Laparoscopic Liver Partition and Portal Vein Ligation for Staged Hepatectomy

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ABSTRACT

Introduction: Associating liver partition and portal vein ligation for staged hepatectomy (ALPPS) has recently been introduced as a feasible strategy that allows complete resection with curative intention in selected patients with otherwise locally unresectable disease due to an insufficient future liver remnant. Minimally invasive surgery has shown several benefits over the open approach in different surgical areas, including liver resections, over the past 2 decades. We report a case of a pure laparoscopic ALPPS.

Case Description: A 73-year-old woman with a single hepatic metastasis from breast cancer was referred to our unit. She had been treated with radical left and right mastectomy 30 and 15 years before referral. Magnetic resonance imaging and positron emission tomographic computed tomography demonstrated a single hypermetabolic 68-mm tumor mass located in the right liver lobe without other systemic tumor dissemination. A laparoscopic right hepatectomy was scheduled, but due to unexpected tumor extension during surgical exploration and the need for a larger than planned liver resection, a pure laparoscopic ALPPS approach was performed. After a 41% future liver remnant hypertrophy, the patient underwent a laparoscopic completion surgery without any complications. She had a favorable recovery and was discharged on postoperative day 3. The histopathological analysis indicated multiple metastatic breast cancer with negative resection margins.

Discussion and Conclusions: Pure laparoscopic ALPPS is feasible and may be performed safely in experienced hands. Minimally invasive access may represent a good alternative to reduce the surgical impact of the ALPPS approach in terms of postoperative recovery in selected patients.

Key Words: ALPPS, Laparoscopic liver surgery, Laparoscopy, Liver malignancy, Minimally invasive surgery.

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INTRODUCTION

Associating liver partition and portal vein ligation for staged hepatectomy (ALPPS) has recently been introduced as a feasible strategy that allows complete resection with curative intention in selected patients with otherwise locally unresectable disease due to an insufficient future liver remnant (FLR).[1–3] This strategy overcomes the main shortcomings of the classic 2-stage approaches with portal vein embolization or ligation (tumor progression and insufficient hypertrophy) by inducing a rapid and large FLR volume increase.[4,5] The worldwide dissemination of the ALPPS approach has triggered different reactions in the surgical community.[6] The impressive short-term FLR hypertrophy observed in the first published series has been widely confirmed by several investigators.[3,6–8] However, the main concern with this new surgical technique is the relatively elevated morbidity and mortality observed in most published series.[1,3,6–9]

Minimally invasive surgery has shown several benefits over the open approach in different surgical areas over the past 2 decades including liver resections.[10] We report a case of a pure laparoscopic ALPPS in a patient with un-

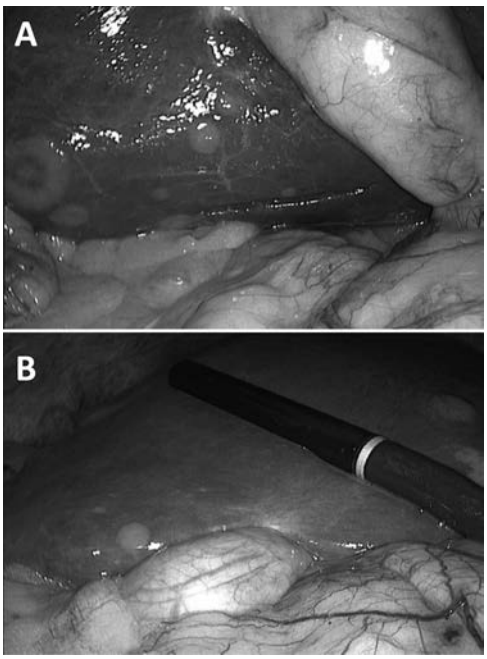

Figure 1. A. Multiple liver lesions are evidenced at laparoscopic exploration. **B.** Intraoperative ultrasound confirmed extended disease in segments 4 to 8 as well as 4 superficial lesions in the left lateral segment.

