Laparoscopic Cholecystectomy: Operative Technique

16

Michael R. Cox

The operative technique described in this chapter is the routine technique with various modifications for specific pathological problems encountered that the author has used for over 25 years. It was initially published in 1994 [1] and the principles have not changed. The first part of the chapter describes the initial dissection techniques and illustrates the technique in a routine case with minimal inflammation. In the second part of the chapter the techniques for various operative problems are described and illustrated. The steps of laparoscopic cholecystectomy to be discussed are summarised in Table 16.1.

Operating Room Setup

The patient is positioned on the table which is orientated to allow for image intensification for the performance of the operative cholangiogram. The patient is supine with the operating surgeon on the left of the patient, the assistant on the right. The scrub nurse can be on either side of the patient, depending on their own preference (Fig. 16.1). A screen is localised on either side of the patient at the level of the head for adequate visualisation of the laparoscopic image by all staff but in particular, the surgeon, assistant and scrub nurse. The position of the laparoscopic camera, light source and insufflator is commonly beneath the left-sided screen (Fig. 16.1).

Peritoneal Access

Routine access is with an open cut-down technique with the blunt insertion of a Hasson port. The base of the umbilicus is picked up with a Moynihan forceps and inverted (Fig. 16.2a). The ridge at the inferior edge defines the region of fusion between the skin, linea alba and the peritoneum at the base of the umbilicus. A vertical 1 cm incision is made to open through the skin, fascia and peritoneum to enter the peritoneal cavity (Fig. 16.2b). If the fascia is not divided a second

Table 16.1 Steps of laparoscopic cholecystectomy

• Peritoneal access
• Port site position
• Exposure, retraction and visualisation of the entire gallbladder
• Initial peritoneal dissection
• Dissection of the gallbladder off the liver and dissection of Calot's triangle
• Identification of the cystic duct and artery
• Operative cholangiogram
• Closure of the cystic duct
• Dissection of the gallbladder off the liver
• Extraction of the gallbladder
• Closure of the umbilical port

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Fig. 16.1 Operating room set up taken from the perspective of the foot of the bed

and/or third incision may be required to divide the fascia. This can be done under vision in thinner patients and by experienced palpation in more obese patients. A large artery forceps is used to ensure the peritoneal cavity has been entered (Fig. 16.2c). This is inserted directly downward and if the peritoneum is intact, with gentle force the forceps can be passed into the peritoneal cavity without injuring underlying tissues. Forceps are pulled back to the fascia level and opened 1 cm and then removed. The Hassan cannula is then inserted into the peritoneal cavity (Fig. 16.2d). The gas tubing is connected and insufflation started once the correct position in the peritoneal cavity has been checked visually with the laparoscope.

Operating Port Sites

After the insertion of the umbilical port a 5 mm port is inserted in the mid clavicular line level to or just above the level of the umbilicus, pointing toward the gallbladder fundus (Fig. 16.3). This is a lower position than many surgeons use and allows for better movement and retraction of the gallbladder and associated organs and tissues. A higher position leads to the instrument coming directly down and too vertical which limits the range of movement and ease with the left arm being held higher. A second 5 mm port is placed in the mid auxiliary line, at a level similar or slightly above the initial 5 mm port (Fig. 16.3). Finally, a 10 mm port is inserted immediately below the xyphoid process of the sternum (Fig. 16.3). If this port is lower than this there is a more acute angle, making manoeuvrability and dissection more difficult.

Some surgeons use a 5 mm epigastric port with a 5 mm clipper and remove stones and insert retrieval bags via the umbilical port. This is an attempt to reduce post-operative pain, although there is little evidence to support this reasoning.

Exposure, Retraction and Visualisation of the Entire Gallbladder

The fundus of the gallbladder is grasped with a ratchet forceps through the anterior auxiliary port. This may be aided by a second forceps in either the mid clavicular or epigastric port, retracting and/or picking up the fundus (Fig. 16.4a). Once attached, the retraction is initially toward the hip, which rotates the gallbladder upward and outward and then in an upward direction, to bring the region of the neck of the gallbladder and Hartmann's pouch into view (Fig. 16.4b). Any congenital adhesions are divided on the gallbladder to expose the peritoneal surface prior to or during the retraction process (Fig. 16.5). The key

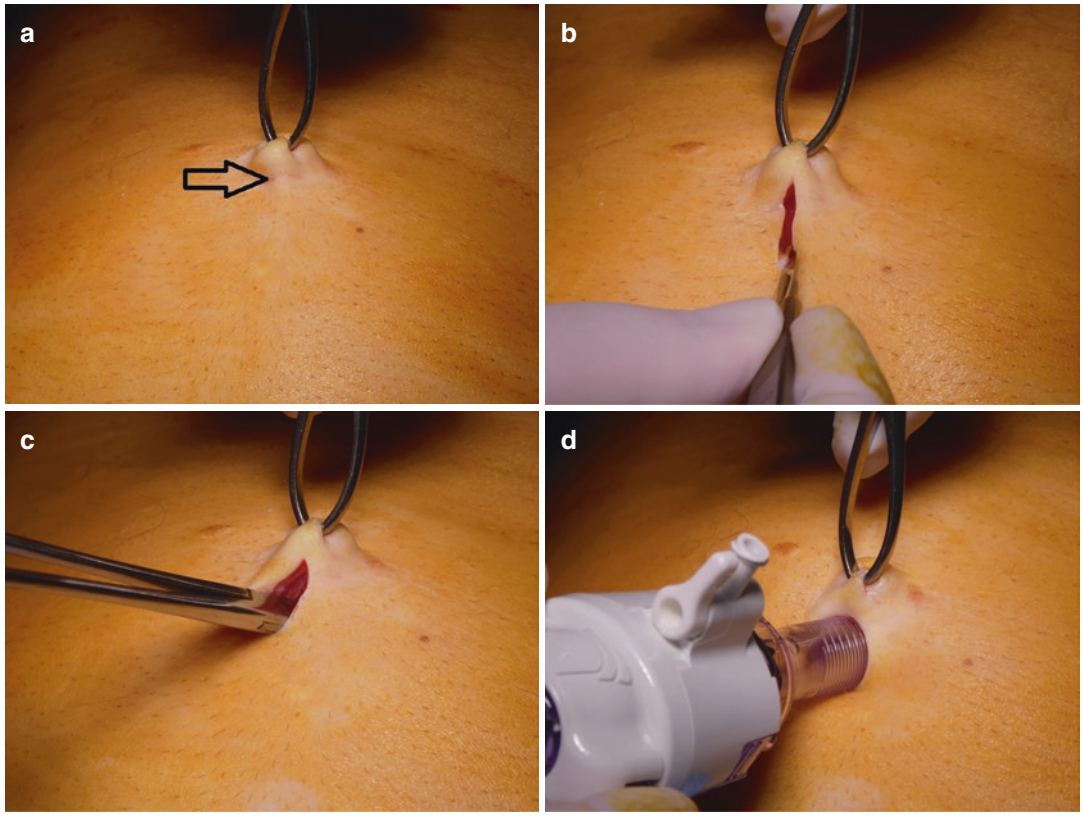

Fig. 16.2 (**a**) Inversion of the umbilicus to expose the inferior edge and point of fusion between the skin fascia and peritoneum (*arrow*). (**b**) 10 mm vertical incision that involves the skin, fascia and peritoneum at the point of fusion. (**c**) Introduction of a large artery forceps to check the peritoneum has been entered. Note this is inserted at right angles to the abdominal wall, not angled upward. (**d**) Hasson port in place

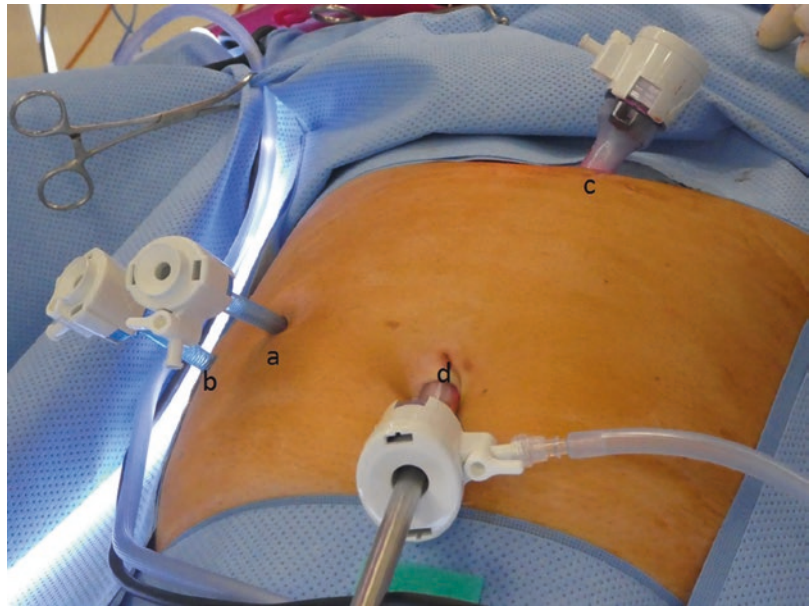

Fig. 16.3 Position of routine operating ports. (**a**) 5 mm mid-clavicular port for dissection. (**b**) 5 mm mid-auxiliary port for the retraction of the fundus of the gallbladder over the liver. (**c**) 10 mm epigastric port for the diathermy hook, irrigation, suction, clip appliers and extraction bag

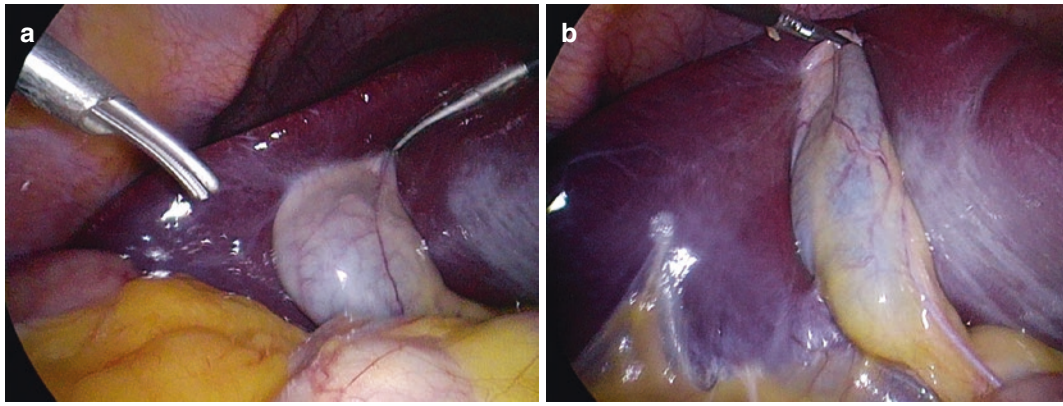

Fig. 16.4 (**a**) Grasping the gallbladder fundus via the mid-auxiliary port with the assistance of a grasper through the epigastric port. (**b**) Once the gallbladder is rotated the fundus is pushed over the liver to expose the whole gallbladder surface down to the Hartmann's pouch or gallbladder neck

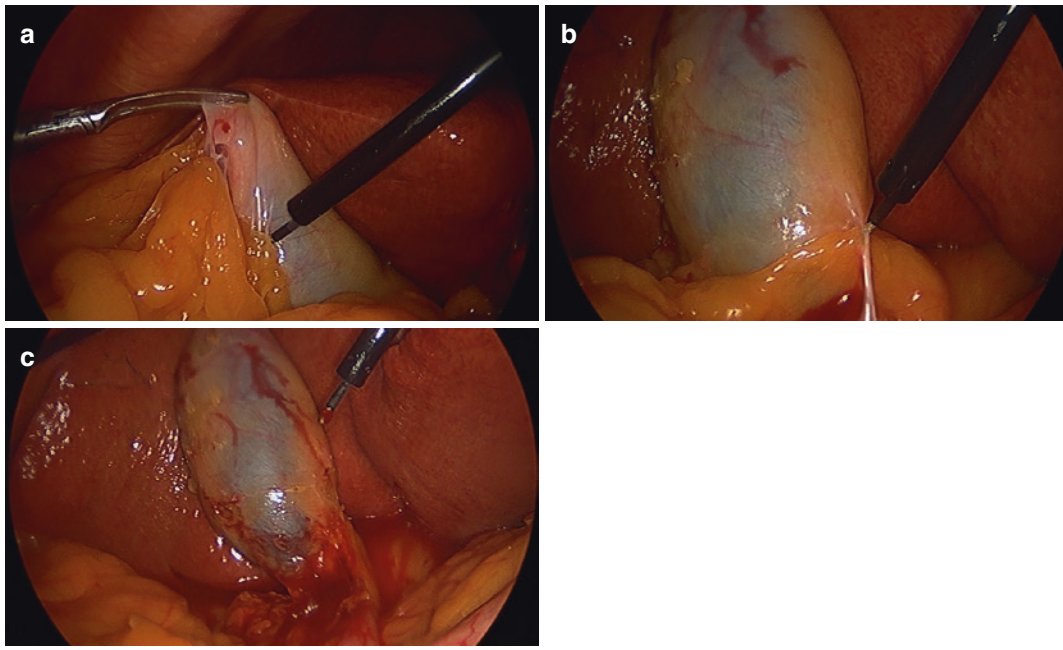

Fig. 16.5 (**a**) Congenital adhesions between the gallbladder and the omentum are frequent. Initially the gallbladder is only retracted slightly and the adhesion is divided staying close to the gallbladder. (**b**) The gallbladder is retracted over the liver to allow further dissection of the congenital adhesions in front of Hartmann's pouch. (**c**) Once all of the adhesions have divided the entire surface of the gallbladder from the fundus to Hartmann's pouch can be easily visualised. These images are using a 0° scope. If the Hartmann's pouch cannot be visualised, then a 30° laparoscope may be required

point is to be able to see the entire surface of the gallbladder down to the region of Hartmann's pouch and gallbladder neck. These steps and most other steps to be described can usually be visualised to a zero-degree laparoscope. It is acknowledged that many surgeons prefer the use of a 30° laparoscope for doing these dissections [2]. However, there is no evidence to support that the routine use of a 30° laparoscope is superior to a zero-degree laparoscope. However, when the vision of the Hartmann's pouch and neck are either at an acute angle or behind structures in front of the gallbladder, changing to the 30° laparoscope is mandatory.

