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ORIGINAL CONTRIBUTIONS

Prevalence of Cholelithiasis and Choledocholithiasis in Morbidly Obese South Indian Patients and the Further Development of Biliary Calculus Disease After Sleeve Gastrectomy, Gastric Bypass and Mini Gastric Bypass

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Abstract
Background Evaluation of the prevalance of cholelithiasis, choledocholithiasis and there management after sleeve gastrectomy, gastric bypass and mini gastric bypass in Indian bariatric patients.
Methods We did a retrospective analysis of our bariatric patient from January 2007 to December 2013 ($n=1397$), for prevalence of cholelithiasis and choledocholithiasis. We did synchronous cholecystectomy in all patients planned for bariatric surgery found to have cholelithiasis on USG. Post-operatively, we followed all the patients with gallbladder in situ for minimum of 18–88 months (mean −32.4) and reviewed data for subsequent development of cholelithiasis/choledocholithiasis. Only those patients who were symptomatic underwent intervention.
Results Prevalence of cholelithiasis and choledocholithiasis in our study was 21.76 and 9.63 %, respectively. The incidence of post-bariatric surgery development of cholelithiasis was 10.53 %; individually, it was 8.42 % in LSG group, 13.4 % in LRYGB group and 12.7 % in MGB patients. The incidence of symptomatic cholelithiasis requiring surgery was 1.94 % after LSG, 4.54 % after LRYGB and 4.25 % after MGB. Post-surgery, six patients developed choledocholithiasis. In our post-bariatric group, the 33 patients who developed symptomatic stones had percentage total weight loss of 30.99 + 4.1 ($P<0.001$). The average time period for readmission of symptomatic patient was 11.26 + 2.67 months.
Conclusions We recommend routine synchronous cholecystectomy with bariatric procedure. In spite of synchronous cholecystectomy, incidence of cholelithiasis in our post-bariatric patient is 10.53 % of which up to one third were symptomatic and required surgery, and incidence of choledocholithiasis is comparable to that of general population.

Keywords Cholelithiasis · Choledocholithiasis · Morbid obesity · Sleeve gastrectomy · Gastric bypass · Mini gastric bypass · ERCP · Transgastric endoscopic papillotomy

Introduction

Morbid obesity is a well-known risk factor for gallstone formation, and others include bariatric surgery with rapid weight loss, post-operative low-calorie diet, female gender, gallbladder motility disorders, short bowel syndrome, diabetes, previous gut surgery and many more [1–5]. The incidence of gallstone disease (GSD) in the USA and Europe has been estimated as 5.9–21.9 % [6]. The published incidence of GSD in India is lower as compared to western data, and regional data shows more incidence in northern India compared to southern states [7, 8]. The incidence of cholelithiasis in morbidly obese patient is increased by up to three to five times [3, 9–11], and in post-bariatric surgery, rapid weight loss increases rate of cholelithiasis and acute cholecystitis [1, 3, 5, 12–14]. Li et al. [15] describe that more than 25 % of original weight loss after bariatric surgery is the only predictive factor for post-operative gallstone formation.

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All bariatric procedures have been associated with formation of gallstones, less common with restrictive procedures like laparoscopic adjustable gastric bands (LAGBs) and laparoscopic sleeve gastrectomy (LSG), and more with malabsorptive procedures like Roux-en-Y gastric bypass (LRYGB). Not much data is available for single loop gastric bypass/mini gastric bypass (MGB). The incidence of gallstone formation varies from 6 to 7 % in gastric bands [13, 16] to 38–52 % after RYGB [1, 3, 14, 17, 18]. Coupaye et al. [19] suggests that there is definitively increased risk of cholelithiasis after LSG and it is comparable to those following RYGB. The management to GSD is again varied; there are groups of people in favour of combining laparoscopic cholecystectomy (LC) with the primary bariatric procedure, and those who oppose it [10, 18, 20, 21]. Few groups recommend ursodeoxycholic acid (UDCA) after bariatric surgery for 6–12 months while there are others who think it is unnecessary [14, 22]. Post-bariatric surgery LC has been advised for only symptomatic disease by few groups [23, 24].

