American Journal of Case Reports

ISSN 1941-5923
© Am J Case Rep, 2016; 17: 759-765
DOI: 10.12659/AJCR.901265

Received: 2016.08.26
Accepted: 2016.09.21
Published: 2016.10.19

First Left Hepatic Trisectionectomy Including Segment One with New Associated Liver Partition and Portal Vein Ligation with Staged Hepatectomy (ALPPS) Modification: How To Do It?

Authors' Contribution:
Study Design A
Data Collection B
Statistical Analysis C
Data Interpretation D
Manuscript Preparation E
Literature Search F
Funds Collection G

ABCDEFG 1 Aiman Obed
ADE 2 Anwar Jarrad
ADE 3 Abdalla Bashir

1 Department of Hepatobiliary and Transplant Surgery, Jordan Hospital, Amman, Jordan
2 Department of Hepatology, Gastroenterology and Hepatobiliary/Transplant Unit, Jordan Hospital, Amman, Jordan
3 Department of Surgery, Jordan Hospital, Amman, Jordan

Corresponding Author: Aiman Obed, e-mail: aimanobed@hotmail.com
Conflict of interest: None declared

Patient: Female, 36
Final Diagnosis: Synchronic CRLM
Symptoms: Abdominal pain • abnormal finding in abdominal-pelvic CT scan
Medication: —
Clinical Procedure: Extended left hepatectomy with left hemicolectomy
Specialty: Surgery

Objective: Unusual clinical course

Background: Associated Liver Partition and Portal vein ligation with Staged hepatectomy (ALPPS) leads to rapid hepatic hypertrophy and decreases incidence of post-hepatectomy liver failure in patients with a marginal future liver remnant. Various procedural ALPPS modifications were previously described. Here, we present the first case of a new ALPPS modification, carrying out a left hepatic trisectionectomy with segment 1.

Case Report: We present the case of a 36-year-old woman with locally advanced sigmoid adeno-carcinoma and extensive left liver metastases extending to segment V and VIII, who received state-of-the-art systemic conversion chemotherapy. Preoperative CT volumetric scan demonstrated a FLR/TLV (Future Liver Remnant/Total Liver Volume) of 22%. A left hepatic trisectionectomy procedure was conducted using our new ALPPS modification.
Sufficient hepatic hypertrophy of FLR was reached with a volume increase of 100%. The period between the 2 stages was 7 days. The patient underwent left trisectionectomy and left colectomy with tumor-free margins. All dissected lymph nodes were tumor-negative. The surgical intra- and postoperative course was uneventful. Medically, the patient acquired an *Acinetobacter* infection, with severe sepsis and acute renal injury. After 3 dialysis sessions, the renal function recovered completely. Afterwards, the patient recovered slowly, and reintroduction ambulation and oral feeding was prolonged. Later on, the patient received Xeloda 1500 mg twice daily as adjuvant chemotherapy.

Conclusions: The new ALPPS modification leads to a sufficient hypertrophy of FRL within 1 week, allowing left hepatic trisectionectomy with tumor-free FRL. Despite the challenging complications, the new ALPPS modification might represent an alternative procedure for use when the classic ALPPS procedure is not applicable. Further studies are required.

MeSH Keywords: Colorectal Surgery • Liver Neoplasms • Portal Vein

Full-text PDF: http://www.amjcaserep.com/abstract/index/idArt/901265

2298 — 5 26

This work is licensed under Creative Common Attribution-NonCommercial-NoDerivatives 4.0 International (CC BY-NC-ND 4.0)

Background

The most important barrier in achieving of R0 resection after a major hepatectomy is often the failure to preserve a sufficient future liver remnant (FLR) and avoiding postoperative liver failure (PLF). Associated Liver Partition and Portal vein ligation for Staged hepatectomy (ALPPS) is a novel technique for the surgical removal of extensive liver tumors, which were previously considered unresectable. This procedure regularly achieves a rapid increase in the volume of the left lateral segments (FLR), often within 1 week after surgery.

However, this procedure is controversial due to its high morbidity and mortality. Since the milestone multicenter study led by Dr. Schlitt was published [1], about 200 papers have followed, thereby establishing an ALPPS procedure registry [2]. In the long history of liver surgery, ALPPS is similar to a little child – it simply requires more time to develop.

As a result, many modifications for ALPPS and selection criteria have been introduced to help decrease the morbidity and mortality of this procedure [3–6]. The benefits of ALPPS are rapid hypertrophy of the FLR, feasibility, and a high rate of R0 resection. Well-recognized weaknesses of ALPPS are morbidity, death, and early tumor recurrence.