Initial Peritoneal Dissection

Maintaining upward traction of the gallbladder a 5 mm grasper through the mid clavicular port that picks up the region of the Hartmann's pouch. This is then retracted to the patient's right and with gentle traction back toward the right iliac fossa to expose the left (medial) side of the gallbladder (Fig. 16.6a, b). The dissection of the peritoneum is commenced high on the gallbladder adjacent to the liver, well above the apex of Calot's triangle (Fig. 16.6b). It is usually performed with hook diathermy but sharp dissection with scissors may be used. The peritoneum and only peritoneum is divided, coming down on the gallbladder side of Calot's triangle which is often identified by the edge of fat that finishes on the gallbladder. Another reliable landmark is the cystic lymph node which the initial peritoneal dissection may go superior to or directly over (Fig. 16.6c). This dissection of the peritoneum is continued across the front of Hartmann's pouch. The Hartmann's pouch is then retracted upward and toward the

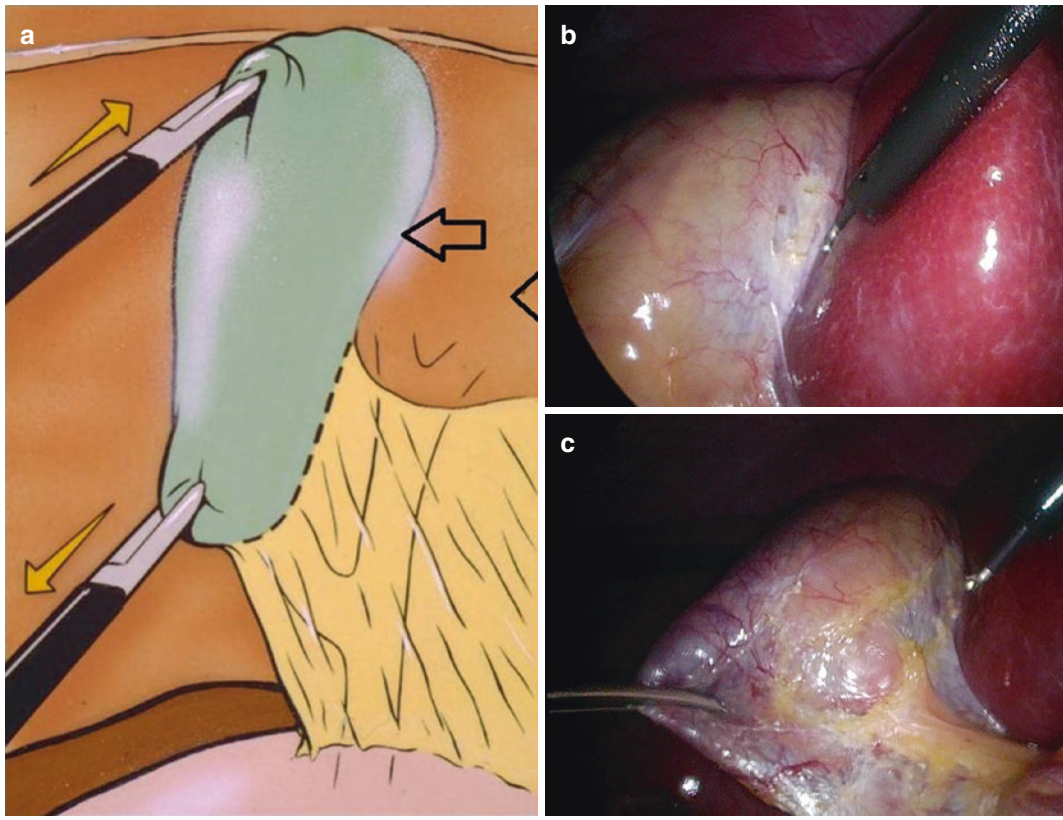

Fig. 16.6 (**a**) Diagrammatic representation of the initial retraction. The *dotted line* denotes the edge of the gallbladder that is not actually visible. The *black arrow* indicates the site to commence the initial dissection. The *yellow arrows* are the direction of the traction of the forceps. Used by permission World Journal of Surgery: Cox MR, et al. Minimizing the risk of common bile duct injury at laparoscopic cholecystectomy. World J Surg (1994) 18: 422–7. (**b**) The region of Hartmann's pouch is grasped by the forceps through the mid-clavicular port and rotated to the left of the screen with some inferior retraction to expose the medial wall of the gallbladder. The starting point for the peritoneal dissection is high on the gallbladder wall above the apex of Calot's triangle where the gallbladder is clearly attached to the liver. (**c**) The peritoneal dissection continues toward the apex of Hartmann's pouch along the line of the upper edge of Calot's triangle. This is often defined by a line of fat. In this dissection the cystic node has been exposed by the peritoneal dissection and the dissection goes over the node

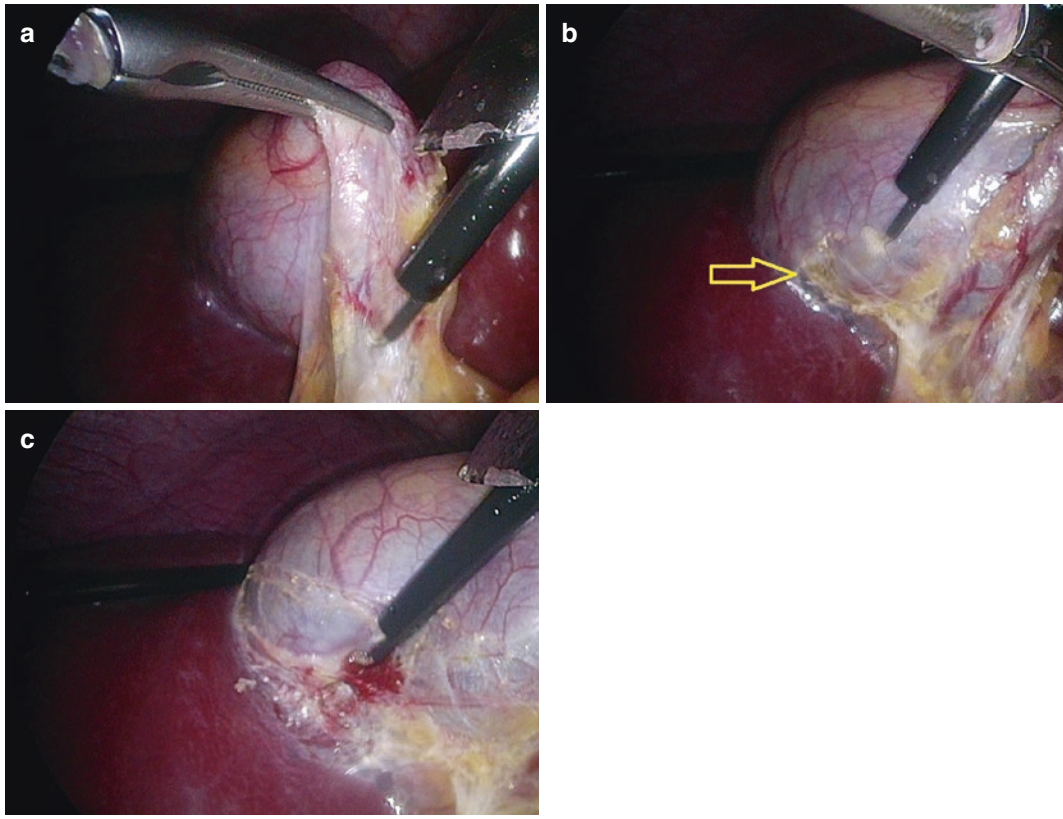

Fig. 16.7 (**a**) The retraction is changed to rotate the Hartmann's pouch medially and upward toward the falciform ligament exposing the lateral surface of the gallbladder. (**b**) The lateral dissection continues staying on the gallbladder until the gallbladder reaches the liver. The apex of this dissection (*arrow*) is the posterior apex of Calot's triangle. (**c**) The peritoneal dissection between the gallbladder and the liver is continued as far up as possible. Note that the distance between the gallbladder and liver has opened up considerably, simply with the division of the peritoneum. Just below the hook is the apex of the Calot's triangle, demonstrating the dissection goes a long way toward the gallbladder fundus

falciform ligament to expose the right (lateral) side of the gallbladder (Fig. 16.7a). The peritoneum is divided along the line, on the gallbladder as far superiorly as possible (Fig. 16.7b, c). In some patients the dissection of the left hand (medial) side is more difficult than the right (lateral) side. In these patients, starting on the right hand (lateral) side above the region of Hartmann's pouch, staying on the gallbladder and dissecting upwards is performed initially. After further dissection on the right (lateral) side retraction back toward the right iliac fossa will improve the exposure of the left (medial) side and allow the dissection to occur on that side.

Dissection of the Gallbladder Off the Liver and Dissection of Calot's Triangle

Maintaining the retraction of the Hartmann's pouch toward the falciform ligament the fatty tissue within the Calot's triangle is exposed and easily seen (Fig. 16.8). This tissue is in the upper portion of Calot's triangle and is dissected away from the gallbladder wall with the plane of dissection on the gallbladder wall. This dissection may be performed with hooked diathermy, blunt dissection with forceps or blunt dissection with a sucker or irrigation dissection or a combination of any or all, depending on the surgeon's preference and the state of the tis-

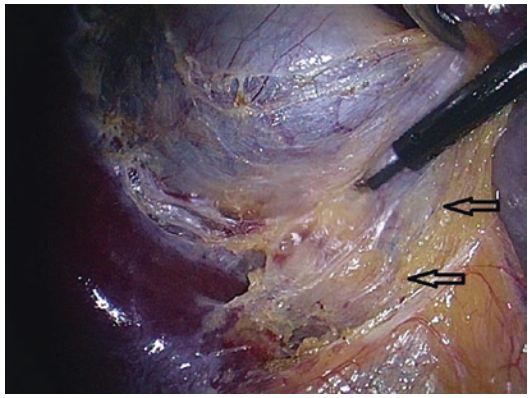

Fig. 16.8 The division of the lateral peritoneum opens up the structures in the upper portion of the lateral side of Calot's triangle. This is defined by the fatty tissue adjacent to the gallbladder. The dissection is continued beneath the gallbladder away from the presumed site of the cystic duct (*black arrow*) and continues toward the fundus of the gallbladder dissecting the gallbladder off the cystic plate. Careful dissection shall identify a cystic artery that is occasionally seen in this area (Fig. 16.10)

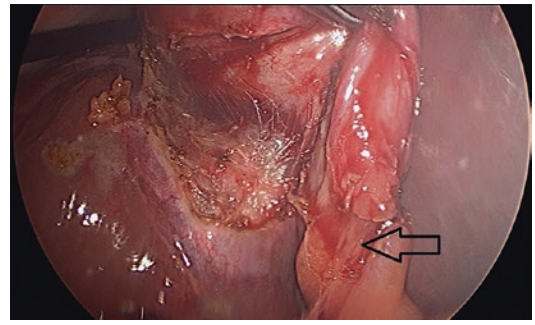

Fig. 16.9 The lateral side of the gallbladder has been dissected off the liver. The gallbladder is retracted with the neck of the gallbladder seen in the lower part of this dissection (*arrow*). Note that this lateral dissection was performed first in this patient due to the inability to visualise the medial side due to inflammation and a large stone impacted in the Hartmann's pouch

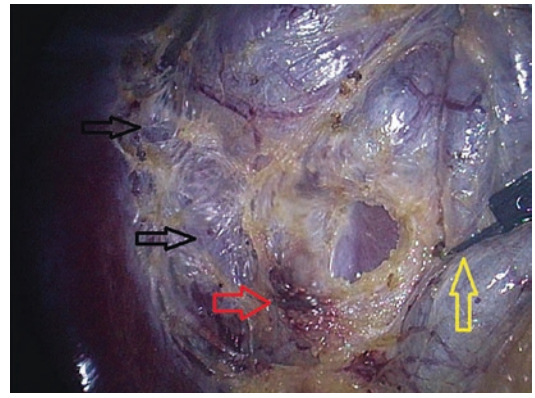

Fig. 16.10 The dissection is continued with the gallbladder having been dissected off the lower portion of the cystic plate (*black arrow*). During this dissection the medial side of the upper part of Calot's triangle has been opened, exposing the under surface of segment 4. Note the hook is against the neck of the gallbladder (*yellow arrow*). No attempt has been made to formally dissect the cystic duct at this stage. A posterior cystic artery has been clipped during this dissection (*red arrow*)

sues. No attempt made to dissect out the presumed cystic duct at this time. The aim of this dissection is to dissect upwards and get the gallbladder off the cystic plate (Fig. 16.9), prior to any attempt at dissecting out the cystic artery and/or cystic duct structures. In a number of cases dissection from the right hand (lateral) side will get through to the left hand (medial) side of the gallbladder at the upper end of Calot's triangle and continue upward to get the gallbladder off the cystic plate of the liver (Fig. 16.10). The dissection from the right hand (lateral) side is continued until no further progress can be made. Once again, there is no attempt made to identify the cystic duct. If the lateral dissection has not got through between the liver and gallbladder the retraction is taken downward toward the right iliac fossa to visualise the right (medial) side has opened up more. The dissection on the left side is then commenced as high as possible on the gallbladder above the region of the Calot's triangle (Fig. 16.11). The dissection on the right (lateral) hand side, alternating with the left hand (medial) side is continued until the gallbladder is dissected off the liver and the superior portion of Calot's triangle is opened (Fig. 16.12). Once the gallbladder is off the liver the dissection goes back to the right hand side and can be continued carefully down toward the region of the neck, dissecting the body of the gallbladder way from the fatty tissue in the Calot's triangle (Fig. 16.13). This may be done either with hook, forceps or blunt sucker type dissection or a combination of these techniques, depending on surgeon preference and the state of the tissues. As the dissection comes down the edge of the gallbladder the cystic artery may divide into two or more branches or may be identified as a single main branch (Fig. 16.14).

