The American Journal of Surgery 218 (2019) 567–570

Contents lists available at ScienceDirect

The American Journal of Surgery

journal homepage: www.americanjournalofsurgery.com

Assessment of clinical outcome of cholecystectomy according to age in preparation for the "Silver Tsunami"

Yoichi Matsui*, Satoshi Hirooka, So Yamaki, Masaya Kotsuka, Hisashi Kosaka, Tomohisa Yamamoto, Sohei Satoi

Department of Surgery, Kansai Medical University, 2-5-1 Shinmachi, Hirakata, Osaka, 573-1010, Japan

ARTICLE INFO

Article history:
Received 24 November 2018
Received in revised form
16 January 2019
Accepted 22 January 2019

Keywords:
Aging population
Cholecystectomy
Gallstones
Older patient
Silver tsunami

ABSTRACT

Background: Recent rapid increases in the aging population have created an impending "Silver Tsunami" in advanced countries. The overall prevalence of gallstone disease and its related complications will soon increase, and there will be a larger demand for gallbladder surgery.

Methods: We examined the outcomes of cholecystectomy according to age among patients with cholelithiasis to determine how a patient's age influences the outcome of cholecystectomy. All patients with gallstone disease who presented for cholecystectomy at our institute from January 2006 to December 2018 were analyzed.

Results: All perioperative outcomes (operation length, length of hospital stay, rate of open surgery, urgent surgery, postoperative complications, incidental gallbladder cancer, postoperative hospital death, concomitant bile duct stones, and total medical costs per patient) increased as patients aged.

Conclusions: To prevent the progression of biliary disease, elective laparoscopic cholecystectomy is recommended before patients with cholelithiasis advance in age.

Introduction

Recent rapid increases in the aging population have created an impending "Silver Tsunami" in advanced countries. Gallstone disease is one of the most common and costly digestive diseases associated with aging.[1,2] The current standard of care for patients with gallstones is cholecystectomy. Considering the rapid rate of aging of the global population, the overall prevalence of gallstone disease and its related complications will soon increase, and there will be a larger demand for gallbladder surgery and endoscopic treatment in the near future.[1,3,4]

Many reports advocate the safety of laparoscopic cholecystectomy for gallstone disease in patients of advanced age, including octogenarians and nonagenarians.[5–10] In contrast, several studies have indicated some problems associated with cholecystectomy in older patients, such as poor outcomes and higher costs in these patients.[1,2,11,12] Under these conditions, an understanding of the outcomes of cholecystectomy according to age would be useful in preparation for the "Silver Tsunami." In the present study, we examined the outcomes of cholecystectomy according to age among patients with cholelithiasis to determine how a patient's age influences the outcome of cholecystectomy.

Methods

All consecutive patients with gallstone disease who presented for cholecystectomy at the Department of Surgery of Kansai Medical University from January 2006 to December 2018 were included. Using the prospectively collected database in our department, we obtained information on patient characteristics, operative data, length of hospital stay, postoperative complications (Clavien–Dindo grades I–V), postoperative hospital death, histopathological status of the gallbladder, rate of concomitant bile duct stones, and medical costs per patient. Preoperative diagnoses of gallstones and bile duct stones were made using ultrasonography, computed tomography, and magnetic resonance cholangiography.

Medical costs included the treatment costs for all gallstone-related diseases, including bile duct stones. Gallstone-related diseases in this study were cholecystolithiasis, choledocholithiasis, obstructive jaundice resulting from bile duct stones, and pancreatitis resulting from bile duct stones. These diseases were defined as those requiring admission. Most concomitant bile duct stones were

* Corresponding author.
E-mail address: matsui@hirakata.kmu.ac.jp (Y. Matsui).

https://doi.org/10.1016/j.amjsurg.2019.01.021

treated with endoscopic retrograde cholangiography and sphincterotomy by endoscopists before cholecystectomy. The costs of the treatments for all of these gallstone-related diseases were included in the medical cost per patient.

Statistical analysis

One-way analysis of variance and Student's t-test were used to estimate the change in age during the observation period (Fig. 2). For one-way analysis of variance, the difference in age was estimated annually. For the *t*-test, the patients were divided into two groups according to the median number of patients [the first half of the study period (before June 2012) and the latter half of the study period (after July 2012)] to compare the average age between the first and latter halves of the study period. For estimation of each perioperative parameter, the patients were dichotomized into two groups: those aged <70 years and those aged ≥70 years; the chi-square test or *t*-test was then performed (Table 1). All statistical analyses were performed using JMP version 10.0.2 (SAS Institute Inc., Cary, NC, USA). A p-value of <0.05 was considered statistically significant).