ALPPS has given hepatobiliary surgeons the ability to help patients with seemingly hopeless extensive liver tumors, whether primary or metastatic, especially those with colorectal liver metastases (CRLM) in the face of a small-for-size FLR.

Here, we describe a new modification of the ALPPS procedure, carrying out an extended left hepatectomy, including segment one, in a 36-year-old woman with synchronic CRLM.

Case Report

A 36-year-old woman, mother of 5 children, presented to our clinic with synchronous colorectal liver metastases. Examination confirmed a 4-cm sigmoid cancer with extensive unresectable liver metastases. After our multidisciplinary tumor board carefully evaluated her case by, she was considered for 6-month state-of-the-art systemic conversion chemotherapy with FOLFOX4 plus bevacizumab. After 6 months, tumor markers have decreased markedly and the tumor size in the liver decreased by about 1.5 cm from the pre-chemotherapy original size, and control colonoscopy showed only sigmoid wall thickening.

Because the left portal vein, including the branches of segment II and III, was definitely encased by the extensive tumor in the liver, performing "classical" ALPPS was excluded (Figure 1).

After a complete new medical evaluation, our tumor board decided to go ahead with the suggested modified ALPPS performed by a hepatobiliary surgeon, because the quality and quantity of the future liver remnant was considered insufficient. The patient was found to have a fatty liver by abdominal ultrasound and this was recognized to be chemotherapy-related. We conducted a CT scan of the whole body using liver triple-phase CT scan with oral and IV contrast and MRCP to exclude important bile duct and vascular anatomical variations of segments 6 and 7 of the liver (Figure 2).

Our patient's BMI was 35.2, corresponding to a weight of 90 kg (198.4 pounds) at a height of 1.60 m (5 ft 3 in). The future liver remnant of the right posterior sector (segment 6 and 7) was 550 ml, FRL/BW ratio (future remnant-to-body weight ratio) 0.61 and standard FRL 22%. The patient was informed about the surgical and medical options and written informed consent was given to undergo a modified ALPPS and subsequent

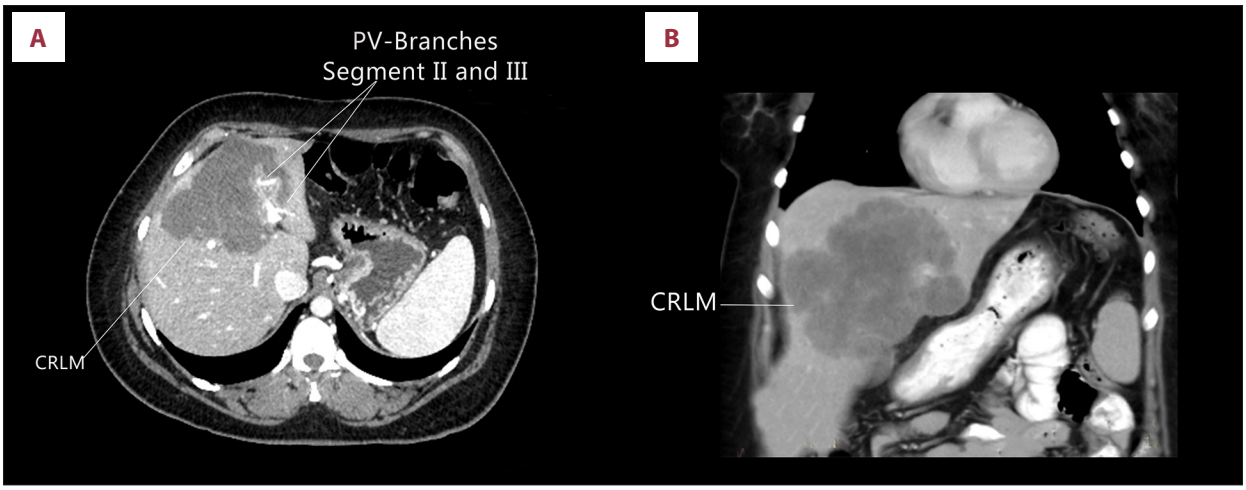

Figure 1. Liver CT scan revealed advanced CRLM with infiltration of the left portal vein and segment II and III PV-branches.

