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Bile duct

Lacunar implementation of the critical view of safety technique for laparoscopic cholecystectomy: Results of a nationwide survey

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ABSTRACT

Background: Bile duct injury remains a dilemma in laparoscopic cholecystectomy, with an incidence still higher than in conventional cholecystectomy. The Critical View of Safety technique is used as one of the important operating technique to reduce bile duct injury incidence. The objective of this study was to determine current practices in laparoscopic cholecystectomy and the use of the Critical View of Safety technique among surgeons and residents in surgical training.

Methods: We conducted an electronic survey among all affiliated members of the Association of Surgeons of the Netherlands containing questions regarding the current practice of laparoscopic cholecystectomy, essential steps of the Critical View of Safety technique, reasons for conversion to open cholecystectomy, and the use of other safety techniques.

Results: The response rate was 37% (766/2,055). In the study, 610 completed surveys were analyzed. Of the respondents, 410 (67.2%) were surgeons and 200 (32.8%) were residents in surgical training. Furthermore, 98.2% of the respondents indicated incorporating the Critical View of Safety technique into current practice. However, only 72% of respondents performed the essential steps of the Critical View of Safety technique frequently. Subsequently, half of respondents were able to identify the corresponding steps of the Critical View of Safety technique, and only 16.9% were able to distinguish these adequately from possible harmful steps. Furthermore, 74.9% selected ≥1 possible harmful steps as part of this technique. Residents significantly performed and selected the essential steps of the Critical View of Safety technique more often than surgeons. Intraoperative cholangiography, intraoperative ultrasound, and fluorescence cholangiography are seldom used. Bail-out techniques such as subtotal cholecystectomy, fundus first dissection, and leaving the gallbladder in situ are familiar to the majority of respondents.

Conclusion: Responses indicate that practically all Dutch surgeons and residents claim to use the Critical View of Safety technique. The majority of surgeons and residents are unable to discern correctly the essential steps of the Critical View of Safety technique from actions not part of the technique and even potentially harmful. Residents' current knowledge regarding the Critical View of Safety technique is superior to those of surgeons.

Laparoscopic cholecystectomy (LC) has taken the medical world by storm since its debut by Eric Mühe in 1985 and widespread implementation shortly thereafter.[1] Currently, cholecystectomy is the most performed abdominal surgical procedure in the world, with one in 500 inhabitants in Europe and the United States receiving this procedure annually, of which >80% is performed laparoscopically.[2,3] Despite the superiority in outcomes, such as decreased postoperative pain and reduced duration of stay, a disquieting increase in the number of bile duct injuries (BDI), a potentially life-threatening complication, was detected. Compared to the average BDI incidence of 0.2% in open cholecystectomy (OC), rates between 0.32% and 1.33% were reported after introduction of LC.[4-8] The current incidence of BDI is reported to be 0.23% to 0.47%.[9,10]

At first, due to the novelty of the minimally invasive approach and the inexperience in the technique among the majority of surgeons, this aggravation was attributed to the learning curve. It is indeed noted that in the early cases of a surgeon's career the

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risk is increased; however, accumulated case load and operator experience have not decreased the incidence of BDI.[11-13] Therefore, misidentification of biliary structures, rather than the laparoscopic approach in itself, is commonly considered the main cause of BDI.

To reduce the risk of misidentification, several methods have been used, such as intraoperative cholangiography (IOC), near-infrared fluorescence cholangiography with indocyanine green, and intraoperative ultrasound (IOUS) to identify (aberrant) anatomy. A well-known method is represented by the critical view of safety technique (CVS) as proposed by Strasberg et al in 1995.[14] This technique was initially a revision of the safe identification of biliary structures in open cholecystectomy and one of the first attempting to transfer these basic principles to the laparoscopic approach. This is in contrast to the historically first promoted technique, which has been around since the implementation of laparoscopic cholecystectomy and is currently known as the "infundibular technique" (IT). The essence of the latter technique is that a ductal structure is identified as the cystic duct (CD) when the traditional "flare" or "funnel" shape is visualized at the infundibulum-CD junction. Despite the potential of CVS, Daly et al have demonstrated that more than half of surgeons still preferred using IT, compared to 27% preferring CVS.[15] Furthermore, >20% of surgeons could not identify CVS on an intraoperative image, and 65% were not able to properly reproduce the description of CVS, despite the fact that this technique has been incorporated in resident training since its introduction. In the Netherlands, the use of CVS among surgeons is estimated to be >90%, and it is currently included in the national guideline for LC.[16,17] However, the extent to which surgeons and surgical residents properly utilize CVS is unknown. In this study, we aimed to determine current practices and perceptions in the performance of safe LC and how CVS is implemented, along with what safety measures are currently performed among practicing surgeons and residents in surgical training.

Methods

On June 20, 2017, all members affiliated to the Association of Surgeons of the Netherlands were approached by E-mail to participate in a Web-based survey (LimeSurvey, LimeSurvey GmbH. Hamburg, Germany). An opt-out option was provided for respondents not wishing to participate in the survey. After initial invitations, 3 reminders were sent to nonresponders with an interval of 4 weeks. Retired surgeons, approached persons with other functions than surgeons or residents, and partial responses were excluded from analysis.