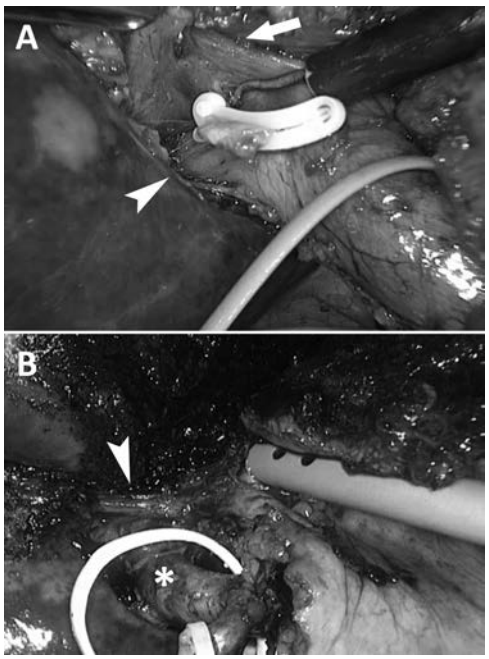

Figure 2. A. Trifurcation of the right portal branch. The main portal vein is encircled with a blue vessel loop. The right portal vein has 3 branches, a right anterior branch (white arrow), segment 6 branch (clipped), and segment 7 branch (arrowhead). **B.** Liver partition is completed. The right bile duct (white arrowhead) and the right hepatic artery (asterisk) are identified.

expected tumor extension during surgical exploration for an elective resection of noncolorectal non-neuroendocrine liver metastases.

CASE REPORT

A 73-year-old woman with a single hepatic metastasis from breast cancer was referred to our unit. She had been treated with radical left and radical right mastectomy 30 and 15 years before referral, respectively. After resection, she completed adjuvant treatment with tamoxifen and radiotherapy. Her body weight was 61 kg and she was monorenal due to a living-related kidney donation several years before. A 6-cm liver mass was found during a routine abdominal ultrasound. Magnetic resonance imaging revealed a single liver lesion of 68-mm diameter located in the right liver lobe. Positron-emission tomographic computed tomography confirmed a hypermetabolic mass and ruled out other systemic tumor dissemination. Laboratory tests were normal. A laparoscopic right hepatectomy was scheduled.

Under general anesthesia, the patient was positioned in supine position with rolls under the right flank. Five trocar ports were placed as follows: umbilicus camera port (12 mm), epigastric port (5 mm), left hypochondrium port at the mild-clavicular line (10 mm), 2 right flank ports at the level of the anterior axillary line (10 mm) and middle axillary line (5 mm). Both surgeons stood at the left side of the patient. Laparoscopic exploration ruled out peritoneal tumor extension but revealed unsuspected hepatic disease with multiple and bilateral metastases **(Figure 1).** After taking down the falciform ligament and resecting the round ligament for a better exposure, a laparoscopic intraoperative ultrasonogram was performed and demonstrated deep lesions in segment 4 with middle hepatic vein compromise. Fresh frozen histological analyses of a biopsy taken from a superficial lesion in segment 4 confirmed metastatic disease from breast origin. Portal pedicle lymphadenopathies were ruled out by observation and lymph nodes sampling with negative fresh frozen examination. Due to unexpected tumor extension and the need for a larger than planned liver resection, an ALPPS approach was considered. During the first step, the portal pedicle was encircled for the eventual need of a Pringle maneuver. Next, 2 atypical resections in segments 2 and 3, including 4 superficial lesions, was carried out using harmonic scalpel (Harmonic Ace; Ethicon Inc., Cincinnati, Ohio) and a 45-mm stapler with a white cartridge (Eche-

Figure 3. Plastic sheath between both hemilivers at the end of the first stage.

lon Endopath; Ethicon Inc.). After dividing the cystic duct, the right portal pedicle was dissected and the right branch of the hepatic artery was encircled with a vessel loop. During portal vein dissection, a trifurcation of the right branch was recognized. Each right branch was clipped individually (Hem-o-lok; Teleflex Medical, Dublin, Ireland) and sectioned **(Figure 2).** Parenchymal transection was carried out 1 cm to the right of the falciform ligament with harmonic scalpel and clips, up to the level of the middle hepatic vein. Hemostasis was made with argon bean coagulator (ABC; Covidien, Mansfield, Massachusetts) and Surgicel Nu-knit (Surgicel; Ethicon Inc.). Subsequently, the cholecystectomy was completed and an intraoperative cholangiography ruled out bile leaks. At the end of the procedure, 2 abdominal drains and a plastic sheet were placed between both cut surfaces **(Figure 3).** The operative time was 300 minutes, and no blood transfusions were required.

