

IS IT POSSIBLE TO REDUCE THE BLEEDING IN HEPATIC RESECTIONS WITHOUT CONDUCTING TOTAL OR PARTIAL VASCULAR EXCLUSION? RESULTS OF THE USE OF BIPOLAR RADIOFREQUENCY WITH COLD NEEDLES

É possível diminuir o sangramento em hepatectomias sem a realização de exclusão vascular total ou parcial? Resultados do uso de radiofrequência bipolar com agulhas resfriadas

José Artur **SAMPAIO**, Fábio Luiz **WAECHTER**, Thiago Luciano **PASSARIN**, Cristine Kist **KRUSE**, Mauro **NECTOUX**, Paulo Roberto Ott **FONTES**, Luiz Pereira **LIMA**

From Department of Hepatobiliopancreatic Surgery and Hepatic Transplantation of Santa Casa of Porto Alegre, Porto Alegre, RS, Brazil.

ABSTRACT - Background - Although the resection is the chosen procedure in the therapeutic treatment of liver malign lesions, the bleeding represents a factor of morbidity with a great impact in the hepatic surgery. With the means of minimizing this complication, several technological options have been utilized, being radiofrequency more recently among them, allowing the procedure to be realized with smaller incisions, without the need of vascular clamping, with minimum hepatic dissection, or bleeding. **Aim** - To present the results of the use of a new technique of hepatic parenchyma resection through parallel needles of bipolar radiofrequency developed by the authors themselves, verifying the impact in the trans-operation bleeding of patients subjected to hepatectomies. **Methods** - Sixty patients were submitted to hepatic resection through the use of bipolar radiofrequency. The pre-operation bleeding was evaluated through the medication of the collected volume in the vacuum and by the weight difference in the compresses utilized during the procedure. All cases were monitored in their hepatocitary function through laboratory tests during the first week of the post-operation. **Results** - The hepatic resections were realized with the mean of 87 minutes, mean incision size of 14 cm and mean bleeding of 58 ml. None of the patients received blood transfusion or derivatives. Central venous catheters were not utilized. All patients obtained fast anesthetic recuperation, leaving the recuperation room to the ward in less than 12 hours. The post-operation drainage was noted down until the drain removal occurring in all patients. The mean hospitalization time was of 3,2 days. After the elevation peak of the hepatic function tests in the first three days, all patients presented regression of them in a one month. **Conclusion** - It is possible, feasible and valid to use radiofrequency needle to perform hepatectomy, even larger ones, reducing bleeding.

HEADINGS - Bipolar radiofrequency. Hepatectomy. Bleeding.

Correspondence:

José Artur Sampaio,
e-mail: jartur@terra.com.br

Source of funding: none
Conflict of interest: none

Received: 27/01/2011
Accepted for publication: 08/03/2011

DESCRITORES - Radiofrequência bipolar. Hepatectomia. Sangramento.

RESUMO - Racional - Embora a ressecção seja ainda o procedimento de escolha no tratamento curativo das lesões malignas do fígado, o sangramento permanece como fator de morbidade com grande impacto na cirurgia hepática. Com o intuito de minimizar esta complicação, diversas opções tecnológicas têm sido utilizadas, entre elas mais recentemente a radiofrequência, permitindo que o procedimento seja realizado com incisões menores, sem necessidade de clampeamento vascular, com mínima dissecação hepática, ou sangramento. **Objetivo** - Apresentar os resultados em uma série de pacientes utilizando nova técnica de ressecção do parênquima hepático através de agulhas paralelas de radiofrequência bipolar desenvolvidas pelos próprios autores, verificando o impacto no sangramento trans-operatório dos pacientes submetidos à hepatectomias. **Métodos** - Sessenta pacientes foram submetidos à ressecção hepática através do uso da radiofrequência bipolar. O sangramento per-operatório foi avaliado através da medição do volume coletado em aspirador e pela diferença de peso nas compressas utilizadas durante o procedimento. Todos os casos foram acompanhados em sua função hepatocitária através de exames laboratoriais durante a primeira semana de pós-operatório. **Resultados** - As ressecções hepáticas foram realizadas com média de 87 minutos, tamanho médio da incisão abdominal de 14 cm e sangramento médio de 58 mililitros. Nenhum paciente recebeu transfusão de sangue ou derivados. Não foram utilizados cateteres venosos centrais. Todos os pacientes obtiveram rápida recuperação anestésica, obtendo alta da sala de recuperação para a enfermaria em menos de 12 horas. A drenagem pós-operatória foi anotada até a retirada do dreno abdominal em todos os pacientes. O tempo de internação hospitalar médio foi de 3,2 dias. Após um pico de elevação das provas de função hepática nos primeiros três dias, todos apresentaram retorno destes exames aos parâmetros pré-operatórios ao final do 1o mês. **Conclusão** - É possível, factível e válida a utilização de agulhas de radiofrequência para a realização de hepatectomias, mesmo maiores, reduzindo o sangramento.

