Anatomical variants of cystic bile ducts: a Magnetic Resonance Cholangiopancreatography retrospective analysis

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Learning objectives

To describe anatomical variants of cystic bile ducts, observed with Magnetic Resonance Cholangiopancreatography (MRCP).

Background

A normal anatomy means a cystic duct, measuring 2-4 cm in length and 1-5 mm in diameter, in the middle tract of the extrahepatic biliary duct, halfway between the porta hepatis and the ampulla of Vater. It frequently shows a tortuous or serpentine course [1]. This anatomy is seen about in 58% of the population [2].

Several types of bile duct variants have been described.

According to *Turner and Fulcher* [1], cystic bile duct may inserted in:

- Right hepatic duct Fig. 2 on page 4
- Left hepatic duct (rarely) Fig. 3 on page 5
- Common hepatic duct high in the porta hepatis Fig. 4 on page 6
- Low in the intra-pancreatic or intra-duodenal portion Fig. 5 on page 7
- Low at the level of ampulla di Vater
- Into the duodenum (rarely)
- Parallel course to the extrahepatic bile duct Fig. 6 on page 8

Mortele [3] suggests cataloguing the variants in three common categories:

- Low cystic duct insertion, with fusion in the distal third of the extrahepatic biliary duct
- Medial cystic duct insertion, with fusion into left medium segment of the extrahepatic biliary duct
- Parallel course of the cystic duct with the common hepatic duct

Dohke et al. [4] reported this classification:

- Hepatic ducts emptying into or near the cystic duct
- Insertion of the cystic duct into the right hepatic duct
- A cystic duct running parallel to the common hepatic duct
- A short cystic duct
- Low insertion of the cystic duct into the common hepatic duct

In literature, the most common variants are distal implant (1.5-9%) and parallel course (1.5-25%) Table 1 on page 9.

Technique

We retrospectively evaluated cystic duct variants in 584 patients, including MRCP examinations performed by a 1.5 Tesla scanner between January 2009 and December 2011.

MRCP is a non-invasive examination without ionic radiation. About 30 minutes before the examination, patients were given approximately 150 ml of a super-paramagnetic contrast medium (Lumirem) to hide the signal given by the gastric contents and the first loop of the small intestine[5].

Revision analysis included the following set of images:

1. Two-dimensional single shot fast spin-echo with thin collimation;
2. Two-dimensional single shot fast spin-echo with slab acquisition;
3. Breath-hold and/or respiratory-triggered three-dimensional fast recovery fast spin-echo sequences.

MR Cholangiopancreatography represents cystic duct and biliary tract as hyperintense structures in T2-weighted sequences or in T1-weighted images when it contains concentrated bile. Usually, the course and the junction with the extrahepatic bile duct of the cystic duct are seen. A change in the angle of image acquisition allows for the differentiation of the cystic duct and the extrahepatic bile duct, if overlapping, and improvement in the visualization of the cystic duct and/or aberrant/accessory duct. The cystic duct is not usually visualized at axial MR imaging [1].

Images for this section:

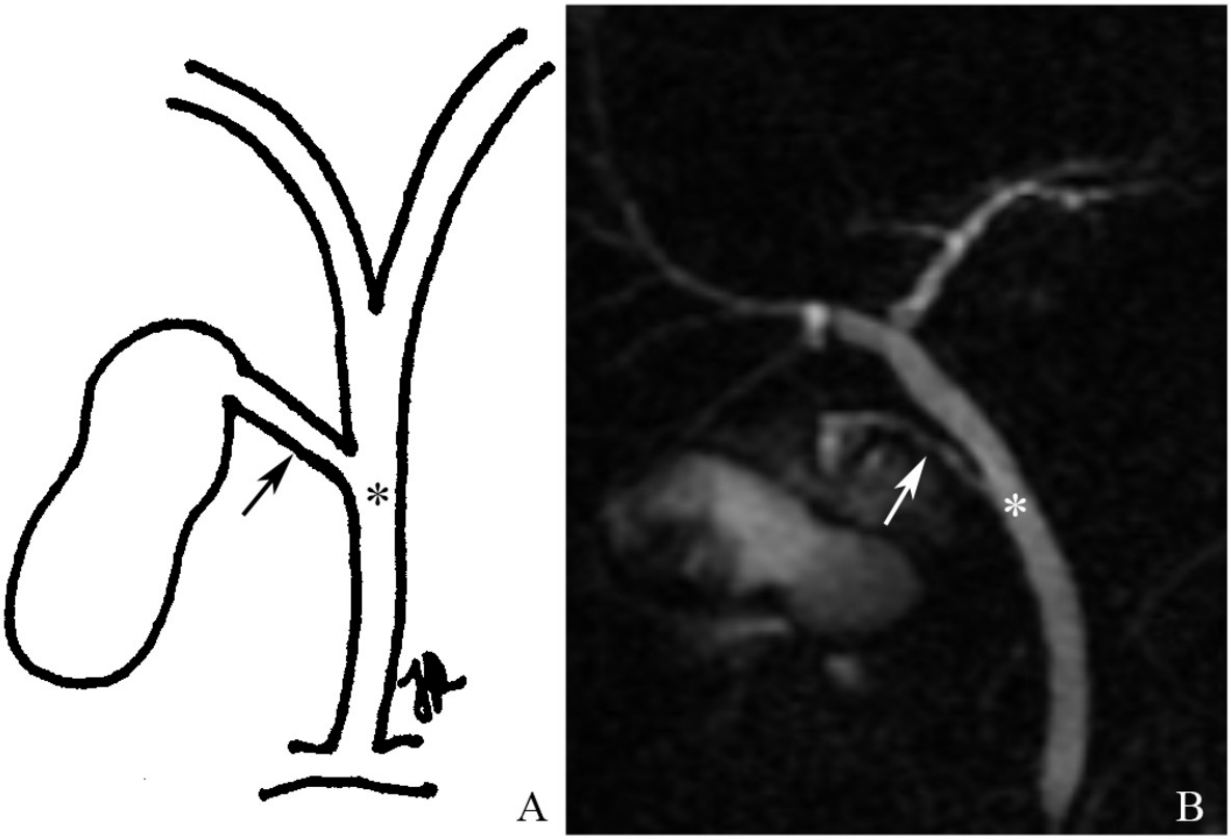


Fig. 1: Normal anatomy of cystic duct in a 29 year-old female patient. A normal anatomy means a cystic duct (black arrow in figure 1A and white arrow in figure 1B), measuring 2-5 cm in length and 1-5 mm in diameter, connecting the gallbladder to the middle tract of the extra-hepatic bile duct (asterisk symbol).