The patient had an uneventful postoperative course restarting oral intake at postoperative day 2. A volumetric computed tomographic scan performed on the sixth postoperative day showed that the FLR volume was 284 cc, representing a 29% volume increase compared with preoperative studies (segments 1 + 2 + 3 = 220 cc). However, the FLR represented only 22% of the total liver volume and the FLR to body weight ratio was 0.45%. A hepato-iminodiacetic acid scintigraphy was performed and showed that the FLR was responsible for 24% of the overall liver function. Due the good clinical condition of the patient and the failure to achieve a sufficient FLR hypertrophy, the patient was discharge 7 days after the first step. A new volumetric computed tomographic scan and hepato-iminodiacetic acid scintigraphy performed 27 days after the first step demonstrated a 41% FLR hypertrophy (310 cc) and a 30% FLR function **(Figure 4).** The FLR/total liver volume ratio was 0.24% and the FLR/body

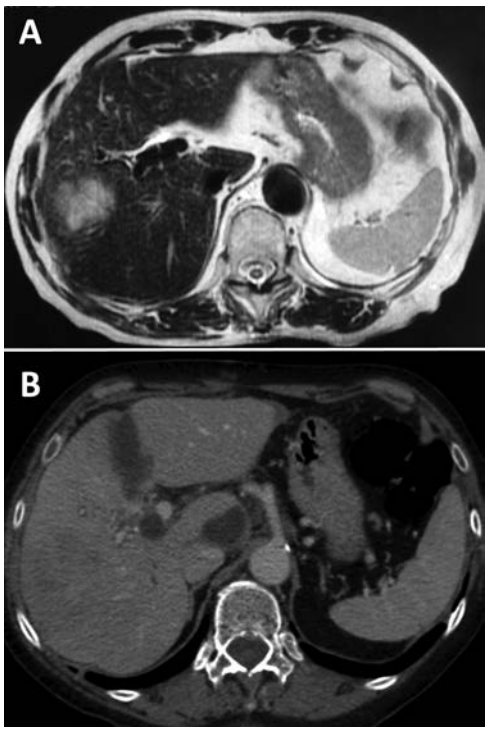

Figure 4. A. Preoperative magnetic resonance image shows a single liver lesion located in the right lobe. The volume of the left lateral segment + segment 1 was 220 cc **B.** The future liver remnant hypertrophied to 310 cc on the postoperative computed tomographic scan.

weight ratio was 0.5%. Given that the patient was in good condition and with normal liver function tests, we decided to go on with the completion surgery.

During the second step, laparoscopic exploration was performed using the same previous incisions. After releasing a few lax adhesions, the plastic sheath was removed and a minimal bile collection was drained between both hemilivers. The right branch of the hepatic artery was easily identified with the vessel loop around it and clipped (Hem-o-lok; Teleflex Medical), as well as the right bile duct. Afterward, the right liver lobe was completely mobilized and the inferior vena cava was identified. After clipping and dividing the middle hepatic vein, the transection of the remaining parenchyma was carried out using harmonic scalpel and 45-mm staplers with white loads. A laparoscopic hanging maneuver was applied to complete the liver transection and control the right hepatic vein with a vascular stapler **(Figure 5).** The specimen was placed in a plastic bag and withdrawn through a Pfannenstiel incision **(Figure 6).** After a detailed hemostasis and biliary stasis, a drain was placed in the right