Literature quotes an incidence of 10–15 % of concomitant choledocholithiasis in population with symptomatic cholelithiasis undergoing cholecystectomy [25]. However, there is paucity of data regarding choledocholithiasis in bariatric patients. Recently, few case reports and small series had been published about transgastric approach for endoscopic papillotomy (TGEP) and common bile duct clearance [26–28] after bariatric surgery or endoscopic access of long afferent limb and retrograde cannulation through biliopancreatic limb which remains a cumbersome procedure [29].

The aim of our study was to do a retrospective analysis of south Indian population in a tertiary care, bariatric centre for the last 6 years to evaluate the prevalence of cholelithiasis, choledocholithiasis and the effect of various bariatric procedures done (LSG, RYGB, MGB) in terms of the development of GSD and symptomatic biliary stone disease, requiring further management and their outcome.

Material and Method

After clearance from ethical committee, the authors did a retrospective analysis of the prospectively collected data of the entire bariatric patient at Global Hospitals, Hyderabad, India from January 2007 to December 2013. During this period, a total of 1397 patient underwent bariatric surgery. All these patients were selected as per proper bariatric guidelines, were suitable candidates for bariatric surgery and were operated by a single senior surgeon.

As a part of pre-operative routine investigations, we got a transabdominal USG done mandatorily in all bariatric patients. The patients who were found to have symptomatic or asymptomatic cholelithiasis, sludge or GB polyps underwent counselling for LC in the same sitting with bariatric procedure as per our hospital protocols. Those who had any evidence of choledocholithiasis were subjected to endoscopic cholangio pancreaticography (ERCP) and bile duct clearance at least 2 weeks before planned bariatric surgery. Post-operatively, UDCA is not routinely prescribed in our bariatric patients. Patient who were lost to follow-up within 18 months from the date of surgery and those who underwent revision bariatric surgery were excluded from the study.

We have fixed follow-up protocols at 2 weeks, 1, 3 and 6 months, and 1 and 2 years after bariatric surgery which is followed in every patient. During these follow-up dates in Outpatient Department (OPD) or in any emergency, if these patients came with any symptoms of painful abdomen, jaundice, fever, vomiting and back radiation of pain, they were evaluated with an USG. If diagnosed to have cholelithiasis, choledocholithiasis, biliary pancreatitis or a combination of any two, they were admitted, further investigations were carried out and appropriate management done (Table 1).

For doing LC in a symptomatic cholelithiasis patient, access was by using 10-mm incision in supraumbilical region by open technique using Hassan's cannula. Rest all ports; 10 mm in subxiphoid, two right subcoastal 5 mm medial and lateral ports were given under laparoscopic vision. Any adhesions to gallbladder were released, Calot's dissection was done using Maryland forceps without much use of cautery, cystic artery and duct were identified, clipped using standard 300/400 titanium clips and divided with scissors, then gallbladder was dissected off liver bed by blunt dissection and cauterization and delivered through supraumbilical port using an endobag. Pre-operative ERCP and stone extraction were done if choledocholithiasis was present in patients who underwent LSG. Transgastric endoscopic papillotomy (TGEP) with stone extraction was combined with LC in those who underwent LRYGB. In patient who underwent TGEP, an extra 15-mm port was put in the left hypochondrium, and access to the ampulla was by creating a 15-mm gastrostomy in the remnant stomach, through which ERCP scope was negotiated, endoscopic papillotomy (EPT) done and stone extracted.

Data was collected regarding age, pre-operative BMI, prevalence of cholelithiasis and choledocholithiasis, development of cholelithiasis and choledocholithiasis post-bariatric surgery, % total body weight loss (TBWL), extra body weight loss (EBWL), percentage of extra body weight loss using BMI of 22 as base line and expressed as mean ± standard deviation. All data were compared and analysed statistically by the chi-square test, Fisher exact test or two-tailed student *t* test with Graph pad Instat 3 software as appropriate. Statistical significance was accepted at $p < 0.05$.

