IJCMBS

Original Article

doi.org/ 10.5281/zenodo.11187739
IJCMBS 2024; 4(2):44-9

Is Cystic Duct Anastomosis a Suitable Option in the Presence of Double Bile Ducts in Living Donor Liver Transplantation?

Canlı Vericili Karaciğer Naklinde Çift Safra Kanalı Varlığında Sistik Kanal Anastomozu Uygun Bir Opsiyon Olabilir mi?

Hüseyin Yönder*[1], Faik Tatlı[1], Mehmet Sait Berhuni[1], Mehmet Yılmaz[2]

[1]Department of General Surgery, Harran University Faculty of Medicine, Sanliurfa/Türkiye,
[2]Department of General Surgery, Dicle University Faculty of Medicine, Diyarbakır/Türkiye,

Abstract

Background: The biliary duct anastomosis performed during living donor liver transplantation (LDLT) surgery is a critical surgical procedure that significantly influences postoperative patient mortality and morbidity. The aim of the present study was to evaluate the feasibility of utilizing the recipient's cystic duct along with the common bile duct in situations where biliary duct anastomosis becomes necessary.

Materials and Methods: In 16 of 49 liver transplants performed at Harran University Faculty of Medicine Organ Transplant Clinic between 2018 and 2021, the donor graft had double bile duct orifice. For the anastomosis of these bile ducts, the cystic duct was used along with the common bile duct in 9 patients, whereas in 7 patients, reconstruction was completed using various techniques without utilizing the cystic duct. Patients who underwent anastomosis to the cystic duct and those who underwent alternative techniques were evaluated in terms of difficulty and complications.

Results: Of the 16 patients included in the study, 7 (44%) were female and 9 (56%) were male. The mean age was 51.18 (±12.77) years. Anastomosis was performed to the cystic duct in nine patients. Regarding postoperative complications, among patients who underwent anastomosis to the cystic duct, only one developed bile leakage, which was treated with endoscopic retrograde cholangiopancreatography (ERCP) and percutaneous drainage. Complications developed in 3 of 7 patients in the other group. The two cases of bile duct strictures were treated with ERCP, while the bile leakage in one patient was conservatively monitored, and the leakage resolved spontaneously.

Conclusion: The utilization of the cystic duct in bile duct anastomosis in LDLT may offer advantages, especially in grafts with multiple and distant bile ducts. When preparing donors for LDLT, when multiple bile ducts are detected in the donor liver preoperatively or intraoperatively, it should be kept in mind that in cases with a narrow donor pool, the cystic duct can also be used in the anastomosis.

Keywords: Living donor liver transplantation, biliary anastomosis, biliary anastomosis to cystic duct

ÖZ

Amaç: Canlı vericili karaciğer nakli (CVKN) ameliyatı sırasında yapılan safra yolu anastomozu postoperatif hasta mortalite ve morbiditesini etkileyen kritik öneme sahip cerrahi bir işlemdir. Bu çalışmanın amacı; safra yolu anastomozu için mecbur kalınan durumlarda koledok ile birlikte alıcı sistik kanalının da kullanılabilirliğini değerlendirmektir.

Gereç ve Yöntem: Harran Üniversitesi Tıp Fakültesi Organ Nakli Kliniği'nde 2018-2021 yılları arasında gerçekleştirilen 49 karaciğer naklinden 16'sında donör greftinde çift safra yolu ağzı mevcuttu. Bu safra yollarının anastomozları için, 9 hastada koledok ile birlikte sistik kanal kullanılırken, 7 hastada ise sistik kanal kullanılmadan farklı tekniklerle rekonstrüksiyon tamamlandı. Sistik kanala anastomoz yapılanlar ve diğer teknikler, zorluk ve komplikasyon açısından değerlendirildi..

Bulgular: Çalışmaya dahil edilen 16 hastanın 7 (% 44)'si kadın, 9 (% 56)'u erkekti. Yaş ortalaması 51.18 (±12,77) idi. Dokuz hastada anastomozda sistik kanal kullanıldı. Postoperatif komplikasyonlar açısından sistik kanala anastomoz yapılan hastaların sadece 1 tanesinde safra kaçağı gelişti, bu hasta endoskopik retrograd kolanjiopankreatografi (ERCP) ve perkütan drenaj ile tedavi edildi. Diğer gruptaki 7 hastanın ise 3'ünde komplikasyon gelişti. Oluşan 2 safra yolu darlığı ERCP ile tedavi edilirken, 1 hastada ki safra kaçağı ise konservatif olarak takip edildi ve kaçak kendiliğinden durdu.

