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Biliary Strictures: Classification Based on the Principles of Surgical Treatment

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Abstract. The classification of biliary strictures used at Hôpital Paul Brousse is based on the lowest level at which healthy biliary mucosa is available for anastomosis. The classification is intended to help the surgeon choose the appropriate technique for the repair. Type I strictures, with a common duct stump longer than 2 cm, can be repaired without opening the left duct and without lowering the hilar plate. Type II strictures, with a stump shorter than 2 cm, require opening the left duct for a satisfactory anastomosis. Lowering the hilar plate is not always necessary but may improve the exposure. Type III lesions, in which only the ceiling of the biliary confluence is intact, require lowering the hilar plate and anastomosis on the left ductal system. There is no need to open the right duct if the communication between the ducts is wide. With type IV lesions the biliary confluence is interrupted and requires either reconstruction or two or more anastomoses. Type V lesions are strictures of the hepatic duct associated with a stricture on a separate right branch, and the branch must be included in the repair. Although this classification is intended for established strictures, it is commonly used to describe acute bile duct injuries. The surgeon must be aware, however, that the established stricture is generally one level higher than the level of the injury at the original operation.

The aim of a biliary repair (whether primary or secondary after failure of previous repairs) is reconstruction of normal biliary anatomy or a wide anastomosis joining healthy biliary mucosa to the mucosa of the intestinal tract. We describe the repair technique as it is practiced in our center and discuss the classification based on this technique [1, 2].

Repair Technique and Classification of Biliary Strictures

After an injury to the biliary tract, unless the patient is referred the day of the injury, the strategy of delayed primary repair is preferred. It consists in treating the complications of the injury (bile peritonitis by drainage, either percutaneous or by laparoscopic; biliary fistula by optimizing the outflow and tolerability; jaundice and itching by symptomatic treatment) and postponing the repair until the biliary tree has dilated as a result of stricture formation. A delay of a month is generally necessary for the local inflammation associated with the previous operation and the biliary fistula to subside, and it facilitates the dissection. The patient is followed up with sequential ultrasound scans and operated on when the biliary confluence is 10 mm wide. Cholangitis is rare if the bile duct has not been instrumented. The time taken by the biliary stump to dilate is generally 2 to 3 months from the injury during which time the natural sequence, from bile peritonitis to a stricture, must be monitored. Occasionally a shorter interval is enough if the duct has been occluded by a clip, the patient presents with jaundice and a dilated biliary tree, and little local reaction is anticipated because of the absence of a leak.

An end-to-end bile duct reconstruction, the preferred technique for immediate repair if there is no loss of tissue, is rarely possible on an established stricture because of tension and the size discrepancy between the two stumps. A hepatojejunal reconstruction with a Roux-en-Y loop is preferred. The loop is 70 cm in length to prevent the flow of alimentary material into the biliary tree and is brought through the mesocolon in the avascular window next to and to the right of the duodenum [3].

The repair technique takes into account the anatomy of the hepatic hilum (Fig. 1, 2) with the modifications induced by the local inflammation and biliary leak consequent to the injury. The adhesions between the inferior aspect of the quadrate lobe and the hepatic pedicle give the impression that the stump has retracted into the liver. Dissection of the quadrate lobe from the colon and duodenum and of the duodenum from the hepatic pedicle reestablishes some of the length of the hepatic pedicle (Fig. 3a, b). Further length and exteriorization of the biliary stump from its apparent intrahepatic position can be obtained by freeing the quadrate lobe from the hepatic pedicle (Fig. 3c). If the biliary stump is long enough, it can be found at this point by puncture with a fine needle, and an intraoperative cholangiogram is obtained. Although the length of the stump can be estimated by cholangiography (preoperatively or intraoperatively), it is the length of healthy biliary mucosa that is available for anastomosis with the jejunum that dictates the type of repair and classification of the stricture. After cholangiography the stump is opened along its anterior aspect to avoid troublesome bleeding from the posterior aspect of the duct or, worse, injury to the portal vein. If 2 cm of biliary mucosa can be obtained simply by these maneuvers, the stricture is a lower pedicular stricture, or *type I stricture* (Table 1, Fig. 4). To limit the dissection of the hepatic pedicle, which is

