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REVIEW ARTICLE

What is the Duct of Luschka?—A Systematic Review

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Abstract
Background Subvesical bile ducts (frequently termed incorrectly "ducts of Luschka") have gained increased clinical recognition in the era of laparoscopic cholecystectomy. Though cited frequently and discussed in the literature, the original description by Hubert von Luschka and many anatomic details of these subvesical bile ducts remain ill-defined.
Study design A systematic literature search was conducted including publications that described either radiographic features or gross anatomy of bile ducts in close contact with the gallbladder fossa. Of 2,545 publications identified from electronic databases, 116 met inclusion criteria.
Results Of 116 articles, 13 incorporated a prevalence study design. These 13 articles investigated 3,996 patients, of whom 156 were diagnosed with a subvesical duct for a prevalence of 4%. The prevalence in articles focusing on subvesical bile ducts was greater than in articles studying biliary anatomy in general (10% versus 3%; $p<0.0001$). Furthermore, of 116 articles, 54 provided detailed anatomic information identifying 238 subvesical ducts, most of which represented accessory ducts. The origin and drainage of these ducts were limited primarily to the right lobe of the liver, but great variation was seen. The mean diameter of the subvesical ducts was 2 mm (range 1–18 mm).
Conclusions The term "ducts of Luschka" should be abandoned and should be replaced by the correct term of "subvesical bile duct". The variability in anatomic location of subvesical bile ducts puts them at risk during hepato-biliary operations. A better understanding of ductal anatomy is elemental in preventing and managing operative injury to the subvesical ducts. This review debunks common myths about the so-called "duct of Luschka" and offers a systematic overview of the anatomy of the subvesical bile duct.

Keywords Duct of Luschka · Subvesical bile duct · Biliary anatomy

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Introduction

Despite being a common subject of discussion, many misperceptions exist about the "ducts of Luschka" or subvesical bile ducts. Some think of them as small bile ducts that drain directly into the body of the gallbladder; others consider them to be networks of miniscule bile ducts between the liver capsule and the gallbladder; while modern literature suggests alternate explanations. With this lack of consensus, clarification of anatomic details of subvesical bile ducts appears necessary.

Though cited and discussed frequently in the literature, the original description by the German anatomist Hubert von Luschka is poorly referenced. In his famous textbook of 1863, Luschka published in detail the anatomy of various organ systems, including the liver, gallbladder, and biliary

tree.[1] Of particular interest, on pages 256 and 257 of his textbook, Luschka described two different tubular structures associated with the wall of the gallbladder. The first type of tubular structure consisted of intra-mural glands draining into the gallbladder lumen, later termed "Luschka crypts." The second type of tubular structure consisted of a network of microscopic ducts within the soft tissue surrounding the gallbladder. Translated from the original German version, Luschka describes:

> From these unquestionably glandular components of the gallbladder ["Luschka crypts"] one must differentiate other hollow structures, which I never completely missed in the already dense connective layer of its wall, in particular also on the peritoneum covered side. These are unequally wide ducts in form and size roughly similar to Beal's liver tubes that have multiple anastomoses amongst each other and are here and there provided with a piston-like attachment. In full clarity, they only become apparent, when the connective fibers by addition of acetic acid become homogeneous. Their wall consists of a very tender base membrane that from the outside has only sparse elongated nuclei resting upon. Their content consists of isolated, larger, round cells with an obvious nucleus that usually includes a larger nucleolus. In addition, one encounters a molecular detritus that in parts represents the only content as well as numerous pigment bodies that according to their behavior to nitric acid were identified as bile pigment. I have not found an open connection of these tubes with any space and I am of the opinion that they represent metamorphosed remnants attached to the wall of the gallbladder of the embryologic basis of which the liver cell network derived.[1]

While preparation of histologic specimens in the 1860s cannot be compared to current standards, the findings of ducts lined with cuboidal epithelium and filled with bile pigment are suggestive of bile ducts, though the very real possibility of preparation artifacts cannot be excluded. The oddity is that according to Luschka, this network of ducts surrounded the circumference of the gallbladder surface and was present on the hepatic as well as peritoneal surface of the gallbladder. Questions also arise about the suggestion that this network of ducts is present to varying extents in most people. From a modern perspective, it is likely that the tubular structures Luschka observed represented lymphatic vessels in the majority and in a few may have been aberrant bile ducts.