Results

During the 13-year study period, 2587 consecutive patients presented to our institution with benign gallbladder diseases. The number of female patients peaked in the sixth decade of life while the number of male patients peaked in the seventh decade (Fig. 1), and the male:female ratio was 1.00:1.06 (1256:1331). The average and median age of these patients steadily increased each year (Fig. 2). The average age of patients in the latter half of the study period was significantly higher than that in the first half (63.6 ± 13.8 vs. 60.4 ± 14.0 years, respectively; $p < 0.0001$). The average age increased by an average of 0.6 years annually during the study period.

All perioperative outcomes (operation length, length of hospital stay, rate of open surgery, urgent surgery, postoperative complications, incidental gallbladder cancer, postoperative hospital death, concomitant bile duct stones, and total medical costs per patient) significantly increased as patients aged (Fig. 3). Among patients aged ≥80 years, open surgery was performed in 22.5%, urgent surgery was performed in 25.1%, postoperative complications occurred in 18.7%, incidental gallbladder cancer was found in 8.0%, hospital death occurred in 2.1%, and concomitant bile duct stones were found in 40.1%. The medical cost per patient among those aged ≥80 years was two-fold higher than that among patients aged <50 years (Fig. 3).

Table 1 shows the differences in the perioperative parameters between the patients aged <70 and ≥ 70 years. All parameters were significantly higher in the patients aged ≥70 than <70 years.

Table 1
Comparison of perioperative parameters of cholecystectomy for gallstone diseases between patients aged <70 and ≥ 70 years.

	Patient age, years		p
	<70 (n = 1704)	≥70 (n = 883)	
Operation length, min	74.2 ± 36.2	83.0 ± 45.2	<0.0001
Postoperative hospital stay, days	4.3 ± 3.7	6.9 ± 8.5	<0.0001
Open surgery	113 (6.6)	165 (18.7)	<0.0001
Urgent surgery	174 (10.2)	152 (17.2)	<0.0001
Postoperative complications	107 (6.3)	106 (12.0)	<0.0001
Incidental gallbladder cancer	28 (1.6)	54 (6.1)	<0.0001
Postoperative hospital death	0 (0.0)	10 (1.1)	<0.0001*
Concomitant bile duct stones	277 (16.3)	264 (29.9)	<0.0001
Medical cost per patient, USD	3714 ± 2737	5289 ± 3816	<0.0001

Data are presented as n (%) or mean ± standard deviation.
*Fisher's exact test was used.

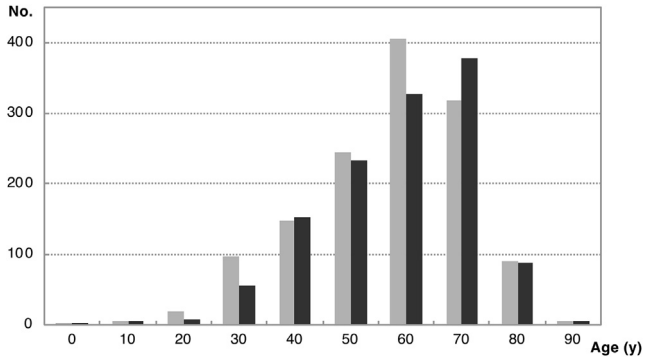

Fig. 1. Number of patients by age who underwent cholecystectomy for gallstone diseases from January 2006 to December 2018. Dark gray indicates men, and light gray indicates women. The number of patients peaked in the sixth and the seventh decades, and the male:female ratio was 1.00:1.06 (1256:1331).

Postoperative hospital deaths were caused by mainly pulmonary or cardiovascular diseases (aspiration pneumonia, n = 3; myocardial infarction, n = 1; pulmonary embolism, n = 1; superior mesenteric artery embolization, n = 1; duodenal penetration, n = 1; colonic perforation, n = 1; small intestinal perforation, n = 1; and fulminant hepatitis, n = 1). All deaths occurred among patients aged ≥70 years, and the mortality rate reached 1.1% among these patients (Table 1). In 9 of these 10 patients, the preoperative performance status score was 3 or 4. Five of these 10 patients underwent emergent cholecystectomy, and 6 of 10 underwent open surgery.

