

Radiofrequency ablation-assisted liver resection: a step toward bloodless liver resection

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BACKGROUND: Liver resection is currently the most efficient curative approach for a wide variety of liver tumors. The application of modern techniques and new surgical devices has improved operative outcomes. Radiofrequency ablation is used more often for liver parenchymal transection. This study aimed to assess the efficacy and safety of radiofrequency ablation-assisted liver resection.

METHODS: A retrospective study of 145 consecutive patients who underwent radiofrequency ablation-assisted liver resection was performed. Intraoperative blood loss, need for transfusion or intraoperative Pringle maneuver, the duration of liver parenchymal transection, perioperative complications, and postoperative morbidity and mortality were all evaluated.

RESULTS: Fifty minor and ninety-five major liver resections were performed. The mean intraoperative blood loss was 251 mL, with a transfusion rate of 11.7%. The Pringle maneuver was necessary in 12 patients (8.3%). The mean duration for parenchymal transection was 51.75 minutes. There were 47 patients (32.4%) with postoperative complications. There is no mortality within 30 days after surgery.

CONCLUSIONS: Radiofrequency ablation-assisted liver resection permits both major and minor liver resections with minimal blood loss and without occlusion of hepatic inflow. Furthermore it decreases the need for blood transfusion and reduces morbidity and mortality.

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Introduction

Liver resection is the only potentially curative treatment for liver tumors^[1-5] and perioperative blood loss is one of the well identified factors affecting morbidity and mortality.^[6-11]

The Pringle maneuver is a valuable tool for controlling intraoperative bleeding but places the patient at a high risk of liver damage because of ischemia-reperfusion injury or other well documented complications.^[12-18]

In an attempt to reduce the complications related to major vascular occlusion, several techniques for liver parenchymal transection without the need of clamping have been described. These surgical techniques combined with anesthetic and critical care improvements have significantly contributed to the reduction of morbidity and mortality associated with major liver resection.^[1-5]

Since the late 1990s, radiofrequency ablation (RFA) has been broadly used for *in situ* thermal destruction of the liver and other solid organ tumors. Subsequently, its use has been expanded to liver parenchymal transection. The standard technique consists of applying the RFA needle along the intended line of parenchymal transection, aiming to create a bloodless plane of coagulative necrosis.^[19-22] Furthermore, these devices can be used not only for liver resection but also for synchronous tumor ablation within the same procedure.

Despite the fact that partial and total vascular occlusions are efficient in controlling intraoperative hemorrhage, their application may cause liver damage due to ischemia-reperfusion injury. Liver ischemia-reperfusion injury have been investigated in depth, and several strat-

egies to minimize their severity have been developed.

This study aimed to determine the efficacy and safety of RFA-assisted liver resection through the analysis of 145 consecutive patients with primary or metastatic liver malignancies and benign liver tumors.

Methods

All patients who had undergone liver resection with the Cool-Tip radiofrequency device at the First Department of Surgery, University of Athens Medical School, LAIKO Teaching Hospital, from August 2001 to August 2008 were included in the study. All patients were evaluated preoperatively with spiral CT, MRI (plus magnetic resonance angiography/magnetic resonance cholangiopancreatography when necessary) and/or positron emission tomography.^[23]

Demographic details, histological type and number of liver tumors, type of procedure, overall operative time, parenchymal transection time, overall amount of intraoperative blood loss and quantity of blood loss during the liver parenchymal transection, were retrospectively collected from patients' notes. Perioperative liver function tests, intra/postoperative complications, length of hospital stay, mortality, and final outcome were also included. The operative time was counted from knife-to-skin time to the closure of skin incision. Liver resection time was defined as the time from the start of radiofrequency probe application to the liver tissue until the conclusion of parenchymal transection. The overall blood loss was calculated by the weight of surgical swabs in addition to the quantity of blood in the suction system for the whole surgical procedure. Blood loss during the parenchymal transection was measured in a similar way.

Techniques

RFA-assisted liver resection was performed as previously described.^[21] Briefly, with the patient in approximately 15 to 20 degree Trendelenburg supine position and the central venous pressure below 5 mmHg, the liver was routinely mobilized. The preferred operation for the liver mobilization was performed as described by Iwatsuki et al.^[24]

The hepatoduodenal ligament and corresponding hepatic veins in the case of right or left liver resection and the ipsilateral branches of the hepatic artery, portal vein and common bile duct were encircled with vessel loops when an anatomical hepatectomy was planned. When segmental or other non-anatomical resections of the liver were planned, the liver incision line was determined through intraoperative ultrasonography. It is essential to mark the resection line before the application of the RFA

probe as RFA coagulates the hepatic tissue, consequently causing significant image alterations on intraoperative ultrasonography. Thus, the visualization of tumor margins and the correlation with the surrounding vascular structures is hindered.^[25]

Following complete liver mobilization, the parenchymal transection commenced with the application of a single 15-cm needle electrode with a 2-cm exposure tip (Radionics Cooltip RFA System-Valleylab, Boulder, Co, USA; a subsidiary of Tyco Healthcare Group LP). The preferred setting of the radiofrequency energy generator was established at 95 watts on the 480 kHz scale and the electro surgical generator was set to the manual control mode.

The RFA needle electrode was inserted superficially into the liver parenchyma and gradual progression to deeper lying tissues follows. Hemostasis of the liver tissue by a single RFA application was achieved in less than one minute and followed by sharp tissue transection (Fig.). For optimal exposure of the cut surfaces of the liver, the open book technique was used. The assistant gently retracted the hepatic lobe or segment that was being resected. This ensured clear visualization of intrahepatic vessels and adequate coagulation before sharp transection. When minor hemorrhage occurred, the cut surfaces were approximated and pressed together in order to minimize the local blood supply and thus enhance the ablation effect (heat-sink phenomenon). Persistent minor hemorrhages or bile leak was controlled with sutures or clips.

The ipsilateral hepatic vein was ligated at the end of parenchymal dissection when an anatomical or extended hepatectomy was intended. The main extrahepatic bile duct structures were preserved and protected by radiofrequency energy. Typically, they were sharply divided and ligated with suture at the end of the liver parenchyma division. Packed red blood cells were transfused as needed to maintain hemoglobin levels above 8%-9% during the intraoperative and immediate postoperative period (24 hours).



Fig. RFA-assisted liver parenchymal transection.

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