Sonuç: CVKN'de safra yolu anastomozunda sistik kanal kullanımı, çoklu ve birbirinden uzak safra yolu olan greftlerde avantaj sağlayabilir. CVKN için donör hazırlanırken donör havuzunun dar olduğu hastalarda, donör karaciğerinde preoperatif veya intraoperatif çoklu safra yolu tespit edildiğinde anastomozda sistik kanalın da kullanılabileceği akılda tutulmalıdır.

Anahtar Kelimeler: Canlı vericili karaciğer nakli, safra yolu anastomozu, sistik kanala safra anastomozu

***Corresponding author:** Dr.Hüseyin Yönder, Faculty of Medicine, Department of General Surgery, Harran University, Osmanbey Campus, Haliliye/Şanlıurfa 63300/Turkiye mail: hyonder@hotmail.com

Received: 15 April 2024
Accepted: 13 May 2024

Cite as: YONDER. H et all. Is Cystic Duct Anastomosis a Suitable Option in the Presence of Double Bile Ducts in Living Donor Liver Transplantation? IJCMBS 2024;4(2):44-9 doi.org/ 10.5281/zenodo.11187739

Creative Commons License IJCMBS offers members open access to reach all published articles freely within the framework of "Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International (CC BY-NC-ND 4.0)" license.

Highlights

- Bile duct anastomosis is of critical importance in liver transplantation.
- Bile anastomosis to the cystic duct can be performed in cases where it is necessary.
- Bile complications can be managed with minimally invasive treatments.

Introduction

Biliary anastomosis in LDLT continues to maintain its critical importance due to its high potential for complications. Biliary complications not only delay postoperative recovery but also significantly impact the quality of life and may reduce graft survival (1).

The presence of multiple distant bile ducts in the donor graft may make anastomosis to the right and left bile ducts of the recipient impossible. Although multiple ducts can be obtained with a high hilar division of the recipient bile ducts, the technical difficulty it poses during anastomosis and the vascularization pattern of the bile ducts, which tends to be from bottom to top, make the proximal bile ducts more prone to ischemia. Therefore, this procedure is generally not recommended. In such cases, various techniques such as hepaticojejunostomy (HJ), multiple anastomoses to the common bile duct, and anastomosis to the cystic duct are attempted to address the issue (1, 2).

Following HJ performed for biliary drainage in the recipient, there may be some disadvantages such as the potential development of enteric leaks, limitations for endobiliary interventions in case of biliary complications, and delayed enteral nutrition. Additionally, edema developing in the intestinal wall due to portal hypertension and portal vein thrombosis presents another challenge from a technical perspective for the anastomosis (3). Furthermore, performing anastomosis to the bile ducts from a very proximal level in the recipient may lead to a swan-neck deformity. Despite a technically correct anastomosis, the presence of a long bile duct can lead to angulation and result in functional obstruction. This can make therapeutic ERCP very difficult.

Due to such circumstances, performing anastomosis to the cystic duct can be a viable solution in biliary reconstruction (2, 14, 15).

The aim of the present study was to investigate whether the cystic duct may be a viable option for biliary anastomosis in LDLT, in grafts with multiple bile ducts and particularly in anatomically challenging cases.

Materials and Methods

Ethical approval was obtained from the Harran University Ethics Committee with decision number HRÜ/23.25.07 dated 28.12.2023 and was implemented in accordance with the rules of the Declaration of Helsinki. Informed consent was obtained from all patients.

The data of 49 patients who underwent liver transplantation in our clinic between June 2018 and May 2021 were retrospectively reviewed. Cadaveric liver transplantation was performed in 11 of 49 patients (22%). The remaining 38 patients (78%) all underwent living donor right lobe liver transplantation. Among the 38 patients, 22 (58%) had a single bile duct, while 16 (42%) had double bile ducts. Patients with double bile ducts were divided into two groups: those in whom one bile duct was anastomosed to the cystic duct, and those in whom other techniques were used to complete the bile duct anastomoses.

Patients' age, gender, primary diagnosis, technique used for biliary anastomosis, use of internal stent, feeding, postoperative biliary complications, and graft weight were recorded. Additionally, the preoperative Model for End-Stage Liver Disease (MELD) scores, operative times, durations of intensive care unit (ICU) stay, and total follow-up periods of these patients were also noted.

