Dome down approach for difficult laparoscopic cholecystectomy

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Background
Visualization of anatomical structures during laparoscopic cholecystectomy may be impaired by difficulties including severe inflammation in Calot's triangle, a short cystic duct, tenting of the ductal structures, or Mirizzi's syndrome.

Purpose
To evaluate the feasibility, safety, and outcome of dome-down laparoscopic cholecystectomy in difficult cholecystectomy.

Patients and methods
A total of 60 patients with difficult laparoscopic cholecystectomy as decided intraoperatively were enrolled. The dome-down technique was used after a trial of the conventional procedure.

Results
There were 33 women (55%) and 27 (45%) men. Their age ranged from 18 to 68 years. Preoperative prediction of difficulty of the operation was anticipated in 37 cases (61.7%). The mean operative time was 102.84 (92–150) min. The conversion rate was 8.3%. The mean hospital stay was 2.5 (2–5) days.

Conclusion
Dome-down laparoscopic cholecystectomy is a feasible and applicable procedure during difficult cholecystectomy, and yet it needs a learning curve for optimum results.

Keywords:
dome down, laparoscopic cholecystectomy, difficult cholecystectomy

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Introduction

During laparoscopic cholecystectomy (LC), the surgeon may encounter difficult situations in which the procedure fails to progress, with a major risk of injuring the major biliary passages because of loss of anatomical details particularly in the triangle of Calot.

LC is known to have a slightly higher complication rate than open cholecystectomy, with the most common complication being injury to the common bile duct (CBD) (0.1–1.4%) [1–3], followed by vascular injury, bowel/hollow viscous injury, pneumoperitoneum-related complication, wound infection, and trocar site herniation [1,4].

Dissection in LC usually starts from the triangle of Calot upward to the fundus of the gall bladder. Initial dissection in the triangle of Calot carries an operative risk for the surgeon because of the probability for misidentification of major bile ducts, increasing the risk of bile duct injury.

Visualization of anatomical structures may be markedly impaired by many factors, including difficult anatomy secondary to severe inflammation or scar tissue, a short cystic duct, tenting of the ductal structures, anomalous right hepatic artery or duct, or Mirizzi's syndrome [5].

One technique to reduce the risk for surgical complications in LC has been the development of an alternative gall bladder dissection sequence. Removal of the gall bladder from the gall bladder bed first (dome-down) is a technique used frequently during open cholecystectomy before the advent of LC and is used commonly when surgeons now convert to the open technique. Dissecting the gall bladder from the gall bladder bed first, and subsequently following the gall bladder to the cystic duct, enables utilization of the preferred surgical principle of dissecting from known anatomy (gall bladder wall) to unknown anatomy (potentially difficult anatomy in the triangle of Calot) [5].

Although described under different names as retrograde or fundus first cholecystectomy, several studies [5] have

emphasized the feasibility of dome-down LC. All had a high success rate and a low rate of conversion to the open technique.

The aim of this study was to evaluate the feasibility, safety, and outcome of the technique of dome-down LC in difficult cholecystitis.

Patients and methods

This was a prospective study carried out on 60 patients admitted to the upper gastrointestinal surgery unit, Alexandria Main University Hospital, over a period of 24 months from March 2013 to March 2015.

Inclusion criteria included all cases with difficult LC as decided intraoperatively after a trial of the conventional procedure. This included the presence of dense adhesions in Calot's triangle, acute cholecystitis, and mirizzi syndrome. We excluded patients with CBD stones and gall bladder cancer. After obtaining the approval of our ethics committee, all patients enrolled in this study were informed about the procedure of conventional LC and they signed a written consent.

All patients were subjected preoperatively to the following: complete assessment of history, thorough general and local abdominal examination, routine laboratory work-up, liver function tests and liver enzymes, abdominal ultrasonography, computed tomography, and magnetic resonance cholangiopancreatography if CBD stones were suspected.

Preoperative prediction of difficulty was judged on the basis of the following: the presence of contracted thick wall gall bladder on preoperative ultrasound or computed tomography, presence of collection in the pericholecystic or the subhepatic space, clinical diagnosis of empyema by severe right hypochondrial pain and tenderness together with fever and leukocytosis, palpable gall bladder, longstanding cases with a history of more than 2 years of gall bladder stones, and suspicion of mirizzi syndrome.

