The American Journal of Surgery 218 (2019) 1152–1155

Contents lists available at ScienceDirect

The American Journal of Surgery

journal homepage: www.americanjournalofsurgery.com

Protocol driven management of suspected common duct stones: A Southwestern Surgical Congress multi-centered trial

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ARTICLE INFO

Article history:
Received 14 March 2019
Received in revised form
4 September 2019
Accepted 10 September 2019

Presented at the Southwestern Surgical Congress 2019 Huntington Beach, CA.

Keywords:
Cholecystectomy
Choledocholithiasis
Common bile duct stones

ABSTRACT

Background: Several options exist for the diagnosis and management of suspected common duct stones. We hypothesized that a protocol-directed approach would shorten length of stay in this patient population.
Methods: Patients from four participating institutions with a peak bilirubin <4 mg/dL underwent surgery as the initial procedure, whereas patients with a bilirubin ≥4 mg/dL underwent endoscopy. The primary endpoint was length of stay. Analysis involved chi square and Wilcoxon-Mann-Whitney test with significance at $p < 0.05$.
Results: 214 patients were managed under the protocol during six-month study period. 111 patients (52%) required endoscopy and surgery. Length of stay and the number of MRCPs performed preoperatively significantly decreased following protocol implementation ($p < 0.05$).
Conclusions: "Surgery first" approach in patients with bilirubin <4 ml/dL resulted in low morbidity and mortality, reduced MRCP, and length of stay.

Introduction

Approximately 700,00 cholecystectomies are performed annually in the United States with common duct stones occurring in 3–20% of these patients.[1,2] Despite their common occurrence, the optimal algorithm for the diagnosis and management of common duct stones has yet to be determined. In 2002, a National Institute of Health (NIH) guideline concluded that magnetic resonance cholangiopancreatography (MRCP), endoscopic ultrasound (EUS), and endoscopic retrograde cholangiopancreatography (ERCP) have similar sensitivities and specificities for the detection of common duct stones.[3] They also concluded that patients at low risk for common duct stones do not require ERCP prior to cholecystectomy. Previous studies have shown that use of intra-operative cholangiogram (IOC) for suspected common duct stones followed by selective post-operative ERCP is the most cost-effective treatment with a reduction in unnecessary endoscopic interventions by 50%.[2,4,5] Despite these studies, the number of surgeons performing IOC during laparoscopic cholecystectomy is decreasing.[6] The Southwestern Surgical Congress (SWSC) recently conducted a retrospective multi-center review of current practices among twelve member institutions. This demonstrated significant variability in management of suspected common duct stones and emphasized the need for standardized protocols across institutions.[7]

He et al. reviewed the American Society of Gastroenterology (ASGE) criteria for suspected choledocholithiasis found that a bilirubin >4 mg/dL, common duct stones seen on ultrasound, and a dilated common duct produced a higher specificity and positive predictive value than other clinical criteria for the presence of common duct stones.[8] A separate single institution study recently found that bilirubin >4 mg/dL could stratify which patients would benefit from preoperative imaging of the common duct.[9] This study demonstrated fewer endoscopies, shorter hospitalization, and no

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https://doi.org/10.1016/j.amjsurg.2019.09.009
0002-9610/

increase in morbidity with this approach. The Southwestern Surgical Congress Multicenter Trial Group (SWSC-MCT) elected to evaluate whether using preoperative bilirubin >4 mg/dl as a sole determinant for preoperative common duct imaging would produce similar results at multiple institutions. This protocol was evaluated to determine if it would lead to shorter length of stay and reduce the number of non-therapeutic endoscopies and MRCP's when compared to historical controls from the prior year.

Methods

Four institutions from the SWSC-MCT agreed to adopt a prospective protocol for suspected common duct stones. These four institutions had participated in a recently published review of "current practices" from twelve institutions that showed significant variation in practice for patients with suspected common duct stones. Raw data from the prior retrospective MCT study of those four institutions were analyzed to serve as the "control" population. The protocol called for patients that had clinical risk factors of common duct stones, i.e. pancreatitis, elevated liver function tests, a dilated common duct, etc., to be stratified by bilirubin < or >4 mg/dL. If bilirubin was <4 mg/dL, initial management would be laparoscopic cholecystectomy with intraoperative cholangiography.