INTRODUCTION

The large increase in knowledge of anatomy and physiology of the liver, as well as the continuous appearance of new technologies, has made the liver resection safer and less morbid, reaffirming the treatment of choice for liver tumors. Despite all these innovations, some complications still deserve better resolution, among them bleeding, biliary fistula and maintenance of liver function after resection, which directly interfere with the prognosis of patients. Among the new technological options, should refer to the ultrasonic aspirator (CUSA® Valleylab, Boulder, CO, USA)^{5,15,28}, the harmonic scalpel^{3,30}, the water jet scalpel^{10,19,20}, the argon^{17,26} cautery, vascular staplers^{18,24,27}, and radiofrequency (RF).

In order to minimize the complications described above, the authors developed a new technique to resect hepatic parenchyma using less extensive laparotomy, without the need for vascular clamping with minimal (or absence) dissection of the liver, or bleeding. To this end, the RF chilled needles and, as source of energy, bipolar electrocautery were created.

The aim of this study is to present the results of using this type of RF through parallel needles in liver resections, checking the impact on trans-operative bleeding.

METHODS

Initial series

From September 2003 to December 2007, a total of 60 patients underwent liver resection by using bipolar RF in Windmills Hospital in Porto Alegre, Brazil. The group of patients had a mean age of 54 years (range 39 to 64 years) consisting of 34 men and 26 women. The treated tumors were: hepatocellular carcinoma (n = 26), metastatic sarcoma (n = 2), metastatic colorectal carcinoma (n = 30), giant hemangiomas (n = 1) and adenoma (n = 1). Except for one patient with liver metastasis of colorectal carcinoma who presented a nodule in each lobe, all other patients had single nodules on preoperative investigation.

All cases were evaluated for their function hepatocyte preoperatively, at 1st, 3rd, and 7th days postoperatively through laboratory tests (transaminase - SGOT, SGPT, lactate dehydrogenase - LDH, alkaline phosphatase - FA, bilirubin - BT, gammaglutamil transferase - Gamma GT and prothrombin time - TP). Computed tomography was performed only in the preoperative evaluation of patients.

Bleeding during surgery was determined by measuring the volume of blood aspirated and the

weight difference surgical bandages. In patients who underwent abdominal drainage, the drainage volume on day 1 postoperatively was controlled through the measurement obtained in the drains in 24 hours. After washing the cavity at the end of surgery, silicone chest tube was placed only in three patients and the abdominal cavity was closed in layers.

The constructive and functional characteristics of the RF needle and the surgical technique are described in separate publication²¹.

TABLE 1 - Number of cases where we used the RF

| Anatomopathological | n |
|---------------------------------|----|
| Hepatocellular carcinoma | 26 |
| Metastatic colorectal carcinoma | 30 |
| Metastatic sarcoma | 2 |
| Hemangioma | 1 |
| Adenoma | 1 |

TABLE 2 - Type of liver resection and trans-operative bleeding average

| Resection | n | Average bleeding (ml) | Mean operative time (min) |
|---------------------|----|-----------------------|---------------------------|
| Major hepatectomy* | 8 | 82 | 89 |
| Minor hepatectomy** | 29 | 54 | 82 |
| Atypical resection | 23 | 47 | 64 |

* Resection of more than three segments; ** resection of up to two segments

RESULTS

Although different sizes, the liver resections were performed with an average of 87 minutes (range 31 to 123 min), with incisions averaged 14 cm (range 8 to 29 cm) and 58 ml of blood loss during surgery (range 4 to 230 ml). No patient received blood transfusion or derivatives. All showed rapid recovery from anesthesia and were discharged from the recovery room to the ward in less than 12 hours. The postoperative pain was treated with intravenous analgesia based on opioids in low doses. In three patients who received abdominal drains, drainage mean the first 24 hours postoperatively was 50.6 ml (range 40 to 67 ml), and the drain was removed on the third postoperative day. The average hospital stay was 3.2 days (range 2 to 5 days). There were no postoperative complications.

A peak elevation of SGOT, SGPT, LDH, and ALP in the first 24 hours occurred, with no evident increase in BT, GammaGT, and TP (Figure 1). On the 3rd postoperative day was observed a significant decrease of enzymes, with normalization on 7th. At the end of the first month, the liver function tests had remained within the normal range in all patients.

