CLINICAL SURGERY INTERNATIONAL

VOL 5

The Biliary Tract

EDITED BY

L. H. BLUMGART BDS MD FRCS

CLINICAL SURGERY INTERNATIONAL

VOL 5

The Biliary Tract

EDITED BY

L. H. BLUMGART BDS MD FRCS

Director and Professor of Surgery, Royal Postgraduate Medical School,
University of London, England

CHURCHILL LIVINGSTONE
EDINBURGH LONDON MELBOURNE AND NEW YORK 1982

CHURCHILL LIVINGSTONE
Medical Division of Longman Group Limited

Distributed in the United States of America by
Churchill Livingstone Inc., 1560 Broadway, New York,
N.Y. 10036, and by associated companies,
branches and representatives throughout
the world.

First published 1982

ISBN 0 443 02322 0

British Library Cataloguing in Publication Data
The biliary tract.—(Clinical surgery
international; v. 5)
1. Biliary tract—Surgery
I. Blumgart, L. H. II. Series
617'.556059 RD546

Library of Congress Cataloging in Publication Data
Main entry under title:
The biliary tract.
(Clinical surgery international; v. 5)
Includes index.
1. Biliary tract—Surgery. 2. Biliary tract—
Diseases. I. Blumgart, L. H. II. Series.
[DNLM: 1. Biliary tract—Surgery. 2. Biliary
tract diseases. W1 CL795U v.5/WI 700 B594]
RD546.B5 1982 617'.556059 82-4532
AACR2

Printed in Great Britain at The Pitman Press, Bath

Preface

Only one hundred years ago, Langenbuch carried out the first cholecystectomy and shortly afterwards choledochotomy was performed. While developments in anaesthesia, blood transfusion, and antibiotics have made surgical approaches to the abdominal viscera possible and safe, more specific advances and particularly in diagnostic radiology have opened the door to precise and ever-advancing approaches to diseases of the biliary tree.

This volume of Clinical Surgery International attempts to bring together the opinions of some of the world's leading authorities with a critical appraisal of established practice in the management of a wide range of disorders and an up-to-date assessment of new techniques in the diagnosis, management, and care of the patient with biliary disease. No attempt has been made to reconcile conflicting opinions but the contributing authors have been asked to place on record their current practice and those aspects of the problem which they consider to be of importance. I have been delighted with the results which reflect an international balance of views on many important aspects of the subject. The reader should find many things to agree with, a good deal to learn, and a great deal to debate.

I wish to record that I had invited the late Professor Clarence Schein of the Albert Einstein School of Medicine, New York City, to contribute the section on post-cholecystectomy problems. His untimely death has left a gap in the ranks of those particularly interested in biliary surgery. His contribution, which would undoubtedly have reflected the pragmatic personal and very practical views expressed in his book on the subject, is sorely missed.

London, 1982 L.H.B.

Contributors

D. J. Allison BSc, MD, FRCR
Consultant and Senior Lecturer, Department of Radiology, Royal Postgraduate Medical School, Hammersmith Hospital, London, England

Stig Bengmark MD, PhD
Professor of Surgery and Director, Department of Surgery, University of Lund; Chief Surgeon, Hospital of Lund, Sweden

Irving S. Benjamin BSc, FRCS
Lecturer in Surgery, Royal Postgraduate Medical School, Hammersmith Hospital, London, England

George Berci MD, FACS
Associate Director of Surgery and Director, Division of Endoscopy, Department of Surgery, Cedars-Sinai Medical Center; Associate Clinical Professor of Surgery, UCLA Medical Center, Los Angeles, U.S.A.