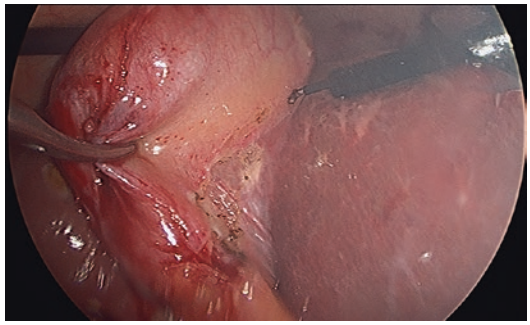

Fig. 16.11 Retraction of Hartmann's pouch toward the right iliac fossa opens up the left (medial) side of the gallbladder dissection in the same patient as Fig. 16.9. Note the lower peritoneal dissection was able to be performed and now the next part of the dissection has started above the previous upper limit of the peritoneal dissection. By doing this as the dissection proceeds downward it enters into the plane between the gallbladder and the cystic plate and opens this plane allowing the gallbladder to be dissected off the liver

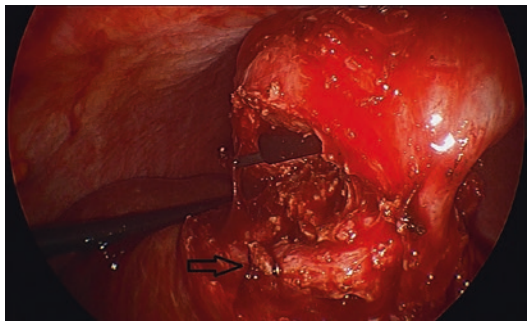

Fig. 16.12 This is a case of acute cholecystitis where the dissection went from the lateral and medial side several times using a combination of hook diathermy, sucker-irrigation and forceps dissection, before the gallbladder was finally dissected off the liver. The hook is between the gallbladder and the liver elevating the gallbladder to expose the anatomy. Note that the presumed cystic duct is visible at the right hand side but there is still a considerable amount of tissue in the lower part of Calot's triangle that is yet to be dissected. The posterior cystic artery clipped (*arrow*) earlier in the dissection

Identification of the Cystic Duct

Once the gallbladder is dissected off the liver and the edge is dissected free the cystic artery may be identified as described above. The artery may then be dissected out. Occasionally the artery when well defined may need to be clipped and divided to allow the cystic duct to be exposed. Identifying the cystic duct is done by dissecting

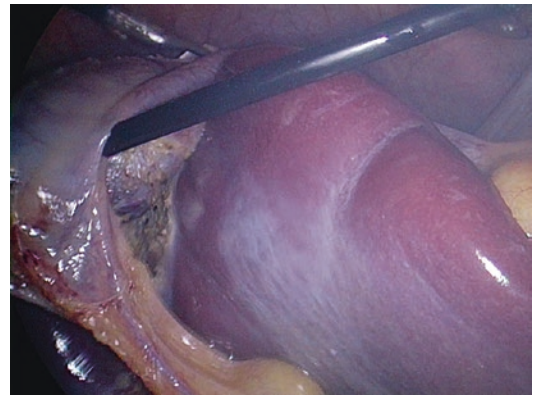

Fig. 16.13 The left (medial) side of the gallbladder is exposed. The hook has passed to lift up the gallbladder, tenting the cystic artery which has yet to be dissected. Note the cystic duct has not yet been exposed

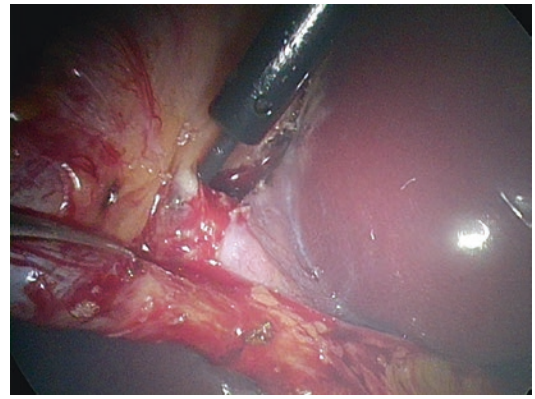

Fig. 16.14 The cystic artery is exposed and identified by dissecting from the upper part of Calot's triangle, moving towards the artery and the duct. The artery is dissected out. Occasionally the artery may need to be divided to allow further dissection and exposure of the cystic duct

down toward the neck of the gallbladder, past the artery if intact. The cystic duct will be the only structure coming out of the gallbladder. Using this technique, the "critical view of safety", as described by Strasberg and others [3–5], is easily achieved (Fig. 16.15).

The principle of this technique is getting the gallbladder off lower part of the cystic plate and moving in a downward direction, rather than trying to only dissect in the "Calot's triangle" and find a duct in "Calot's triangle", which is a frequent reason for mis-identification leading to duct injuries (Chap. 23). Getting the gallbladder off the liver at the cystic plate and moving down

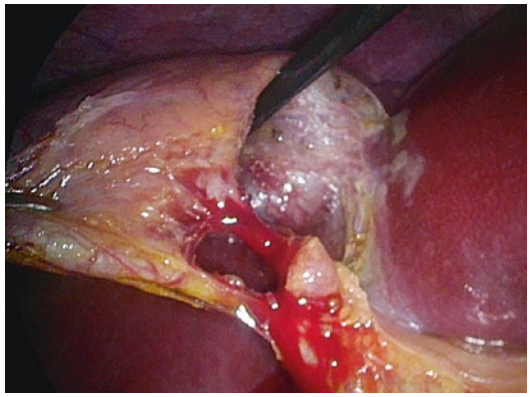

Fig. 16.15 The completed dissection with Calot's triangle well opened out, including the dissection of the gallbladder off the inferior portion of the cystic plate. Note that the cystic artery and duct are clearly identified, achieving the "critical view of safety"

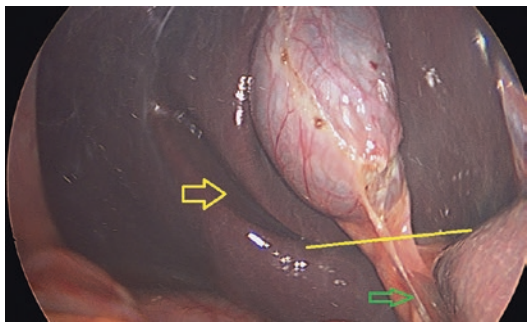

Fig. 16.16 Rouviere's sulcus is marked with a *yellow arrow* and at its base run the right posterior sectoral ducts and sheath. The common bile duct (*green arrow*) is noted to be below a line drawn from the sulcus to the under-surface of segment 4 (*yellow line*)

keeping the dissection on the gallbladder will avoid any mis-identification of duct structures including; a right posterior sector duct, a right hepatic duct or a common hepatic duct.

Other techniques that may be used to guide the safe dissection include the identification of Rouviere's sulcus [6] (Chap. 1; Figs. 1.18 and 16.16). Whilst the author does not use this routinely it is a useful adjunct when identifying the dissection, particularly in an acutely inflamed gallbladder with a mass effect or a chronically inflamed contracted gallbladder. The principle is to stay above the line drawn between Rouviere's sulcus which contains the right posterior sector ducts at its base across to the under-surface of segment 4. It is below this line that the common hepatic duct exists so maintaining the dissection above the line is considered safe (Chaps. 1 and 23, Fig. 1.18). One disadvantage is that a Rouviere's sulcus cannot be clearly identified in 18% of cases (Chap. 1). Whilst this can be used as an adjunct it does not replace the dissection of the liver off the gallbladder as a safe, reliable technique.

Operative Cholangiogram

The rationale for performance of routine operative cholangiography (OC) is presented in Chaps. 17 and 23. After clipping the cystic duct as close to the gallbladder neck as possible (Fig. 16.17a) or even the neck of the gallbladder a transverse, slightly downward incision is made in the cystic duct, large enough to allow insertion of the catheter (Fig. 16.17b). The cystic duct is then milked backward to ensure there are no stones, after which the common bile duct is then milked back with forceps on the lateral side, to ensure free backflow of clean bile (Fig. 16.17c). If cystic duct stones are detected these are milked out with forceps, being careful to place the forceps below the stone and milking upward, rather than crushing the stones (Fig. 16.18).

A 5-French ureteric catheter can then be inserted using either a Concord needle or an Olsen-Redick clamp. The Concord needle gives a more direct line down into the cystic duct, which is useful when using transcystic exploration (Chap. 20) or transcystic stenting for common bile duct stones (Chap. 21). The entry point for the Concord needle is just below the costal margin and 3–4 cm medial to a line drawn in the direction of the mid clavicular port and where this intersects with the costal margin. This line determines the position of the neck of the gallbladder. The needle is inserted downward and brought close to the opening in the cystic duct. The use of a 5-French ureteric catheter provides good flow for a good quality cholangiogram and also allows the passage of wires for transcystic stenting (Chap. 21) or baskets for transcystic exploration (Chap. 20). The tip of the catheter is pointed toward the opening, inserted into the opening so that it enters the lumen and then with

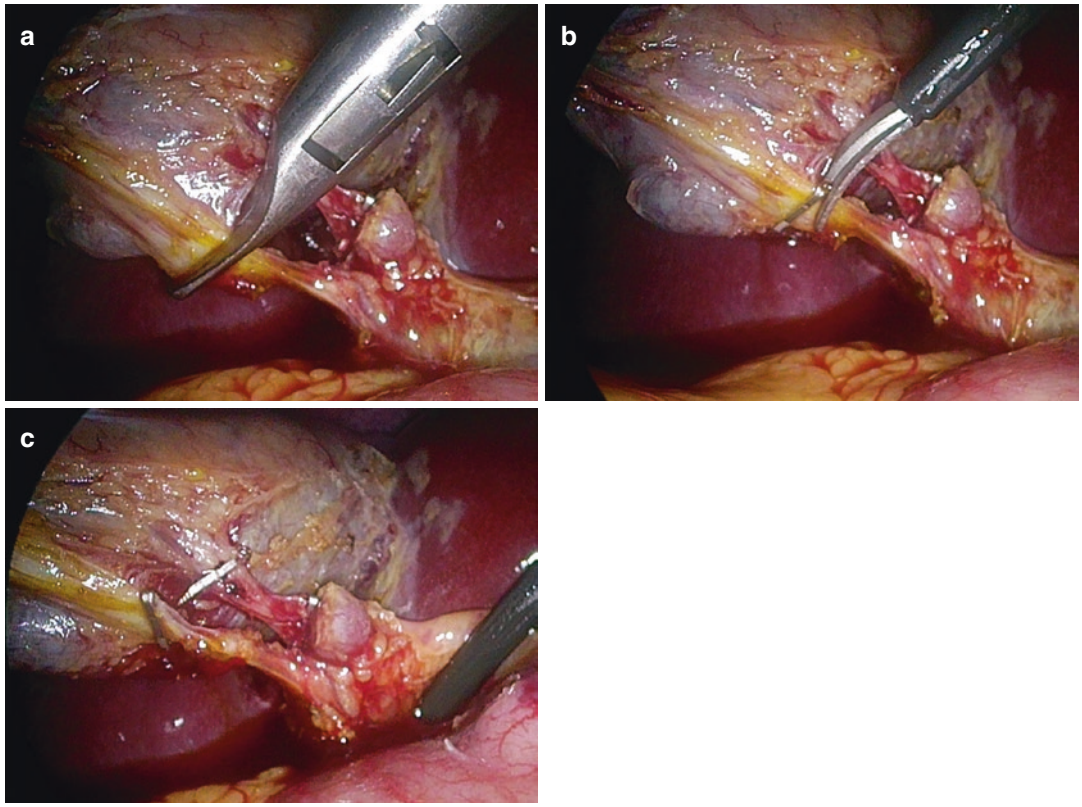

Fig. 16.17 (**a**) Placement of a single clip at the proximal end of the cystic duct. This clip may, at times, go across the neck of the gallbladder. (**b**) Incising the cystic duct just distal to the clip with a slightly downward orientation which enables easier insertion of the catheter for the cholangiogram. (**c**) After the cystic duct is incised, the duct is milked back to ensure backflow of clean bile. Scissors, forceps or a sucker may be used to milk the duct. There are two clips on the adjacent cystic artery that were to control bleeding that occurred earlier during the dissection. Usually only one clip is placed on the cystic artery on the distal extent of the vessel to allow identification of the site of this structure. Some surgeons would prefer not to clip the artery at all (Chap. 19)

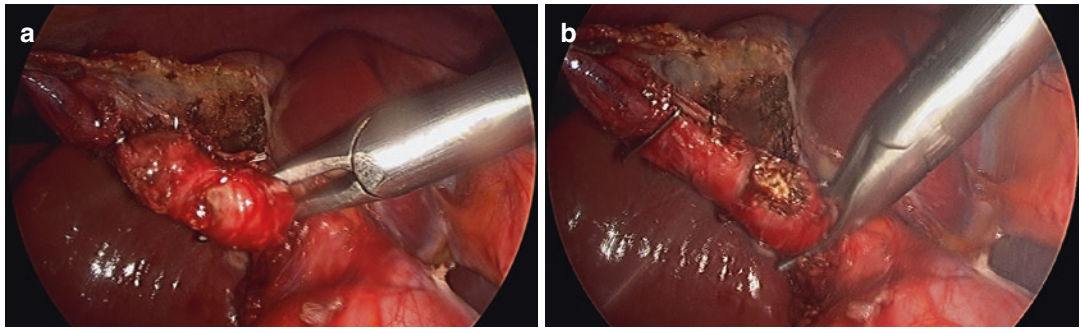

Fig. 16.18 An empty clip applicator placed just distal to a stone visible within the cystic duct (**a**) and milked upwards toward the incision in the cystic duct (**b**). Once milked out the stone is retrieved with a stone forceps

