Cholecystectomy Vs. Cholecystostomy for the Management of Acute Cholecystitis in Elderly Patients

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Abstract

Background Data comparing outcomes following cholecystectomy and cholecystostomy tube placement (CTP) in elderly patients are lacking. We aimed to compare the post-procedural outcomes between cholecystectomy and CTP in elderly patients with acute cholecystitis.

Methods We performed a retrospective, population-based analysis using the National Inpatient Sample for the period 2000–2014. Patients ≥ 65 years old admitted with a primary diagnosis of acute cholecystitis and who underwent either cholecystectomy or CTP during their hospitalization were included. Multivariable linear and logistic regression models were used to analyze post-procedural complications, mortality, length of stay, and total charges. The effect of procedure type on patient outcomes, stratified by acalculous and calculous cholecystitis, was also performed.

Results A total of 200,915 patients were included, of which 7516 underwent CTP and 193,399 underwent cholecystectomy. The median age of patients undergoing CTP and cholecystectomy was 80 (IQR 73–87) and 75 (IQR 70–81), respectively. Patients undergoing CTP were more likely to have post-procedural infection (OR 2.25; 95% CI 2.07, 2.45), bleeding (OR 1.28; 95% CI 1.19, 1.37), and inpatient mortality (OR 9.27; 95% CI 7.95, 10.81). On average, CTP patients stayed 1.25 days longer (95% CI 1.14, 1.37) in hospital after the procedure. The benefits of cholecystectomy were consistent in patients with acalculous and calculous cholecystitis.

Conclusions Elderly patients with both acalculous and calculous acute cholecystitis managed with CTP have higher incidences of post-procedural morbidity and mortality, and longer post-procedure length of hospital stay, as compared to cholecystectomy. Unless prohibitive surgical risks exist, elderly patients with acute cholecystitis should undergo cholecystectomy.

Keywords Acute cholecystitis · Elderly · Cholecystectomy · Cholecystostomy

Introduction

Acute cholecystitis is a common disease that affects up to 20% of all patients with symptomatic gallstone disease.[1] In the USA, gallstones are the fifth leading diagnosis for emergency department visits, resulting in a significant clinical and economic burden.[2] Generally, laparoscopic cholecystectomy is the treatment of choice, as it is considered effective and safe with low rates of morbidity and mortality.[3,4]

As the progressive aging of the US population occurs, it is expected that the number of elderly patients with acute cholecystitis will also increase. Elderly patients often have significant comorbidities and age-related changes that lead to a decreased physiologic reserve, particularly during physical stress such a surgical intervention. Compared to surgical resection, cholecystostomy tube placement (CTP) presents as an attractive, less invasive alternative procedure in these patients.[5–8] Current guidelines put emphasis on the severity of the disease and recommend urgent gallbladder drainage with CTP in patients with severe acute cholecystitis (grade III) associated with organ system

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dysfunction.[9] Unfortunately, data analyzing outcomes following cholecystectomy or CTP in elderly patients with acute cholecystitis are conflicting.[10–18]

We hypothesized that elderly patients undergoing CTP would have worse post-operative outcomes, compared to those undergoing cholecystectomy. Therefore, we aimed to compare the post-procedural outcomes, length of stay, and charges between CTP and cholecystectomy in elderly patients with acute cholecystitis.

Material and Methods

A cohort of patients was identified using the National Inpatient Sample (NIS) database between January 1, 2000 and December 31, 2014. The NIS is the largest publically available all-payer health care database in the USA and includes over seven million hospitalizations from 1000 hospitals each year, representing a 20% stratified sample of all hospital discharges in the USA. Eligible patients were identified using International Classification of Disease, 9th revision, Clinical Modification (ICD-9-CM) diagnostic and procedural codes.

Patients ≥ 65 years old admitted with primary diagnosis of acute cholecystitis (ICD-9-CM 574.0–574.91 and 575.0–575.12) who underwent CTP (51.0–51.03) or cholecystectomy (51.2–51.24) during non-elective hospital admissions were eligible for inclusion. Patients with acalculous cholecystitis were identified using the codes 575.0, 575.1, and 575.10. Patients who had an unknown or missing discharge disposition ($n = 566$) were excluded from the analysis.

