ORIGINAL RESEARCH PAPER

Medical Science

EVALUATION OF CENTRAL VENOUS AND CAVAL RETROHEPATIC PRESSURES ON HEPATECTOMIES FOR COLORECTAL LIVER METASTASIS

KEY WORDS: Central Venous Pressure. Hepatectomy. Hemodynamics. Anesthesia. Central venous catheterization.

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ABSTRACT

Hemostasis during hepatectomy is the most important factor in order to guarantee low bleeding loss, avoid hemotransfusions and have low morbimortality rates. The aim of the present study is to evaluate the hemodynamic monitoring involving the retrohepatic inferior vena cava and determine if its absolute value corresponds to the measurements observed in the superior vena cava.

INTRODUCTION

Liver resections are surgical procedures that are currently performed but with a high risk of massive hemorrhage during the surgical procedure1. With the evolution of the knowledge of the anatomy and physiology of the Liver and the development of new technologies for lower bleeding during a transection to the liver parenchyma, as well as the enhancement of anesthetic techniques, liver resections became safer and, has reduce of morbimortality.2-7 Another major factor for the reduction of complications in hepatectomies was the development of new surgical techniques, especially in major resections (removal of three or more segments), as well in hepatic transplantation.8-10

Despite this, perioperative incidences are still observed, such as bleeding and the occurrence of gas embolism during the transection of the hepatic parenchyma. The occurrence of bleeding at this time is not uncommon, even when vascular structures are easily located and accessed correctly.11-12

The liver is endowed with a groove due to the central circulation, which makes the transection of the parenchyma a delicate and often complex act. In addition, patients with hepatectomy had chronic or hepatic liver disease secondary to the use of chemotherapy, and both factors potentiate the risk of bleeding. That is why the knowledge of hemodynamic hepatic is elementar for anaesthetic and rehabilitation in complex anesthesizing, especially in severe patients.13-17

One of the most widely used techniques to prevent and control intraoperative bleeding is based on the control of blood inflow to the liver, through the clamping to pedicle hepatic, associated with maintenance of central venous pressure (PVC) between 0 and 5 mmHg. During the surgery there is constant manipulation of liver over the inferior hepatic vena cava (VCIRH), and it is believed that this may underestimate the values of PVC, because a compression of the VCIRH generates a difference of pressure between this and the superior cavity. Therefore, we are interested, there is an absolute pressure on the pressure between the upper and lower retrohepatic systems (PVCRH) during the hepatectomies.

TECHNICAL

Five patients with colorectal liver metastasis without chronic liver disease, with indication for surgical resection of the liver lesions, attended at the liver clinic of the Gaffrée and Guinle University Hospital (HUGG) were selected. Each patient was submitted to preoperative medical evaluation according to the routine of the service.

Anesthesia management and intraoperative care were standardized. All patients underwent general anesthesia combined with continuous epidural. Sedation was performed with midazolam and epidural block with epidural catheter retention. Bupivacaine was the local anesthetic of choice at 0.125% -0.5%. General anesthesia was induced with propofol (2.5 mg / kg), lidocaine (1.5 mg / kg), fentanyl (3 mg / kg). Orotracheal intubation was facilitated with atracurium (0.5 mg / kg).

After anesthetic induction, radial artery puncture wa performed for the measurement of mean arterial pressure (MAP) 'online'. Right internal jugular vein puncture (PVJID) was also performed using the Seldinger technique guided by ultrasonography. The double lumen catheter (Arrow International, Reading, PA) was positioned in the superior vena cava (SVC) near the right atrial (AD) insertion. Positioning control was performed by radioscopy through an image intensifier. PVJID allowed the measurement of PVC online during the anesthetic period.

Patients were submitted to the same surgical incision (bilateral subcostal with xiphoid prolongation), and the use of Thompson retractors was employed in all patients. After an inventory of the cavity, in order to measure the PVCRP, a double lumen catheter (Arrow International, Reading, PA) was introduced by right gonadal vein dissection (VGD) at its insertion in the IVC, positioned cranially in the IVC, of the hepatic veins; the correct positioning was evaluated by intraoperative ultrasonography. (Figure 1)

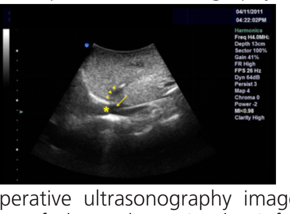

Figure 1- Intraoperative ultrasonography image showing the correct positioning of the catheter in the inferior vena cava (asterisk) in its retrohepatic portion; the tip of the catheter (arrow) positioned at the inflow of the median hepatic vein (arrowhead).