Over the years, small subvesical bile ducts were termed "ducts of Luschka" despite the discrepancy with Luschka's original publication. These unusual bile ducts have received many acronyms, such as sub- or supravesicular ducts and were considered frequently to be aberrant ducts. Many aspects of these subvesical bile ducts have been subject to investigation and have been reported in the literature in numerous confusing and contradicting descriptions. Yet, a broadly accepted, fundamental understanding of subvesical ducts is missing in the biliary lexicon, evident by the lack of a common definition, clear anatomic details, and a systematic classification. The aim of this review is to clarify the common myths associated with the subvesical bile ducts or "ducts of Luschka" and to define the proper anatomy.

Methods

Systematic Literature Search and Study Selection

A systematic literature search of electronic databases, including PubMed (National Library of Medicine), EMBASE (Elsevier) and PubMed Central (National Library of Medicine), was conducted with the last search carried out on July 14, 2009. The term "bile duct(s)" was used in combination with the following other search terms: "Luschka", "subvesical/subvesicular", "supravesical/supravesicular", "accessory", "aberrant", "(chole)cyst(ic)ohepatic", "hepat(ic)o(chole)cystic", "subserosal", and "subcholecystic". The literature search was performed without restriction of year of publication. Studies were limited to the English language and human studies. Original articles, review articles, editorials, and letters-to-the-editor were considered only if original patient data were provided by the author. Abstract publications from local, national, or international meetings were excluded. To be included in our review, the publication had to describe radiographic features or gross anatomy of bile ducts in close contact with the gallbladder fossa. Bile ducts in close contact with the cystic duct but not the gallbladder fossa and bile ducts whose relationship to the gallbladder fossa was not specified were excluded. The references of the selected studies were cross-searched for additional relevant literature.

Data Collection

Only studies describing bile ducts traversing within or in close contact with the gallbladder fossa were included, including gallbladder interposition (i.e., the common hepatic bile duct or both hepatic bile ducts draining into the gallbladder). For review of the prevalence of subvesical bile ducts, only articles with population- or institution-based prevalence study design were considered. This approach mandated review of the biliary anatomy in the entire study cohort. Studies that provided data on the incidence of operative injuries to subvesical bile ducts alone were not sufficient for prevalence assessment. For review of the anatomy

of subvesical bile ducts, the studies had to report either the origin or the endpoint of the duct. Studies that had insufficient anatomic details were excluded. For a bile duct to be classified as "hepaticocholecystic duct", evidence of the duct draining into the gallbladder lumen was required; injury during cholecystectomy alone was not sufficient. The term "accessory bile duct" was reserved for bile ducts supernumerary from the formal biliary anatomy. The term "aberrant bile duct" was limited to bile ducts embedded in connective tissue on the surface of the liver in the absence of surrounding hepatic parenchyma.

The systematic literature search was performed by a single investigator (T.S.). Of 2,545 publications identified from the electronic databases, 116 met inclusion criteria for the systematic review (Fig. 1). Publications that met inclusion criteria for systematic review were subject to data collection performed independently by two investigators (T.S., D.B.A.).

Statistical Methods

The pooled results on overall prevalence and prevalence of anatomic landmarks were described as a percentage or mean unless specified otherwise. Each study was weighted according to sample size. Chi-square test was used to compare results between groups.