Surgical outcomes of interest were post-operative complications during the index hospitalization, discharge disposition (including inpatient mortality), length of stay, and total hospital charges. Post-operative complications included venous thromboembolism (415.11, 453.40–453.42, and V12.51), wound complications (998.13, 998.30–998.32, and 998.83), infection (54.91, 86.04, 567.22, 569.5, 995.9–995.99, 996.64, 998.5–998.59, and 999.3–999.39), bleeding (99.0–99.09, 998.11, and 998.12), and shock (998.0–998.09). A composite complication (i.e., at least one post-operative complication) was also analyzed.

Comorbidities of interest included hypertension (401–401.9 and 402–402.91), primary and secondary diabetes (249–249.91 and 250–250.93), obesity (278–278.8), renal insufficiency (585–585.9), coronary artery disease (414–414.9), peripheral vascular disease (443–443.9), cardiac failure (410–410.9, 428–428.9), renal failure (38.95, 39.95, 584–584.9, 586, and V45.11), respiratory failure (31.1–31.29, 96.04, 96.05, 96.7–96.72, and 799.1), chronic obstructive pulmonary disease (COPD) (491–492.8), and sleep apnea (327.23).

Statistical Analysis

Patient and hospital characteristics were compared across procedures using chi-square and Wilcoxon-Mann-Whitney tests, where appropriate. Unadjusted, bivariate analyses of complications, discharge disposition, length of stay, and hospital charges across procedures were conducted using chi-square and Wilcoxon-Rank-Sum tests.

Multivariable analyses on the effect of CTP, compared to cholecystectomy, were performed using logistic, generalized logistic, and linear regression models, where appropriate. All models were adjusted for sex, race/ethnicity, comorbidities, type of cholecystitis, primary insurance, household income, hospital region, teaching status, and size. Age was modeled as a restricted cubic spline in all adjusted models.

Additionally, the effect of acalculous cholecystitis, compared to calculous cholecystitis, on the procedure/patient outcome relationships was also assessed by including interaction terms in the multivariable models described above. A Wald chi-square test was used to assess if the effect was different across acalculous status.

All analyses were performed using SAS software version 9.4 (SAS Inc., Cary, NC), and a p value < 0.05 was considered significant for all the statistical methods.

Results

A total of 200,915 patients were included, of which 7516 underwent CTP and 200,915 cholecystectomy. The median age of patients undergoing CTP and cholecystectomy was 80 (IQR 73–87) and 75 (IQR 70–81), respectively ($p < 0.0001$). Patients undergoing CTP had higher prevalence of comorbidities such as renal insufficiency, coronary artery disease, peripheral vascular disease, COPD, respiratory failure, cardiac failure, and renal failure (Table 1). No difference was seen in the time between admission and CTP (median 2 days, IQR 1–3 days) or cholecystectomy (median 2 days, IQR 1–3 days).

CTP was associated with higher incidences of infectious complications (13.3 vs. 4.5%, $p < 0.0001$), bleeding (17.1 vs. 9.5%, $p < 0.0001$), and inpatient mortality (4.7 vs. 1.2%, $p < 0.0001$) (Table 2).

After adjusting for type of cholecystitis, patient demographics, comorbidities, and hospital characteristics, patients undergoing CTP were significantly more likely to have post-procedural infection (OR 2.25; 95% CI 2.07, 2.45), bleeding (OR 1.28; 95% CI 1.19, 1.37), and inpatient mortality (OR 9.27; 95% CI 7.95, 10.81). On average, CTP patients stayed 1.25 days longer after the procedure (95% CI 1.14, 1.37) in hospital (Table 3).

Patients with both acalculous and calculous cholecystitis had worse post-procedural outcomes after CTP (Table 4).

Table 1 Patient and hospital characteristics among patients undergoing cholecystectomy and cholecystostomy tube placement for acute cholecystitis

