ABSTRACT Background: Laparoscopic cholecystectomy revolutionized the management of Gall stone disease, which is now designated as the standard gold treatment for symptomatic cholelithiasis. However, around 15-20% of patients continue to have post-cholecystectomy syndromes, the causes of which are diverse. One crucial reason is retained cystic duct stones, which are usually missed intraoperatively. Focused attention towards the same with some intraoperative manoeuvres would help to reduce their contribution to the post-cholecystectomy syndrome. Methods: The study was carried over two years, from June 2019-March to 2021, during which 380 Laparoscopic Cholecystectomy were studied. Patients detected to have cystic duct stones by noting abnormal bulge, adhesions, nonuniformity of duct and confirmed by tactile sensation by instrument. These patients were subjected to different intraoperative manoeuvres like milking of duct, complete dissection of CD-CBD junction and ligation of CD close to CBD, the opening of cystic duct over stone etc., were utilized. Results: We found cystic duct stones in 40(10.5%) out of 380 Laparoscopic cholecystectomies performed, which were managed laparoscopically. We have made some classifications according to the position of stone in the cystic duct and managed accordingly. Upon follow-up, we found that out of 40 patients with detected cystic duct stones, no patients had any complaints postoperatively until now. Conclusion: We conclude that the incidence of CD stones is underestimated and under-reported, which is a significant cause of PCS. However, suppose attention is given to CD during Laparoscopic cholecystectomy and adapting some safe and straightforward manoeuvres. In that case, they can be effectively managed, decreasing the possibility of the postcholecystectomy syndrome, Remnant cystic duct stump stone, and post-op CBD stone.

KEYWORDS Laparoscopic cholecystectomy, Post-cholecystectomy syndromes, Cystic duct calculi, Common bile duct, Cystic duct

Introduction

Laparoscopic cholecystectomy has made a significant change in the management of Gall Bladder stone disease and has become the procedure of choice for symptomatic biliary disease [1,2]. Laparoscopic cholecystectomy is still the standard gold treatment for symptomatic cholelithiasis, and it relieves the symptoms of gall stone disease in as many as 80-85% of cases [3]. However, the remaining continue to have post-cholecystectomy syndromes (15-20%). The remnant cystic duct calculi is an im-
portant culprit for the post-cholecystectomy syndrome, which may predispose recurrent CBD stones [4,5,6,7]. As per the basic steps of laparoscopic cholecystectomy, we always stay close to gallbladder-cystic duct junction during calots dissection keeping Hartmann’s pouch in lateral and upward traction [8]. Because of this, the stones may slip into the cystic duct, or we may miss the distal stones in the cystic duct. If we leave these stones and clip above, there is always a possibility of remnant cystic duct stone and slipping stone into CBD. For this, we adopt some techniques laparoscopically to overcome this difficulty in cystic duct stone disease.

Epidemiological evidence suggests that most bile duct stones originate in the gall bladder [9,10]. The initial stage represents passage through the cystic duct and thus inability to negotiate the CD or in early stages; these calculi are in the cystic duct. Multiple small calculi may slip into the cystic duct. However, the first stone is the lead point and risks further stone migration. Patients with a history of recent biliary colic, mucocoele or intraoperative manipulation of gall bladder during calots dissection may predispose to cystic duct stones [11]. Most of such stones are missed during surgery and thus continue to give postcholecystectomy syndromes. We represent a series of patients whose attention towards cystic duct was focused and different manoeuvres adapted for intraoperative management of cystic duct stones whenever detected.

A prospective study was carried out for 380 patients over two years from March 2019 to March 2021 by a single surgeon and his team. All the patients were subjected to laparoscopic cholecystectomy using standard 4-port technique after documentation of GB calculi using ultrasonography for diagnosis. Intraoperatively attention was focused on the cystic duct, contour, unusual bulge, tactile feedback using Maryland forceps, and any undue adhesions. Different manoeuvres were exploited to manipulate cystic duct stones whenever found near Gall Bladder, or CD-CBD junction was dissected, cystic duct ligated close to CBD or transverse/longitudinal incision over a cystic duct to extract the stones before clipping the cystic duct-CBD junction.

The cystic duct stones were arbitrarily classified and managed accordingly. The whole series of patients were followed for a period 6-months to one year with history & clinical examination and USG & LFTs whenever need felt. All cases of symptomatic gall stone disease plan for laparoscopic cholecystectomy which are having cystic duct stone detected intraoperatively or preoperatively by ultrasound include of this study and Patients with cholelithiasis with CBD stone, Mirizzi syndrome and patients in whom subtotal cholecystectomy was done and cases which needed conversion into open cholecystectomy exclude of this study.

Procedure

Same basic steps were done for laparoscopic cholecystectomy. During calots dissections, attention was focused on the cystic duct, contour, unusual bulge, tactile feedback using Maryland forceps, and any undue adhesions of stone in the cystic duct. Cystic duct stones are mobile or impacted (Table 1) (Fig 1). Impacted stones are proximal (GB-cystic duct junction), middle and distal (cystic duct-CBD junction) (Fig 2). When there is some suspicion about cystic duct stone, careful dissection was done up to cystic -CBD junction. Some manoeuvre noted down in the table has been done to get rid of the calculi or sludge in the cystic duct. In all of the cases, we could clip distally beyond the stone in the cystic duct. Some cases that we could not clip are excluded from the study having mirizzi syndrome managed by open conversion.