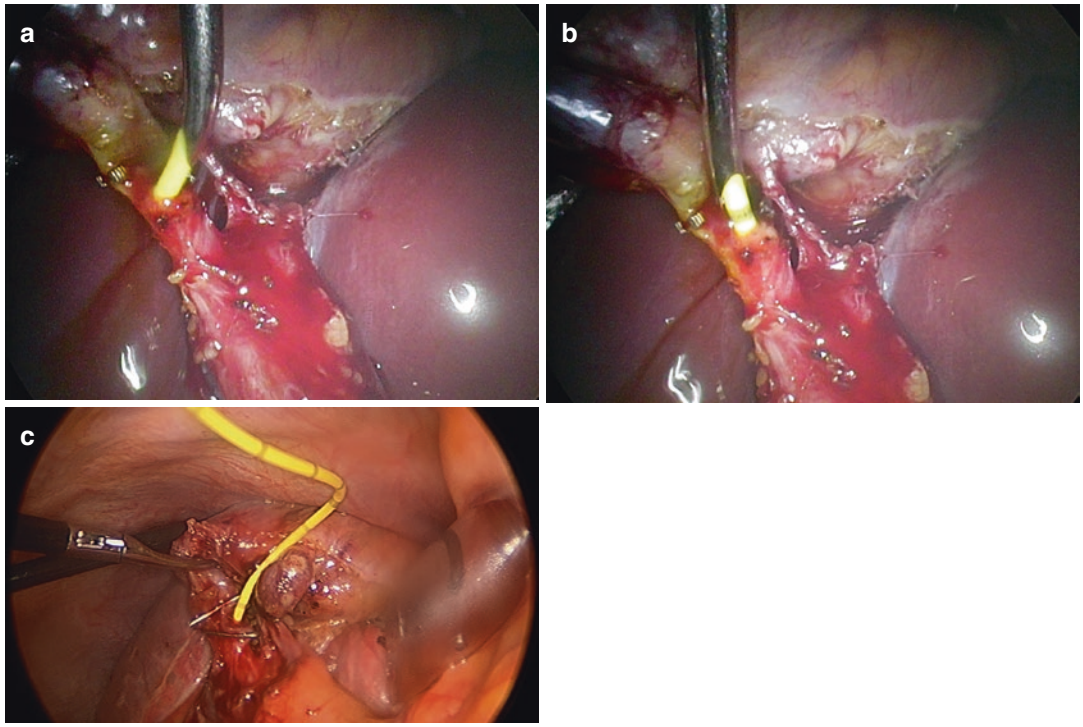

Fig. 16.19 (**a**) Insertion of the 5 French ureteric catheter initially at right angles to the duct to enter the lumen. (**b**) The Concord needle is then rotated so that the catheter is aligned with the direction of the cystic duct and carefully advanced. (**c**) The catheter is secured with a clip placed so as not to occlude the catheter

a rotation of the Concord needle in the direction of the cystic duct the catheter is gently inserted into the cystic duct (Fig. 16.19a, b). Once in position the catheter is secured with a partially closed clip passed through the epigastric port (Fig. 16.19c). The catheter is flushed with saline to ensure there is free flow with no occlusion or leakage of saline out of the cystic duct opening.

There are three causes for occluded flow:

1. *The catheter is occluded by the clips.*
2. *The end of the catheter is jammed into one of the spiral valves within the cystic duct.*
3. *A stone in in the cystic duct occluding the cystic duct.*

Once the catheter is in place and flushed with the saline the saline is changed for contrast. This is done with the catheter lower than the patient's duct to prevent any aspiration of gas into the catheter which might then mimic stones on the cholangiogram.

The image intensifier is then positioned so that the clips securing the catheter are in the middle of the field. Ensure that there are no objects (laparoscope, leads, graspers or ports) projecting the operative field. If using an Olsen ready clamp to insert the catheter this should go through the mid clavicular port rather than the epigastric port. Using the epigastric port results in the instrument passing across the duct and obscuring a proportion of the duct during the operative cholangiogram. Once the correct position is obtained the contrast is slowly injected during screening to outline the entire biliary tree (Fig. 16.20). The findings to check are listed in Table 16.2. A more detailed technique and interpretation of the OC is described in Chap. 17.

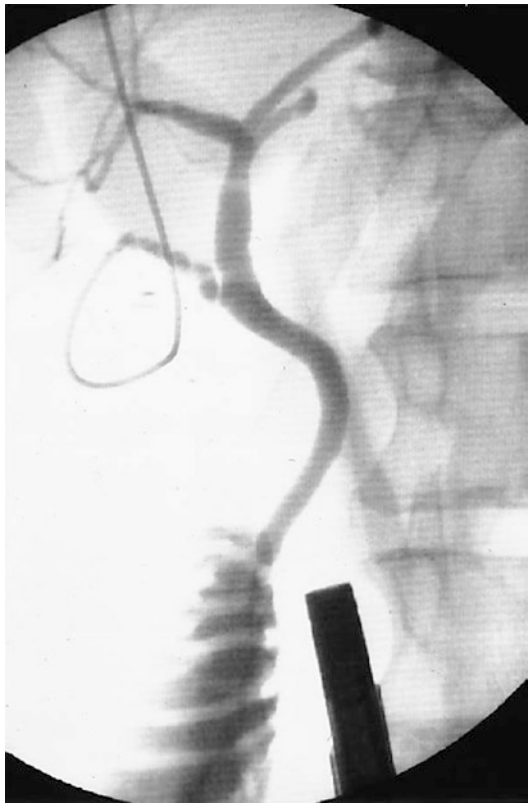

Fig. 16.20 A normal operative cholangiogram with clips near the centre of the field. All the intra-hepatic ducts (Segments 2–8) are seen, the length of the cystic duct is noted, and there is rapid free flow into the duodenum with no filling defects. The CBD has a diameter of 4–5 mm and a tapered distal end

Table 16.2 Checklist for findings on operative cholangiogram (Fig. 16.20)

• Cystic duct length, entry point to the hepatic duct and stones
• Intra-hepatic ducts all present, particularly segments 5, 6, 7 and 8
• Common bile duct diameter
• Filling defects in the common hepatic or common bile duct
• Free flow into the duodenum
• Tapered distal end of the bile duct

Closure of the Cystic Duct

The catheter is removed and the cystic duct is closed with clips. The most distal clip must be placed at the lowest point of the dissection on the cystic duct (Fig. 16.21a). This ensures that any small holes or potential holes that were caused during the dissection or milking out stones that are not visible, shall be proximal to the clip and therefore excluded, minimising the risk of a bile leak. A second clip is placed above the first. The surgeon needs to ensure that the clip is well across the duct. Clips should not be crossed as this creates a scissor action which may result in a bile leak. After clipping the duct if the artery has not been previously clipped, it is then clipped (Fig. 16.21b). The two structures are then divided, usually the duct first and the artery second.

Dissection of the Gallbladder Off the Liver Bed

Once the duct and artery are divided the neck of the gallbladder is retracted toward the midline and up toward the falciform ligament, which will expose the under surface and left side of the gallbladder that is still attached to the liver bed (Fig. 16.22a). Usually the upward retraction from the anterior auxiliary port is maintained but in some cases this may need to be brought downward to allow the gallbladder to rotate and improve the expose the edge of the dissection. The dissection is commenced at the left (medial) side and moved to the right (lateral) side (Fig. 16.22b). This dissection of the gallbladder off the liver is continued until the fundus is reached. During the dissection adjustments of the retraction of the gallbladder over the liver by the anterior auxiliary port usually requires a downward movement whilst continuous upward and medial movement of the retractor of the neck of the gallbladder via the mid clavicular port is required. Prior to dividing the last portion of the gallbladder attachment the gallbladder fossa and the clips in the region of Calot's triangle should be checked for haemostasis and bile leaks with gentle irrigation and careful inspection. Once this is done the final portion of the peritoneal attachment can be divided.

Extraction of the Gallbladder

Using a retrieval bag will reduce the risk of wound contamination, bile leakage and loss of stones. Insert the bag via the epigastric port,

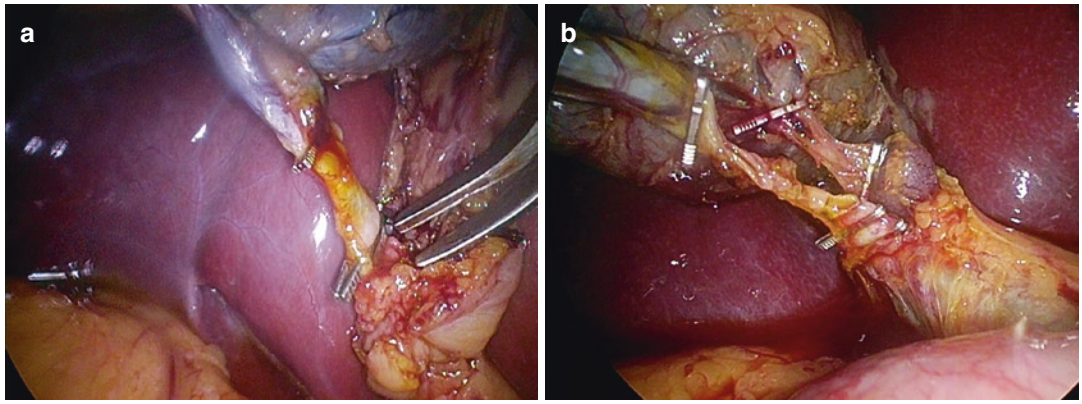

Fig. 16.21 (**a**) Placement of the first cystic duct clip at the distal most portion of the cystic duct dissection. The clip that held in the catheter is still present and is removed once the first clip has been applied. (**b**) The cystic duct and artery clipped prior to division

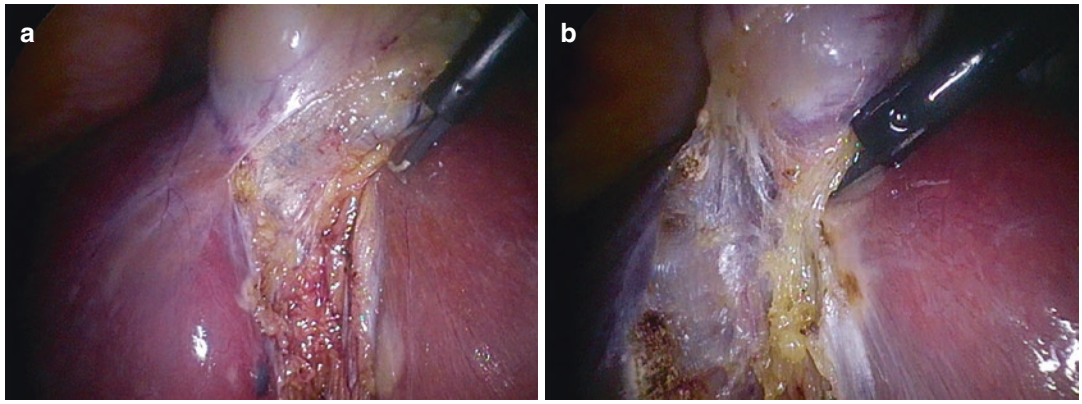

Fig. 16.22 (**a**) Retraction of the gallbladder upwards medially exposes the line of dissection between the gallbladder and the cystic plate. Note that due to the previous dissection about half of the gallbladder has already been dissected off the cystic plate. (**b**) The dissection continues starting at the medial (left side) and dissecting along the tissue plane between the gallbladder and the cystic plate. At this stage there is only the peritoneal dissection of the fundus remaining

opening it facing the opening toward the anterior auxiliary port, allowing the bag to unfold superiorly over the liver. The gallbladder is then inserted into the bag (Fig. 16.23), along with any spilt stones that are too big to retrieve with stone forceps. Whilst a retrieval bag is frequently used it is not necessary to use it routinely, if there are no anticipated difficulties (Table 16.3).

In order to retrieve the gallbladder, the laparoscope is changed from the umbilical port to the epigastric port and the bag or gallbladder neck is grasped with a 10 mm tooth forceps. Extraction at the umbilical port is preferred as it is easier to enlarge the fascial defect and skin wound for the extraction of large stones or swollen gallbladders. Using the technique described with a linear incision along the linea alba allows easy elongation of that wound as opposed to transverse wounds. The bag and gallbladder are then brought up into the umbilical part and the port is removed. The apex of the bag or gallbladder can then be grasped with forceps. The umbilical port site may need to be gently dilated with forceps to allow the gallbladder and stones to come out.

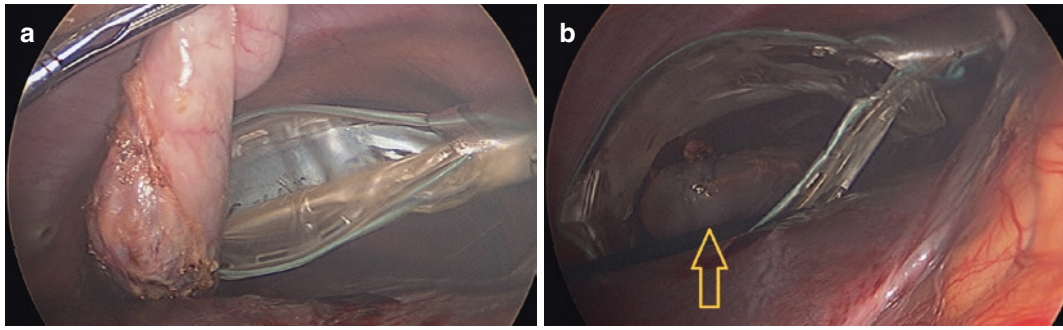

Fig. 16.23 (**a**) The retrieval bag passed via the epigastric port with the gallbladder held by the fundus via the mid axillary port. The forceps are passed into the bag unrolling the bag. (**b**) The gallbladder inside the bag prior to closing the bag (*Yellow arrow*)

Table 16.3 Factors which make gallbladder extraction without a bag difficult

• Holes in the gallbladder
• Acutely inflamed gallbladder
• Spilt stones that need to be retrieved
• Large stones
• Obese patients
• Previous operative procedures leaving a scarred umbilical area

Closure of the Umbilical Port

The base of the umbilicus is grasped and inverted. The fascial defect can usually be visualised or demonstrated with dissecting forceps. An absorbable suture, using a "U" shaped needle is then placed across the apex (Fig. 16.24a) and held to expose the lower end of the fascial defect. The inferior end is then sutured and held to expose the entire fascial defect between the two sutures (Fig. 16.24b). This defect can then be closed with a series of interrupted sutures to ensure adequate and complete closure of the umbilical port site.