Discussion

The change in the age distribution makes it increasingly important to monitor the outcomes of the most common surgical procedures in older patients. Cholecystectomy is the most common procedure performed in this age group, and age is an independent predictor of a worse outcome after cholecystectomy.[1,6]

Our results of the histogram showed that many patients were in an advanced age group and that the numbers of male and female patients were almost equal. These results mean that the 5-F risk factors for gallstones (female, forty, fatty, fair, fecund)[13–15] do not fit the aging society. The average age has increased during the most recent 13 years. This trend is expected to persist, reflecting the era

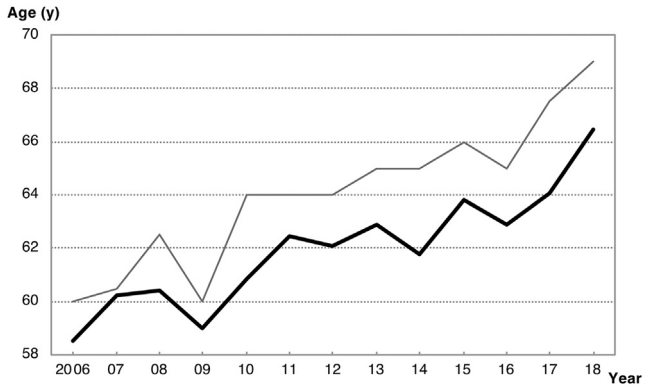

Fig. 2. Annual average (thick line) and median (thin line) age of the patients who underwent cholecystectomy for gallstone diseases. The average age increased by an average of 0.6 years annually.