This survey was composed of 14 questions. The full survey can be found in Appendix 1. Questions 1 through 6 covered current function, subspecialization, years of practice or year of surgical training, number of laparoscopic cholecystectomies during career, number of laparoscopic cholecystectomies in the past 12 months, and workplace (by type of institution). Questions 7 through 10 focused on the current use of CVS. In question 11, 9 statements regarding the certain moments in LC were presented in random order. To evaluate the current practice in LC, respondents were requested to grade each statement according to the frequency with which they would apply it in daily practice on a 5-point Likert-type scale of 1 (never) to 5 (always). Question 12 was designed to evaluate the current knowledge of CVS and intentionally placed after question 11 to not bias the responses regarding the current practice in LC. Six statements were provided in random order; the respondents were asked to select the steps (multiple selections were allowed) which are, in their opinion, essential to CVS. Half of these 6 statements are not considered part of CVS and have been determined previously to even be potentially hazardous techniques ("identification of the cystic duct–common hepatic duct junction," "the cystic duct is transected after the funnel-shaped junction between the infundibulum and the cystic duct is recognized," and "to identify corresponding structures, Calot's hepatobiliary triangle [cystic duct—common hepatic duct—liver] has to be cleared entirely from fat and fibrous tissue").[14,18] Question 13 focused on the situations in which the respondent would convert to OC. Lastly, in question 14 respondents were asked with what frequency certain imaging and safety techniques were utilized on a 5-point Likert-type scale of 1 (never) to 5 (always). All responses were anonymous. Respondents were able to leave additional remarks.

Statistical analysis

Data was analyzed with IBM SPSS Statistics for Windows, version 21.0 (IBM Corp. Armonk, NY) and Microsoft Excel (Microsoft Corp., Redmond, WA). Data are presented as numbers and percentages. Data derived from Likert-type scales were grouped in 2 categories: 1 through 3 ("never," "rarely," "sometimes") and 4 with 5 ("regularly" and "always"). Groups were compared using χ^2 test or Fisher exact test. In case of ≥2 categories, post hoc testing was performed using the standardized residual method, followed by Bonferroni adjustment to the Z critical of 1.96 corresponding to an α of 0.05, to determine the categories with disparity. Figures were created with GraphPad Prism for Windows version 5.0 (GraphPad Software, La Jolla, CA).

Results

Invitations were sent to 2,102 E-mail addresses and successfully delivered in 2,055 cases. In total, 207 respondents chose not to participate. Overall, the response rate was 766 (37%). In addition, 156 responses were excluded (retired surgeons 28%; functions other than surgeons or residents 3%; partial responses 69%). Finally, 610 completed surveys were included for further analysis. Of the included respondents, 410 (67.2%) were surgeons and 200 (32.8%) were residents in surgical training. Among the surgeons, the most reported subspecialization was gastrointestinal surgery (56.1%), followed by surgical oncology (45.6%) and trauma surgery (22.9%). For the residents, the majority (52%) reported not having differentiated as yet, followed by a differentiation toward gastrointestinal surgery (18.0%) and surgical oncology (16.5%). The majority of surgeons and residents were employed in general teaching hospitals (58.5% and 72.0%, respectively). Detailed respondent information can be found in Table 1.

Regarding the LC caseload, more than two-thirds of responding surgeons had performed >300 LCs during their career. For residents, 45% had performed or assisted in >100 LCs in total. In the

Table 1
Respondent information.

	Surgeons (n = 410)		Resident in surgical training (n = 200)	
	N	(%)	N	(%)
Subspecialization				
Surgical oncology	187	(45.6)	33	(16.5)
GI surgery	230	(56.1)	36	(18.0)
HPB surgery	31	(7.6)	3	(1.5)
Pediatric surgery	20	(4.9)	3	(1.5)
Pulmonary surgery	32	(7.8)	6	(3.0)
Trauma surgery	94	(22.9)	20	(10.0)
Vascular surgery	49	(12.0)	16	(8.0)
No specialization	2	(0.5)	104	(52.0)
Workplace				
University hospital	68	(16.6)	55	(27.5)
General teaching hospital	240	(58.5)	144	(72.0)
General nonteaching hospital	91	(22.2)	—	

GI, gastrointestinal; *HPB*, hepatopancreaticobiliary.

Table 2
Experience of respondents.

	Surgeons (n = 410)
	N (%)
Total years practicing	
<5 y	100 (24.4)
5–10 y	104 (25.4)
10–15 y	100 (24.4)
>15 y	106 (25.9)
LC during career	
<100	17 (4.1)
100–300	104 (25.4)
301–500	127 (31.0)
>500	162 (39.5)
LC in the past 12 mo	
<10	62 (15.1)
10–25	97 (23.7)
26–50	151 (36.8)
>50	100 (24.4)
	Residents (n = 200)
	N (%)
Year of training	
Year 1	17 (8.5)
Year 2	28 (14.0)
Year 3	44 (22.0)
Year 4	33 (16.5)
Year 5	42 (21.0)
Year 6	36 (18.0)
LC during career	
<50	47 (23.5)
50–100	62 (31.0)
101–200	66 (33.0)
>200	25 (12.5)
LC in the past 12 mo	
<10	40 (20.0)
10–25	61 (30.5)
26–50	68 (34.0)
>50	31 (15.5)

LC, laparoscopic cholecystectomy.

past year, ≈60% of the surgeons and half of the residents had performed >25 LCs. Overall 21.5% performed >50 LCs in the past 12 months. The detailed experience of respondents is delineated in Table 2.