Problems Arising During the Dissection and Technical Solutions

Peritoneal Access

Previous midline incisions: There is a risk of bowel being adherent to the posterior surface of the abdominal wall where a previous laparotomy has been performed using a midline incision that involves the umbilicus. Using the technique described, or any other technique through the umbilicus risks the injury to the bowel during the insertion of the initial port. The solution is to place a 10 mm port away from the midline, where it is less likely for bowel to be adherent to the abdominal wall. This is dependent upon the indication for and the operative procedure performed previously. If appropriate, this may be done in the mid abdomen on the right hand side in the mid clavicular line. If not, the right iliac fossa may be appropriate. If it is felt that the entire right side may be at risk, then insertion of the initial port in the left hand side may be required. The technique for insertion of the initial port may be either an open technique using a Hassan cannula or a closed technique using a visual inspection entry port.

Umbilical hernia: The presence of an umbilical hernia does not exclude the use of the umbilicus for the initial port. However, it does require a different technique which allows for a safe entry and subsequent formal repair of the umbilical hernia at the completion of the laparoscopic cholecystectomy [7, 8].

The apex of the hernia is grasped and retracted using Moynihan's forceps. A transverse incision is then made at the base of the hernia through the skin, the sac and into the hernia orifice at the inferior edge of the hernia orifice. Entry is then checked with gentle insertion of forceps and then a Hassan cannula can be inserted into the peritoneal cavity. This

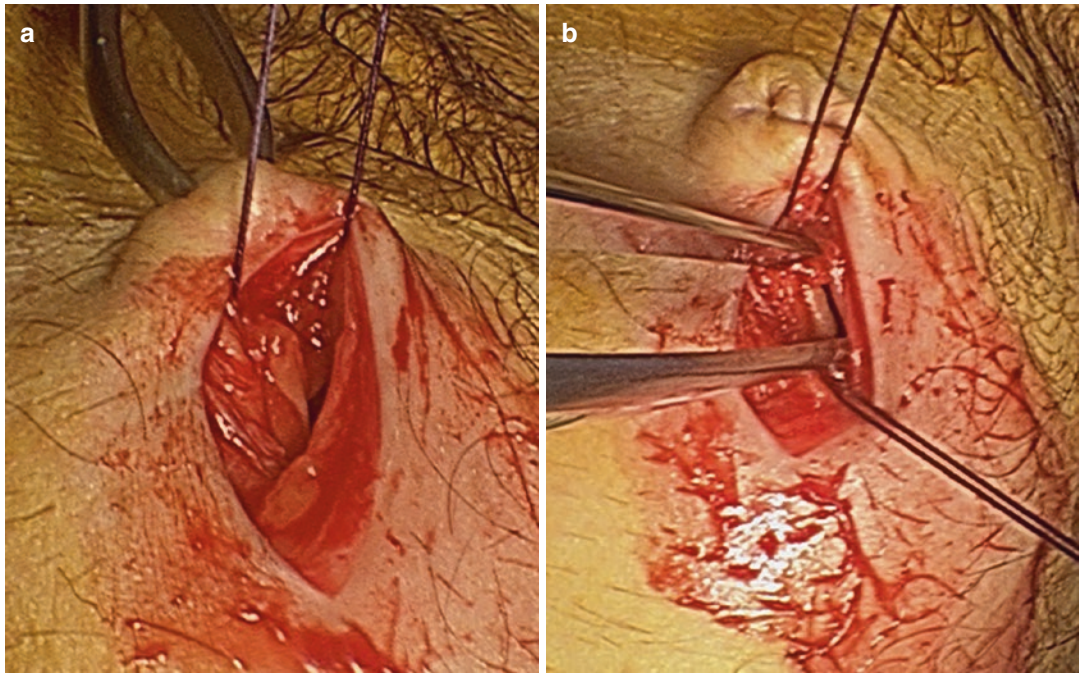

Fig. 16.24 (**a**) The base of the umbilicus is grasped and inverted to expose the incision through the linear alba fascia. The initial suture is placed as the apex of the fascial defect and lifted upward. (**b**) A suture is placed superiorly and inferiorly which holds the linear alba fascia. This allows clear visualisation and identification of the fascial defect so that further sutures to be placed and formally close the umbilical port site. This formal suturing of the fascia defect should significantly reduce the incidence of port site hernia

technique requires that the hernia be easily reducible. If it is easily reducible occasionally the omentum will be traversed but gentle traction backwards on the port will usually allow the omentum to drop away and for successful procedure to continue. If the hernia is not easily reducible then there is a risk of injury to omental vessels or bowel if they are incorporated in the non-reducible hernia, in this circumstance the initial port should be placed away from the umbilicus in the midline.

When the umbilical hernia is used for the port, at the completion of the laparoscopic cholecystectomy the skin incision may be extended laterally and the hernia sac formally dissected out. The fascial margin of the hernia is then dissected. Due to the concern of potential mesh infection the author prefers to repair the umbilical hernia with a 2-layer Mayo repair using an O prolene sutures. Currently there is little or no data to support either technique.

Previous umbilical hernia repair: The majority of umbilical hernias repaired in the last 20 years will have used mesh. Therefore, an alternative site is required for this initial port for several reasons. Passing a port through mesh will difficult with the additional risk of associated bowel adhesions to the deep surface. Extraction of the gallbladder through the mesh could be very difficult. Finally, there is a concern about the risk of subsequent mesh infection. Therefore, using a visual access port 4–5 cm above or below the previous umbilical hernia repair in the midline will provide good access and positioning for the primary port.

Exposure and Visualisation of the Gallbladder Wall and Hartmann's Pouch Area

Post-operative adhesions: This may be following a mid-line laparotomy where at least some of the adhesions will be along the under surface of the anterior wound. These are easily visualised with the

port in the right iliac fossa (Fig. 16.25a, b). Provided there is reasonable space and the abdominal wall can be identified, a 5 mm port can be placed in the anterior auxiliary line and these adhesions dissected with sharp and/or diathermy dissection to expose the midline and the entire liver edge safely (Fig. 16.25c, d). If retraction of the adhesions is required to facilitate this dissection a second 5 mm port can be inserted (usually in the right iliac fossa) to achieve this.

If there is no peritoneal space defined with the initial port insertion or no space to safely insert a second port to allow safe dissection of these adhesions, conversion to open surgery through a right sub-costal incision is indicated.

Adhesions to the anterior abdominal wall in the right upper quadrant can be divided in a similar fashion as described for the midline adhesions. This dissection continues until the liver edge is defined. Then the adhesions between the liver edge and the abdominal wall can be safely divided using either sharp dissection or diathermy dissection. After the dissection there will often be a space open up over the liver. The majority of the liver edge from the falciform ligament out laterally to the lateral part of the liver needs to be mobilised from the anterior abdominal wall to allow adequate retraction of the gallbladder. Similarly, post-operative adhesions between the anterior and superior surface of the liver and abdominal wall and diaphragm also need to be divided, in order to retract the gallbladder up over the liver and provide adequate access to the Hartmann's pouch area. Having defined and dissected out the lower edge of the liver and the anterior surface of the liver the dissection can now move on to dissecting the adhesions away from the under surface of the liver. This would start medially at segment 4 and move laterally toward where the gallbladder would be located. As the under surface of the liver is exposed and the dissection moves laterally the gallbladder will usually be found and can be dissected away from the adhesions. Care is needed to ensure there is not misidentification of either the duodenum, colon or small bowel as the gallbladder. The failsafe technique is that only the gallbladder is attached to the liver with a peritoneal attachment. Therefore, careful dissection needs to

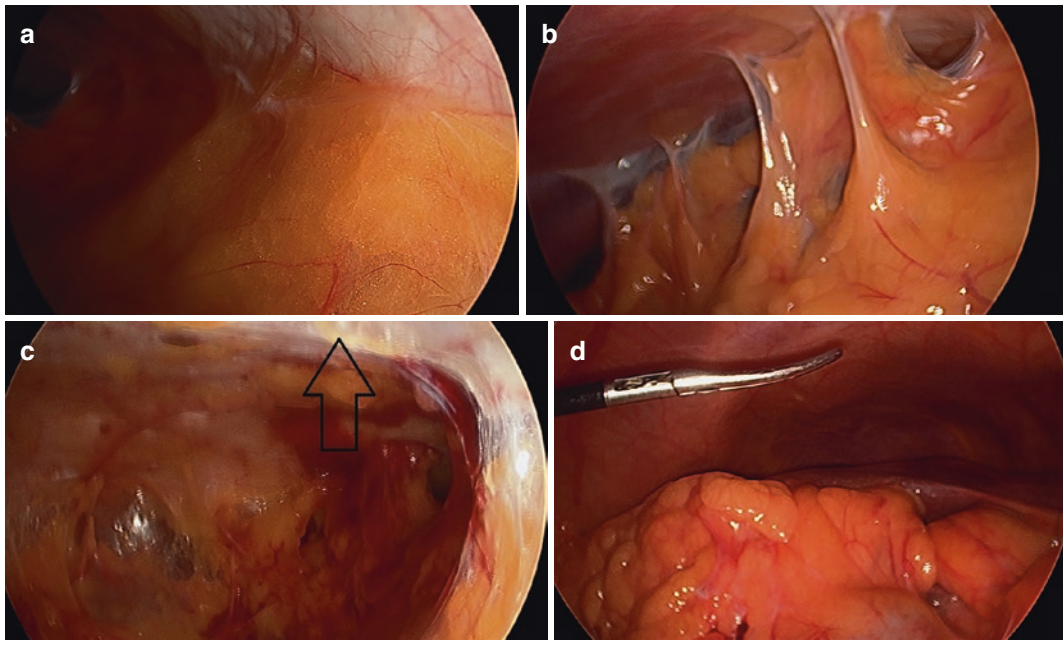

Fig. 16.25 Adhesions in the midline (**a**) and the right upper quadrant obscuring the liver (**b**) following a previous right hemicolectomy for a colorectal cancer and a subsequent laparotomy for a small bowel obstruction. (**c**) After the division of the adhesions the site for the umbilical port can be safely identified (*arrow*) and inserted under vision. (**d**) Clear vision of the right upper quadrant after division of adhesions identified

continue until the gallbladder is clearly identified. Continued dissection of the adhesions away from the gallbladder will help to determine this. Once the gallbladder is identified the dissection continues around to the lateral surface of the gallbladder and then segment 5 and segment 6 need to be fully mobilised in order to allow the gallbladder to be retracted over the liver. As with division of any adhesions in revision surgery, this requires a careful approach under vision and stopping where it gets difficult and going back to the more medial side, where it is easier, and then going across in the lateral direction again. The majority of the under surface of the right liver needs to be mobilised to allow complete visualisation and retraction of the gallbladder to enable the dissection of the gallbladder to proceed. Leaving adhesions laterally on the under surface of segment 5 or 6 may result in capsular tears when the gallbladder is retracted over the liver or during other parts of the dissection.

If the adhesions cannot be safely dissected either away from the liver or where the gallbladder cannot be clearly defined safely or where there is concern of risk of injury to duodenum, colon or small bowel, the laparoscopic dissection needs to be converted to an open operation via a right subcostal incision.

Failure to adequately visualise Hartmann's pouch: In some obese patients the umbilicus is much lower anatomically than in non-obese patients (Fig. 16.26a). The culmination of a lower umbilical port position and an obese omentum and colon makes vision of the Hartmann's pouch through the umbilical port difficult. This is best anticipated and the insertion of three ports in the midline can be planned. These are an epigastric port, a midline port about 15–18 cm lower and a third midline port about 10–12 cm lower again (Fig. 16.26b). If the lower port site coincides with the umbilicus, it may be used. However, in the super obese these three ports are often all above the umbilicus. The 30-degree laparoscope is inserted in this middle port and a fan retractor is inserted in the lower most port (Fig. 16.26c). This provides good visualisation of the gallbladder surface (Fig. 16.26d). This may require the assistant to be standing on the left hand side of the patient behind the surgeon, in order to hold both the retractor and the 30-degree laparoscope.

Inflammatory adhesions between the gallbladder and adjacent structures: Severe acute or chronic inflammation of the gallbladder often results in adhesions between the gallbladder and surrounding structures. These may be just simple inflammatory adhesions or may represent a sealed off gallbladder perforation where the wall of the surrounding structure is part of the wall of the contained perforation. The other possibility is that there is a fistula between the gallbladder and either the duodenum, colon or rarely small bowel. A fistula may have been expected pre-operatively and the assessment and management of this is described in Chap. 13.

Once part of the gallbladder is defined careful dissection of these inflammatory adhesions staying against the gallbladder wall will usually enable safe separation of the gallbladder from the adjacent structure. If need be, it is better to enter the gallbladder than risk injury to the duodenum or bowel. A combination of sharp and blunt dissection is preferred, only using diathermy when the structure divided is not adjacent to the enteric wall.

Where a sealed off perforation has occurred the dissection through inflammatory tissue leads into a cavity. The opening of the cavity will then usually make continuation of the dissection and defining the edge fairly straightforward. Once again, the surgeon should choose entering the gallbladder if the plane is not clear. Once the dissection is completed the duodenum or bowel is carefully inspected to make sure there is no associated hole or fistula.

