IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 17, Issue 6 Ver. 5 (June. 2018), PP 10-19
www.iosrjournals.org

A Comparative Study of Different Surgical Techniques in Common Bile Duct Exploration under Protocols of Enhanced Recovery after Surgery

Sayyada Orainab Jalal[1], Mohammed Aameruddin Khan Hashmi[2], Zijun Liu[3]
[1](*Department of General Surgery, Nanjing First Hospital Affiliated to Nanjing Medical University, No. 68 ChangLe Road, Nanjing 210006, China)*
[2](*Department of General Surgery, Nanjing First Hospital, Affiliated to Nanjing Medical University, No. 68 ChangLe Road, Nanjing 210006, China)*
[3](*Corresponding Author: Department of General Surgery, Nanjing First Hospital, Affiliated to Nanjing Medical University, No. 68 ChangLe Road, Nanjing 210006, China)*
Corresponding Author:Zijun Liu. Email: liuzijundoctor@sina.com

Abstract:
Background:*Common bile duct exploration (CBDE), a relatively common procedure for common bile duct patients, includes various techniques of surgical treatment. Enhanced Recovery after Surgery (ERAS) incorporates a number of evidence-based peri-operative interventions to decrease surgical stress, improve post-operative outcomes, and aid recovery enabling decreased length of hospital stay.*
Objective:*The aim of present study was to compare different surgical approaches of CBDE, open/laparoscopic with primary closure/T-tube drainage; after incorporating marginally adjusted principles of ERAS; to see whether different CBDE surgical techniques and drainage methods employed indicate difference in post-operative hospital length of stay and physical activities; and to evaluate the feasibility and safety of ERAS in CBDE.*
Materials and Methods:*In this prospective study a total of 73 common bile duct stone patients undergoing CBDE between August 2016 and December 2017 were included. The study population was compared based on operative approach, open/laparoscopic technique with primary closure/t-tube, after implementation of an adjusted ERAS protocol.*
Result:*The average length of hospital stay was found to be better in laparoscopic approach with primary closure, mean - 5.1 days, when compared to other procedures. Prolonged length of hospital stay was recorded in patients undergoing open surgery, and with t-tube drainage. Statistically significant improvement in physical activities on post-operative day 3 was shown by patients aged 41-55 years when compared to patients aged 71-85 years old.*
Conclusion: *Laparoscopic approach ensures shorter length of hospital stay in comparison to open procedure with regard to CBDE. Primary choledochotomy closure after CBDE (both open and laparoscopic) results in shorter hospital length of stay when compared with t-tube drainage. Principles of ERAS program can be applied in common bile duct patients with minor adjustments*
Keywords:*enhanced recovery pathways; enhanced recovery after surgery; laparoscopic common bile duct exploration, open common bile duct exploration, primary closure, T-tube drainage.*

Date of Submission: 28-05-2018 Date Of Acceptance: 11-06-2018

I. Introduction

Choledocholithiasis, common bile duct stones, occurs in 3.4%-17% of patients with symptomatic gallstones[1,2]. Common bile duct exploration (CBDE) is an operation that is performed to treat choledocholithiasis. Other modes of treatment include percutaneous or endoscopic means (Endoscopic Retrograde Cholagiopancreatography [ERCP]). Surgical CBDE can be performed in either an open or laparoscopic fashion. The first common bile duct stone was removed through an incision in the duct by Courvoisier in 1890[3]. In the early 1990s, with the widespread adoption of laparoscopic cholecystectomy, CBDE was first performed in a minimally invasive setting[4]. Laparoscopic CBDE, performed through small incisions; typically 4, similar to a laparoscopic cholecystectomy, has been shown to result in shorter hospital length of stay, decreased hospital costs, and possibly fewer post-operative complications, when compared with the two-stage approach of ERCP and cholecystectomy[5,6]. The majority of patients who undergo open surgery stay in hospital significantly longer than patients who undergo laparoscopic surgery. Conventionally, by the end of a

CBDE, the choledochotomy is managed with an external drain, also known as a T-tube, which is sutured in place with absorbable suture in order to drain the biliary system and allow access for future interventions should the need arise.

About two decades ago, a Danish group led by Henrik Kehlet reported on a series of colonic surgery patients who were treated with enhanced multimodal interventional pathways that included epidural analgesia, early oral nutrition, and early mobilization[7]. It was the first step in the development of fast-track programs, later to be known as enhanced recovery pathways. Several evidence-based studies have reported that many of the traditional approaches to peri-operative care, such as preoperative bowel clearance, use of nasogastric tubes, use of graduated diets, and prolonged bed rest are unnecessary[8,9]. The replacement of a few traditional approaches in peri-operative surgical care with evidence-based practices such as carbohydrate loaded liquids prior to surgery, regional anesthesia, minimally invasive techniques, avoidance of hypothermia during surgery, optimal management of postoperative pain, and prophylaxis for post-operative nausea and vomiting has indicated that surgical recovery can be accelerated[10]. This multimodal multidisciplinary approach referred to as enhanced recovery after surgery (ERAS) or enhanced recovery pathways (ERP's) comprises not only surgeons but also anesthesiologists, and nurses as active participants of the surgical care team. Prime recommendations of ERAS include preoperative patient/family information and counseling, prevention of oral bowel preparation, minimal preoperative fasting, preoperative carbohydrate loading, single dose antibiotic prophylaxis half an hour prior to surgery, opioid-sparing multimodal analgesia, epidural anesthesia, avoidance of fluid overload, no nasogastric decompressiontubes, no drains, prevention of postoperative nausea and vomiting, early removal of Foley's catheters, early oral nutrition and nutritional supplements, and early mobilization.

