TECHNICAL REPORT

Total or partial anatomical resection of segment 8 using the ultrasound-guided finger compression technique

Guido Torzilli, Fabio Procopio, Angela Palmisano, Matteo Donadon, Daniele Del Fabbro, Matteo Marconi, Giovanna Scifo & Marco Montorsi

Liver Surgery Unit, 3rd Department of Surgery, University of Milan – School of Medicine, IRCCS Istituto Clinico Humanitas – HUMANITAS CANCER CENTER, Razzano, Milan, Italy

Abstract

Background: A new surgical technique to define intra-operatively segmental and subsegmental areas of the liver using ultrasound-guided bimanual liver compression has been recently described. However, this technique does not allow disclosure of the subsegmental ventral (S8v) and dorsal (S8d) portions of segment 8 (S8). Another technique that overcomes these limitations is described.

Methods: Six patients with hepatoma, cirrhosis and no evidence of portal vein thrombosis were submitted to the procedure. Demarcation of the resection area was achieved using ultrasound-guided finger compression of the S8 subsegmental portal branches (P8v and P8d).

Results: The procedure was feasible in all patients and demarcation was always obtained within 1 min of bimanual ultrasound-guided compression. In one patient, the entire S8 was resected. In the remaining five patients, the dorsal (four patients) or the ventral (one patient) portion was removed, respectively. There was no mortality or morbidity and no blood transfusions were administered.

Conclusions: Disclosure of the subsegmental portions of S8 using the ultrasound-guided compression technique was feasible, safe and effective, and represents the completion of the ultrasound-guided compression technique for performing segmental and subsegmental anatomical resection of the liver.

Keywords

intra-operative ultrasonography, ultrasound-finger compression, anatomical resection, hepatocellular carcinoma, liver cirrhosis

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Correspondence

Guido Torzilli, Liver Surgery Unit, Third Department of Surgery, University of Milan – School of Medicine, IRCCS Istituto Clinico Humanitas – HUMANITAS CANCER CENTER, Via Manzoni 56, 20089 Rozzano, Milan, Italy. Tel: +39 02 8224 4083. Fax: +39 02 8224 4590. E-mail: guido.torzilli@unimi.it

Introduction

A complete or partial fully anatomical resection of segment 8 is generally considered a demanding procedure. Several techniques have been proposed to perform anatomic segmental resection of segment 8 but all are considered challenging to perform, invasive and associated with drawbacks. The posterosuperior location of segment 8, its boundaries represented by the right and middle hepatic veins at the caval confluence, and the complete absence of anatomical landmarks on the liver surface, particularly in the cirrhotic liver, are the main reasons accounting for its complexity. The authors have recently described a new surgical procedure to define intra-operatively the segmental and subsegmental areas of the liver using ultrasound-guided bimanual liver compression and resecting these in a fully anatomical fashion. However, this technique only enables definition of segment 8 by countercompressing the adjacent segment or section and does not allow disclosure of the subsegmental ventral and dorsal portions of segment 8. A new approach is therefore described which allows selective disclosure of each subsegmental branch to segment 8 rather than allowing complete or partial anatomical resection of segment 8 using the ultrasound-finger compression technique.

Methods

Terminology

The terminology for liver anatomy and resection is based on the Brisbane classification. Segments and section abbreviation are shown according to Takayasu et al.’s classification.
Eligibility criteria

According to our previously reported selection flow chart, patients harbouring hepatocellular carcinoma (HCC) and suitable for the surgical approach were those without ascites, without or with esophageal varices amenable for endoscopic eradication and with a serum bilirubin level lower than 1.5 mg/dl.

Patients with HCC located in segment 8 were considered potential candidates for this procedure.

The presence of tumoural thrombosis in segment 8 (P8) or the sectional portal branch was considered an exclusion criteria from the herein described procedure.

Patients

Six consecutive patients undergoing hepatic resection for HCC met the eligibility criteria for anatomical S8 segmentectomy using intra-operative ultrasound (IOUS)-guided finger compression. All were male with a mean age of 71 years (range 57–79), and all had hepatitis C virus (HCV)-related cirrhosis.