	Cholecystectomy $N = 193,399$	Cholecystostomy $N = 7516$
Sex, *n* (%)		
Male	89,759 (46.4)	4033 (53.7)
Female	103,557 (53.6)	3483 (46.3)
Acalculous cholecystitis	19,827 (10.3)	3449 (45.9)
Age, in years, median (IQR)	75 (70–81)	80 (73–87)
Race/ethnicity, *n* (%)		
Non-Hispanic White	124,970 (77.5)	4991 (76.2)
Non-Hispanic Black	10,407 (6.5)	624 (9.5)
Hispanic	16,862 (10.5)	566 (8.6)
Other	9107 (5.6)	369 (5.6)
Missing	32,053	966
Presence of comorbidities, *n* (%)		
Hypertension	115,424 (59.7)	3929 (52.3)
Diabetes	51,608 (26.7)	2523 (33.6)
Obesity	17,726 (9.2)	662 (8.8)
Renal insufficiency	15,514 (8.0)	1429 (19.0)
Coronary artery disease	49,758 (25.7)	2725 (36.3)
Peripheral vascular disease	6696 (3.5)	508 (6.8)
Chronic obstructive pulmonary disease	4616 (2.4)	276 (3.7)
Sleep apnea	4430 (2.3)	263 (3.5)
Respiratory failure	6500 (3.4)	329 (4.4)
Cardiac failure	24,164 (12.5)	2368 (31.5)
Renal failure	14,782 (7.6)	1665 (22.2)
Primary insurance, *n* (%)		
Public	173,062 (89.6)	6950 (92.6)
Private	17,297 (9.0)	460 (6.1)
Other/self-pay	2696 (1.4)	95 (1.3)
Household income, *n* (%)		
Low	45,325 (23.9)	1688 (22.9)
Medium	50,006 (26.4)	1715 (23.3)
High	48,091 (25.4)	1905 (25.9)
Highest	46,091 (24.3)	2050 (27.9)
Hospital region, *n* (%)		
Northeast	35,723 (18.5)	2589 (34.5)
Midwest	40,883 (21.1)	1689 (22.5)
South	78,221 (40.5)	2102 (28.0)
West	38,572 (19.9)	1136 (15.1)
Hospital location, *n* (%)		
Rural, non-teaching	28,845 (15.0)	456 (6.1)
Urban, non-teaching	97,490 (50.5)	2305 (30.7)
Urban, teaching	66,547 (34.5)	4743 (63.2)
Hospital size, *n* (%)		
Small	25,169 (13.1)	913 (12.2)
Medium	50,872 (26.4)	1757 (23.4)
Large	116,841 (60.6)	4834 (64.4)

IQR, interquartile range

Table 2 Post-operative complication, discharge disposition, hospital charges, and length of stay among patients undergoing cholecystectomy and cholecystostomy tube placement for acute cholecystitis.

	Cholecystectomy *N* = 193,399	Cholecystostomy *N* = 7516	*p* value*
Post-operative complications, *n* (%)			
Venous thromboembolism	5688 (2.9)	463 (6.2)	< 0.0001
Wound complications	393 (0.2)	14 (0.2)	0.75
Infection	8765 (4.5)	1000 (13.3)	< 0.0001
Bleeding	18,454 (9.5)	1284 (17.1)	< 0.0001
Shock	320 (0.2)	16 (0.2)	0.32
Any complication, *n* (%)	29,326 (15.2)	2299 (30.6)	< 0.0001
Discharge disposition, *n* (%)			
Routine	139,539 (72.2)	1791 (23.8)	< 0.0001
Transfer	29,515 (15.3)	3085 (41.1)	< 0.0001
Home health care	21,986 (11.4)	2285 (30.4)	< 0.0001
Died	2359 (1.2)	355 (4.7)	< 0.0001
Hospital charges, in thousands, median (IQR)	34.2 (21.5–56.2)	39.2 (24.7–64.4)	< 0.0001
Total length of stay (days), median (IQR)	5 (3–7)	7 (5–10)	< 0.0001
Post-procedure length of stay (days), median (IQR)	3 (1–5)	5 (3–8)	< 0.0001

IQR, interquartile range

*Chi-square tests were used for categorical variables, while Wilcoxon-Rank-Sum tests were used for continuous variables

Table 3 Crude and adjusted effects of cholecystostomy tube placement, compared to cholecystectomy, on outcomes, among elderly patients with acute cholecystitis

