

The effect of radiofrequency-assisted liver resection on liver function

Radyofrekans yardımcı karaciğer reseksiyonunun karaciğer fonksiyonlarına etkisi

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Abstract

Aim. To investigate the effects of Radiofrequency (RF)-assisted liver parenchyma dissection technique for the treatment of colorectal metastatic liver tumors in liver parenchymal function. **Methods.** Fifteen patients with colorectal hepatic metastases underwent radiofrequency assisted hepatic resection. Preoperative and postoperative (1st day and 8th day) liver function tests were evaluated. **Results.** Aspartate aminotransferase (AST) and Alanine transaminase (ALT) was increased in 100% of patients on the day after RF. However, 8 days after surgery ALT and AST levels have almost fully recovered. Serum bilirubine, alkaline phosphatase (ALP) and Gamma-glutamyl transpeptidase (GGT), levels were not increased in postoperative period. **Conclusion.** Hepatic parenchymal transection with RF device is an effective method to resect colorectal hepatic metastases. Careful patient selection will help to minimize the incidence of liver failure which may occur after RFA.

Keywords: Radiofrequency, hepatic resection, liver function

Özet

Amaç. Bu çalışmada kolon kaynaklı karaciğer metastazlarında Radyofrekans (RF) yardımcı karaciğer reseksiyonunun karaciğer fonksiyonlarına etkisi irdelenmiştir. **Yöntemler.** Bu çalışmaya kolorektal karaciğer metastazlarında RF yardımcı karaciğer rezeksiyonu gerçekleştirilen 15 hasta dahil edilmiştir. Hastaların ameliyat öncesi, ve ameliyat sonrası 1. ve 8. günlerde karaciğer fonksiyon testleri çalışılmıştır. **Bulgular.** Hastaların Aspartate aminotransferase (AST) ve Alanine transaminase (ALT) düzeylerinin ameliyat sonrası 1. günde istatistiksel olarak anlamlı oranda arttığı görüldü. Ancak bu değerlerin ameliyat sonrası 8. günde normal değerlerine ulaştığı tespit edildi. Hastaların ameliyat sonrası bilirubine, alkaline phosphatase (ALP) ve Gamma-glutamyl transpeptidase (GGT) serum düzeylerinde ise ameliyat öncesi değerlerine göre anlamlı bir değişiklik görülmedi. **Sonuç.** Kolorektal karaciğer metastazlarında radyofrekans yardımcı karaciğer rezeksiyonu etkili bir yöntemdir. Ancak RF uygulaması sonrası karaciğer yetmezliğiyle karşılaşmamak için uygun hasta seçimi önemlidir.

Anahtar sözcükler: Radyofrekans, karaciğer rezeksiyonu, karaciğer fonksiyonu

Geliş tarihi/Received: May 10, 2012; **Kabul tarihi/Accepted:** April 15, 2013

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Introduction

Control of intraoperative hemorrhage represents a significant problem in hepatic surgery. Bleeding and blood transfusion have been shown to increase post-operative morbidity and mortality [1-3].

Radiofrequency Ablation (RFA) has gained wide acceptance as a safe alternative to surgery in the management of early hepatocellular carcinoma and metastatic liver tumors. Radiofrequency (RF) also used for hepatic parenchymal transection. Despite its benefits, RF entails some risks (such as liver failure, abscess, bile duct injury) and can be life threatening.

Common tests that are used to evaluate liver function include: Alkaline phosphatase (ALP), Alanine transaminase (ALT), Aspartate aminotransferase (AST), Gamma-glutamyl transpeptidase (GGT) and serum bilirubin. Injury of the liver results in release of the substance into the blood.

Herein, we reported the effect of hepatic resection with RF-assisted parenchymal transection device on liver function tests in 15 patients with colorectal hepatic metastases.

Materials and methods

We conducted a retrospective review of our hepatobiliary database to identify patients with colorectal hepatic metastases undergoing resection with a RF device. This study was approved by the Ethics Committee of Cumhuriyet University Medical Faculty.

Between January 2008 and July 2011, fifteen patients underwent RF-guided liver resection for colorectal hepatic metastases at our hospital.

15 patients (9 male, 6 female, age range, 44-76; mean age 59 years) were studied. Based on Child-Pugh classification, 9 patients (60%) were considered as class A, and 6 patients (40%) as class B. Before treatment, all patients were examined by abdominal ultrasonography, Computed Tomography (CT) or Magnetic Resonance Imaging (MRI).

