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Percutaneous Microwave Ablation Liver Partition and Portal Vein Embolization for Rapid Liver Regeneration

A Minimally Invasive First Step of ALPPS for Hepatocellular Carcinoma

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To the Editor

Since its introduction by Schnitzbauer et al[1] in 2012, associating liver partition and portal vein ligation for staged hepatectomy (ALPPS) became a promising strategy for patients with insufficient future liver remnant (FLR). Despite the efficacy of ALPPS in triggering rapid hypertrophy of FLR, high incidence of postoperative morbidity and mortality poses a major drawback, especially for those hepatocellular carcinomas (HCCs) with liver cirrhosis. We read the paper with great interest by Gringeri et al[2] describing a new minimally invasive laparoscopic microwave ablation and portal vein ligation for staged hepatectomy (LAPS) on the future transection plane, resulting in a satisfactory hypertrophy of FLR and an easier second step in HCC. Since anatomic hepatectomy (right/extended right hemihepatectomy or right trisectionectomy) was usually applied for huge HCC, with a relatively lower hypertrophic rate as 48.7% compared with colorectal liver metastasis (CRLM)[3] in ALPPS or modified ALPPS, and considering the enormous stress upon patients enduring 2 laparotomies, we present a novel minimally invasive approach implementing percutaneous microwave ablation liver partition and portal vein embolization (PALPP) instead of the first step of ALPPS for rapid liver regeneration.

A 43-year-old man (weight 67 kg; height 170 cm; body mass index 23.3 kg/m^2) was admitted with a liver mass discovered incidentally by ultrasound. Medical history was significant for 15 years of hepatitis B virus infection. Serum α-fetoprotein (AFP) was 885.2 ng/L. Dynamic enhanced computed tomography (CT) imaging revealed multiple masses in the right lobe, a 2.0 cm × 1.5 cm intrahepatic metastasis in segment III (sIII), and a 1.5 cm × 1.5 cm intrahepatic metastasis in segment IV (sIV) (Fig. 1A, B). The patient's Stevenson body surface area was 1.74 m^2, with standard liver volume (SLV) of 1231.2 mL in Urata format. Liver volumetric CT scan measured the FLR at 355.6 mL, which was accounting for 28.9% of the total SLV. Since the inadequate FLR could not allow for a 1-step right trisectionectomy in combination with tumor resection in sIII, PALPP was designed to meet the challenges of this complicated case.

First, under ultrasonographic guidance, percutaneous microwave ablation (PMA) was applied every 3 cm along the transection plane until formation of a necrotic groove from the inferior liver to the suprahepatic veins. The PMA antenna was positioned on the right side of the transection plane at a power of 60 W set as a 3-minute ablation cycle. The tumor in sIV was ablated simultaneously. The tumor in the sIII was preoperatively controlled by dehydrated alcohol. The patient experienced a 2-day fervescence with peak body temperature measured at 38.9°C. Liver function was suboptimal on day 1 post-PMA, returning to normal range on day 2.

Three days after PMA, portal vein embolization (PVE) was performed. Coil was placed into the trunk of the right portal vein, followed by injection of mixed embolic agent (total volume of 0.2 mL, 2 mL medical glue, and 2 mL Lipiodol) into the distal right portal vein (Fig. 1C). The patient sustained a mild fever after PVE, with liver function maintained within normal range. Enhanced CT imaging obtained 10 days after PVE revealed a satisfactory hypertrophy of FLR with volume of 502.1 mL, accounting for 40.8% of the SLV and amplitude increase of 41.2% (Fig. 1D).

A well-planned right trisectionectomy in conjunction with sIII tumor resection was performed on day 14 after PVE. Minimal adhesion was noted along the PMA line (Fig. 1E). Anterior approach was taken during right trisectionectomy. The transection line was made at the left side of the PMA plane (1.5 cm wide). The tumor previously saturated with dehydrated alcohol in sIII was then removed (Fig. 1F). The total operation time was 300 minutes. Postoperative course was significant for mild ascites requiring medical treatment (Clavien-Dindo grade II). The patient remained free of fever, bile leak, or liver dysfunction. A 16.1% gain in FLR volume was observed on CT scan performed on postoperative day (POD) 7, with total volume of 583 mL (Fig. 1G). The patient was discharged on POD 15.

Since high morbidity (mean 44%, grade ≥3b) and 3-month mortality rate (mean 11%) remain serious drawbacks of ALPPS, specialists continue to modify surgical methodology, yielding novel techniques such as anterior approach in ALPPS,[3] complete laparoscopic ALPPS,[4] the LAPS procedure,[2] RALPP,[5] and monosegment ALPPS.[6] Unfortunately, all of these interventions consist of 2 surgical procedures and impose enormous physical and psychological stress upon patients enduring 2 laparotomies.

We introduce PALPP procedure as an effort to reduce the morbidity and mortality associated with large HCC tumors. We present the first case to our knowledge reporting a new minimally invasive procedure for treatment of primary liver carcinoma with insufficient FLR. In our center, 3 cases of HCC and 1 case of perihilar cholangiocarcinoma have been performed using this new minimally invasive approach with optimistic outcome (data were not shown).