DISCUSSION

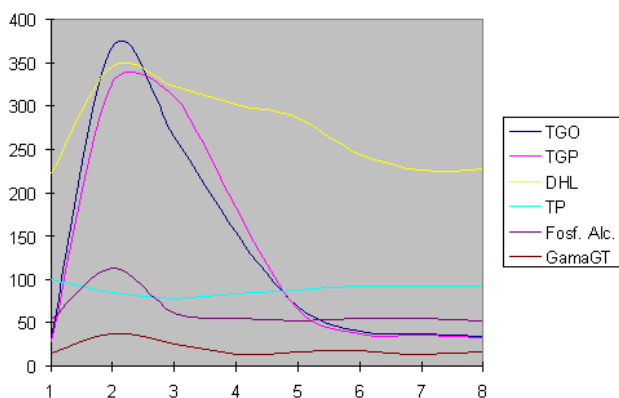


FIGURE 1 - Curve of liver function tests in the first seven days

The improvement of surgical technique, associated with the development of centers of excellence in treatment of liver diseases, and the explosion of new technologies, solidified the status of "gold standard" procedure for resection in the treatment of hepatic neoplasms.

The morbidity of the procedure, preferably referred to bleeding (requiring transfusion), the biliary fistula and liver failure, remains the Achilles heel of surgeons of the liver, which meant that different techniques were developed in order to avoid them, because they require large dissections of the hepatic ligaments, the vena cava and portal pedicle and are associated with the use of various types of vascular control or clamping^{1,2,6,9,16,28}. Added to this, the need for ligatures along the section of the parenchyma. The latter, when carried out in fragile vessels and hepatic peripheral glissonian approach often turn out to traumatize them, consuming additional surgical time and blood loss. Moreover, disruption may be cause for bile leak providing post-operative complications. During these procedures, high cost components may be needed. Although the domain of these techniques has enabled the modern liver surgery, complication rates remain high, especially in patients with chronic liver disease.

Among the cutting-edge technologies, is highlighting the use of RF as well known in the therapeutic armamentarium ablation of liver lesions^{3,4,11,12,21}. Recent studies have shown^{3,13,14,22,25} hepatectomies performed using the monopolar RF, where the blood loss and the occurrence of fistula bile was almost nil. In none of these series was demonstrated clinical or abnormal liver function that would represent failure.

In the technique applied in recent series^{13,14,22,25} the theoretical basis of coagulation necrosis by the heat produced by RF, is based on tissue temperature

elevation, which occurs at the expense of intermittent waves of energy through a conductor monopolar cooled continuously (Cool Tip Radionics, Burlington, MA). This energy is dissipated through a monopolar plate. The temperature control of the needle prevents there early clotting cells around it, slowing the increase in tissue resistance, and allowing more uniform and extensive necrosis of the region. These authors^{13,14,22,25} have shown that this distortion occurs in a cell radius of 0.5 cm around the needle, producing uniform and bloodless tissue mass. In the case of a monopolar system, the grounding plate is mandatory, and the risk of burns occur in front of the large discharge of energy, are not negligible.

The procedure described here is grounded in the physical and physiological studies obtained with the use of RF associated with the cooling of the needle⁸. As a fundamental difference highlights the use of a handle with two separate needles, transmitting energy between them, so bipolar, provided linearly controlled area of necrosis, without the risk of dissipation of current to tissue distance, thus preventing heat injuries. With accumulated experience, the authors found that the need for lower power (60W x 100W) makes the procedure safer and as effective as monopolar RF used in a way.

The monitoring of the impedance causes the shutdown of the generator when is reached denaturing cell, ensuring free procedure for resection. In this denatured liver tissue, as rubbery consistency, it is not possible to distinguish any vascular or biliary structures. This ensures occlusion of blood vessels and bile ducts of the line section, sealing also small lymphatic channels of the bloody face. The absence of biliary fistula associated with low levels of trans-operative bleeding and postoperative drainage, seal the latter point of view, as well as the findings of other authors who use the RF for liver resections^{13,14,22,25}.

In the vast majority of hepatectomies aminotransferase elevations are described on a temporary basis, returning to normal levels by the end of a few days, a fact observed in these cases. Even in patients who underwent resections without vascular clamping without bleeding these enzymes show an increase in their baseline values, demonstrating that the surgical impact on the liver may be your main driver, and do not represent degree of functional impairment^{1,2,6}. The authors' impression is that the necrosis obtained with the method is not primarily responsible for the elevated transaminases, since, regardless of the size of the resection, the change in liver function tests, postoperative, was similar.

