

## Correlation of Magnetic Resonance Colangiopancreatography Bile Duct Image Data With Laboratory Data

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### ABSTRACT:

**Purpose:** Several etiologies come to the fore in gallstones' formation, especially the chemical content of bile and impaired motility of the gallbladder. This study aims to reveal the connections by evaluating the radiological images and laboratory data of patients who underwent MRCP for any reason in our center.

**Material and Methods:** The data of patients who underwent MRCP with a pre-diagnosis of cholestasis in a single center in 2019-2020 with the ethics committee's approval were retrospectively analyzed. Choledock diameter, presence of cholelithiasis and choledocholithiasis, and variation of the cystic duct were evaluated on MRCP images. In addition, laboratory data were examined, and the relationship between them was statistically compared.

**Results:** Of the 193 patients who underwent MRCP with a pre-diagnosis of bile duct pathology, 59.1% were female(n=114), 40.9% were male(n=79). Their mean age was 63.1±19.4. While the cystic duct was normal in 35.3%(n=68) of the patients, 64.7%(n=125) had anatomical variation. There was no difference between genders in terms of the presence of variation in the cystic canal. There was no significant relationship between the presence of variation and gallstones. A positive correlation was found between common bile duct diameter and presence of gallstones and WBC, neutrophil, and ALP values.

**Conclusion:** Although it is thought that bile duct variations may be effective in the formation of gallstones, it was observed that the variational cystic duct was not effective in gallstone formation in our case series. In MRCP, we found that the increase in the diameter of the common bile duct and the high values of WBC, neutrophils, and ALP support the presence of gallstones.

**Keywords:** Choledoc diameter, Choledocholithiasis, Cholelithiasis, Cystic duct variation, MRCP

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### INTRODUCTION

Bile production is a complex process in which hepatocytes are actively involved. There is a wide range of hormones that govern the production and cycle of bile. Bile contains almost all body components (Strazzabosco & Fabris, 2008). Bile acids make up 67% of bile and is synthesized from hepatocytes. Phospholipids (lecithin) make up 22% of bile. Bile consists of 4.5% proteins, 4% cholesterols, and 2% bile pigments (bilirubin) (Reshetnyak, 2013). The produced bile is transported through the bile ducts. Most of the bile acids

produced are brought to the gallbladder through the hepatic ducts. Bile acids that accumulate in the gallbladder are both concentrated and stored (Guyton & Hall, 2001). Bile, which is produced in the liver and deposited in the gallbladder due to the stimulation of the intestinal system with food, is poured into the second continent of the duodenum through the common bile duct. Bile acids aid in the digestion of fats, the absorption of fat-soluble vitamins, and the excretion of degradation products produced due to metabolic events.

Gallstone formation increases depending on age,

gender, race, and body weight. It is more common in older age, female gender, obese people, women who have given birth more than others, and blond race (Chowdhury & Lobo, 2011). It is known that many mechanisms are effective in the formation of gallstones. However, it is still not clearly elucidated (Muñoz et al., 2019).

The first method used to show gallstones and common bile duct stones is ultrasonography (USG). USG is the most commonly used method because it is both an inexpensive and non-invasive method. In cases that cannot be seen clearly with USG, the gall bladder and bile ducts can be visualized more clearly with Computed tomography (CT) and Magnetic resonance (MR) methods (Özden, et al., 2020). Magnetic resonance cholangiography (MRCP) is the second most frequently used imaging method after USG to show the bile ducts (Hanbidge, et al., 2004). MRCP is commonly used in symptomatic patients to exclude choledocholithiasis, exclude gallstone-related diseases (cholangitis and pancreatitis), and preoperative investigation of bile ducts (D'Angelo, et al., 2017). MRCP is used more than CT in bile duct pathologies because it is not exposed to radiation in the patient, does not need a contrast agent, and shows the bile ducts better. Studies have shown that MRCP is the best method for hepatobiliary system imaging (Mustafa, 2017).

Anatomical variations of both intrahepatic and extrahepatic bile ducts are common. Studies show that anatomical variations of the bile ducts are associated with stone formation, cholangitis, and pancreatitis attacks (Mortelé & Ros, 2001). Another importance of anatomical variations is that they cause iatrogenic injuries during the operation (Kapoor et al., 2002).