The aim of present study was to compare different surgical techniques used in CBDE, open/laparoscopic with primary choledochotomy closure/T-tube drainage; after incorporating marginally adjusted principles of ERAS; to see whether different CBDE surgical techniques and drainage methods employed indicate difference in post-operative hospital length of stay and physical activities; and to evaluatethe feasibility and safety of ERAS protocols in CBDE.

II. Materials and Methods

This prospective comparative study was carried out on patients of Department of General Surgeryat Nanjing First Hospital (8th floor), No. 68 ChangLe Road, Nanjing, China from August 2016 to December 2017. A total of 73 adult subjects (both male and female) of age ≥18 years were randomly selected for this study.

Subjects: The study population was drawn from patients with common bile duct stones undergoing CBDE between August 2016 and December 2017.

Inclusion criteria:

1. Patients with common bile duct stoneswith/without gallstones
2. Patients aged ≥ 18 years
3. Patients who are medically stable
4. Patients able to give informed consent concerning post-operative activity

Exclusion criteria:

1. Patients requiring emergency surgery
2. Patients with tumors of the common bile duct
3. Patients having common bile duct stonesaccompanied with intra-hepatic stones
4. Pregnant women
5. Patients with genetic disorders
6. Patients with other debilitating or life-threatening diseases
7. Patients who are physically inactive
8. Patients with a history of drug or alcohol abuse

Patients were divided into four groups according to the operative procedure performed on them.
Group A (n= 9 patients) – Open CBDE with primary closure
Group B (n= 21 patients) – Open CBDE with t-tube drainage
Group C (n= 17 patients) **–** Laparoscopic CBDE with primary closure
Group D (n= 26 patients) – Laparoscopic CBDE with t-tube drainage

Procedure methodology

Ward staff helped identify eligible patients undergoing CBDE and notified the researcher. After written informed consent was obtained, activity trackers, to record physical activities,were provided to all patients and assistance fromnursing staff was useful in collecting data of the recruited patients. Parameters promptly

recorded for implementation of adjusted enhanced recovery pathways included: socio-demographic characteristics such as age and gender, height, weight, surgical approach, post-operative physical activity (including: number of steps taken by the patients and time taken to do so, distance covered), amount of calorie intake, post-operative per oral food intake time, post-operative bowel movement activities including flatus, hospital length of stay, drainage tube removal time, and general condition of the patient. Patient satisfaction and performance of each step was evaluated to improve patient compliance and clinical outcomes.
Enhanced Recovery Pathway Guidelines enforced for this study are shown in the table below:

Table no: 1

Pre-operative protocols	Intra-operative protocols	Post-operative protocols
Patient/family education and counseling	Multimodal analgesia	Multimodal analgesia
Prevention of oral bowel preparation	Maintain normothermia	Early mobilization
Carbohydrate loading	Avoid nasogastric tube placement	Early nutritional support
Antibiotics	Fluid management	Blood glucose control
Multimodal analgesia		

As there is no set ERAS protocol for CBDE yet this study included a few minor adjustments, as shown in the table below:

Table no: 2

Minor adjustments enforced:
Balloon breathing exercises
Early ankle pump exercises
Placement of drain and t-tube, as necessary

All patients and/or families received specialized counseling and education regarding anesthesia, surgical procedure, and discharge criteria pre-operatively. Means of education included personal counseling, brochures and/or multimedia information. Patients were instructed to quit smoking and abstain from alcohol. Patients were instructed to perform balloon blowing exercises to strengthen lung function. Patients were encouraged to continue a clear liquid diet 4-6 hours before anesthesia induction, and pre-operative carbohydrate loading was urged. Pre-operative antibiotics were administered 30 minutes prior to incision. A multimodal, opioid-sparing, pain management plan was put in place pre-operatively. Body temperature was monitored intra-operatively to avoid hypothermia. Intra-operative fluid infusion was monitored to avoid excess fluid administration and volume overload.

By the end of surgery, Ropivacaine was injected into the incision site to prevent post-operative pain in open surgery. NSAIDs, when not contraindicated, and acetaminophen,were used as post-operative multimodal analgesia. Patients were encouraged to accelerate bowel movement 6 hours after surgery to restore bowel continuity. Physical activities were recommended 6 hours after surgery. Early ankle pump exercises were encouraged. Early removal of Foley's catheter was put into practice, ideally 6 hours after surgery. Patients were urged to take up liquid diet 6 hours post-surgery for nutritional support; blood sugars were monitored to avoid hypoglycemia. Patients were allowed to continue other medications, such as anti-hypertensive, they might be using to control underlying diseases 6 hours post-surgery. Smooth discharge was ensured for all patients. First follow up was scheduled 3 days after discharge for all patients.

