Leading article

Anatomical orientation and cross-checking – the key to safer laparoscopic cholecystectomy

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In the context of human error analysis, bile duct injury is usually due to an error of perception rather than to deficient knowledge or decision making, or the technical skill of the surgeon[1]. The perceptual error, but not necessarily the duct injury, usually occurs early in the course of surgery, at the stage of initial anatomical orientation or preliminary dissection[1]. Importantly, such errors of perception frequently go unrecognized, so that the operator fixes his or her anatomical reference points incorrectly and commences dissection in an area of danger. The critical juncture at which an injury prevention strategy will be most effective is during the process of perception and recognition, specifically at the time of anatomical identification and orientation, before the start of dissection.

There is no current established formal routine aimed at minimizing perceptual error at the stage of anatomical orientation, although several well established precautions exist to reduce the risk of bile duct injury. These include identification of the 'safety zone', Strasberg's 'critical view' and intraoperative cholangiography[2–4]. A common deficiency of all these precautions is a reliance on the initial anatomical orientation being correct. If the anatomical reference points have been fixed incorrectly, injury may occur while performing the precautionary measure. Surgeons who are disorientated may start dissecting too far medially, believing they are in a safe zone when, in fact, they are operating in a danger zone. This may result in inadvertent dissection of the hepatic pedicle and misinterpretation of the common bile duct as the cystic duct, leading to the classical bile duct injury[5]. Similarly, when the common bile duct has been mistaken for the cystic duct, placement of a cholangiography catheter constitutes an injury in itself, which will occur before a cholangiogram has been obtained.

The following system of orientation and cross-checking has been developed to counter the limitations and risks of relying solely on anatomical reference points in the area of the gallbladder and Calot's triangle. It uses a wider anatomical area and emphasizes the segmental anatomy of the liver and the anatomy of the hepatic pedicle. Many general surgeons are not familiar with this anatomy, despite the fact that laparoscopic cholecystectomy is one of the most commonly performed procedures. *Fig. 1* displays the camera view of the appropriate hepatic and biliary anatomy (also available as an electronic movie from *BJS Online*).

Using a clock-face analogy, the gallbladder lies in the 7 to 10 o'clock position. The liver medial to this is segment IV. Segment IV is bordered medially by the falciform ligament which lies between the 2 and 5 o'clock positions. At 4 o'clock, there is usually a bridge of liver parenchyma connecting segments II and IV. At 5 o'clock, the falciform ligament enters the liver. Occupying an arc between here and 7 o'clock is the hilar plate, the area where the peritoneum covering the hepatic pedicle joins with the capsule of segment IV. The hepatic

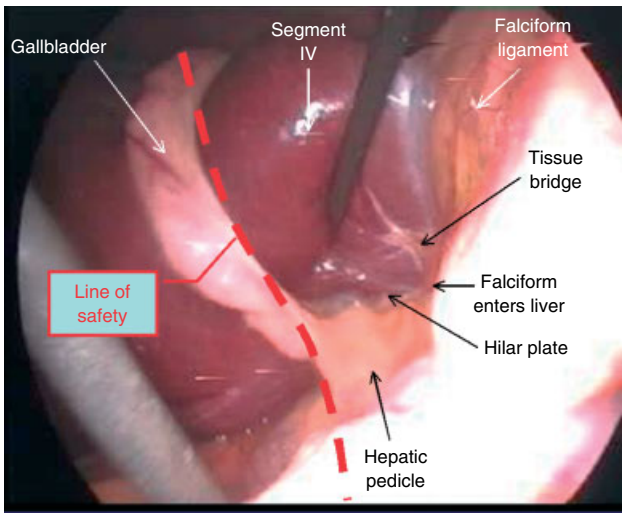

Fig. 1 Anatomical orientation demonstrating the 'line of safety'

pedicle, containing the bile duct, hepatic artery and portal vein, is located between the hilar plate and the duodenum, seen inferiorly in the orientation view. An imaginary line, overlaid along the lateral border of segment IV and passing lateral to the hepatic pedicle, divides the operative field into two areas. If dissection is kept strictly lateral to this line, safe dissection of the cystic artery, cystic duct and lower third of the gallbladder is possible, to obtain Strasberg's critical view. The risk of encountering the hepatic pedicle structures, or even their most common variants, is minimized, although the wary will remain vigilant for a posterior sectoral duct or an aberrant right hepatic artery that may pass in this area. Dissection that strays medial to this line risks bile duct injury and the operator should never enter this territory. When this system of anatomical orientation is not feasible, owing to severely distorted anatomy, excessive inflammation or unexpected pathology, the safe option is conversion to an open operation.

Following initial orientation, a verbal cross-check between the surgeon and assistant must be carried out before any dissection is undertaken and repeated after dissection, before any structures are clipped or divided. The discipline of cross-checking the anatomy is crucial. Although not strictly independent, the probability of an error of anatomical orientation is less if both operator and assistant have to make the same error of perception. In the framework of human cognition and error analysis, elevating thoughts and decision-making processes from a subconscious, intuitive level (with a low accuracy) to a deliberate oral expression should result in a more accurate outcome, as thinking has occurred at a higher cognitive level[1]. Furthermore, cross-checking provides an opportunity to correct oneself, allows verification by a colleague, and ensures that anatomical orientation is actually done, as an oral description of the anatomy can only be given when the orientation is completed. One recent leading article in this Journal on patient safety has emphasized the rigorous cross-checks that airline pilots perform with their co-pilots[6] and a culture of cross-checking drugs has been present within the nursing profession for many years.

The orientation and cross-check also serves as an anatomical teaching tool and can help in assessment of operative competency. If the operator is a trainee and the assistant is the trainer, it reassures the trainer that the trainee has achieved correct orientation. If the trainee verbalizes the orientation to the trainer as a matter of routine, there is less pressure on the reticent beginner who may be afraid to seek reassurance.

Many laparoscopic surgeons may feel that they already conduct an anatomical orientation process automatically, perhaps subconsciously. The importance of elevating the process from the automatic, subconscious level to an orally expressed cross-check, performed in every operation, cannot be overstressed. This system has been used in over 800 patients, with no biliary injury. Its addition to existing safety techniques should reduce perceptual error and improve patient safety during cholecystectomy.

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