Patients who underwent living donor right lobe liver transplantation and developed double bile ducts when the biliary tree was divided during surgery were included in the study. Patients who underwent cadaveric liver transplantation and patients with single bile duct were excluded from the study.

In patients undergoing anastomosis to the cystic duct, the anastomosis was performed using 5/0 or 6/0 polydioxanone (PDS) sutures, depending on tissue thickness. The posterior aspect of the anastomosis was sutured continuously with PDS sutures, while the anterior aspect was individually sutured with PDS sutures as well. The same technique was applied for the second anastomosis made to the main hepatic duct. In both anastomoses, once suturing of the posterior aspect was completed, an appropriately sized internal stent was passed into the lumen, followed by completion of suturing of the anterior aspect (Figure 1).

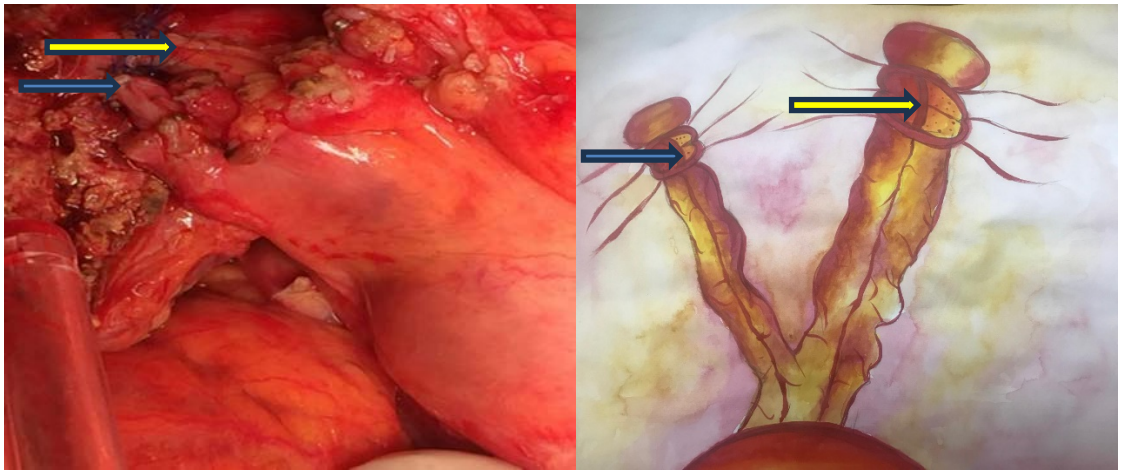

Figure 1: Blue arrow cystic duct anastomosis, yellow arrow main hepatic duct anastomosis and illustration of the cystic duct and common hepatic duct

Statistical Analysis

All statistical analyses were performed using SPSS version 21.0 (SPSS Inc, Chicago, IL) software package. Kolmogorov-Smirnov and Shapiro-Wilk tests were used to test the conformity of continuous variables to normal distribution. All continuous variables were presented as mean ± standard deviation and median (max - min). For normally distributed variables, the Student's t-test was used to compare differences between two independent groups. For non-normally distributed variables, the Mann-Whitney U test was used. ANOVA test was used to compare normally distributed variables between more than two groups, whereas Kruskal-Wallis test was used for non-normally distributed variables. Categorical variables were analyzed using the Chi-square test. A p value of <0.05 was considered statistically significant in all analyses.

Results

Between June 2018 and May 2021, a total of 49 patients underwent liver transplantation at our clinic. Of these patients, 11 received cadaveric liver transplants and 38 underwent living donor liver transplantation. In living donor transplants, 22 patients had a single bile duct and 16 patients had double bile ducts (Table 1). Of the 16 patients with double bile ducts, 9 (56%) were male and 7 (44%) were female. The mean age of the patients was 51.18 (±12.77) years.

In cadaveric liver transplants, only 1 (9%) patient developed complications during postoperative follow-up. Biliary stricture developed in this patient, and was resolved after endoscopic retrograde cholangiopancreatography (ERCP). Among the 22 patients who underwent living donor right lobe liver transplantation and had a single bile duct, complications were encountered in 5 (23%) cases. Biliary stricture in three patients was resolved by ERCP and bile leakage in two patients was resolved by ERCP and percutaneous drainage.