Statistical analyses

This is a qualitative study. For this study, no questionnaire was designed. This study included 73 patients who went through varying procedures of common bile duct exploration for the removal of common bile duct stones. ANOVA test was used for analysis of variance between multiple parameters. Tukey's Multiple Comparison test was used to compare the post-operative activity sessions of each group on three consecutive days post-surgery. Data were analyzed using the Statistical Program for the Social Sciences software version 20 (SPSS Inc., Chicago, IL, USA) and the GraphPad Prism software version 5.01. $p < 0.05$ was considered statistically significant.

III. Results

All 73 patients included in this study underwent different surgical techniques of CBDE, which included: open CBDE with primary choledochotomy closure, open CBDE with t-tube drainage, laparoscopic CBDE with primary choledochotomy closure, and laparoscopic CBDE with t-tube drainage. Implementation of modified principles of ERAS was applied to all 4 surgical techniques. Patients in all groups were comparable in terms of gender,and indication of surgery.

The most used surgical approach in this study was laparoscopic CBDE with t-tube drainage (35%), while the least used approach being open CBDE with primary closure (12%) (Graph2). Surgical approach for most female patients was shown to be laparoscopic CBDE and for male patients laparoscopic CBDE with t-tube(Graph 3). 64% of surgeries were accompanied with a t-tube for drainage purposes.

Mean age of patient population was 60.6 years. Overall post-operative physical activity shown by all age groups indicates significant improvement from day 1 to day 2 in regard to numbers of steps taken whereas, numbers of steps taken on day 2 and day 3 were found to be similar (Table 3). Patients aged between 41-55 years were shown to have statistically significant increase in physical activity on day 3 when compared with patients aged between 71-85 years ($p = 0.02$) (Table 4, 5).Activity sessions showed no significant relation with patient's gender or surgical approach (Table 6, 7).

There was no significant relation found between patient age and post-operative hospital length of stay. The average hospital length of stay for patients aged 25 to 40 years was 5.6 days, least among all age groups. Prolonged length of hospital stay was found to be in patients aged 71-85 years, which was recorded at 7.5 days on average (Table 8, 9).

Shortest length of hospital stay was seen in laparoscopic CBDE with primary closure, average - 5.1 days. Prolonged length of hospital stay was recorded with open CBDE with t-tube drainage, average - 7 days (Table 10, 11).

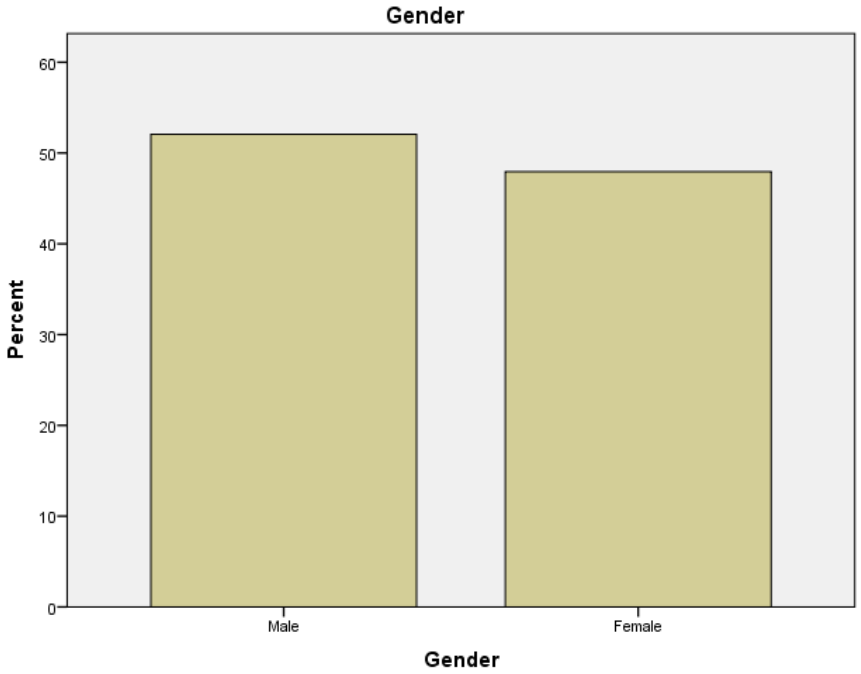
Statistically significant difference in post-operative length of hospital stay was found amongst the groups (Table 10). Results were determined using paired t-test. Pairs in which significant differences were recorded are:

1. Open CBDE with primary closure and open CBDE with t-tube drainage, $p = 0.03$.
2. Laparoscopic CBDE with primary closure and laparoscopic CBDE with t-tube drainage, $p = 0.01$.
3. Laparoscopic CBDE with primary closure and open CBDE with t-tube drainage, $p = 0.02$.
4. Open/Laparoscopic CBDE with primary closure and open/laparoscopic CBDE with t-tube drainage, $p = 0.01$.

