

Avoiding Common Bile Duct Injury During Laparoscopic Cholecystectomy

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With the introduction of laparoscopic cholecystectomy, the general surgery community was thrust into the new world of minimally invasive surgery. The marked benefits of laparoscopic cholecystectomy became apparent in a short period of time, driving the procedure to widespread use long before any clinical trials or studies were available to document the procedure's safety. Although there was early concern over the potential dangers of the laparoscopic approach,¹ it took several years before there was enough data to verify this concern.² The most significant of these potential dangers is injury to the bile ducts.

BILE DUCT INJURY

Injury to the biliary ducts during the performance of a cholecystectomy is not unique to the laparoscopic approach.^{3,4,5,6,7,8} Bile duct injury has long been recognized as a potential complication during open cholecystectomy. Through proper training and recognition of the causative factors, the incidence of bile duct injuries has been reduced to approximately 0.2% for open cholecystectomy.^{7,8} Some reviews report rates as low as 0.07%.⁵ When we compare these numbers to laparoscopic cholecystectomy, we find series of laparoscopic cholecystectomies that report as low an incidence of bile duct injury as that seen with the open technique.^{9,10} But when the experience across the United States is examined, we see that the incidence of bile duct

injuries is higher, with an overall incidence of 0.6%, three times that of the open procedure!² Although the "learning curve" has been blamed for some of this increase in duct injuries,¹¹ the injuries are still being reported, nearly six years after the introduction of laparoscopic cholecystectomy. It has been suggested that many of these injuries are preventable,^{12,13} and with proper technique there is no reason we should not be able to reduce the rate of bile duct injury to that which is seen with the open procedure.

For open cholecystectomies, injuries to the bile duct have been attributed to the following: (1) inadequate access, exposure, and assistance; (2) absence of operative cholangiograms; (3) patient's obesity; and (4) early dissection of Calot's triangle.¹⁴ It is further suggested that the vast majority of these injuries

are avoidable if "the principles of safe cholecystectomy are adhered to."^{14,15} In a review of 130 bile duct injuries that occurred during the performance of laparoscopic cholecystectomy,¹⁶ 74% of the injuries occurred because the surgeon mistook the common bile duct for the cystic duct. The surgeon then proceeded to ligate and divide the common bile duct and, in 54% of the cases, excised a segment of the common hepatic duct. Only 22% of the cases had a cholangiogram performed, and in all but two of the cases in which a cholangiogram was performed, the study indicated the injury and the surgeon ignored the findings (Fig. 1)! Whether we blame these injuries on poor exposure, absence of operative cholangiograms, patient's obesity, acute inflammation, or poor technique in retraction of the triangle of Calot, we can say adamantly

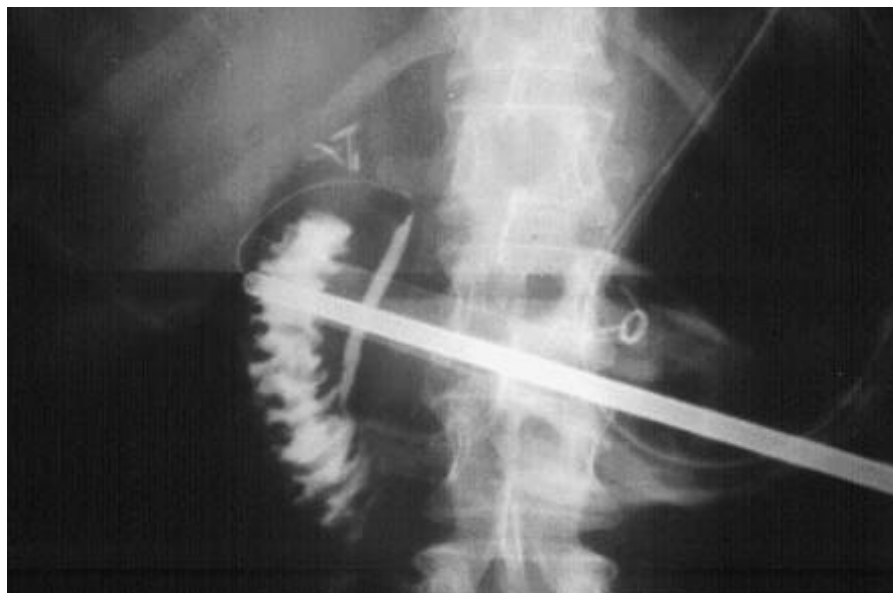


Figure 1. Intraoperative cholangiogram demonstrating a common bile duct cannulation. The operating surgeon read the film as normal because there was free flow of dye into the duodenum. For a complete study, the upper radicles must be visualized!

