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# Preoperative left hepatic lobe devascularisation to minimize perioperative bleeding in a Jehovah's Witness undergoing left hepatectomy

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## ABSTRACT

**INTRODUCTION:** Major liver resection in a Jehovah's Witness presents unique clinical challenges requiring multimodal blood minimization strategies to reduce perioperative complications. We report a case where complete left hepatic lobe devascularisation was undertaken to minimize bleeding in a Jehovah's Witness undergoing left hepatectomy.

**PRESENTATION OF CASE:** A 65-year-old male Jehovah's Witness presented for open left hepatectomy for a large left-sided hepatocellular carcinoma involving segment IV of the liver. Three weeks prior to surgery, the patient underwent left portal vein embolization. To isolate and devascularise the left lobe, the gastroduodenal artery and left hepatic artery were then occluded with coils. The bed of the left hepatic artery was then embolised to stasis with particles. Finally, the anastomosis back to the right hepatic artery was also occluded by coils. The patient underwent uneventful surgery with an estimated blood loss of 450 ml.

**DISCUSSION:** Left hepatectomy in a Jehovah's Witness patient is feasible but requires careful planning and a multidisciplinary approach. Major liver resection represents a well defined but complex haemostatic challenge from tissue and vascular injury, further complicated by hepatic dysfunction, and activation of inflammatory, haemostatic and fibrinolytic pathways. In addition to the haemoglobin optimization strategies utilized preoperatively, the use of interventional radiology techniques to further reduce perioperative bleeding should be considered in all complex cases.

**CONCLUSION:** Combination of portal vein embolization and hepatic lobe devascularisation to produce total vascular occlusion of inflow to the left lobe radiologically allowed a near bloodless surgical field during major liver resection in a Jehovah's Witness patient.

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## 1. Introduction

Major liver resection in a Jehovah's Witness presents unique clinical challenges requiring multimodal blood minimization strategies to reduce perioperative complications and improve outcomes. Even in expert surgical units, unexpected blood loss during left hepatectomy, coupled with aggressive fluid resuscitation and

dilutional coagulopathy may represent a final common pathway toward life-threatening haemorrhage. We overview our multidisciplinary management focusing specifically on our preoperative radiological interventions employed to minimize perioperative bleeding. This case is reported in line with the SCARE criteria [1] and compliant with the PROCESS guidelines [2].

## 2. Presentation of case

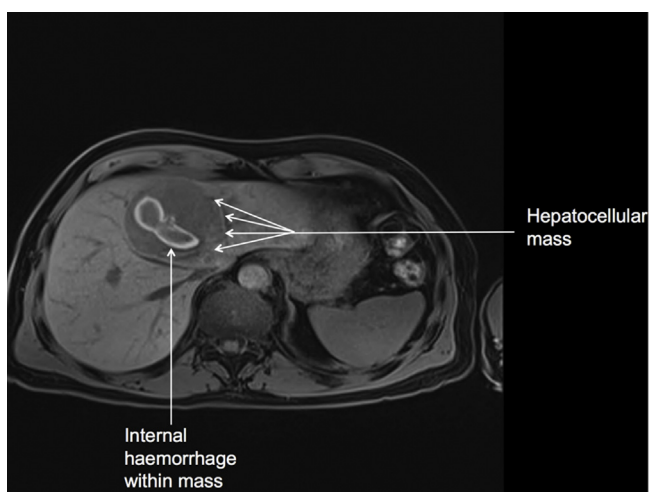
A 65-year-old male presented for open left hepatectomy for a left-sided hepatocellular carcinoma in a University teaching hospital. Computed tomography and magnetic resonance imaging (MRI) demonstrated a large tumour involving the entire segment IV, positioned between the middle and the left hepatic veins. A T1-weighted axial MRI at the level of right hepatic vein demonstrated

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**Table 1**  
Perioperative laboratory values.

