Causes and Prevention of Laparoscopic Bile Duct Injuries Analysis of 252 Cases From a Human Factors and Cognitive Psychology Perspective

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Objective: To apply human performance concepts in an attempt to understand the causes of and prevent laparoscopic bile duct injury.

Summary background data: Powerful conceptual advances have been made in understanding the nature and limits of human performance. Applying these findings in high-risk activities, such as commercial aviation, has allowed the work environment to be restructured to substantially reduce human error.

Methods: The authors analyzed 252 laparoscopic bile duct injuries according to the principles of the cognitive science of visual perception, judgment, and human error. The injury distribution was class I, 7%; class II, 22%; class III, 61%; and class IV, 10%. The data included operative radiographs, clinical records, and 22 videotapes of original operations.

Results: The primary cause of error in 97% of cases was a visual perceptual illusion. Faults in technical skill were present in only 3% of injuries. Knowledge and judgment errors were contributory but not primary. Sixty-four injuries (25%) were recognized at the index operation; the surgeon identified the problem early enough to limit the injury in only 15 (6%). In class III injuries the common duct, erroneously believed to be the cystic duct, was deliberately cut. This stemmed from an illusion of object form due to a specific uncommon configuration of the structures and the heuristic nature (unconscious assumptions) of human visual perception. The videotapes showed the persuasiveness of the illusion, and many operative reports described the operation as routine. Class II injuries resulted from a dissection too close to the common hepatic duct. Fundamentally an illusion, it was contributed to in some instances by working too deep in the triangle of Calot.

Conclusions: These data show that errors leading to laparoscopic bile duct injuries stem principally from misperception, not errors of skill, knowledge, or judgment. The misperception was so compelling that in most cases the surgeon did not recognize a problem. Even when irregularities were identified, corrective feedback did not occur, which is characteristic of human thinking under firmly held assumptions. These findings illustrate the complexity of human error in surgery while simultaneously providing insights. They demonstrate that automatically attributing technical complications to behavioral factors that rely on the assumption of control is likely to be wrong. Finally, this study shows that there are only a few points within laparoscopic cholecystectomy where the complication-causing errors occur, which suggests that focused training to heighten vigilance might be able to decrease the incidence of bile duct injury.

KEY POINTS:

1. The operations of 252 patients who had major bile duct injuries during laparoscopic cholecystectomy were analyzed.

2. Mechanism of injury:
   a) Class I (7% of cases)
      i) CBD mistaken for cystic duct, but recognized
      ii) Cholangiogram incision in cystic duct extended into CBD
   b) Class II (22% of cases)
      i) Lateral damage to the CHD from cautery or clips placed on duct
      ii) Associated bleeding, poor visibility

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c) Class III (61% of cases)
   i) CBD mistaken for cystic duct, not recognized
   ii) CBD, CHD, R, L hepatic ducts transected and/or resected
ci) Class IV (10% of cases)
   i) RHD mistaken for cystic duct, RHA mistaken for cystic artery, RHD and RHA transected
   ii) Lateral damage to the RHD from cautery or clips placed on duct

3. In 188 cases (75%), the operation was completed without the surgeon suspecting that an injury had occurred.

4. In 33 cases the operation was converted from a laparoscopic to an open procedure because of difficulties with exposure.
   a) Nevertheless, the injury was discovered in only six (18%) of these patients.

5. 64 injuries were recognized at the initial operation, but only 15 were identified early enough for the surgeon to limit the injury.
   a) 9 were diagnosed from routine operative cholangiograms,
   b) 17 from cholangiograms obtained specifically to look for an injury,
   c) 7 from examining the specimen,
   d) the rest when an injured bile duct was seen.

6. In class I, class III, and some class IV injuries the mistake involved misidentifying the common duct (or right hepatic duct) for the cystic duct, followed by deliberate cutting of the misidentified duct.

7. In the class II and some class IV injuries, the mistake consisted of performing the dissection in the triangle of Calot unintentionally too close to the bordering common hepatic or right hepatic duct.
   a) The ducts were not seen because they were covered by connective tissue or inflammation.
   b) The underlying nature of the error in either case was misperception.

8. Although surgical practice has largely settled on selective instead of routine use of operative cholangiography, if properly interpreted, cholangiography can limit the frequency and severity of bile duct injuries.
   a) But what is needed is an even simpler method of locating the course of the ductal system during the operation, something simpler than cholangiography or ultrasonography.

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