Operative procedure

All patients received general anesthesia; third-generation cephalosporins (ceftriaxone) and metronidazole (to prevent anaerobic infection in case of stone spillage) were administered on induction. The patient was prepped and draped, exposing the upper right part of the abdomen. Pneumoperitoneum was created by a Veress needle and the pressure was set at 14 mmHg. A zero degree scope was entered through a 10 mm supraumbilical port. The patient was repositioned in a 30° reverse Trendelenburg position with a 10° tilt to the left. The procedure was then continued using the American four-port technique as a conventional LC (two 10 mm trocar in the supraumbilical and epigastric regions and two 5 mm trocars in the right midclavicular and anterior axillary lines).

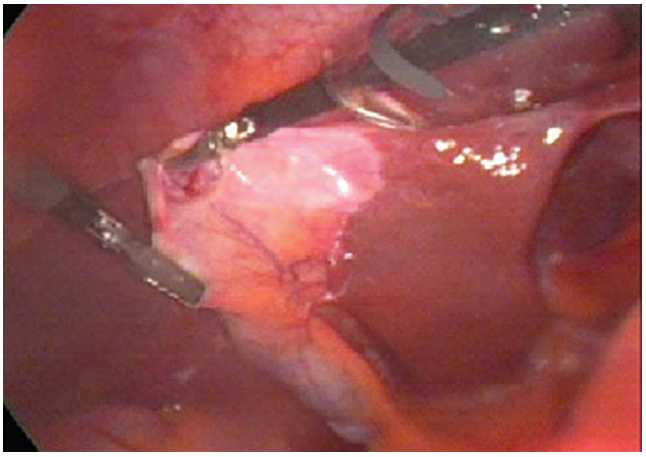
After general laparoscopic exploration, adhesions between the gall bladder with the omentum or the duodenum were detached by blunt or sharp dissection. If the gall bladder was distended, it was aspirated by a needle connected to a suction machine. The Hartman pouch was grasped and retracted laterally to open the triangle of Calot (Fig. 1).

If, after careful dissection of the Calot triangle, the operation was found to be difficult on the basis of the inclusion criteria, the decision of converting to the dome-down technique was made instead of conversion to open cholecystectomy as we believe that if the procedure is laparoscopically difficult, it will also be difficult by the open method.

For the dome-down technique, dissection of the gall bladder was started from the fundus (Fig. 2). This was accomplished using either monopolar diathermy (on a curved maryland forceps or hook) or a 5 mm ultrasonic vessel sealing device (Harmonic scalpel Shears with curved blades; Ethicon EndoSurgery Inc., ACE 36, West Somerville, NJ, USA).

The dissecting instrument was placed in the epigastric 10 mm port. A grasper was inserted by the assistant through the right axillary 5 mm port to retract the fundus of the gall bladder downwards and laterally. Another grasper was introduced through a 5 mm right clavicular port that was used to retract the liver upwards and medially, creating a space between the liver and the fundus of the gall bladder.

Figure 1



Lateral retraction on the Hartman pouch.

By traction–counter traction, keeping close to the wall of the gall bladder, we were able to keep the body of the gall bladder apart from the gall bladder bed (Fig. 3). Hemostasis by electrocautery or ultrasonic energy was performed as needed to keep the field as dry as possible.

The cystic artery was usually identified before the cystic duct and was divided between two clips or by the harmonic scalpel. Dissection around the cystic duct was then carried out so that the cystic duct was the only structure attaching the gall bladder with the CBD (Fig. 4).

Intraoperative cholangiography (IOC) was possible at this stage and the procedure was performed selectively to confirm the safety of the dissection and to exclude any bile duct injury. The cystic duct was then divided between three clips: two clips on the stump and one on the proximal part.

The gall bladder was removed from the epigastric trocar. In all cases, we left a tube drain in the subhepatic space. Conversion to open cholecystectomy was planned at any time if there was failure of progress in dissection with the dome-down technique.

