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ORIGINAL ARTICLE

Laparoscopic bile duct injuries: timing of surgical repair does not influence success rate. A multivariate analysis of factors influencing surgical outcomes

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Abstract

Background: Many factors contribute to the success of biliary reconstructions following laparoscopic bile duct injury. We previously reported that control of intra-abdominal infection, complete preoperative cholangiography, surgical technique and surgical experience affected the results. There is no consensus, however, on whether the timing of the operation is important.

Methods: We examined factors influencing the success of the *first* repair of 307 major bile duct injuries following laparoscopic cholecystectomy. Factors were assessed for cases initially repaired either by the *primary* surgeon or a *biliary* specialist. Bivariate and multivariate analyses were used to determine the significance of comparisons.

Results: A total of 137 injuries were initially repaired by a biliary surgeon and 163 injuries were initially repaired by the primary surgeon; seven were managed non-surgically. Repairs by primary surgeons were performed earlier than those by biliary surgeons (11 vs. 59 days; $P < 0.0001$). Bivariate analysis of the entire cohort suggested that later repairs might have been more successful than earlier ones (17 vs. 50 days; $P = 0.003$). Multivariate analysis, however, showed that the timing of the repair was unimportant ($P = 0.572$). Instead, success correlated with: eradication of intra-abdominal infection ($P = 0.0001$); complete preoperative cholangiography ($P = 0.002$); use of correct surgical technique ($P = 0.0001$), and repair by a biliary surgeon ($P = 0.0001$). Separate multivariate analyses of outcomes for primary and biliary surgeons revealed that timing was unrelated to success in either case.

Conclusions: The success of biliary reconstruction for iatrogenic bile duct injuries depended on complete eradication of abdominal infection, complete cholangiography, use of correct surgical technique, and repair by an experienced biliary surgeon. If these objectives were achieved, the repair could be performed at any point with the expectation of an excellent outcome. We see no reason to delay the repair for some arbitrary period.

Keywords

laparoscopy, bile duct injury, biliary structure, surgical repair, biliary reconstruction

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Introduction

Although it is associated with less overall morbidity, laparoscopic cholecystectomy has a higher rate of major bile duct injury than does open cholecystectomy (0.3–0.7% of cases vs. 0.1–0.2% of cases).[1,2] Although practising surgeons in the USA have now progressed beyond the initial learning curve associated with this technique, bile duct injuries still occur at a relatively constant rate.[3,4] Our group and others have described the mechanism of injury, guidelines for prevention, clinical findings, and factors influencing the success of treatment.[3–33] Although prevention would be ideal,[4,5,9] the best way to limit morbidity is through early recognition and appropriate treatment. Many aspects of the management of a case influence its outcomes. We found that the success of the initial repair was the most important variable influencing the length of illness, and that factors influencing success included: the

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level of experience of the surgeon performing the repair; the preoperative eradication of intra-abdominal infection, and complete preoperative imaging.[6] Others have claimed, however, that the timing of the repair has an effect.[13–16] The current study examines this question.

Materials and methods

We analysed 307 cases of major bile duct injury following laparoscopic cholecystectomy that were referred for evaluation and/or treatment. Of these, 137 injuries were initially repaired by a *biliary surgeon* and 163 injuries were initially repaired by the *primary surgeon*; seven were managed non-surgically.

The patient's clinical presentation was recorded. Three groups were defined based on the level of inflammatory manifestations at the time of injury recognition:

1 operative recognition;
2 none/systemic inflammatory response syndrome (SIRS): no inflammatory manifestations or SIRS manifestations: (fever [≥38 °C]; leucocytosis [white blood cells ≥11 k/cm^2]; respiratory rate ≥20/min; heart rate ≥90/min), and/or
3 complicated: cases with cholangitis (Charcot's triad), peritonitis, sepsis (hypotension, shock, organ dysfunction) or abdominal abscess.

The bile duct injuries were classified using the Stewart–Way classification (Table 1). Class I injuries (5% of cases) involved an incision in the common bile duct with no loss of duct. These injuries occurred when the common bile duct was mistaken for the cystic duct and the mistake was recognized during the initial operation (usually in operative cholangiograms), or when an incision in the cystic duct for a cholangiogram catheter was unintentionally extended into the common bile duct. Class II injuries (24% of cases) consisted of lateral damage to the hepatic duct with a resultant stenosis and/or fistula. These injuries resulted from unintended application of clips or cautery to the bile duct, usually during attempts to control bleeding in the triangle of Calot. Class III injuries, the most common (61% of cases), involved transection and excision of a variable length of the duct, which always included the cystic duct–common duct junction. Class III injuries resulted from an error of perception whereby the common bile duct was misidentified as the cystic duct. The surgeon transected the common duct (deliberately, thinking it was the cystic duct) early in the dissection and transected the common hepatic duct unknowingly later as the gall bladder was separated from the liver bed. Class III injuries were subdivided based on the proximal extent of the injury as follows: in class IIIa injuries, a remnant of the common bile duct or common hepatic duct remained; in class IIIb injuries, the proximal transaction was at the bifurcation at the common hepatic duct; in class IIIc injuries, the bifurcation of the common hepatic duct had been excised, and in class IIId injuries, the proximal line of resection was above the first bifurcation of the lobar ducts (into segmental ducts). Class IV injuries (10% of cases) involved damage (transection or injury) of the right hepatic duct (or a right segmental duct), often combined with injury to the right hepatic artery. Class IV injuries were caused by misidentifying the right hepatic duct (or right posterior segmental duct) as the cystic duct and the right hepatic artery as the cystic artery, or from lateral injury to the right hepatic duct during dissection in Calot's triangle.

Only factors contributing to the success of the *first repair* were analysed. Many (51%) patients in this cohort required more than one surgical procedure to achieve a successful result, but as the timing of repair relates best to the initial surgical procedure, only initial repairs were analysed in this study.

We examined the influence of the following factors on the success of surgical reconstruction: clinical presentation group; control of intra-abdominal infection; complete preoperative cholangiography; use of correct surgical technique; surgical experience; associated right hepatic artery injury; level of injury (or Stewart–Way class), and timing of surgical repair.[6] Criteria used as evidence of right hepatic artery injury included: ligation or clipping cited during the initial cholecystectomy or a subsequent operation; identification of right hepatic artery ligation during a biliary repair or videotape review; hepatic angiography demonstrating right hepatic artery injury, and non-enhancement of the right hepatic lobe during the arterial phase of a contrast computed tomography (CT) scan.

The correct method for performing a hepaticojejunostomy was considered to comprise a single layer, end-to-side anastomosis of healthy bile duct (non-viable ductal tissue removed) to the

Table 1 Distribution of injuries and level at the time of injury

	Total	Level				Right hepatic artery injury (%)
		A CBD/CHD	B Bifurcation	C Above bifurcation	D Segmental ducts	
Class I, *n* (%)	16 (5%)	16 (100%)				0
Class II, *n* (%)	72 (24%)	63 (88%)	8 (11%)	1 (1%)	0	11 (15%)
Class III, *n* (%)	187 (61%)	115 (61%)	36 (19%)	26 (14%)	10 (5%)	58 (31%)
Class IV, *n* (%)	32 (10%)			19 (69%)	13 (41%)	19 (60%)
Total, *n* (%)	307 (100%)	194 (63%)	44 (14%)	46 (15%)	23 (7%)	88 (29%)

CBD, common bile duct; CHD, common hepatic duct