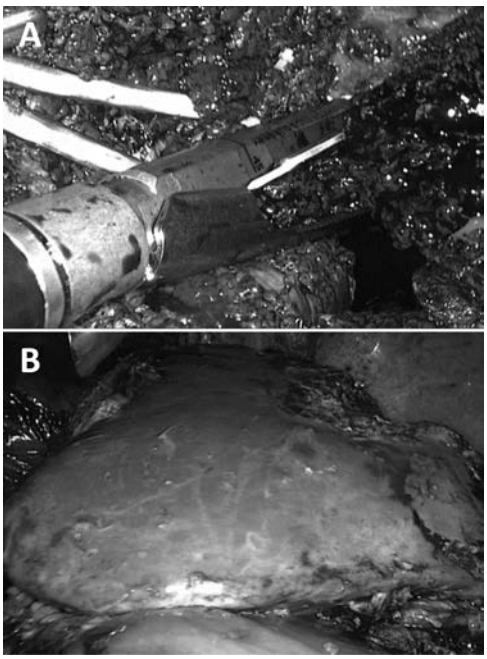

Figure 5. A. Laparoscopic hanging maneuver is applied to complete the right trisectionectomy. **B.** Liver remnant at the end of the second stage.

subphrenic space. The operative time was 180 minutes, and 2 units of packed red blood cells were transfused due to a preoperative hematocrit of 28 mg/dL. The patient had a favorable recovery without any complications and was discharged on the third postoperative day. The histopathological analysis indicated an estrogen receptor positive metastatic breast cancer with negative resection margins. Three months after surgery, the patient is disease free and under adjuvant therapy with anastrozole.

DISCUSSION

Advanced laparoscopic surgery has become routine in several diseases at high volume surgical centers. In the specific field of hepatopancreatobiliary surgery, the laparoscopic revolution started with the first laparoscopic cholecystectomy and continued nowadays with the accomplishment of very complex procedures such as pancreaticoduodenectomies and liver resections with satisfactory results.[10,11] As the experience in advanced laparoscopic surgical techniques grew, more complex cases and major liver resections were addressed by this approach.[12] The 2008 Louisville consensus statement showed that laparoscopic liver surgery is a safe and effective approach to the management of surgical liver disease in the hands of trained surgeons with experience in hepatobiliary and advanced laparoscopic surgery.[10] Furthermore, other studies have demonstrated that the oncological effectiveness of laparoscopic liver resections in selected patients is equivalent to that of the open technique.[13,14]

There are only 2 previous reports in the literature, as letters to the editor, regarding the use of laparoscopy during the ALPPS approach with few details provided about the technical aspects and specific outcomes of both cases reported.[15,16] These investigators stress that total or partial use of laparoscopy is a valid alternative and might facilitate the second operation because of less adhesion formation. With regard to the patient discussed here, contrary to these previous reports, we decided not to mobilize the right liver during the first stage of the ALPPS because we believe this maneuver is not always necessary and leaves more dissected surfaces for potential future adhesions. We believe that the benefit of less adhesion formation is especially important in those patients in whom the completion procedure has to be delayed for any reason, such as the case presented here.

The ALPPS approach has been associated with considerable risk of morbidity and mortality in most series published.[1,3,9,17] There are several reasons that explain the high complication rate observed and are mainly related to the type of patients treated, the complexity of the newly developed 2-stage procedure and the obligatory surgeon's learning curve. On the other hand, opposite to the classical 2-stage approaches, the ALPPS involves a short interval period between 2 major operations where a significant inflammatory syndrome is present. Laparoscopic liver surgery has proven several advantages over the open approach, including minimal scarring, preservation of the abdominal wall with less pain and improved diaphragmatic kinetics, better collateral venous drainage with fewer postoperative ascites, reduction in fluid and temperature shifts, shorter hospital stays, fewer transfusion requirements, faster recovery, and fewer adhesions[12–14,18]. The use of a laparoscopic approach during ALPPS, even if performed in the first operation only, might help to reduce the surgical impact of this 2-stage surgical strategy, offering an enhanced postoperative recovery and probably reducing the complication rate, especially for wound-related complications.