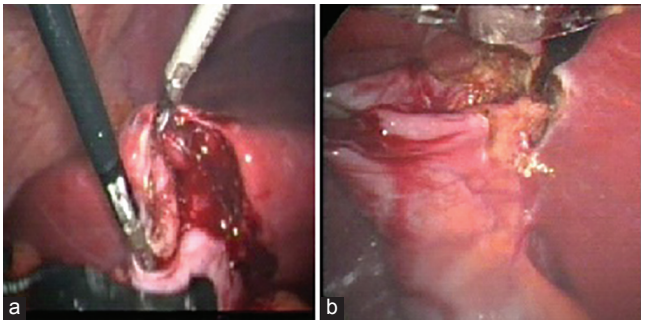
Results

This study was carried out on 60 patients who had difficult LC in the gastrointestinal surgical unit, Faculty of Medicine, Alexandria University, during a 2-year period from March 2013 to March 2015. All patients signed consent for LC. Cholecystectomy by the dome-down technique was subsequently performed after failure of the conventional technique.

Among these patients, there were 33 women (55%) and 27 (45%) men, with a female to male ratio of 1.22. The age ranged from 18 to 68 years, with a mean age of 53.3 years (Table 1).

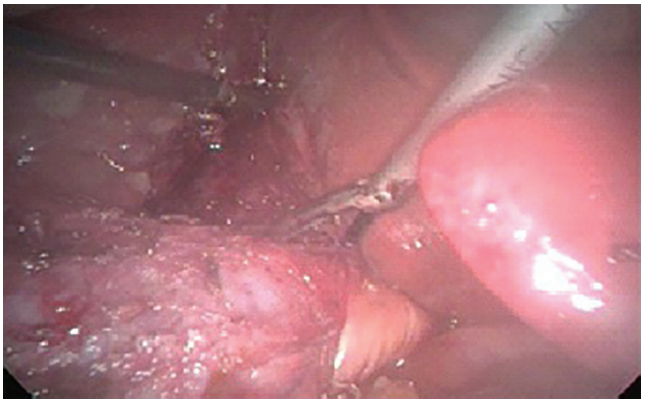
In terms of the mode of admission, 37 patients (61.6%) were admitted on an elective basis, 13 (21.6%) were operated in an emergency because of an attack of acute cholecystitis, five patients (8.3%) after extraction of CBD stones by endoscopic retrograde cholangiopancreatography, and five patients (8.3%) were operated by interval cholecystectomy. Interval cholecystectomy was performed in four cases after resolution of an attack of acute mild biliary pancreatitis and in one case, 3 months after resolution of an attack of acute cholecystitis that was managed conservatively in another hospital. These patients were operated within 72 h of admission after improvement of the attack of pancreatitis on the basis of clinical examination (disappearance of pain, fever, and epigastric tenderness) and a decrease in amylase level.

Figure 2



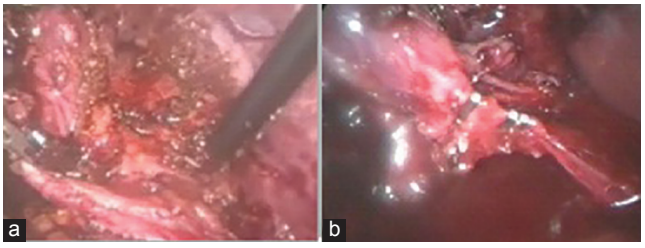
(a) Dissection at the fundus with ultrasonic dissection shears, (b) traction–counter traction at the fundus.

Figure 3



Dissection close to the wall of the gall bladder.

Figure 4



(a, b) Cystic duct (arrow) is the only attachment to the common bile duct.

Preoperative prediction of difficulty of the operation was anticipated in 37 cases (61.7%).

Nine patients had undergone a previous abdominal surgery; six patients had undergone an appendectomy and three women had pfanensteil scar tissue.

Thirty-eight patients had associated comorbid diseases in our cases; 16 patients were hypertensive, 27 patients were diabetic, 19 patients had ischemic heart disease, three patients had renal impairment, four patients had

chronic obstructive pulmonary disease, five patients had hepatomegaly, and three patients had liver cirrhosis.

According to the American Association of Anesthesiology (ASA) classification, 42 patients were class II, 13 patients were class I, and five patients were class III (Table 2).