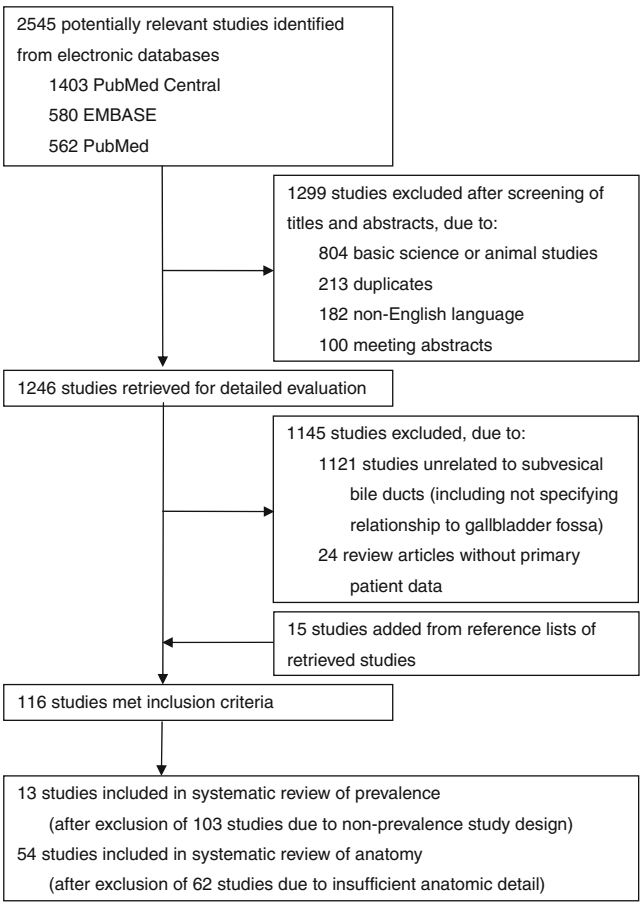

Fig. 1 Selection of articles for inclusion in systematic review

Results

Prevalence of Subvesical Bile Ducts

Of 116 articles which met inclusion criteria, 13 [2–14] incorporated a prevalence study design. All 13 studies reported data from original articles. The date of publication ranged from 1937 to 2006. All articles had a study design based on institutional prevalence; no population-based studies were identified. Eleven articles involved anatomic screening performed on cadavers or operative specimens, while two articles involved radiographic screening. These 13 articles comprised 3,996 patients, of whom 156 were diagnosed with a subvesical duct for a prevalence of 4%. The prevalence within each article ranged from 0.1% to 55% (median 5%). Only 4 of the 13 articles focused on the prevalence of subvesical bile ducts as the primary end-point, while the remaining studies were anatomic evaluations of biliary anatomy in general. The prevalence in the articles focusing on subvesical bile ducts was greater than in the remaining articles (10% versus 3%; $p<0.0001$).

Anatomy of Subvesical Bile Ducts

Of 116 articles that met inclusion criteria, 54 [3–11,13–57] provided detailed anatomic information on either the origin and/or the endpoint of the bile ducts traversing in contact with the gallbladder fossa. These 54 articles were published between 1942 and 2008, including original articles or case series in 49, letters-to-the-editor or brief communications in 4, and review articles with case series in one article. The method of diagnosis included radiographic tests in 24 articles, gross or microscopic anatomic inspection in 17, and a combination of both in 13. These examinations were performed during either an operation in 30 articles, clinical evaluation in 14, post-mortem examination in 5, or evaluation of operative liver specimens in 3; two articles used more than one setting.

In these 54 articles, 229 patients were identified whose description met inclusion criteria and the article provided anatomic details (mean age at diagnosis 49 years, female 63%). Fifty-seven patients had an incidental finding of an asymptomatic subvesical duct, while 25 were diagnosed after injury to a subvesical bile duct, 7 had symptoms ostensibly originating directly from the subvesical bile duct, and in 140, the status of symptoms was unknown. Of these 229 patients, 9 had more than 1 subvesical bile duct for a total of 238 subvesical bile ducts. Of these 238 ducts, 54 represented accessory bile ducts, 19 were main bile ducts, 3 were

segmental or sectorial bile ducts, and 1 was an aberrant bile duct network; exact classification was not possible in 161.

The origin and drainage of these ducts is listed in Table 1. Although the gallbladder fossa straddles the right and left anatomic lobe of the liver, 69% of subvesical bile ducts (43 of 62 with a known site of origin) originated from the right lobe. Drainage into the right lobe occurred in 40% of subvesical bile ducts (86 of 215 with a known site of drainage), while drainage into the gallbladder was the most common site of final drainage (48%—i.e., hepaticocholecystic bile ducts). Beyond this right-sided distribution, a common pattern was not detected, because subvesical bile ducts varied in size, involved different duct classifications, and had different points of origin or drainage.

Further information about anatomic details remains scarce. The diameter of the subvesical bile ducts was mentioned only for 55 ducts. The average diameter in these 55 ducts was 2 mm (range 1–18 mm). The length of the bile duct segment traversing along the gallbladder fossa was measured for only 33 ducts and was on average 35 mm (range 8–82 mm). Histologic details were only provided in two articles. The relation of the subvesical bile duct to the liver capsule was not described reliably with the exception of one article.

Discussion

Knowledge of the anatomy of the biliary tree with its well-known tendency for structural variations is important to surgeons operating in the right upper quadrant. One of the more common anatomic variations of concern is the subvesical bile duct (incorrectly known as the "duct of Luschka"). Subvesical bile ducts are important from a clinical perspective and pose a potential risk for injury during gallbladder and hepatic operations. Recent studies suggest that clinically relevant bile leaks complicate approximately 0.4–1.2% of cholecystectomies.[58–61] Injury to a subvesical duct is one of the most common causes of cholecystectomy-associated bile leak and occurs as often as major bile duct injuries and leaks from the cystic duct stump.[58–61] Indeed, recent studies suggest that about 27% of clinically relevant bile leaks are caused by inadvertent injury to a subvesical bile duct [58–61]; this finding provides an estimated incidence of clinically relevant subvesical bile duct leaks after cholecystectomy in 1 of every 633 operations. With about 550,000 cholecystectomies performed annually in the United States,[62] one would expect about 868 patients to be affected in this country annually by clinically relevant injuries to a subvesical bile duct from this operation alone.