All patients were treated with a open surgical treatment. Under general anesthesia, right subcostal incision was performed. The peritoneal cavity was examined for evidence of extrahepatic disease. The location of tumors was defined according to Couinaud's nomenclature. The liver was then mobilized according to the size and site of the lesion to be excised. The purpose of the treatment was to achieve at least 1 cm margin of normal liver parenchyma around the lesion. Application of vascular inflow occlusion (Pringle's manoeuvre) did not performed.

Radiofrequency (RF) probe has been employed for liver resection. RF ablation of the liver parenchyma to induce coagulative desiccation was carried out along this line with a six in-line needle (electrode) RF probe and a 470 kHz generator (SURTRON[®] SB; Laboratory for Electronic Design (LED) Spa, Aprilia, Italy). This machine has main frequency of 50 Hz and produces 70-150 Watts of power.

The serial applications of RF probe along the liver transection line by multiple insertions of RF probes, so as to create a 'zone of coagulation necrosis'. Once an area was coagulated, the probe was withdrawn completely and placed 1-1.5 cm away from the previous application. Once the plane of coagulation was created, the parenchyma was divided with a crushing clamp. The transection plane was then closely inspected for biliary leaks. All veins >3 mm and suspected biliary structures at the plane of transection were ligated. A drain was placed at the site of resection. After hemostasis was assured, the abdomen was closed in standard fashion.

In all patients liver function tests were monitored before and after resection (at 1st and 8th postoperative days).

Statistical analyses

The data of the study were loaded to SPSS program (Statistical Package for Social Sciences) (ver: 14.0). Kruskal-Wallis and Mann-Whitney U tests were used on the evaluation of the data. Statistical significance was used on 0.95 confidence interval and p value less than 0.05.

Results

15 patients (9 male, 6 female; age range, 44-76; mean age 59 years) were enrolled in this study. Nine patients had a single tumor and 6 had multiple tumors. The diameter of the tumors ranged 1-4 cm (mean 2.2 cm). Surgical resections ranged from metastasectomies to hemi-hepatectomies (Table 1).

Table 1. Kind of operations.

Operation type	No
Metastasectomies	5
Segmentectomy	7
Hemi-hepatectomies	3

The median resection time was 60 mins (range, 40-110 min). The median blood loss during resection was 90 mL (range, 15-500 mL). Mean preoperative and postoperative hemoglobin values were 13.7 g/dL (SD \pm 1.6) and 11.8 g/dL (SD \pm 1.4), respectively.

Soon after surgery, all patients were nursed primarily in the surgical ward. Operative and hospital mortality was nil. Median postoperative stay was 9 days (range, 5-16 day). There were 5 postoperative complications. Three patients developed a incisional wound infection and 2 developed pulmonary infection.

There was a significant change in liver function 24 hrs after resection compared with preoperative values, which almost completely normalized at one week (Table 2).

Table 2. Preoperative and postoperative liver function tests.

	ALP (Mean \pm SD)	ALT (Mean \pm SD)	AST (Mean \pm SD)	GGT (Mean \pm SD)	T. BİL (Mean \pm SD)
Preoperative	86.40 \pm 5.96	16.46 \pm 3.90	19.80 \pm 3.70	23.46 \pm 9.87	0.57 \pm 0.16
Postop 1 st day	84.4 \pm 8.87	272.86 \pm 43.49	391.40 \pm 142.94	26.40 \pm 9.69	0.54 \pm 0.13
Postop 8 th day	85.40 \pm 11.40	17,13 \pm 4.71	23.73 \pm 5.14	25.06 \pm 23.19	0.54 \pm 0.15
Statistical analysis	P=0.730 (p>0.05)	p=0.001 (p<0.05)	p=0.001 (p<0.05)	p=0.745 (p>0.05)	p=0.839 (p>0.05)

Aspartate aminotransferase (AST) and Alanine transaminase (ALT) was increased in 100% of patients on postoperative 1st day (p<0.05). However, 8 days after surgery ALT and AST levels have almost fully recovered (p>0.05).

Serum alkaline phosphatase (ALP), Gamma-glutamyl transpeptidase (GGT) and bilirubine level differences of preoperative and postoperative 1st day and postoperative 8th day were not statistically significant (p>0,05).