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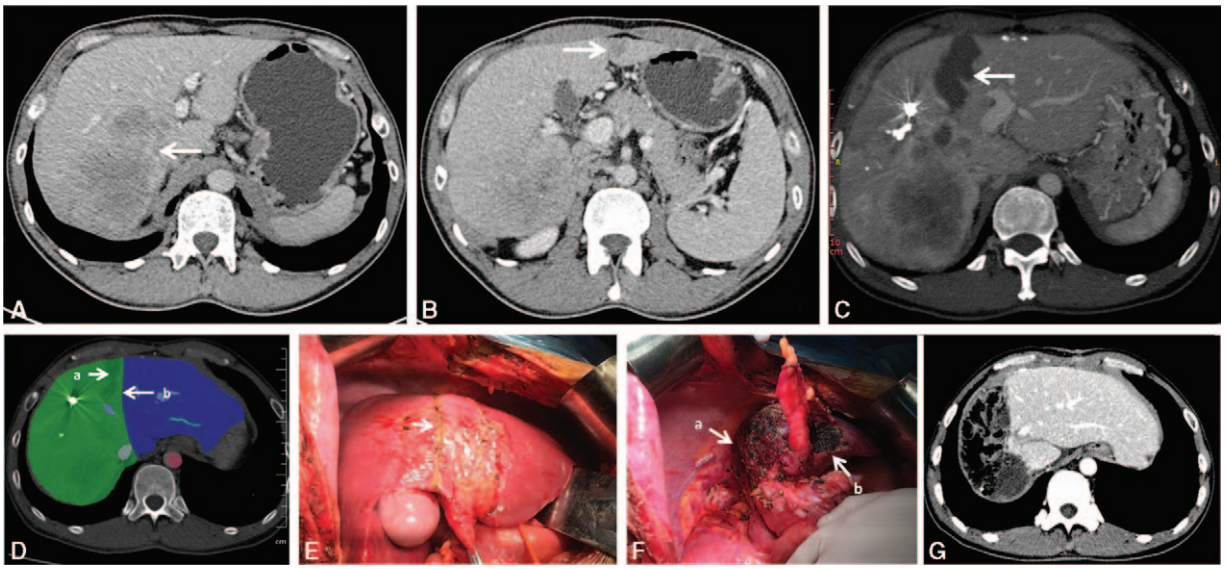

FIGURE 1. A, Computed tomography (CT) scan showing a sizable mass (arrow) in the right lobe of the liver. B, A 2.0 cm × 1.5 cm satellite lesion (arrow) situated in sIII. C, Occlusion of the right portal vein and the transection plane (arrow) after PVE and PMA. D, PMA transection plane (A); parenchymal transection line (B), as planned lateral to PMA plane. E, PMA transection plane (arrow) with minimal adhesion found intraoperatively. F, Completed right trisectionectomy and excision of the sIII lesion. G, CT scan confirming FLR hypertrophy on postoperative day 7. PVE indicates portal vein embolization.

Compared with the dual-operation paradigm of classic and modified ALPPS, the PALPP offers alleviated technical burden attributable to less adhesion after PMA. PMA and PVE are ''in situ'' procedures; tumor spread caused by direct PVL and parenchymal involvement in ALPPS could thus be mitigated by the less invasive technique. Moreover, the application of PMA in combination with PVE allows a rapid increase of FLR in a shorter time than traditional PVE/PVL. Inflammatory cytokines such as interleukin-6, tumor necrosis factor-α, and the STAT3 pathway induced by PMA play an important role in the remnant hypertrophy,[2,7] and would elicit effects even if the parenchyma were not completely spit by PMA, consistent with prior evidence of successful ''partial ALPPS.''[8] Finally, in situ splitting line made at the left side of the PMA plane shows microscopically coagulative necrosis, thus effectively reducing intraoperative blood loss and risk of postoperative bleeding and bile leak. The outcome of hypertrophic rate in our case was 41.2%, with a satisfactory liver function postoperatively, which is similar to the results as described in HCC.[3]

Promising as it seems to be, this technique, as we conservatively suggest, should be applied on those indicated for right/extended right hemihepatectomy or right trisectionectomy in primary liver carcinoma and colorectal liver metastases,[4] with the insufficient FLR being the major concern. Fortunately, more than 95% of the ALPPS procedures for HCC were reported as right hemihepatectomy or right trisectionectomy. Chan et al[3] reported 17 cases of ALPPS for HCC, in which 14 cases were right hemihepatectomy and 3 were right trisectionectomy. A series of 202 ALPPS was analyzed by Schadde et al which revealed that 141 cases (70%) were CRLM, in which right hemihepatectomy was performed in 106 cases (52%) and right trisectionectomy in 86 cases (43%).[9] Whereas for those extensive bilobar colorectal liver metastases, a monosegment ALPPS was suggested.[6]

In summary, we provide a novel surgical approach to cases of locally advanced liver tumors. We think that PALPP could be a more minimal technique alternative to the first step of ALPPS, and associated with low morbidity and mortality rates for huge primary liver carcinoma in which an anatomic hepatectomy was needed. Further application and evaluation of PALPP is necessary to demonstrate its safety and efficacy in selected cases.

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