that they ultimately occurred because the surgeon violated one of the simplest and most basic of all surgical principles: *No structure is ligated or divided until it is identified.* In biliary tract surgery, this is of even greater importance, because we are trained to recognize the various anomalies and variations that occur in the biliary tree. Furthermore, we understand the significance of a mistake in this area and the morbidity that occurs if the wrong structure is divided. So as with open cholecystectomy, we can say that the vast majority of these bile duct injuries are avoidable—if “the principles of safe cholecystectomy are adhered to.”

PREVENTION

The key to avoiding the injury of misidentification, and therefore the



Figure 2a. The cystic duct–common bile duct junction is the classic landmark that is used to verify the identity of the cystic duct. The junction must be clearly seen, demonstrating the common bile duct and the common hepatic duct.

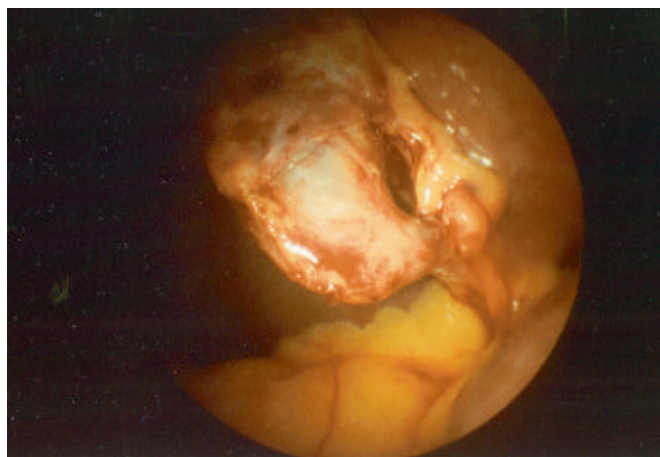


Figure 2b. The neck of the gallbladder or the “infundibulum” has also been used as a landmark to find and verify the identity of the cystic duct.

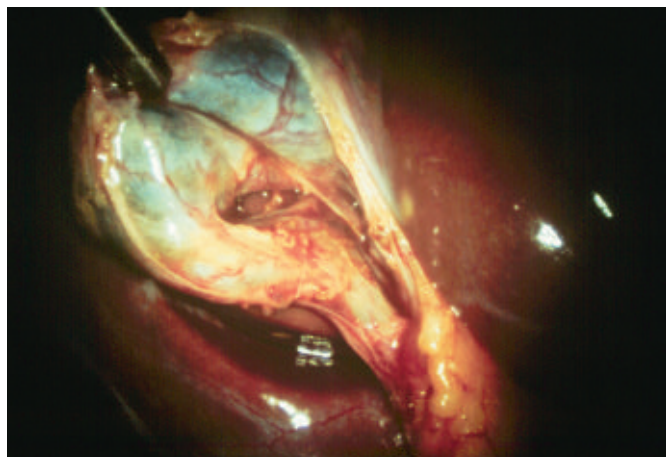


Figure 3. The infundibulum is clearly visualized as the transition between the gallbladder and the cystic duct. This requires a complete circumferential dissection of the infundibulum.

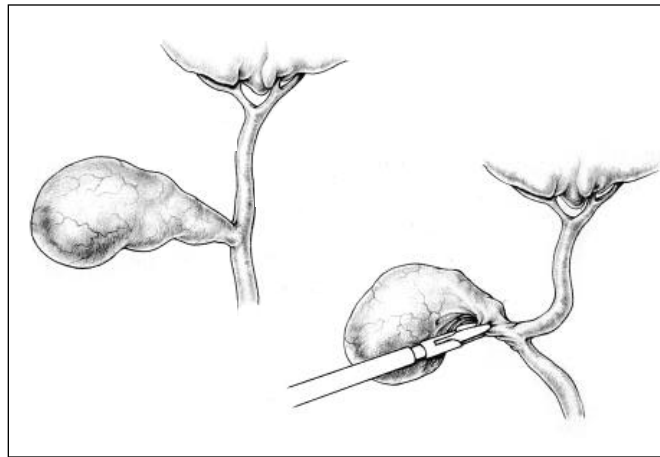


Figure 4. Diagram demonstrating how the anatomy can be distorted with the traction that is applied during a laparoscopic cholecystectomy. For this reason, the tissues have to be completely dissected circumferentially from the gallbladder down to the cystic duct so that a common hepatic duct will not be missed in the posterior tissues.