Discussion

Hepatic resection is the only potentially curative treatment option in patients with primary or metastatic liver tumors. But, hemorrhage and bile leakage remain the main problems for a liver resection. Operative blood loss can occur during dissection and parenchymal transection. Several methods, for example low central venous pressure anesthesia, the Pringle maneuver are presently employed to minimize hemorrhage during hepatic resection.

Argon beam coagulation, the Cavitron Ultrasonic Surgical Aspirator (CUSA), The Ligasure vessel sealing system, The harmonic scalpel, Hydrojet and Microwave tissue coagulation transection are commonly employed for reducing blood loss and avoidance of transfusion. Weber et al. [4], first described radiofrequency use to minimize blood loss during hepatic resection, in 2001; they showed that by creating a 2-3 cm wide zone of coagulative necrosis, avascular bed that could be sharply divided with minimal blood loss during parenchymal dissection. The 'sequential coagulate-cut' RF-assisted liver resection technique is a safe liver transection technique associated with minimal blood loss and it

has facilitated tissue-sparing liver resection [5]. RF energy is used by converting current into heat. The high-frequency current is delivered through an electrode placed in tissue to cause ionic agitation and consequently friction and tissue heating. The latter causes cellular dehydration which results in coagulative desiccation. Cell death occurs at 49°C after 4-9 min [6]. In contrast to coagulation of neoplastic tissue, coagulation of normal liver parenchyma is very fast.

As a consequence of heat application, RF-assisted liver resection causes some adverse effects [7]. Liver failure was the most severe complication and was associated with the highest mortality [8-10]. In this report, we investigated the effect of radiofrequency-assisted liver parenchyma dissection technique in liver parenchymal function. Vascular inflow occlusion (Pringle's manoeuvre), can increase the effectiveness of RF by preventing heat loss owing to the 'heat-sink' effect. Vascular inflow occlusion, was not applied in our patients.

Ohnishi et al. [9] reported that, thermal injury may lead to bile duct injury and intraductal chilled saline perfusion (ICSP) through a nasobiliary tube during an RFA reduced the bile duct injury [9]. It was also shown that cooling of the biliary tract with chilled saline has been used to prevent biliary injury by RFA [11].

Hering et al. [12] advised power setting of 70 W. Parenchymal ablation is achieved in about 4-7 seconds with a setting of 70 W. They reported that this energy level is effective and safe ablation of hepatic parenchyma [4]. High level of energy (power settings in excess of 100 W) associated with 'superheating' and sudden explosions of the liver tissue, which could potentially cause cracking and massive hemorrhage from the parenchyma if a hepatic or portal vein was in close proximity. In this study, we did not pass 100 W during RF applications with our device. As the parenchyma is heated, the solubility of dissolved nitrogen is decreased, resulting in microbubble formation (the RFA-associated phenomenon of 'outgassing') [13]. It was reported that the procedure-specific complication rate is %10 [14] and it was also reported that 350 RFA sessions with a cooled-tip perfusion electrode, in 255 patients with liver tumors resulted %10 major complications [8].

Aspartate aminotransferase is an enzyme found in high amounts in heart muscle, liver and skeletal muscle cells. Alanine transaminase is an enzyme found in the highest amounts in the liver. Injury to the liver results in release of the substance into the blood. In this study, ALT and AST levels were increased in %100 of the patients on the day after RF ablation. The increase of these enzymes after RF indicated the liver injury. This injury may be tolerated by the patients with preoperative normal liver functions, but it may be dangerous in the patients with preoperative abnormal liver functions tests. Koda et al. [15] reported that in patients with a high Pugh score (Pugh score ≥ 8 points), RFA induces long-term deterioration of the liver parenchymal functions and causes serious complications. It was also demonstrated that Child-Pugh classification was related to post-treatment liver failure and Child B or C was a risk factor for post-treatment liver failure [16]. Therefore these patients may not be appropriate candidates for RFA. Patient age, tumor size and number were not significant factors precipitating this complication [8].

Our early experience with this RF ablation procedures, hepatic parenchymal transection did not result in bile leak or postoperative bleeding. Theoretically, the potential large amount of coagulation necrosis along the plane of transection poses a risk for postoperative infection [17]; however, in the present experience no hepatic abscess or subhepatic collections were observed.

RF ablation is very helpful in liver resection. But, RF-assisted liver resection causes a sudden increase in transaminase levels soon after the resection. In patients with abnormal pre-treatment liver parenchymal functions, RF may induce important complications.

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