Critical view of safety

In total, 99% of respondents indicated familiarity with CVS and 98.2% of respondents indicated that they use CVS in practice. Of the latter, 87.1% replied using CVS "always," and 10.5% using it "regularly." The respondents who reported not knowing CVS were all surgeons, practicing >15 years, with an oncological or vascular subspecialization. In these surgeons, the lifetime caseload of LC and that of the past year were low (<100 and <10 LCs, respectively). Of the respondents who reported using CVS, two-thirds selected "because I was trained this way" as a reason for using the technique. Residents selected this option significantly more often than surgeons (88.0% vs 56.3%, respectively; $P < .001$). Among responding surgeons, this option was significantly selected more often by those practicing ≤10 years (85.3%) compared to surgeons practicing ≥10 years (27.7%; $P \leq .001$). The reason "this is the most trustworthy method of preventing BDI" was selected by 73.5% of respondents and equally often by residents as by surgeons (73.5% vs 73.4%; $P = .982$). Other reasoning provided for use of CVS by the respondents was "due to current guidelines" or "for training purposes." Eleven respondents stated that they did not use CVS, of whom 4 replied that they used a method they deem more reliable.

Current practice of laparoscopic cholecystectomy

With regard to the identification of Rouvière's sulcus, the majority of respondents (72.1%) did so "always" or "regularly." Residents did this significantly more often than surgeons (78.2% vs 68.8%; $P = .017$). Opening of the peritoneal envelope as far as possible from the liver hilum was done "always" or "regularly" by the vast majority of respondents (94.5%), with no significant difference between the residents and surgeons ($P = .813$). The responses were divided regarding the statement in which the full dissection of Calot's hepatobiliary triangle (consisting of the CD, the common hepatic duct [CHD], and the liver) free from fat and fibrous tissue was described: Half of the respondents indicated clearing Calot's triangle completely on a regular basis, whereas a third responded that they did so rarely or never. Groups did not differ significantly in this respect ($P = .227$).

Circumferential overview of the junction of the CD and the cystic artery (CA) at the level of the gallbladder was frequently done by the majority of respondents (95.6% and 82.6%, respectively) and was done just as often by residents and surgeons ($P = .158$ and $P = .758$, respectively). In addition, 92.8% of respondents completely dissect the infundibulum free from the liver bed "regularly" or "always," with no significant difference between residents and surgeons ($P = .481$). Residents report clipping the CA before the CD "regularly" or "always" significantly more often than surgeons (76.5% vs 66.8%; $P = .016$). Conversely, clipping of the CD before the CA was replied "regularly" or "always" by one-third of the respondents and significantly more often by surgeons (36.5% vs 21.9%; $P < .001$). Within the surgeons group, responding surgeons with the least amount of practicing years (<5 years and 5–10 years) first clip the CA significantly more often than responding surgeons with more experience (10–15 years and >15 years). The fundus first approach of LC is done rarely (overall, 80.9% "sometimes" or less). However, according to the responses, this approach is done significantly more often by residents than by surgeons ("regularly" or "always" by 24.6% vs 16.4%; $P = .017$). In addition, 72% of respondents performed all 3 steps constituting CVS (circumferential overview of the junction of both CD and CA at the level of the gallbladder by dissecting the infundibulum free of the liver) either "regularly" or "always." Although no significant difference existed between residents and surgeons (74% vs 71%; $P = .851$), among surgeons, the group with the most years practicing (>15 years) performed the 3 steps of CVS significantly less often than those practicing ≤15 years.

A detailed representation of the frequency in which these techniques are used by residents and surgeons can be seen in Table 3 and Fig 1.

Aspects of the critical view of safety

The statements presented to the respondents in question 12 and the number of respondents who selected these as essential steps of CVS are presented in Table 4. Among the 3 statements that are not considered part of CVS, overall 8.5% of respondents selected the identification of the CD-CHD junction as part of CVS. The statement describing IT for recognition of the CD was selected by 51.3% of respondents. The third statement covering the entire clearance of Calot's hepatobiliary triangle including the CHD was selected by 38.2% of respondents. Within all these 3 statements, no significant difference was found between residents and surgeons ($P = .988$, $P = .073$, and $P = .256$, respectively). Among surgeons, identification of the of the CD-CHD junction was selected significantly more often by surgeons practicing over 15 years compared to those with less working years ($P = .001$).

Regarding the 3 statements that are considered an essential part of CVS, the vast majority (86.1%) selected the statement con-

Table 3
Current execution of laparoscopic cholecystectomy by respondents.

	Statements	Surgeons ($N=410$)						Residents ($N=200$)	P value‡	All respondents ($N=610$)
		<5 y ($N=100$)	5–10 y ($N=104$)	10 –15 y ($N=100$)	>15 y ($N=106$)	P value†	Overall			
		N (%)	N (%)	N (%)	N (%)		N (%)	N (%)		N (%)
Q1	Identification of Rouvière's sulcus	79 (79.0)	69 (66.3)	*43 (43.0)	54 (50.9)	.003	245 (59.8)	151 (75.5)	.019	396 (64.9)
Q2	Opening of the peritoneal envelope as far as possible from the liver hilum	95 (95.0)	91 (87.5)	89 (89.0)	94 (88.7)	.607	369 (90.0)	184 (92.0)	.813	553 (90.7)
Q3	Full clearance of Calot's hepatobiliary triangle (CD-CHD-liver) from fat and fibrous tissue	52 (52.0)	51 (49.0)	56 (56.0)	54 (50.9)	.797	213 (52.0)	102 (51.0)	.494	315 (51.6)
Q4	Circumferential overview of the CD-gallbladder junction after dissection	97 (97.0)	92 (88.5)	91 (91.0)	92 (86.8)	.202	372 (90.7)	189 (94.5)	.758	561 (92.0)
Q5	Circumferential overview of the CA-gallbladder junction after dissection	87 (87.0)	78 (75.0)	79 (79.0)	72 (67.9)	.031	316 (77.1)	168 (84.0)	.158	484 (79.3)
Q6	Complete freeing of the gallbladder infundibulum from the liver bed before transection of the CD and the CA	94 (94.0)	89 (85.6)	93 (93.0)	89 (84.0)	.142	365 (89.0)	178 (89.0)	.481	543 (89.0)
Q7	Transection of the CA before the CD	*87 (87.0)	*77 (74.0)	*51 (51.0)	*45 (42.5)	<.001	260 (63.4)	150 (75.0)	.016	410 (67.2)
Q8	Transection of the CD before the CA	*16 (16.0)	*24 (23.1)	43 (43.0)	*61 (57.5)	<.001	144 (35.1)	43 (21.5)	<.001	187 (30.7)
Q9	Fundus first dissection of the gallbladder	12 (12.0)	13 (12.5)	19 (19.0)	20 (18.9)	.234	64 (15.6)	48 (24.0)	.017	112 (18.4)
	Execution of CVS (Q4, Q5, Q6)	80 (80.0)	69 (66.3)	77 (77.0)	*65 (61.3)	.010	291 (71.0)	148 (74.0)	.851	439 (72.0)