A fistula is usually identified during dissection where there is no clear plane discerned between the gallbladder and the adjacent structure (Fig. 13.14b). When this is found a cholangiogram performed via the gallbladder may confirm the fistula. If in doubt the gallbladder can be opened, dissecting the gallbladder away from the wall of the adjacent portion of the gut, leaving the gallbladder wall on the potential fistula. This can then be carefully inspected and if there is a fistula the gallbladder is resected along with the fistula tract and the defect in the bowel repaired accordingly (Chap. 13). This may be done either laparoscopically or after

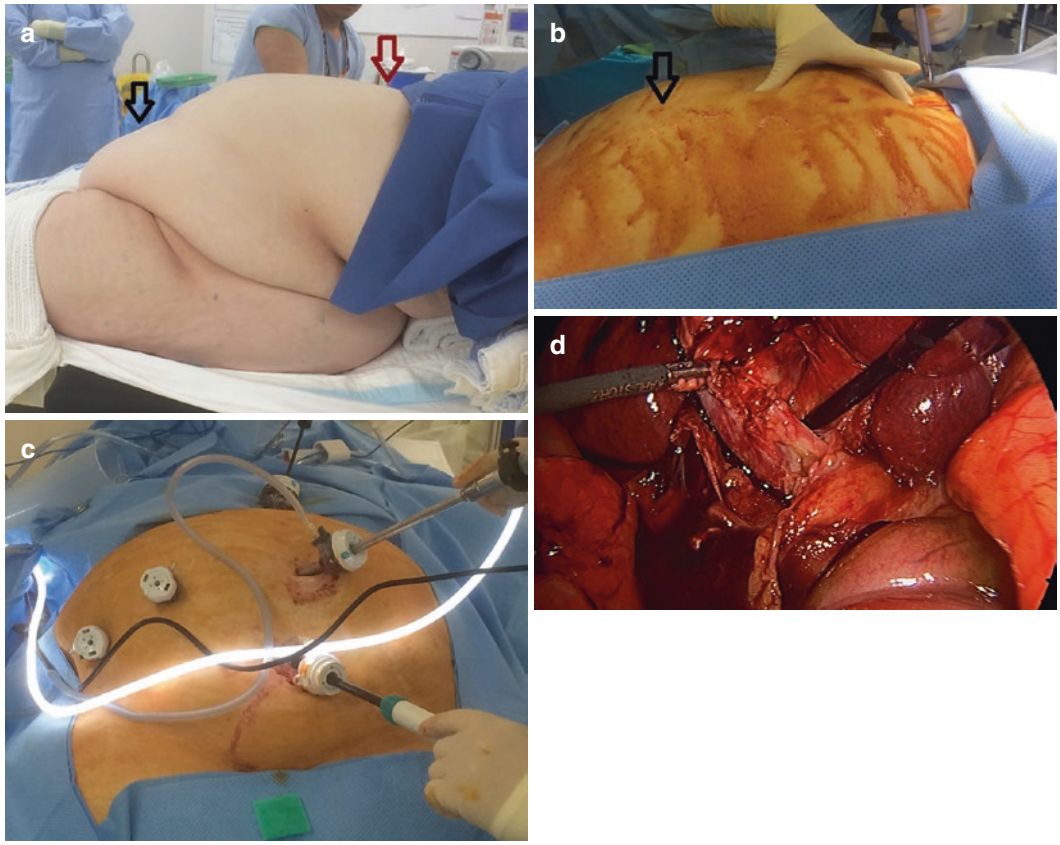

Fig. 16.26 (**a**) A 210 kg patient with acute cholecystitis. The black arrow points to the site of the umbilicus which is over the pubic symphysis in a very large apron and is clearly inappropriate for the initial port site. The *red arrow* indicates the site of the xyphisternum. (**b**) Position of the midline 10 mm ports. The upper port at the epigastrium (*middle finger*), the middle laparoscope port 15–18 cm lower down (*Thumb*) and the lowest port for the fan retractor (*Arrow*) a further 10–12 cm lower. The initial port is the central port using an optical visual port technique. (**c**) The position of the three midline ports and the two lateral ports. The epigastric port for dissection, the central port for the 30-degree laparoscope and the lowest port for the fan retractor. This is placed over the omentum and colon and retracts these downward to expose the entire gallbladder wall. It is important to have the lateral 5 mm ports going directly to the gallbladder to avoid creating a fulcrum that makes the movement of instruments and dissection more difficult. (**d**) The vision obtained in this 210 kg patient with the ports and retractors as described. Here the gallbladder has been dissected off the liver down toward the cystic duct with the sucker behind the distal body of the gallbladder. Note the good vision and the exposure of the duodenum and neck of gallbladder despite the very large patient

conversion to open surgery depending on the surgeon's skill set.

Initial Peritoneal Dissection

Inability to expose the left (medial) side of the gallbladder: In some cases, due to gallbladder distension, omental adhesions or a large stone impacting the Hartmann's pouch, the medial side of the gallbladder cannot be exposed. Traction of the gallbladder neck or Hartmann's pouch toward the falciform ligament will expose the lateral side and the dissection may be started there (Fig. 16.9). Once the peritoneum and if possible, some of the gallbladder is dissected free, retraction back to expose the medial side with downward traction on the gallbladder neck will often open up the medial side and allow the peritoneal dissection to commence high on the

gallbladder and come down across the superior part of Calot's triangle on the edge of the gallbladder (Fig. 16.11).

Inability to expose the lateral side of the gallbladder: Similarly, in some cases, particularly with a large stone impacted in the neck of the gallbladder, the dissection of the peritoneum around the region of Hartmann's pouch and the initial component of the lateral side is not possible. Attempts may be made to dis-impact the stone and if this is successful exposure is improved. However, it is quite often that this is not possible. The technique to adopt at this stage is to divide the peritoneum on the lateral side high up on the gallbladder and come as low as possible. This allows for some mobilisation and may allow for better exposure of the lateral surface. Once this is done as much as possible then go back to the medial side of the gallbladder and dissect the gallbladder wall off the liver, coming down to the upper part of Calot's triangle. Continuing going from one side to the other will eventually enable dividing the peritoneum on the inferior edge on the left hand side. Once the peritoneum has been divided, then the dissection of the gallbladder off the liver and the upper part of Calot's triangle is performed as previously described. In the inflamed situation this dissection is best performed with either forceps, sucker or irrigation dissection rather than diathermy dissection.

Unable to dissect between the gallbladder and the liver: This is often due to either severe acute inflammation with induration of the tissue or severe chronic inflammation with dense fibrotic tissue that prevents adequate dissection of the gallbladder from the liver and upper portion of Calot's triangle. The temptation in this situation is to dissect further down in Calot's triangle and to try and dissect out "a cystic duct". This must be avoided, as the inflammatory reaction and fibrosis, which draws the common hepatic duct and common bile duct closer to the distal gallbladder reducing the size of Calot's triangle and leading to injury due to mis-identification. Furthermore, there is the risk that the dissection moves too far medially where there is less inflammation and the dissection is more easy. This region is anterior to the hepatic ducts and risks misidentification of the hepatic duct as the cystic duct. On these occasions using the Rouviere's sulcus (Fig. 16.6) as a guide to the anatomy is useful.

When this situation of being unable to safely dissect the gallbladder off the liver, there are two options: transection of the gallbladder or conversion to open surgery. Continuing to dissect more distally risks getting lost and having a misidentification error and biliary and or vascular injury (Chap. 23). Whether done laparoscopic or open the initial option is to transect the gallbladder (Fig. 16.27a). The transection of the gallbladder wall is safe and should be performed using diathermy and dividing the gallbladder wall with the intention of defining the posterior wall and then dividing it (Fig. 16.27b). During this dissection the cystic artery may be encountered and is frequently associated with brisk bleeding, as the artery is encased in the fibrotic tissue, making the dissection difficult. If the artery can be identified, dissected out and clipped, this is preferable. The more common finding is brisk bleeding. This can usually be controlled with a clip which incorporates the bleeding artery and the edge of the transected gallbladder. Once the surface of the gallbladder facing the laparoscope is open the dissection can be continued both on the medial and lateral side until the posterior wall is defined. During the opening and the transection process any stones are removed with stone forceps to maintain clear vision. These may either be placed laterally to be picked up later or removed via the epigastric port. Having identified the back wall allows further dissection of the gallbladder off the liver toward the fundus mobilising the gallbladder and providing better vision of the distal segment of the gallbladder. The proximal gallbladder may be ligated to increase the exposure further and reduce stone spillage (Fig. 16.27c). Now the distal stump can be visualised. If a 30-degree laparoscope has not been used, it should be changed to one at this point. Having defined the posterior wall the distal gallbladder may now be dissected downward keeping the dissection plane on the gallbladder wall and the cystic duct defined (Fig. 16.27d) and an operative cholangiogram performed (Fig. 16.27e). It is essential that this downward dissection stays on the gallbladder

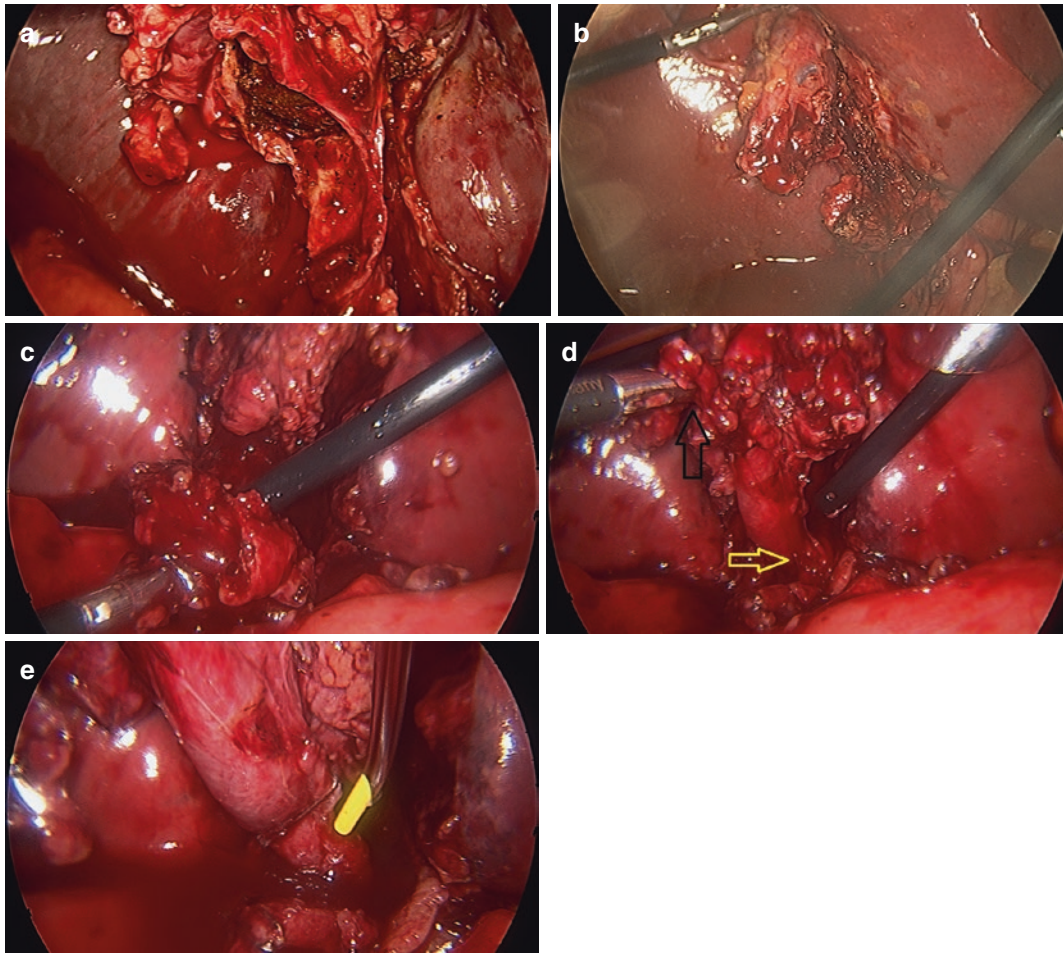

Fig. 16.27 (**a**) A partially transected gallbladder in acute cholecystitis where there is a large stone in the proximal gallbladder and the gallbladder was not able to be safely dissected off the liver. The posterior wall of the gallbladder is now easily and safely defined. (**b**) The completely transected gallbladder with clear exposure of the plane between the gallbladder and cystic plate. (**c**) The proximal gallbladder has been ligated to prevent stone spillage and improve exposure. Having defined the posterior wall it can be safely dissected with blunt dissection using a 30-degree laparoscope. It is important for this dissection to stay on the gallbladder wall. (**d**) The upper portion of the gallbladder stump is retracted upward (*black arrow*) allowing safe distal dissection and identification of the cystic duct. There has been about 2–2.5 cm of distal gallbladder dissected out after the transection. (**e**) The cystic duct dissection complete and a catheter inserted for an operative cholangiogram

wall and does not use any energy devices. If this is not possible then a sub-total cholecystectomy may be required. Sub-total cholecystectomy is a safe bail out option avoiding a difficult and dangerous resection of the entire gallbladder.