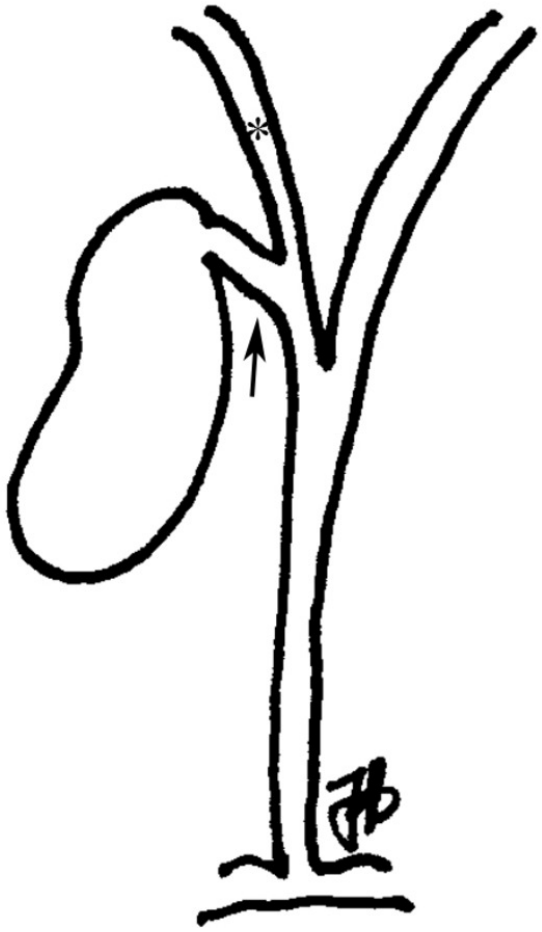


Fig. 2: Cystic bile duct (black arrow) inserted in right hepatic duct (asterisk symbol).

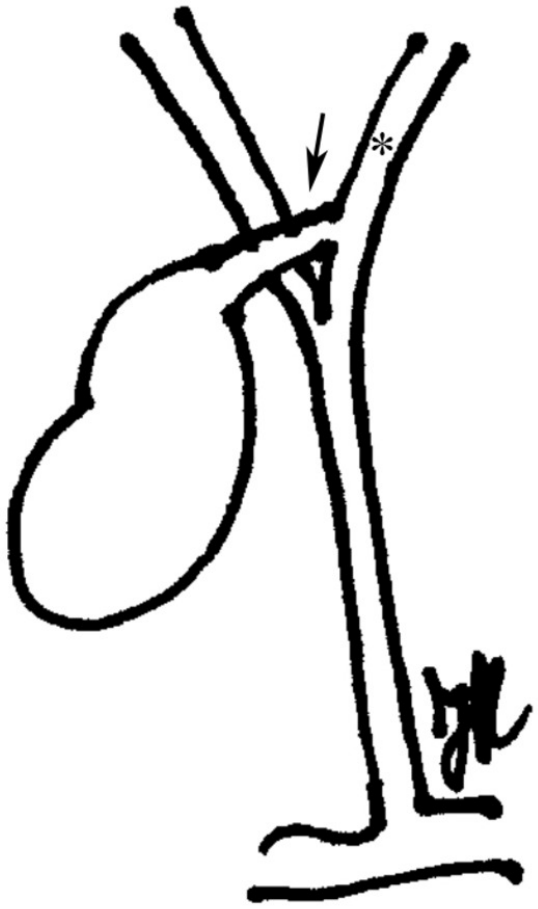


Fig. 3: Cystic bile duct (black arrow) inserted in left hepatic duct (asterisk symbol).

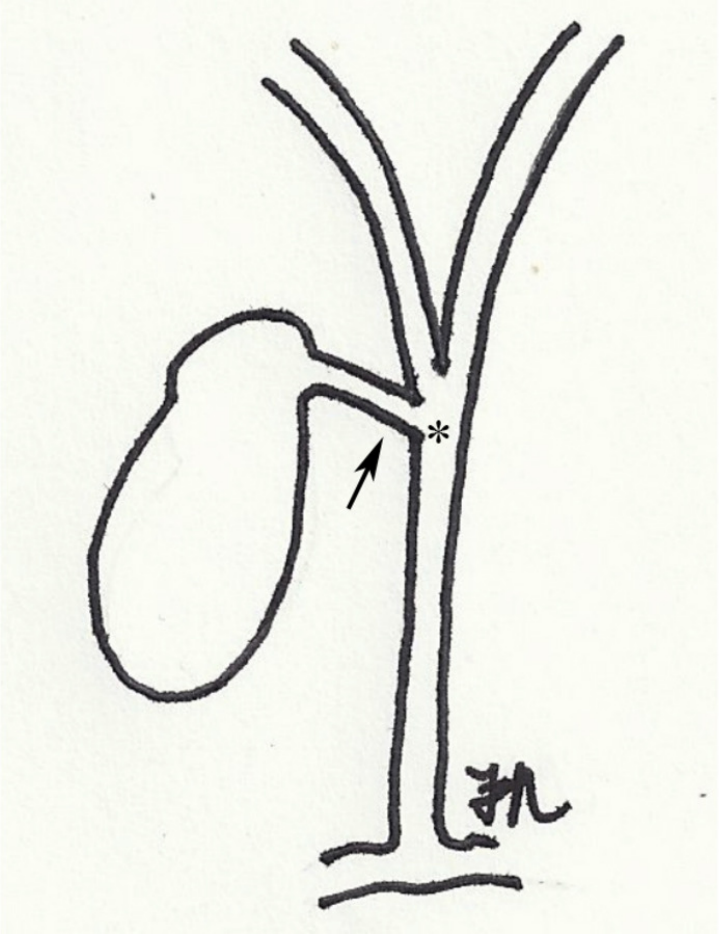


Fig. 4: Cystic bile duct (black arrow) inserted high in the porta hepatis (asterisk symbol), next to the primary biliary confluence.

Fig. 5: Cystic bile duct (black arrow) inserted low in the intra-pancreatic portion of biliary duct (asterisk symbol).

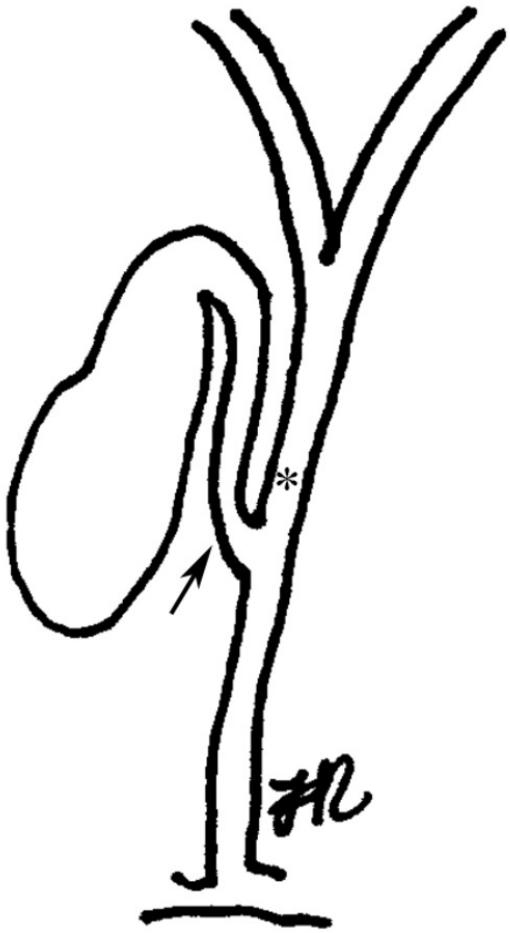


Fig. 6: The drawing shows the cystic bile duct (black arrow) with parallel course to the extra-hepatic bile duct (asterisk symbol).