Values represent the amount of responses on the Likert type scale containing "regularly" or "always."
CA, cystic artery; *CD*, cystic duct; *CHD*, common hepatic duct; *CVS*, critical view of safety.
* Significant difference according to the standardized residual method.
† P value for difference among surgeons' experience level.
‡ P value for difference between surgeons overall and residents.

cerning the dissection of the entry point of the CD into the gallbladder until circumferential overview is achieved. This statement was selected significantly more often by residents than by surgeons (92.5% vs 82.9%; $P=.001$). The corresponding statement regarding the CA was selected by 67.4% of the respondents and again was selected significantly more often by residents than by surgeons (78.5% vs 62.0%; $P<.001$). The final essential part of CVS, dissecting the gallbladder infundibulum free from the liver for approximately one-third, was selected by 79.3%, significantly more by residents compared to surgeons (84.5% vs 76.8%; $P=.028$).

Surgeons practicing >15 years selected all 3 statements considered to be essential to CVS significantly less often than those practicing ≤15 years. The statements concerning the dissection of the entry point of the CD into the gallbladder until circumferential overview is achieved and the dissection of the infundibulum free from the liver for approximately one-third were chosen significantly more often as an essential part of CVS by the group of surgeons practicing <5 years as compared to the other groups of surgeons.

Overall, the percentage of respondents who selected only and all 3 statements in line with CVS was 16.9%. Residents and surgeons did not differ significantly. Surgeons practicing <5 years selected all 3 of the statements in accordance with CVS and none of the disagreeing statements significantly more often than those with >5 years of practice.

Three-quarters of the respondents selected at least one of the statements not related to CVS. No significant difference between surgeons and residents or among surgeons was found. The respondents who performed >50 LCs in the past 12 months did not select the statements associated with CVS significantly more often (19.1% vs 16.3%; $P=.448$) or select the unrelated statements less often (75.6% vs 74.7%; $P=.845$) compared with those who performed fewer LCs. Gastrointestinal surgeons selected only the statements attributed to CVS significantly more often than nongastrointestinal surgeons (18.3% vs 11.1%; $P=.045$) and selected the statement describing IT significantly less often (44.3% vs 54.4%; $P=.042$).

Conversion to open cholecystectomy

The respondents' considerations in converting to OC are delineated in Table 5. Overall, the most common reason for converting to OC was "in case of severe bleeding" (65.4%), followed by "when the Critical View of Safety is not achieved" (58.0%) and "extensive adhesions involving the surrounding structures and organs" (44.9%). The reasons for conversion chosen least often were "spillage of gallstones due to gallbladder damage," "spillage of bile due to gallbladder damage," and "in case of shrunken gallbladder" (none, 0.2%, and 5.2%, respectively). Surgeons would convert to OC when CVS was not achieved significantly more often than residents in training (61.2% vs 51.5%; $P=.022$).

Use of other techniques to perform safe laparoscopic cholecystectomy

IOC is never performed by 57.9% of respondents. In addition, 73.0% of the residents never perform IOC, in contrast to 50.5% of the surgeons ($P<.001$). The majority of respondents never perform near-infrared fluorescence cholangiography with indocyanine green and IOUS (86.1% and 84.8%, respectively) during LC. Bail-out procedures such as laparoscopic subtotal cholecystectomy and leaving the gallbladder in situ are performed by the majority of respondents (60.7% and 55.7%, respectively). Of the respondents, 12.3% never performed the first technique and 30.0% never performed the latter. The current use of other safety techniques during LC is delineated by Fig 2.