Laparoscopic Sub-Total Cholecystectomy: Having transected the gallbladder and defined the back wall a gallbladder stump consisting Hartmann's pouch and a proximal gallbladder. Prior to any further operating the lumen is carefully inspected and all stones removed (Fig. 16.28). The inspection of the gallbladder lumen provides information about the size of the residual gallbladder and ensures that no stones remain in the distal portion of the gallbladder. If the inspection of the lumen of the gallbladder reveals an obvious cystic duct lumen a catheter can be inserted and a cholangiogram performed (Fig. 16.29). However, it is the author's experience when the dissection of the distal gallbladder toward the cystic duct is not possible the orifice of the cystic duct is often not visible or not able

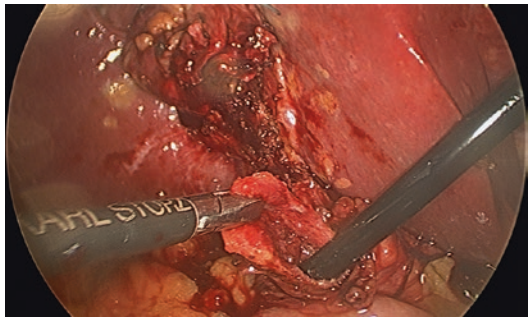

Fig. 16.28 A transected gallbladder stump carefully inspected to ensure there are no residual stones. This requires the use of a 30-degree laparoscope and care to ensure the gallbladder stump lumen is fully assessed

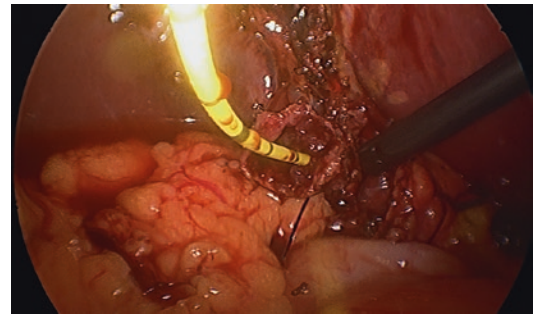

Fig. 16.29 A cholangiogram catheter inserted into the cystic duct orifice that was visible through the transected gallbladder. This has been secured with a loop

to be cannulated. Once it is certain that there are no stones remaining in the stump attempts may be made to close the stump with either ligation or suture. It is the author's experience that usually when the dissection is not possible, the residual component of the gallbladder is rigid and cannot be mobilised to ligate nor can it be closed with sutures. If the tissue is pliable enough to close this usually means it is able to be dissected a little further. The open stump of the gallbladder is left in situ and the proximal gallbladder is removed. Although the gallbladder wall attached to the liver can be left in situ by simply cutting the gallbladder off, usually with diathermy. A bile leak is anticipated and expected and is managed with the placement of a drain into the gallbladder fossa. The anticipated leak can then be managed with a subsequent ERCP sphincterotomy and stent (Fig. 16.30) (Chap. 22).

Some surgeons have described in these difficult dissections doing a fundus down dissection similar to that described in open surgery. This is not recommended in either laparoscopic or open surgery as there is a real risk that dissecting fundus down, when the inferior edge of the cystic plate is reached, rather than the dissection staying on the gallbladder wall the dissection goes down the liver surface. This then leads the dissection directly to the hepatic confluence with the risk of a serious combined bile duct and vascular injury [9] (Chaps. 1 and 23). Therefore, a fundus down technique should not be performed at laparoscopic or open surgery.

Identification of the Cystic Duct

The usual reason for not being able to identify the cystic duct has been discussed in the previous section and is because of the inability of dissecting the gallbladder off the liver and subsequent dissection of the superior part of the Calot's triangle. It is critical when faced with the inability to do this not to dissect lower down in the hope of finding a cystic duct structure, as the cystic duct structure may be a hepatic duct (Chap. 23).

Operative Cholangiogram

Table 16.4 lists the problems associated with insertion of the catheter to achieve and operative cholangiogram. Some cystic ducts are simply too small for a 5-French ureteric catheter and changing to a smaller 4 or 3-French catheter is usually successful. The only difficulty is that there is less flow through these catheters, making it more difficult to define the biliary tree. The other difficulty is that if CBD stones are identified a stone basket or standard wire will not go down these smaller catheters. However, if a smaller catheter is required it is much less likely that there will be a common bile duct stone, as the cystic duct is too small to transmit these stones.

When there is a valve or the catheter will not be fed into the cystic duct then the cystic duct can be dissected further with blunt dissection (Fig. 16.31) and then opened more distally. The catheter can then usually be inserted with ease (Fig. 16.32).

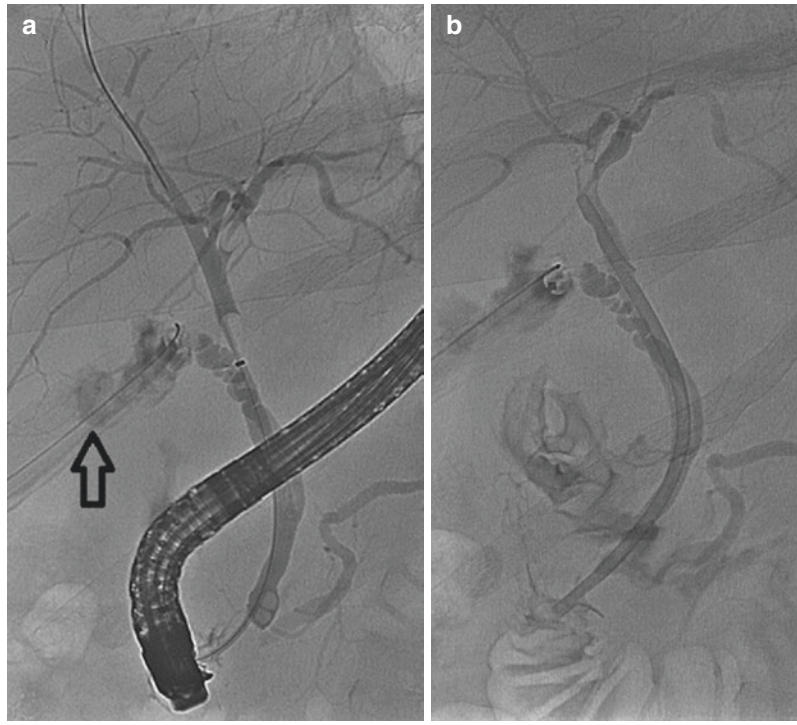

Fig. 16.30 (**a**) ERCP after a subtotal cholecystectomy for severe emphysematous, gangrenous cholecystitis where the neck of the gallbladder was unable to be closed safely due to the severe inflammation. The leak of contrast is seen from the cystic duct stump and is controlled by the drain placed in the gallbladder fossa (*arrow*). There are two distal CBD stones. (**b**) A sphincterotomy was performed and the stones removed. The leak is managed with the insertion of a plastic stent. The bile leak resolved immediately and the drain removed 48h later. The stent was removed 3 months at a repeat ERCP

Table 16.4 Problems associated with cholangiogram catheter insertion

• Duct too small
• Valve preventing insertion or unable to get into the lumen
• Avulsed cystic duct
• Stone occluding distal flow

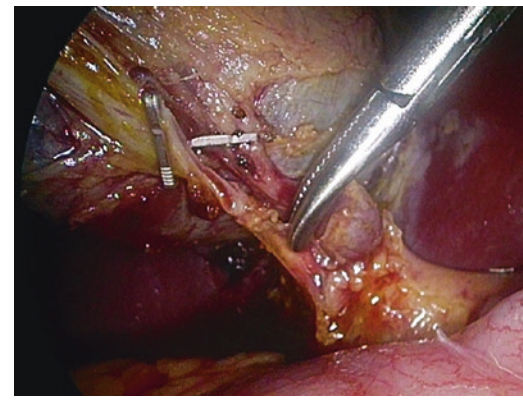

Fig. 16.31 After the failure to milk out a stone further dissection of the cystic duct is required to define the stone and allow safe milking of the cystic duct. Note that this is done with blunt dissection

An avulsed cystic duct can still have a cholangiogram performed. The cystic duct will often retract back into the fatty tissue in the region of Calot's triangle. It is important to clearly identify this and if a 30° laparoscope is not being used this would usually be of benefit. Careful identification without performing any dissection is required. The tip of the cystic duct having been located can then be picked up with a forceps (Fig. 16.33a). If the cystic duct is long enough further dissection may be performed, a side hole made, a catheter inserted and the cholangiogram obtained (Fig. 16.33b). If this is not able to be performed safely it is important to ensure that the

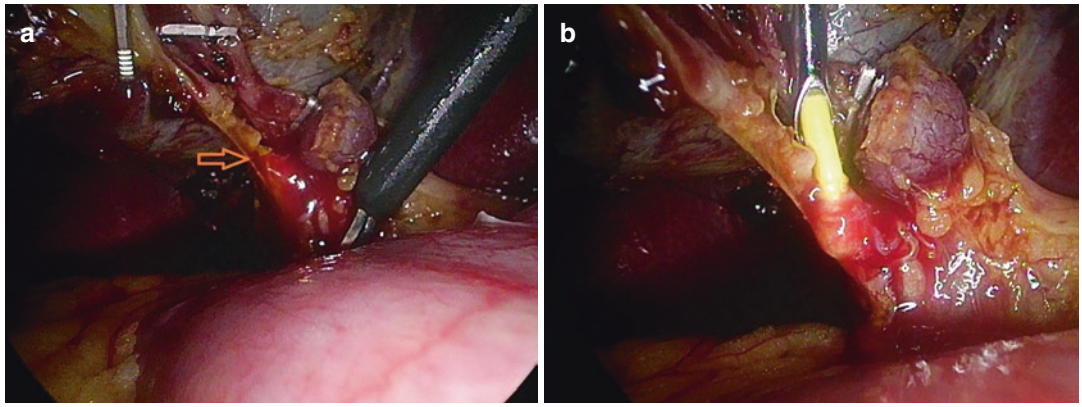

Fig. 16.32 (**a**) After a failed cannulation of the cystic duct, the cystic duct was dissected a further 1.5 cm and opened 1 cm distal to the initial opening (*arrow*). (**b**) The catheter was inserted to the 2 cm mark and a cholangiogram obtained

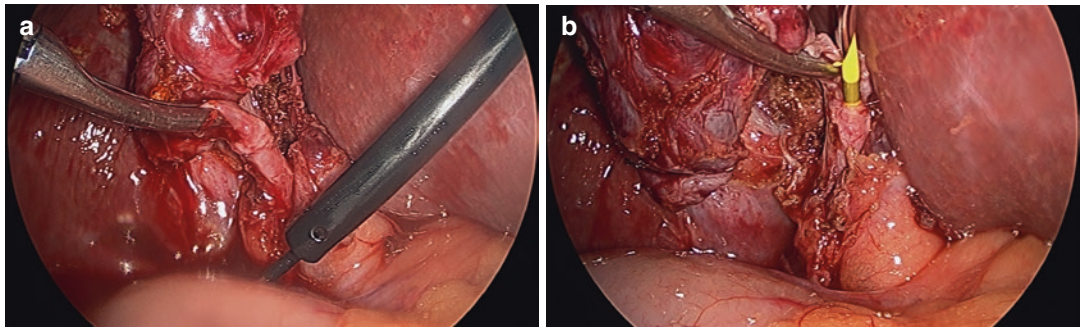

Fig. 16.33 (**a**) An avulsed cystic duct due to severe acute inflammation. The avulsion occurred at the junction of the neck and the cystic duct. The proximal portion was carefully picked up and retracted to allow for further dissection. (**b**) The cystic duct was dissected distally with careful blunt dissection, opened and a catheter inserted and a cholangiogram performed, which in this case demonstrated common bile duct stones

cystic duct is closed securely. In this case, where an operative cholangiogram has not been able to be performed, consideration should be given to post-operative biliary imaging (CT cholangiogram or MRI) depending on the clinical picture.

The indication and management of a stone occluding the cystic duct has been discussed previously in this chapter.

Closure of the Cystic Duct

The problems associated with the closure of the cystic duct are summarised in Table 16.5. A short cystic duct may be apparent during the dissection (Fig. 16.34) or on the operative cholangiogram (Fig. 16.35). Provided two clips can safely be placed across the duct without impinging on the cystic duct, common hepatic duct confluence this is an appropriate technique for closure. This is safest when the cystic duct has actually been defined at the dissection and the edge of the common bile duct is visible (Fig. 16.34b). However, when defined an operative cholangiogram further gentle forceps dissection may be required to define the edge of the common hepatic or right hepatic duct and ensure that it is not incorporated

Table 16.5 Difficulties with closure of the cystic duct

• Short cystic duct
• Wide cystic duct
• Severe inflammation or gangrenous cholecystitis
• Damaged cystic duct

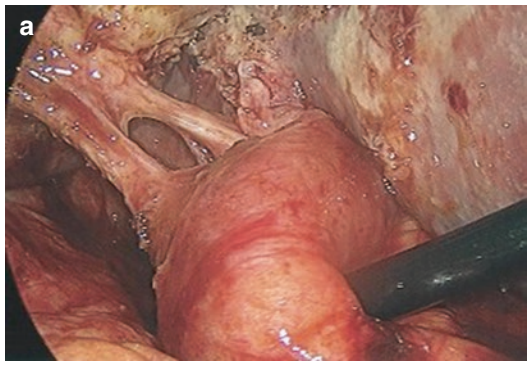

Fig. 16.34 (**a**) There is a short cystic duct and cystic artery in this patient with a chronically inflamed gallbladder. A sucker is against the dilated common bile duct. This was confirmed with operative cholangiography. (**b**) Clips placed carefully on the cystic duct and artery without impinging on the CBD

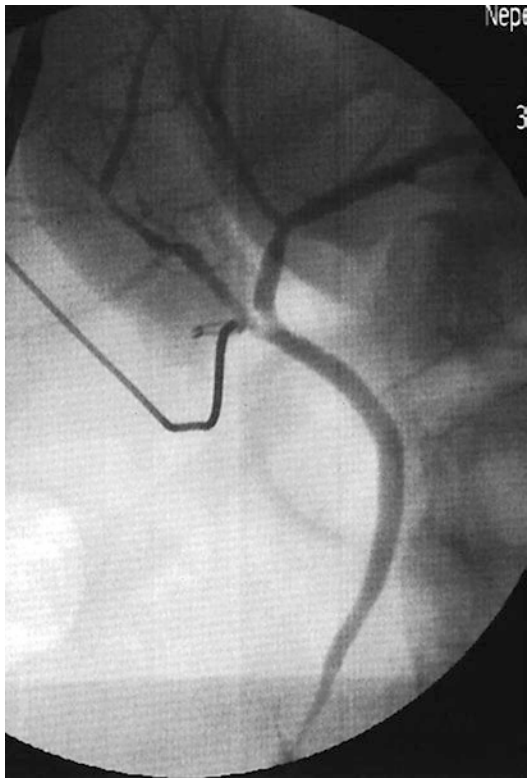

Fig. 16.35 An operative cholangiogram demonstrating a short cystic duct that joins the right posterior sector duct. This short cystic duct was not noted during the dissection but by using the approach of dissecting the gallbladder off the liver there was no risk of injuring this right sectorial duct. The length of the cystic duct should be routinely assessed at cholangiography for this reason (Chap. 17)

in the clips. If the cystic duct stump is too short to allow two clips to be safely placed on the cystic duct, it should be closed with a suture technique, being careful to only pick up the cystic duct. If this is not considered possible laparoscopically conversion to an open operation is required.