This work is licensed under Creative Common Attribution-NonCommercial-NoDerivatives 4.0 International (CC BY-NC-ND 4.0)

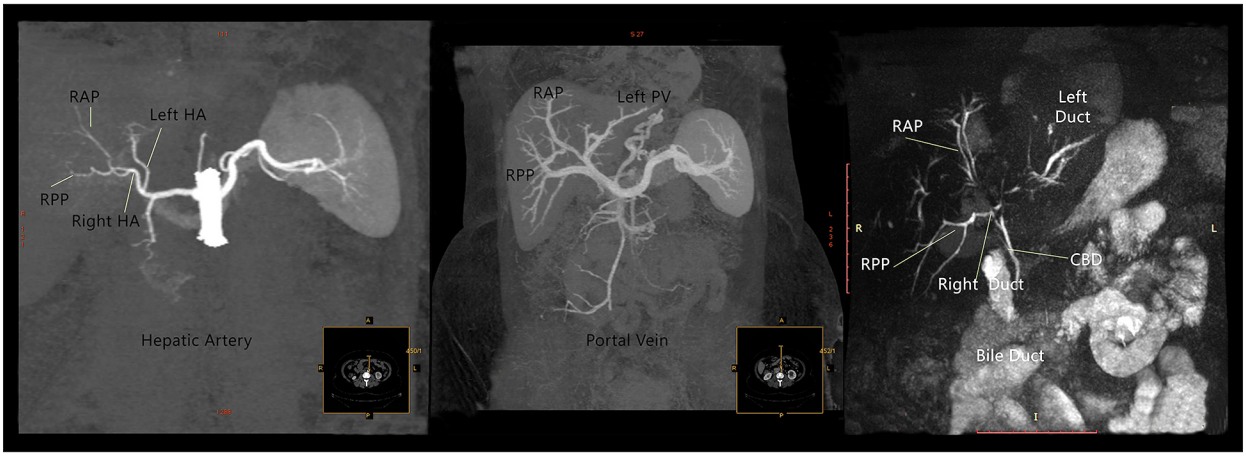

Figure 2. Angio- CT scan and MRCP showed the right posterior pedicle (RPP) without relevant vascular or biliary abnormalities.

resection. The patient fulfilled the selection criteria for the ALPPS procedure.

Indication for "conventional" ALPPS is anticipated when the FLR/TLV is below 25%, the FLR/BWR is lower than 0.5 in patients with a normal liver, or the FLR is below 30%. After chemotherapy or in patients with fibrosis, cholestasis, or fatty liver, the threshold is definitely higher, at 30–40% [1,7m8].

The surgical technique for the modified ALPPS procedure consists of the 2 following stages (Figure 3).

Step One Procedure:

1. A modified right subcostal incision was made following general anesthesia.
2. A systematic examination was then carried out to exclude extrahepatic disease in the peritoneal cavity, precluding liver resection.
3. Assessment of the liver was conducted by visual inspection, bimanual palpation, and intraoperative ultrasound. The future liver remnant was found to be bluish, soft, and fatty.
4. The liver was then mobilized by dissection of the round, falciform, and triangular ligaments.
5. The dissection along the posterior right liver and vena cava was conducted sharply, isolating the right, middle, and left hepatic vein and dividing larger pedicles that enter the vena cava directly from the right and left liver lobe. The retrohepatic vena cava was completely freed. Left and middle veins were encircled by cotton tape.
6. In the porta hepatis, the left hepatic artery and the left portal vein were encircled with cotton tape after cholecystectomy, and the bile duct was untouched. Periportal and hilar lymph nodes dissection was performed.
8. The right anterior pedicle (RAP) of the portal vein, bile duct, and hepatic artery were identified and dissected later during the operation.
9. The resection landmark is the anterior wall of the right hepatic vein, next to Rouvier's sulcus. The anterior branches of the right hepatic vein to segments 5\8 were occluded during parenchymal dissection.
10. Parenchymal dissection was performed with dissecting scissors used for blunt preparation.

Step 2 Procedure:

1. Careful exploration of the abdomen.
2. Left hepatic artery and portal vein were identified and ligated.
3. Left and middle hepatic veins were transected by vascular stapler.
4. The left duct was identified and ligated; a bile leakage test was conducted via the open left bile duct.
5. Extended left hepatic lobe was removed.
6. Left colectomy with standard lymph nodes dissection was also performed with side-to-side anastomosis.

Modified ALPPS was performed in accordance with the previously mentioned surgical steps (Figure 3). The patient was hemodynamically stable during both operations and she received 6 unites of red packed cell and 8 fresh frozen plasma units during the first operation. During the first operation, the FLR appeared bluish, soft, and vulnerable. This intraoperative condition of the liver confirmed our preoperative concerns about the quality of the FLR.