Results

We performed 380 laparoscopic cholecystectomies from June 2019 to March 2021. out of them, 274(72.1%) were female, and 106 (27.9%) were males. 195(51.3%) were between the age group of 40-50 years, 85 (22.3%) were between 30-40 years, and 40 (10.5%) were between 50-60 years, and 24(6.31%) were less than 30 years and 36 (9.47%) more than 60 years old. In addition, we have 2 cases of sickle cell, a 28year female and 21year old male and one case 23year old female with PCOD. Sixty-six percent (66%) of patients were operated on for symptomatic cholelithiasis, whereas 26% were operated for Acute cholecystitis and found cystic duct stones in 40(10.5%) patients having 32 impacted stones with proximal duct stones in 20patients, distal stones in 7 patients, 5 patient had stones in the middle part of the cystic duct and 8 patients (20%) are having freely mobile stones (Table 2). 25(62.5%) cases of these cystic duct stone patients are female, and 15 (37.5%) cases are male 35 cases (87.5%) were having multiple small stones in USG. Intraoperatively we had come across long cystic duct in 35(87.5%) cases, visible stone in 10(25%) cases, distal cystic duct adhesion to CBD in 5(12.5%) cases, nonuniformity of duct/abnormal bulge in 8(20%) cases (Table 2). LFT was normal in all of the cases. Preexisting mild pain was there in all of the cases.

Discussion

The incidence of cystic duct stones is not that uncommon. However, due to the usual missing of such stones upon preoperative evaluation and loss of tactile feedback due to widespread use of LC, detecting such stones is difficult without focused attention to the duct. In 1912, Florcken [12] described the first case of cystic duct remnant containing stones. Zhou et al. [13] found 4
Table 1 Classifications and management of Cystic duct stone.

| Cystic duct stone | Management |
|-------------------|------------|
| 1. Mobile stones  | Milking of the cystic duct by Maryland and non-toothed grasp and clipping distal to stone. |
| 1. Impacted stones| Clipped distally. |
| 2. Proximal (a)   | Clipped proximally-open cystic duct-remove stones-clipped distally |
| 3. Middle (b)     | Complete dissection of cystic duct up to CD-CBD junction-clip proximal-transverse/longitudinal incision to remove the stone-free flow of bile-distal clipping |
| • Distal (c)      | |

Table 2 Incidence and Predisposing Factors of Cystic duct stones.

| Cystic duct stones                  | Total (40) |
|-------------------------------------|------------|
| Mobile stones                       | 8 (20%)    |
| Proximal impacted                   | 20 (50%)   |
| Middle impacted                     | 5 (12.5%)  |
| Distal impacted                     | 7 (17.5%)  |

| Factors                             |            |
|-------------------------------------|------------|
| USG finding of Small multiple stones in GB | 35 (87.5%)|
| Long cystic duct                    | 35 (87.5%)|
| Visible stone                       | 10 (25%)   |
| Nonuniformity of duct              | 8 (20%)    |
| Distal adhesion                     | 5 (12.5%)  |

Patients with CD remnant stone in a series of 371 patients of the post-cholecystectomy syndrome. The incidence of cystic duct remnant stones after cholecystectomy as such has been reported to be less than 2.5% [13,14]. However, the incidence of cystic duct stones has been reported between 11-20%. It thus could be the cause of PCS (post-cholecystectomy syndromes) in as many as 25% of patients in another series [15]. In our series, we have addressed this group of patients and found that clearing the remnant cystic duct from any sludge or calculi reduces PCS incidence. Although USG could not detect preoperatively cystic duct stones, we found as many as 40 (10.6%) out of 380 patients with CD stones intraoperatively by focused attention to CD. Patients whose cystic duct was dilated had an unusual bulge; undue adhesions around calot’s triangle were found to have more incidence of cystic duct stones. This incidence is remarkably similar to a study by Mahmud S and his colleagues, who had an incidence of CD stones of about 12.3% [16].

Such intraoperatively detected CD stones and intraoperative vigilance can thus decrease PCS incidence by utilizing safe and straightforward manoeuvres. Milking of cystic duct towards GB before clipping is one such manoeuvre [17]. Furthermore, the CD should be clipped close to CBD by complete dissection up to the CD-CBD junction. This helps in two ways, any proximal CD stone is removed with the specimen, and secondly, CD stump remnant (>1cm) [18] is prevented, which is also associated with PCS. More frequently, the CD stones are proximal and are removed with specimen by default without any specific manoeuvre or surgeon’s attention. However, the distal stones need more attention that is usually missed and may remain with the CD stump. Such stones are more often a source of PCS, thus the need for complete dissection of CD-CBD junction. In some cases in our series, it was tough to get some distal margin of the cystic duct for clipping where we made a transverse/horizontal incision over the stone to extract the impacted stone and put a clip at the distal end of the cystic duct taking particular precaution so that it should not override CBD. The same things have been attempted in a series of Mahmud et al. [11]. The probable cause of the low incidence of CD stones in laparoscopic cholecystectomy so far reported may be due to such missed distal CD stones.

**Conclusion**

We conclude that the incidence of CD stones is underestimated and under-reported, which is a significant cause of PCS. However, suppose focused attention is given to CD during Laparoscopic cholecystectomy and exploiting some safe and straightforward manoeuvres. In that case, they can be effectively dealt with by reducing PCS, Remnant cystic duct stump stone and post-op CBD stone. With a slight suspicion of cystic duct stone, proper dissection up to cystic -CBD junction with tactile feedback by Maryland and, if needed, opening the duct and milking may decrease the incidence of missed stone in the cystic duct and thereby post-cholecystectomy syndrome.
Acknowledgement
All authors acknowledge from the bottom of the heart to Mr Somadatta Das, PhD Research Scholar, S’O’A deemed to be University, Bhubaneswar, for his contribution to the technical work and timely help in literature collection and analysis.

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

Conflict of interest
There are no conflicts of interest to declare by any of the authors of this study.

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