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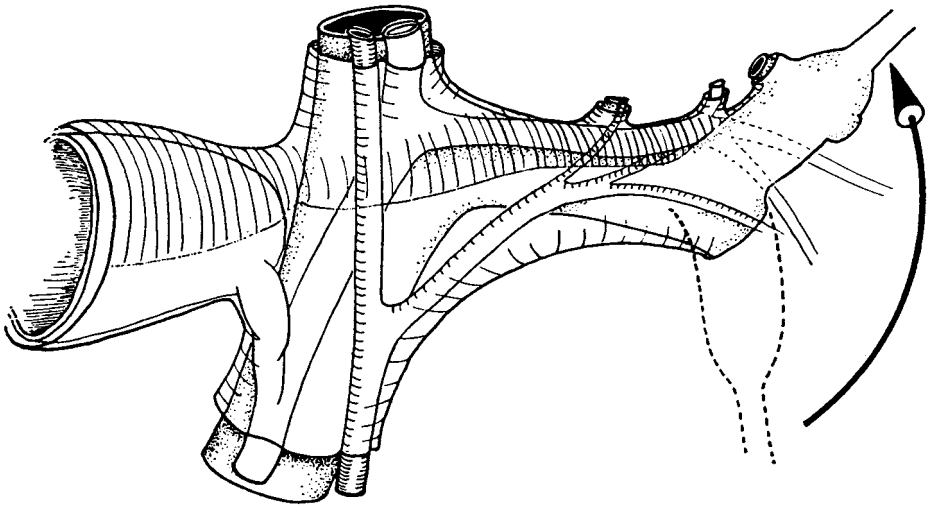

Fig. 1. Anatomy of the hepatic hilum. Hilar plate (hatched area) covers the elements of the hilum and is in continuity with the gallbladder plate on the right and the umbilical plate on the left. Bile ducts are immediately under the hilar plate along the whole length of the hilum, with no blood vessels in between.

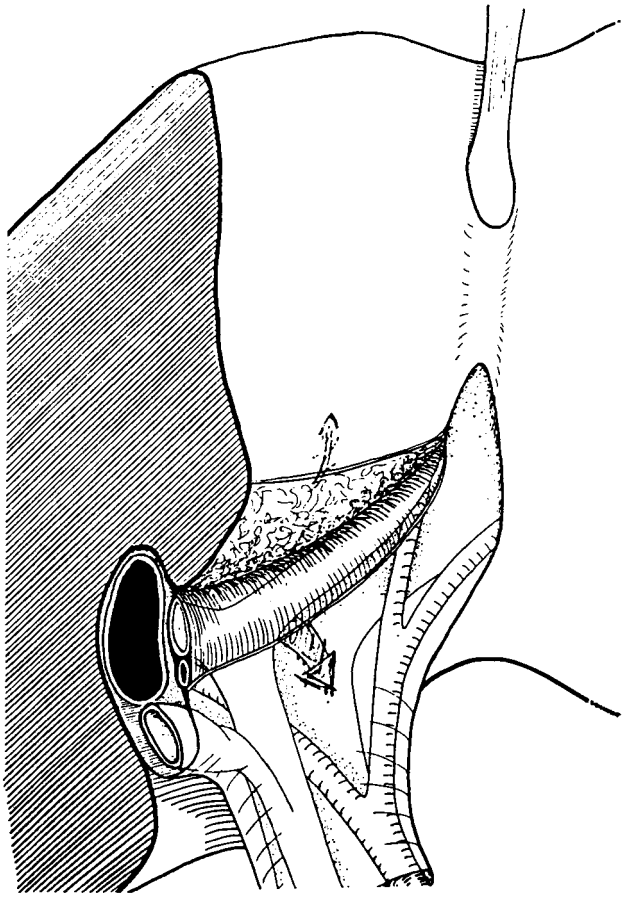

Fig. 2. Lowering the hilar plate. This maneuver lowers the anterior aspect of the biliary confluence and that of the left and right ducts.

dangerous particularly if a previous repair has been attempted, the anastomosis is made side-to-side. Care must be taken to avoid injury to arterial branches that may cross the duct anteriorly.