The patient was observed in an intensive care unit. On day 7, a volumetric liver CT scan showed an increase in the size of the right posterior sector (Segment 6+7), about 100% (1190 cm^2) larger than its original size. The FLR/BW ratio increased to 1.3%. The standard FLR increased to 0.47% (Figure 4). During the inter-stage phase, there were no signs of complications such as an infection or a bile leak. The patient was subsequently taken to the operating room and the extended left hepatic trisectionectomy with left colectomy was completed during step 2.

This work is licensed under Creative Common Attribution-NonCommercial-NoDerivatives 4.0 International (CC BY-NC-ND 4.0)

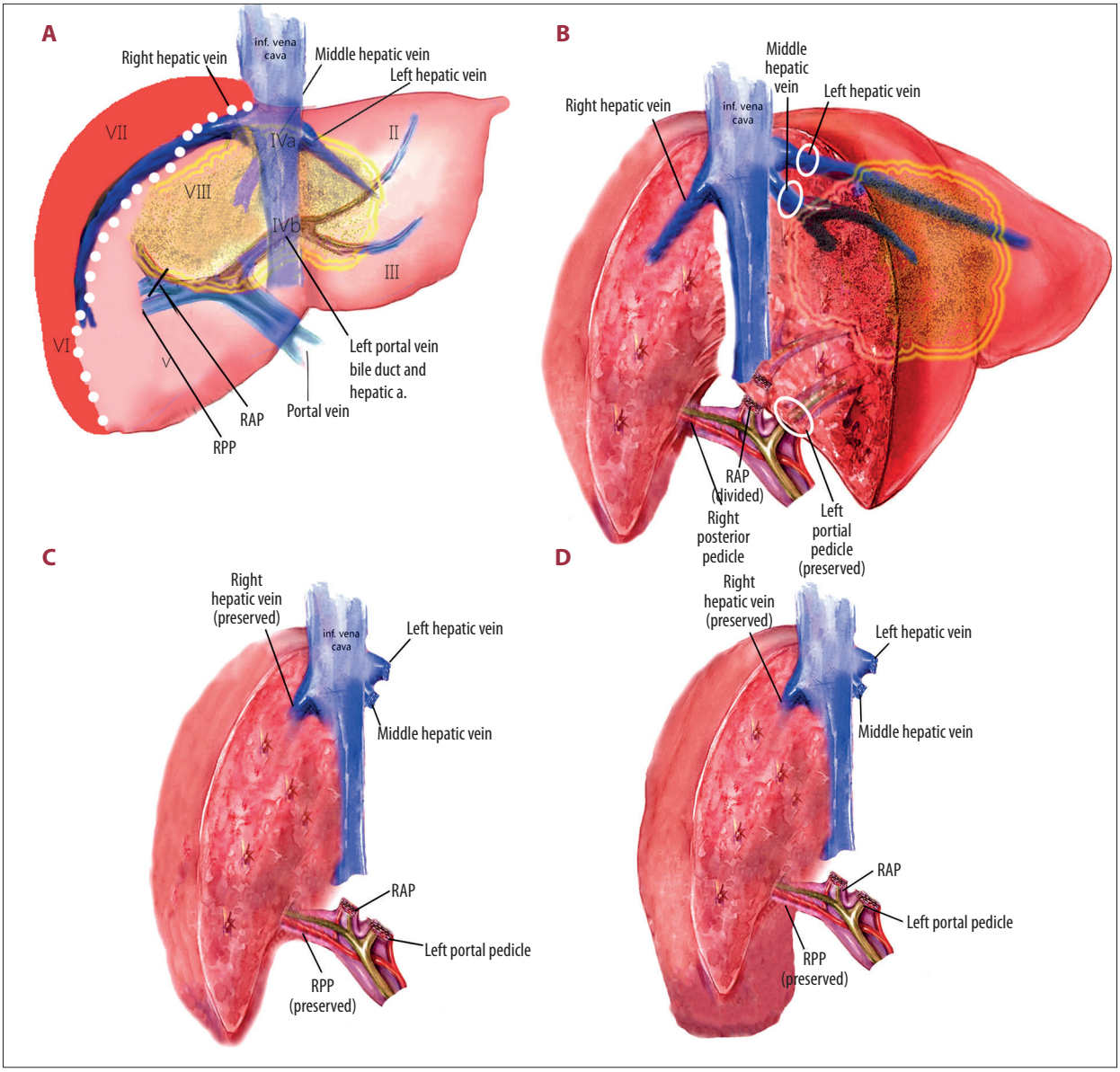

Figure 3. (**A**) The extent of CRLM with planned resection line (white) and dividing line-up (Black) of veins and RAP. (**B**) The divided liver after carrying out step 1. (**C**) The liver after removing the extended left lobe (step 2). (**D**) Further volume increase 1 week after step 2.

