Management of hemorrhage of retro hepatic inferior vena cava injury during piggy-back technique for liver transplantation

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Received: 30 January 2007 / Accepted: 23 January 2008

Abstract

Background Injury to large abdominal vessels is still one of the most terrifying results of trauma or intraoperative faults, as the management of the hemorrhage is hardly difficult due to being torrentially and unaware of the proper reparation. The controversial problem is which technique should be preferred in case of injury to RHIVC and how can it be managed with minimal risk.

Patients and Methods Over two-year period, we retrospectively analyzed the patients who had undergone adult-to-adult liver transplantation and collected data about the injuries to RHIVC during recipient hepatectomy. All patients were treated with the same surgical technique including digital compression and continuous suturing the tear.

Results Twenty five patients (21 male, 4 female) were detected. The causative factors for end stage liver disease included hepatitis B, hepatitis C with or without hepatocellular carcinoma, autoimmune hepatitis, alcoholic hepatitis,

cryptogenic hepatitis, Wilson disease, and nonalcoholic steatohepatitis. Mean diameter of the injury was measured 0.5 cm (range: 0.2–1.6). Only three patients (12%) had more than one injury. Mean amount of blood loss between injury and repair was 130 cc (40–350 cc). There was no operative mortality.

Conclusion Calmness of the operative team followed by the appropriate surgical approach is the key of the success in case of any injury to RHIVC. Digital compression technique can be enough to prevent massive bleeding and repair the injury tract without any vascular exclusion that may result with serious postoperative complications. We proposed this technique because of its ability by most surgeon and easy to perform in a safe way.

Keywords Retrohepatic inferior vena cava · Approach to vena cava injury · Surgical technique · Digital compression

Introduction

Retrohepatic segment of inferior vena cava (RHIVC) is very important, especially in cases of segmental hepatic resection or recipient hepatectomy involving piggy-back procedure. Thus, basic and precise knowledge of the surgical anatomy of the RHIVC is essential for hepatic surgery. This mystery segment of RHIVC lies in a groove in the posterior part of the liver between the caudate and right lobe [1]. This segment is too dangerous as inferior phrenic, accessory hepatic and usually the right suprarenal veins open into this segment. Because of these openings which haven't precise location, IVC needs to be treated as kindly as possible during hepatic surgery in order to avoid uninvited injuries resulted in massive hemorrhage. Particularly, accessory hepatic veins can be easily injured when mobilizing the right

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lobe of the liver from RHIVC during hepatic surgery. These avulsion injuries may result in lacerations into the RHIVC and the leading severe hemorrhage can be fatal. Although there are different surgical approaches to IVC injury including several types of vascular exclusion, these techniques are not both easy and convenient for all patients. We describe a technique to control this type of RHIVC injuries caused iatrogenically during recipient hepatectomy that was managed without any vascular exclusion.

Patients and methods

Between August 2004 and October 2006, 25 patients sustained injury to RHIVC when they were performed recipient hepatectomy during adult-to-adult living related liver transplantation (LRLTx) in Ege University School of Medicine, Organ Transplantation and Research Center. The retrospectively collected data included demographic features, primary pathogenesis of the patients, the diameter of the injury, blood loss during repair, and postoperative complication. All patients were treated with the same surgical procedure to repair RHIVC injury. Data were expressed as the mean $\pm$ SD or median value. All data analysis was done using SPSS 13.0 for Windows.

Surgical Technique

All patients underwent tracheal intubation and were given complex anesthesia. Arterial catheterization was positioned routinely for monitoring blood pressure, and a deep venous cannula was inserted for blood transfusion. Pulmonary artery pressure was also monitored. All patients were employed a Mercedes-like incision and recipient hepatectomy was performed using piggy back technique for liver transplantation. All injuries to RHIVC were recognized while recipient hepatectomy was performing.

Firstly, the reason should be eradicated by taking under control the traction of the liver as a life saver step, thus, further damage is prevented. Maintaining enough exposure is also important to recognize the injury site (Fig. 1). Secondly, it shouldn't be forgotten that the pressure of IVC is significantly low. Variation of the individual basic values obtained in the horizontal position was small (range 3 to 10 mm Hg). So, it may be enough to stop bleeding from IVC just by putting your index finger on the area of tear without any vascular exclusion. During digital compression, the low pressure must be taken into consideration. This step leads to maintain a clear area, which prevent any further progress. After taking under control the bleeding for a while, by fixing the index finger of the left hand at the same position, a suture with 5/0 polypropylene suture material is performed at the superior of the tear area located on the safe region (Fig. 2). This first suture is almost out of direct goal but it is

used to lift the IVC to ensure the adequate view of the tear line. While first assistant is managing the elegant traction of the first suture, the index finger of the left hand is slipped backward only about 1 or 2 mm to see the tear area (Fig. 3). Second suture is then performed in a continuous manner