Operative procedure

Access is obtained by a J-shaped laparotomy or thoracophrenolaparotomy when the tumour is located at the hepatocaval confluence. The liver is fully mobilized and explored using IOUS (Aloka Alpha 10; Aloka Ltd, Tokyo, Japan) with 2–6 MHz convex, 5–10 MHz T-shaped and 5–10 MHz microconvex probes. The microconvex and convex probes are used for the compression. The hepatic hilum is encircled with a tourniquet, the right triangular and right coronary ligaments are divided, and the right hemi-liver is mobilized. The portal pedicle feeding the right anterior section and right coronary ligaments are divided, and the right hemi-liver is mobilized. The portal pedicle feeding the right anterior section (P5-8) is identified by IOUS, and from that landmark the segmental branch for segment 8 (P8) and its subsegmental branches for the dorsal (P8d) and ventral (P8v) portions are identified.

The left hand of the surgeon together with the right hand of the IOUS probe are positioned under IOUS guidance to show the P8 at the level selected for compression to perform a segmental or subsegmental resection of S8 (Fig. 1a and d). The compression site has to be selected to avoid inadvertent compression of other vascular structures. Using the left fingertips and the IOUS probe itself, the surgeon compresses bilaterally the liver at the targeted position resulting in the compression of P8 in the previously identified ventral and dorsal tracts (Fig. 1b and e); this manoeuvre is monitored constantly using real-time IOUS by means of the probe used for compression (Fig. 1c and d). For the P8v the probe compression sites are usually located on the supero-anterior surface of the liver, and the finger compression sites are just in proximity and cranial with the hepatocaval junction (antero-cranial approach) (Fig. 1b). For the subsegmental ventral area of segment 8 compression can be applied on P7 in a counter-compression fashion or directly to P8v: in both condition, the compression window on the IOUS scan is obtained by positioning the finger compression site on the posterior surface of the liver which was previously mobilized (antero-posterior approach) (Fig. 1c). Compression is maintained until the surface of the liver distal to the compression site starts to discolour (Fig. 1b and e). At this point, the assistant marks the discoloured area with the electrocautery device and the compression is released (Fig. 1f).

Liver resection is performed under intermittent Pringle’s manoeuvre using Pean-clasia and bipolar forceps for vessel coagulation. Vessels thicker than 2 mm are ligated with sutures (3/0). During the resection, IOUS is used to control the trajectory driving the dissection plane to the P5-8 branch to be ligated at the site of the compression. Resection is completed with exposure of the right hepatic vein and the middle hepatic vein on the cut surface of which the extension is based on the level of compression: the more distal it appears the shorter the exposure length of the hepatic vein (Fig. 1g).

Results

All six patients underwent successful anatomical resection, consisting of complete segment 8 in one, segment 8 dorsal resection in four and segment 8 ventral extended to S4 superior in the remaining case. In the first case compression was applied to P8v and P7 using the antero-cranial and antero-posterior approaches, respectively, in the other four to P8d directly: two using the antero-cranial and two using the antero-posterior approach, respectively. In the last case compression was applied to P8v and to P4 superior using the antero-cranial approach. The demarcation area was evident on the liver surface within a minute of compression.

Thoracophrenolaparotomic incision was carried out in two patients. Mean operation length was 398 min (range 264–556). Mean clamping time was 93 min (range 41–205). Mean blood loss was 308 ml (range 50–700); no patients received a blood transfusion. Two closed suction drains were positioned in each patient.
and removed on the 7th post-operative day (pod) according to the drain discharge bilirubin level as previously reported. The post-operative course was uneventful and all patients were discharged on the 8th pod.

Pathological examination showed single HCC (three high, one medium and two low grade of differentiation). The mean tumour diameter was 2.7 cm (range 2.1–3.6). There was no macro- or micro-vascular invasion and the mean tumor-free margin was 3 mm (range 0–6).