Table 1: Distribution of patients according to the number of bile ducts

Variables		Female	Male	Total
Bile Duct Anastomosis	Single Bile Duct	12	21	33
	Double bile duct and no anastomosis to the cystic duct	2	5	7
	Double bile duct and anastomosis to the cystic duct	5	4	9
Total		19	30	49

Of the 16 living donor liver transplant patients with double bile ducts, the cystic duct was used for anastomosis of one of the bile ducts during biliary reconstruction in 9 patients. In 5 of the remaining 7 patients, reconstructions were performed in different localizations of the common bile ducts, and additional HJ reconstructions were performed in 2 patients. In patients with double bile ducts, the anterior sector of the transplanted right lobe graft was draining as a separate bile duct, while the posterior sector was also draining as a separate bile duct. A separate anastomosis was performed for each sector of the bile duct. Table 2 presents the demographic data of the patients and information regarding which anatomical structure the biliary anastomoses were performed on.

In patients who underwent anastomosis to the cystic duct, biliary complications occurred in only one patient (11%). The bile leakage that occurred in this patient was brought under control with ERCP and percutaneous drainage. In the other group, biliary complications developed in 3 of 7 patients (42%). Of these three patients, two developed biliary stricture and one developed bile leakage. Biliary strictures in two patients were treated with ERCP, while bile leakage in one patient resolved spontaneously with conservative follow-up (Table 2).

The mean follow-up period of our patients was 492.18 (±279.10) days. The mean MELD score was 17.68 (±5.88). The median graft weight was 700 (500-1150) g and the mean operative time was 12.5 (8-15) hours. The median duration of ICU follow-up was 5 (2-17) days (Table 3).

The patients with double bile ducts who underwent biliary anastomosis to the cystic duct and those who did not were statistically compared in terms of certain parameters. There was no significant difference in terms of mean age, MELD score, and graft weight (Table 3).

When comparing the operative times to assess the technical difficulty of biliary anastomosis, no significant difference was found between the two patient groups (p=0.231, Table 3).

Similarly, when comparing the two patient groups in terms of ICU stay, no significant difference was found (p=0.340, Table 3). The mean follow-up durations after discharge were significantly lower for patients who underwent anastomosis to the cystic duct compared to those who did not (p=0.008, Table 3).

Table 2: Demographic information of patients with double bile ducts and data regarding anastomoses

N	Primary Disease	Age	Sex	Graft Weight	Number of Bile Ducts	Internal Stent	Feeding Catheter	Anterior Sector	Posterior Sector	Bile-related Complication
1	HBV	58	M	580	2	+	-	Right	Left	-
2	HCV	67	F	700	2	+	-	Choledoch	Cystic Duct	Bile Leak, ERCP, Percutaneous Drainage
3	PSC	63	M	730	2	+	-	HJ	Choledoch	Bile Leak, Conservative Follow-up
4	HBV	21	M	705	2	+	-	Right	Choledoch	Bile Duct Stenosis, ERCP
5	Cryptogenic	38	F	630	2	+	-	Right	Left	Bile Duct Stenosis, ERCP
6	HBV	59	M	600	2	+	-	Right	Choledoch	
7	HBV	56	M	620	2	+	-	Choledoch	Cystic Duct	
8	HBV	60	M	770	2	+	-	Choledoch	Right	
9	Secondary Biliary Cirrhosis	53	F	690	2	+	-	HJ	Choledoch	
10	HBV, HCV	46	F	500	2	+	-	Cystic Duct	Left	
11	Cryptogenic	57	F	970	2	+	-	Choledoch	Cystic Duct	
12	HBV	56	M	810	2	+	-	Cystic Duct	Choledoch	
13	Cryptogenic	31	M	1150	2	+	-	Cystic Duct	Choledoch	
14	HBV	53	F	905	2	+	-	Cystic Duct	Choledoch	
15	HBV	39	M	890	2	+	-	Cystic Duct	Choledoch	
16	Cryptogenic	62	F	640	2	+	-	Choledoch	Cystic Duct	

Abbreviations: N: Patient Number ERCP: Endoscopic retrograde cholangiopancreatography, HBV: Hepatitis B, HCV: Hepatitis C, HJ: Hepaticojejunostomy, PSC: Primary Sclerosing Cholangitis,