Pairs which did not show any significance were:

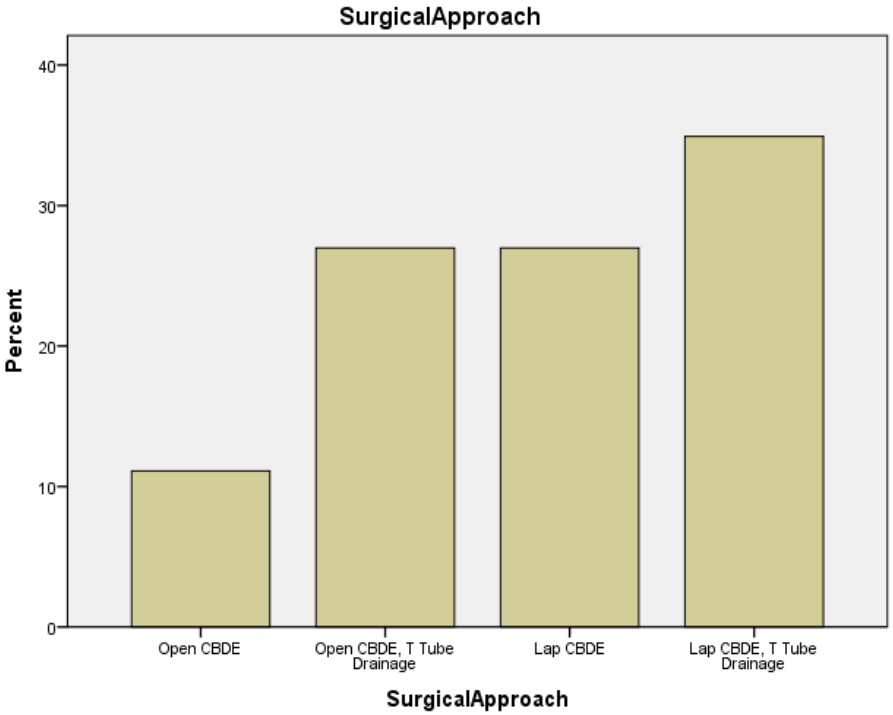
1. Open CBDE with primary closure and laparoscopic CBDE with primary closure, $p = 0.3$
2. Open CBDE with t-tube drainage and laparoscopic CBDE with t-tube drainage, $p = 0.6$
3. Open CBDE with primary closure and laparoscopic CBDE with t-tube drainage, $p = 0.3$
4. Open CBDE with primary closure/t-tube drainage and laparoscopic CBDE with primary closure/t-tube drainage, $p = 0.06$

Graph 1: Gender Distribution



The above mentioned graph shows the gender distribution of patients in our study. It shows that almost 52% patients were male while 48% patients were female. This indicates that there is no gender specification for patients who are a part of this study

Graph 2: Surgical Approach Distribution



Graph 3: Cross Tabulation between Gender and Surgical Approach Used

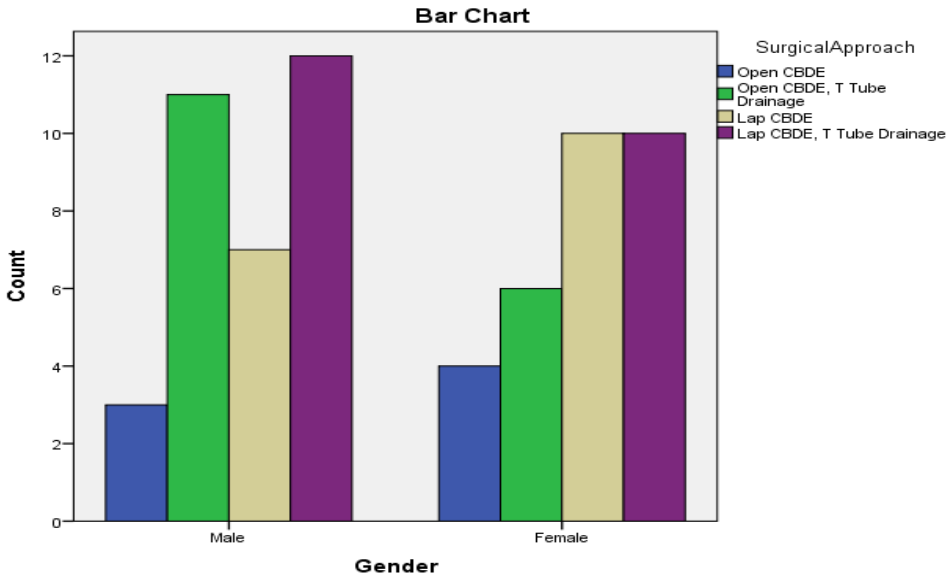


Table no: 3Statistics

		Age	Height	Weight	POAD1	POAD2	POAD3
N	Valid	73	73	73	73	73	73
	Missing	0	0	0	0	0	0
Mean		60.6712	163.9863	62.7877	36.8356	157.2740	170.5342
Std. Deviation		12.36826	8.31914	10.67445	22.58749	126.35832	106.58501
Minimum		28.00	150.00	43.00	10.00	10.00	11.00
Maximum		85.00	185.00	90.00	96.00	630.00	619.00