If bilirubin was >4 mg/dL, initial intervention would be endoscopy and/or MRCP. Endoscopy included endoscopic ultrasound and/or endoscopic retrograde cholangiopancreatography. The management of identified common duct stones were not defined and left to the existing practice patterns of the participating institutions. An IRB approved retrospective review of consecutive patients from January to June 2018 were analyzed and compared to the historic controls of the prior study. Patients were included if they had clinical indicators of common duct stones that led to either preoperative imaging of the common duct or intraoperative cholangiography. Protocol violations were identified as patients having endoscopy or MRCP as the initial intervention when the bilirubin was <4.0 mg/dL. These patients were excluded from the analysis.

Patient age, total bilirubin on presentation, initial intervention and length of stay were analyzed. Initial intervention was described as surgery (cholecystectomy with IOC), endoscopy (EUS and/or ERCP) or MRCP. Analysis involved chi square and Wilcoxon-Mann-Whitney test with significance defined as $p < 0.05$.

Results

The initial interventions for patients with suspected common duct stones before and after protocol implementation are demonstrated in Fig. 1. Six hundred seventy-five patients were analyzed prior to initiation of the protocol over a 12-month period. Median age was 49 years (IQR: 30.7–64.1). Median bilirubin was 1.8 mg/dL (IQR: 0.8–3.7). Initial intervention was surgery in 378 (56%), endoscopy in 202 (30%), and MRCP in 95 (14%) patients. Median length of stay was 4 days (IQR: 2–5). Two hundred seventy-three patients were identified from the four participating institutions for inclusion as the protocol patients. Protocol violations were identified in 59 patients (21%), leaving 214 patients for analysis. All protocol violations were for patients undergoing endoscopy prior to surgery with an initial total bilirubin of <4 mg/dL. These excluded patients often presented as admissions to a non-surgical service. The initial interventions for patients included in this analysis were surgery in 112 patients (52%), endoscopy in 96 patients (45%), and MRCP in 6 patients (3%). Endoscopy and surgery were performed in 111 patients (52%). Eleven patients in the "surgery first" group required postoperative endoscopy based upon a positive IOC. Four patients had common duct stones found on MRCP and had endoscopy followed by surgery.

The overall morbidity and mortality rates were 16% and 1.4%, respectively. Pancreatitis was the most common morbidity, occurring in 12 patients. Other morbidities included pulmonary (8 patients) and cardiovascular events (3 patients), superficial surgical site (2 patients) and deep space infections (4 patients), retained common duct stones after initial intervention (4 patients) and dislodged t-tube (1 patient). Three patients died within 30 days of the operation, from a myocardial infarction, liver failure in the setting of advanced cirrhosis, and a subdural hematoma unrelated to the biliary disease.

A comparison of pre-protocol implementation to post-implementation is shown in Table 1. The median age was similar in both study groups. Patients in the post-protocol study had a higher median bilirubin compared to the pre-protocol study patients. The percentage of patients undergoing MRCP as the first diagnostic intervention significantly decreased post-protocol implementation from 14% to 3%. Also, median LOS was significantly decreased following adoption of the protocol, 3 days vs 4 days ($p < 0.05$). One hundred twelve patients had a bilirubin of <4.0 mg/dL and underwent laparoscopic cholecystectomy with

Table 1
Comparison of pre- and post-protocol demographics and outcomes.