	Puente et al. (1983)	Ausch et al. (2005)	Mortele et al. (2006)	De Filippo et al. (2008)
Distal	8 (1.5%)	7 (2,5%)	9%	4,5%
Proximal	12 (0,3%)	6 (2,1%)		
Into accessory/aberrant duct	1			
Into right hepatic duct				2.7%
Parallel course	61 (1,5%)	6 (2.1%)	1.5-25%	

Table 1: Distribution of cystic bile variants according to several classifications reported in literature.

Imaging findings OR Procedure details

Anatomical variants have been described following a standardized evaluation system considering the course and the level of implant (according to Turner et al. Classification) [1].

In our series, anatomic variants of the cystic duct have been described in 103 patients (17.6%) Table 2 on page 14; 81 patients (13.9%) showed abnormal implant: a distal insertion has been revealed in 41 cases (7%) Fig. 7 on page 15 Fig. 8 on page 15, whereas a proximal one in 31 cases (5.3%) Fig. 9 on page 16. In 3 patients (0.5%), the cystic duct drained into the right hepatic duct Fig. 10 on page 17 Fig. 11 on page 18 and in 6 patients (1%) into aberrant/accessory duct Fig. 12 on page 19 . Variants in the course of the cystic bile duct have been described in 41 patients (7%); the cystic duct has a parallel course, known as bayonetted cystic duct [2], to the common hepatic duct in 18 patients (3.1%) Fig. 13 on page 20 and it curls around the common hepatic duct in 23 cases (3.9%).

Finally, we observed an aberrant hepatic duct emptying into the cystic duct in 8 patients (1.4%) Fig. 14 on page 21.

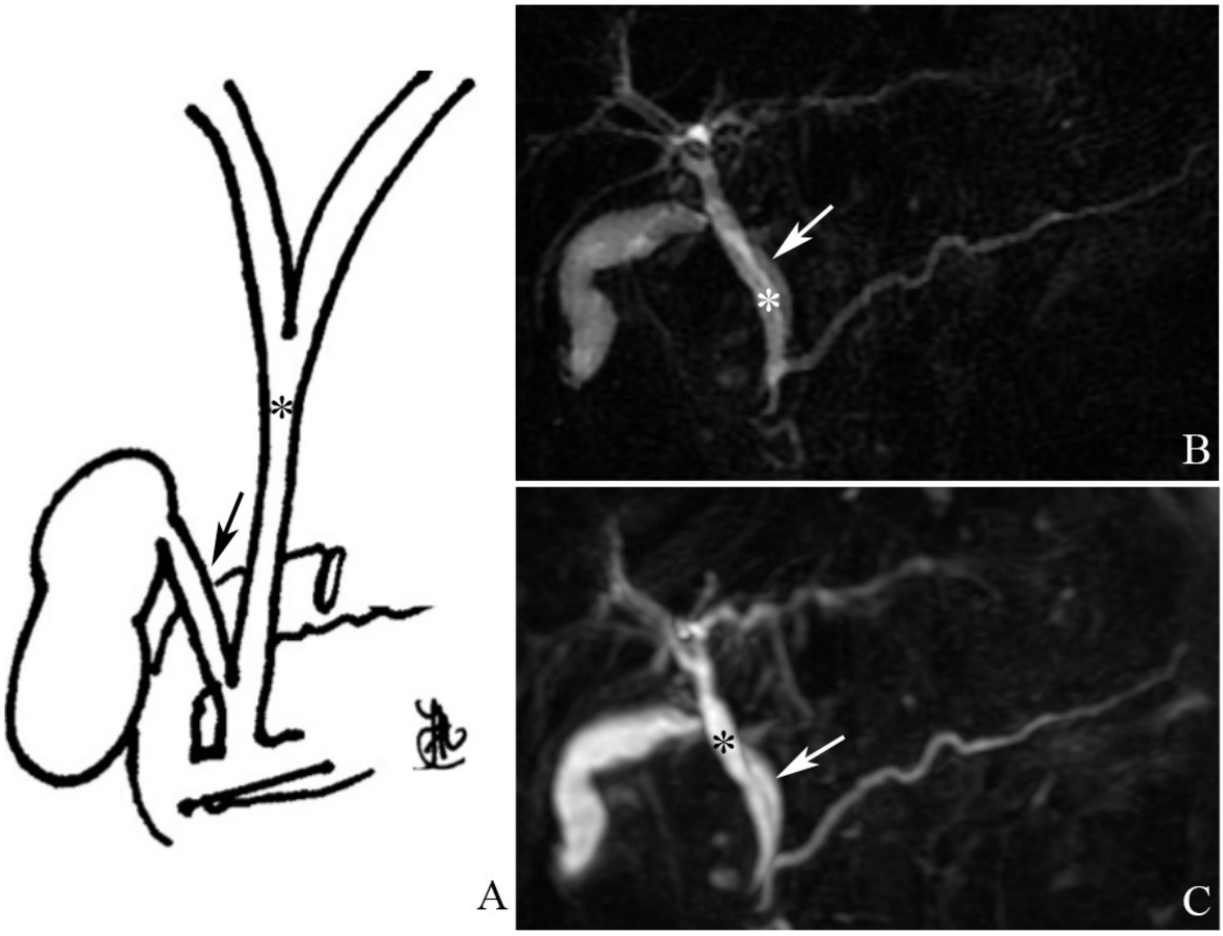


Fig. 8: Drawing (figure 8A) and MRCP exam of a 57 year-old female (figure 8B and 8C) showing distal insertion of the cystic bile duct in the intra-pancreatic portion of extra-hepatic duct (asterisk); as a consequence, the cystic duct has iuxtapapillary location.
References: Radiodiagnostic and Oncological Radiotherapy Unit, University Hospital "Policlinico-Vittorio Emanuele" - Catania/IT