In the Hospital Italiano de Buenos Aires, we have already performed 29 ALPPS procedures. The first 28 cases of our series were performed by the open approach with the technique described previously.[19] It is important to remark that the patient discussed here was the last patient of our series, and we attempted the laparoscopic approach only after gaining a considerable experience and domi-

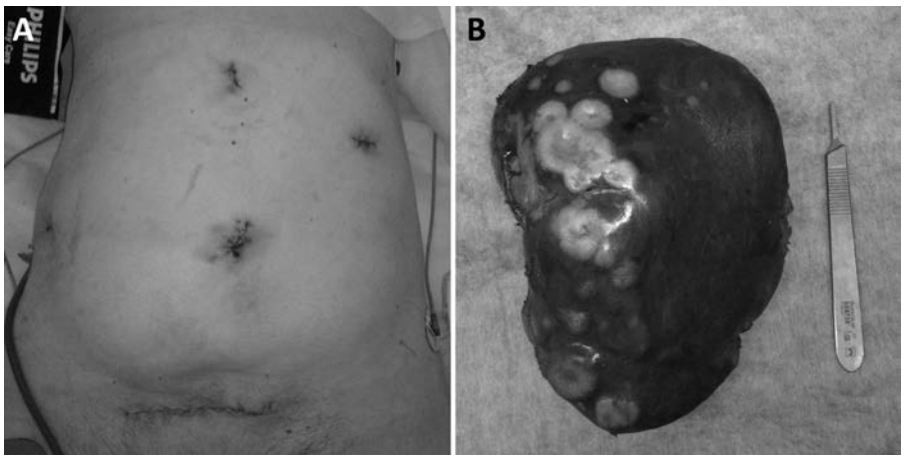

Figure 6. A. Trocar positioning and suprapubic incision. **B.** Macroscopic view of the right trisectionectomy specimen with multiple metastases.

nating the technical principles of the open ALPPS approach as well as previous experience with laparoscopic liver resections.[20]

The ALPPS approach has been demonstrated to be a valuable surgical option when unexpected tumor extension is encountered during an elective surgical exploration of a patient with apparently resectable disease.[3,21] In the presented case, a laparoscopic right hepatectomy was planned, and after discovering multiple bilateral liver metastases, it was possible to perform the first stage of ALPPS, maintaining the original minimally invasive approach. Within noncolorectal non-neuroendocrine liver metastases, breast tumors have been considered a favorable group for resection, with 5-year survival rates of up to 53% in patients with a long median disease-free interval between the primary tumor resection and liver metastases.[22] With this in mind, and given that the patient had a 15-year disease-free interval after her last radical mastectomy, we decided to go on with the aggressive resection of the liver metastases. Even though an R0 resection was technically possible in this patient with successful short-term outcomes, future studies in larger populations will be needed to determine the actual impact of this approach on patients' long-term survival.

The delayed hypertrophy seen in this patient might have been associated with different factors such as advanced age, poor nutritional status, and probably an insufficient partition of the liver parenchyma. Whether less surgical trauma and nonmobilization of right hemiliver have also contributed to a reduced hypertrophy has to be elucidated.

The ALPPS approach undoubtedly represents a maximally technical challenge in state-of-the-art hepatopancreatobiliary surgery. Laparoscopic ALPPS should only be attempted at specialized centers, by surgeons experienced in the ALPPS technique and complex laparoscopic liver surgery. Because laparoscopy lacks the palpation, which is important to diagnose occult lesions, a correct evaluation with intraoperative ultrasonogram is of utmost importance to ensure that the oncologic goals of the procedure are not compromised by the minimally invasive approach.

CONCLUSIONS

Our report demonstrates that pure laparoscopic ALPPS is feasible and may be performed safely in experienced hands, reaffirming that those candidates for the ALPPS approach might also benefit from minimally invasive surgery. We therefore believe that, due to the known benefits of laparoscopic surgery, minimally invasive access may represent a good alternative to reduce the surgical impact of the ALPPS approach in terms of postoperative recovery and may reduce surgical complications in selected patients.

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