majority of bile duct injuries, is to achieve absolute identification either anatomically or radiographically prior to proceeding with the operative procedure. If this cannot be achieved, the surgeon has an obligation to convert the procedure to an open cholecystectomy. Even with an open cholecystectomy, there may be situations in which the anatomy cannot be defined, and this is the place for the "partial cholecystectomy" or a simple tube cholecystostomy that has been discussed in the literature of open cholecystectomy.¹⁷

Anatomic Identification

Anatomic dissection requires the surgeon to identify certain landmarks before the procedure can safely proceed. The infundibulum of the gallbladder and/or the cystic duct–common bile duct junction must be absolutely identified if the surgeon is going to rely on simple anatomic dissection (Fig. 2).

This requires a dissection that clearly demonstrates the anatomical landmarks without question. If there is any question regarding the proper identification of the landmarks, then further dissection is required. Anatomic dissection has classically been done either "retrograde" (fundus first) or "orthograde" (from cystic duct to fundus). Although it has been argued that a retrograde dissection is the safest, there are proponents for both techniques. In laparoscopic cholecystectomy the true "retrograde" or fundus-first dissection is difficult and often not possible. Once the gallbladder has been detached from the liver, it can be very difficult to elevate the liver and achieve exposure in the porta hepatis. An equivalent dissection can be performed by starting high on the neck of the gallbladder and mobilizing the body of the gallbladder without detaching the fundus. The dissection is then carried down the

neck of the gallbladder until the cystic duct has been defined (Fig. 3), just as in the open fundus-first dissection. It is imperative that the dissection be circumferential so that the surgeon does not risk missing a bile ductal that may be lying posterior and distorted by the upward traction that is placed on the gallbladder (Fig. 4). Careful retraction of Hartman's pouch downward and laterally will help to restore the normal angle between the cystic duct and the common hepatic duct and open up the triangle of Calot (Fig. 5). This will aid the surgeon in identifying the proper tissue plane in which to dissect.

Inadequate exposure (due to inflammation, obesity, bloody operative field, etc.) can be overcome by the liberal use of additional ports for retraction, angled telescopes (Fig. 6), and heparinized irrigation to clear the field. If exposure cannot be achieved, then the surgeon is obligated to

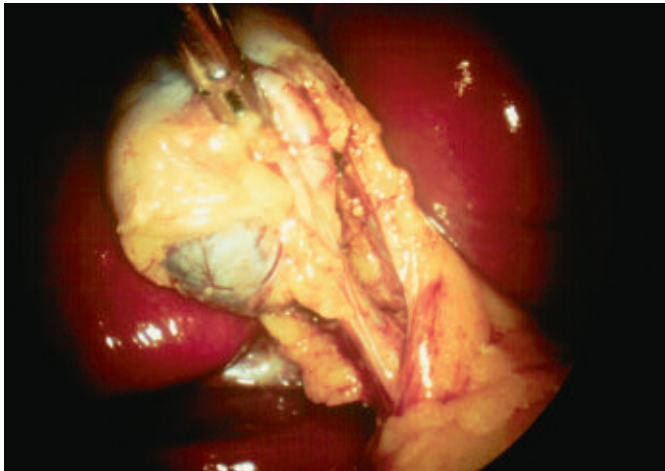


Figure 5a. Picture demonstrating incorrect retraction on the gallbladder with straight upward pull, collapsing the triangle of Calot.