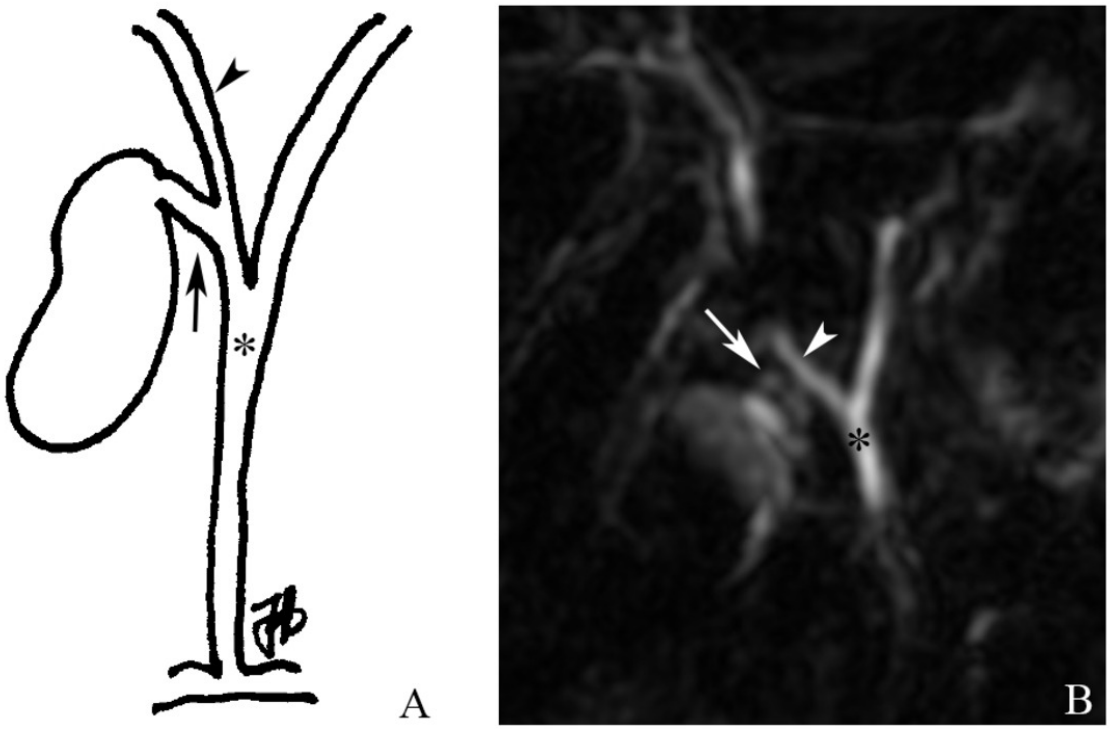


Fig. 10: Drawing (figure 10A) and MRCP exam of a 54 year-old male (figure 10B) showing insertion of the cystic bile duct (respectively black and white arrows) in the right hepatic duct (asterisk).
References: Radiodiagnostic and Oncological Radiotherapy Unit, University Hospital "Policlinico-Vittorio Emanuele" - Catania/IT

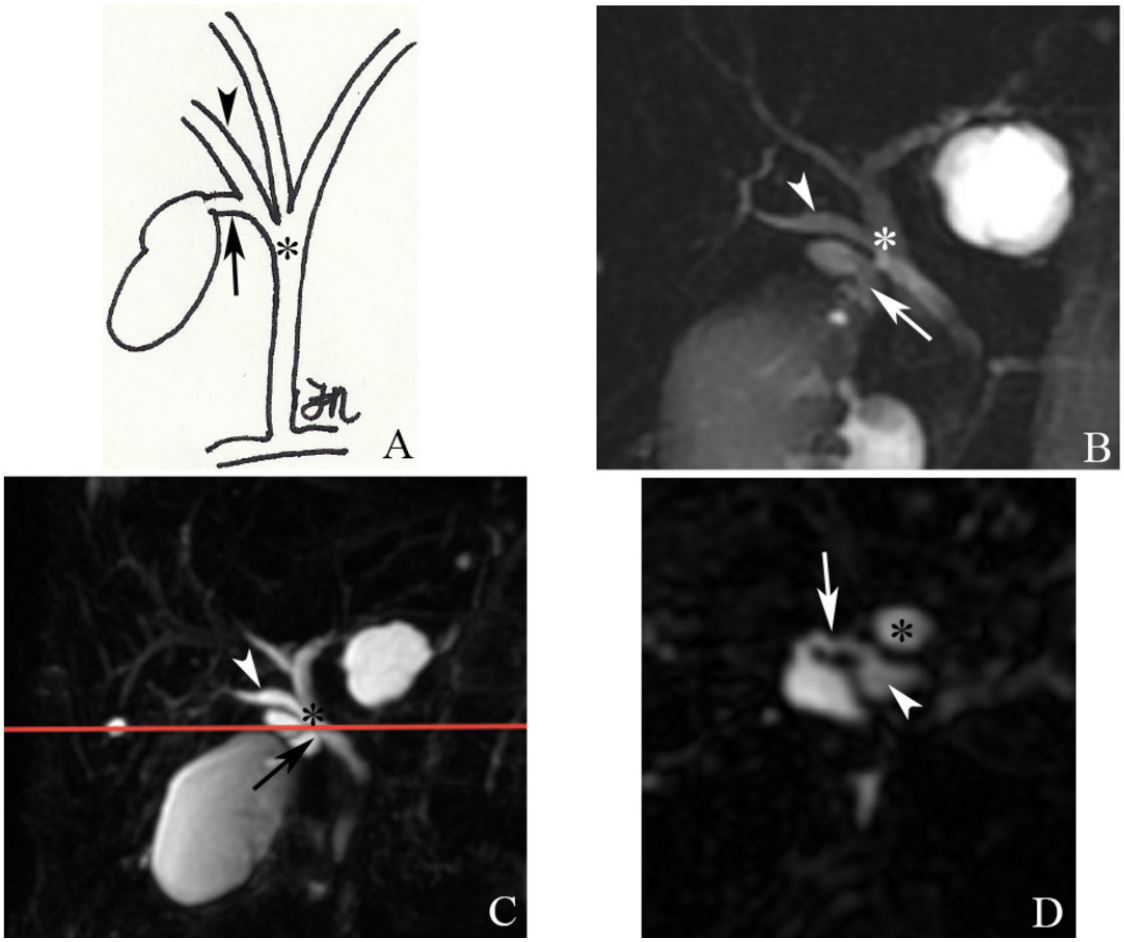


Fig. 12: Cystic duct with insertion in aberrant right hepatic duct (Figures 12A-D). SSFSE thick slab acquisition (figure 12B) and FRFSE image (figure 12C) shows an aberrant right hepatic duct (arrowheads) draining into the distal part of extra-hepatic duct; the cystic duct is poorly depicted (overlap with aberrant duct). Axial FRFSE image (figure 12D) - acquired at the level of aberrant insertion - clearly demonstrates the common hepatic duct (asterisk), and cystic duct (arrows) draining into the aberrant right hepatic duct (arrowheads).
References: Radiodiagnostic and Oncological Radiotherapy Unit, University Hospital "Policlinico-Vittorio Emanuele" - Catania/IT

Discussion

MRCP has the advantage of preliminary demonstration of intra and extra-ductal biliary anatomy, reserving ERCP, an invasive procedure, for patients with high probability of therapeutic intervention [7].

Variants are often difficult to identify during laparoscopic cholecystectomy:

- Common hepatic duct or the right hepatic duct can be confused with the cystic duct;

- Presence of accessory bile duct, an additional bile duct draining the same area of the liver, or aberrant bile duct, the only bile duct draining a particular segment of the liver;
- Parallel course implies a common fibrous sheath around the cystic duct and common hepatic duct.

The imaging findings of cystic bile duct variants allow the surgeon to be more careful, during the procedure; in fact, all these situations may cause problems such as inadvertent ligation or transaction of the extrahepatic bile duct at cholecystectomy, leading to anatomical and clinical complications (biliary pain, calculosis, atrophy of hepatic segments draining into the ligated hepatic ducts, cholangitis, bile leakage) [1, 5, 7-9].

According to Bahram [7], in about 22% of cases, the surgeon considered the MRCP as a helpful tool for the surgical procedure, improving pre-operative comprehension of bile duct anatomy.