The most common method used to classify anatomical variations is Huang classification (Huang, et al., 1996). This classification is typed according to the relationship between the hepatic bile ducts and the cystic duct.

This study evaluated the cystic duct exit variations from the common bile duct, common bile duct diameter, presence of bile stones, and biochemical and hematological data of patients who underwent MRCP.

## **MATERIAL AND METHODS**

### **Purpose and Type of the Study**

This study is a research article examining retrospective data. To analyze radiological image data and laboratory data of patients who underwent MRCP with pre-diagnosis of bile duct pathology.

### **Sampling and Participant**

In our study, archive data of patients who were admitted to Sivas Cumhuriyet University Health Services Application and Research Hospital General Internal Medicine and Gastroenterology service with abdominal pain and underwent MRCP with a pre-diagnosis of cholestasis between 01.01.2019 and 31.12.2020 were analyzed.

### **Data Collection Tools**

In the study, MRCP images obtained using a 1.5 Tesla unit (Siemens, Acra, Germany) without contrast were used. Existing MRCPs in the study were re-evaluated in terms of gallstones' presence, the directional canal's variational status, and common bile duct diameter. Also ALT, AST, Total Bilirubin, Direct Bilirubin, ALP, GGT, Amylase, CRP, and hemogram parameters were examined as blood tests. Patients with malignancies, patients who underwent cholecystectomy, patients who underwent common bile duct surgery, and patients under 17 years of age were excluded from the study.

### **Statistical Analysis**

Statistical comparisons were made using the statistical software package SPSS 22.0 (SPSS Inc., Chicago, IL, USA). The Kolmogorov-Smirnov test was used for normal distribution. Student T-test, Pearson Correlation analysis were used to compare parameters without normal distribution, and the Chi-Square test was used to compare categorical variables obtained by counting. The exact statistics were noted as "Mean  $\pm$  standard deviation (SD)" and "Median (interquartile, IQR)". The significance level was accepted as 0.05.

### **Ethical Approval**

This study was planned by obtaining the decision of Sivas Cumhuriyet University Non-invasive Clinical Research Ethics Committee numbered 2021-01 / 31

and the permission of the institution.

**RESULTS**

193 patients were included in the study. 59.1% of the cases were women (n=114), and 40.9% were men (n=79). The average age of the patients was 63.1±19.4. Choledocholithiasis in 9 patients, cholelithiasis in 60 patients, and both cholelithiasis and choledocholithiasis in 22 patients were detected in 193 MRCP patients. No stones were detected in the biliary system in 102 patients. There was no difference between genders in terms of gallstones' presence among patients who underwent MRCP (p = 0.213) (Table 1).

While the cystic duct was normal in 35.3% (n=68) of

the MRCP errors, there was anatomical variation in the cystic duct in 64.8% (n=125) (Table 2). No significant difference was observed between the genders in terms of variations (p = 0.798) (Table 1). There was no significant relationship between cystic duct variations and the presence of stones in the biliary system (p = 0.138). A positive correlation was found between age and common bile duct diameter (p <0.05). It was observed that as the common bile duct diameter increased, the possibility of gallstones increased (p <0.05). It was observed that the WBC, neutrophil, and ALP values increased with gallstones' presence (Table 3). A positive correlation was found between the increase in common bile duct diameter and WBC, neutrophil, and ALP values (Table 3).

**Table 1.** The relationship between the variation status of the ductus cysticus and the presence of gallstones with gender was analyzed in patients who underwent MRCP

		Ductus Cysticus			P	Gallstone			P	
		Normal	Variational	Total		No	Yes	Total		
Gender	Male	S	27	52	79	p=0.798 <sup>[a]</sup>	46	33	79	p=0.213 <sup>[b]</sup>
		%	34.2%	65.8%	100%		58.2%	41.8%	100%	
	Female	S	41	73	114		56	58	114	
		%	36.0%	64.0%	100%		49.1%	50.9%	100%	
Total	S	68	125	193	102	91	193			
	%	35.2%	64.8%	100%	52.8%	47.2%	100%			

[a] There was no significant relationship between the variational structure of the Ductus Cysticus and gender (p = 0.798).