Initially, her postoperative course was uneventful and there were no signs of post-hepatectomy liver failure according to the 50-50 criteria. However, the patient experienced a severe abdominal infection with *Acinetobacter*, causing sepsis on postoperative day 8 after the second surgical step. The infection was treated and controlled with the proper sensitive antibiotics.

She received Tigecycline and the infection was controlled, but bilirubin increased dramatically. We stopped Tigecycline and started Colistin, the only remaining sensitive antibiotic.

Unfortunately, the patient developed acute renal injury with uremic pericarditis due to Colistin toxicity, which required 3 sessions of dialysis by our nephrology team. The renal function recovered completely within days. The right-sided pleural effusion was treated with ultrasound (US)- guided aspiration. At the same time, bile leak or duct narrowing was ruled out by endoscopic retrograde cholangiopancreatography (ERCP) and a CT scan revealed normal condition (Figure 5).

Liver enzymes and coagulation parameters were normalized within 5 days; the bilirubin was elevated for 8 weeks postoperatively, from day 8 after the second step procedure, related

This work is licensed under Creative Common Attribution-NonCommercial-NoDerivatives 4.0 International (CC BY-NC-ND 4.0)

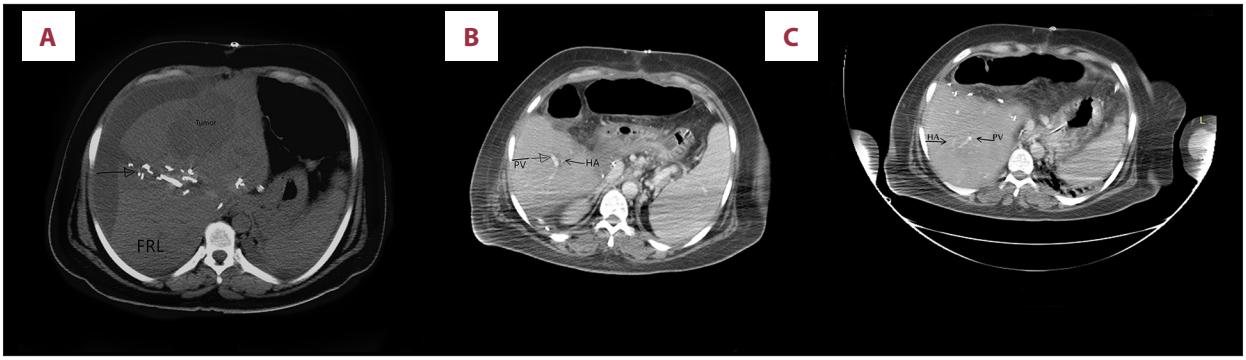

Figure 4. (**A**) The divided liver with FLR after 7 days. (**B**) FLR 8 days after step 2 with patent HA and PV. (**C**) Confirmed further volume increase of FLR 4 weeks after step 2 with patent HA and PV.