If the stump is shorter than 2 cm, a satisfactory length for anastomosis (i.e., approximately 2 cm) can be obtained by extending the opening on the anterior part of the stump into the left duct, an artifice that defines a *type II stricture*. Lowering the hilar plate, as originally described by Hepp and Couinaud [4], is not mandatory but may improve exposure of the left duct: Once the dissection on the hepatic pedicle has been taken to the junction between the quadrate lobe and the hilum, the liver capsule at this junction is incised, and the plane between the liver and the hilar plate is entered. Bleeding is usually minor and ceases with compression or a few points of diathermy. The dissection is continued until the hilar plate is lowered and rotated forward; the superior part, with the biliary confluence, left hepatic duct, and right hepatic duct, becomes the anterior part. In strictures where no stump of the hepatic pedicle is present but the right and the left duct communicate, at least through healthy mucosa on the ceiling of the biliary confluence, a satisfactory length for the anastomosis can be obtained by opening the left duct along its length (*type III strictures*); lowering the hilar plate is always necessary. If lowering the hilar plate is not sufficient, further exposure can be obtained on the left by cutting the parenchymal bridge that often joins segments 3 and 4 across the round ligament. These maneuvers do not lengthen the left bile duct but facilitate its approach because they abolish the hump of the posterior part of the quadrate lobe. If the ducts are separated or communicate only by a narrow opening with indurated lining (called callus), separate anastomoses are required or reconstruction of the biliary confluence is needed, defining *type IV strictures*. The mobility and exposure of the right duct can be improved by opening the retracted tissue of the gallbladder plate with the diathermy point until the most superficial part of the liver parenchyma in the gallbladder fossa is incised (cave a branch of the middle hepatic vein if the incision is carried too deep).

Type V lesions are special insofar as a separate right duct is present in addition to stenosis of the main bile duct. For optimal repair, the right ductal injury must be known from the history, examination of an early postoperative or later radiographic study, or sometimes the cholangiogram obtained during the repair. The duct must be included in the repair by reconstructing a new biliary confluence or by a separate anastomosis. Failing to do so exposes the patient to the risk of recurrent cholangitis originating from the excluded segment or sector.