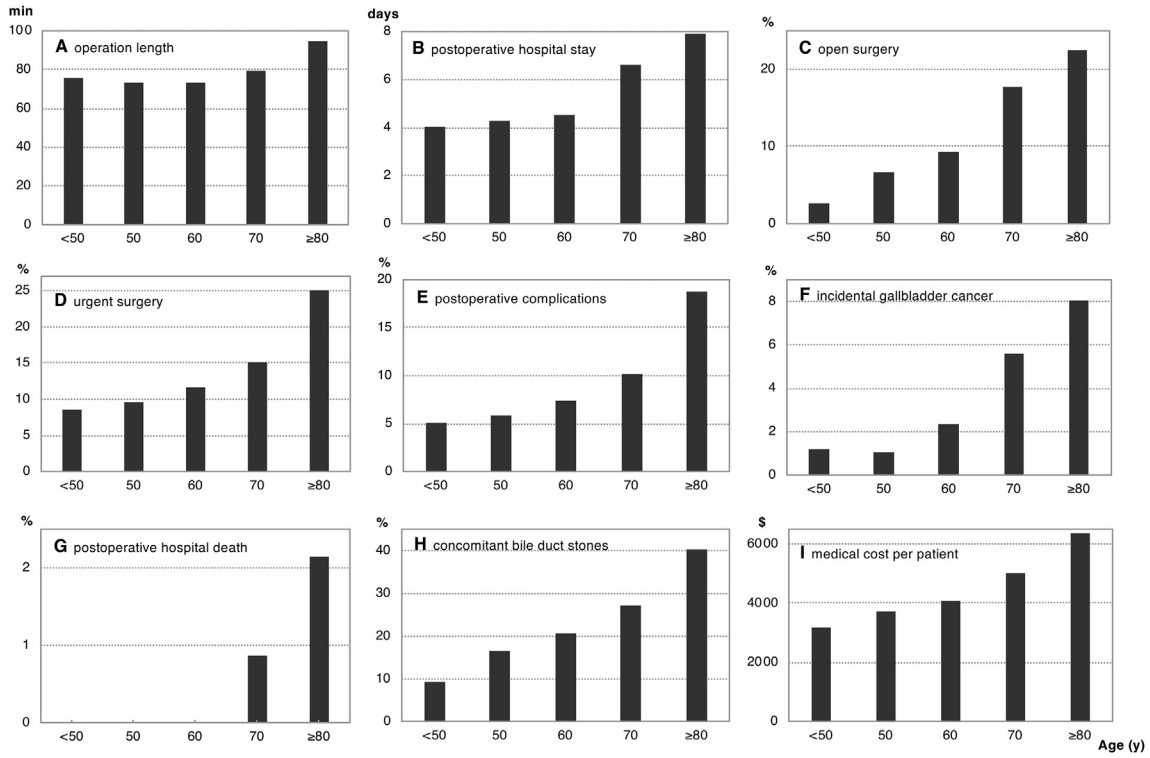

Fig. 3. Perioperative outcomes of cholecystectomy for gallstone diseases according to age. **A**: Operation length. **B**: Length of hospital stay. **C**: Rate of open surgery. **D**: Rate of urgent surgery. **E**: Rate of postoperative complications (Clavien–Dindo grades I – V). **F**: Rate of incidental gallbladder cancer by postoperative histopathological examination. **G**: Rate of postoperative hospital death. **H**: Rate of concomitant bile duct stones. **I**: Total medical cost per patient for gallstones and their related diseases, including bile duct stones. All perioperative outcomes significantly worsened as patients aged.

of an aging population in advanced countries.

Longer operations in older patients are mainly due to the higher rate of open surgery and/or urgent surgery in these patients. In addition, although this study did not estimate how long the patients were symptomatic preoperatively, we consider that many experienced repeated gallstone symptoms for a long time, resulting in chronic cholecystitis. These chronic gallbladder conditions in turn caused the longer operations and poorer prognosis in the older patients of the present study. In contrast, the operation length in the patients aged <50 years was slightly longer than that among patients in their 50s and 60s. The reason for this is that single-incision surgery was introduced in our department in 2009 according to previously reported criteria.[16,17] Single-incision surgery takes a relatively longer operation time, and this procedure was mainly performed in younger and middle-aged patients in our department, not in patients of advanced age.

The rate of open surgery increased with age. Possible reasons for this are the higher rate of previous upper abdominal surgery in older patients and the much more frequent performance of urgent cholecystectomy for acute cholecystitis in these older patients. Indeed, one-quarter of the patients aged ≥80 years underwent urgent surgeries.

The postoperative hospital mortality rate was around 0.9% among patients in their 70s and 2.1% among those in their 80s; no mortality occurred among patients aged <70 years. Postoperative mortality is an important factor in decision-making regarding elective cholecystectomy for patients of advanced age.[1,6,7] Additionally, we cannot overlook the higher rate of incidental cancer among the patients aged ≥70 years. The results indicate that incidental gallbladder cancer is more likely to be diagnosed in older patients, as previously reported.[18] Although whether gallstones cause gallbladder cancer is controversial,[19–21] this result strongly suggests that gallstones possibly lead to gallbladder cancer because most of these older patients had chronic gallstones for a long time.

The rate of concomitant bile duct stones dramatically increased with age, and >40% of the patients aged ≥80 years had concomitant bile duct stones. Most of these older patients had a long history of gallstones since middle-age. Having gallstones for a long time would increase the incidence of stones exiting the gallbladder and entering the bile duct. Therefore, patients with silent gallstones are expected to have a high incidence of developing bile duct stones when they become octogenarians.

All of these worsening outcomes with aging result in higher medical costs among patients of advanced age. In particular, the longer hospital stay, the higher rate of postoperative complications, and the higher rate of bile duct stones directly led to higher medical costs among the older patients in this study. Indeed, the medical cost per patient aged ≥80 years was two-fold higher than that per patient aged <50 years.

The authors recognize several limitations to this study. One of the main limitations is that this was a retrospective, descriptive, observational, non-comparative single-center study. These characteristics of the study design limit the generalizability of our results. Especially among developing countries in which the population comprises a higher number of younger than older people, the 5-F risk factors for gallstones would be true; thus, our data do not fit for these countries or areas. However, our results may be applied to advanced countries showing signs of an impending “Silver Tsunami.”

Physicians and surgeons can use these outcomes to make informed decisions regarding cholecystectomy. Earlier recognition and intervention in patients with cholelithiasis could prevent the progression of biliary disease to acute cholecystitis, cholangitis, or biliary pancreatitis and mitigate the need for urgent surgery, thus

also lowering medical costs. In conclusion, when gallstone symptoms have occurred, it seems reasonable to recommend elective laparoscopic cholecystectomy before the patients advance in age.