Images for this section:

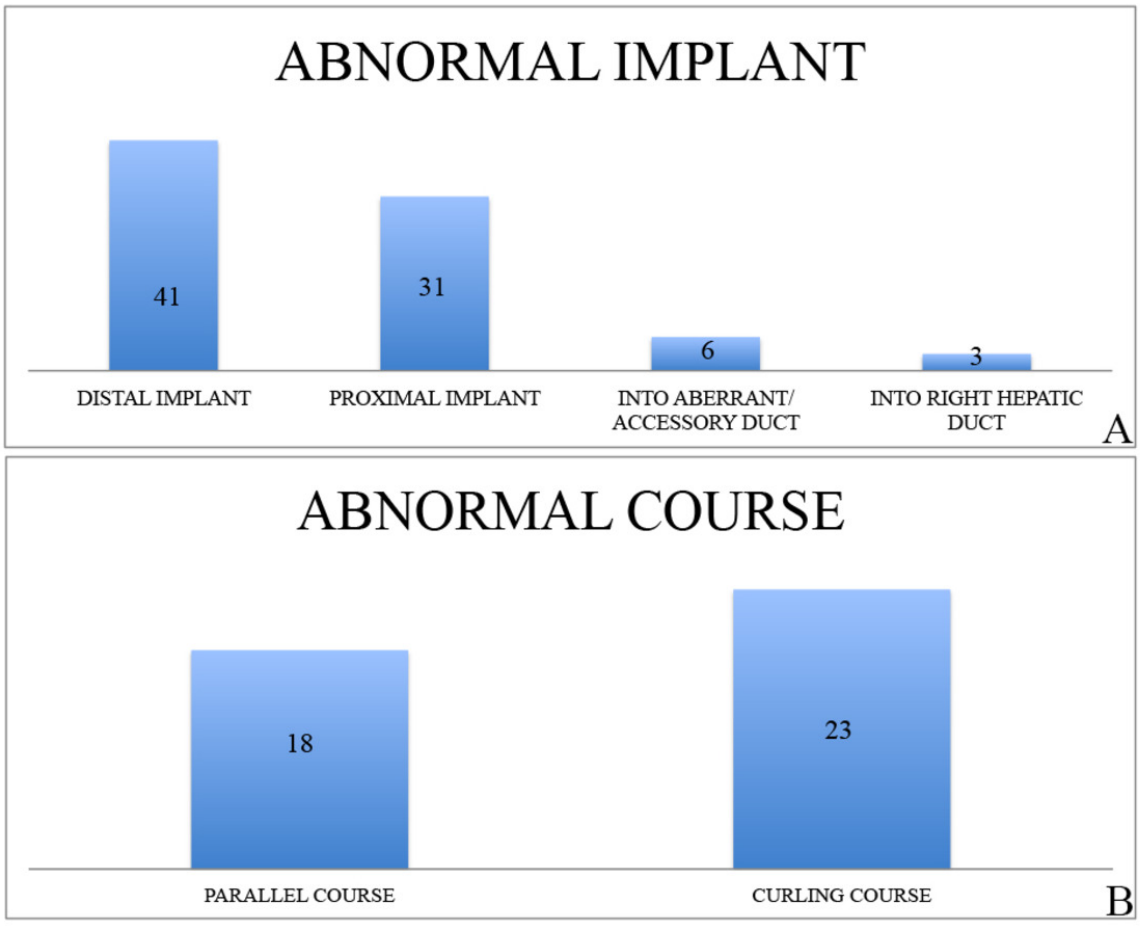


Table 2: Abnormal implant (table 2A) and course (table 2B) detected in our series. The cystic bile duct in 81 patients (13.9%) showed abnormal implant: a distal insertion has been revealed in 41 cases (7%), whereas a proximal one in 31 cases (5.3%). In 3 patients (0.5%), the cystic duct drained into the right hepatic duct and in 6 patients (1%) into aberrant/accessory duct. The cystic bile duct in 41 patients (7%) showed an abnormal course; the cystic duct has a parallel course to the common hepatic duct in 18 patients (3.1%) and it curls around the common hepatic duct in 23 cases (3.9%).

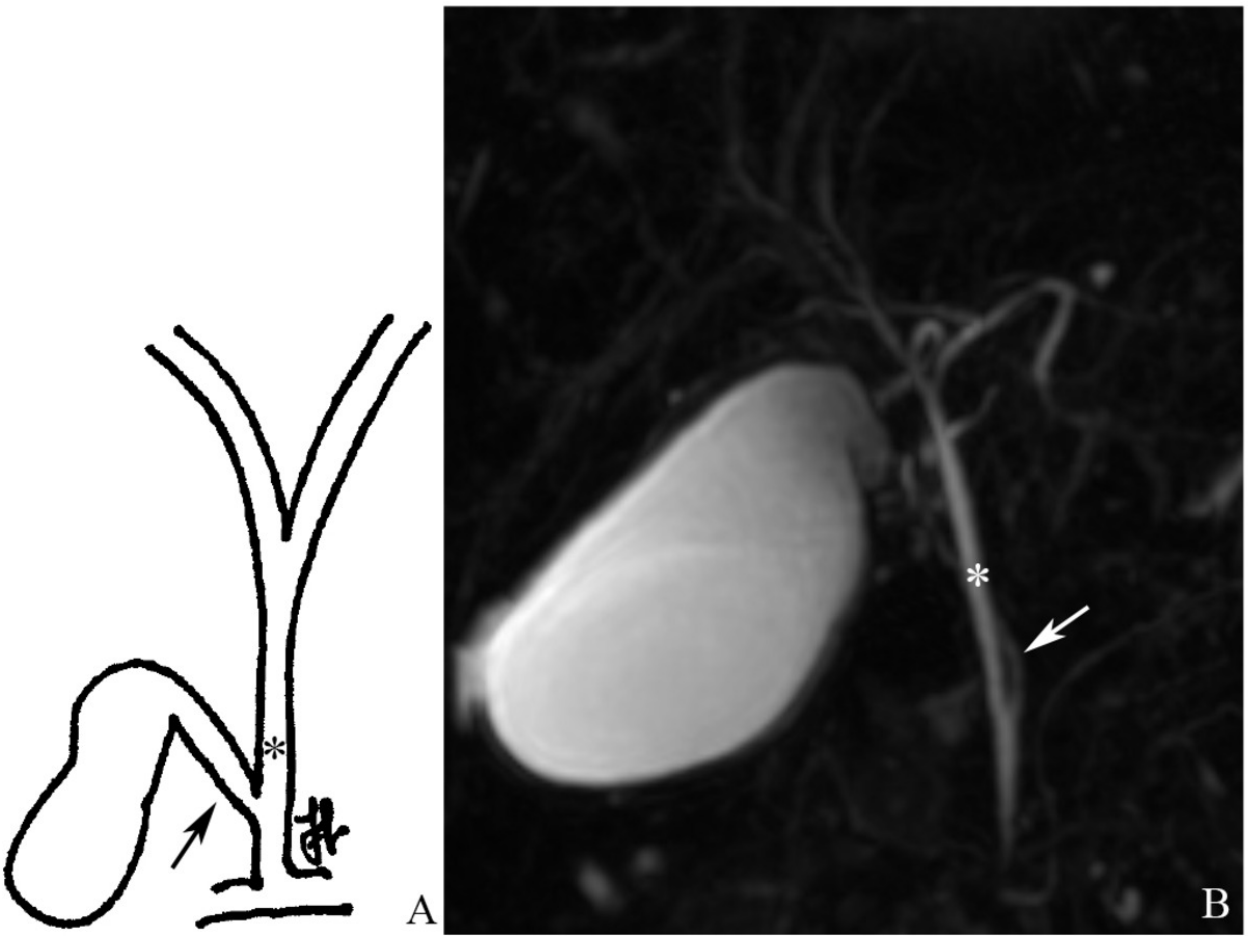


Fig. 7: Drawing (figure 7A) and MRCP exam of a 62 year-old female (figure 7B) showing distal insertion of the cystic bile duct (respectively black and white arrows) in the extra-hepatic duct (asterisk), near to the ampulla di Vater.