Besides making the operation much less stressful for the surgeon, the possibility of using two sets of bipolar needles for two surgeons making resection

also allows that a drastic reduction of operative time, contributing to less aggressive surgery. In this series there was considerable decrease in surgical time with the use of two sets. This was particularly interesting, since with the technique of liver resection using monopolar RF no reference was done in the decrease of surgical time, with some authors referring increased operative time^{13,14,22,25}.

The low length of stay in hospital showed a favorable outcome, with less pain and faster return to daily activities. This is explained by the fact of the operation become less invasive, with no need for central venous access and with considerably smaller incisions, making a hepatectomy procedure less aggressive in terms of surgical trauma.

Equally important benefit is obtained by non-use of materials in high-cost (blood and blood products, adhesives, biological meshes) and postoperative (intensive care and catheters for central venous access), providing that the hospital cost also decrease considerably.

In this context, the RF ablation of tumors has allowed patients with low functional reserve had controlled their lesions, leading to waiting for transplantation in patients with primary tumors^{4,11,12}, or allowing an increase in its survival in cases of metastatic lesions²¹. However, despite the appropriate use of RF ablation, local recurrence at the site of ablation varies around 40%³. This high recurrence rate is due to the difficulty to obtain necrosis of tumor cells in regions close to large vessels, as well as larger lesions^{3,8}. Lower rates of recurrence, around 5%¹⁴, have been obtained when the Pringle maneuver is associated with the ablation procedure, which in turn is poorly tolerated in the postoperative period of patients with chronic liver disease with low functional reserve.

Within this paradox of functional hepatic reserve and better rates of long-term survival obtained only with the resection, liver resection assisted by RF technique described here (without clamping vascular dissection and minimal bleeding, minimal incisions and low complication rates), allow the authors infer that this new technique allows expansion of indications for resection of a significant population of patients with chronic liver or metastatic disease, previously rated as inoperable and conducted to alternative treatments.

If on one hand the technique described here, plus several general benefits, allows greater peace in the realization of the resection technique, is valid to note that knowledge of hepatic anatomy and experience in complex resections are important in the success of this procedure, reserved for liver surgeons with experience in this operation.

CONCLUSION

It is possible, feasible and valid to use radiofrequency needle to perform hepatectomy, even larger ones, reducing bleeding

REFERENCES

1. Bismuth H. Major hepatic resection under total vascular exclusion. *Ann Surg* 1989; 210: 13-19.
2. Brancatisano R, Isla A, Habid N. Is radical hepatic surgery safe? *Am J Surg* 1998; 175: 161-163.
3. Curley SA, Izzo F, Ellis LM, Nicolas Vauthey J, Vallone P. Radiofrequency ablation of hepatocellular cancer in 110 patients with cirrhosis. *Ann Surg* 2000; 232: 381-391.
4. De Baère T, Risse O, Kuoch V, Dromain C, Sengel C, Smayra T, El Din MG, Letoublon C, Elias D. *AJR* 2003; 181: 695-700.
5. Fasulo F, Giori A, Fissi S, Bozzetti F, Doci R, Gennari L. Cavitron Ultrasonic Surgical Aspirator(CUSA) in liver resection. *Int Surg* 1993; 77(1): 64-66.
6. Fong Y, Cohen AM, Fortner JG et al. Liver resection for colorectal metastases. *J Clin Oncol* 1997; 15: 938-946.
7. Gertsch P, Pelloni A, Guerra A, Krpo A. Initial experience with the harmonic scalpel in liver surgery. *Hepatogastroenterology* 2000; 47(33): 763-766.
8. Haemmerich D, Chachati L, Wright AS, Mahvi DM, Lee Jr. FT, Webster JG. Hepatic radiofrequency ablation with internally cooled probes: Effect of coolant temperature on lesion size. *IEEE Trans Biomed Eng* 2003; 50(4): 493-500.
9. Hansen PD, Isla AM, Habid NA. Liver resection using total vascular exclusion, scalpel division of the parenchyma and a simple compression technique for haemostasis and biliary control. *J. Gastrointest Surg* 1993; 3: 537-542.
10. Hata Y, Sasaki F, Takahashi H, Ohkawa Y, Taguchi K, Une Y, Uchino J. Liver resection in children using a water-jet. *J Pediatr Surg* 1994; 29(5): 648-650.
11. Livraghi T, Solbiati L, Meloni F, Ierace T, Goldberg SN, Gazelle GS. Percutaneous radiofrequency ablation of liver metastases in potential candidates for resection. The Test-of-Time Approach. *Cancer* 2003; 97(12): 3027-3035.
12. Livraghi T, Goldberg SN, Lazzaroni S, et al. Small hepatocellular carcinoma: treatment with radiofrequency ablation versus ethanol injection. *Radiology* 1999; 210: 655-661.
13. Lupo L, Gallerani A, Aquilino F, Di Palma G, DeFazio M, Guglielmi A, Memeo V. Anatomical hepatic resection using radiofrequency thermoablation in the treatment of primary or secondary liver tumors. *Tumori* 2003; 89(4): 105-106.
14. Navarra G, Spalding D, Zacharoulis D, Nicholls JP, Kirby S, Costa I, Habib NA. *HPB* 2002; 4(2): 95-97.
15. Nakayama H, Masuda H, Shibata M, Amano S, Fukuzawa M. Incidence of bile leakage after three types of hepatic parenchymal transection. *Hepatogastroenterology* 2003;50(53): 1517-1520.
16. Nuzzo G, Guiliante F, Giovanni I et al. Hepatic resections in normothermic ischaemia. *Surgery* 1996;120:852-8.
17. Postema RR, Plaisier PW, ten Kate FJ, Terpstra OT. Haemostasis after partial hepatectomy using argon beam coagulation. *Br J Surg* 1993; 80(12): 1563-1565.
18. Ramacciato G, Aurello P, D'Angelo F, Caramitti A, Barillari P, Fornasari V. Effective vascular endostapler techniques in hepatic resection. *Int Surg* 1998; 83(4): 317-323.
19. Rau HG, Wichmann MW, Schinkel S, Buttler E, Pickelmann S, Schauer R, Schildberg FW. Surgical techniques in hepatic resections: Ultrasonic aspirator versus Jet-Cutter. A prospective randomized clinical trial. *Zentralbl Chir* 2001; 126(8): 586-590.
20. Rau HG, Schardey HM, Buttler E, Reuter C, Cohnert TU, Schildberg FW. A comparison of different techniques for liver resection: blunt dissection, ultrasonic aspirator and jet-cutter. *Eur J Surg Oncol* 1995; 21(2): 183-187.