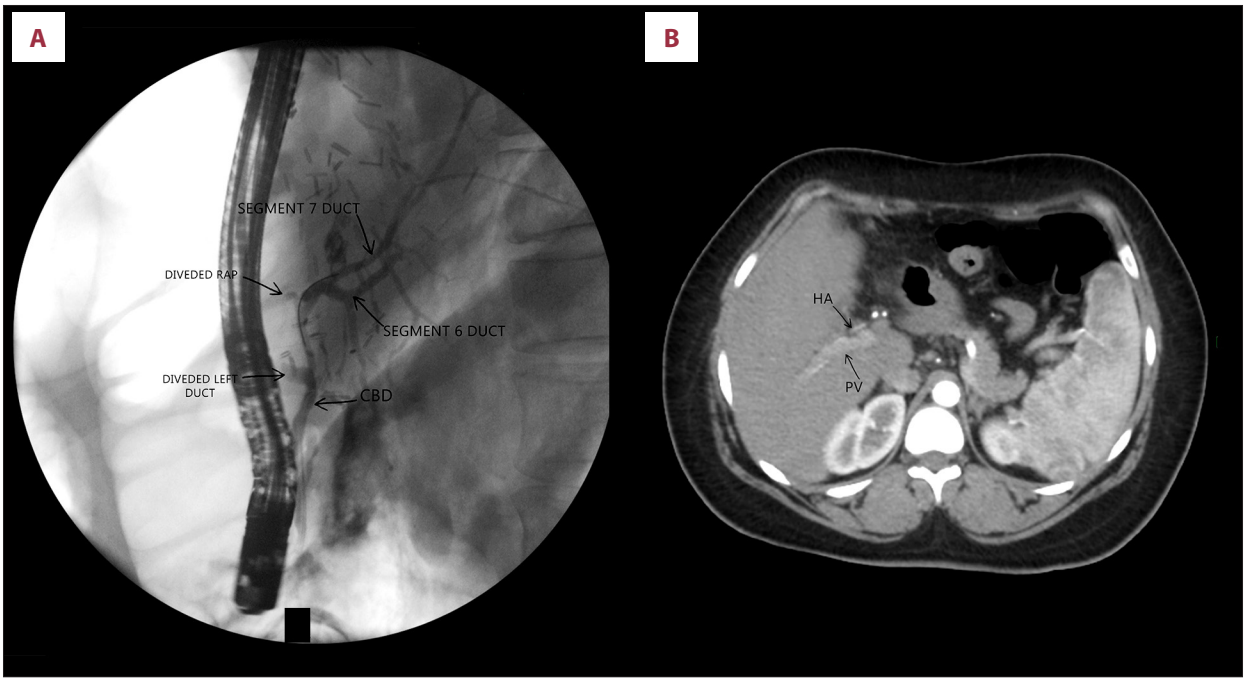

Figure 5. (**A**) FLR with normal postoperative ERCP Examination. (**B**) Patent FLR vessels.

to the severe sepsis and the adverse effect of Tigecycline. Subsequently, the patient recovered slowly, and reintroduction of ambulation and oral feeding was prolonged. Later on, the patient received Xeloda 1500 mg twice daily as adjuvant chemotherapy.

Postoperatively, hepatectomy and colectomy specimens underwent a standard pathological work-up. Histology findings showed colon cancer and liver metastases with free margins, tumor stage pT3, N0, M1, R0, G2. Synchronous liver biopsy taken from the FLR showed regenerative parenchyma with broadening of the trabecular liver cells, fatty degeneration of about 30%, and elevated proliferative activity estimated at 10%, with Ki67-positive nuclear reaction of regenerating hepatocytes.

Discussion

Up to 50% of patients with colorectal cancer (CRC) simultaneously show liver metastases. The only existing therapy that improves survival in patients with colorectal liver metastases is surgical resection.

Nowadays, liver resection is considered a curative approach to obtain better survival rates in patients with colorectal cancer liver metastases. Especially, patients with synchronic CRLM must be assessed by a hepatobiliary multidisciplinary board, which must include an experienced liver surgeon, since early surgical presentation for patients with potentially resectable colorectal cancer liver metastases is paramount for overall survival and highlights the importance of a preoperative multimodality evaluation. Inconsistencies between the ideas

This work is licensed under Creative Common Attribution-NonCommercial-NoDerivatives 4.0 International (CC BY-NC-ND 4.0)

of oncologists and hepatic surgeons regarding respectability and its underutilization may lead to worse patient survival [9].

If the primary CRC is without obstruction symptoms, "liver surgery first" can be performed. When CRLM is unresectable, the target of preoperative chemotherapy is to downstage the liver mass to allow resection. After chemotherapy, hepatic resection must be recommended to patients with optimal response after neo-adjuvant chemotherapy [10].

Neo-adjuvant chemotherapy with FOLFOX4 plus bevacizumab is well tolerated and has a positive response rate leading to curative surgery, which suggests an excellent survival advantage in previously unresectable CRC with simultaneous metastatic metastases [11].

The main obstacle in achieving an R0 resection after major hepatectomy is the inability to preserve an adequate future liver remnant to avoid post-hepatectomy liver failure, associated liver partition and portal vein ligation with staged hepatectomy (ALPPS). This is a novel technique for the resection of tumors previously considered unresectable [12].

ALPPS has evolved into various modified forms. Machado et al. performed laparoscopy during the first stage of the procedure. They indicated that laparoscopic ALPPS might prevent rigid adhesions, allowing an easier second stage. Later on, many institutions around the world performed laparoscopic ALPPS and several procedures were demonstrated in the recent literature [13–17].

Gauzolino et al. described 3 additional types of the "classic" ALPPS procedure. Similar to the original ALPPS procedure, these modified types permit surgical removal of hepatic tumors that were originally considered unresectable. Nevertheless, the efficiency and safety of these modified approaches cannot be evaluated at present due to a lack of detailed data [18–20].