Result

The total number of patient retrospectively evaluated were 1397, with an average follow-up of 32.4 ± 7.2 months (range

Table 1 Patient with symptomatic cholelithiasis with/without choledocholithiasis

P	Age/sex	PO BMI	C BMI	EBWL Kg/(%)	TWL (%)	TPS	BP	CP	DB/IB	ALP	GGT	Amy	USG GB	USG CBD (D)	USG CBD	MRCP	PD	Time min
01	28/F	38.6	9.1	23.3 (54.8)	23.6	7.26	LSG	P, D	1.1/0.7	98	79	11	MS	3 mm			LC	40
02	46/M	43.2	14.3	42.1 (67.1)	32.9	13.1	LRYGB	P	1.2/1.0	102	88	14	MS	4 mm			LC	35
03	38/F	47.1	14.4	35.8 (57.1)	30.4	9.7	LRYGB	D	1/0.6	74	46	8	MS+s	4 mm			LC	40
04	42/F	48.2	17.3	38.6 (65.5)	35.4	10.9	LRYGB	P, N, V, F, C	4.6/3.2	312	146	56	MS+s	8 mm	2 S		LC + TGEP	122
05	36/M	37.6	8.4	25.4 (53.8)	22.3	9.86	LSG	P, D	1.3/0.7	184	64	28	MS+s	5 mm			LC	35
06	28/F	39.1	14	36.8 (99.6)	35.8	10.4	LSG	P, D	0.8/0.6	98	46	7	SS	3 mm			LC	40
07	33/F	51	17.3	38.3 (66.4)	34.1	11.8	LRYGB	F, D	1.6/0.8	164	78	198	S	6 mm		MRCP	LC	40
08	41/F	54.3	17.1	40.4 (76.1)	31.4	10.56	LRYGB	P, D	1/0.4	112	66	32	MS+s	5 mm			LC	45
09	52/F	39.4	11.1	29.4 (77)	28.1	9.63	LRYGB	P, N, F, C	3.2/1.9	278	115	26	MS+s	7 mm	3 S	MRCP	LC + TGEP	138
10	53/M	44.5	12.8	41.8 (64.7)	28.4	11.46	LSG	P, D	0.6/0.4	98	42	6	MS	4 mm			LC	35
11	33/F	48.4	16.3	47.6 (69.6)	33.6	16.76	LRYGB	P, D	0.8/0.3	46	34	5	MS+s	3 mm			LC	40
12	38/F	42.4	12.3	23.7 (70.5)	28.9	9.56	MGB	P	0.9/0.6	98	34	6	SS	4 mm			LC	30
13	41/F	53.4	18.7	39.7 (65.6)	34.9	12.76	LRYGB	N, V, D	0.8/0.4	84	29	9	SS	4 mm		MRCP	LC	40
14	44/F	39.7	11	26.3 (74.6)	27.6	9.73	LSG	P, F, C	5.1/3.4	378	156	468	MS+s	10 mm	2 S+s	MRCP	LC + ERCP	35 + 45
15	47/F	53.6	15.3	40.5 (53.3)	28.4	11.03	LRYGB	P, D	0.9/0.5	94	68	21	MS+s	3 mm			LC	35