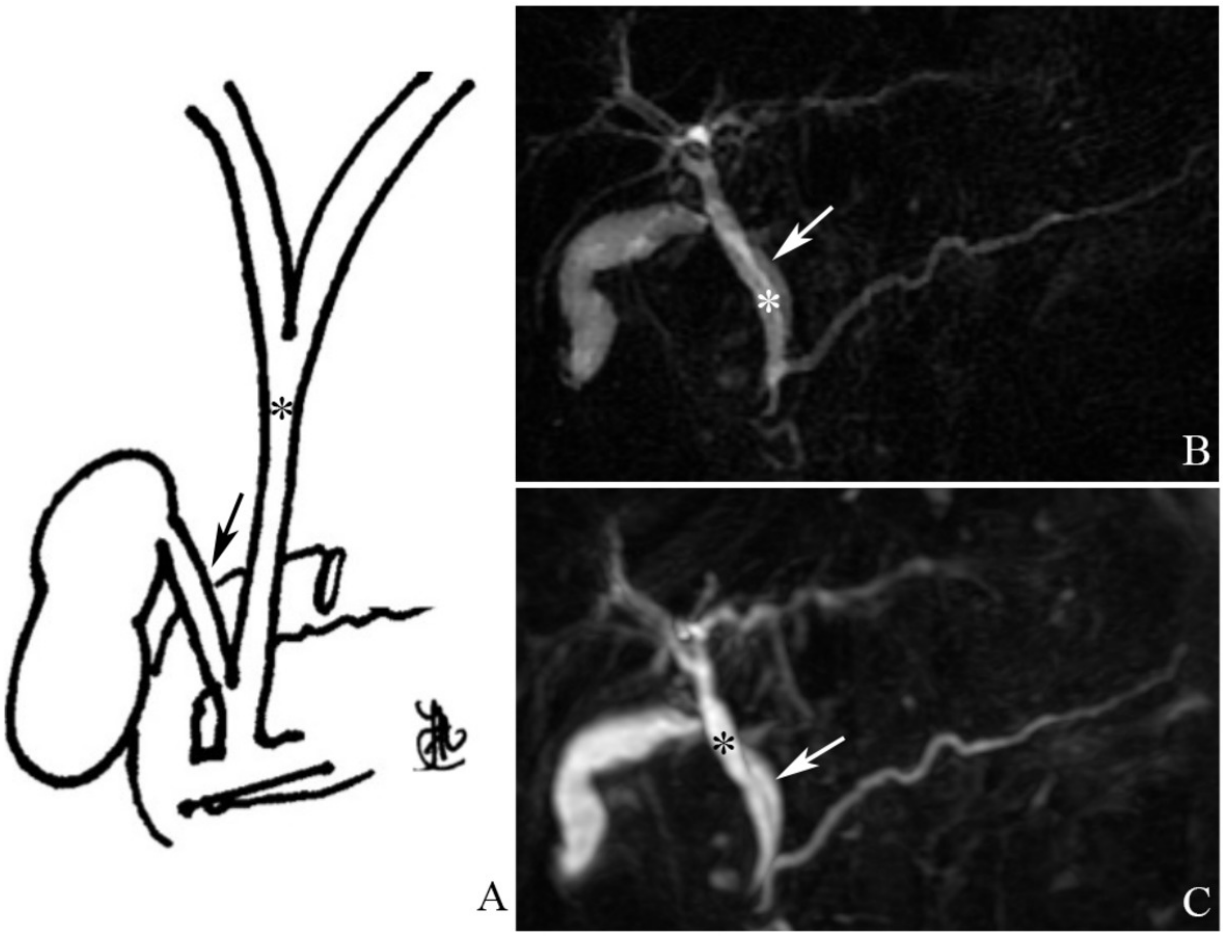


Fig. 8: Drawing (figure 8A) and MRCP exam of a 57 year-old female (figure 8B and 8C) showing distal insertion of the cystic bile duct in the intra-pancreatic portion of extra-hepatic duct (asterisk); as a consequence, the cystic duct has iuxtapapillary location.

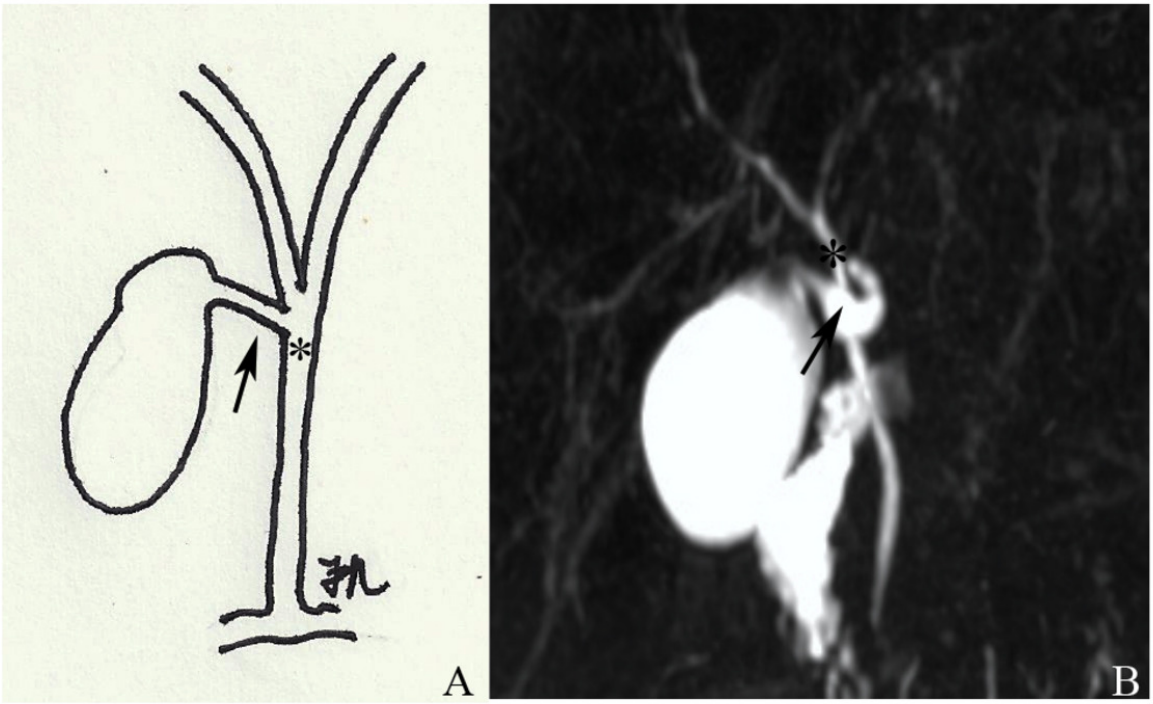


Fig. 9: Drawing (figure 9A) and MRCP exam of a 24 year-old female (figure 9B) showing high insertion of the cystic bile duct (respectively black and white arrows); the cystic duct runs anteriorly to the common hepatic duct, and drains next to the primary biliary confluence (asterisk).