The true prevalence of subvesical bile ducts has been the subject of considerable debate. In this systematic review, we found an overall prevalence of subvesical bile ducts of 4% in institution-based reports. Potential exists that this reported prevalence overestimates the true prevalence, because only studies with positive findings of subvesical ducts were included, while studies with negative results were not part of this review. In contrast, the limited sensitivity of detecting small subvesical bile ducts may result in an underestimation of the true prevalence. Indeed, studies that focused on subvesical bile ducts were able to identify subvesical bile ducts in 10% of the population, suggesting a true prevalence of greater than 4%. Taking into consideration the prevalence of subvesical ducts found in this review and the incidence of subvesical bile duct injuries described after cholecystectomy,[58–61] one can estimate that about 1 in 25 patients with a subvesical bile duct will suffer from a potentially preventable and clinically relevant bile leak after cholecystectomy. Actual injury to the subvesical bile duct is likely to occur even more frequently, because many of these injuries are thought to remain asymptomatic. Regarding management of subvesical bile duct injuries, this review demonstrated that not all such ducts are accessory ducts. The broadly accepted intra-operative approach of ligation of small ducts and reconstruction of larger ones appears appropriate, recognizing that there is a potential risk for undrained hepatic segments. Hence, knowledge about the proximal and distal anatomy of the injured subvesical bile duct may prove quite crucial.

Anatomic knowledge about the subvesical bile duct is confounded by a multitude of different descriptions of these subvesical bile ducts in the literature, and no standardized definition exists or is accepted universally. Through the

Table 1 Anatomic and radiographic descriptions of 238 subvesical bile ducts

Origin of subvesical bile duct		Drainage of subvesical bile duct	
Gallbladder mesentery	3	Gallbladder	103
Segmental duct	28	Segmental duct	9
B4 segmental duct (n=2)		B5 Segmental duct (n=5)	
B5 segmental duct (n=20)		B6 segmental duct (n=4)	
B6 segmental duct (n=1)		Sectorial duct	35
Segment from right hepatic lobe (n=4)		Right posterior sectorial duct (n=6)	
Segment from left hepatic lobe (n=1)		Right anterior sectorial duct (n=29)	
Sectorial duct	6	Main duct	68
Right posterior sectorial duct (n=4)		Common hepatic duct (n=19)	
Right anterior sectorial duct (n=2)		Right hepatic duct (n=42)	
Main duct	25	Left hepatic duct (n=6)	
Common hepatic duct (n=10)		Cystic duct (n=1)	
Right hepatic duct (n=12)		Unknown	23
Left hepatic duct (n=3)			
Unknown	176		

information gathered in this systematic review, the following conclusions became evident: the subvesical bile duct is a topographic description of a bile duct (or bile ducts) which run in contact with the gallbladder fossa. In general, most subvesical bile ducts are part of the biliary system of the right hepatic lobe. This description can encompass different types of bile ducts, including (1) superficial variations of segmental and sectorial bile ducts, (2) superficial or intercommunicating accessory bile ducts, (3) hepaticocholecystic ducts, and (4) aberrant bile ducts (Table 2; Fig. 2). A reliable statement about the prevalence of each anatomic subtype cannot be made due to the expected presence of a strong publication bias with a tendency to publish case reports with rather rare and curious abnormalities/anomalies. Also, the prevalence of small aberrant bile ducts is expected to be underreported because most will not appear on radiographic imaging and, in the case of an operative injury, many will likely not cause a clinically relevant or even recognized bile leak. Bile ducts in close contact with the cystic duct but not the gallbladder fossa should be considered separately from subvesical bile ducts. Although rare, it is important to recognize gallbladder or cystic duct duplications which can present with an "additional duct" in the cholecystohepatic triangle of Calot. While these duplications can sometimes mimic subvesical ducts, they need to be considered separately as well.

