3. Management of Strasberg Type B and C biliary injuries.
Figure 4. Intrahepatic multiple stenosis in right bile duct. A CMRI with stenosis. B. CT scan after right hepatectomy.
Complex biliary stenosis

No cholangitis

Surgical treatment

Cholangitis

Percutaneous transhepatic biliary drainage

Stenosis
Bismuth Type 3,4,5

Lobar atrophy. Localized Intrahepatic stenosis

Portal hypertension. SBC. Extended intrahepatic stenosis

Hepatico-jejunostomy

Hepatectomy. Percutaneous dilatation

Interventional radiology. Liver tx.

Figure 5. Algorithm for management of postoperative diagnosed biliary stenosis