The variables analyzed were MAP, PVC and PVCRH. The measurements of PVC and PVCR were performed by the same monitor (Datex-Ohmeda Cardiocap / 5), at the end of expiration, whose values were transcribed to a spreadsheet in the following times: t1- pre-hepatic manipulation, t2- post dissection of the hepatic pedicle, (after 5 minutes of clamping), t4-during reperfusion (2.5 minutes after pedicle disclaiming), and completion of haemostasis of the bloody area of the liver.

Anesthesia was maintained with 1-2% sevoflurane. When necessary, nitroglycerin was used for the purpose of vasodilation. Efortil was used for pressure adjustments and noradrenaline to obtain vessel pressure in cases of persistent hemodynamic instability.

RESULTS

The values of PVC and PVCRH were obtained simultaneously, at the surgical times described in the technique, and tabulated (Table 1). For statistical analysis, the Prism 7.0b program (GraphPad Software, Inc., CA) was used. The data were inserted into patient-separated worksheets, in two distinct columns, representing PVC and PVCRH, and submitted to t-test (Student's t-test) analysis. This test was applied in all patients, however in patient 4 (# 4), as there was the same variation of 1mmHg in the 5 surgical times (t1 to t5), it was not possible to perform a paired test (Test t). Therefore, in this specific case, it was necessary to use the Wilcoxon Rank test. There was a numerical difference between the PVC and PVCRH in the different times in all the patients, that is, in no measurement was found the same value. There was a statistical difference in 4 of the 5 patients (Table 2).

Table 1 - values of PVC and PVCRH recorded in the 5 patients in the surgical times (t1 to t5).

PAC	PVCt$_1$	PVCRHt$_1$	PVCt$_2$	PVCRHt$_2$	PVCt$_3$	PVCRHt$_3$	PVCt$_4$	PVCRHt4	PVCt$_5$	PVCRHt$_5$
#1	7	10	3	4	7	9	5	7	8	9
#2	6	8	4	5	10	13	4	5	3	4
#3	5	6	0	1	5	7	3	4	4	5
#4	5	6	2	3	5	6	3	4	7	8
#5	6	8	6	7	9	10	4	5	9	10

Table 2 - Statistical data with mean of the difference between PVC and PVCRH of each patient, correlation coefficient and P value.

PAC	Media da diferença	Coeficiente de correlação (r)	P valor
#1	1,8	0,9424	0,008
#2	1,6	0,8944	0,016
#3	1,2	0,9845	0,003
#4	1,0	-	0,062(ns)
#5	1,2	0,9785	0,003

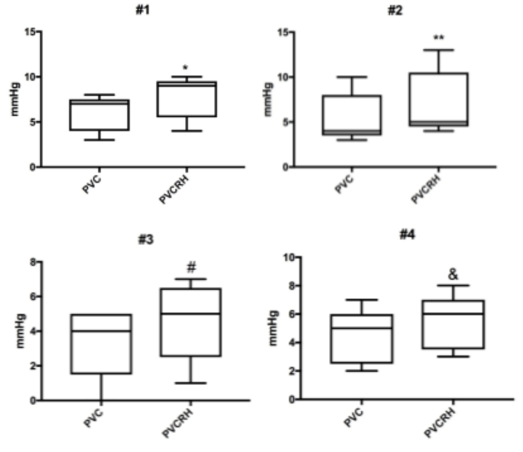

Figure 2 - Each graph represents the measurements between PVC and PVCRH in mmHg of each patient, in 5 different surgical times. The statistical analysis showed P significant value in 4 of the 5 patients: # 1 (* p = 0.008); # 2 (** p = 0.016); # 3 (# p = 0.003); # 4 (& p = 0.062); # 5 (% p = 0.003).

DISCUSSION

Transection of the parenchyma is the most delicate surgical time of hepatectomy, since portal branches, branches of the hepatic artery and hepatic veins are sectioned, which can trigger massive hemorrhages. In this way, vascular control becomes essential to minimize the risk of intraoperative hemorrhage. Large blood losses result in hemodynamic instability and need for blood transfusion, which in turn is not free of risks and has the unwanted consequence of generating an inflammatory response. It is known that the latter is deleterious to the surgical recovery and may have as an outcome from the insufficiency of multiple organs and systems even the death of the patient.19-21 Faced with such possibilities, the main concern during the transection of the hepatic parenchyma is ensure effective hemostatic control, avoiding to the maximum hypovolemia and the necessity of blood transfusions.