On laparoscopic exploration, adhesions attached to the gall bladder were found in 43 patients, severe chronic inflammation in 45 patients, empyema of the gall bladder in 18 patients, a recent attack of acute pancreatitis in five patients, a short cystic duct in three patients, cirrhosis in eight patients, and hepatomegaly in four patients.

The gall bladder was dissected from its bed using monopolar diathermy in 36 cases and by ultrasonic energy (harmonic scalpel) in 24 cases. The amount of blood loss as aspirated by suction machine ranged from 10 to 200 ml.

IOC was performed in 13 patients because of undefined anatomy in eight patients and for preoperative elevated liver enzymes with suspicion of CBD stones in five patients. No filling defect was detected intraoperatively and assurance of safety of major bile duct confirmed.

In terms of intraoperative complications, gall bladder perforation with bile spillage occurred in 15 patients. No bile duct or visceral injury was recorded. The mean operative time was 102.84 (92–150) min. The learning curve improved with time. The mean operative time of the first 10 patients was 2.5 h, which decreased to a mean of 1 h in later patients. The procedure was aborted in five cases and converted to open cholecystectomy because of failure of proper identification of anatomical details in the Calot triangle; the conversion rate was 8.3%. The details of these patients are shown in Tables 3 and 4.

Early postoperative complications were encountered in 13 patients: eight with chest infection, three with port site infection, and two with a small subhepatic collection that was drained percutaneously. The mean hospital stay was 2.5 (2–5) days until the drain was removed. No early postoperative mortality occurred. The pathology results were as follows: acute cholecystitis in 35 patients, gangrene of the gall bladder in 18 patients, and empyema in seven patients (Table 5).

Table 1 Patients' characteristics

Variables	Number (%)
Total number of patients	60 (100)
Age [mean (range)] (years)	53.3 (18–68)
Sex	
Males	27 (45)
Females	33 (55)
Female to male ratio	1.22
Mode of admission	
Elective	37 (61.7)
Emergency	13 (21.7)
Preoperative ERCP	5 (8.3)
Interval cholecystectomy	5 (8.3)
Preoperative prediction of difficulty	37 (61.7)

ERCP, endoscopic retrograde cholangiopancreatography.

Table 2 Preoperative state in our patients

Variables	Number (*n*) (%)
Comorbid disease	38 (63.3)
Hypertension	16 (26.6)
DM	27 (45)
Ischemic heart disease	19 (31.6)
Renal impairment	3 (5)
COPD	4 (6.6)
Hepatomegaly	5 (8.3)
Cirrhosis	3 (5)
ASA classification	
Class I	13 (21.6)
Class II	42 (70)
Class III	5 (8.3)

ASA, American Association of Anesthesiology; COPD, chronic obstructive pulmonary disease; DM, diabetes mellitus.

Table 3 Operative findings in our patients

Variables	Number (*n*) (%)
Difficulties	
Attachment of adhesions	43 (71.6)
Severe chronic cholecystitis	45 (75)
Empyema	18 (30)
Recent acute pancreatitis	5 (8.3)
Short cystic duct	3 (5)
Cirrhosis	8 (13.3)
Hepatomegaly	4 (6.6)
Method of dissection	
Monopolar diathermy	36 (60)
Ultrasonic energy	24 (40)
Blood loss [mean (range)]	(10–200) ml
Intraoperative cholangiography	
Done	13 (21.6)
Not done	47 (78.3)
Operative time [mean (range)]	102.84 (92–150) min
Conversion rate	5 (8.3)
Gall bladder perforation	15 (25)

Discussion

The aim of this study was to assess the feasibility of a different mode of dissection of the gall bladder and whether this technique is safe in terms of a risk of bile duct injury in difficult situations. This study describes our first experience with this technique at the department of upper gastrointestinal surgery, faculty of medicine, Alexandria University, Egypt. In the past, difficult cholecystectomies were converted immediately to an open approach, but 55 cases were saved from the morbidity of big incision thanks to the dome-down approach.