	PRE-PROTOCOL	POST-PROTOCOL	p-value
Number	675	214	
Median Age (years)	49 (IQR: 30.7–64.1)	48 (IQR: 33.0–62.0)	0.52
Median Bilirubin (mg/dL)	1.8 (IQR: 0.8–3.7)	2.6 (IQR: 1.4–4.3)	P < 0.05
Initial intervention n (%)			
Surgery	378 (56%)	112 (52%)	P < 0.05
Endoscopy	202 (30%)	96 (45%)	
MRCP	95 (14%)	6 (3%)	
Median LOS (days)	4 (IQR: 2–5)	3 (IQR: 2–4)	P < 0.05

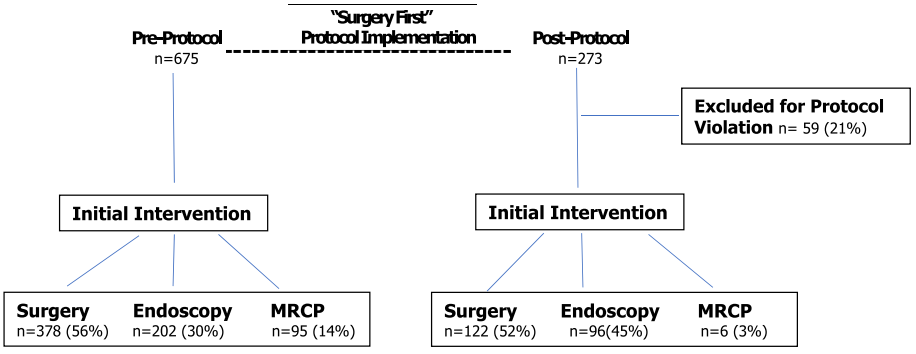

Fig. 1. Consort diagram of patients with suspected common bile duct stones before and after protocol implementation.

intra-operative cholangiography as the initial intervention. Eleven of these patients (10%) had a common duct stone identified on IOC, thus giving bilirubin of <4.0 mg/dL a negative predictive value of 90% (95%CI: 84.1–94.1). One hundred two patients had a bilirubin of >4.0 mg/dL and underwent initial endoscopy (96 patients) or MRCP (6 patients). Common duct stones were identified in fifty-six patients for a positive predictive value of 54% (95%CI: 48.461.3). Sixty-five patients had common duct stones treated by endoscopy with two patients requiring second endoscopy for retained stones seen on operative cholangiography following ERCP. Two laparoscopic transcystic duct explorations were performed in the surgery first group with positive IOC.

Discussion

For over 25 years laparoscopic cholecystectomy has been the standard of care for the treatment of gallbladder disease.[10] During this period, laparoscopic manipulation of the common bile duct for both diagnosis and treatment has increasingly been avoided. Preoperative MRCP was been deemed safe and effective for identifying common duct stones in elective laparoscopic cholecystectomy,[11] therefore we have seen an increase in preoperative MRCP from 0.9% to 8.6% of laparoscopic cholecystectomy patients between 2004 and 2013. This change in pre-operative work up occurred despite a length of stay or patient cost comparison.

The results of our current study demonstrate the use of MRCP prior to surgery decreased significantly compared to the control study. This decrease in MRCP use was associated with a shorter length of stay since the therapeutic interventions were often delayed by a day for the diagnostic MRCP. The usefulness of MRCP to evaluate for the presence of common duct stones has been recently questioned in the literature. Richard et al. demonstrated that MRCP has a high false negative rate and is less accurate compared to IOC at the time of cholecystectomy.[12] Thirteen of 56 patients in their study with a negative MRCP (no common duct stones) were shown to have stones in the common duct on IOC. Additionally, MRCP has been shown to be of little clinical utility for the diagnosis of common duct stones since most patients go on to require additional procedures, such as ERCP or cholecystectomy.[13] This literature and the results of this study support a more reserved use of MCRP for the detection of common duct stones.

