

New technique in hepatic parenchymal transection for living related liver donor and liver neoplasms

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Background

Many different surgical techniques have been described for hepatic parenchymal transection. A retrospective analysis of perioperative mortality, length of hospitalization and blood transfused during operation in two patient groups undergoing liver resection was carried out. In group A, we developed a new technique to resect hepatic parenchyma, using an ultrasonic surgical aspirator with monopolar floating ball cautery, while in group B the crushing clamp technique was used.

Methods

In all, 42 patients with liver resection were enrolled in group A and 107 resections in group B. All patients had hepatic neoplasms except for seven living transplant donors. In group A 43% of resections involved ≥ 3 segments and 57% involved ≤ 2 segments; in group B 36.4% involved ≥ 3 segments and 63.6% consisted of ≤ 2 segments. Statistical analysis utilised

independent T square (Pearson Q square) and Mann–Whitney U test.

Results

In group A 2.4% of patients died perioperatively, while 3.7% died in group B; mean length of stay (LOS) was 10.9 days in group B and 8.0 days in group A. The length of procedure was 7.5 h in group B and 6.7 h in group A. In group A, 79% did not undergo blood transfusion intraoperatively as opposed to 61% in group B. A mean of 0.5 U of blood was utilized in group A and 1.60 U in group B.

Discussion

The new method of parenchymal transection seems to reduce the LOS, length of procedure and need for intraoperative blood transfusion.

Keywords

liver resection, CUSA, tissue link

Introduction

The ongoing shortage of organs has led surgeons to develop innovative surgical techniques to expand the donor pool. In the field of liver transplantation this goal has been accomplished recently with the development of living related donor transplantation, which represents the natural evolution of surgical procedures based on the segmental anatomy of the liver as in the case of reduced-sized cadaveric and split liver transplantation [1]. Improvements in surgical technique and an increased understanding of hepatic anatomy [2] have now reduced the risk of donor death from elective hepatic resection to <1 [1].

The adoption of modern devices has recently changed the method of parenchymal transection during hepatectomy in many units from a classic crushing clamp

technique [3, 4] to a combination of an ultrasonic dissection with a special type of cautery [5, 6]. We have developed a new technique for resecting hepatic parenchyma using an ultrasonic surgical aspirator in association with a monopolar floating ball. The combination of the ultrasonic dissector with monopolar cautery, which employs radiofrequency and saline irrigation to coagulate tissue, has been utilized in 35 liver resections and then extended to 7 living donor hepatectomies at our institution. The present paper compares this new method with a group of liver resections previously performed with the classical crush clamping technique.

Methods

Patients

Between July 2001 and May 2003, 42 liver resections

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were performed with the new combination method (group A) at a newly established transplant facility, which has resulted from a partnership between the University of Pittsburgh Medical Center Health Systems and the Italian Government. Historical controls comprised 107 patients who underwent resection with the crushing clamp technique (group B) at the same institution between July 1999 and May 2003.

All patients had benign or malignant liver tumours except for seven living donors for liver transplant in group A (Table 1). All the lesions were located in otherwise healthy livers except for 10 patients (2 in group A, 8 in group B) who had hepatocellular carcinoma on a background of HCV-related cirrhosis (Child Pugh grade A patients). None of the patients had jaundice at the time of operation.

Mean age was 50.2 years in group A and 52.2 years in group B. In group A the male-to-female ratio was 1:1, whereas in group B it was 1:0.75.

In group A 43% of resections involved ≥ 3 segments and 57% involved ≤ 2 segments; in group B 36% involved ≥ 3 segments and 64% involved ≤ 2 segments. Perioperative mortality, length of hospital stay (LOS), units of blood transfused during operation and duration of operation were compared between groups, together with the mean of the postoperative peaks of transaminases and total bilirubin level.

Operative Technique

All types of liver resection can be performed by the new technique. For an anatomical right hepatectomy a bilateral subcostal incision is employed with an upward midline extension. Preliminary mobilisation of the right liver and skeletonisation of the retrohepatic inferior vena cava is carried out with ligation of all accessory hepatic veins following the usual piggyback technique for right

hepatectomy except that accessory veins >3 mm are preserved.

Parenchymal Transection

The hepatic parenchyma is transected by combining the following four techniques in succession. (1) Parenchymal tissue is fragmented and the biliary and vascular structures are skeletonised with the ultrasonic dissector. (2) Vascular haemostasis and coagulation of tiny bile ducts is achieved with the monopolar floating ball. (3) Fibrous and vascular-biliary structures are divided by electrocautery. (4) Tissue and irrigation fluids mixed with parenchyma detritus are sucked away using a paediatric aspirator and the integrated aspirator in the ultrasonic dissector.

The ultrasonic dissector is applied at the proposed transection line after the liver capsule has been opened by diathermy set on coagulation at 70 W. The ultrasonic dissector setting is 90% in amplitude, with very high tissue selection, while the irrigation rate is 5 ml/h, with suction set at the maximum strength. The monopolar floating ball setting is 75 W with an irrigation rate of 2.5 ml/h. Parenchymal transection is begun by sectioning the caudate lobe isthmus. An umbilical tape is passed through this section to mark the surface of the liver resection.