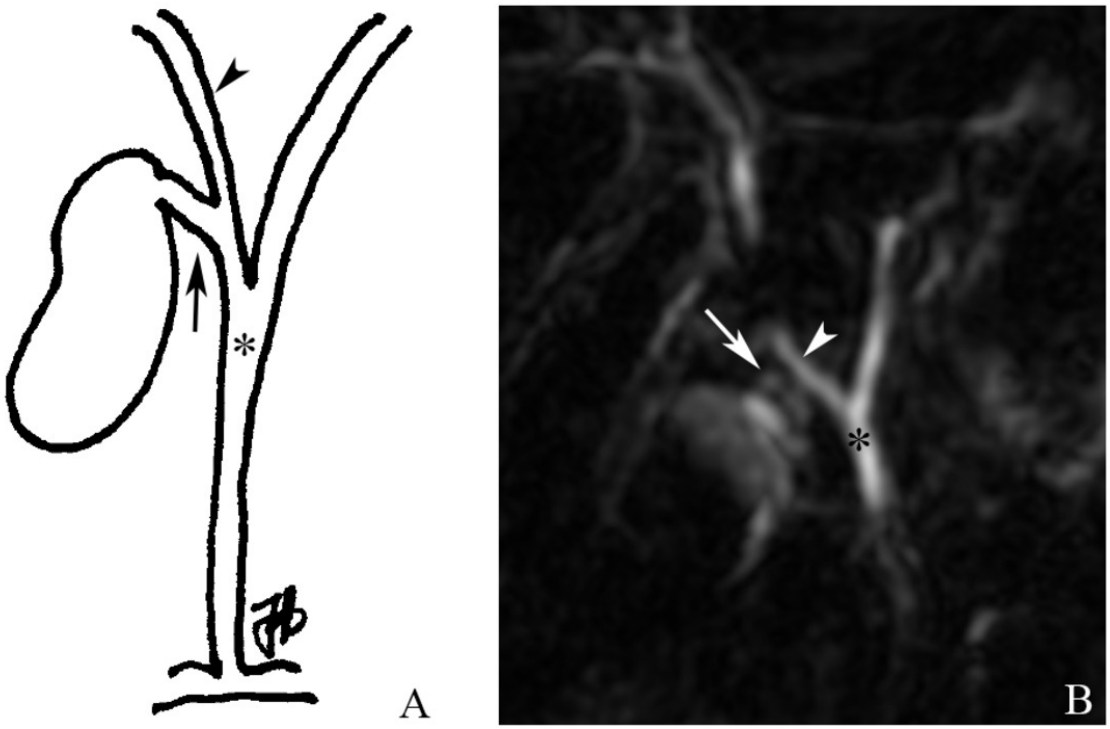
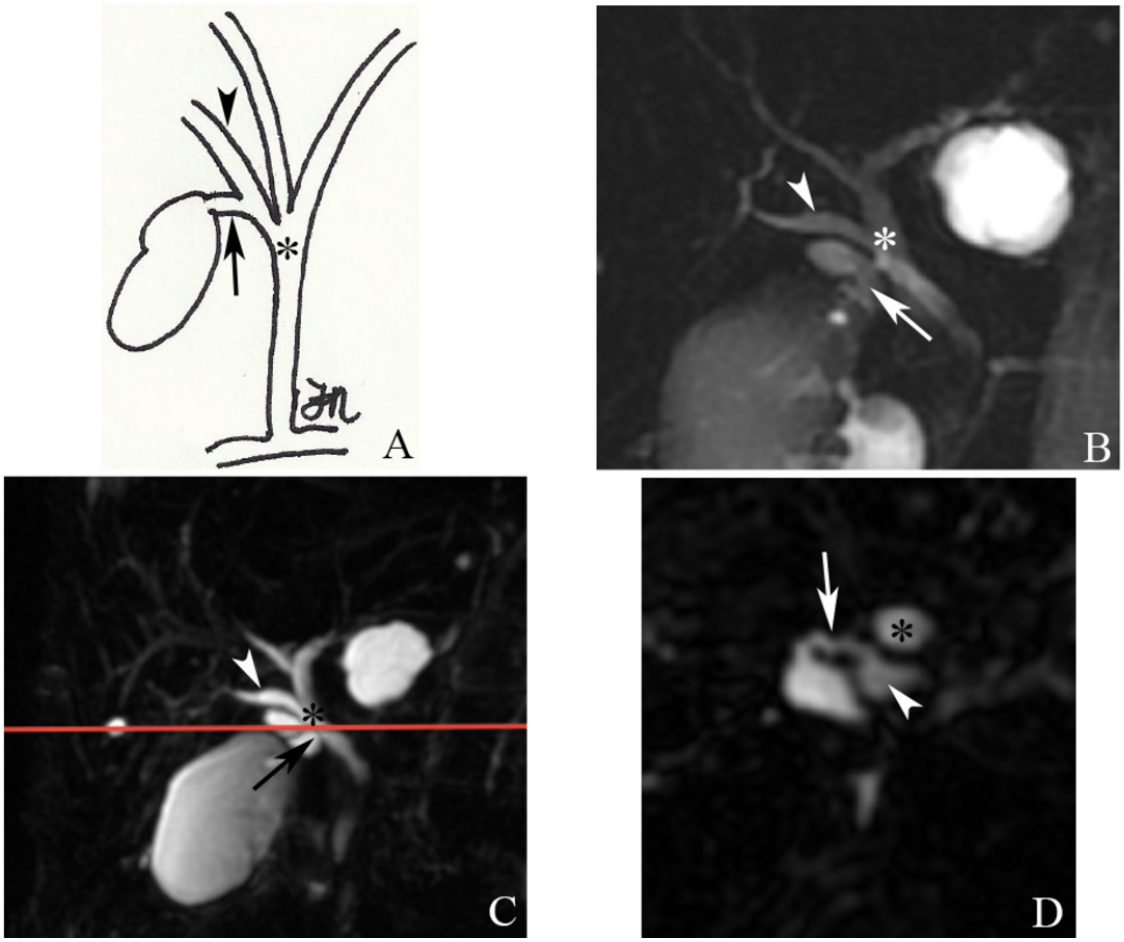


Fig. 10: Drawing (figure 10A) and MRCP exam of a 54 year-old male (figure 10B) showing insertion of the cystic bile duct (respectively black and white arrows) in the right hepatic duct (asterisk).

Fig. 11: Drawing (figure 11A) and MRCP images (figures 11B and 11C) showing cystic duct insertion (respectively black and white arrows) into the caudal branch of right hepatic duct (asterisk).