21. Sampaio JA, Waechter FL, Passarin TL, Kruse CK, Nectoux M, Fontes PRO, Lima LP. Características construtivas e funcionais das agulhas de radiofrequência bipolares resfriadas para reduzir o sangramento nas ressecções hepáticas. *ABCD Arq Bras Cir Dig*. 2011; 24(2):173-175
22. Solbiati L, Livraghi T, Goldberg SN, et al. Percutaneous radiofrequency ablation of hepatic metastases from colorectal cancer: long-term results in 117 patients. *Radiology* 2001; 221: 159-166.
23. Stella M, Percivale A, Pasqualini M, Profeti A, Gandolfo N, Serafini G, Pellicci R. Radiofrequency-assisted liver resection. *Gastrointest Surg* 2003; 7(6): 797-801.
24. Sugo H, Mikami Y, Matsumoto F, Tsumura H, Watanabe Y, Kojima K, Futagawa S. Hepatic resection using the harmonic scalpel. *Surg Today* 2000; 30(10): 959-962.
25. Wang WX, Fan ST. Use of the Endo-GIA vascular stapler for hepatic resection. *Asian J Surg* 2003; 26(4): 193-196.
26. Weber JC, Navarra G, Jiao LR, Nicholls JP, Jensen SL, Habib NA. New technique for liver resection using heat coagulative necrosis. *Ann Surg* 2002; 236(5): 560-563.
27. Wolf RF, Xie H, Petty J, Teach JS, Prah SA. Argon ion beam hemostasis with albumin after resection. *Am J Surg* 2002; 183(5): 584-587.
28. Wrightson WR, Edwards MJ, McMasters KM. The role of the ultrasonically activated shears and vascular cutting stapler in hepatic resection. *Am Surg* 2000; 66(11): 1037-1040.
29. Yamamoto Y, Ikai I, Kume M, Sakai Y, Yamauchi A, Shinohara H, Morimoto T, Shimahara Y, Yamamoto M, Yamaoka Y. New simple technique for hepatic parenchymal resection using a Cavitron Ultrasonic Surgical Aspirator and bipolar cautery equipped with a channel for water dripping. *World J Surg* 1999; 23(10): 1032-1037.
30. Zacharoulis D, Asopa V, Navarra G, Nicholls JP, Jensen SL, Habib NA. Hepatectomy using intraoperative ultrasound-guided radiofrequency ablation. *Int Surg* 2003; 88(2): 80-82.