Table 2 Types of subvesical bile ducts

1) Segmental or sectorial subvesical bile duct
Definition: bile duct with unusual superficial course in proximity to gallbladder fossa, but otherwise typical anatomy
Typical location: right posterior segmental or sectorial duct draining separately into main duct; the entire duct can run superficial to the gallbladder (especially in intra-hepatic gallbladders) or only part of the duct can arch or loop toward the gallbladder
Prevalence: common
2) Accessory subvesical bile duct
Definition: bile duct supernumerary from the formal biliary tree
Typical location: originating from the right posterior or right anterior sector draining into a main bile duct while coursing along the gallbladder fossa
Prevalence: likely the most common type
Subtype: intercommunicating accessory subvesical bile duct (accessory duct between major intra-hepatic biliary channels)
3) Hepaticocholecystic bile duct
Definition: bile duct that drains directly into the gallbladder
Typical location: sectorial bile duct from the right lobe draining into the gallbladder
Prevalence: as a curious anatomic variant, its prevalence is likely over-reported in relation to other types of subvesical ducts
Subtype: gallbladder interposition (common hepatic duct or both hepatic ducts draining into gallbladder; very rare)
4) Aberrant subvesical bile duct
Definition: network of small bile ducts within the connective tissue/capsule of the gallbladder fossa
Typical location: in the peri-hepatic connective tissue of the gallbladder fossa; usually ending blindly in the periphery but connecting with intra-hepatic bile ducts centrally
Prevalence: rare

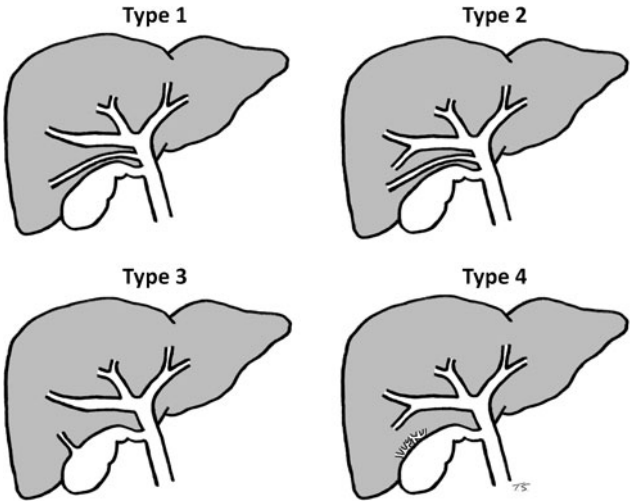

Fig. 2 Types of subvesical bile ducts: type 1—segmental or sectorial subvesical bile duct, type 2—accessory subvesical bile duct, type 3—hepaticocholecystic bile duct, type 4—aberrant subvesical bile duct

Detailed histologic descriptions of subvesical ducts are for the most part absent. It is a frequent perception that subvesical ducts, different from the classic portal triad of larger segmental bile ducts, are not accompanied by a portal vein and hepatic artery, which are usually only absent with septal and interlobular bile ducts that are typically less than 0.3 mm in diameter.[63] The origin of this perception is not entirely clear, because the published literature does not provide adequate documentation or information to make this conclusion. The presence of peri-biliary glands, which are usually seen in the segmental bile ducts but not in septal and interlobar ducts,[63] is unknown for subvesical bile ducts. Furthermore, the association of subvescial bile ducts with the liver capsule (intra- versus extra-hepatic) is also unclear.

Little is known also about the etiology of subvesical bile ducts. It is conceivable that subvesical bile ducts may represent a congenital variation or an acquired condition. First, autonomous embryologic growth of bile ducts from the ductal plate during early development forming variations of new bile ducts in atypical locations is a commonly stated theory on the embryologic development of subvesical bile ducts.[8] These variations are thought to originate from the liver anlage, but theoretically they could also originate from the gallbladder anlage itself, which would explain a potential anatomic course outside the liver capsule. Such new growth of bile ducts must be of congenital origin, because developed bile ducts can either vanish or hypertrophy due to environmental factors, but it is thought that totally new bile ducts cannot be produced de novo.[64] The theory of autonomous

growth does not explain why these bile ducts occur at this particular location and have not been recognized in various other areas of the liver, with the exception of aberrant bile ducts in the peri-hepatic ligaments or peri-cholecystic tissue. Regarding an acquired condition, one theory states that subvesical bile ducts might be normally developed peripheral bile ducts located in an area where liver parenchyma regressed as part of the hepatic remodeling.[8] Also, it is possible that detectable subvesical bile ducts are the result of hypertrophy of parenchymal branches caused by local inflammation, like cholecystitis. Overall, it is conceivable but unproven that bile ducts close to the liver surface are probably common in other areas of the liver as well, but due to lack of their clinical relevance, such bile ducts have not received the same amount of attention or scrutiny.