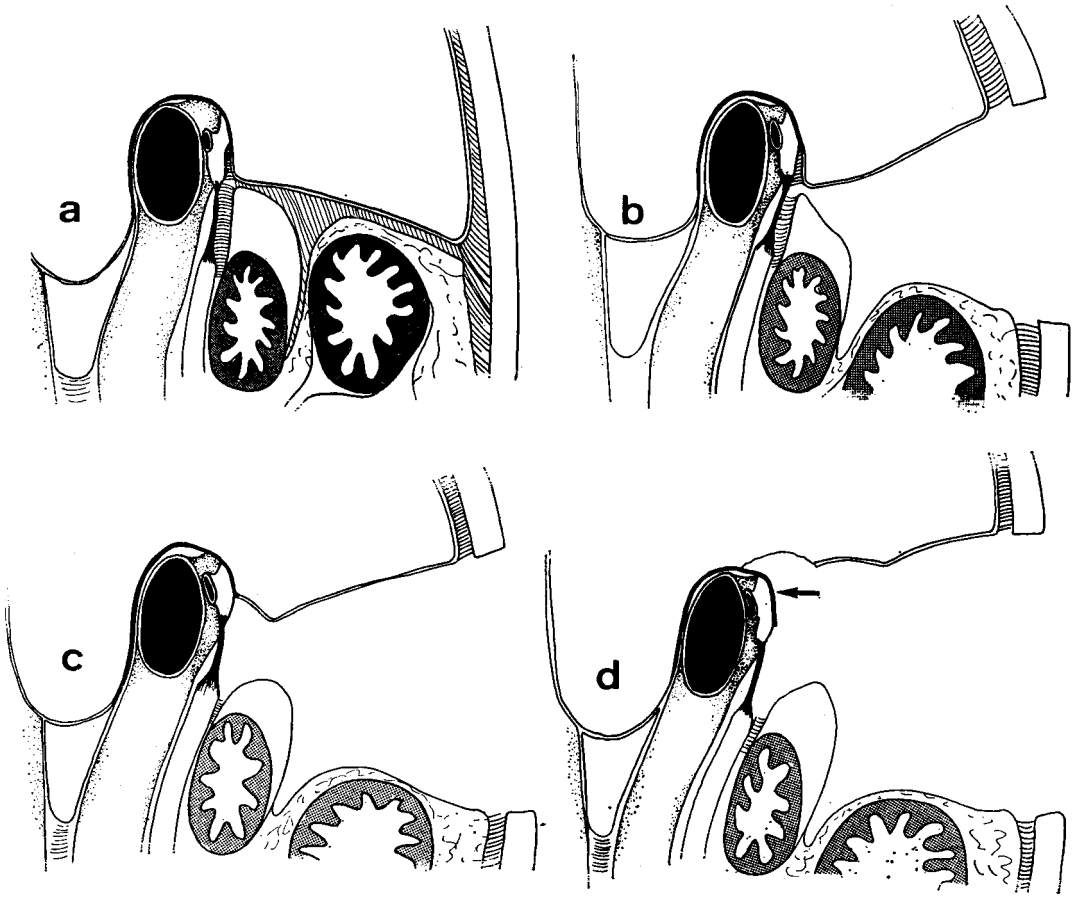

Fig. 3. Technique for exposing the hepatic hilum to treat a postoperative biliary stricture. **a.** Anatomy of the hilar region demonstrating adhesions between the quadrate lobe, duodenum, and colon. The inferior aspect of the quadrate lobe covers the biliary stump. **b.** After freeing the colon and duodenum, the biliary stump appears to be intrahepatic. This is a false impression owing to adhesions between the inferior aspect of the quadrate lobe and the hepatic pedicle. **c.** Dissection between the inferior aspect of the quadrate lobe and the hepatic pedicle is completed, exposing the whole length of the biliary stump in the hepatic pedicle. If, after opening of the stump, 2 cm of healthy biliary mucosa is available for the anastomosis, no further dissection is needed (type I stricture). **d.** Incision of Glisson's capsule at the posterior border of the quadrate lobe gives access to the superior aspect of the hilar plate. Rotating the hilum forward and inferiorly exposes the anterior aspect of the biliary confluence and left duct, which can be opened to lengthen the anastomosis.

Table 1. Classification of established biliary strictures and the repair technique.

Type	Definition (available healthy biliary mucosa) (see Fig. 1)	Repair
I	Common hepatic or main bile duct stump $\geq$ 2 cm	Anterior opening of the stump of the bile duct and side-to-side anastomosis with a jejunal loop
II	Common hepatic duct stump $<$ 2 cm	Anterior opening of the stump extending onto the left duct; lowering the hilar plate is not mandatory but may help expose the left duct
III	Ceiling of the biliary confluence is intact; right and left ductal systems communicate	Lowering the hilar plate and anterior opening of the left duct; extension into the right duct not necessary if the communication between the right and left branches is wide
IV	Ceiling of the confluence is destroyed; bile ducts are separated	Lowering the hilar plate; reconstruction of the ceiling of the biliary confluence or separate anastomosis on the right and left ducts
V	Type I, II, or III+ stricture of an isolated right duct	As above+ separate anastomosis of the isolated right duct
Isolated right duct or right branch stricture	—	Anastomosis on the isolated right duct or abandon (according to presentation and symptoms)

Isolated right branch strictures, sparing drainage of the left liver and a variable number of segments in the right liver, do not belong to the original classification of bile duct strictures, as the descriptive term is sufficiently explicit. Treatment and the reconstruction modalities cannot be generalized, depending to some extent on the volume of liver tissue involved and the mode of presentation. Whereas it is acceptable to treat expectantly strictures with few symptoms accompanied by atrophy of the corresponding liver, recurrent episodes of cholangitis require repair following the principles stated above. Resection of the affected parenchyma is necessary only in exceptional circumstances.

The above-mentioned classification of biliary *strictures* has been integrated in a commonly used classification of biliary *injuries* after laparoscopic cholecystectomy [5]. The surgeon must be aware, however, that the level of the injury is generally lower than the level of the stricture that results because of initially inapparent ischemic or thermal damage and because of some compensatory shortening that accompanies dilatation of the duct above the stricture.