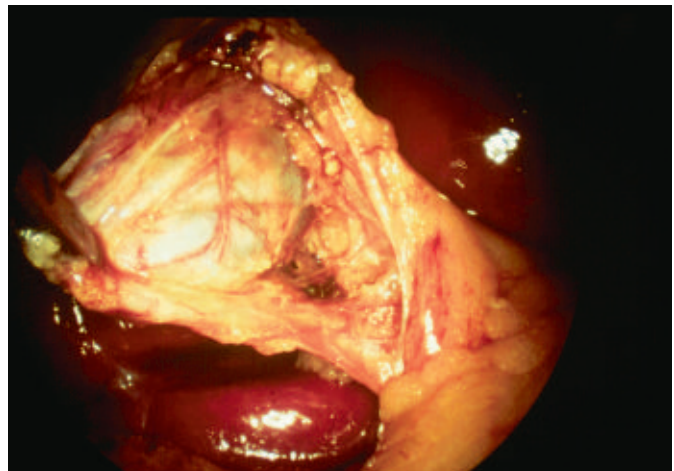


Figure 5b. Same case as above, but now with outward and downward retraction on Hartman's pouch, opening up the triangle of Calot.

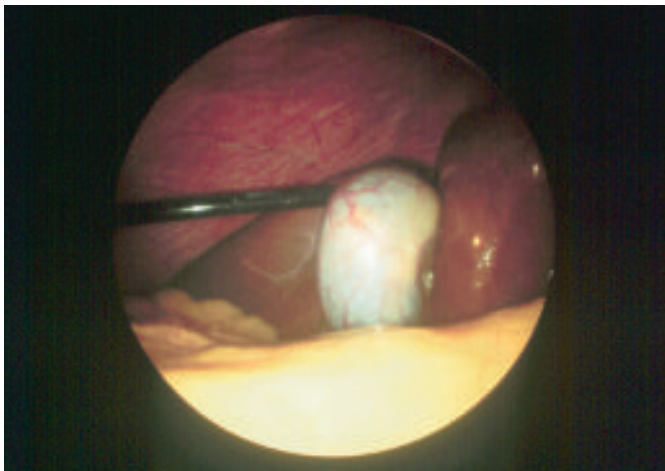


Figure 6a. View through a 0° telescope in a morbidly obese patient. The view of the porta hepatis is obscured by the omentum and transverse colon.

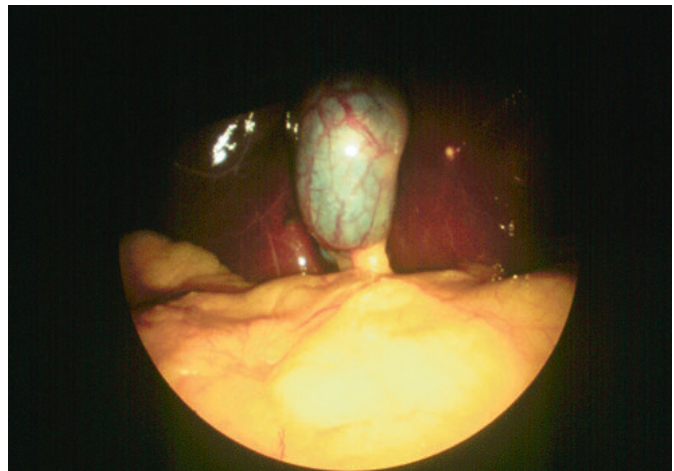


Figure 6b. Same patient as in 5a, but now the view is with a 30° telescope demonstrating the improved visualization of the porta hepatis.

convert to an open procedure. Laparoscopy is a visual procedure, and the surgeon cannot rely on tactile blind dissection that can often be used effectively in open surgery.

Radiographic Identification of Anatomy

If the anatomy is to be identified radiographically, it is important that the initial placement of the cholangiogram be performed in an area of known anatomy, otherwise a duct injury can be inflicted by the placement of the catheter itself. Safe cannu-



Figure 7a. A cholangiogram demonstrating an accessory duct in the triangle of Calot. This structure could easily be mistaken for a posterior cystic artery during the dissection of the triangle of Calot if the cholangiogram were not available.

lation of the biliary system can be accomplished either through the gallbladder itself or preferably through the distal cystic duct at the infundibulum of the gallbladder. This will avoid an inadvertent injury due to cannulation of the common bile duct. But even with an inadvertent cannulation of the common bile duct, the cholangiogram will be of benefit in identifying the injury before it is converted to a major high duct injury. This has a significant impact on the morbidity that the patient will experience. In one study, it was demonstrated that the routine use of cholangiography reduced the incidence of "high" duct injuries when compared to series in which selective cholangiography was performed.¹⁸ Even though the number of duct injuries was not reduced, the severity of the injury was directly affected by the use of the cholangiogram. The need for an enteric-biliary anastomosis was zero in the group that had routine cholangiography, while it was as high as 89% in the groups that practiced selective cholangiography. With the anatomy identified by cholangiography, further dissection of the triangle of Calot can be performed safely using the cholangiogram as a road map. This should reduce the risk of injury to an accessory duct or an aberrant right hepatic duct that may be injured in the process of removing the gallbladder despite adequate identification of the cystic duct (Fig. 7). These structures can be "in harm's way," especially when there is a component of acute inflammation. These structures can easily be