In respect to Luschka's publication, reports of networks of ducts on the mesenteric and peritoneal surface of the gallbladder similar to Luschka's description have been reported in the older literature.[65] It is conceivable that the earlier reports of "bile duct networks" were in fact peri-cholecystic lymphatic vessels. Hence, we believe that Luschka did not describe any subvesical biliary conduits. The term "duct of Luschka", therefore, provides an imprecise description and should be avoided completely. In our opinion, the term "subvesical bile duct", which has already been proposed by several authors in the past, appears more appropriate. Nevertheless, the term "subvesical bile duct" can also have limitations in providing sufficient information, because this term focuses only on the relationship to the gallbladder. We suggest reserving the use of this term only when further detailed anatomy is unknown. In patients where more precise anatomy is known, a more detailed description should be used, e.g., "subvesical segment V bile duct" or "subvesical accessory right posterior sectorial bile duct" or "subvesical aberrant bile duct." Note that the term "hepaticocholecystic bile duct" does not require the addition of the adjective "subvesical" but should include its origin, e.g., "right lobar hepaticocholecystic bile duct." In accordance with this review, a proposed definition of the "subvesical bile duct" should include "any bile duct traversing in close contact with the gallbladder fossa."

In summary, subvesical bile ducts represent a plethora of various anatomic variations which have in common that a part of the bile duct traverses in close contact with the gallbladder fossa. While the traditional teaching typically only includes hepaticocholecystic and aberrant bile ducts, bile ducts near the gallbladder fossa are comprised of four types. They can be categorized into (1) segmental or sectorial subvesical bile ducts, (2) accessory subvesical bile ducts, (3) hepaticocholecystic bile ducts, and (4) aberrant subvesical bile ducts. Although the gallbladder fossa borders on both the right and left lobe of liver, there is a tendency for subvesical bile ducts to originate from and/or drain into the right lobe. Like most intra-hepatic bile ducts, subvesical bile ducts are rather small in diameter measuring on average 2 mm in size, which makes them difficult to identify on preoperative imaging; though great variations in size can occur. Vigilance of these anatomic variations is crucial to minimize the risk of operative injury, particularly during cholecystectomy. We believe that most subvesical bile ducts (type 1 and 2) are injured when surgeons deviate from proper anatomic planes; rarely injury of subvesical bile ducts (type 3 and 4) is inevitable.

References

1. Luschka H. Die Anatomie des Menschen in Rücksicht auf die Bedürfnisse der praktischen Heilkunde bearbeitet. Die Anatomie des menschlichen Bauches. Tübingen: Laupp; 1863;2(1):235-263.
2. Balasegaram M. Hepatic surgery: present and future. Ann R Coll Surg Engl 1970;47:139-158.
3. Benson EA, Page RE. A practical reappraisal of the anatomy of the extrahepatic bile ducts and arteries. Br J Surg 1976;63:853-860.
4. Daseler EH, Anson BJ, Hambley WC, Reimann AF. The cystic artery and constituents of the hepatic pedicle. Surg Gynecol Obstet 1947;85:47-63.
5. Govsa F, Aktan ZA, Varol T, Uckan H, Arisoy Y, Senyilmaz Y. Variations in the union of the ductus cysticus with the ductus hepaticus communis. Turk J Gastroenterol 1996;7:163-167.
6. Gupta SC, Gupta CD, Arora AK, Gupta SB. A study of subvesical duct in corrosion casts. Indian J Med Res 1977;66:338-340.
7. Healey JE, Schroy PC. Anatomy of the biliary ducts within the human liver. Arch Surg 1953;66:599-616.
8. Kitami M, Murakami G, Suzuki D, Takase K, Tsuboi M, Saito H, Takahashi S. Heterogeneity of subvesical ducts or the ducts of Luschka: a study using drip-infusion cholangiography-computed tomography in patients and cadaver specimens. World J Surg 2005;29:217-223.
9. Ko K, Kamiya J, Nagino M, Oda K, Yuasa N, Arai T, Nishio H, Nimura Y. A study of the subvesical bile duct (duct of Luschka) in resected liver specimens. World J Surg 2006;30:1316-1320.
10. Kune GA. The anatomical basis of liver surgery. Aust NZ J Surg 1969;39:117-126.
11. Lamah M, Dickson GH. Congenital anatomical abnormalities of the extrahepatic biliary duct: a personal audit. Surg Radiol Anat 1999;21:325-327.
12. Lurje A. The topography of the extrahepatic biliary passages. Ann Surg 1937;105:161-168.
13. McQuillan T, Manolas SG, Hayman JA, Kune GA. Surgical significance of the bile duct of Luschka. Br J Surg 1989;76:696-698.
14. Moosman DA, Coller FA. Prevention of traumatic injury to the bile ducts. Am J Surg 1951;82:132-143.
15. Abeysuriya V, Salgado S, Deen KI, Kumarage SK. Hepaticocystic duct and a rare extra-hepatic "cruciate" arterial anastomosis: a case report. J Med Case Reports 2008;2:37.
16. Albishri SH, Issa S, Kneteman NM, Shapiro AMJ. Bile leak from duct of Luschka after liver transplantation. Transplantation 2001;72:338-340.
17. Aoki T, Imamura H, Sakamoto Y, Hasegawa K, Seyama Y, Kubota K, Makuuchi M. Bile duct of Luschka connecting with the cystohepatic duct: the importance of cholangiography during surgery. AJR 2003;180:694-696.