Table No. 4: ANOVA Test for Activity Sessions and Age Group

		Sum of Squares	df	Mean Square	F	Sig.
POAD1	Between Groups	5.594	3	1.865	2.365	.079
	Within Groups	54.406	69	.788		
	Total	60.000	72			
POAD2	Between Groups	1.944	3	.648	1.569	.205
	Within Groups	28.494	69	.413		
	Total	30.438	72			
POAD3	Between Groups	3.338	3	1.113	3.312	**.021**
	Within Groups	23.182	69	.336		
	Total	26.521	72			

Table No. 5: Tukey's Test for Activity Sessions and Age Groups

Dependent Variable	(I) Age	(J) Age	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
POAD1	25-40 Years	41-55 Years	-.83529	.45175	.260	-2.0247	.3541
		56-70 Years	-.74706	.42531	.303	-1.8668	.3727
		71-85 Years	-.24706	.45175	.947	-1.4364	.9423
	41-55 Years	25-40 Years	.83529	.45175	.260	-.3541	2.0247
		56-70 Years	.08824	.26377	.987	-.6062	.7827
		71-85 Years	.58824	.30457	.225	-.2136	1.3901
	56-70 Years	25-40 Years	.74706	.42531	.303	-.3727	1.8668
		41-55 Years	-.08824	.26377	.987	-.7827	.6062
		71-85 Years	.50000	.26377	.239	-.1944	1.1944
	71-85 Years	25-40 Years	.24706	.45175	.947	-.9423	1.4364
		41-55 Years	-.58824	.30457	.225	-1.3901	.2136
		56-70 Years	-.50000	.26377	.239	-1.1944	.1944
POAD2	25-40 Years	41-55 Years	.04706	.32693	.999	-.8137	.9078
		56-70 Years	-.07059	.30779	.996	-.8809	.7398
		71-85 Years	.34118	.32693	.725	-.5196	1.2019
	41-55 Years	25-40 Years	-.04706	.32693	.999	-.9078	.8137
		56-70 Years	-.11765	.19089	.927	-.6202	.3849
		71-85 Years	.29412	.22042	.545	-.2862	.8744
	56-70 Years	25-40 Years	.07059	.30779	.996	-.7398	.8809
		41-55 Years	.11765	.19089	.927	-.3849	.6202
		71-85 Years	.41176	.19089	.146	-.0908	.9143
	71-85 Years	25-40 Years	-.34118	.32693	.725	-1.2019	.5196
		41-55 Years	-.29412	.22042	.545	-.8744	.2862
		56-70 Years	-.41176	.19089	.146	-.9143	.0908
POAD3	25-40 Years	41-55 Years	-.44706	.29489	.434	-1.2234	.3293
		56-70 Years	-.00588	.27763	1.000	-.7368	.7250
		71-85 Years	.14118	.29489	.964	-.6352	.9175
	41-55 Years	25-40 Years	.44706	.29489	.434	-.3293	1.2234
		56-70 Years	.44118	.17218	.059	-.0121	.8945
		71-85 Years	.58824*	.19881	**.021**	.0648	1.1117
	56-70 Years	25-40 Years	.00588	.27763	1.000	-.7250	.7368
		41-55 Years	-.44118	.17218	.059	-.8945	.0121
		71-85 Years	.14706	.17218	.828	-.3062	.6004
	71-85 Years	25-40 Years	-.14118	.29489	.964	-.9175	.6352
		41-55 Years	-.58824*	.19881	**.021**	-1.1117	-.0648
		56-70 Years	-.14706	.17218	.828	-.6004	.3062

*. The mean difference is significant at the 0.05 level.

Table No. 6: Sessions and Surgical Approach

		Sum of Squares	df	Mean Square	F	Sig.
POAD1	Between Groups	2.746	3	.915	.960	.418
	Within Groups	56.238	59	.953		
	Total	58.984	62			
POAD2	Between Groups	1.922	3	.641	1.432	.243
	Within Groups	26.396	59	.447		
	Total	28.317	62			
POAD3	Between Groups	2.149	3	.716	1.861	.146
	Within Groups	22.709	59	.385		
	Total	24.857	62			

Table No. 7: Activity Sessions and Gender

		Sum of Squares	df	Mean Square	F	Sig.
POAD1	Between Groups	.878	1	.878	1.055	.308
	Within Groups	59.122	71	.833		
	Total	60.000	72			
POAD2	Between Groups	.000	1	.000	.000	.996
	Within Groups	30.438	71	.429		
	Total	30.438	72			
POAD3	Between Groups	.009	1	.009	.025	.875
	Within Groups	26.511	71	.373		
	Total	26.521	72			