pulled into the field of dissection with the upward traction that is applied to the gallbladder during this procedure. An additional advantage of the routine use of cholangiography is that it allows the surgeon to minimize his dissection of the triangle of Calot and the tissues more proximally along the common bile duct. This minimizes the risk of bleeding in an area in which placements of clips or use of cautery can be dangerous. Even though proper technique dictates against the haphazard use of clips and cautery in the triangle of Calot and near the common bile duct, when bleeding occurs in these areas, the temptation for a quick fix often supersedes common sense on the part of the surgeon. The surest way of avoiding the temptation is not to place oneself in the situation of having to deal with the problem.

LIGATION AND DIVISION OF DEFINABLE STRUCTURES

With the anatomy properly identified, the surgeon can safely move on to ligate and divide the cystic duct. Efforts to identify the cystic artery should wait until the cystic duct is identified and divided. This will prevent the surgeon from having once again to dissect into the triangle of Calot, where the risk of creating an injury to vital structures is the greatest. With the cystic duct ligated and divided, upward traction on the neck of the gallbladder will expose the cystic artery as it enters the gallbladder (Fig. 8). This will allow the surgeon to ligate and divide the cystic artery high



Figure 7b. A cholangiogram demonstrating an aberrant right hepatic duct, with the cystic duct coming directly off of the right hepatic duct. If the surgeon relied on the cystic duct-common bile duct junction as his point of reference without a cholangiogram, an injury to the right hepatic duct would be likely.

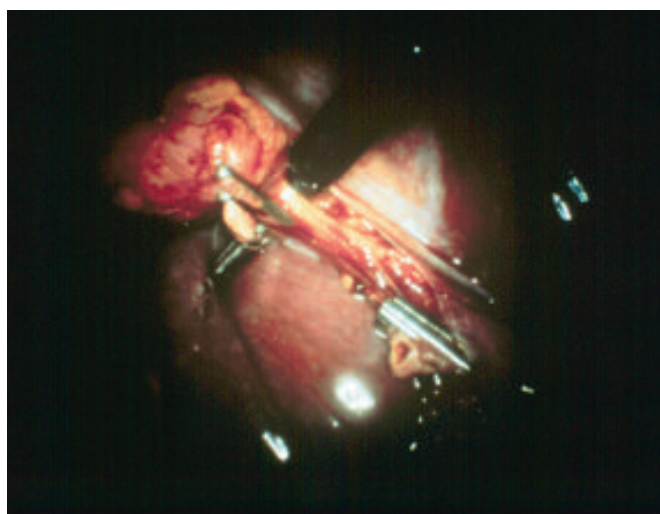


Figure 8. The cystic artery is easily found high up on the gallbladder once the cystic duct has been divided.