ERCP has largely replaced common duct explorations as the treatment modality of choice for common duct stones. The identification of patients with suspected common duct stones and the optimal timing of ERCP for these patients has been highly debated. Previous studies have shown that between 25 and 50% of patients undergo unnecessary endoscopic procedures prior to cholecystectomy due to the suspicion of common duct stones.[2,14] In addition, research has demonstrated that length of stay can be decreased with a “surgery first” approach (laparoscopic cholecystectomy with IOC) for the management of suspected common duct stones. In a retrospective review, Lin et al. demonstrated that patients who underwent laparoscopic cholecystectomy had an average LOS of 2.9 days compared to 7.0 days in patients who underwent preoperative ERCP.[14]Additionally, Chang et al. previously demonstrated that patients with mild to moderate gallstone pancreatitis are best managed with selective post-operative ERCP following cholecystectomy with IOC. They demonstrated a significant decrease in cost, LOS, and reduction in endoscopic procedures with a surgery first protocol.[5]

The diversity in strategies between institutions for the management of common duct stones was highlighted in the previously published Southwestern Surgical Congress Multi-Center Trial. This study demonstrated that a surgery first approach was utilized in seven of 12 institutions, while endoscopy and MRCP were preferred in the other five institutions.[7] The current study was designed to determine whether a protocol to risk stratify patients with suspected common duct stones could be adopted successfully at multiple institutions. Our study confirms that by adopting this “surgery first” protocol patients receive less pre-operative testing and have decreased lengths of stay.

One of the biggest challenges for implementing this protocol for the management of suspected common duct stones is the identification of high-risk patients. The American Society for Gastrointestinal Endoscopy (ASGE) has developed a risk assessment tool for predicting the presence of common duct stones based on preoperative laboratory and imaging results.[15] In these guidelines, high risk patients are considered to have a >50% probability of common duct stones and pre-operative ERCP should be strongly considered prior to surgery if available at the institution. Patients are considered high risk if they have any one of three very strong predictors: common duct stone on ultrasound, clinical evidence of ascending cholangitis, or a total bilirubin $\geq$4 mg/dL. Patients are also considered high risk if they have the combination of a dilated common bile duct (>6 mm) and a total bilirubin between 1.8 and 4.0 mg/dL. The estimated specificity and positive predictive value of these high-risk predictors were shown to be 74% and 64%, respectively, based on a retrospective review of 2724 patients.[8] He et al. went on to demonstrate that the specificity of the ASGE guidelines increased to 94% with the use of more restrictive criteria (bilirubin >4.0 mg/dL, common bile duct dilation, and/or confirmation of common duct stones on ultrasound). Based upon the results of this study and previously published research, we recommend using a total bilirubin of <4.0 mg/dL as the main clinical indicator to identify patients who may safely undergo laparoscopic cholecystectomy with IOC as the initial treatment modality.

Utilization of total bilirubin <4.0 mg/dL as the main criteria to select patients for a surgery first approach has been shown to decrease the number of endoscopic procedures and length of stay in patients with suspected common duct stones in a single institution study.[8] We expected to see a decreased utilization of ERCP in participating centers after implementation of the protocol, however, ERCP was still frequently performed. The average bilirubin was higher in the current patient population compared to the control cohort, which may be contributing to these results.

There were 59 protocol violations in the six-month study period, which deserve additional scrutiny. These represented patients with normal or low bilirubin that still underwent preoperative endoscopy or MRCP prior to surgical consultation and were excluded since they did not follow the protocol. These patients represented a “low risk” population for common duct stones and had they been included, would have lengthened hospital stay for the overall group to where it did not reach significance. This represents a weakness of our study that will require future studies to further validate or refute the results of this study. This highlights the difficulty in establishing new protocols across multiple institutions. Implementation of this protocol requires multidisciplinary buy-in from everyone on the patient's care team, including hospitalists, gastroenterologist and surgeons. Optimal utilization of this protocol requires clear communication between specialists and should encourage surgeons to take primary control of the patient's care from the time of admission until discharge.

Our study has the limitations inherent in comparison of a prospective protocol with “historic” controls. While our complication rate of 16% is low, we lack the pre-protocol complication rates to better evaluate any negative side effects of the protocol change. In addition, our sample size was significantly reduced by the fifty-nine protocol violations. As data from this and other similar studies is available in the literature, we anticipate greater acceptance and compliance with protocol directed treatments.