16	40/M	48.3	16.7	58.3 (71.5)	34.5	14.56	LRYGB	P, N, V, F, C	3.1/2.0	264	184	98	MS+s	9 mm	3 S		LC + TGEP	115
17	29/F	43.5	10.9	28.6 (58.8)	25	9.86	LSG	P, F	1.2/0.8	154	102	132	S	5 mm		MRCP	LC	50
18	35/F	46.3	12.8	31.6 (60.2)	27.7	9.2	LRYGB	P	0.6/0.4	54	38	6	MS	4 mm			LC	35
19	39/F	48.6	17.2	46.1 (72.6)	35.3	14.33	LRYGB	P, D	0.9/0.5	64	34	7	SS	3 mm			LC	35
20	40/F	42.1	9.9	28.6 (57.8)	23.5	8.86	LSG	P, D	0.5/0.2	58	44	8	MS+s	3 mm			LC	40
21	36/F	38.6	14.1	36.7 (102.8)	36.2	13.06	LSG	D	0.4/0.2	60	42	10	S	4 mm			LC	25
22	38/F	52.1	17	38.8 (62.8)	32.6	11.33	MGB	P, D	0.7/0.3	89	36	13	MS	4 mm			LC	40
23	55/F	62.3	24	63.7 (64.3)	38.5	16.33	LRYGB	P, N, V, F, C	4.2/2.6	266	152	87	MS+s	10 mm	2 S	MRCP	LC+ ERCP	40 + 35
24	31/F	43.8	16.2	35.3 (85.8)	36.8	10.73	LRYGB	P, D	1/0.4	140	88	12	MS+s	5 mm		MRCP	LC	40
25	42/F	46.4	14	37.7 (65.5)	30.2	11.26	LRYGB	P, D	0.6/0.3	54	44	4	S	4 mm			LC	45
26	46/F	38.9	11.8	29.8 (84.9)	30.3	9.6	LSG	P, V, F	2.6/1.1	216	102	132	MS+s	9 mm	2 S+s	MRCP	LC + TGEP	105
27	38/M	46.4	15.1	42.1 (70.7)	32.8	12.06	LRYGB	P	0.4/0.2	46	35	8	MS	3 mm			LC	45
28	41/F	40.1	11.7	27.3 (77.4)	29.1	7.6	LSG	P, D	0.5/0.3	48	40	3	MS+s	4 mm			LC	50
29	43/F	45.6	15.3	38.1 (74.1)	33.5	12.7	LRYGB	P, N	0.6/0.4	54	38	5	MS	4 mm			LC	45
30	47/F	49.4	16.8	40.8 (68.7)	33.9	13.33	LRYGB	P, D	1.4/0.4	142	45	10	MS+s	5 mm		MRCP	LC	30
31	52/F	39.2	10.6	23.5 (74.6)	27	8.6	LSG	P	0.6/0.2	46	34	6	MS	3 mm			LC	35
32	35/M	44.6	12.7	39.4 (55.8)	28.5	11.36	LSG	P, N, V	1.1/0.6	124	68	68	MS	5 mm			LC	40
33	29/F	48.9	15.5	40.1 (57.3)	31.6	12.3	LRYGB	P, D	0.7/0.3	46	28	6	SS	4 mm			LC	40