Table 3: Comparative data according to the number of bile ducts

Type of Anastomosis		**Double bile duct and no anastomosis to the cystic duct**	**Double bile duct and anastomosis to the cystic duct**	**Total**	***p*-value**
Number of patients		7 (% 44)	9 (% 56)	16	
Mean age (year)		50.29 ± 15.32	51.89 ± 11.34	51.18 ± 12.77	0.813
Sex	Male	5	4	9	
	Female	2	5	7	
Mean follow-up (day)		686.29 ± 137.96	341.22 ± 270.53	492.18 ± 279.10	0.008*
Mean MELD score		17.57 ± 4.28	17.78 ± 7.16	17.68 ± 5.88	0.947
Graft weight		690 (580-770)	810 (500-1150)	700 (500-1150)	0.140
Operative time (hours)		12 (8-15)	13 (11-15)	12.5 (8-15)	0.231
Postoperative intensive care unit stay (day)		5 (2-6)	5 (2-17)	5 (2-17)	0.340

Abbreviations: MELD: Model for end stage liver disease

Discussion

Biliary complications in LDLT are reported in the literature with a wide range. ranging from 0.4% to 67%. and they continue to be the leading cause of postoperative morbidity (4. 12. 13). Secondary to biliary complications. delayed healing. decreased graft survival. and decreased quality of life may be observed. As a result of these complications. the patient remains hospitalized for a long time and cannot be discharged. The risk of biliary complications may increase due to factors such as having smaller and multiple bile ducts and devascularization during hilar dissection (5). Increased donor age also leads to an increase in biliary morbidities (1). In the present study. none of the biliary complications experienced in patients with single or double bile ducts resulted in a reduction of graft survival or mortality in the patients. Biliary complications were managed with rapid interventions. and necessary interventional procedures were promptly implemented. No patient required reoperation or experienced mortality due to this reason.

In their study. Pamecha et al. found that the number of bile ducts and the number of anastomoses were independent risk factors for the development of biliary complications in adults. In this study. biliary reconstruction with HJ was frequently performed in patients with multiple bile ducts (6). In the present study. the rate of biliary complications in cadaveric liver transplants with choledochocholedochostomy remained at 9%. In LDLT. however. the complication rate increased and exceeded 20%. independent of the number of bile ducts (single or double). In fact. this result alone shows that the most optimal option in liver transplantation is cadaveric liver transplantation and that countries should put more effort into cadaveric organ donation.

In a meta-analysis. Chok et al. identified factors determining the type of biliary reconstruction in liver transplantations as the type of liver disease. graft size. width and number of bile ducts in the donor and the recipient. presence of known bile duct disease. history of abdominal trauma or surgery. and presence of inflammatory bowel disease (7). In the present study. we did not differentiate patient groups based on the primary diagnosis. In other words. we did not exclude any diagnostic group from the study. Furthermore. statistical analysis showed that there was no significant difference in graft weight among the compared groups ($p=0.060$. Table 3). In larger patient groups. the preferred biliary anastomosis technique can be determined according to the patient's primary diagnosis and the results can be compared. Since our number of patients is not large enough to allow such a study. centers with larger patient groups can conduct such studies and interesting results can be obtained.

Although there are numerous studies in the literature on the overall incidence of biliary complications in liver transplantation. the number of studies focusing on anastomoses performed in the presence of multiple bile ducts is limited (1. 4. 8. 9). Therefore. it continues to be a topic of discussion in LDLT. The main limitation of the present study was the small number of patients. which restricted us from making definitive statements on this issue. In a series of 5 patients in whom cystic duct anastomosis was performed end-to-end and end-side-to-side in LDLT patients with multiple bile ducts. Malago et al. yielded promising results. They emphasized the prerequisite of having a sufficiently long and vascularized cystic duct for this procedure (10). In addition. the study by Salvalaggio et al. demonstrated that the presence of multiple bile ducts is a risk factor for biliary complications. especially in pediatric patients (11). Our patient group consisted only of adult patients. Since growth and development continue in pediatric patients. the most effective technique for biliary anastomosis may vary in these patients. Studies on this subject with a large number of patients will shed light on finding the most effective technique in the pediatric patient group. In the study by Muhammed et al. it was found that complications in LDLT patients with multiple bile ducts were similar to those in patients with single bile duct (4). In two recent studies by Kollmann and Arıkan. it was stated that the number of bile ducts and the type of anastomosis did not alter the outcomes in LDLT (1. 8). In their meta-analysis. Zhang et al. stated that although anastomosis to the cystic duct for biliary reconstruction is never the first choice. it can be used in the presence of multiple bile ducts if there is a reasonably wide cystic duct (9). In the present study. biliary complications were observed in only 1 out of 9 patients. which is encouraging regarding the feasibility of using the cystic duct for biliary anastomosis.

Study limitations

The retrospective nature of our study. its single-center design. and the limited number of cases can be considered as limiting factors.