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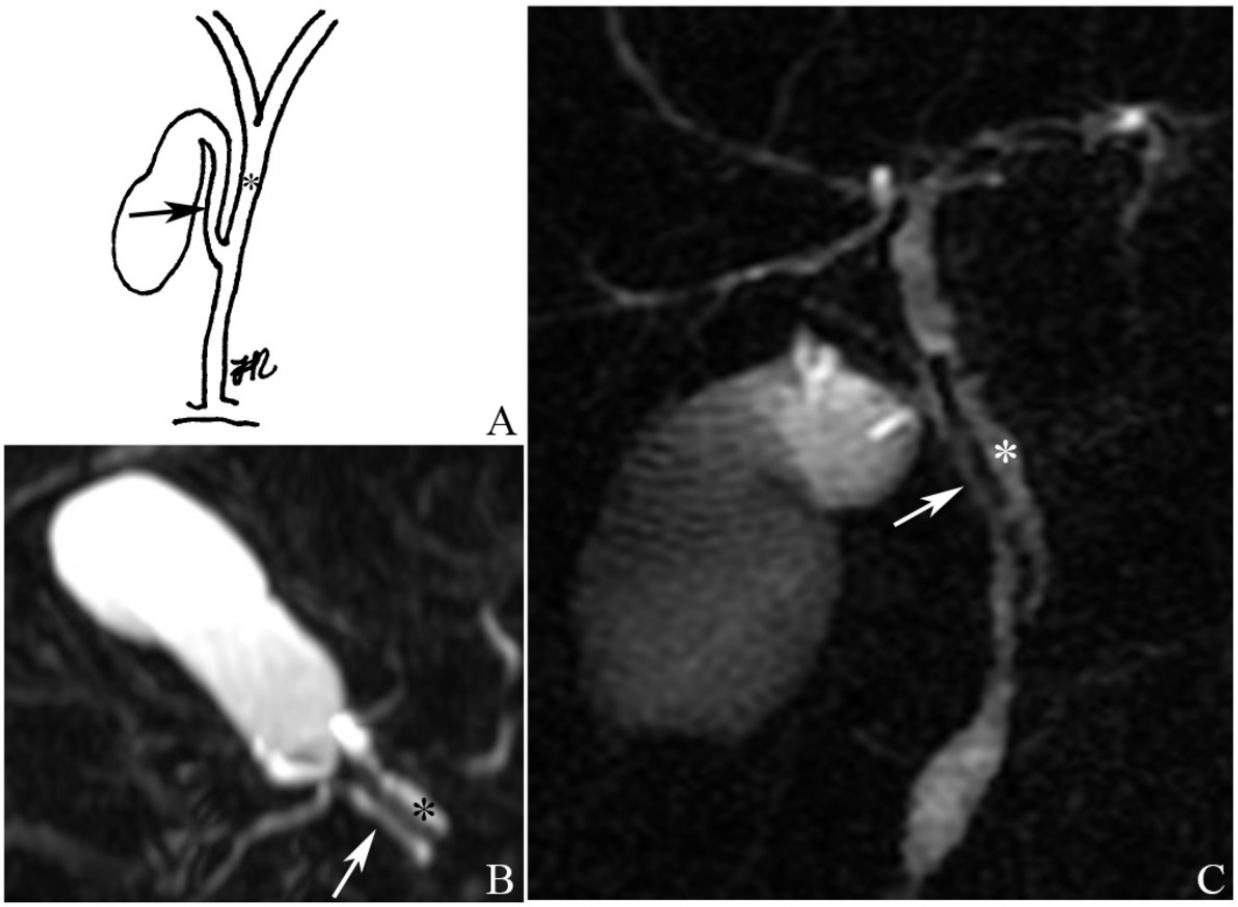

Fig. 13: Cystic duct (arrow) with parallel course to the common hepatic duct (asterisk). The images (figure 13B and 13C) have a bayonetted appearance.

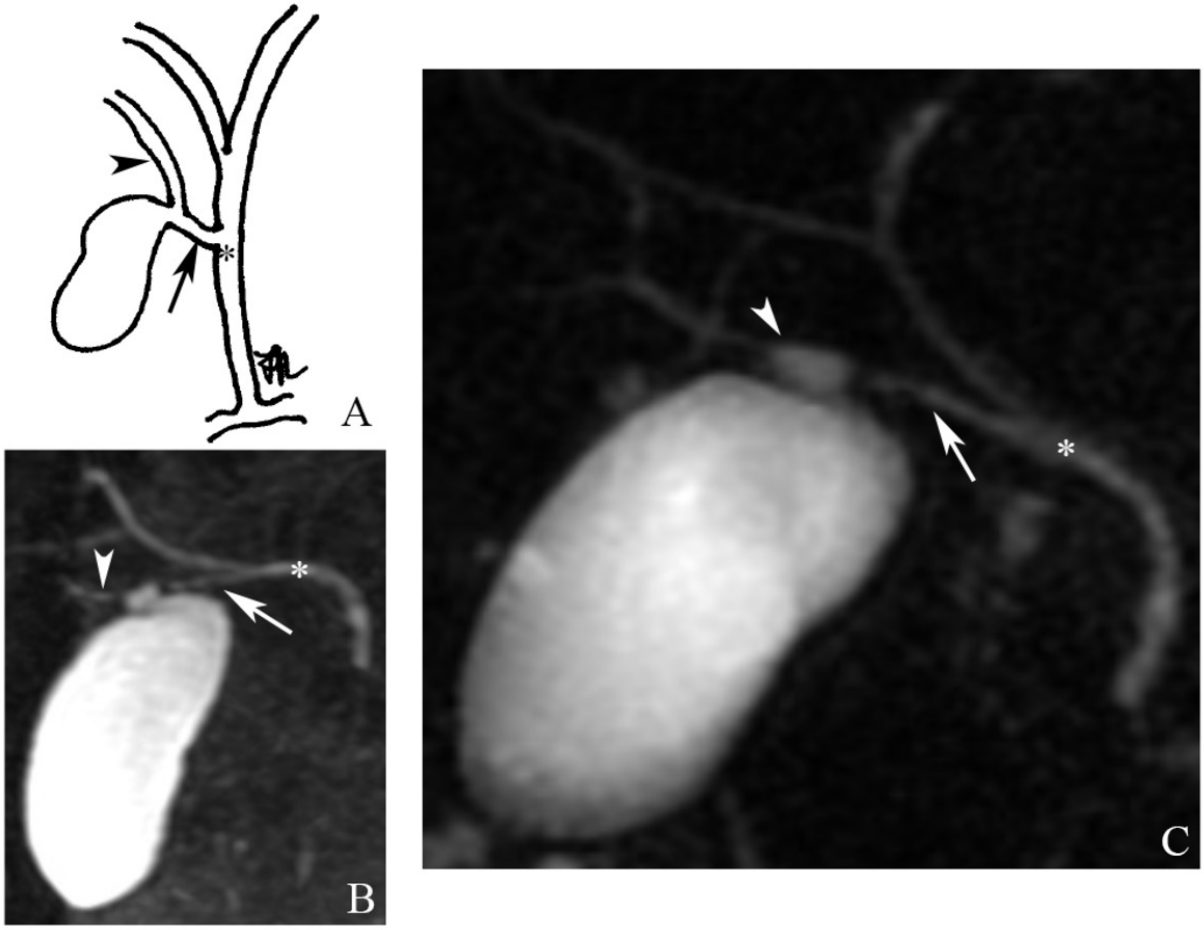

Fig. 14: Images show aberrant right hepatic duct (asterisk) draining into the cystic duct (arrow).

Conclusion

Anatomic variants of cystic duct are common and usually have no clinical significance [1]; however, in a progressively developing pre-operative routine using MRCP, knowledge of these variants is important in avoiding surgical implications that can jeopardize the good outcome of the operation [1, 4-7, 10].

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