POBMI pre-operative BMI, *C-BMI* change in BMI, *EBWL* excess body weight loss (in percentage), *TPS* time (in months) post-bariatric surgery, *TWL(%)* % of total weight loss, *BP* bariatric procedure done, *CP* clinical presentation (P-Rt hypochondrium/epigastric pain, *N* nausea, *V* vomiting, *D* dyspepsia, *C* cholangitis), *DB/IB* direct/indirect bilirubin, *Amy* amylase, *USG GB* USG gallbladder (*SS* single stone, *MS* multiple stone, *s* sludge, S+s stone and sludge), USG CBD: *D* diameter, *S* stone, *Ss* stone and sludge, *MRCP* magnetic resonance cholangio pancreaticography, *PD* procedure done, *LC* lap cholecystectomy, *ERCP* endoscopic retrograde cholangio pancreaticography, *TGEP* transgastric endoscopic papillotomy, *TIME MIN* total time of procedure done in minutes

18–88 months). A total of nine patients, who were lost to follow-up within 18 months time frame and five patients who underwent revision bariatric procedure were excluded from the study. Of the remaining total 1383 patients in study group (Table 2), 160 (11.6 %) patients (M 31, F 129) already underwent lap cholecystectomy ± ERCP before bariatric surgery. On admission and evaluation, further 141 patients (10.2 %) (M 23, F 118) were diagnosed to be suffering from symptomatic or asymptomatic gallstone disease (including stones, sludge and polyps) who underwent concomitant LC with bariatric procedure. In these 141 patients, 11 patients (M 3, F 8) were also diagnosed for choledocholithiasis or sludge in CBD (9.65 % of patient with cholelithiasis), and they successfully underwent pre-operative ERCP and duct clearance without stent placement before planned bariatric surgery. As already 301 patients in the study group had their LC done (pre-operatively/concomitantly), so effective number of patients left in the study group were 1082 of which 617 underwent LSG (57.0 %), 418 underwent LRYGB (38.6 %) and 47 (4.4 %) underwent MGB. The cases in MGB arm were less as we started this procedure in early 2012 only.

In the follow-up, 114 patients (10.5 %) (M 16, F 98) were found to develop cholelithiasis (Table 3); of these, 33 patients (3.04 % of total patient or 28.9 % of those developing cholelithiasis) (M 6, F 27) were symptomatic or developed acute cholecystitis and required intervention. Eighty-one patients were found to have cholelithiasis or sludge in routine post-bariatric USG scanning at 6 months, 1- or 2-year interval, and since they were asymptomatic, they were followed up without requirement for surgery. For detecting symptomatic patients (Table 1), most common clinical presentations were pain in the abdomen in the right hypochondrium or epigastric region which was defined by patient as occasional spasmodic, sharp or radiating to back ($n=29$, 87.8 %), followed by vague dyspeptic symptoms ($n=19$, 57.6 %), associated with occasional nausea ($n=7$, 21.2 %) and/or vomiting ($n=5$, 15.1 %). Eight patients (24.2 %) presented with fever of which five had cholangitis. Initial diagnosis was by USG for cholelithiasis/choledocholithiasis, and in doubtful cases, MRCP was done for further diagnosis (Table 1). For analysing the data of this post-bariatric group, they were divided into asymptomatic (group A, $n=81$) and symptomatic (group B, $n=33$) group (Table 3). It was found that group B patients had relatively more weight loss and EBWL than group A patients, and it was statistically significant ($P<0.05$). The % EBWL and TBWL in group B was statistically more that group A and quite significant ($P<0.001$). The average time frame for admission with acute symptoms in group B patients was 11.26 ± 2.23 months (7.26–16.76 months), and % TBWL was 30.99 ± 4.13. All the 81 patients in group A were totally asymptomatic during the entire follow-up period of mean 31.6 (range 18–84) months.

Table 2 Procedure wise development of cholelithiasis/choledocholithiasis in study group of 1383 patients

	Cholelithiasis			Choledocholithiasis		
	Total	Males	Females	Total	Males	Females
Pre-op LC	160	31	129	18	4	14
Synchronous LC	141	23	118	11	3	8
Post-bariatric cholelithiasis (symptomatic)	114 (33)	16 (6)	98 (27)	6	1	5

Table 3 Follow-up patients after bariatric surgery developing cholelithiasis/choledocholithiasis

	Group A (asymptomatic)	Group B (symptomatic)	*P* value
Patients	81	33	
Follow-up	31.6 months (18–84)	32.4 months (20–88)	
Age	38.9 ± 7.21	39.6 ± 6.59	NS
Pre-op BMI	44.9 ± 6.37	45.6 ± 5.71	NS
Change in BMI	12.79 ± 4.37	14.29 ± 3.21	<0.05
BMI at evaluation	32.86 ± 3.83	31.23 ± 3.54	<0.05
EBWL (Kg)	32.1 ± 9.91	36.85 + 9.15	<0.05
% EBWL	60.33 ± 12.89	69.13 ± 11.83	<0.001
% TBWL	26.57 + 5.37	30.99 ± 4.13	<0.001
Admission with symptoms (months)		11.26 ± 2.67	

NS not significant

In patients who underwent LSG, two cases presented as cholangitis, one of these patients had choledocholithiasis, and other had sludge in CBD which also produced biliary pancreatitis. Four patients who underwent LRYGB and presented with choledocholithiasis underwent TGEP with stone extraction in the same sitting with LC. TGEPT combined with LC procedure time was 105–138 min (120 ± 13.88 min).