18. Bledsoe SE, Maull KI. Image of the month. Arch Surg 2008;143:1127-1128.
19. Bryant TL. Laparoscopic cannulation of an accessory hepatic duct: a case report. J Laparoendosc Surg 1991;1:207-209.
20. Champetier J, Letoublon C, Alnaason I, Charvin B. The cystohepatic ducts: surgical implications. Surg Radiol Anat 1991;13:203-211.
21. Cho A, Okazumi S, Miyazawa Y, Takayama W, Natsume T, Kouno T, Ochiai T. Extrahepatic course of the subsegmental biliary branch of the anteroinferior area of the liver. Hepatogastroenterology 2003;50:1263–1265.
22. Frakes JT, Bradley SJ. Endoscopic stent placement for biliary leak from an accessory duct of Luschka after laparoscopic cholecystectomy. Gastrointest Endosc 1993;39:90–92.
23. Goor DA, Ebert PA. Anomalies of the biliary tree. Arch Surg 1972;104:302–309.
24. Hashmonai M, Kopelman D. An anomaly of the extrahepatic biliary system. Arch Surg 1995;130:673–675.
25. Hayes MA, Goldenberg IS, Bishop CC. The developmental basis for bile duct anomalies. Surg Gynecol Obstet 1958;107:447–456.
26. Heloury Y, Leborgne J, Rogez JM, Robert R, Lehur PA, Pannier M, Barbin JY. Radiological anatomy of the bile ducts based on intraoperative investigation in 250 cases. Anat Clin 1985;7:93–102.
27. Izzidien AY. Cholecystohepatic duct. J R Coll Surg Edinb 1979;24:361-362.
28. Jackson JB, Kelly TR. Cholecystohepatic ducts: case report. Ann Surg 1964;159:581–584.
29. Javors BR, Simmons MZ, Wachsberg RH. Cholangiographic demonstration of the cholecystohepatic duct of Luschka. Abdom Imaging 1998;23:620–621.
30. Jenkins MA, Ponsky JL, Lehman GA, Fanelli R, Bianchi T. Treatment of bile leaks from the cystohepatic ducts after laparoscopic cholecystectomy. Surg Endosc 1994;8:193–196.
31. Kellam LG, Howerton RL, Goco IR, Nolan RE. Accessory bile duct and laparoscopic cholangiography: report of three cases. Am Surg 1996;62:270–273.
32. Kihne MJ, Schenken JR, Moor BJ, Karrer FW. Persistent cholecystohepatic ducts. Arch Surg 1980;115:972–974.
33. Kocaoglu M, Ugurel MS, Bulakbasi N, Somuncu I. MR cholangiopancreatography of a case with a biliary tract variation and postoperative biliary duct injury. Diagn Interv Radiol 2005;11:219–221.
34. Lin RK, Hunt GC. Left hepatic duct of Luschka. Gastrointestinal Endoscopy 2004;60:984.
35. Losanoff JE, Kjossev KT, Katrov E. Hepaticocystic duct: a case report. Surg Radiol Anat 1996;18:339–341.
36. Mori S, Kasahara M. Papillary adenocarcinoma of the subvesical duct. J Hepatobiliary Pancreat Surg 2001;8:494–498.
37. Niemeier OW. Report of a case of unusual anomaly of the bile ducts in an adult with obstructive jaundice. Surgery 1942;12:584–590.
38. Niiyama H, Yoshida J, Kuroki N, Maeda Y, Nagata T. Intersegmental connection with aberrant hepatic duct. Abdom Imaging 1994;19:425–426.
39. Ortiz VN, Vidal E, Padilla JS. Surgical significance of persistent cholecystohepatic ducts. Bol Asoc Med PR 1989;81:355–358.
40. Paul M. An important anomaly of the right hepatic duct and its bearing on the operation of cholecystectomy. Br J Surg 1948;35:383–385.
41. Rappoport AS, Diamond AB. Cholangiographic demonstration of postoperative bile leakage from aberrant biliary ducts. Gastrointest Radiol 1981;6:273–276.
42. Redkar RG, Davenport M, Myers N, Howard ER. Association of oesophageal atresia and cholecystohepatic duct. Pediatr Surg Int 1999;15:21–23.