Table No. 8: Age and Post-Operative Hospital Stay

	25-40 years	41-55 years	56-70 years	71-85 years
N	5	16	36	16
Mean	5.6	6.5	5.7	7.5
Std. Deviation	1.517	1.365	2.005	3.120
Minimum	4	4	2	5
Maximum	7	10	14	15

Table No. 9: Age and Post-Operative Hospital Stay

		Sum of Squares	df	Mean Square	F	Sig.
Age	Between Groups	37.48	3	12.49	2.6	0.05
	Within Groups	323.9	69	4.694		
	Total	361.4	72			

Table No. 10: Surgical Approach and Post-Operative Hospital Stay

	Open CBDE	Open CBDE with t-tube	Lap CBDE	Lap CBDE with t-tube
N	9	21	17	26
Mean	5.778	7.095	5.176	6.5
Std. Deviation	1.394	2.914	1.425	2.045
Minimum	4	4	2	3
Maximum	8	15	7	14

Table No. 11: Surgical Approach and Post-Operative Hospital Stay

		Sum of Squares	df	Mean Square	F	Sig.
Surgical Approach	Between Groups	38.18	3	12.73	2.7	0.05
	Within Groups	322.3	69	4.672		
	Total	360.5	72			

Table No. 12: Paired Samples T-test for Surgical Approach and Post-Operative Hospital

	Paired Differences					t	df	Sig.
	Mean	Std. Dev.	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pair 1. Open CBDE – Open CBDE with T-tube.	-1.22	1.48	0.49	-2.361	-0.083	2.475	8	**0.03**
Pair 2. Open CBDE --- Lap. CBDE	0.77	2.38	0.79	-1.056	2.612	0.978	8	0.35
Pair 3. Open CBDE with T-tube --- Lap. CBDE with T-tube	0.47	4.31	0.94	-1.490	2.443	0.505	20	0.61
Pair 4. Lap. CBDE --- Lap. CBDE with T-tube	-1.29	1.92	0.46	-2.285	-0.302	2.766	16	**0.01**
Pair 5. Open CBDE --- Lap. CBDE with T-tube	-0.55	1.50	0.50	-1.715	0.60	1.110	8	0.30
Pair 6.								

Lap CBDE --- Open CBDE with T-tube	1.76	2.99	0.72	0.227	3.30	2.433	16	**0.02**
Pair 7. Primary closure (open/lap) --- T-tube drainage (open/lap)	1.57	3.06	0.60	0.340	2.813	2.626	25	**0.01**
Pair 8. Open (primary closure/t-tube) --- Lap (primary closure/t-tube)	1.06	3.02	0.55	-0.063	2.197	1.93	29	0.06

IV. Discussion

In recent years, protocols of enhanced recovery after surgery have proven to be favorable in terms of improved post-operative outcomes, and fast-tracked patient recovery in the setting of colorectal, orthopedic, and genitourinary surgery, as well as expanding into obstetric and pancreatic surgery. The introduction of ERAS principles in colorectal surgery resulted in reduced recovery time and a decrease in the length of hospital stay without affecting morbidity and mortality rates significantly[11]. Expansion of ERAS protocol in surgical sub-specialties has not been widely implemented which prompted us to adopt enhanced recovery pathways for CBDE. This study compared various parameters amongst the four surgical techniques used in CBDE after implementing an adjusted ERAS protocol.

In accordance with key ERAS recommendation, pre-operative carbohydrate loading was encouraged with the purpose of alleviating insulin resistance induced by surgery. Insulin resistance is a crucial metabolic response to surgery and has shown to prolong recovery, increase mortality and morbidity post-surgery. Its early detection and treatment would directly lead to improvement of outcomes. Pre-operative intake of carbohydrates has resulted in attenuating the development of post-operative insulin resistance[12,13]. It has also been shown to be safe and improve patients' sense of well-being[14]. Blood sugar levels in all patients, diabetic and non-diabetic, were monitored peri-operatively and found to be in control.

Multiple studies have shown that minimizing opioids is associated with earlier return of bowel function and decreased length of hospital stay[15]. Use of NSAIDs, when not contraindicated, and of acetaminophen has been shown to improve postoperative analgesia and reduce systemic opioid intake and some of their dose-dependent adverse effects that have been shown to delay post-operative recovery[16,17]. Multimodal; opioid-sparing, analgesics were put in place to effectively manage post-operative pain. Pain scores were regularly monitored and no complaints of post-operative discomfort greater than normal were reported. Intra-operative fluid infusion was monitored to avoid excess fluid administration and volume overload. Intravenous fluid overload can significantly impair organ function, increase post-operative morbidity, and prolong length of hospital stay[18].

As there is no set ERAS protocol for common bile duct surgeries yet, we implemented a program based on the general guidelines of ERAS with a few minor adjustments. Modifications made in the ERAS protocol included: the balloon blowing exercise, early ankle pump exercises, and use of a t-tube drain as and when necessary.