Table 4 Patients' conversion to open cholecystectomy

Patients (n = 5)	Cholecystitis	Reasons for conversion
1	Severe chronic	Short cystic duct, uncontrolled bleeding, liver cirrhosis
2	Acute gangrenous	Undefined anatomy, common bile duct not seen
3	Severe chronic	Mirizzi syndrome
4	Severe chronic	Mirizzi syndrome
5	Acute	Dense adhesions at Calot triangle

Table 5 Postoperative course in our patients

Variables	Number (n) (%)
Postoperative complications	13 (21.6)
Chest infection	8 (13.3)
Port site infection	3 (5)
Subhepatic collection	2 (3.3)
Hospital stay [mean (range)]	2.5 (2–5) days
Mortality	0
Pathology results	
Acute cholecystitis	35 (58.3)
Gall bladder gangrene	18 (30)
Empyema	7 (11.6)

In the experience described here, dome down laparoscopic cholecystectomy (DDLC) was not performed routinely, but was used only in difficult cases when we failed with the standard technique to achieve adequate exposure or to perform a safe dissection. The selective use of this technique was also recommended by Kelly [6] in 1.1% of all laparoscopic cholecystectomies. A few investigators have recommended that the technique should be used routinely in all laparoscopic cholecystectomies. Cengiz *et al.* [7] found the DDLC with ultrasonic dissection to have a shorter operative time compared with the standard technique and also patients complained of less postoperative pain and nausea. Neri *et al.* [8] also suggested the DDLC to be the technique of choice as they found it more simple to perform with a shorter operative time.

Most studies on DDLC concluded that the technique is safe and feasible, with a low risk of biliary injury and decreased rate of open conversion.

The main advantage of the DDLC technique is the ability to visualize and identify anatomy as the dissection proceeds from an anatomically identified area (fundus of the gall bladder) in a step-by-step manner to a densely hidden area. Mahmud and colleagues found the procedure safe and feasible, and prevented conversion in difficult LC from 5.2 to 1.2%.

Although gallstones are more common in women, 27 patients (45%) were men. This increased incidence of difficult cholecystectomy in Egyptian men may be because of delayed presentation, especially the elderly with comorbid diseases such as diabetes mellitus. This observation was also reported by Wang *et al.* [9] and Mahmud *et al.* [10].

Thirty-eight patients (63.3%) had associated risk factors such as old age and comorbid diseases which is a high incidence. Moreover, 47 patients were ASA II or III. We believe that the dome-down technique is usually performed in such high-risk patients; thus, surgeons performing LC in these cases should be skilled in this technique.

Fundus first LC was performed in the study of Wang *et al.* [9] in 36 elderly patients (older than 65 years of age) with acute cholecystitis; conversion to open cholecystectomy was necessary only in one patient (2.7%).

Gupta *et al.* [11] compared conventional LC with DDLC and observed that the mean operative time was 15 min less in the DDLC group than the conventional group in difficult cholecystectomies (89.8 + 14.05 vs. 104.8 + 18.6 min). A randomized clinical trial [7] that compared ultrasonic fundus first dissection versus electrocautery dissection at the triangle of Calot postulated that the former technique had a shorter operative time and hospital stay, and resulted in a lower postoperative pain score and less nausea.

A malleable laparoscopic liver retractor was necessary in nine of 11 cases published by Kelly [6]. Their opinion was that only liver retraction solved the problem as it improved the view and made the dissection easier. They found that the use of a grasper to directly push the liver was safe only in two cases. Mahmud *et al.* [10] used the thick peritoneal rim at the edge of the liver for liver retraction and did not use a liver retractor.

IOC was performed only in 13 cases. Introduction of the cholangiogram catheter was technically challenging as the cystic duct was difficult to find initially with distorted anatomy because of dense adhesions. In some cases, after complete separation of the gall bladder from the gall bladder bed, the cystic duct–CBD junction was evident and the possibility of bile duct injury was remote. No IOC was performed by Kato *et al.* [12] as the anatomy was clear as this technique obviated the risk of bile duct injury. In another report, Tuveri *et al.*[13] performed IOC routinely in 50 patients done with DDLC and achieved a success rate of 74%. Kelly [6] reported that IOC was desirable for disclosure of ambiguous anatomy and impossible in difficult cases. Mahmud *et al.* [10] were obliged to perform IOC in 68.5% of their patients as they also included patients with CBD stones in their study, but this failed in 24% and did not attempt it in one patient because

of a very short cystic duct. We excluded patients with CBD stones from our study and this made us indolent to prolong the operative time in these difficult cases.

