Chapter 15
Commentary: Perceptual Errors Leading to Bile Duct Injury During Laparoscopic Cholecystectomy

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Despite the passage of more than 25 years since the introduction of laparoscopic cholecystectomy, the incidence of bile duct injury (BDI) continues to be higher than that associated with open cholecystectomy [1]. Laparoscopic surgery is very different than an operation performed by open laparotomy. These differences relate to the mode of access to the operative field, the different degrees of freedom of motion of the instruments, the "fulcrum effect" of laparoscopic ports (leading to reversed motion of instruments), and the reduced haptic sense that the surgeon has of the operative field. (It should be noted that surgeons' tactile sense is not changed, but their ability to discriminate palpable details of the operative field is significantly reduced.) Compared to open surgery, probably the biggest difference when performing a laparoscopic cholecystectomy is the imaging of the operative field. The image is two dimensional, magnified, directed by an individual other than the surgeon, and oriented from a relatively fixed point originating caudad to the operative field [2].

These visual and haptic differences lead to the significant perceptual errors that have been well described by Dr. Stewart in this very engaging chapter. Dr. Stewart has reviewed the neurologic and psychologic basis of the surgeon's perception of the operative field during laparoscopic cholecystectomies. These neurocognitive principles have been related to biliary injuries by reviewing operative reports and videotapes of both uncomplicated laparoscopic cholecystectomies and those resulting in BDI. Because of the perceptual limitations while performing laparoscopic cholecystectomy, Dr. Stewart has listed several "rules of thumb" that may decrease the incidence of BDI, which I will expand upon.

Given the perceptual errors inherent in the performance of laparoscopic cholecystectomy, surgeons must develop systematic safety maneuvers to overcome these

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E. Dixon et al. (eds.), *Management of Benign Biliary Stenosis and Injury*, DOI 10.1007/978-3-319-22273-8_15

shortcomings in an attempt to minimize the incidence of BDI. Although some cases of bile duct injury occur passively during dissection, the vast majority are purposeful, direct injuries of the bile duct caused by a misidentification of a bile duct (common bile duct, common hepatic duct or hepatic duct) for the cystic duct. Several strategies and tactics can be used to decrease the likelihood of BDI. A basic strategy is to utilize tactics which increase the anatomical information available to the surgeon. One would be the use of an angled scope that, when used correctly, can render alternative views of the operative field despite the fixed origin of the laparoscope at the umbilicus. In addition to the other perceptual limitations of laparoscopy, this mode of imaging is capable of viewing only the visible surface of the operative field, and haptics are limited, as noted above. The French have a saying, "la main voit," meaning the hand sees. During laparoscopy, the long rigid instruments can only transmit limited information regarding force feedback, so the operative field is largely experienced visually. Thus, we have found it helpful to utilize ultrasound during laparoscopic operations to see beyond the visible surface [3]. Laparoscopic ultrasound specifically allows the operator to image the location and size of the main bile ducts. The ultrasound imaging can be repeated as many times as desired, and unlike cholangiography, does not require either ionizing radiation or incision of a ductal structure which may, in so doing, result in a common bile injury. In particularly difficult cases, we will often perform the ultrasound early in the operation to locate the common bile duct in relation to where we suspect the correct dissection plane to be.

Dr. Stewart's discussion of framing the situation during performance of laparoscopic cholecystectomies is a very important concept. It is easy for a surgeon to frame atypical anatomy as a variant of normal that can be ignored. The most common type of biliary anatomy is present in less than half of all patients, so the surgeon must be mindful of the many patterns of aberrant anatomy. The discovery of an abnormally large cystic duct, accessory bile duct(s) or a duct of Luschka, or an unusual location or size of the cystic artery should stimulate surgeons to re-frame the operative situation and pause before proceeding. It is extremely important that, should a surgeon have any doubt about the anatomy he has exposed during a laparoscopic cholecystectomy, another surgeon be asked to view the operative field. The second individual will come to the situation with a completely different frame of reference and thus help clarify and potentially redirect the dissection.

