Chapter 19
Commentary: The Classification and Injury Patterns of Iatrogenic Bile Duct Injury During Laparoscopic Cholecystectomy

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A bile duct injury (BDI) is one of the most dramatic complications during cholecystectomy. The incidence increased twofold after the introduction of the laparoscopic procedure (0.2–0.6 %) compared with open cholecystectomy (0.1–0.2 %). It has been shown that the incidence might be higher (0.7 %) for the single port laparoscopic procedure. The socioeconomic impact of BDI has been shown in many studies. There is also a relation with increased rates of malpractice litigation. BDI during cholecystectomy remains an area of extensive discussion in the literature including different opinions on incidence, prevention, and classification. There is a wide variety treatment options with ongoing controversy. The (long term) outcome of treatment of BDI is reported with different endpoints ranging from complications or mortality after surgery to normal liver function tests during follow up or no strictures/reoperations, and quality of life. The diversity in outcome in studies on patients suffering from a BDI is partly due to the fact that there is a wide variety on the definition of BDI. Another factor is the selection of patients with BDI in a study; for example: a cohort study at a primary institute or a selected group of patients from a referral center or a survey about BDI. Subsequently different classification systems have been used. Classification should be the first principal step in the management of patients suffering from a BDI. The wide variety in classification systems is one of the most important problems for comparison of studies on BDI. In the Chapter on the Classification and Injury patterns of BDI by E. K. Bartlett and Ch. M. Vollmer the 14 existing classification systems and differences between these systems have extensively been described. This is an elegant overview of different components in patients with a BDI which can be included in a classification system, as well as highlighting some of the shortcomings within these systems.

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First of all there is no uniformity about the terminology used for "intraoperative damage of the biliary system during cholecystectomy". This is currently ranging from: a bile duct injury which might be interpreted as an injury of the "major" (common extra hepatic) bile duct; or a biliary injury which might be interpreted as any injury of the biliary system; or bile leakage after cholecystectomy to be interpreted as a leakage from the ductal system probably without an injury of the duct. More recently a new description was added the so-called vasculobiliary injury the combination of a bile duct injury with a vascular injury. The vascular injury here is also not well defined; it is still within the range from an injury of the marginal 6 and 12 o'clock artery, the (right) hepatic artery or the (right) portal vein.

Considering the enormous lack of uniformity between the different classification systems the first most important question should be: What is the aim of the classification system? How do you want to use it in daily practice. It might be used as an aid to identify the mechanism of the injury or by some others as a guide for a treatment and/or referral pattern. It could also be used to identify the severity of the bile duct lesion, the proximal extent of the bile duct lesion, or even more extensively the overall injury pattern. The description of injury pattern might range from transection to tangential duct lesions with or without information of lesions of the vascular system. Other classifications describe all aspects of injury of the entire anatomy within the ligament. The classifications have frequently been used to compare the outcome of different studies but therefore we might need more details of patient characteristics (for adequate case-mix control).

Looking at the well-established classification systems described in the chapter one could indeed distinguish classification systems according to the mechanism (Stewart-Way), the anatomy of the bile duct (Bismuth); the level of the duct, or the biliary system = including leakage of cystic duct (Strasberg/Neuhaus); and more advanced anatomic classification systems including the vasculobiliary system (Hannover). Some systems prefer to restrict the classification mainly to facilitate selection of referral or treatment (Mc Mahon, Amsterdam, Sandha). On the opposite there was recently an initiative to include more clinical aspects such as the time of detection; early versus delayed postoperative, frequently associated with ongoing biliary sepsis or obstructive jaundice or even secondary biliary cirrhosis. These aspects should be included, being of importance for better guidance of therapy and comparison of outcome. The latest developed ATOM classification is combining all previous classification items including these clinical aspects [1].

Remarkably I was personally involved in the development of two different classification systems, the restricted Amsterdam classification [2] and the recent published extended ATOM classification [1]. There might be a certain confusion why to be involved in both or probably a change using another classification. It is due to the increasing understanding of the difficulty using the current classification systems and realizing shortcomings not only in the Amsterdam but also other classifications. It might be helpful to discuss these problems from daily practice using a few studies we performed recently in an attempt to analyze different aspects of outcome in our patient cohort. In the period 1992 up to 2012 a consecutive series of 800 patients (721 patents after laparoscopic cholecystectomy and 79 after open cholecystectomy)

was referred to the Academic Medical Center, Amsterdam, for treatment of a BDI. Centralization of a large cohort of patients with BDI in the Netherlands, a relative small country with a well-defined referral pattern, enabled us to analyze different aspects of diagnostic work-up, management and outcome for all different types of BDI. Results of such a group of patients with BDI "at large" including all types of injury and different endoscopic, radiological and surgical treatment facilities treated are scarcely available.