Individually, the incidence of GSD post-bariatric surgery was 8.42 % in LSG group, 13.4 % in patients undergoing LRYGB and 12.7 % in MGB patients. The incidence of stone formation in patient undergoing LRYGB or MGB is significantly more common, compared to those in patient undergoing LSG (Table 4). However, the development of symptomatic cholelithiasis in either LSG or LRYGB group is quite significant ($P<0.001$). *P* value for MGB was not calculated due to less number of case and erroneous results.

In all patients, LC was possible with no need for open conversion. Post-operatively, there was no mortality, and average hospital stay was 2–5 days (2.27 ± 0.72 days). Twenty-eight patients were discharged on day 2, and one patient with severe adhesion and intraoperative ooze requiring drain in situ stayed in hospital stay till day 5. Other two patients developed pain abdomen and clinical signs of mild pancreatitis and were

Table 4 Procedure wise development of gallstone disease

Procedure	Total no.	Cholelithiasis (%)	Symptomatic (%)[a]	*P* value	Males	Females	CBD stones
LSG	617 (783–166)	52 (8.42)	12 (23.07)	$p < 0.001$	3	9	2
LRYGB	418 (552–134)	56 (13.39)	19 (33.92)	$p < 0.001$	3	12	4
MGB	47 (48–1)	6 (12.76)	2 (33.33)	–	0	2	0

[a] Symptomatic of those developing cholelithiasis

discharged on day 4. Two patients with presentation of pancreatitis and on evaluation found to have only gallstone, underwent LC and discharge on day 3. Two patients had persistent pain at 15-mm port site and were on pain killers for 5 days post-discharge. One patient had 15-mm port site infection which required dressing.

Discussion

Incidence of cholelithiasis in India appears to be 6–7 % [7, 8, 30, 31]. Swartz et al. [32] found that prior cholecystectomy in patients scheduled for bariatric surgery was anticipated at percentages of 11–23 %; in our study, it was 11.56 % (160/1383). The prevalence of cholelithiasis in a given population is considered the sum of patients with proven cholelithiasis plus those with evidence of prior cholecystectomy [33]. The prevalence of cholelithiasis in bariatric population has been estimated at about 13.6 to 47.9 %. [10, 11, 16, 21, 32, 34–40]; in our study, it was 21.76 %. As cholelithiasis is more common in women, they outnumber men in the development of both symptomatic and asymptomatic cholelithiasis (Table 4) in all bariatric procedures performed.

The incidence of post-bariatric surgery development of GSD is reported from 6.7 to 52.8 % [1, 3, 9–11, 14, 34, 36, 41, 42]. In our group of 1082 patients, the prevalence was 10.53 % ($n = 114$), individually it was 8.42 % in LSG group, 13.4 % in patients undergoing LRYGB and 12.7 % in MGB patients. The reported incidence of symptomatic cholelithiasis after various bariatric procedures has been estimated to be from 2.9 to 14.7 % (Table 5). Our results in Indian patients indicate the incidence of symptomatic cholelithiasis requiring surgery to be 3.04 % and individually 1.94 % after LSG, 4.54 % after LRYGB and 4.25 % after MGB. Definitely, the incidence of cholelithiasis and choledocholithiasis is quite high in those who underwent LRYGB compared to LSG group; at present thought, MGB seems to be associated with increased risk of cholelithiasis but due to less number of cases, it is difficult to compare and maybe long-term follow-up and more number of procedures will further clarify the situation.