Conclusion

Utilizing a surgery first approach in patients with a total bilirubin of <4.0 mg/dL was a safe approach for the management of patients with suspected common duct stones. This protocol decreased length of stay and decreased utilization of MRCP compared to pre-protocol implementation. Adoption of this "surgery first" protocol amongst surgeons and gastroenterologists should be considered for patients with suspected common duct stones.

References

1. Costi R, Gnocchi A, Di Mario F, Sarli L. Diagnosis and management of choledocholithiasis in the golden age of imaging, endoscopy and laparoscopy. *World J Gastroenterol*. 2014;20(37):13382–13401.
2. Collins C, Maguire D, Ireland A, Fitzgerald E, O'Sullivan GC. A prospective study of common bile duct calculi in patients undergoing laparoscopic cholecystectomy: natural history of choledocholithiasis revisited. *Ann Surg*. 2004;239(1):28–33.
3. Natcher WH. NIH state-of-the-science statement on endoscopic retrograde cholangiopancreatography (ERCP) for diagnosis and therapy. *NIH Consens State Sci Statements*. 2002;19(1):1–26.
4. Brown LM, Rogers SJ, Cello JP, Brasel KJ, Inadomi JM. Cost-effective treatment of patients with symptomatic cholelithiasis and possible common bile duct stones. *J Am Coll Surg*. 2011;212(6):1049–1060. e1-7.
5. Chang L, Lo S, Stabile B, Lewis R, Toosie K, de Virgilio C. Preoperative versus postoperative endoscopic retrograde cholangiopancreatography in mild to moderate gallstone pancreatitis: a prospective randomized trial (Structured abstract). *Ann Surg*. 2000;231(1):82–87.
6. Sirinek KR, Schwesinger WH. Has intraoperative cholangiography during laparoscopic cholecystectomy become obsolete in the era of preoperative endoscopic retrograde and magnetic resonance cholangiopancreatography? *J Am Coll Surg*. 2015;220(4):522–528.
7. Frazee R, Regner J, Truitt MS, et al. The southwestern surgical congress multicenter trial on suspected common duct stones. *Am J Surg*. 2019;217(6):1006–1009.
8. He H, Tan C, Wu J, et al. Accuracy of ASGE high-risk criteria in evaluation of patients with suspected common bile duct stones. *Gastrointest Endosc*. 2017;86(3):525–532.
9. Manning A, Frazee R, Abernathy S, et al. Protocol-driven management of suspected common duct stones. *J Am Coll Surg*. 2017;224(4):645–649.
10. Cox M, Wilson T, Luck A, P.L J, Padbury R, Toouli J. Laparoscopic cholecystectomy for acute inflammation of the gallbladder. *Ann Surg*. 1993;218(5):630–634.
11. Zang J, Yuan Y, Zhang C, Gao J. Elective laparoscopic cholecystectomy without intraoperative cholangiography: role of preoperative magnetic resonance cholangiopancreatography - a retrospective cohort study. *BMC Surg*. 2016;16(1):4–9.
12. Richard F, Boustany M, Britt LD. Accuracy of magnetic resonance cholangiopancreatography for diagnosing stones in the common bile duct in patients with abnormal intraoperative cholangiograms. *Am J Surg*. 2013;205(4):371–373.
13. Badger WR, Borgert AJ, Kallies KJ, Kothari SN. Utility of MRCP in clinical decision making of suspected choledocholithiasis: an institutional analysis and literature review. *Am J Surg*. 2017;214(2):251–255.
14. Lee HW, Park DH, Lee JH, et al. Prevalence and predictors of unnecessary endoscopic retrograde cholangiopancreatography in the two-stage endoscopic stone extraction followed by laparoscopic cholecystectomy. *J Gastrointest Surg*. 2019;23(8):1578–1588.
15. Maple JT, et al. The role of endoscopy in the evaluation of suspected choledocholithiasis. *Gastrointest Endosc*. 2010;71(1).