	Reference ranges	Pre-operative	Postop	Day 1	Day 2	Day 3	Day 4	Day 5 Discharge
Prothrombin Time (sec)	11–15	12	16	14	12		12	11.0
Activated Partial Thromboplastin Time (sec)	22–38	28	33	30	28		27	28.8
Fibrinogen clauss (g/L)	2.0–4.0	4.3	6.1	4.3	5.9		2.9	2.8
International Normalized Ratio	<1.5	1.0	1.6	1.5	1.4		1.2	1.0
Haemoglobin (g/L)	130–180	120	124	116	107	111	116	122
White blood cell (x10 <sup>9</sup> )	4.0–11.0	10.0	11.3	10.7	12.7	8.2	7.7	7.7
Platelets (x10 <sup>9</sup> )	150–400	209	176	178	162	186	191	213
Lactate (mmol/L)	11–15	1.6	2.6	1.9	1.6		1.6	1.7
Urea (mmol/L)	3.2–7.3	4.5	5.8	5.7		3.2		2.9
Creatinine (umol/L)	62–106	76	91	71		69		76
Albumin (g/L)	35–52	37	29	25		25		27
Globulins (g/L)	25–35	32	28	25		26		27
Bilirubin (umol/L)	<18	16	14	12		7		12
Alkaline phosphatase (IU)	40–130	84	70	64		68		80
Alanine transaminase (IU)	<51	313	764	681		489		371
Aspartate aminotransferase (IU)	<41	312	633	431		212		122
Gamma-glutamyl tranferase (U/L)	<51	90	102	89		91		114



**Fig. 1.** T1 weighted axial MRI at the level of right hepatic vein demonstrating mass with internal haemorrhage.



**Fig. 2.** Venogram showing major branches of portal vein prior to left portal vein embolization.

internal haemorrhage within the mass (Fig. 1). Liver volumetry showed the whole liver size to be 1730 mL with the volume of the right lobe (future liver remnant) being 1160 mL. Hepatobiliary iminodiacetic acid scanning volumetry estimated the future liver remnant to be 6.7%/min/m<sup>2</sup>. Preoperative haematology, renal function and coagulation profiles are summarised in Table 1. The patient refused any form of blood or blood products.

Preoperative haemoglobin optimization performed 4 weeks prior to surgery included IV iron therapy, and oral folate, vitamin B and ascorbic acid. Synthetic EPO was not considered as the preoperative haemoglobin was 120 g/dL and renal function was normal. Three weeks prior to surgery, the patient underwent left portal vein embolisation. The portal vein was accessed via the right liver, as there was distortion on the left due to the large tumour (Fig. 2). The portal system was mapped and branches supplying the left inclusive of segment 4 were identified and particle embolised to near stasis (Boston Scientific Contour 355–500 um, Boston Scientific, Marlborough, Massachusetts, USA). A metal coil (Boston Scientific Interlock-35, Boston Scientific, Marlborough, Massachusetts, USA) was placed in the left portal vein 15 mm from the portal confluence to allow a suitable clamp and tie off position at the time of surgery. The right-sided access was removed and the track into the liver was embolised with Gelfoam pledgets (Pfizer, Kalamazoo, Michigan, USA).

One day prior to left hepatectomy exploration of the hepatic arterial anatomy was undertaken. It was known that the patient had a replaced right hepatic artery originating off the superior mesenteric artery (common variant), however a functional celiac artery stenosis was diagnosed causing retrograde blood supply of the left lobe via the gastroduodenal artery and via large anastomosis with the right hepatic artery (Fig. 3). To isolate and devascularise the left lobe, a retrograde approach via the right hepatic artery or gastroduodenal artery (GDA) was planned. The GDA could not be cannulated owing to its torturous pathway off superior mesenteric artery branches. The right hepatic artery was cannulated and a microcatheter placed through the anastomosis with the left hepatic artery and manipulated back to the bifurcation of the GDA and common hepatic artery. The GDA and left hepatic artery were occluded with coils (Boston Scientific Interlock-18, Boston Scientific, Marlborough, Massachusetts, USA) (Fig. 4). The bed of the left hepatic artery was embolised to stasis with particles (Boston Scientific Contour 355–500 um, Boston Scientific, Marlborough, Massachusetts, USA). The anastomosis back to the right hepatic artery was then occluded by coils (Boston Scientific Interlock-18, Boston Scientific, Massachusetts, USA) (Fig. 5). The procedure was completed with a closure device to the right groin (Exoseal, Cordis, Warren, NJ, USA).