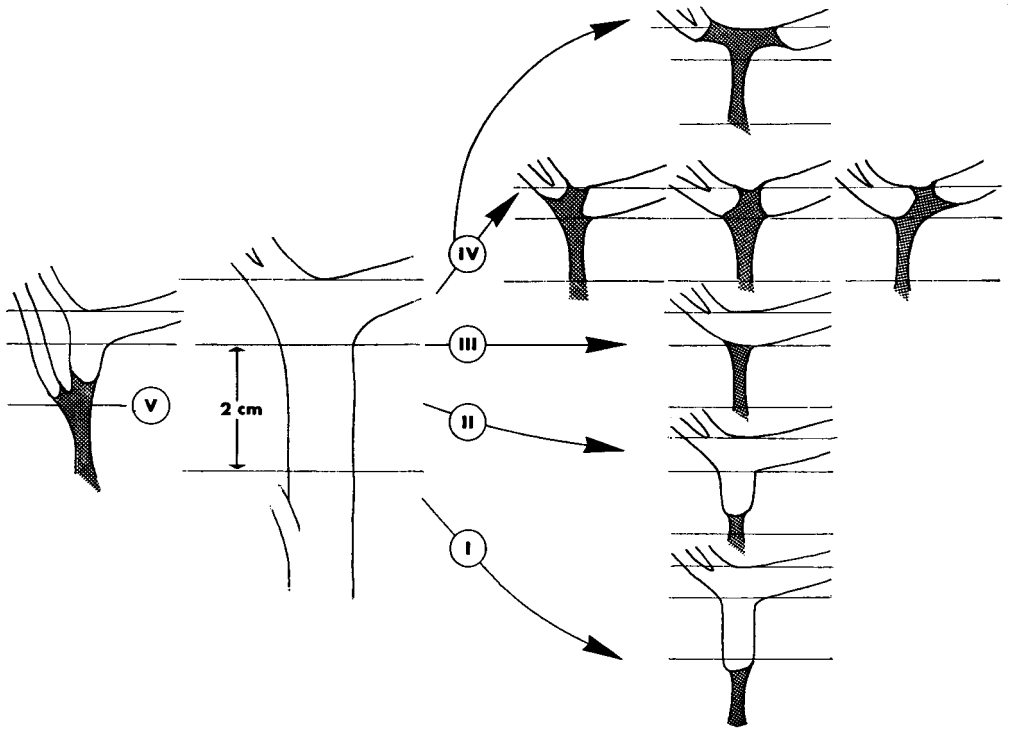

Fig. 4. Classification of biliary strictures based on the repair technique (Table 1).

Résumé

La classification des sténoses de la voie biliaire utilisée à l'Hôpital Paul Brousse est basée sur le plus bas niveau de muqueuse saine de la voie biliaire principale disponible pour anastomose. Cette classification a pour but d'aider le chirurgien à choisir la technique la plus adaptée pour réparer la voie biliaire. Dans les sténoses de type l, le moignon restant de la voie biliaire est au moins 2 cm long et peut être anastomosé sans avoir besoin ni d'ouvrir le canal gauche ni d'abaisser la plaque hiliaire. Dans les lésions de type II où la longueur du moignon de la voie biliaire est inférieure à 2 cm, il faut, pour réaliser une anastomose satisfaisante, ouvrir le canal gauche. II n'est pas toujours nécessaire d'abaisser la plaque hiliaire, mais ce geste peut améliorer l'exposition. Les sténoses de type III, dans lesquelles seul le plafond du confluent supérieur est intact, nécessitent un abaissement de la plaque hilaire et une anastomose sur le foie gauche. II n'est pas nécessaire d'ouvrir l'arbre biliaire du foie droit si la communication entre les deux foies est large. Dans les lésions de type IV, le confluent supérieur est interrompu, et la reconstruction nécessite deux anastomoses séparées ou plus. Dans les lésions de type V, la sténose du canal hépatique est associée à une sténose d'une branche droite séparée, nécessitant la réparation des deux. Bien que cette classification ait_été établie pour des sténoses constituées, elle est souvent utilisée pour décrire les lésions traumatiques de la voie biliaire. II faut simplement rappeler que la sténose correspond généralement à un niveau au-dessus de la lésion traumatique lors de la première intervention.

Resumen

La clasificación de las estenosis biliares que se usan en el Hospital Paul Brousse se basa en Identificar el nivel más bajo en el cual se encuentre mucosa biliar sana disponible para anastomosis. El propósito de la clasificación es servir al cirujano en la escogencia de la debida técnica para la reparación. Las estenosis Tipo I, con un muñón mayor de 2 cm, pueden ser reparadas sin necesidad de abrir el canal izquierdo y sin necesidad de descender la placa hiliar. Las estenosis Tipo II, con un muñón de menos de 2 cm, requieren la apertura del canal izquierdo para lograr una anastomosis satisfactoria; no siempre es necesario descender la placa hiliar, pero hacerlo puede mejorar la exposición. Las lesiones Tipo III, en las cuales se encuentra intacto el techo de la confluencia biliar, requiera el descenso de la placa biliar y la anastomosis al sistema del canal izquierdo. No hay necesidad de abrir el canal derecho si la comunicación entre los canales es amplia. En las lesiones Tipo IV se encuentra interrumpida la confluencia y requieren bien su reconstrucción o dos anastomosis separadas. Las lesiones Tipo V son estenosis del canal hepático asociados con una estenosis de una rema derecha separada, y tal rama debe ser incluida en la reparación. Aunque esta clasificación trata de las estenosis ya establecidas, es comúnmente utilizada para describir lesiones agudas de la vía biliar. El cirujano debe ser consciente, sin embargo, de que la estenosis establecida está generalmente ubicada en un nivel superior del nivel de la lesión producida durante la operación original.

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