Henri Bismuth MD
Professor of Surgery, Université Paris Sud; Director of the Hepato-biliary Surgical Unit, Hôpital Paul Brousse, Villejuif, France

L. H. Blumgart BDS, MD, FRCS(Eng, Edin, Glas)
Professor of Surgery and Director, Department of Surgery, Royal Postgraduate Medical School, Hammersmith Hospital, London, England

N. B. Bowley MB, BS, FRCR
Consultant Radiologist, Royal Postgraduate Medical School, Hammersmith Hospital, London, England

Peter G. Jones MS(Melb), FRCS(Eng), FRACS, FACS, FAAP(Hon)
Surgeon, Head of Unit, Department of General Surgery, Royal Children's Hospital, Melbourne, Australia

M. R. B. Keighley MS, FRCS
Consultant Surgeon and Reader in Surgery, General Hospital, Birmingham, England

Björn Lindgren PhD
Lecturer, Department of Economics, University of Lund; Project Manager, Swedish Institute for Health Economics, Lund, Sweden

D. A. Lloyd MChir(Cantab), FRCS, FCS(S.A.)
Senior Paediatriç Surgeon, King Edward VIII Hospital, Durban; Senior Lecturer in Paediatric Surgery, Faculty of Medicine, University of Natal, South Africa

N. J. Lygidakis MD
Honorary Consultant Surgeon, Hammersmith Hospital, London, England

Charles K. McSherry MD
Director of Surgery, Beth Israel Medical Center, New York; Professor of Surgery, Mount Sinai School of Medicine of the City University of New York, New York, U.S.A.

Frank G. Moody MD
Professor and Chairman, Department of Surgery, University of Utah School of Medicine, Salt Lake City, Utah, U.S.A.

Leon Morgenstern MD, FACS
Director of Surgery, Cedars-Sinai Medical Center; Clinical Professor of Surgery, UCLA School of Medicine, Los Angeles, U.S.A.

Roger W. Motson MS, FRCS
Senior Surgical Registrar, The London Hospital, London, England

J. M. A. Northover MS, FRCS
Senior Surgical Registrar, The Middlesex and St Mark's Hospitals, London, England; lately Arris and Gale Lecturer, Royal College of Surgeons of England

Erwin Seifert MD, FACG
Professor of Internal Medicine and Gastoenterology, 1st Medical Department, Städtisches Krankenhaus Kemperhof Koblenz, W. Germany

Ralph A. O. Sörbris MD, PhD
Assistant Professor of Surgery, University of Lund, Sweden

John Terblanche MB, ChB, ChM(Cape Town), FCS(S.A.), FRCS(Eng)
Professor of Surgery and Head of the Department of Surgery, University of Cape Town; Chief Surgeon, Groote Schuur and Somerset Hospitals, Cape Town; Co-Director of the South African Medical Research Council Liver Research Group, University of Cape Town Medical School, S. Africa

Ronald K. Tompkins MD, MSc, FACS
Professor of Surgery and Assistant Dean, Student Affairs, UCLA School of Medicine, Los Angeles, U.S.A.

James Toouli B(Med)Sci, PhD, MB, FRACS
Lecturer, Department of Surgery, Flinders University; Consultant Surgeon, Flinders Medical Centre, South Australia

James McK. Watts MB, BS, FRACS
Professor of Surgery, Flinders University of South Australia

Lawrence W. Way MD
Professor of Surgery, University of California; Chief, Surgical Service, San Francisco V.A. Medical Center, San Francisco, U.S.A.

J. A. M. White FRCS, FRCS(Edin)
Chief, Ambulance and Emergency Medical Services, Province of Natal; formerly Senior Lecturer in Surgery, University of Natal, South Africa

Malcolm J. Whiting BSc, PhD
Senior Hospital Scientist/Lecturer, Flinders Medical Centre and Flinders University of South Australia

Contents

1. *Applied surgical anatomy of the biliary tree* 1
J. M. A. Northover and J. Terblanche

2. *Gallstone dissolution — present and future* 17
J. McK. Watts, J. Toouli and M. J. Whiting

3. *Diagnostic approaches in the biliary tract* 35
N. B. Bowley and I. S. Benjamin

4. *Endoscopy and biliary disease* 61
E. Seifert

5. *Interventional radiology and biliary tract disease* 82
D. J. Allison and N. B. Bowley