The following day the patient proceeded to left hepatectomy. A curved bilateral subcostal incision was made to approach the liver with maximal exposure provided by a Thompson retractor system (Thompson Surgical Instruments, MI). Intraoperative ultra-

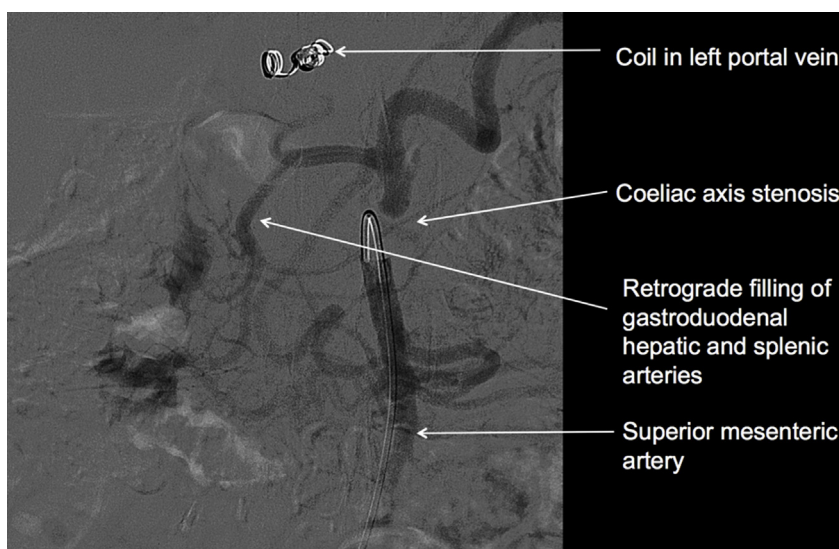


Fig. 3. Superior mesenteric angiogram shows collateralized supply to the common hepatic and splenic arteries.

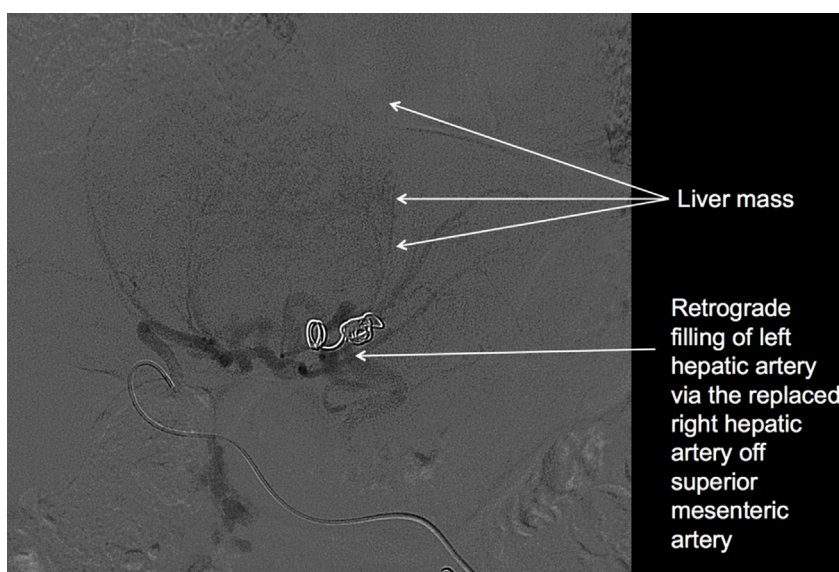


Fig. 4. Left hepatic angiogram via right hepatic artery showing arterialized blood supply to the mass.

sound showed a large tumour in the left lobe of the liver abutting the left hepatic vein, close to the middle hepatic vein. The left lobe was mobilised fully while the right lobe was mobilised partially to provide access to both the infra- and supra-hepatic portions of the inferior vena cava, to allow for vascular control if needed. The lesser omentum and ligamentum venosum were divided and an open cholecystectomy was performed.