Fig. 1 Exposure of the tear

Fig. 2 Pressure of the finger and first suture at the safe (undamaged) area

Fig. 3 Slipping backward of the finger and starting the repair

Fig. 4 Employing the continuous suturation

at the tear area and this performance is carried on until the tear is completely covered (Fig. 4). To finish the repair, the backward suture in a continuous manner is performed and knotted at the beginning point (Fig. 5). The key point to stop bleeding completely is ability to perform simultaneously both proper traction and continuous suturation while pre-

Fig. 5–6 After finishing the tear line, going back again and knotting the both ends at the starting point

venting active bleeding with the compression of the index finger at the same time. The traction maintains a clean area on the IVC 2 mm in size.

Results

There were 21 male and 4 female patients with a mean age of 46 ± 8 years (range: 28–59 years). All patients underwent adult-to-adult LRLTx. Primary pathology of chronic liver disease was mostly found as hepatitis B in 17 patients (68%) that seven of these patients were also diagnosed with hepatocellular carcinoma. The other causative factors included hepatitis C, alcoholic cirrhosis, autoimmune hepatitis, cryptogenic hepatitis, non alcoholic steatohepatitis, and Wilson disease. MELD score was followed as: between 5–14 for 8 patients (32%), 15–24 for 13 patients (52%) and ≥ 25 for 5 patients (20%). Median score of MELD was 19. Three patients sustained two ruptures of the RHIVC and

only one patient had three ruptures of the RHIVC. Median diameter of RHIVC injury was 0.4 cm (range: 0.2–1.6 cm). All injuries were repaired using digital compression technique without employing any vascular exclusion methods. The mean amount of bleeding during injury was 130 ± 84 cc (range: 40–350 cc). No patient was required re-operation due to postoperative hemorrhage. There was no operative mortality. All detailed clinical data are shown in Table 1.

Discussion

The injury of RHIVC undoubtedly seems to be a disaster for both surgeon and patients. The reasons for these types of injuries are followed as: (a) hepatectomy for malign tumors or other liver diseases (b) piggy back dissection for liver transplantation, (c) tears of the hepatic veins due to acceleration-deceleration movement of the liver in case of blunt injury, and (d) penetrating injuries. The injury of RHIVC is a life-

Table 1 Clinical data

Patient no	Sex	Age (years)	MELD value	Primary diagnosis	Diameter of IVC injury (cm)	Hemorrhage during repair (ml)
1	M	53	23	HBV	0.3	100
2	M	41	24	HBV	0.4	150
3	M	52	11	HBV+HCC	0.6	180
4	M	53	19	HBV	1.4	280
5	F	40	21	HBV	0.3	80
6	M	47	15	HBV+HCC	0.4	100
7	M	52	24	HBV	0.2, 0.5	120
8	M	31	24	Autoimmune hepatitis	0.5	80
9	M	42	14	HBV	0.3, 0.6	260
10	M	56	13	HBV+HCC	0.3	50
11	F	57	19	Nonalcoholic steatohepatitis	1.2	130
12	M	45	21	Alcoholic hepatitis	0.6	100
13	M	55	24	HCV	0.4	80
14	M	28	27	HBV	0.5	60
15	M	50	9	HBV+HCC	0.2, 0.3, 0.3	230
16	M	39	16	HBV	1.4	220
17	M	53	29	HBV	0.2	40
18	F	36	16	Criptogenic hepatitis	0.5	75
19	M	50	20	Autoimmune hepatitis	1.6	350
20	M	39	12	Wilson disease	0.5	60
21	M	31	17	HBV	0.8	150
22	M	45	43	HCV+HCC	0.4	80
23	M	59	7	HBV+HCC	0.3	40
24	M	58	14	HBV+HCC	0.2	40
25	F	51	8	HBV+HCC	0.2, 0.4	200

IVC: Inferior vena cava, HBV: hepatitis B virus, HCV: hepatitis C virus

HCC: hepatocellular carcinoma, MELD: The Model for End-Stage Liver Disease

threatened damage because of its major role in the blood circulation and also its predisposition for air emboli. In a study of 102 patients with injuries of IVC, Baeshko et al, were reported the lethality after traumatic injuries of supra and retrohepatic segments of IVC as a rate of 100% [2]. However this rate was 60.6% and 30.6% for suprarenal and renal segment and infrarenal segments, respectively. This study may be quite enough to see the importance of these injuries.