Discussion

Since its introduction by Strasberg et al. over two decades ago, CVS as both a safety technique and an educational tool to prevent BDI in LC has received considerable acclaim. This is illustrated by the implementation of CVS by the Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) in their guidelines for the clinical application of laparoscopic biliary tract surgery, and by the inclusions of a "best practice laparoscopic cholecystectomy" chapter utilizing CVS in the guideline "gallstone disease" by the

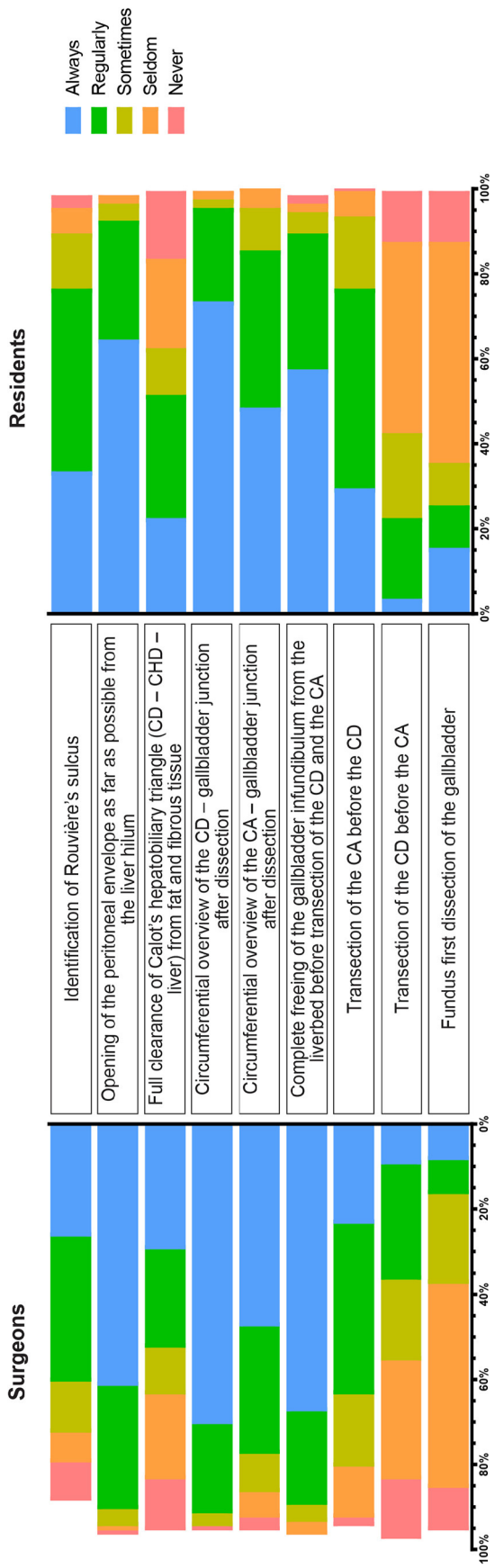

Fig. 1. Comparison of current use of laparoscopic cholecystectomy techniques between surgeons and residents. *CA*, Cystic artery; *CD*, Cystic duct; *CHD*, Common hepatic duct.

Association of Surgeons of the Netherlands.[19,20] Furthermore, a recent Delphi study as part of the Tokyo Guideline 2018 formation reported consensus regarding the use of CVS whenever possible.[21]

In a previous survey, responses by Dutch surgeons already demonstrated that CVS is widely accepted and implemented in the Netherlands.[16] The fact that this survey yields a comparable percentage of CVS use (98.2%) among responses confirms that this technique remains the standard of care in the Netherlands. The most common reason for its use given in the present survey is due to the implementation of CVS in surgical training, as is illustrated by the vast majority of residents who chose this response. Just over half of the surgeons selected this reason. Not unexpectedly, the group of surgeons practicing for ≤10 years selected this reason significantly more often, since their surgical education began after the implementation of CVS 20 years ago. Three-quarters of respondents used CVS because they find it the most trustworthy technique to prevent BDI in LC.

Regarding the current practices in LC, all 3 essential components belonging to CVS are performed either "regularly" or "always" by 72% of respondents. This is done significantly less often by experienced surgeons (>15 years of experience). When subsequently asked for the definition of CVS, only 57.4% selected these statements as essential parts of CVS. The discrepancy in replies that exists among 1) residents and surgeons reporting use of CVS in daily practice, 2) respondents actually performing the fundamental elements of the technique, and 3) those indeed able to correctly define the definition of CVS is peculiar. Respondents clearly indicated that they use CVS on a regular basis, yet the results of this survey seem to indicate that they are not consistent in specifying which steps are essential to the technique. Even though this survey has been conducted anonymously, social desirability bias might still be present, specifically regarding the initial question concerning the use of CVS in practice. Nijssen et al reported a similar inconsistency.[22] In their study, operative reports and video reviews of complicated LCs were compared. CVS was described in 80% of the operative reports, yet was correctly reached in only 10.8% of the cases.

In addition, 16.9% of all respondents selected only the statements most accurately corresponding with CVS (i.e., without selecting any other statement not associated with the definition of CVS). Conversely, three-quarters of the respondents selected at least one of the 3 statements not describing elements of CVS as being a component of CVS. The techniques portrayed by these statements are possible harmful actions. For instance, more than half of respondents incorrectly selected the statement describing IT as an essential aspect of CVS. In a previous study critically analyzing 21 patients being referred with common bile duct (CBD) injury after LC, it was noted that in a majority of cases a technique was described matching IT. Particularly in difficult conditions such as inflammation and fibrosis, the CD could be hidden from sight by shortening and thickening. This might lead to erroneous interpretation of the CBD or other structures as a "false infundibulum," thereby provoking BDI, when using IT.[18] Furthermore, two-fifths of the respondents selected the statements concerning the full dissection of Calot's hepatobiliary triangle, including the CHD, from fat and fibrous tissue as part of CVS. In their original article describing CVS, Strasberg et al did indeed state that for unequivocal identification of the CD and CA, essentially the structures to be divided, Calot's hepatobiliary triangle must be cleared of fat and fibrous tissue. The key components of the critical view are that the infundibulum is dissected free from the liver surface and that 2 structures, the CD and the CA, are observed entering the gallbladder. It was explicitly noted that visualization of the CBD is unnecessary, even undesirable, with regard to CVS due to risk of iatrogenic damage. In this survey, this step was therefore not implied

Table 4
Aspects of the critical view of safety technique among respondents.