Discussion
Anatomical segmental liver resection should at least theoretically be considered the gold standard surgical approach to HCC based on its pattern of intrahepatic spread. Indeed, it answers requirements both for conservative removal of the tumour with maximal sparing of liver parenchyma and radical removal of the disease by including the feeding portal area, which is considered to be the main gate for intrahepatic tumour spread. However, focusing on the isolated resection of segment 8, this operation is still considered a challenging hepatectomy because of its postero-superior position, the branching pattern of the subsegmental feeding portal branches, and the lateral margins represented by the right and middle hepatic vein at their caval confluence. Furthermore, complete absence of the landmarks on the liver surface makes reliable anatomical demarcation of segment 8 impossible. Previously, different techniques have been proposed for anatomical segmental liver resection including the removal of segment 8. Early in 1980, Makuuchi et al. proposed IOUS-guided puncture of the portal branch feeding the tumour with subsequent injection of a dye, usually indigo-carmine. Other authors suggested the insertion of a balloon catheter through a transhepatic approach, or, through a branch of superior mesenteric vein, while more recently ultrasound-guided ablation of the entire feeding glissonian sheath has been proposed. Specifically focusing on segment 8, Mazziotti et al. proposed the division of the liver along the main portal fissure, and subsequently to approach segment 8 glissonian pedicle intraparenchymally. Other authors directly approached P8 through a small incision on the liver surface. Once the technique proposed by Makuuchi et al. was excluded, which had limited diffusion requiring extreme skill in the puncture technique, all other methods that followed had the main drawback of being invasive. Indeed, they resulted in enlarging the cut surface or in an additional invasive procedure per se possible vehicles of morbidity by damaging the targeted vessel. In the event the latter would have been improperly selected, this happens more frequently than reported, the extension of the resection area could be the consequence, which is exactly what a selective anatomical resection approach aims to avoid.

The ultrasound-guided finger compression technique has recently been proposed as a suitable alternative to these aforementioned procedures, allowing safe segmental, subsegmental and even sectional anatomic liver resection. This surgical tech-
nique is not invasive and does not require any interventional procedure such as puncture, injection of dye, catheterization or ablation. Furthermore, complete reversibility once compression is released makes it safe. However, during the initial experience, direct compression of P8, P8v or P8d separately was considered unfeasible.

It may be argued that procedures are long, margins are not adequate and liver stiffness could limit its use in hard cirrhotic livers. Relatively long operations have been associated with those series featured by the best results in terms of safety, and some of the most promising results in terms of long-term survivals for HCC even when advanced are associated with long surgical procedures. Furthermore, operation length does not depend on the herein described maneuver but on our strict intra-operative protocol which has been extensively described and comprehends accurate pre-resectional preparation of the operative field, and a meticulous post-resectional check. This is indirectly confirmed by the discrepancy between the mean operation time (398 min) and the mean clamping time (93 min). Concerning the tumour exposure on the cut surface, it is not in contradiction with a fully anatomical resection respecting the oncological requirements for this kind of tumour, and several experiences are confirming this aspect. Indeed any new microscopic lesion undetectable at IOUS outside the segment removed, although eventually close to the tumour burden should be considered oncologically as any other fore site including those located in non-adjacent segments since it is expression of tumour dissemination through the portal branches: schema shown in Fig. 2 tries to better clarify this concept.

Concerning the limitation of the feasibility of this approach to compressible livers only, paradoxically it could act as selection criteria for anatomical resection itself. Indeed liver stiffness is inversely related to the liver functional reserve and somehow to indication at surgery. A hard and not compressible liver should not be treated with an anatomical resection, and it could be even argued if it should be treated surgically.

In conclusion, this further advancement allowing compression of each single ventral and dorsal portal branches of segment 8 enables direct disclosure of the subsegmental portions of segment 8. In this way an ultrasound-guided compression segmentectomy, which was originally proposed for segments 2 and 3 only, has also been recently proposed for the other segments with the exclusion of the segment 8 subsegments, becomes a suitable technique to be offered for anatomical removal of S8 not only entirely but also partially. In this sense, this report represents the completion of a technique, which now offers the chance to precisely disclose, in a safe and reversible way, any segmental or subsegmental portion of the liver and thus carry out hepatic anatomical but limited resections of any tumour site.

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Conflicts of interest
None declared.

References