A wide cystic duct not controlled with a clip may be closed using either larger clips, endoloop ligation or suture ligation. When using any of these techniques it is necessary to be sure that only the cystic duct tissue is included in the loop, clip or suture. Including tissue adjacent to the cystic duct in this ligature may cause partial or complete occlusion of the common hepatic duct.

In patients with a very severely inflamed or gangrenous gallbladder, with inflammation extending down into the cystic duct area, there may be concern regarding the viability of the cystic duct. If possible the cystic duct should be dissected further down to allow the closure to be on better quality tissue (Fig. 16.31). However, in the case of severe inflammation this is frequently not possible (Fig. 16.36). The risk of a subsequent bile leak is both immediate or in the first 48h when the tissue initially holds but then subsequently gives way. This is managed expectantly by leaving a drain in the gallbladder fossa for a minimum of 72h. It is rare for a bile leak due to poor tissue to occur beyond 72h. The management of an expected bile leak is an ERCP, sphincterotomy and insertion of a stent (Fig. 16.30) (Chap. 22).

Fig. 16.36 The cystic duct (*arrow*) dissected out in a patient with gangrenous cholecystitis affecting the entire gallbladder. No further distal dissection was performed due to concerns about losing control and vision of the cystic duct. After a normal cholangiogram the cystic duct was clipped and a drain placed in the gallbladder fossa anticipating a possible leak. There was no leak and the drain was removed after 72h with no subsequent problems

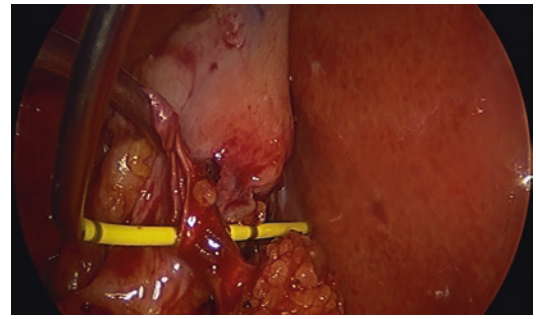

Fig. 16.37 A hole in the posterior wall of the cystic duct that occurred during a difficult dissection in acute cholecystitis when the neck of the gallbladder tore off the gallbladder

Table 16.6 Causes of troublesome bleeding

• Gallbladder wall in inflamed gallbladder
• Division of the cystic artery
• Arterial bleeding in the gallbladder fossa
• Hepatic vein in the gallbladder fossa
• Bleeding from the gallbladder fossa

A damaged cystic duct may be easily identified (Fig. 16.37) or it may be occult with the damage being on the posterior surface and not easily visualised. This can occur during dissection, particularly during milking out of stones impacted in the cystic duct. Placement of the clips occluding the cystic duct at the most distal point of dissection will mean the clip is placed below any overt or occult injuries and prevent subsequent bile leakage.

Dissection of the Gallbladder Off the Liver

Having got to the point of performing the operative cholangiogram and securing the cystic duct difficulty in dissecting the gallbladder off the liver can occur in two situations. This dissection in a cirrhotic patient may lead to significant bleeding from the gallbladder fossa. The avoidance and management of this is discussed in Chap. 19. Very occasionally the chronic inflammation may be so severe that the plane between the gallbladder and the liver is unable to be defined. This will usually have been defined already during the dissection of the distal gallbladder off the liver and the dissection of the cystic duct. If the dissection of the gallbladder off the liver is considered unsafe a partial cholecystectomy dividing the gallbladder wall at the edge of the liver and deliberately leaving the portion of the gallbladder wall attached to the liver is an appropriate approach appropriate approach as described above. This may be done with either diathermy dissection or harmonic scalpel. The mucosa of the gallbladder remnant left on the liver can be diathermied (Fig. 16.37).

Bleeding

Severe or troublesome bleeding may occur from various sites and at various stages of the laparoscopic cholecystectomy (Table 16.6). Bleeding from the hepatic arteries or portal veins should never occur if the principles of dissection described earlier in this chapter are followed. Bleeding from the gallbladder wall during or after the division of the peritoneum is not uncommon, particularly in acutely inflamed hyperaemic gallbladder. This may be ignored if it is not interfering with exposure and the dissection. However, where the bleeding is troublesome, retracting the gallbladder onto the bleeding to compress the bleeder and reduce the blood flow from the vessel and dissecting the opposite side should be performed. A brisk arterial bleed from the edge of the divided peritoneum in an acutely inflamed gallbladder is usually controlled with careful

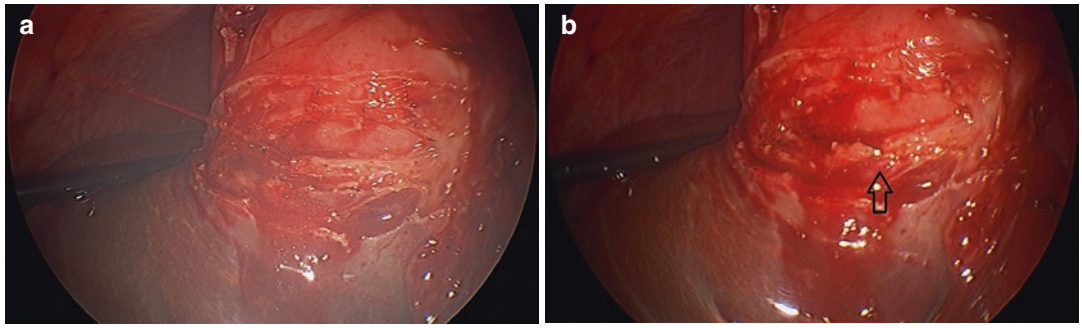

Fig. 16.38 (**a**) Brisk arterial bleed in a patient with acute cholecystitis from the right (lateral) sided peritoneal dissection. (**b**) The vessel is sitting up and easily visualised and can be controlled with the careful placement of a single clip (*arrow*)

placement of a single clip (Fig. 16.38). Careful diathermy to the site picked up with forceps is another option, provided it is on the gallbladder wall and away from the cystic duct area. Diathermy to bleeding that is not clearly on the gallbladder wall must not be performed.

Brisk bleeding from a presumed divided cystic artery appears different from that of bleeding just from the divided peritoneal surface. It requires a patient, careful and precise approach to avoid damage to other structures. The use of diathermy, multiple large clips or hasty dissection runs the risk of injury to the hepatic ducts and other critical structures. If the bleeding vessel can be seen clearly and picked up precisely and clipped without incorporating any other tissue this should be done (Fig. 16.38b). However, frequently the vessel retracts into the surrounding inflamed tissue within Calot's triangle, making precise haemostasis difficult (Fig. 16.39a). In that setting retracting the Hartmann's pouch immediately and up toward the falciform ligament will often control the bleeding for a period of time (Fig. 16.39b). This will then allow further dissection to occur laterally to mobilise the gallbladder off the liver (Fig. 16.39c), making the medial dissection easier. Having dissected posteriorly then retracting to the right iliac fossa to expose the region of the artery may then expose the artery and allow precise clipping (Fig. 16.39d). An alternative method is to place a grasper across the region of Calot's triangle to control the bleeding without performing any further dissection. Holding the grasper in place for 3–5 min will usually allow enough haemostasis that careful dissection of the gallbladder away from the liver, with careful and precise definition of the cystic artery can then be performed. Once having dissected the cystic artery this can be picked up and clipped. In some cases, a combination of retraction of the gallbladder, dissection of the gallbladder posteriorly and occlusion of the bleeding with the forceps is required. The essential point is precise ligation of the artery and only the artery. Where the precise haemostasis is not possible this is an indication for conversion to open operation to allow initial control of the bleeding and precise identification and ligation of the vessel.

During the dissection of the gallbladder off the gallbladder fossa there may be arterial bleeding from an artery running up between the gallbladder and the liver. These vessels can usually be picked up and clipped with ease. As these are up on the gallbladder fossa, well away from Calot's triangle, there is no risk of injuring any duct. If they cannot be picked up they can be sutured laparoscopically with a 3/0 prolene suture.

The other source of troublesome bleeding from the gallbladder fossa can be from opening into a tributary of the middle hepatic vein. This is usually dark blood and occasionally the lumen of the vessel may be clearly visualised, particularly

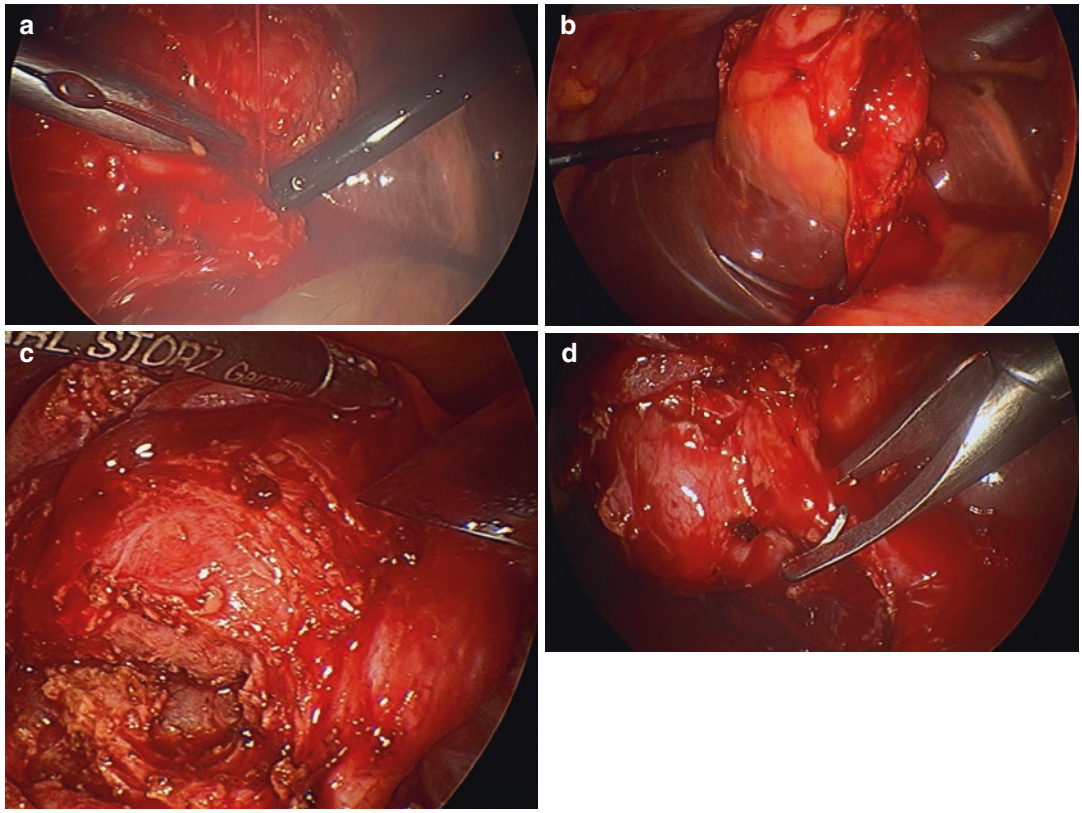

Fig. 16.39 (**a**) Brisk bleeding from a side hole in the cystic artery during dissection for severe acute cholecystitis. The vessel is retracted and cannot be seen clearly. It is vital that clips are not simply thrust in to this area or large amounts of diathermy used in an attempt to control such a bleeder. (**b**) Retraction of the gallbladder upwards and towards the falciform ligaments exposes the lateral side tamponading the bleeding and allowing the dissection on the lateral side to be performed. (**c**) The dissection of the lateral side of the gallbladder allows mobilisation of the medial side. In this severely inflamed gallbladder that dissection was able to be continued quite a distance. There was a slow ooze from the bleeding site that was largely controlled with the retraction. (**d**) When retracted back to expose the left (medial) side the region of the artery and the duct were able to be dissected with blunt dissection. The artery was defined and controlled with a single clip

when the hepatic venous pressure is less than the insufflation pressure. This may be able to be controlled with diathermy on a high setting, provided the diathermy is only applied to the gallbladder fossa above the superior margin of the Calot's triangle. An alternative is suture ligation of the bleeder with 3/0 prolene. Pressure with gauze or haemostatic material is another option. If haemostatic material works the one risk of leaving this behind is it may result in a postoperative abscess in the gallbladder fossa. Failure to control the bleeding from a hepatic vein in the gallbladder bed is an indication for conversion to an open operation and suture ligation of this vessel. Bleeding from the gallbladder fossa is not uncommon in acute or severe chronic inflammation. This is normally easily controlled with diathermy on a higher setting. It is essential that diathermy of the gallbladder fossa never goes beyond the inferior edge of the gallbladder fossa (cystic plate) into the region of the upper Calot's triangle. Furthermore, diathermy must never be used close to the clips on either the cystic artery or the cystic duct. Current from the clips will be conducted through the clips and may result in diathermy injury to underlying hepatic ducts with

subsequent stricturing (Chap. 23). When there is bleeding from the gallbladder fossa managed with extensive diathermy a drain should be placed in the gallbladder fossa due to the risk of damage to a subvesical duct and subsequent bile leak (Chaps. 1 and 22).

Difficulty Extracting the Gallbladder

Some cases of inflamed gallbladder or where the stones are very large may be difficult to extract through the umbilical port. Another cause of difficult extraction can be fibrosis of the fascia in this area due to previous surgery. When dilation with artery forceps is unsuccessful there are two techniques which may be used. The first is to open the gallbladder and remove or crush and remove the stones with forceps. Unfortunately, this does not always work, particularly if there are very large, hard stones or where there is a severely inflamed thick-walled gallbladder. The other option is to pass an artery forceps into the inferior edge of the port site, open it slightly to allow the insertion of a scalpel blade to divide the facia. Provided the patient is not straining and the scalpel blade and the artery forceps are moved together to prevent injury to any other structures, this is safe. The fascial wound is carefully closed with a series of interrupted absorbable sutures (Fig. 16.24).

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