6. *Intraoperative diagnostic procedures* 99
L. Morgenstern and G. Berci

7. *Cholecystitis* 121
R. W. Motson and L. W. Way

8. *Cholecystectomy and common duct explorations* 128
C. K. McSherry

9. *The post-cholecystectomy patient* 143
L. H. Blumgart and N. J. Lygidakis

10. *The obstructed biliary tract* 157
I. S. Benjamin

11. *Carcinoma of the gallbladder and biliary ducts* 183
R. K. Tompkins

12. *Biliary, pancreas and papilla of Vater interrelationships* 197
F. G. Moody

13. *Postoperative strictures of the bile duct* 209
H. Bismuth

14. *Infection and the biliary tree* 219
M. R. B. Keighley

15. *Biliary disease in the tropics* 236
D. A. Lloyd and J. A. M. White

16. *Diseases of the bile ducts in the paediatric age-group* 252
P. G. Jones

17. *Economic aspects of gallstone disease and its management* 270
S. Bengmark, B. Lindgren and R. Sörbris

Index 283

1 *Applied surgical anatomy of the biliary tree*

J. M. A. NORTHOVER and
JOHN TERBLANCHE

Biliary anatomy first became of practical importance to surgeons towards the end of the last century, following the first cholecystectomy by Carl Langenbuch in 1882 (Glenn & Grafe 1966). In 1900 George Emerson Brewer of the Mount Sinai Hospital, noting the 'many new and ingenious operative procedures' being carried out on the biliary tract, produced one of the first practical guides to the surgical anatomy of this region. Confronted with this developing surgical challenge, he performed 160 dissections 'to educate his tactile sense for recognition of structures which, during operation, are often concealed from view or rendered visible only with difficulty'. The modern surgeon, with excellent anaesthesia, muscle relaxation and good lighting at his command, enabling him to use direct vision rather than his sense of touch to demonstrate the biliary anatomy, must surely be grateful!

Following Brewer's work, the first half of this century saw the publication of many studies which amply demonstrated the enormous range of individual variation that so characterises this region (Flint 1923, Friend 1929, Michels 1955); indeed, the well-read surgeon of today can be forgiven if he remains baffled by the complexities reported in the literature. More recently, however, several surgeons have stressed the limited surgical usefulness of much of this data, preferring to emphasise the important major variations (Benson & Page 1976, Kune & Sali 1980).

In this chapter those aspects of *practical* importance and interest to the surgeon will be emphasised, for there are few areas of operative surgery in which accidents due to failed recognition of local anatomy can so easily lead to catastrophe. In addition, the blood supply of the bile duct will be carefully considered, as this previously neglected topic may well have clinical importance in the development of postoperative complications after various operative procedures.

Anatomical 'normality' in the biliary tree

Normality, in the sense of an anatomical pattern which is repeated in the majority of individuals, is a term which cannot be used in relation to the biliary tree (Dowdy 1969, Benson & Page 1976). Variation is such that less than 50% of individuals exhibit a pattern common in even major details. Any attempt to define the 'normal' anatomy of the biliary tree, therefore, would be artificial and misleading, so each major area of the extrahepatic biliary tree and its related vessels will be considered separately, and the more important variational groups described.

Bile ducts at the liver hilum

The ducts in the hilum may be encountered either deliberately during partial hepatectomy or when dealing with a tumour or stricture at the porta hepatis, or accidentally in the course of a difficult cholecystectomy! It is important to note that some portion of both the right and left hepatic ducts, and hence their confluence, *are always extrahepatic* and, therefore, accessible at the porta (Kune & Sali 1980). In some cases portions of the major tributaries of the right and left ducts are also outside the liver (Fig. 1.1).