Possible statements	Surgeons (*N* = 410)						Residents (*N* = 200)	*P* value‡	All Respondents (*N* = 610)
	<5 y (*N* = 100)	5–10 y (*N* = 104)	10–15 y (*N* = 100)	>15 y (*N* = 106)	*P* value†	Surgeons overall			
	N (%)	*N* (%)	*N* (%)	*N* (%)		*N* (%)	*N* (%)		*N* (%)
Identification of the CD-CHD junction	2 (2.0)	7 (6.7)	8 (8.0)	*18 (17.0)	.001	35 (8.5)	17 (8.5)	.988	52 (8.5)
The CD is transected after the funnel-shaped junction between the infundibulum and the cystic duct is recognized	46 (46.0)	59 (56.7)	48 (48.0)	47 (44.3)	.284	200 (48.8)	113 (56.5)	.073	313 (51.3)
To identify corresponding structures, Calot's hepatobiliary triangle (CD-CHD-liver) has to be cleared entirely from fat and fibrous tissue	39 (39.0)	39 (37.5)	41 (41.0)	44 (41.5)	.931	163 (39.8)	70 (35.0)	.256	233 (38.2)
Dissection of the entry point of the CD into the gallbladder until circumferential overview is achieved	*93 (93.0)	84 (80.8)	85 (85.0)	*78 (73.6)	.002	340 (82.9)	185 (92.5)	.001	525 (86.1)
Dissection of the entry point of the CA until circumferential overview is achieved	73 (73.0)	68 (65.4)	67 (67.0)	*46 (43.4)	.000	254 (62.0)	157 (78.5)	<.001	411 (67.4)
Dissection of the infundibulum free from the liver bed for approximately one-third	*90 (90.0)	90 (86.5)	73 (73.0)	*62 (58.5)	.000	315 (76.8)	169 (84.5)	.028	484 (79.3)
All statements regarding CVS, none of the other	*25 (25.0)	13 (12.5)	15 (15.0)	9 (8.5)	.008	62 (15.1)	41 (20.5)	.096	103 (16.9)
Any statement not regarding CVS	72 (72.0)	82 (78.8)	72 (72.0)	80 (75.5)	.627	306 (74.6)	151 (75.5)	.817	457 (74.9)

Values represent number of responses selecting the given statement as essential step of the Critical View of Safety technique.
CA, cystic artery; *CD*, cystic duct; *CHD*, common hepatic duct.
* Significant difference according to the standardized residual method.
† *P* value for difference among surgeons' experience level.
‡ *P* value for difference between surgeons and residents overall.

among the essential components of CVS. However, it is still a possibility that this statement is interpreted differently by the respondents. A separate analysis excluding this statement was therefore conducted, which did not cause any change in the resulting significance.

Residents prove to have superior knowledge over surgeons regarding the essential steps of CVS, selecting the correct statements significantly more often than surgeons, as do surgeons with the least amount of years practicing as compared to those practicing for a longer period. The most obvious explanation is because of the implementation of CVS in current surgical education and in laparoscopic skills courses. Gastrointestinal surgeons grasp the essence of CVS better than those with a different subspecialization.

Still, in some cases with aberrant anatomy or gross fibrosis caused by, for example, chronic cholecystitis, it is not possible or is even detrimental to (continue to) perform LC using CVS. These situations therefore call for a different approach. Fortunately, these bail-out techniques (i.e., laparoscopic subtotal cholecystectomy, fundus-first dissection, and leaving the gallbladder in situ) are performed by the majority of respondents: only 12.3%, 7%, and 30%, respectively replied that they never utilized these techniques. This indicates that alternatives to standard LC are well established. This survey however did not evaluate the considerations regarding whether or when to use these bail-out techniques.

Regarding conversion to open surgery, surgeons seem to convert more often than residents. This might be due to increased reluctance of residents, resulting from decreased exposure of residents to OC as compared to practicing surgeons. However, these results are also representative of current practice: An important decision like conversion is a major event in LC and is often not made by residents alone without consulting a superior.

Other considerations for conversion to OC were insufficient progression and/or overview and when malignancy is suspected. Also, some respondents rightfully added that conversion to open surgery does not necessarily facilitate an easier operation as conditions do not change and the magnification of the surgical area provided by the endoscope is lost.

The use of IOC during LC is highly variable across the world. Initially the main purpose of performing this procedure was to diagnose CBD stones, but because of the wide availability of endoscopic retrograde cholangiopancreatography and magnetic resonance cholangiopancreatography, its necessity has been greatly diminished. Previous surveys have demonstrated that IOC is still customary in the United Kingdom and the United States, with 93% to 99% of surgeons reporting its use, 24% to 27% on a routine basis.[23,24] In contrast to these countries, IOC is rarely used outside these parts of the world.[16,25] In the present survey, half of surgeons and almost three-quarters of residents in surgical training

Table 5
Respondents' considerations to convert to open cholecystectomy.