For vascular control, the commonly used technique is to restrict hepatic blood inflow from the hepatic artery and portal vein, combined with the maintenance of a central venous pressure (PVC) between 0 and 5 mmHg. The decrease in the value of PVC implies a significant reduction of blood flow through the hepatic veins, which drain directly into the inferior vena cava (IVC). However, the establishment of a standard with low PVC requires a thorough preoperative evaluation, verifying if there are adequate cardiovascular conditions to maintain such a parameter.23-26

It was well documented by Redai et al (2004) that an increase of only 0.5 cmH2O, equivalent to 0.37 mmHg, results in significant bleeding.18 In turn, the control study by Nishiyama et al (2004) demonstrated that PVC maintained between 2 mmHg and 5 mmHg significantly reduces bleeding.20 On the other hand, Lentschener and Ozier (2002) demonstrated the presence of risks, such as cardiovascular instability and development of gas embolism, by maintaining extremely low PVC. Air embolism, when it occurs, is due to the suction of atmospheric air through open orifices in the hepatic veins during parenchymal transection.21

The measurement of PVC is performed by introducing a luminal catheter through the internal jugular or subclavian veins, which is positioned in the superior vena cava (SVC) on the topography of its insertion in the right atrium inside the thoracic cavity. Thus, PVC does not vary according to the manipulation of intra-abdominal structures. The retrohepatic portion of the vena cava, on the other hand, is inside the abdominal cavity and is constantly compressed as the liver is manipulated during the surgical procedure and, therefore, may present higher values than that observed in SVC. Thus, it was postulated that retro-hepatic inferior vena cava pressure could be used as a hemodynamic parameter and provide more reliable values of central venous pressure.

The comparison of the obtained results showed that there was a difference between the absolute values of PVC and PVCRP recorded simultaneously during the different operative times, being observed that the value of PVC is lower than that of the PVCRH. This result may serve as a warning for the need for more reliable hemodynamic control. The ideal would be to keep PVC at even lower levels. Lin et al [28] considered PVC between 2 and 3 mmHg as ideal (less blood loss during partial hepatectomies) among 5 groups of PVC maintained at different levels in a series of 97 patients. In the obtained results, it was demonstrated that the PVCRH is in average greater of 1 to 1,8mmHg (Tables 1 and 2), which suggests that the recommended PVC should be less than 3mmHg.

In view of the above, aiming at a better hemodynamic control in hepatic surgeries, the hemodynamic parameters used by the anesthesiologist to guide his behavior should be reconsidered. The introduction of catheters by the jugular route would be the best option, provided there are devices of greater length so that they can be correctly positioned. It is necessary to carry out randomized controlled trials, with a larger number of patients, to validate this new proposed parameter.