[b] There was also no significant relationship between the presence of gallstones and gender (p = 0.213). (p <0.05 was considered significant)

**Table 2.** Number and incidence of variation types of the cystic channel

	Cystic Canal Variation	n:193	%
1	Normal	68	35.2
2	Variational	125	64.8 <sup>[a]</sup>

[a] Cystic duct variation was detected in 64.8% of the patients.

**DISCUSSION**

Presence of stones in the biliary system is a common disease today and is one of the leading causes of abdominal pain (Hu, et al., 2017). It continues to pose a severe public health problem in developed countries. Although it has low mortality, it is a significant health problem due to its high morbidity. Due to the developments in imaging techniques such as USG and MRI, the possibility of early and accurate diagnosis has increased. With the development of ERCP and laparoscopic surgery techniques, more effective treatment has been revealed.

In the study, images and laboratory values of patients who underwent MRCP with a pre-diagnosis of biliary system pathology in our hospital were examined. It is known that MRCP, which is a non-invasive method, is a preferable method in terms of the presence of stones in the biliary system, the diameter of the common bile duct, and the evaluation of anatomic variations in the cystic canal (Wan et al., 2018). Although its clinical significance has not been clearly demonstrated yet, there are many anatomical variations of both intrahepatic and extrahepatic bile ducts. Evaluating such variations

with imaging techniques before the surgical procedure may be a warning to avoid iatrogenic bile duct injuries in surgery.

Many environmental and genetic etiological factors are involved in the formation of gallstones. The

reasons such as high cholesterol saturation of bile, excessive bile concentration, lack of proteins that inhibit nucleation, and hypomotility in the gallbladder come to the fore in etiological terms (Venneman & van Erpecum, 2010).

**Table 3.** The relationship between choledoc diameter and gallstones with age and blood parameters was analyzed

	Choledoc Diameter (p value)	Gallstone (p value)
Age	0.000	0.021
ALT	0.801	0.246
ALP	0.047 <sup>[a]</sup>	0.040 <sup>[a]</sup>
Amylase	0.352	0.321
AST	0.970	0.206
CRP	0.066	0.430
D. Bilirubin	0.062	0.441
GGT	0.269	0.167
Creatine	0.851	0.418
LDH	0.558	0.216
Lymphocyte	0.716	0.449
MPV	0.958	0.090
Neutrophil	0.000 <sup>[a]</sup>	0.027 <sup>[a]</sup>
PLT	0.093	0.068
T. Bilirubin	0.106	0.337
WBC	0.000 <sup>[a]</sup>	0.039 <sup>[a]</sup>
Neutrophil/ Lymphocyte	0.065	0.095

[a] WBC, neutrophil and ALP values were found to be positively correlated with choledoc diameter and gallstones ( $p < 0.05$  was considered significant).

The effect of anatomical variations of bile ducts on gallstone formation is still unclear. In the patient series examined in this study, it was observed that the cystic duct variations detected in the MRCP images were not effective in the formation of gallstones. In patients with MRCP, it was observed that the risk of stones increased as the age progressed, and consequently, the diameter of the common bile duct increased. WBC, neutrophil, and ALP values were significantly increased in patients with increased common bile duct diameter and gallstones. These elevations were found to be an expected result in biliary tract pathologies and were consistent with the literature (Mei et al., 2019).

The prediction that the presence of the variational cystic duct may increase stones' formation by negatively affecting the bile drainage was not met in our study. We think that anatomical and physiological compensation mechanisms may have come into play in this regard. Therefore, it would be more enlightening to conduct a comprehensive study including a more detailed anatomical

examination, including other parts of the biliary tract.

## CONCLUSION

Although it is thought that bile duct variations may be effective in the formation of gallstones, it was observed in our study that cystic duct variations were not effective in gallstone formation. We have seen that the increase in the diameter of the common bile duct and the height of WBC, neutrophils, and ALP in patients with MRCP support the presence of gallstones.

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## Conflict of Interest

There is no conflict of interest.