	Crude		Adjusted*	
	OR (95% CI)	*p* value	OR (95% CI)	*p* value
Post-operative complications				
Venous thromboembolism	2.17 (1.97, 2.39)	< 0.0001	1.65 (1.47, 1.84)	< 0.0001
Wound complications	0.92 (0.54, 1.56)	0.75	0.63 (0.33, 1.20)	0.16
Infection	3.23 (3.02, 3.47)	< 0.0001	2.25 (2.07, 2.45)	< 0.0001
Bleeding	1.95 (1.84, 2.08)	< 0.0001	1.28 (1.19, 1.37)	< 0.0001
Shock	1.29 (0.78, 2.13)	0.32	0.65 (0.36, 1.15)	0.14
Any complication	2.47 (2.34, 2.59)	< 0.0001	1.64 (1.55, 1.75)	< 0.0001
Discharge disposition				
Routine	REF	–	REF	–
Transfer	2.10 (2.04, 2.16)	< 0.0001	5.78 (5.37, 6.23)	< 0.0001
Home health care	2.09 (2.03, 2.16)	< 0.0001	5.80 (5.39, 5.24)	< 0.0001
Died	2.46 (2.34, 2.58)	< 0.0001	9.27 (7.95, 10.81)	< 0.0001
	CIE (95% CI)	*p* value	CIE (95% CI)	*p* value
Hospital charges, in thousands	9.33 (8.20, 10.45)	< 0.0001	−2.15 (−3.32, −0.98)	0.0003
Total length of stay, in days	2.65 (2.53, 2.78)	< 0.0001	0.97 (0.85, 1.10)	< 0.0001
Post-procedure length of stay, in days	2.44 (2.32, 2.55)	< 0.0001	1.25 (1.14, 1.37)	< 0.0001

OR, odds ratio; *CI*, confidence interval; *CIE*, change in estimate

*Adjusted for type of cholecystitis, sex, age, race, insurance, income, hospital region, hospital location, hospital size, and presence of the following comorbidities: hypertension, diabetes mellitus, obesity, renal insufficiency, coronary artery disease, peripheral vascular disease, chronic obstructive pulmonary disease, sleep apnea, cardiac failure, renal failure, and respiratory failure

Table 4 Adjusted effects of cholecystostomy tube placement, compared to cholecystectomy, on outcomes among elderly patients with acute cholecystitis, stratified by type of cholecystitis

	Acalculous cholecystitis	Calculous cholecystitis	
	OR (95% CI)*	OR (95% CI)*	*p* value
Post-operative complications			
Venous thromboembolism	1.29 (1.20, 1.38)	1.26 (1.16, 1.38)	0.77
Wound complications	0.88 (0.59, 1.33)	0.60 (0.34, 1.06)	0.28
Infection	1.27 (1.19, 1.35)	1.53 (1.44, 1.61)	< 0.0001
Bleeding	1.03 (0.97, 1.09)	1.15 (1.10, 1.21)	0.0027
Shock	0.74 (0.49, 1.11)	0.77 (0.51, 1.17)	0.89
Any complication	1.16 (1.11, 1.22)	1.30 (1.25, 1.35)	0.00030
Discharge disposition			
Routine	REF	REF	–
Transfer	4.74 (4.23, 5.31)	6.09 (5.52, 6.73)	0.0011
Home health care	4.92 (4.38, 5.52)	6.27 (5.67, 6.92)	0.0017
Died	7.30 (5.69, 9.38)	9.66 (7.90, 11.81)	0.082
	CIE (95% CI)*	CIE (95% CI)*	*p*-value
Hospital charges, in thousands	− 3.10 (− 4.78, − 1.41)	− 1.35 (− 2.91, 0.20)	0.49
Total length of stay, in days	0.84 (0.66, 1.03)	1.08 (0.91, 1.25)	0.0028
Post-procedure length of stay, in days	1.31 (1.15, 1.47)	1.21 (1.06, 1.35)	0.32

OR, odds ratio; *CI*, confidence interval; *CIE*, change in estimate

*Adjusted for acalculous cholecystitis, sex, age, race, insurance, income, hospital region, hospital location, hospital size, and presence of the following comorbidities: hypertension, diabetes mellitus, obesity, renal insufficiency, coronary artery disease, peripheral vascular disease, chronic obstructive pulmonary disease, sleep apnea, cardiac failure, renal failure, and respiratory failure

Discussion

The management of elderly patients with acute cholecystitis is still controversial. We aimed to compare the post-procedural outcomes between cholecystectomy and CTP, and we found that patients undergoing CTP had higher incidences of post-procedural morbidity, mortality, and longer post-procedure length of hospital stay.