REFERENCES

1- Okuda K, Nakayama T, Taniwaki S, et al. A new Technique of hepatectomy using an occlusion balloon catheter for the hepatic vein. Am J Surg 1992; 163: 431-434.
2- Frankel TL, D`Angelica MI. Hepatic resection for colorectal metastases. J Surg Oncol 2014; 109:2-7.
3- Elias D, Debaere T, Muttillo I, Cavalcanti A, Coyle C, Roche A. Intraoperative use of radiofrequency treatment allows an increase in the rate of curative liver resection. J Surg Oncol 1998; 67: 190-191.
4- Ramacciato G, Aurello P, D'Ângelo F, Caramitti A, Barillari P, Fornasari V. Effective vascular endostapler techniques in hepatic resection. Int Surg 1998; 83(4): 317-323.
5- 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.
6- Rau HG, Schardey HM, Buttler E, Reuter C, Cohnert TU, Schildberg FW. A comparision of different techniques for liver resection: blunt dissection, ultrasonic aspirator and jet-cutter. Eur J Surg Oncol 1995; 21(2): 183-187.
7- Cherqui D, Benoist M, Malassagne B, Humeres R, Rodriguez V, Fagniez PL. Major liver resection for carcinoma in jaundiced patients without preoperative biliary drainage. Arch Surg 2000; 135: 302-308.
8- BelghitiJ, Hiramatsu K, Benoist S, Massault PP, Sauvanet A, Farges O. Seven hundred fourty-seven hepatectomies in the 1990s: an update to evaluate the actual risk of liver resection. J Am Coll Surg 2000; 191: 38-46.
9- Tanabe G, Sakamoto M, Akazawa K, et al. Intraoperative risk factors associated with hepatic resection. Br J Surg 1995; 82: 1262-1265.
10- Farges O, Malassagne B, Flejou JF, Balzan S, Sauvanet A, Belghiti J. Risk of major liver resection in patients with underlying chronic liver disease: a reappraisal. Ann Surg 1999; 229: 210-215.
11- Gozzeti G, Mazzioti A, Grazi GL, Jovine E, Gallucci A, Gruttadauria S, Frena A, Morganti M, Ercolani G, Masetti M, Pierangeli F. Liver resection without blood transfusion. Br J Surg. 1995; 82: 1105-10.
12- Berrevoet F, De Hemptinne B. Use of topical hemostatic agents during liver resection. Dig Surg. 2007; 24: 288-93.
13- Rothenberg DM, O`Connor CJ, Tuman KJ. Anesthesia and the hepatobiliary system. In: Miller RD, Anesthesia, 7th edition. Churchill Livingstone, 2010: 2135-2153.
14- McNally SJ, Revie EJ, Massie LJ, McKeown DW, Parks RW, Garden OJ, Wigmore SJ. Factors in perioperative care that determine blood loss in liver surgery. HPB 2012, 14:236-241.
15- Huntington JT, Royall NA, Schmidt CR. Minimizing blood loss during hepatectomy: a literature review. Journal of Surg Oncol 2014; 109: 81-88.
16- C. Lentschener and Y. Ozier. Anaesthesia for elective liver resection: some points should be revisited. European J of Anaesthesiology 2002; 19: 780-788
17- Clavien PA, Petrowsky H. DeOliveira ML, Graf R. Strategies for safer liver surgery and partial liver transplantation. N Engl J Med 2007; 356: 1545-59.
18- Redai I, Emond J, Bretjens T. Anesthetic considerations during liver surgery. In; Khatri VP, Schneider PD, eds. Liver Surgery: Modern Concepts and Techniques. Surgical Clinics of North America 2004; 84: 401-411.
19- Kooby DA, Stockman J, Ben-Porat L, Gonem M, Jarnagin WR, Dermatteo RP, Tuorto S, West D, Blumgart LH, Fong H. Influence of transfusions on perioperative and long-term outcome in patients following hepatic resection for colorectal metastases. Ann Surg 2003; 237: 860-9.
20- Wang HY, Zhao QY, YF Yuan. Perioperative changes of coagulation functions in the local advanced liver cancer patients receiving liver transplantation. Ai Zhenh 2008 Jul; 27(7):743-7.
21- Upile T, Jerjes W, Mahil J, Upile N, Sudhoff H, Wright A, Hopper C. An explanation for the worsened prognosis in some cancer patients of perioperative transfusion: the time-dependent release of biologically active growth factors from stored blood products. Eur Arch Otorhinolaryngol 2011; 268: 1789-1794.
22- Lentschener C, Ozier Y. Anesthesia for elective liver resection: some points should be revisited. Eur J Anaesthesiol 2002; 19:780-788.
23- Stéphan F, Rezaiguia-Delclaux S. Usefulness of a central venous catheter during hepatic surgery. Acta Anaesthesiol Scand 2008; 52: 388-396
24- Berlin DA, Bakker J. Starling curves and central venous pressure. Critical Care (2015) 19:55
25- Topaloglu S, Calik KY, Calik A, Aydin C, Kocyigit S, Yaman H, Kutanis D, Karabulut E, Dohman D, Orem A, Arslan MK. Efficacy and safety of hepatectomy performed with intermittent portal triad clamping with low central venous pressure BioMed Research International volume 2013, article ID297971, 8 pages.
26- Sand L, Rizell M, Houltz E, Karlsen K, Wiklund J, Denstedt Herges H, Stenqvist O, Lundin S. Effect of patient position and PEEP on hepatic, portal and central venous pressures during liver resection. Acta Anaesthesiol Scand 2011; 55: 1106-1112.
27- Tenório NJ, Goldengerg A, Triviño T. The exhibition of the right contour of the inferior cava vein in the hepatic surgery. Acta Cir Bras [serial online] 2002 Mar-Apr; 17(2). Available from URL: http://www.scielo.br/acb.
28- Lin,CX, Guo,Y, Lau,WY, Zhang,GY,Huang,YT, We,WZ, Lai,EC: Optimal central venous pressure during partial hepatectomy for hepatocellular carcinoma. Hepatobilliary pancreat Dis Int. 2013;Oct 12(5), 520-4.