Hepatobiliary surgeons in Hong Kong first reported the use of an anterior approach in ALPPS in 2 patients. Later, Ardiles et al. showed that 37% of the patients in the International ALPPS Registry experienced liver resection using an anterior approach during the first stage of ALPPS [21,22].

Li et al. developed a no-touch technique to treat tumor infiltration of the right portal vein or biliary bifurcation as part of ALPPS, and Robles et al. in Spain described a new modified form of the ALPPS procedure, which they termed associating liver tourniquet and portal ligation with staged hepatectomy [23,24].

In general, the aim of these techniques is to eliminate all metastases in the future liver remnant, which has insufficient volume to maintain the liver functionality and induce hypertrophy [25].

Our case is the first in which ligation of the right anterior portal pedicle was attempted, in order to allow the posterior sector of the right liver lobe for hypertrophy to produce sufficient future liver size. The feasibility and the technical steps in this case were attempted and carried out with the basic principles of the originally described ALPPS.

The location and extent of liver metastatic deposits dictates the location and the extent of liver resection. An overall predominance of right hepatic lobe metastases has been documented, independent of site of the primary colorectal carcinoma [26]. Hence, most ALPPS were described with the associated ligation of the right portal vein, in our case where our patient had an extensive left liver lobe metastatic deposits including liver segments 5 and 8. She was a candidate for associated ligation of the right anterior pedicle (RAP) of the portal vein with preserving and allowing liver segment 6 and 7 hypertrophy as a future liver remnant.

We anticipated that an increasing portal inflow through ligation of the RAP itself with the *in situ* resection is sufficient to induce appropriate hypertrophy; therefore, we deliberately omitted ligation of the left portal vein and decided to ligate only the RAP. As expected, the hypertrophy outcome of segment 6 and 7 was adequate after 7 days, resulting in 100% volume increase of FLR.

Although the right hepatic vein branches to segments 5 and 8 were occluded during the first step, congestion of liver segments 5 and 8 did not occur, due to the existing venous drainage via middle hepatic vein branches.

Long-term outcomes of classical ALPPS at this time exist presently for CRLM. Taking the high rate of recurrences into consideration, our patient underwent routine systemic conversion chemotherapy with radiological and tumor marker response. Furthermore, the performed preoperative systemic conversion chemotherapy also serves us as an excellent selection parameter to carry on with the modified ALPPS.

In summary, specific variations in the technical aspects of the ALPPS procedure exist in different surgical centers worldwide. Our modified ALPPS was feasible, with satisfactory a 6-month short-term result, and without any signs of recurrence. It induces adequate liver hypertrophy and at the same time it can offer the possibility of a cure to patients with tumors previously declared unresectable, especially when the classical ALPPS for whatever reason is not applicable.

This work is licensed under Creative Common Attribution-NonCommercial-NoDerivatives 4.0 International (CC BY-NC-ND 4.0)

Conclusions

Despite the severe postoperative medical complications, left hepatic trisectionectomy with the new modified ALPPS technique appears to be surgically applicable and promising. Further investigations are required, especially in regard to proper selection of patients.

Conflict of interest

The authors declare they have no conflicts of interest. The authors certify that they have received no financial support for this report.

Acknowledgements

The authors thank Leith Alrabadi, Doha Obed, and Saif Demeh for valuable advice, providing purely technical help and general support.

References:

1. Schnitzbauer AA, Obed A, Schlitt HJ et al: Right portal vein ligation combined with *in situ* splitting induces rapid left lateral liver lobe hypertrophy enabling 2-staged extended right hepatic resection in small-for-size settings. Ann Surg, 2012; 255: 405–14
2. Clavien PA, Lillemoe KD et al: Note from the editors on the ALPPS eLetters-to-the-Editor. Ann Surg, 2012; 256: 552
3. Gauzolino R, Castagnet M, Blanleuil ML et al: The ALPPS technique for bilateral colorectal metastases: 3 "variations on a theme". Updates Surg, 2013; 65: 141–48
4. Bjornsson B, Gasslander T, Sandstrom P et al: *In situ* split of the liver when portal venous embolization fails to induce hypertrophy: A report of 2 cases. Case Rep Surg, 2013; 2013: 238675
5. Schadde E, Malago M, Hernandez-Alejandro R et al: Monosegment ALPPS hepatectomy: extending resectability by rapid hypertrophy. Surgery, 2015; 157: 676–89
6. Tsui TY, Heumann A, Vashist YK e al: How we do it: double *in situ* split for staged mesohepatectomy in patients with advanced gall bladder cancer and marginal future liver remnant. Langenbecks Arch Surg, 2016; 401: 565–71
7. Nadalin S, Capobianco I, Li J et al: Indications and limits for associating liver partition and portal vein ligation for staged hepatectomy (ALPPS). Lessons Learned from 15 cases at a single centre. Z Gastroenterol, 2014; 52(1): 35–42
8. Alvarez FA, Ardiles V, Sanchez Claria R et al: Associating liver partition and portal vein ligation for staged hepatectomy (ALPPS): tips and tricks. J Gastrointest Surg, 2013; 17(4): 814–21
9. Choti MA, Thomas M, Wong SL et al: Surgical resection preferences and perceptions among medical oncologists treating liver metastases. Colorectal Cancer ,2016; 23(2): 375–81
10. Adam R, de Gramont A, Figueras J et al. of the EGOSLIM (Expert Group on OncoSurgery management of LIver Metastases) group: Managing synchronous liver metastases from colorectal cancer: A multidisciplinary international consensus. Cancer Treat Rev, 2015; 41(9): 729–41
11. Suenaga M, Fujimoto Y, Matsusaka S et al: Perioperative FOLFOX4 plus bevacizumab for initially unresectable advanced colorectal cancer. Onco Targets Ther. 2015; 8: 1111–18
12. Cai YL, Song PP, Tang W, Cheng NS: An update systemic review of the evolution of ALPPS and evaluation of its advantages and disadvantages in accordance with current evidence. Medicine (Baltimore),2016; 95(24): e3941
13. Machado MA, Makdissi FF, Surjan RC et al: Totally laparoscopic ALPPS is feasible and may be worthwhile. Ann Surg, 2012; 256: e13
14. Machado MA, Makdissi FF, Surjan RC et al: ALPPS procedure with the use of pneumoperitoneum. Ann Surg Oncol, 2013; 20: 1491–93
15. Conrad C, Shivathirthan N, Camerlo A et al: Laparoscopic portal vein ligation with *in situ* liver split for failed portal vein embolization. Ann Surg, 2012; 256: e14–15
16. Cai X, Peng S, Duan L et al: Completely laparoscopic ALPPS using round-the-liver ligation to replace parenchymal transection for a patient with multiple right liver cancers complicated with liver cirrhosis. J Laparoendosc Adv Surg Tech A, 2014; 24: 883–86
17. Xiao L, Li JW, Zheng SG et al: Totally laparoscopic ALPPS in the treatment of cirrhotic hepatocellular carcinoma. Surg Endosc, 2015; 29: 2800–1
18. Gauzolino R, Castagnet M, Blanleuil ML et al: The ALPPS technique for bilateral colorectal metastases: 3 "variations on a theme". Updates Surg, 2013; 65: 141–48
19. Bjornsson B, Gasslander T, Sandstrom Pet al: *In situ* split of the liver when portal venous embolization fails to induce hypertrophy: A report of 2 cases. Case Rep Surg, 2013; 2013: 238675
20. Schadde E, Malago M, Hernandez-Alejandro R et al: Monosegment ALPPS hepatectomy: Extending resectability by rapid hypertrophy. Surgery, 2015; 157: 676–89
21. Chan AC, Pang R, Poon RT et al: Simplifying the ALPPS procedure by the anterior approach. Ann Surg, 2014; 260: e3
22. Ardiles V, Schadde E, Clavien PA et al: Commentary on "Happy marriage or "dangerous liaison": ALPPS and the anterior approach". Ann Surg, 2014; 260: e4
23. Li J, Kantas A, Ittrich H et al: Avoid "All-Touch" by hybrid ALPPS to achieve oncological efficacy. Ann Surg, 2016; 263: e6–7
24. Robles R, Parrilla P, Lopez-Conesa A et al: Tourniquet modification of the associating liver partition and portal ligation for staged hepatectomy procedure. Br J Surg, 2014; 101: 1129–34
25. García-Pérez R, Revilla-Nuin B, Martínez CM et al: ALPPS *vs.* PVL for staged hepatectomy in rat model. PLoS One, 2015; 10(12): e0144096
26. Holbrook RF, Rodrigues-Bigas MA, Ramakrishnan K et al: Pattern of colorectal metastases according to couinauds segments. Dis Colon Rectum, 1995; 38(3): 245–48

This work is licensed under Creative Common Attribution-NonCommercial-NoDerivatives 4.0 International (CC BY-NC-ND 4.0)