Conflicts of interest

The authors have no conflicts of interest to disclose.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Acknowledgments

We would like to express our sincere appreciation to secretaries Ayaka Fujimoto and Kumi Sakamoto of the Department of Surgery, Kansai Medical University. We also thank Angela Morben, DVM, ELS, from Edanz Group (www.edanzediting.com/ac), for editing a draft of this manuscript.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.amjsurg.2019.01.021.

References

1. Kuy S, Sosa JA, Roman SA, et al. Age matters: a study of clinical and economic outcomes following cholecystectomy in elderly Americans. *Am J Surg*. 2011;201:789–796.
2. Novello M, Gori D, Saverio SD, et al. How safe is performing cholecystectomy in the oldest old? A 15-year retrospective study from a single institution. *World J Surg*. 2018;42:73–81.
3. Bartels SJ, Naslund JA. The underside of the silver tsunami – older adults and mental health care. *N Engl J Med*. 2013;368:493–496.
4. Parmar AD, Sheffield KM, Adhikari D, et al. PREOP-Gallstones: a prognostic nomogram for the management of symptomatic cholelithiasis in older patients. *Ann Surg*. 2015;261:1184–1190.
5. Dubecz A, Langer M, Stadlhuber RJ, et al. Cholecystectomy in very elderly – is 90 the new 70? *J Gastrointest Surg*. 2012;16:282–285.
6. Nielsen LBJ, Harboe KM, Bardram L. Cholecystectomy for the elderly: no hesitation for otherwise healthy patients. *Surg Endosc*. 2014;28:171–177.
7. Hazzan D, Geron N, Golijanin D, et al. Laparoscopic cholecystectomy in octogenarians. *Surg Endosc*. 2003;17:773–776.
8. Kwon AH, Matsui Y. Laparoscopic cholecystectomy in patients aged 80 years and over. *World J Surg*. 2006;30:1204–1210.
9. Pålsson S, Saliba G, Sandblom G. Outcome after cholecystectomy in the elderly: a population-based register study. *Scand J Gastroenterol*. 2016;51:974–978.
10. Maxwell JG, Tyler BA, Rutledge R, et al. Cholecystectomy inpatients aged 80 and older. *Am J Surg*. 1998;176:627–631.
11. Legner VJ, Massarweh NN, Symons RG, et al. The significance of discharge to skilled care after abdominopelvic surgery in older adults. *Ann Surg*. 2009;249:250–255.
12. Sugiyama M, Atomi Y. Treatment of acute cholangitis due to choledocholithiasis in elderly and younger patients. *Arch Surg*. 1997;132:1129–1133.
13. Barbara L, Sama C, Morselli Labate AM, et al. A population study on the prevarence of gallstone disease: the Sirmione Study. *Hepatology*. 1987;7:913–917.
14. Maclure KM, Hayes KC, Colditz GA, et al. Weight, diet, and the risk of symptomatic gallstones in middle-aged woman. *N Engl J Med*. 1989;321:563–569.
15. Nakeeb A, Comuzzie AG, Martin L, et al. Gallstones: genetics versus environment. *Ann Surg*. 2002;235:842–849.
16. Matsui Y, Yamaki S, Hirooka S, et al. Evaluation of relative criteria for single-incision laparoscopic cholecystectomy. *Asian J Surg*. 2018;41:216–221.
17. Matsui Y, Hirooka S, Yamaki S, Satoi S. Letter to the editor regarding an update of the "Evaluation of relative criteria for single-incision laparoscopic cholecystectomy". *Asian J Surg*. 2019;42:470–471. https://doi.org/10.1016/j.asjsur.2018.10.008.
18. Muszynska C, Lundgren L, Lindell G, et al. Predictors of incidental gallbladder cancer in patients undergoing cholecystectomy for benign gallbladder disease: results from a population-based gallstone surgery registry. *Surgery*. 2017;162:256–263.
19. Ryu S, Chang Y, Yun KE, et al. Gallstones and the risk of gallbladder cancer mortality: a cohort study. *Am J Gastroenterol*. 2016;111:1476–1487.
20. Gracie WA, Ransohoff DF. The natural history of silent gallstones – the innocent gallstone is not a myth. *N Engl J Med*. 1982;307:798–800.
21. Lai HC, Chang SN, Lin CC, et al. Does diabetes mellitus with or without gallstones increases the risk of gallbladder cancer? Results from a population-based cohort study. *J Gastroenterol*. 2013;48:856–865.