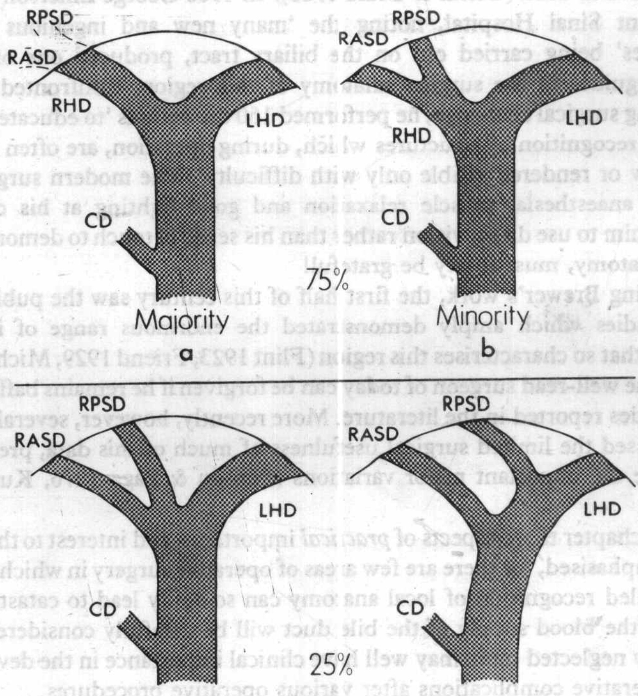

Fig. 1.1 Patterns of formation of hepatic ducts. A true right hepatic duct (RHD) is present in 75% of individuals, usually formed within the liver (a), but sometimes outside (b). In 25% no true RHD is found, the segmental ducts forming a triple confluence with the LHD (c) or joining it separately (d). In the latter instance, the RASD has in the past been wrongly designated an 'accessory' duct. RASD = right anterior segmental duct; RPSD = right posterior segmental duct; RHD = right hepatic duct; LHD = left hepatic duct; CD = cystic duct.

Right hepatic duct (RHD)

Just as the bronchial tree has a fairly constant pattern of branches, so have the intrahepatic bile ducts. Hjortsjo (1951) and later Healey & Schroy (1953) clearly demonstrated that each area of the liver has its own, nameable bile duct, and that the area ducts drain into major segmental ducts.

The functional right lobe (that part of the liver to the right of the lobar fissure, marked by the gallbladder fossa and the inferior vena cava) comprises two segments, anterior and posterior. In 75% of individuals the right anterior and posterior segmental ducts join to form a true right hepatic duct, i.e. a single channel carrying the whole bile output of the functional right lobe; *in the remaining 25% there is no true RHD*, the segmental ducts emptying into the left hepatic duct (LHD) separately (Fig. 1.1) (Healey & Schroy 1953, Balasegarem 1970, Kune & Sali 1980). This important point has bearing on the question of so-called 'accessory' bile ducts and will be referred to below.

Among those individuals (75%) in whom a true RHD is present, it is wholly extrahepatic in but a few. The extrahepatic segment is of variable length, being 1.0–2.5 cm long in 80% of cases, but may be up to 6 cm in length (Johnston & Anson 1952, Kune & Sali 1980).

The RHD is readily approached by dividing the peritoneum and fat overlying it in the porta hepatis. The right hepatic artery usually runs inferior to it, while the right branch of the portal vein lies posterior to these two structures.

'Accessory' bile ducts

Flint introduced the term 'accessory bile duct' in 1923 having found a structure in 15% of individuals which issued from the right lobe of the liver and entered the common hepatic duct (CHD) distal to the termination of the 'true' RHD. Since then many other authors have reported such 'accessory' ducts, usually in 10–30% of individuals, so that the term has become established in the nomenclature and minds of surgeons (Moosman & Coller 1951, Johnston & Anson 1952, Lichtenstein & Nicosia 1955, Michels 1955, Hayes et al 1958, Benson & Page 1976).

However, since the first description of the segmental pattern of liver drainage, several authors have shown that 'accessory' bile ducts occur in that group (approximately 25% of the population) in whom no true RHD exists — the 'extra' or 'accessory' duct and what was erroneously thought to have been the 'true' RHD in these individuals are, in fact, the two major segmental ducts from the right lobe draining separately into the LHD (Fig. 1.1c and 1.1d) (Healey & Schroy 1953, Hobsley 1958, Kune 1970). Damage to an 'accessory' duct will affect the bile drainage of a finite portion of the liver, while inadvertent, unnoticed division will lead to a sustained bile leak which may threaten the patient's life (Kune & Sali 1980).

In short, the term 'accessory' in this context (defined in Blakiston's *Gould Medical Dictionary* (1972) as pertaining to 'a lesser organ or part which supplements a similar organ or part') is both erroneous and dangerous, and should be dispensed with.