Reason to convert to open cholecystectomy	Surgeons (*N* = 410)	Residents (*N* = 200)	*P* value	Overall (*N* = 610)
	N (%)	*N* (%)		*N* (%)
In case of shrunken gallbladder	24 (5.9)	8 (4.0)	.335	32 (5.2)
When the Critical View of Safety is not achieved	251 (61.2)	103 (51.5)	.022	354 (58.0)
Extensive adhesions involving the surrounding structures and organs	173 (42.2)	101 (50.5)	.053	274 (44.9)
Bile leakage (with an intact gallbladder)	73 (17.8)	43 (21.5)	.275	116 (19.0)
Spillage of bile due to gallbladder damage	1 (0.2)	0	.485	1 (0.2)
Spillage of gallstones due to gallbladder damage	0	0	–	0
In case of severe bleeding	259 (63.2)	140 (70.0)	.096	399 (65.4)

Values represent number of responses of each case in which the respondent would convert to open cholecystectomy.

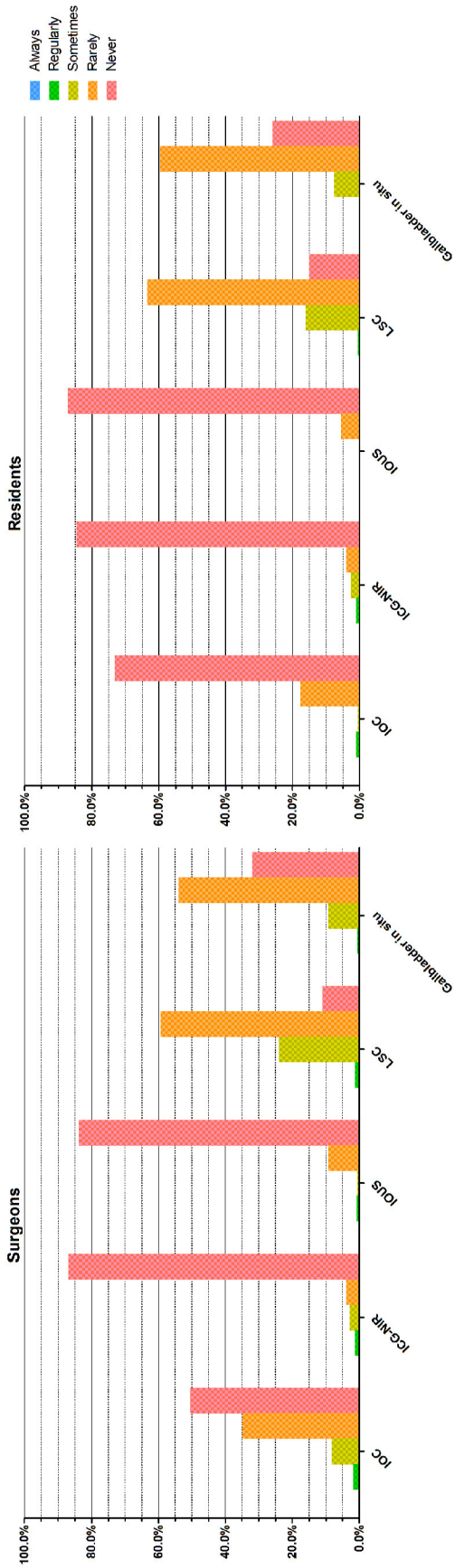

Fig. 2. Use of other safety techniques during laparoscopic cholecystectomy by surgeons and residents. *ICG-NIR*, near-infrared fluorescence cholangiography with indocyanine green; *LSC*, laparoscopic subtotal cholecystectomy.

state that they never perform IOC during LC. With these numbers, it is not inconceivable that a large portion of these residents have never performed or even witnessed IOC at all, considering the duration of their career so far. Also, IOUS, once a promising and minimally invasive alternative to IOC, is never performed by the vast majority of either group. Because the use of these supporting imaging techniques is declining and infrequent use has already led to inadequate exposure among surgical trainees, incorporation of these techniques in standard surgical practice seems unfavorable.

The response rate of this survey was 37%, a rate comparable to other surveys approaching a similar wide range of possible respondents. Partly due to the large number of invited participants, this survey yielded a high number of replies. A possible limitation is the possibility of imbalance among respondents. Surgeons more proficient in laparoscopic surgery, such as those with gastrointestinal or oncologic subspecialization in the Netherlands, might be more inclined to respond to the survey. Furthermore, no selection was made based on whether surgeons still perform LC. This is slightly compensated by the question regarding the number of LCs in the past year and the fact that most surgeons who, because of differentiation or other reasons, do not perform LC were not motivated to respond to the survey. This is illustrated by the many replies from respondents no longer performing LC among the opt-outs.

In conclusion, the responses to this survey indicate that CVS is well known among Dutch surgeons and residents in surgical training, nearly utilized by all in daily practice. However, the percentage of respondents who actually perform CVS and furthermore recognize all correct steps of CVS is lower. It is therefore probable that CVS as a safety technique and educational tool for residents is less frequently used and more poorly understood in the Dutch surgical field than is suggested by its incorporation in national guidelines and skills courses. Residents and younger surgeons have better understanding of this topic, which is in line with the fact that courses with regard to CVS were structurally installed only a decade ago. Considering that these findings originate from a country like the Netherlands in which CVS is widely implemented, it is conceivable that the proficiency regarding CVS in other countries utilizing this technique could be equal or less. As a useful method to prevent BDI in noncomplex LC and to teach residents the basic principles of cholecystectomy, we suggest that the essential steps and pitfalls of CVS, as well as when not to perform CVS, should be featured more thoroughly in the present curriculum for residents in surgical training with special regard to surgical anatomy, preferably "before the job."