The porta hepatis was then dissected to demonstrate the abnormal hepatic arterial anatomy as identified on preoperative cross-sectional imaging and hepatic angiography. Patency of the replaced right hepatic artery was assessed by Doppler and hand palpation after trial occlusion of left hepatic and main hepatic arteries. Subsequently, both the left hepatic artery and middle hepatic artery were ligated and oversewn with 4/0 prolene. There was normal portal venous and biliary anatomy. The left portal vein and left hepatic duct were identified, ligated, divided and oversewn in their extra-hepatic course. The liver was seen to demarcate well.

The resection plane was defined and the liver capsule was marked with diathermy, preserving the middle hepatic vein using

intraoperative ultrasound. Prior to, and during the hepatic dissection and resection phases, a low central venous pressure with goal directed therapy using a patient-specific, surgery-specific haemodynamic algorithm, previously described from our institution [3]. Parenchymal transection was conducted by the Harmonic Scalpel (Ethicon, NJ) in the superficial portion. The major parenchymal transection was performed using the Echelon Flex powered vascular stapling device with vascular staples (Ethicon, NJ). Two such staplers were used to minimize the staple reloading time. Total parenchymal transection was performed in eighteen minutes. Bleeding sites in the cut surface were controlled with 3/0 prolene sutures and argon beam coagulation. 400 mL of blood was recovered during the course of the surgery by cell salvage (Haemonetics, MA), with 190mls of this re-infused into the patient post-resection. The estimated blood loss was 450mls. The cut hepatic surface was then packed with clean abdominal packs and a 20-min haemostatic/biliostatic pause was instituted. Upon review, a single site of bile leak was detected at the hilum and oversewn. Although abdominal drains for major liver resections are not rou-

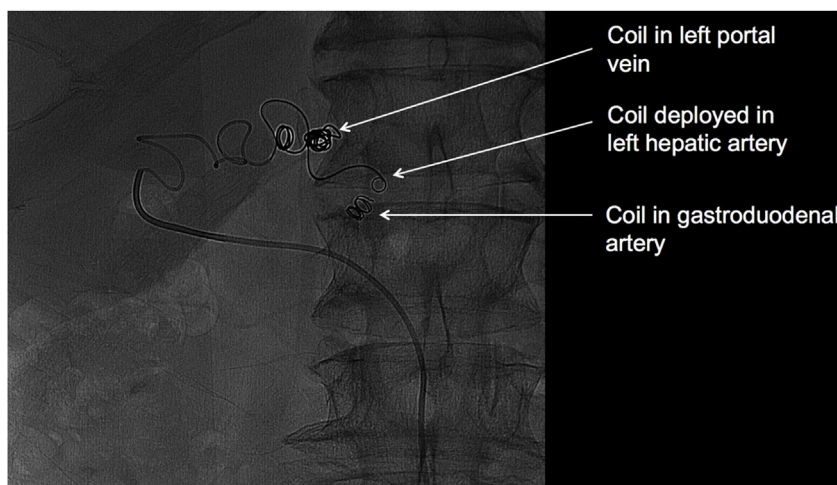


Fig. 5. Final static radiograph of coils and catheters in vessels as indicated.

tinely used in our centre, the detection of the bile leak and the unique circumstances of the patient prompted the insertion of a 10F Jackson-Pratt drain. Perioperative haematology, biochemistry and coagulation values are summarised in Table 1. The post-operative course was uncomplicated with a haemoglobin nadir of 107 g/dL, before returning to 122 g/dL at discharge. Liver synthetic function showed mild derangement post-operatively before normalizing prior to discharge (Table 1). Six-months post discharge the patient continues to make satisfactory progress.

### 3. Discussion

This case illustrates that complex liver resection in a Jehovah's Witness patient is feasible but requires careful planning and a multidisciplinary approach. Although bleeding during left hepatectomy is uncommon, there are numerous factors associated with a higher risk of bleeding, even in expert surgical units. Major liver resection represents a well defined but complex haemostatic challenge from tissue and vascular injury, further complicated by hepatic dysfunction, and activation of inflammatory, haemostatic and fibrinolytic pathways. Pre-existing hepatic insufficiency resulting in reduced levels of procoagulant and anticoagulant factors normally synthesised in the liver can also be contributory.

