Error traps and vasculo-biliary injury in laparoscopic and open cholecystectomy

STEVEN M. STRASBERG

Section of Hepatobiliary-Pancreatic and Gastrointestinal Surgery, Department of Surgery, Washington University in Saint Louis, 1 Barnes Hospital Plaza, St. Louis, MO 63110, USA

Abstract
Many biliary misidentification injuries occur due to error traps-methods that work well in most circumstances but which are apt to under certain conditions. We have identified four such traps from an extensive experience in repair of biliary injuries. The most common cause of misidentification results from the “infundibular technique” error trap. This problem is usually associated with severe inflammation which hides the cystic duct and obliterates the triangle of Calot making the common hepatic duct appear to be part to the gallbladder wall. Another error trap — the “fundus-down” cholecystectomy has been associated with injuries in which the vascular component of the injury has been even more serious than the biliary one i.e., “vasculo-biliary injuries” These vasculo-biliary injuries result in hepatic infarction requiring liver resection, possibly including transplantation. As opposed to the infundibular technique error trap the fundus down error trap usually occurs at open cholecystectomy after conversion. The two other error traps are due to failure to perceive the presence of an aberrant right hepatic duct on cholangiography and injury to the common bile duct in the case of a “parallel union” cystic duct. Knowledge of these error traps and their avoidance can help to reduce the incidence of biliary injuries.

Introduction
An error trap is a method that works well in most circumstances but which is apt to fail under certain conditions. Because it is usually effective, the user develops confidence in it and may not recognize that something is amiss when a dangerous combination of circumstances arises. In 2000 we described how one method for ductal identification in laparoscopic cholecystectomy, i.e., the infundibular technique, was prone to be misleading in the presence of certain operative conditions. This was the first article that focused on visual deception in the pathogenesis of biliary injury. Since then we have identified other error traps associated with biliary injury. One of these — the “fundus-down” cholecystectomy — has been associated with injuries in which the vascular component of the injury is even more serious than the biliary one. Therefore, we will introduce a new term to cover such injuries — “vasculo-biliary injuries”. The purpose of this article is to expand the understanding of error traps in cholecystectomy. This analysis is based on operative notes of the original operation, radiological studies, and findings at the time of repair in about 250 biliary injuries seen by the author either through referral practice or as a result of acting as an expert.

Error trap 1. The “infundibular view” error trap, or how severe inflammation, large impacted stone, intrahepatic gallbladder, congenital adhesions, and other factors that tend to hide the cystic duct and draw the common hepatic duct against the gallbladder make the infundibular technique unreliable

The infundibular technique is a method of ductal identification. “Conclusive identification” is based on three-dimensional demonstration of the funnel-like shape of the lower end of the gallbladder and adjacent cystic duct (funnel = infundibulum [Latin root]) (Fig. 1A). To execute the infundibular technique the putative cystic duct is followed onto the gallbladder, or the lower end of the gallbladder is traced down to the cystic duct, or both. An essential element of the dissection is that it is circumferential on both structures. When dissection is completed the funnel-shaped union of cystic duct with gallbladder can be seen in three dimensions and the “infundibular view” has been obtained. That represents “conclusive identification” by this technique, i.e., the surgeon has successfully reached the endpoint of an
acceptable technique. Again, it should be emphasized that the infundibular technique calls for circumferential or three-dimensional “360°” display of the funnel. Seeing it in two dimensions, i.e., simply by clearing one or two surfaces of the apparent cystic duct-gallbladder junction, is inadequate.

We have collected or read numerous operative records of procedures in which surgeons seem to have followed the infundibular technique correctly to its endpoint of the “infundibular view”, and in which a misidentification injury occurred. Characteristically, the surgeon describes following what was thought to be the cystic duct (actually the circumferentially dissected common bile duct [CBD]) to a point where it seemed to flare into the gallbladder. In retrospect, the false “flares”, i.e., false “infundibular views” occur when the CBD is followed up to an inflammatory mass within which the cystic duct is hidden (“hidden cystic duct syndrome”) (Fig. 1B). This visual deception is most likely to occur when one or more of the following factors are present — severe acute or chronic inflammation, a large stone in the pouch of Hartmann, adhesive bands between the gallbladder and the common hepatic duct, and intrahepatic gallbladder. Chronic inflammation tends to cause retraction of structures in the porta hepatis, bringing the gallbladder against the CHD. Both chronic and acute inflammation tend to cause adherence of the CHD to the gallbladder so that it appears as part of the gallbladder wall. This deception is heightened by factors that obscure the cystic duct, such as a large gallstone impacted at the lower end of the gallbladder, and factors that prevent retraction of the gallbladder and display of the cystic duct, such as a thick gallbladder wall, a distended gallbladder, a contracted gallbladder, or an intrahepatic gallbladder. The result is that when the CBD is mistakenly thought to be the cystic duct and is followed upward circumferentially it may be seen to flare in a way which is visually inseparable from the appearance of a true “infundibular view”. If this view is relied upon for ductal identification it will, in these cases, result in division of the CBD. Usually a second division of the biliary tree at a higher level will follow the first injury in most cases, because surgeons will believe they are dissecting along the left side of the gallbladder while in reality the dissection is along the left side of the CHD. As the gallbladder is “taken off the liver bed” the CHD or right and left hepatic ducts will be divided. Injuries to the right hepatic artery are a common associated injury when the latter occurs; the latter does not usually result in a vasculo-biliary injury, as it is usually silent. Surgeons who have been deceived by the masquerade of the false infundibular view are completely convinced that they have divided the cystic duct, and their operative descriptions provide a clear record of their thoughts in this regard.2

Figure 2 is an operative photograph taken at the time of a repair of a biliary injury of the type being described. The patient had had an attempted laparoscopic cholecystectomy on the day prior to the repair. There was moderately severe inflammation. A biliary injury was recognized when the surgeon saw the open end of the CHD. The patient was referred without completing the cholecystectomy, thus providing this revealing picture. Note that a section of the CHD has been removed between the clip on the CBD and the open end of the CHD. More importantly, the resected segment of the CHD can be seen tightly applied to and appearing to be part of the wall of the gallbladder. Essentially, the triangle of Calot had been obliterated by cicatrizing inflammation. Note how the lower end of the gallbladder with the tightly adherent CHD appears like the bowl of a funnel and how a circumferentially dissected CBD attaching to this structure might be mistaken for the cystic duct.

Fig. 1. A The usual anatomy when the infundibular technique is used; note the flaring of the cystic duct-common bile duct (CBD) union which has a characteristic funnel shape (heavy black line). B Anatomical situation in some cases of classical injuries. Flaring (heavy black line) occurs when the CBD is followed up to an inflammatory mass within which the cystic duct is hidden. As a result, the CBD is mistakenly identified as the cystic duct. Note position of common hepatic duct (CHD)