Given the neurocognitive aspects of normal visual and haptic perception that can lead to error, Dr. Steven Strasberg and I described a strategy to help prevent common bile duct injury during laparoscopic cholecystectomy more than two decades ago [4]. We advocated performing a dissection that results in displaying the so-called critical view of safety. This involves dissecting all of the connective tissue away from the posterior aspect of the lower part of the gallbladder to elevate it away from the cystic plate until two, and only two, structures are seen entering the gallbladder. This involves a complete dissection of the upper boundary of the "hepatocystic triangle." Many surgical textbooks recommend dissecting Calot's triangle. Calot's triangle was described in the 19th century by an anatomist, with the base of the triangle being the hepatic duct and the two sides of the triangle being the cystic duct and the cystic artery. In real life, these structures generally do not converge on

the gallbladder wall to form a triangle, and the boundaries represent a very small area. Rather, we attempt to dissect out the ventral portion of the hepatocystic triangle—formed by the posterior wall of the gallbladder, the cystic duct, and the liver edge extending down to the hepatic ducts. The upper border of this triangle, along the gallbladder wall, is dissected beginning well away from the infundibulum; all of the fat and fibrous tissue is removed, separating the gallbladder from the cystic plate.

When beginning the dissection well up on the gallbladder, a virtual "top down" dissection is performed, minimizing the risk of BDI during the early part of the dissection. (A true top down approach beginning at the fundus of the gallbladder is difficult during laparoscopic cholecystectomy due to the need to elevate the right lobe of the liver for exposure, which is challenging after separating the fundus from the gallbladder bed. Furthermore, the laparoscopic top down approach has been reported to cause devastating vasculobiliary injuries, so should be applied cautiously [5].) When the critical view of safety is demonstrated, it should be safe to proceed with ligation and division of the cystic structures.

Severe acute and chronic inflammation of the gallbladder both can distort the anatomy and increase the risk of BDI. Early acute cholecystitis, characterized by edema, may actually simplify the operation because of tissue fluid delineating the dissection planes. Subacute cholecystitis, that occurring between 3 or 4 days and several weeks after the onset of inflammation, can lead to a very difficult and bloody dissection. Scleroatrophic cholecystitis can lead to the most difficult dissections of all, where the gallbladder is "shrink wrapped" to a very small size and may be difficult to even find, let alone dissect. Abnormalities of anatomy or difficult dissection in a zone of danger should lead the operating team to question whether to proceed. Surgeons should know their limitations, realize that in the vast majority of the cases gallbladder removal is done for elective reasons, and understand techniques by which they may "bail out" of the acute situation.

Sometimes adding an additional laparoscopic port, for instance a 10 mm port to place a large grasping instrument, may improve retraction of the difficult gallbladder. Performing an ultrasound examination to locate the bile duct may be of help. Although frequently unsuccessful due to obstructing cystic duct stones, performing a cholangiogram through the gallbladder itself may allow identification of the biliary structures. Performing a partial cholecystectomy, whereby the posterior wall of the gallbladder is left in place while removing all of the anterior wall and gallstones, and leaving a drain in the right upper quadrant, may be appropriate. Laparoscopically placing a cholecystostomy tube may be a good way of getting out of trouble when a surgeon realizes he or she is in over his/her head early in the operation. Finally, converting to an open operation may be the ultimate step in enhancing one's appreciation of the anatomy by increasing the haptic sense of the operative field. There is concern that younger surgeons trained in the era of laparoscopic cholecystectomy may not be able to perform a technically better open cholecystectomy than laparoscopic cholecystectomy, and thus this strategy of conversion may not be appropriate for all individuals. The same is true if a bile duct injury occurs and is recognized. Given the emotional strain resulting from a bile duct injury, the surgeon should not

attempt a repair himself. If an experienced hepatobiliary surgeon is immediately available, that individual should be asked to perform the reconstruction. If there is no such personnel, the operating surgeon should not feel obliged to convert to a laparotomy, but instead leave drains in the operative field and refer the patient directly to a tertiary center from the operating room.

In summary, laparoscopic cholecystectomy continues to be associated with a higher rate of bile duct injury than open cholecystectomy. As Dr. Stewart has identified, many injuries are due to the neurocognitive perceptual errors caused by laparoscopic instrumentation and techniques. Understanding those limitations and attempting to combat them by recruiting additional sensory information and tactics that minimize the chance of BDI is particularly relevant. Perhaps most important is to develop a strategy of routinely dissecting to display the critical view of safety, a technique that we believe does decrease the risk of bile duct injuries.

References

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