Left hepatic duct (LHD)
This structure is hardly ever seen during routine cholecystectomy, though it can be damaged during this procedure (Warren et al 1971). Unlike the right lobe, the left lobe of the liver is always drained by a single channel, the true left hepatic duct, and in most cases all its tributaries are intrahepatic (Healey & Schroy 1953, Kune & Sali 1980). The left hepatic artery usually runs below or behind the LHD, while the left branch of the portal vein may, unlike the right branch, partly spiral around the upper border of its hepatic duct to form an anterior relation of the latter as the two structures pass into the liver substance (Hobsley 1958).

The confluence of hepatic ducts

The point at which the right and left hepatic ducts join is often known to surgeons as 'the bifurcation'. From a functional standpoint, however, the term 'confluence' is more accurate; further, as 'bifurcation' suggests *two* 'branches', this term is especially inappropriate and misleading in those 25% of individuals in whom two right segmental ducts open separately into the left hepatic duct (Fig. 1.1c and 1.1d).

The confluence is always accessible in the normal individual, beneath the peritoneum in the porta hepatis; infrequently it is overlaid by the right hepatic artery. Sometimes the right and left hepatic ducts have a long extrahepatic course, so that the confluence may lie well down into the free edge of the lesser omentum where it is liable to damage during cholecystectomy.

Common hepatic duct (CHD)

This bile duct segment is of enormous surgical importance, being involved in two-thirds of postoperative strictures (Warren et al 1971). It is formed by the final confluence of all ducts issuing from the liver and ends when the lumen of the cystic duct opens into it to form the common bile duct (CBD). Its width does not differ significantly from the CBD (see below). In most individuals it is 2.5–3.5 cm in length (Flint 1923), but this is variable. In approximately 2% of cases, the CHD is non-existent, the cystic duct opening into the hepatic duct confluence (Benson & Page 1976), while in about 15–20% the CHD extends downwards behind the duodenum before the cystic duct opens into it (Flint 1923, Johnston & Anson 1952).

The major relations of the common hepatic duct are fairly constant; it lies in the right edge of the lesser omentum, with the common hepatic artery (CHA) to its left and the portal vein situated posteriorly. Its important variable neighbours are the right hepatic artery (RHA), cystic artery and cystic duct (Fig. 1.2). As the CHA normally bifurcates below the hepatic bile duct confluence, the RHA has to cross the CHD to reach the liver. In about 90% of cases, the RHA passes behind the duct, while in the rest it passes in front and is hence more prone to accidental injury (Daseler et al 1947, Michels 1955). The cystic artery usually arises in Calot's triangle and hence is not normally directly related to the CHD; in about 22%,

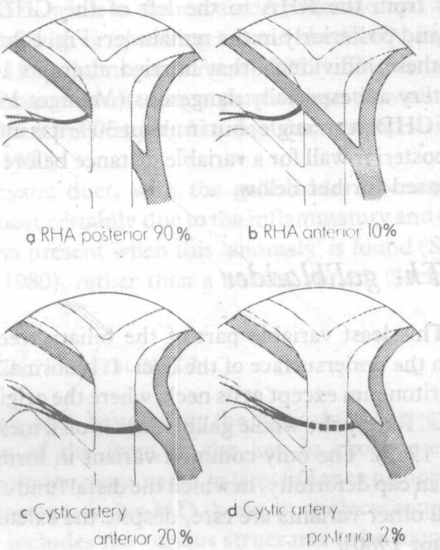

Fig. 1.2 Arterial relations of the common hepatic duct. The right hepatic artery normally passes behind the CHD (a); in the 10% in whom it passes in front of the duct (b), it is more vulnerable to operative damage. The cystic artery normally arises within Calot's triangle (a and b), but in about 22% it crosses the CHD from the left — anteriorly in 20% (c) and posteriorly in 2% (d). In these individuals hasty attempts to secure a bleeding cystic artery are particularly liable to damage the CHD.