Table 5 Cholecystectomy in symptomatic post-bariatric patients

Study by	Year	No. of patients	Procedures	Study type	Synchronous Cholecystectomy	UDCA given	Mean follow-up (months)	Requirement of cholecystectomy (%)
Swartz et al. [32]	2005	319	RYGB (lap+open)	Prospective and retrospective	No	Yes	7.5	14.7
Caruna et al. [18]	2005	125	LRYGB	Prospective	No	No	>16	8
Patel et al. [43]	2006	199	LRYGB	Prospective	No	No	17.8	6.0
Portenier et al. [44]	2007	984	RYGB	Prospective	Yes	No	6–144	8.1
Ellner et al. [35]	2007	324	–	Retrospective	No	No	4–25	9
Patel et al. [23]	2009	1050	LRYGB	Retrospective	Selective	No	32.3	4.9
Li et al. [15]	2009	548	LRYGB LSG	Retrospective	No	No	>36	8.7 3.8
Tsirline et al. [45]	2014	1398	LRYGB LSG LAGB	Prospective	No	Yes	49	10.6 3.5 2.9
Sioka et al. [46]	2014	106	LSG	Retrospective	No	No	26	4.7
Moon et al. [47]	2014	586	LRYGB LSG LAGB	Retrospective	Yes	No	24	5.7 6.1 0
Coupaye et al. [19]	2015	150	LRYGB LSG	Prospective	Selective	No	>24	13 12

Taking consideration in to the fact that we did concomitant cholecystectomy with bariatric procedure in patients found to have cholelithiasis or this percentage of symptomatic patients would have been higher. It has been reported that cholecystectomy may be required in 3–30 % of patients developing cholelithiasis [5, 12, 15, 21, 36, 43, 48], and in our series, it was 28.94 % (33 of 114 patents).

In our study, the prevalence of choledocholithiasis is 9.63 % (29/301) of patients with cholelithiasis. There has not been much literature about the incidence of choledocholithiasis in post-bariatric patients; Lalor et al. [49] gave an estimate of 0.7 % in their case series. Other cases of attempted ERCP and TGEP have been published but all are small series or case reports and mostly done by endoscopist who have not documented the bariatric case population in study [24, 28, 50–52]. In our series, six patients (Tables 1 and 2) developed choledocholithiasis (5.26 % of those developing cholelithiasis).

As described by Li et al. [15], at least 25 % weight loss is associated with cholelithiasis formation. In our group of 1082 patient, those developing cholelithiasis had total weight loss (TWL) of 26.57 ± 5.37 % and the 33 patients who developed symptomatic stones had TWL percentage of 30.99 ± 4.13. The symptomatic patients were admitted for surgery after 11.26 ± 2.67 months of primary bariatric procedure (range 7.26–16.76 months).

Conclusion

From retrospective review of our prospective collected data, we conclude that in obese south Indian patients, the prevalence of cholelithiasis appears to be 21.76 % and choledocholithiasis to be 2.09 % (9.63 % of those with concomitant cholelithiasis). There are many authors who recommend routine synchronous cholecystectomy [2, 9, 53, 54], and we do the same as it adds just 15 ± 3 min to our bariatric procedure without any additional morbidity. All the stones formed within 2 years from the bariatric procedure, and no patient became symptomatic after 2 years, even those having stones. We also propose that post-bariatric surgery, choledocholithiasis can be effectively managed by ERCP or TGEP in cases of LSG and LRYGB, respectively.

The only weakness of our study seems to be its retrospective nature. We were able to gather proper history of preoperative cholecystectomy/ERCP information in all our patients whether the procedure was done at our institution or not. We believe that a large enough number of patients were included in this study to validate our results. Also, the mean follow-up period was 32.4 months (range 18–88), and considering the findings that almost all patients developed symptomatic or asymptomatic cholelithiasis within 24 months of bariatric procedure, the follow-up seems to be adequate.

Compliance with Ethical Standards

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

Ethical Approval Since it is a retrospective study, for this type of study, formal consent is not required.

Informed Consent Informed consent was obtained from all individual participants included in the study.

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