Theoretically, CTP is an attractive alternative to cholecystectomy. Unlike cholecystectomy, gallbladder drainage can be performed bed-side and without need of general anesthesia. In fact, previous studies have shown the benefits of CTP in elderly and comorbid patients. Horn and colleagues[10] analyzed 278 consecutive patients (median age 72.5) who underwent CTP. Indications for drainage included high burden of comorbid diseases and prolonged symptom duration. They reported 5% 30-day mortality, and in 55% of the cases, CTP was the definitive treatment. Similarly, Zarour et al.[11] studied 119 patients with CTP (median age 75.8) and reported seven periprocedural deaths (6%) and 54% were definitely managed with CTP. Jang et al.[12] also suggested that CTP was an effective and safe option in elderly patients (median age 73.8) with acute cholecystitis (2% mortality). In our study cohort, CTP was associated with a crude mortality of 4.7%. High post-procedural mortality (15–17%) has been seen in other studies.[13–15] We believe that the increased mortality observed is attributable to the fact that decompression and drainage of the gallbladder does not equate to sepsis source control, which may still be driven by ongoing inflammation of a necrotic gallbladder. In addition, mortality can be related to catheter dislodgment and/or hemorrhage.

Studies comparing CTP with cholecystectomy have shown conflicting results. A Cochrane systematic review including only randomized clinical trials showed no significant difference in morbidity and mortality between the two interventions.[16] Melloul et al.[17] compared 23 CTP patients (median age 65) with 19 cholecystectomy patients (median age 63), and found that overall morbidity was 9% after CTP and 47% after cholecystectomy ($p = 0.01$); however, no difference was seen in mortality (13 vs. 16%, $p = 1.0$). Zehetner and colleagues[18] performed a retrospective single-institution study by matching 1:1 CTP and cholecystectomy patients and reported no significant difference between drainage and surgical resection regarding morbidity (17 vs. 9%, $p = 0.67$) and mortality (13 vs. 0%, $p = 0.23$), respectively. Loftus et al.[19] retrospectively analyzed patients treated at their institution ($n = 42$ per group), and after matching by age, cholecystitis severity grade, and VASQIP predicted 30-day mortality, found that CTP patients had higher 30- and 180-day mortality. Our nationwide analysis demonstrated that, even after adjusting for significant comorbidities, elderly patients with acute cholecystitis still had significantly better outcomes after undergoing cholecystectomy. CTP patients were more likely to have post-operative complications and over nine times as likely to die during their hospitalization. Post-procedure length of hospital stay was also significantly increased in CTP patients.

CTP is often the treatment of choice for patients with acalculous cholecystitis.[20,21] Therefore, we performed a subset analysis dividing the cohort in patients with calculous and acalculous cholecystitis. Interestingly, patients with acalculous cholecystitis still had significantly better post-operative outcomes after cholecystectomy, as compared to CTP.

This study is not without limitations. The NIS does not link hospital records, and therefore, complications, readmissions, and mortality occurring after the initial hospital discharge cannot be evaluated in this dataset. There is also potential for coding errors and differences in coding practices across hospitals. For instance, as there are no specific diagnostic codes mentioning "acalculous cholecystitis," the codes used to identify these patients may have included other types of cholecystitis. In addition, details about the severity of cholecystitis (e.g., grade of acute cholecystitis by Tokyo guidelines) and duration of symptoms are not provided by NIS, and thus, we were not able to adjust for them in our analysis. Finally, this study did not take into account the decision algorithm used by the physician regarding the use of CTP or cholecystectomy. There is an assumption that the reason for CTP was to benefit frail patients from its less invasive nature. However, we have shown that in these patients, CTP was still associated with very high morbidity and mortality rates.

To our knowledge, this is the first study comparing outcomes of CTP and cholecystectomy in elderly patients in a national cohort. Considering the studies showing an increase in use of CTP for treatment of cholecystitis in elderly patients,[8,22] we believe our results are timely and add relevant evidence to this controversial topic.

Conclusion

Elderly patients with both acalculous and calculous acute cholecystitis managed with CTP have higher incidences of post-procedural morbidity and mortality, and longer post-procedure length of hospital stay, compared to cholecystectomy. Our findings suggest that elderly patients with acute cholecystitis should undergo cholecystectomy unless there are prohibitive surgical risks.

Author Contribution Francisco Schlottmann, Charles Gaber, Paula Strassle, Marco G. Patti, and Anthony G. Charles conceived the study and helped with literature search and writing of the manuscript.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

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