Whilst use of total vascular isolation and controlled hypoperfusion in liver resection for an intrahepatic cholangiocarcinoma has been reported [4], we report a case of preoperative total left hepatic lobe devascularisation to minimize perioperative bleeding in a Jehovah's Witness. For Jehovah's Witness patients, blood transfusion is not a therapeutic option. Therefore, in addition to the haemoglobin optimization strategies utilized preoperatively, the use of interventional radiology was paramount for the successful outcome of this case.

Multi-disciplinary approach and careful preoperative planning were crucial to achieving minimal intraoperative blood loss. Staged preoperative left portal vein embolization followed by left hepatic artery embolization and low central venous pressure anaesthesia were major contributors to the reduction of intra-parenchymal bleeding. The use of two stapling devices to reduce reload time facilitated the parenchymal transection time of less than twenty minutes. The use of the Cell Saver (Haemonetics, MA) for intraoperative cell salvage allowed the recovery of 190 mls of blood to be returned to the patient. Meticulous surgical technique, clear communication between the surgical and anaesthetic team and rapid transection time were important surgical aspects in achieving this outcome without the need for the Pringle Manoeuvre. Topical

haemostatic agents like Tisseal (Baxter, IL) and Floseal (Baxter, IL) were not used in this case owing to the presence of human blood products.

Whilst preoperative portal vein embolization is well described in the context of augmenting liver function by promoting liver hypertrophy in remaining tissue prior to liver resection, in and of itself it may not reduce intraoperative blood loss or the need for transfusion postoperatively [5]. In this case, due to the excellent estimated functional volumetry of the future liver remnant, liver hypertrophy was not absolutely indicated preoperatively. We embolised the left portal vein in order to reduce the size of the left lobe, and minimize intraoperative bleeding. Portal vein embolization might decrease extrahepatic recurrences [6,7], which had additional implications in Jehovah Witness patients regarding bleeding related complications during liver resection. We completed radiological devascularisation of the tumour within 24-h of the planned surgery to reduce the timeframe for collateralization of blood supply.

In conclusion, the techniques described, in particular the use of preoperative angio-embolisation can be further researched in a larger patient population to reduce blood loss and therefore the need for blood transfusions and its associated risks. Further, complex liver resection is increasingly performed on patients at the extremes of age with underlying medical conditions, and with a greater degree of liver insufficiency. Further, more patients receive newer oral anticoagulants and antiplatelet drugs preoperatively, without clear therapeutic approaches for reversal or management. Hepatic artery embolization has been demonstrated to reduce blood flow by causing tissue necrosis in the treatment of liver metastases [8], and in hereditary haemorrhagic telangiectasia [9]. However, to our knowledge, the combination of portal vein embolization and hepatic artery embolization to produce total vascular occlusion of inflow to the left lobe radiologically has not been previously reported. The unique radiological intervention employed in our case served to allow a near bloodless resection of a hepatocellular carcinoma in a Jehovah's Witness patient.

### Conflict of interest

Nil conflicts declared by each author.

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### Ethical approval

Austin Health Research Ethics committee has approved this report being submitted for publication. Written informed consent has been obtained.

### Consent

Written and informed consent for publication, including all de-identified images have been provided by the patient.

### Authors contribution

A/Prof Laurence Weinberg: responsible for study concept, data collection, data interpretation, collation of all images and writing of the paper. He was also the principle anaesthetist involved in the anaesthesia management of this case.

A/Prof Vijayragavan Muralidharan and Dr Su Kah Goh were responsible for data interpretation, collation of all images and writing of the paper. They were also the principle surgeons involved in the surgical management of this case.

Dr Manfred Spanger was the interventional radiologist who performed all the interventional radiology procedures. He was responsible for collection and interpretation of all radiological images, data interpretation and writing of the paper.

Drs Jonathan Banting, Georgina Hanus and Diana Abu-ssaydeh were all involved in the management of this case. They assisted with data collection, data interpretation, preparation of all images and writing of the paper.

All authors were involved in drafting the article. All authors have read the final manuscript and approved it for submission.

### Guarantor

A/Prof Laurence Weinberg is the Guarantor.

### Acknowledgement

Nil.

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