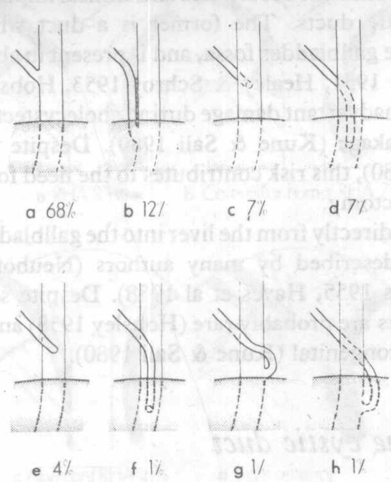

Fig. 1.3 Termination of the cystic duct (after Moosman & Coller 1951). In about two-thirds of individuals the cystic duct joins the common duct at an angle, entering its right side (a). In the remaining one-third (b–h) it either runs parallel with the duct, often incorporated in its wall, or spirals around it before entering the lumen. In all these situations, the dissection involved in an attempt to remove the *whole* cystic duct may damage the common duct or its blood supply.

however, it arises from the RHA to the left of the CHD, thence crossing it anteriorly in 20% and posteriorly in the remainder (Fig. 1.2c and 1.2d) (Daseler et al 1947). It is in these individuals that hurried attempts to secure a retracted, bleeding cystic artery are especially dangerous (Maingot 1980). The cystic duct normally joins the CHD at an angle, but in about 30% it is intimately bound to the right, anterior or posterior wall for a variable distance before the lumina join (Fig. 1.3). This is discussed further below.

The gallbladder

This least variable part of the biliary tree is usually globular, lying in its fossa on the undersurface of the liver. It is normally bound down to the liver surface by peritoneum except at its neck, where the origin of the cystic duct is enveloped in serosa. Rarely the whole gallbladder is on a mesentery, predisposing to torsion (Ashby 1965). The only common variant in form, occurring in up to 18%, is the Phrygian cap deformity, in which the distal fundus is folded upon itself (Boyden 1935). All other variants are rare, despite the exhaustive descriptions in some texts (Maingot 1980).

The arterial supply is via the cystic artery, which usually arises from the right hepatic artery in Calot's triangle (vide supra: CHD). In 15–20% of individuals an accessory cystic artery is present (Flint 1923, Michels 1955, Benson & Page 1976, Northover 1980) which also usually arises from the RHA. Venous drainage is via vessels running directly into the liver and several veins which join the pericholedochal venous plexus (vide infra: Bile duct blood supply — venous drainage).

Controversy surrounds the occurrence and clinical importance of the subvesical and cholecystohepatic ducts. The former is a duct which runs in the liver substance deep to the gallbladder fossa, and is present in about 50% of individuals (Moosman & Coller 1951, Healey & Schroy 1953, Hobsley 1958, Balasegarem 1970); it is liable to inadvertant damage during cholecystectomy, which may cause troublesome bile leakage (Kune & Sali 1980). Despite views to the contrary (Chilton & Mann 1980), this risk contributes to the need for routine use of a drain following cholecystectomy.

Bile ducts passing directly from the liver into the gallbladder (cholecystohepatic ducts), have been described by many authors (Neuhof & Bloomfield 1945, Williams & Williams 1955, Hayes et al 1958). Despite some reports of a high incidence, these ducts are probably rare (Hobsley 1958) and usually secondary to disease rather than congenital (Kune & Sali 1980).

The cystic duct

This structure is very variable in length and mode of union with the common hepatic duct. It arises from the neck of the gallbladder, usually rapidly narrowing to 1–3 mm internal diameter. In most people, the duct follows a straight oblique course to join the CHD. The junction is easily seen with minimal dissection in about 65%, while in the remainder, often deceptively, the duct runs a longer course, parallel with or spiralling around the CHD (Fig. 1.3) (Flint 1923, Moosman & Coller 1951, Johnston & Anson 1952). The distal part of the cystic duct in these circumstances is often incorporated into the wall of the CHD so that attempts to remove it entirely may lead to duct damage and stricture (Warren et al 1971, Kune & Sali 1980).

Absence of the cystic duct, with the gallbladder opening directly into the common duct, is almost certainly due to the inflammatory and erosive effect of the large gallstone always present when this 'anomaly' is found (Sutton & Sachatello 1967, Kune & Sali 1980), rather than a normal variant (Jackson & Kelly 1964).