The mean hospital stay was 2.5 (2–5) days, which is longer than that in previous reports. This was because the majority of patients had uncontrolled diseases and 37 patients had been operated in an emergency, because of which we had to extend the period of postoperative observation and ensure stabilization before discharge.

Control of bleeding from the bed of the gall bladder was possible by either source of energy. It stopped by gentle application of an electrically charged hook or spatula or between the shears of a harmonic scalpel. The cystic artery was usually double clipped and cut when encountered. The amount of blood loss as aspirated by suction ranged from 10 to 200 ml, indicating efficiency of hemostasis. Bleeding were encountered in three cirrhotic patients (with coagulopathy) in whom the liver bled horribly on touch that forced us to convert in one case.

On the basis of our experience with the technique, we found that it was not easy to perform in cases of dense adhesion and needed time to learn. Liver retraction was difficult to apply and resulted in troublesome bleeding from pressure. Control of the position of the gall bladder was difficult and the gall bladder wall was friable. On the basis of a questionnaire, Alley *et al.* [14] found that the mean number of patients who needed during the learning curve was 14.7 and recommended that the DDLC technique be incorporated into residency teaching programs to deal with difficult cholecystectomies. In agreement, Tuveri *et al.* [13] confirmed that the procedure was laborious and it was hard for them to apply traction in the correct plane.

However, although technically challenging, with patience, we could divide all attachments safely between the gall bladder and the liver so that at the end of dissection, only the cystic duct anchored the gall bladder to the major bile ducts.

We found no significant difference in the method of dissection between ultrasonic energy and monopolar diathermy. The theoretical risk of lateral spread of electrocautery did not cause any bile duct injury in our cases. In four patients, gall bladder perforation with bile spillage occurred because of the close application of the jaws of the harmonic scalpel to the wall of the gall bladder. One case of bile duct injury and bile peritonitis occurred in the study of Alley *et al.* [14], which was attributed to stray current of electrocautery that forced them to change their method of dissection to ultrasonic energy for safety. Fullum *et al.* [5] and Rosenberg and Leinskold [15] recommended the use of ultrasonic energy with DDLC for safety and reported that it facilitated the dissection by a cavitation effect on tissue planes [5]. However, no case of bile duct injury was reported in the study of Gupta *et al.* [11] and Mahmud *et al.* [10], who used solely monopolar electrocautery in cases in which the DDLC was used. To avoid diathermy injury, Tuveri *et al.* [13] halted their electrocautery dissection at the level of the infundibilum of the gall bladder.

In terms of the condition of the liver at the time of surgery, the technique was beneficial in five patients with hepatomegaly that would otherwise have made the dissection difficult and tedious. On the three cases with cirrhosis, two were completed with difficulty and in the third case, excessive bleeding from a major hepatic sinus forced us to convert to open surgery. Kelly [6] warned against the use of this technique in six cirrhotic patients in their series.

The operation was converted to open cholecystectomy in five cases. Two of them were because of the presence of mirizzi syndrome. The close proximity of the cystic duct and Hartman's pouch to the CBD made further dissection dangerous and the procedure was converted to open to deal with the defect in CBD. The decision was made and the defect in the CBD was repaired over a T-tube. Fullum *et al.* [5] treated two cases successfully with DDLC, which allowed safe and precise identification of the anatomy. In the study of Kelly [6], the technique conferred them with a technical advantage in mobilization of the gall bladder before Calot triangle dissection. Mahmud *et al.* [10] reported that mirizzi syndrome was one of the reasons for conversion to open surgery.

Gall bladder perforation and bile spillage occurred in 15 cases (25%). They were managed by repeated saline irrigation and suction till the aspirate became clear with an intraoperative extra dose of antibiotic and metronidazole injection. Gupta *et al.* [11] reported the misshape of a duodenal perforation that was converted to open surgery and 28 gall bladder perforations and bile spillage that neither prolonged the hospital stay nor led to postoperative complications.

Fifty-five difficult cholecystectomies were performed by the DDLC in this analysis, with a success rate of 91.6%. Multiple reports [10,11,16] emphasized that DDLC saved a considerable proportion of patients from the morbidity of open cholecystectomy.

Conclusion

Dome-down LC is a feasible and applicable procedure during difficult cholecystectomies, and yet it needs a learning curve for optimum results.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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