Another important marker to trace the liver transection surface is the section point of the right hepatic duct. This duct is opened with tenotomy scissors approximately 3 cm above its point of confluence with the common hepatic duct, which has previously been marked with a 6-0 stitch. Through the opening in the common hepatic duct, an endoluminal survey of the course and patency of the right, left and common hepatic ducts is carried out with a biliary probe. After an endoluminal irrigation of the biliary tree with antibiotic solution, the right hepatic duct is closed with a running suture of 6-0 polydioxanone sulphate. The hepatic parenchyma transection continues from the liver's anterior margin at the middle point of the gallbladder bed to the marked tracing on the convex surface of the liver, progressively marking the line of division to the anterior border of the retrohepatic vena cava.

During this transection deep within the hepatic parenchyma, two major calibre accessory venous branches (3–4 mm) that drain hepatic segments V and VIII into the middle hepatic vein are identified, dissected, clamped

Table 1. Main diagnosis in groups A and B

Diagnosis	Group A	Group B
Liver metastasis	15	46
Benign liver tumour	14	42
Bile duct cancers	3	9
Hepatocellular carcinoma on cirrhosis	2	8
Hepatocellular carcinoma	1	2
Living related liver donor	7	0
Total	42	107

Table 2. Length of stay, length of procedure and blood use in groups A and B

Parameter	Group A	Group B
LOS <10 days (%)	36 (38)	66 (62)
LOS >10 days (%)	6 (15)	41 (85)
LOP <7 h (%)	32 (77)	51 (47)
LOP >7 h (%)	10 (2)	56 (53)
No intraoperative blood usage (%)	33 (78)	65 (60)
Intraoperative blood usage (%)	9 (22)	42 (40)

LOS (length of stay) is not dependent of type of procedure (Mann–Whitney U test); LOP (length of procedure) is not dependent of type of procedure (Mann–Whitney U test); blood use (Pearson χ^2) is dependent of type of procedure.

with Pott angled non-traumatic paediatric clamps and sectioned. The trunks of these veins are double-sutured with 5-0 prolene. As the parenchymal transection approaches the plane in front of the vena cava, De Bakey angled forceps are used to facilitate the dissection of the tissue on the anterior wall of the cava and allow more precise haemostasis with the monopolar floating ball.

The transection ends with the exposure of the entire retrohepatic vena cava and complete separation of the left and right hemi-livers, which remain connected only by the right arterial and portal pedicle, the common trunk of the middle and left hepatic veins and the large accessory hepatic vein of segment I running into the vena cava.

At the end of the transection, the liver is placed in its cavity in a physiological position for 30 min, during which time the organ can partially regain a more physiological haemodynamic status. Finally the vascular structures are divided and over-sewn with polypropylene running suture.

Statistical Analysis

Independent χ^2 analysis (Pearson χ^2) and t-test were used to analyse the above parameters, with the Mann–Whitney U test.

Results

One of 42 patients from group A died perioperatively and 4 of 107 in group B. Mean LOS was 10.9 days in group B and 8 days in group A ($p = 0.07$). Operative time was less with the new technique (6.7 h vs 7.5 h); this was not statistically significant (Table 2).

In group A, 79% of patients did not undergo blood transfusion intraoperatively as opposed to 61% in group B ($p = 0.04$).

An average 0.5 U of blood was utilized in group A while 1.60 U was used in group B.

Finally, mean postoperative peaks of transaminases and total bilirubin did not change significantly in the two groups (Table 3).

Discussion

In the hepatic resection field, most recent work has focused on technical improvements to optimise the efficacy of the hepatectomy for living donation. Living donor liver transplantation remains a controversial area in which the demand for transplants outweighs concerns about the risk of donation; only two donor deaths were reported among 600 hepatectomies performed in the USA up to the year 2001 [7].

Over the last 40 years the technique of parenchymal transection has changed from the use of knife and scissors [8] to finger fracture [4], the crush clamp technique [3] and the use of more complex devices such as waterjet and ultrasonic dissectors [5–9]. The ultrasonic dissector allows very precise resection along the anatomical planes of the liver, and when it is used in association with intraoperative ultrasound it allows preservation of fine venous tributaries of the middle hepatic vein. This facility will play a fundamental role in living related liver transplantation.

The lack of a completely bloodless field was the weak point of parenchymal transection with the ultrasonic

Table 3. Comparison (t-test) of mean postoperative peaks of transaminases and total bilirubin in group A and group B

Type of procedure	Mean \pm SD AST	Mean \pm SD ALT	Mean \pm SD total bilirubin
Group A	362.53 \pm 203.53	332.51 \pm 195.80	2.03 \pm 1.38
Group B	343.14 \pm 244.27	298.60 \pm 213.88	2.06 \pm 1.78
p value (CI 95%)	<0.1	<0.4	<0.6

dissector. Use of the monopolar floating ball has overcome this problem. In fact, when used properly and without haste, this special cautery almost completely eliminates ligation of vessels and allows coagulation of vascular structures over 5 mm in size. In our experience the association of these two techniques seems to reduce the LOS, length of procedure and need for intraoperative blood transfusion.

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