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## REFERENCES

- Chowdhury, A. H., & Lobo, D. N. (2011). Gallstones. *Surgery (Oxford)*, 29(12), 610-617. <https://doi.org/10.1016/j.mpsur.2011.09.008>
- D'Angelo, T., Racchiusa, S., Mazziotti, S., & Cicero, G. (2017). Magnetic Resonance (MR) Cholangiopancreatography Demonstration of the Cystic Duct Entering the Right Hepatic Duct. *Am J Case Rep*, 18, 242-245. [Doi:10.12659/ajcr.902620](https://doi.org/10.12659/ajcr.902620)
- Guyton, A., & Hall, J. (2001). *Tıbbi Fizyoloji*. 10 Print. Nobel Bookstore, Ankara.
- Hanbidge, A. E., Buckler, P. M., O'Malley, M. E., & Wilson, S. R. (2004). From the RSNA refresher courses: imaging evaluation for acute pain in the right upper quadrant. *Radiographics*, 24(4), 1117-1135. <https://doi.org/10.1148/rg.244035149>
- Hu, A. S. Y., Menon, R., Gunnarsson, R., & de Costa, A. (2017). Risk factors for conversion of laparoscopic cholecystectomy to open surgery – A systematic literature review of 30 studies. *The American Journal of Surgery*, 214(5), 920-930. <https://doi.org/10.1016/j.amjsurg.2017.07.029>
- Huang, T., Cheng, Y., Chen, C., Chen, T., & Lee, T. (1996). Variants of the bile ducts: clinical application in the potential donor of living-related hepatic transplantation. *Transplantation proceedings*, 28 (3), 1669-1670.
- Kapoor, V., Peterson, M. S., Baron, R. L., Patel, S., Eghtesad, B., & Fung, J. J. (2002). Intrahepatic Biliary Anatomy of Living Adult Liver Donors: Correlation of Mangafodipir Trisodium—Enhanced MR Cholangiography and Intraoperative Cholangiography. *American Journal of Roentgenology*, 179(5), 1281-1286.
- Mei, Y., Chen, L., Zeng, P. F., Peng, C. J., Wang, J., Li, W. P., Du, C., Xiong, K., Leng, K., Feng, C. L., Jia, J. H. (2019). Combination of serum gamma-glutamyltransferase and alkaline phosphatase in predicting the diagnosis of asymptomatic choledocholithiasis secondary to cholecystolithiasis. *World J Clin Cases*, 7(2), 137-144. <https://dx.doi.org/10.12998/wjcc.v7.i2.137>
- Mortelé, K. J., & Ros, P. R. (2001). Anatomic variants of the biliary tree: MR cholangiographic findings and clinical applications. *American Journal of Roentgenology*, 177(2), 389-394.
- Muñoz, L. E., Boeltz, S., Bilyy, R., Schauer, C., Mahajan, A., Widulin, N., Herrmann, M. (2019). Neutrophil Extracellular Traps Initiate Gallstone Formation. *Immunity*, 51(3), 443-450.e444. <https://doi.org/10.1016/j.immuni.2019.07.002>
- Mustafa, M. H. A. (2017). Study of Hepatobiliary Diseases using Magnetic Resonance Cholangiopancreatography (MRCP). Sudan University of Science and Technology.
- Özden, H., Gömeç, M., & Kurtulan, O. (2020). Ectopic Pancreas Tissue in the Gallbladder: An Incidental Mass in Laparoscopy. *Archives of Iranian Medicine*, 23(11), 761-763.
- Reshetnyak, V. I. (2013). Physiological and molecular biochemical mechanisms of bile formation. *World journal of gastroenterology: WJG*, 19(42), 7341.
- Strazzabosco, M., & Fabris, L. (2008). Functional anatomy of normal bile ducts. *The Anatomical Record: Advances in Integrative Anatomy and Evolutionary Biology: Advances in Integrative Anatomy and Evolutionary Biology*, 291(6), 653-660.
- Venneman, N. G., & van Erpecum, K. J. (2010). Pathogenesis of gallstones. *Gastroenterol Clin North Am*, 39(2), 171-183, vii. doi:10.1016/j.gtc.2010.02.010
- Wan, J., Ouyang, Y., Yu, C., Yang, X., Xia, L., & Lu, N. (2018). Comparison of EUS with MRCP in idiopathic acute pancreatitis: a systematic review and meta-analysis. *Gastrointestinal Endoscopy*, 87(5), 1180-1188.e1189. <https://doi.org/10.1016/j.gie.2017.11.028>