Injuries to inferior vena cava including not more than 10 mm generally occur by tearing the accessory hepatic veins while performing piggy-back technique or posterior approach aiming the division of the liver from IVC or while dissection with right clamp on the superior IVC. On the other hand, the injuries larger than 10 mm are particularly caused by the first assistances who try to the traction of the liver in an uncontrollable manner. Fortunately, most of the tears have a longitudinal location on the IVC because of its anatomical structure. It makes the technique for reparation of these tears much easier.

Although the most of the surgeons are aware of the danger of injury to RHIVC, the essential approach to repair and stop bleeding is controversial. Approach to the injuries of this covered space constitutes a real problem because of the obscurity of this area by the most of the surgeons. Correct timing and surgeon's ability may save the patient's life. Because the large amounts of blood can be lost in seconds in case of IVC injury, some surgeons prefer vascular occlusion to prevent massive bleeding. In case of injury to RHIVC, approach to stop bleeding varies from traditional clamping procedures including total vascular exclusion to hypothermia, cardioplegia, and circulatory arrest that are made during operation [3]. Various types of vascular exclusion during hepatectomy have been used to reduce operative blood loss and postoperative complications [4–8]. However, it should be pointed out that when total hepatic blood flow is excluded cardiac output suddenly decreases and arrhythmia or cardiac arrest may result. Without challenging with these problems, we presented a surgical technique to control bleeding of RHIVC due to iatrogenic injuries during recipient hepatectomy for LRLTx. According to our search for any literature about the management to control bleeding in case of injuries of RHIVC, Ai-Jun et al reported the largest study about this subject, in 2004 [9]. This technique that was not described in detail was performed for only two patients.

Every surgeon has his/her own manner of approach to vascular injury differentiated from ligation and division to preserve and repair by suturing. IVC is very sensitive because of its slim anatomical structure and thin composition of its vascular wall. Therefore, it is easily prone to injuries during hepatic surgery including elective or emergent operative procedures. Cirrhotic patients whose liver has dense fibrotic adjacent tissues with peripheral vascular structures are very good applicant for these injuries during recipient hepatectomy for liver transplantation. In addition, out of good exposure may not permit to perform any type of

vascular occlusion to reduce blood loss in case of RHIVC injury. Digital compression is applicable to patients whose conditions are critical and for whom total vascular exclusion can not be prepared for in advance or in patients who have only a few small IVC ruptures [8]. Otherwise, performing vascular occlusion with any vascular clamps or some other instruments to control bleeding may cause additional trauma and excessive hemorrhage which can be resulted in death. However, during IVC exclusion, dramatic changes in hemodynamic response can be examined. Because acid-base imbalance and hyperkalemia can also easily appear, blood gases, the acid-base balance, and other biochemical indexes should be monitored closely. Therefore total vascular exclusion should be avoided and used as infrequently as possible.

First of all, the surgeon should be calm and make anesthetist aware of the severity of the patient's condition. The care must be taken to prevent not only hypotension, but also possible air emboli. Because it is already known that the pressure in the IVC may easily lead air emboli, Because it is already known that the pressure in the IVC may easily lead air emboli, the care must be taken to prevent not only hypotension, but also possible air emboli. The second step is a careful determination of exposure to ensure the most proper position to perform surgical repair. It shouldn't be forgotten that the key to success is selecting the appropriate operative procedure. With an elegance compression movement of the index finger on the site of injury located on RHIVC, the continuity of bleeding can be easily stopped for a while. Meanwhile, the repairing with a continuous 5/0 polypropylene suture is performed with the right hand. This fast surgical intervention may be decreased blood loss, effectively. According to our study the largest volume was found as 350 cc which is very low for IVC injury. Most of the values of blood loss were detected under 150 cc. This result may be considered the unique reason to perform this technique.

One of the important parts of this surgical technique is beginning to repair from the strong, undamaged wall of the RHIVC. Thus, it may be prevented to enlarge the size of injury. However, the upward traction of this first safe suture by the first assistant may lead a clear area and give permission to easily realize the tract of injury. Then second suture is performed by the operator who still controls the massive bleeding with the digital compression of the left index finger during this procedure. After the good exposure and appropriate operative procedure, the third most important factor of the success for this injury is simultaneous working of first assistant and operator during traction and compression movements performing this technique.

Conclusions

We propose this simple operative procedure for all IVC injuries both in elective hepatic surgery and emergent

laparotomy due to hepatic and IVC trauma. Management of blood loss and repair without vascular exclusion can be easily achieved with this surgical technique.

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