Registration was according to the Amsterdam classification system adapted officially in the past in this country. During the development of this classification system in 1996 we intended to prepare a simplified classification as a guide for the general surgeon who could link the type of injury directly to the diagnostic work-up and treatment of the BDI. This was in order to facilitate the surgeons to refer patients with a BDI directly to different specialists (gastroenterologist, radiologists, surgeons) in those days working in separate referral units. Therefore only basic aspects of potential treatment in the future were included ranging from short term drainage of the duct (type A: cystic duct leakage), to (endoscopic) stenting (type B: bile duct leakage,), long-term endoscopic/percutaneous stenting and dilatation (type C: bile duct stricture,) and surgery (type D: bile duct transection). Considering the cohort of 800 patients subdivided within the Amsterdam classification and the final treatment as summarized in Table 19.1, it might be clear that this concept was not working adequately. In particular patients classified with a type B, C, and D injury group underwent total different endoscopic, radiological or rendezvous procedures and surgical interventions. Furthermore it is established nowadays in the Netherlands that these patients should preferably be referred to a multidisciplinary team discussing the therapeutic approach together and independent of the specialism. This problem will be the same using other classifications since the overlap of therapeutic possibilities increased during the past years. Even for patients with total transection (type D) a nonsurgical approach by the Rendezvous technique can be employed in selected cases.

Table 19.1 Patients ($n=800$) referred to AMC, Amsterdam, for treatment of a bile duct injury: Type of injury according to Amsterdam Classification and the different treatments after referral

Period 1992–2012	$n=800$	%
Type of injury:		
A, cystic duct leakage	216	27
B, common bile duct leakage	139	17.4
C, common bile duct stricture	90	11.2
D, bile duct transection/segm	355	44.4
Treatment after referral:		
ERCP and stent	396	49.5
Radiology PTD	96	12
Rendezvous	25	3.1
Hepaticojejunostomy	265	33
Liver resection	11	1.4
Others	9	1.1

Secondly the Amsterdam classification also included a certain connotation of severity of the injury: a minor injury (type A) and major injury (type B–D) as also implied in the Mc Mahon classification. This might also suggest already a potential difference in outcome. Others even adapted the words as "significant" injury versus "insignificant" injury. Analyzing again the AMC study cohort, the in hospital mortality and long term BDI related mortality after treatment for type A injury was resp. 3/216 (2.8 %) and 9/216 (4.2 %) versus after the type D injury treated by hepaticojejunostomy resp. 2/265 (0.8 %) and 6/265 (2 %) [3]. So the initial hospital mortality of the minor (insignificant) type A lesions after endoscopic drainage was relative high compared with the major (significant) type D lesion after surgery. The higher in-hospital mortality for a relative simple injury and endoscopic treatment (a normal biliary ductal system) was not due to failure of the endoscopic procedure but the patient selection/condition at referral. This could not to be recognized in the classification we used. Patients with type A lesions had a delayed referral pattern (median period of 10 days) most suffering from biliary peritonitis, sepsis and 25 % of these patients also underwent a re-laparotomy before referral. A high ASA classification (III–IV) was another independent risk factor for mortality. All patients died due to ongoing biliary sepsis in combination with high ASA score. So there is an enormous bias in selection. This is another shortcoming of the classification to facilitate comparison of outcome. In order to compare these results with other studies we need more clinical information at the time of referral/detection of the injury. This is not found in any of the classifications except for ATOM.

The clinical information as for example provided by the ATOM classification is also of crucial importance for the ongoing discussion about early versus delayed surgical treatment of type D injury. In our series of 265 patients with a hepaticojejunostomy (HJ) we found the clinical pattern at referral, mostly delayed presentation with ongoing biliary peritonitis and sepsis, by far the most important factor for the choice of early versus delayed surgery strategy. These factors of the patient population should be included in outcome studies addressing this ongoing topic about timing of intervention.

We also recently evaluated patients (11/800, 1.4 %) who underwent a liver resection after BDI [4]. These patients had an Amsterdam classification type C: $n=1$ and type D: $n=10$ and the Strasberg classification was type C: $n=2$, type D: $n=2$, and type E: $n=7$. For adequate description of these injuries/patients however we also needed addition information about the vascular injury including: right hepatic art: $n=3$ and proper hepatic artery: $n=1$ and portal vein: $n=2$ and portal vein and right hepatic artery: $n=1$. Fortunately this is already included in the Hannover classification which might be helpful to provide more details about the injury status. In the study we also included information about the timing of resection (acute resection: $n=2$ delayed: $n=9$). Recurrent biliary sepsis and atrophy during the disease progression was crucial to understand the mechanism and planning the extent of resection and reconstruction. In a recent review of hepatic resection for post-cholecystectomy BDI it was shown that an isolated Strasberg E4–5 injury with concomitant hepatic artery injury was an independent predictor for liver resection and outcome [5]. So additional information on vascular injury during classification might be helpful.

Reporting the problems of the "extreme" vasculobiliary injuries together with Steven Strasberg [6] and discussing the association with fundus-down cholecystectomy in severely inflamed gallbladders we also realized that more details about the clinical setting are needed to clarify the mechanism and potential outcome. An improved detailed classification could also be helpful here. Realizing that the incidence of vascular injury is not insignificant, reported up to 7–35 % of the biliary injuries as mentioned in the chapter by Bartlett and Vollmer, more detailed information on vascular injury in a classification might be the minimum for the future.

In summary: The extensive number of classifications of BDI available nowadays might be a prediction that the ultimate classification was not yet identified. So far the Strasberg classification has been used most frequently and was a major step forward to compare adequately the outcome of BDI in the literature. However realizing the shortcomings of all classifications as mentioned above the new ATOM classification system might fill the gap but it is a slightly complicated, time-consuming system. The ability of an extensive complex time consuming classification system such as ATOM should be weighed against advantages in reporting and comparing management and outcome studies on bile duct injury in the future.

References

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