Appendix 1. –. Survey (Translated from Dutch)

Demographic data

Question 1. *What is your current function?*

- Surgeon
- Resident in surgical training
- Retired surgeon
- Other (specify)

Question 2. *What is your subspecialization?*
(Multiple answers possible. In case of resident in surgical training en not yet differentiated towards a subspecialization, please select ***not applicable****)*

- Surgical Oncology
- Gastrointestinal Surgery
- Hepatopancreaticobiliary Surgery
- Pediatric Surgery
- Pulmonary Surgery

- ○ Trauma Surgery
- ○ Vascular Surgery
- ○ Not applicable

Question 3A. *(If surgeon) How many years are you practicing surgery?*

- ○ < 5 years
- ○ 5 to 10 years
- ○ 10 to 15 years
- ○ > 15 years

Question 3B. *(If resident) What year of the education are you currently in?*

- ○ Year 1
- ○ Year 2
- ○ Year 3
- ○ Year 4
- ○ Year 5
- ○ Year 6

Question 4A. *(If surgeon) How many laparoscopic cholecystectomy procedures did you perform or supervise in your carrieer up to now?*

- ○ < 100
- ○ 300
- ○ 301 to 500
- ○ > 500

Question 4B. *(If resident) How many laparoscopic cholecystectomy procedures did you perform or have you assisted in your carrieer up to now?*

- ○ < 50
- ○ 50 to 100
- ○ 101 to 200
- ○ > 200

Question 5A. *(If surgeon) How many laparoscopic cholecystectomy procedures did you perform or supervise in the past 12 months?*

- ○ < 10
- ○ 10 to 25
- ○ 26 to 50
- ○ > 50

Question 5B. *(If resident) How many laparoscopic cholecystectomy procedures did you perform or have you assisted in the past 12 months?*

- ○ < 10
- ○ 10 to 25
- ○ 26 to 50
- ○ > 50

Question 6. *What is your workplace?*

- ○ University hospital
- ○ General teaching hospital
- ○ General non-teaching hospital
- ○ Other (specify)

Current use of the Critical View of Safety technique

Question 7. *Do you know the critical view of safety technique?*

- ○ Yes
- ○ No

Question 8. *Do you use the Critical View of Safety (CVS) technique?*

- ○ Yes
- ○ No

Question 9A. *(If answer was "Yes" at Question 8) Why do you use this technique?*

- ○ Because I was trained this way
- ○ this is the most trustworthy method of preventing BDI
- ○ Other (specify)

Question 9B. *(If answer was "No" at Question 8) Why do you* ***not*** *use this technique?*

- ○ This method is cumbersome.
- ○ I use a different method I deem more trustworthy
- ○ Other (specify)

Question 10A. *(If answer was "Yes" at Question 8) Use of the Critical View of Safety technique in de daily practice.*

	Never	Rarely	Sometimes	Regularly	Always
How often do you use the CVS technique	○	○	○	○	○

Question 10B. *(If answer was "No" at Question 8) What technique do you use to remove a gallbladder?*

Please provide a short description of your method.

Current practice of laparoscopic cholecystectomy

Question 11. *Please indicate of the following actions in what frequency you apply them.*

	Never	Rarely	Sometimes	Regularly	Always
Identification of Rouvière's sulcus	○	○	○	○	○
Opening of the peritoneal envelope as far as possible from the liver hilum	○	○	○	○	○
Full clearance of Calot's hepatobiliary triangle (cystic duct—common hepatic duct—liver) from fat and fibrous tissue	○	○	○	○	○
Circumferential overview of the cystic duct—gallbladder junction after dissection	○	○	○	○	○
Circumferential overview of the cystic artery—gallbladder junction after dissection	○	○	○	○	○
Complete freeing of the gallbladder infundibulum from the liver bed before transection of the cystic duct and the cystic artery	○	○	○	○	○
The cystic artery is transected before the cystic duct	○	○	○	○	○
The cystic duct is transected before the cystic artery	○	○	○	○	○
The gallbladder is dissected fundus first from the liver bed	○	○	○	○	○

Aspects of the Critical View of Safety technique

Question 12. *In case you employ the Critical View of Safety technique, what are, according to you, the essential steps of this technique?*
(Multiple answers are possible)

- ○ Identification of the cystic duct—common hepatic duct junction
- ○ The cystic duct is transected after the funnel-shaped junction between the infundibulum and the cystic duct is recognized
- ○ To identify corresponding structures, Calot's hepatobiliary triangle (cystic duct—common hepatic duct—liver) has to be cleared entirely from fat and fibrous tissue
- ○ Dissection of the entry point of the cystic duct into the gallbladder until circumferential overview is achieved
- ○ Dissection of the entry point of the cystic artery into the gallbladder until circumferential overview is achieved
- ○ Dissection of the infundibulum free from the liver bed for approximately one third.

Conversion to open cholecystectomy

Question 13. *In which of the following cases would you convert to an open procedure?*
(Multiple answers are possible)

- ○ In case of shrunken gallbladder
- ○ When the Critical View of Safety is not achieved
- ○ Extensive adhesions involving the surrounding structures and organs
- ○ Bile leakage (with an intact gallbladder)
- ○ Spillage of bile due to gallbladder damage
- ○ Spillage of gallstones due to gallbladder damage
- ○ In case of severe bleeding
- ○ Other (specify)

Other techniques

Question 14. *In what frequency do you employ the following techniques?*

	Never	Rarely	Sometimes	Regularly	Always
Intraoperative radiological cholangiography	○	○	○	○	○
Intraoperative fluorescence (ICG) cholangiography	○	○	○	○	○
Intraoperative ultrasonography	○	○	○	○	○
Partial cholecystectomy	○	○	○	○	○
Leave the gallbladder in situ	○	○	○	○	○

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