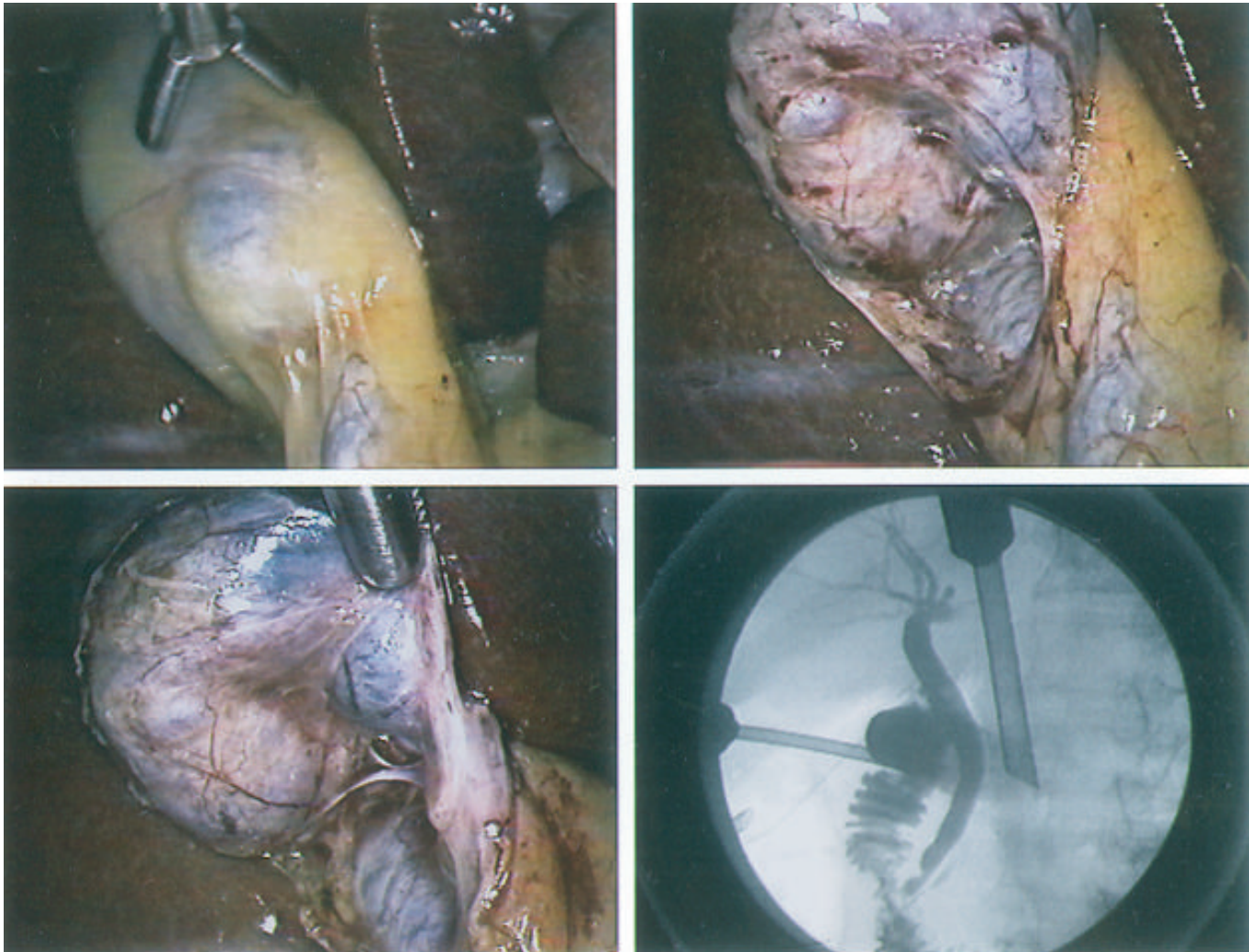


Figure 9. A sequence of pictures demonstrating how the cystic duct and the neck of the gallbladder can be intimately associated with the common hepatic duct. As a result, any cautery or placement of clips in this area must be done under direct vision for fear of injury to any of these structures.

on the gallbladder, minimizing the chance of injury to an aberrant right hepatic artery.

Caution should be exercised as the surgeon proceeds to take the gallbladder off of the liver bed. Cautery or other energy sources should be used sparingly until the dissection has actually reached the liver bed itself. The initial attachments of the neck of the gallbladder or the hepatico-cystic ligament often contain a posterior branch of the cystic artery and, if divided without ligation, can lead to hemorrhage. This dissection should initially be performed bluntly, ligating any structure that appears to be vascular. This area is still close enough to the common hepatic duct and right hepatic duct that injury to these structures is possible during the course of attempting to gain hemostasis if bleeding were to occur (Fig. 9). Avoiding a hemorrhage in this area will eliminate this risk. Certainly, the placement of clips or the use of

cautery should always be under direct visualization.

RECOMMENDATIONS

No matter what technique a surgeon uses to perform laparoscopic cholecystectomy, it is absolutely imperative that

- the anatomy is positively identified prior to ligation and division of any definable structure.
- full unobstructed visualization of the operative field is achieved.
- there is no blind clipping, cutting, or cauterization performed.

These simple and basic concepts have been true for open cholecystectomy and continue to be true for laparoscopic cholecystectomy. With careful attention paid to these basic concepts, and early conversion to open cholecystectomy in the event that these principles cannot be adhered to, the incidence of bile duct injury should approach zero! **STI**

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