43. Roberts RH, Pettigrew RA, VanRij AM. Bile leakage after laparoscopic cholecystectomy: biliary anatomy revisited. Aust N Z J Surg 1994;64:254–257.
44. Rochon C, Metrakos P, Tchervenkov JI, Fernandez M, Paraskevas S, Barkun J, Deschesnes M, Stein L. Endoscopic stenting as first-line treatment in duct of Lushka leaks after choledochocystic anastomosis in two cases of liver transplantation. Transplantation 2005;79:740–741.
45. Schofield A, Hankins J, Sutherland F. A case of cholecystohepatic duct with atrophic common hepatic duct. HPB 2003;5:261–263.
46. Schorlemmer GR, Wild RE, Mandell V, Newsome JF. Cholecystohepatic connections in a case of extrahepatic biliary atresia. JAMA 1984;252:1319–1320.
47. Shah O. The missing common bile duct (hepaticocystic duct). Surgery 2007;142:424–425.
48. Sharif K, de Ville de Goyet J. Bile duct of Luschka leading to bile leak after cholecystectomy: revisiting the biliary anatomy. J Pediatr Surg 2003;38:E21–23.
49. Stanton R, Craig PI, Jorgensen JO, Morris DL. Leakage via aberrant bile duct due to cholangiocarcinoma. HPB Surg 1998;11:125–128.
50. Stokes TL, Old L Jr. Cholecystohepatic duct. Am J Surg 1978;135:703–705.
51. Sutherland F, Mitchell P. Accessory bile duct in the gallbladder bed. Can J Surg 2001;44:65–66.
52. Tabrisky J, Pollack EL. The aberrant divisional bile duct: a case report. Radiology 1971;99:537–538.
53. Tung HY, Hu CK, Lu YC. Duct of Luschka: a case report. Formos J Surg 2003;36:29–32.
54. van der Linden W. Anomalous hepatic ducts as accidental findings in biliary surgery. Acta Chir Scand 1967;133:83–86.
55. Walia HS, Abraham TK, Baraka A. Gall-bladder interposition: a rare anomaly of the extrahepatic ducts. Int Surg 1986;71:117–121.
56. Williams C, Williams AM. Abnormalities of the bile ducts. Ann Surg 1955;141:598–605.
57. Wright KD, Wellwood JM. Bile duct injury during laparoscopic cholecystectomy without operative cholangiography. Br J Surg 1998;85:191–194.
58. Misra M, Schiff J, Rendon G, Rothschild J, Schwaitzberg S. Laparoscopic cholecystectomy after the learning curve: what should we expect? Surg Endosc 2005;19:1266–1271.
59. Wills VL, Jorgensen JO, Hunt DR. Role of relaparoscopy in the management of minor bile leakage after laparoscopic cholecystectomy. Br J Surg 2000;87:176–180.
60. Braghetto I, Bastias J, Csendes A, Debandi A. Intraperitoneal bile collections after laparoscopic cholecystectomy: causes, clinical presentation, diagnosis, and treatment. Surg Endosc 2000;14:1037–1041.
61. Lien HH, Huang CS, Shi MY, Chen DF, Wang NY, Tai FC, Chen SH, Lai CY. Management of bile leakage after laparoscopic cholecystectomy based on etiological classification. Surg Today 2004;34:326–330.
62. National Center for Health Statistics. Health, United States, 2008. Hyattsville; 2009:387.
63. Nakanuma Y, Hoso M, Sanzen T, Sasaki M. Microstructure and development of the normal and pathologic biliary tract in humans, including blood supply. Microsc Res Techniq 1997;38:552–570.
64. Sergi C, Adam S, Kahl P, Otto HF. The remodeling of the primitive human biliary system. Early Hum Dev 2000;58:167–178.
65. Halpert B. Morphological studies on the gallbladder. Bull Johns Hopkins Hosp 1927;41:77–103.