Balloon blowing exercises are shown to be effective for COPD patients, spinal cord injury patients, and elderly patients[19]. It is a conservative exercise intended to assist patients in obtaining an optimal posture, strengthening respiratory function, and lumbar-pelvic stability. We included balloon blowing exercise in our protocol as majority of our study population was elderly (mean - 60.6 years). No incidence of lower back pain or respiratory complications was reported. However, the balloon blowing exercise has not yet been extensively researched or tested experimentally[20]. Early ankle pump exercises, which help decrease swelling in the knee and lower leg, were encouraged to avoid blood clots.

ERAS protocol guidelines entail no nasogastric decompression tubes and no drains as some key elements. They tend to delay post-operative recovery which leads to prolonged length of hospital stay and may increase infectious complications. Evidence from controlled clinical studies in a number of operations has shown that the routine use of drains seems unnecessary[9].

Traditionally, a t-tube is inserted into the choledochotomy by the end of CBDE. A t-tube is placed in the common bile duct to prevent bile leakage, which could build-up post-operatively. Uncontrolled bile leak can be life-threatening if not recognized and treated actively. In addition to acting as a drain, the t-tube can be used to visualize the common bile duct post-operatively to check for residual stones, if any. When absence of residual stones is confirmed, the t-tube can be removed. Other indications for t-tube insertion include ampullary edema, stenosis, history of common bile duct stones/common bile duct stone removal, noticeable debris after removal of common bile duct stone, and a smaller diameter of the common bile duct. However, t-tube insertion has its own risks; possibility of biliary infection, premature dislodgement of t-tube, or improper healing of the hole left in the common bile duct by the t-tube resulting in bile leakage. Thus, the use of a t-tube after CBDE could be

considered debatable. Out of the 73 patients included in our study 47 (64%) patients had a t-tube inserted for drainage purposes.

The patients who went through primary closure had significantly decreased length of hospital stay than those who went through t-tube drainage, irrespective of primary approach being open or laparoscopic, $p = 0.01$. Studies have shown that primary closure resulted in a marked advantage over t-tube drainage, with a mean difference in hospital length of stay of 4.7 days in an open procedure[21] and 3.3 days in the laparoscopic setting[22].

Out of the 73 patients included in our study 43(59%) patients underwent laparoscopic CBDE. Studies have shown that even today many surgeons remain apprehensive of undertaking laparoscopic CBDE. This could be attributed to the fact that retained common bile duct stones are 2.8 times more likely to occur in laparoscopic CBDE than in open CBDE,this indicates a higher level of clearance in open CBDE[23,24]. Other reasons could include inadequate expertise in laparoscopic techniques on part of surgeons and/or surgical staff, lack of necessary equipment, or patient preference for open surgery.

Although it has been widely established that a laparoscopic approach ensures earlier return to physical activities when compared to an open surgery we did not find any statistical significance between post-operative physical activities and surgical approach employed. This could in part be due to implementation of an ERAS protocol, primarily peri-operative multimodal analgesia.

Available literature on ERAS in CBDE concluded that the application of an enhanced recovery program in patients undergoing CBDE was shown to be a very favorable and safe method of treatment and significant for better short and long term results[25].

Limitations and future prospects: The small sample size of patients from one surgical specialty is a limitation, therefore cannot be generalized. Intra-operative conditions like duration of surgery and number of common bile duct stones, and post-operative complications were not analyzed due to unavailability of substantial data. There is limited literature available on ERAS in CBDE; future researchers could select large sample sizes. As very little work has been done in the past in this regard, this study helped in increasing the literature review on this topic, this could encourage other researchers to work on the same or more advanced topic in order to obtain better results, using comparably larger sample sizes.

V. Conclusion

In conclusion, present study shows that laparoscopic CBDE with primaryclosure has decreased length of hospital stay when compared to other CBDEtechniques. Additionally, primary closure can be considered as the preferred technique over t-tube drainage in uncomplicated cases of both open and laparoscopic CBDE.
This study helpedunderstand the implications of enhanced recovery pathways in CBDE. Principles of ERAS programin CBDE are feasible in our set-up.

Conflict of interest: No potential conflict of interest relevant to this research article was reported.