Calot's triangle

This area, bounded by the cystic duct, common hepatic duct and the inferior surface of the liver, is the key to cholecystectomy. J-F. Calot (1861–1944), a Frenchman more noted in later life as an orthopaedic surgeon, first emphasised its importance in his MD thesis on cholecystectomy in 1890 (Wood 1979). The triangle includes the various structures to be sought or avoided when isolating the gallbladder (Fig. 1.4). Moosman & Coller (1951) highlighted the dangers in this area when they reported that, within the triangle and in accidental reach of a clamp placed on the cystic duct, are: the right hepatic artery in 83% of individuals, the aberrant right hepatic artery, when present, in 93% (i.e. in 16% of all individuals), and an 'accessory' bile duct, when present, in 85% (approximately

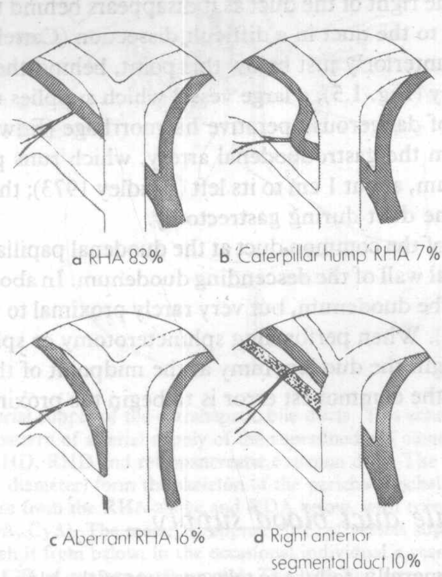

Fig. 1.4 Incidence of structures at risk in Calot's triangle. These structures all lie within range of a clamp carelessly applied to the cystic duct. The 'caterpillar hump' RHA (b) may be seen approaching the gallbladder and mistaken for the cystic artery, with serious results.

10% of all individuals). The RHA is in especial danger when it describes a loop to the right (the 'caterpillar hump') within the triangle, towards the neck of the gallbladder, as it does in about 7% (Benson & Page 1976); it may then be mistaken for the cystic artery and divided.

A thorough knowledge of the variations within Calot's triangle is surely a fundamental requirement for those embarking on biliary surgery.

Common bile duct (CBD)

Formed by the confluence of the common hepatic and cystic ducts, the CBD is normally located in the free edge of the lesser omentum, and subsequently passes behind the pancreas to enter the second part of the duodenum. In up to 20% of individuals, however, the CBD is not visible, as the confluence lies behind the duodenum or pancreas (Flint 1923, Moosman & Coller 1951, Johnston & Anson 1952).

The diameter of the CBD is variable; since the advent of operative cholangiography the individual importance of diameter as an indication for duct exploration has diminished. Sometimes, however, when the cholangiogram is difficult to interpret, duct diameter is a useful parameter in the decision to explore. Leslie (1968), in a useful practical study, found that ducts below 9 mm in diameter never contained stones, while those over 17 mm always had distal obstructive pathology, hence deserving exploration.

The CBD has several surgically important relations. The 'common duct lymph gland', located to the right of the duct as it disappears behind the duodenum, can be a useful pointer to the duct in a difficult dissection (Cattell & Braasch 1959). Crossing the duct anteriorly just below this point, behind the duodenum, is the retroduodenal artery (Fig. 1.5), a large vessel which supplies the duct and which can be the source of dangerous operative haemorrhage (Edwards 1941, Henley 1955). It arises from the gastroduodenal artery, which runs parallel to the duct behind the duodenum, about 1 cm to its left (Bradley 1973); this constant relation aids avoidance of the duct during gastrectomy.

The termination of the common duct at the duodenal papilla is normally found on the posteromedial wall of the descending duodenum. In about 5% the papilla is in the third part of the duodenum, but very rarely proximal to its normal position (Lindner et al 1976). When performing sphincterotomy or sphincteroplasty it is therefore best to begin the duodenotomy at the midpoint of the second part and proceed distally — the commonest error is to begin too proximally (Kune & Sali 1980).

Bile duct blood supply

Generally, failure to take account of the blood supply of an organ at operation can lead to disastrous complications (Michels 1955). However, the blood supply of the bile duct has received scant attention from surgeons and anatomists alike, almost certainly because the duct survives routine surgical