Conclusion

In conclusion. despite all the advancements in surgery. biliary complications continue to be a significant problem in LDLT. Despite the conflicting data in studies with a limited number of cases in the literature. in our experience. the postoperative outcomes of cases with cystic duct anastomosis are certainly not poor. Even if biliary complications develop. endoscopic management is possible. We believe that cystic duct anastomoses performed with good surgical technique may have similar or even better postoperative outcomes compared to other types of anastomoses. However. large prospective series with longer

postoperative follow-up are needed to evaluate the effectiveness of cystic duct anastomosis in biliary reconstruction.

Acknowledgements: *We would like to thank painter Günay Yönder for her beautiful drawing showing the anatomy of the bile duct.*
Ethical Approval: *This study was approved by the Harran University Faculty of Medicine Ethics Committee. (Date: 28.12.2023; Protocol Number: HRÜ/23.25.07). Informed consent was obtained from all patients.*
Author Contributions: *Concept: H.Y., M.S.B., F.T. Literature Review: H.Y., M.S.B. Design: H.Y., M.S.B. Data acquisition: H.Y. Analysis and interpretation: M.Y., F.T. Writing manuscript: H.Y., M.S.B., M.Y. Critical revision of manuscript: M.Y., F.T.*
Conflict of Interest: *The author(s) do not have any potential conflict of interest regarding the research. authorship and/or publication of this article.*
Financial Disclosure: *This research received no specific grant from any funding agency in the public. commercial. or not-for-profit sectors*

References

1. Arikan T. Emek E. Bozkurt B. et al. Does multiple bile duct anastomosis in living donor liver transplantation affect the postoperative biliary complications? Transplant Proc 2019; 51(7):2473–7.
2. Suh KS. Choi SH. Yi NJ. et al. Biliary reconstruction using the cystic duct in right lobe living donor liver transplantation. J Am Coll Surg 2004; 199(4):661–4.
3. Jung DH. Ikegami T. Balci D. et al. Biliary reconstruction and complications in living donor liver transplantation. Int J Surg 2020; 82S:138–44.
4. Muhammad ZM. Farah Z. Bushra Z. et al. Results of multiple biliary ducts anastomosis in living donor liver transplantation. Adv Res Gastroentero Hepatol 2016; 2:555581.
5. Nguyen NTT. Harring TR. Goss JA. et al. Biliary reconstruction in pediatric liver transplantation: a case report of biliary complications and review of the literature. J Liver 2015; 4(2):179.
6. Pamecha V. Sasturkar SV. Sinha PK et al. Biliary reconstruction in adult living donor liver transplantation: the allknots-outside technique. Liver Transpl 2021; 27(4):525-35.
7. Chok KSH. Lo CM. Systematic review and meta-analysis of studies of biliary reconstruction in adult living donor liver transplantation. ANZ J Surg 2017; 87(3):121-5.
8. Kollmann D. Goldaracena N. Sapisochin G. et al. Living donor liver transplantation using selected grafts with 2 bile ducts compared with 1 bile duct does not impact patient outcome. Liver Transpl 2018; 24(11):1512–22.
9. Zhang S. Zhang M. Xia Q. et al. Biliary reconstruction and complications in adult living donor liver transplantation: systematic review and meta-analysis. Transplant Proc 2014; 46(1):208-215.
10. Malagó M. Testa G. Hertl M. et al. Biliary reconstruction following right adult living donor liver transplantation end-to-end or end-to-side duct-to-duct anastomosis. Langenbecks Arch Surg 2002; 387(1):37-44.
11. Salvalaggio PR. Whitington PF. Alonso EM. et al. Presence of multiple bile ducts in the liver graft increases the incidence of biliary complications in pediatric liver transplantation. Liver Transpl 2005; 11(2):161-6.
12. Nakamura T. Iida T. Ushigome H. et al. Risk factors and management for biliary complications following adult living-donor liver transplantation. Ann Transplant 2017; 22:671–6.
13. Ikegami T. Yoshizumi T. Soejima Y. et al. Appropriate use of stents to prevent biliary complications after living donor liver transplantation. J Am Coll Surg 2018; 226(2):201.
14. Turner MA. Fulcher AS. The cystic duct: normal anatomy and disease processes. Radiographics 2001; 21(1):3-22.
15. Pina LN. Samoilovich F. Urrutia S. Rodríguez A. A et al. Ferreres AR. Surgical considerations of the cystic duct and Heister valves. Surg J (N Y) 2015; 1(1):23-7.