References

[1]. Houdart R, Perniceni T, Darne B, Salmeron M, Simon JF. Predicting common bile duct lithiasis: determination and prospective validation of a model predicting low risk. Am J Surg. 1995; 170:38–43
[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;239:28–33
[3]. Lyass, S. & Phillips, E.H. SurgEndosc (2006) 20 (Suppl 2): S441. https://doi.org/10.1007/s00464-006-0029-0
[4]. Teitelbaum E.N., Yang A.D., Mahvi D.M. (2016) Primary Closure or T-Tube Drainage After Open or Laparoscopic Common Bile Duct Exploration? In: Millis J., Matthews J. (eds) Difficult Decisions in Hepatobiliary and Pancreatic Surgery. Difficult Decisions in Surgery: An Evidence-Based Approach. Springer, Cham
[5]. Cuschieri A, Lezoche E, Morino M, et al. E.A.E.S. multicenter prospective randomized trial comparing two-stage vs single-stage management of patients with gallstone disease and ductal calculi. SurgEndosc. 1999;13:952–7
[6]. Rogers SJ, Cello JP, Horn JK, et al. Prospective randomized trial of LC+LCBDE vs ERCP/S+LC for common bile duct stone disease. Arch Surg. 2010;145:28–33
[7]. Bardram L, Funch-Jensen P, Jensen P, Crawford ME, Kehlet H. Recovery after laparoscopic colonic surgery with epidural analgesia, and early oral nutrition and mobilisation. Lancet. 1995 Mar 25; 345(8952):763-4
[8]. Kehlet H, Wilmore DW: Evidence-based surgical care and the evolution of fast-track surgery. *Ann Surg*. 2008; 248(2):189–98. 10.1097/SLA.0b013e31817f2c1a
[9]. Kehlet H, Wilmore DW. Multimodal strategies to improve surgical outcome. Am J Surg. 2002;183:630 – 641
[10]. Kehlet H, Dahl JB. Anaesthesia, surgery, and challenges in postoperative recovery. Lancet. 2003;362:1921–1928
[11]. Altaf Ahmed Malik, Sumat-ul-khurshid, Nisar Ahmad Chowdhri, FazlQadirParray. Enhanced Recovery after Surgery (ERAS) in Patients Undergoing Colorectal Surgeries. International Journal of Surgical Research. 2013; 2(5):57-62
[12]. Smith MD, McCall J, Plank L, Herbison GP, Soop M, Nygren J. Preoperative carbohydrate treatment for enhancing recovery after elective surgery. Cochrane Database Syst Rev. 2014; (8):CD009161
[13]. Li, L., Wang, Z., Ying, X. et al. Surg Today (2012) 42: 613. https://doi.org/10.1007/s00595-012-0188-7
[14]. American Society of Anesthesiologists Committee. Practice guidelines for preoperative fasting and the use of pharmacologic agents to reduce the risk of pulmonary aspiration: application to healthy patients undergoing elective procedures: an updated report by the American Society of Anesthesiologists Committee on Standards and Practice Parameters. Anesthesiology. 2011; 114:495–511

[15]. Thiele RH, Rea KM, Turrentine FE, et al. Standardization of care: impact of an enhanced recovery protocol on length of stay, complications, and direct costs after colorectal surgery. J Am Coll Surg. 2015; 220:430–443
[16]. Aryaie A, Lalezari S, Sergent W, et al. Decreased narcotic consumption with the addition of IV-acetaminophen in colorectal patients: a prospective, randomized, double-blinded, placebo controlled study. Dis Colon Rectum. 2015;58:e123
[17]. Wu CL, Rowlingson AJ, Partin AW, et al. Correlation of postoperative pain to quality of recovery in the immediate postoperative period. RegAnesth Pain Med. 2005; 30:516–522
[18]. Chappell D, Jacob M, Hofmann-Kiefer K, Conzen P, Rehm M. A rational approach to perioperative fluid management. Anesthesiology. 2008; 109:723–740
[19]. Jun, H.-J., Kim, K.-J., Nam, K.-W., & Kim, C.-H. (2016). Effects of breathing exercises on lung capacity and muscle activities of elderly smokers. Journal of Physical Therapy Science, 28(6),1681–1685. http://doi.org/10.1589/jpts.28.1681
[20]. Boyle, K. L., Olinick, J., & Lewis, C. (2010). THE VALUE OF BLOWING UP A BALLOON. North American Journal of Sports Physical Therapy : NAJSPT, 5(3),179–188
[21]. Gurusamy KS, Koti R, Davidson BR. T-tube drainage versus primary closure after open common bile duct exploration. Cochrane Database Syst Rev. 2013;6, CD005640
[22]. Gurusamy KS, Koti R, Davidson BR. T-tube drainage versus primary closure after laparoscopic common bile duct exploration. Cochrane Database Syst Rev. 2013;6, CD005641
[23]. Hamzeh MH, Hani T, Farah K, Aurélie M, Ali T, Jamal H, Faek RJ. Outcomes of Laparoscopic vs Open Common Bile Duct Exploration: Analysis of the NSQIP Database. J Am Coll Surg. 2017;224: 833-840. https://doi.org/10.1016/j.jamcollsurg.2017.01.062
[24]. Grubnik VV, Tkachenko AI, Ilyashenko VV, Vorotyntseva KO. Laparoscopic common bile duct exploration versus open surgery: comparative prospective randomized trial. SurgEndosc 2012; 26:2165 e2171
[25]. Stefka G, Galina C, Magdalena A, Ivo Z, Emil P, Georgi G. Adjusted enhanced recovery programme after laparoscopic common bile duct exploration. Clinical Nutrition ESPEN. 2016; 12, pp. e56

Sayyada Orainab Jalal "A Comparative Study of Different Surgical Techniques in Common Bile Duct Exploration under Protocols of Enhanced Recovery after Surgery."IOSR Journal of Dental and Medical Sciences (IOSR-JDMS), vol. 17, no. 6, 2018, pp10-19.