

# Hanging Maneuver of Liver Resection: An Early Experience

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## ABSTRACT

### Introduction

The posterior approach to liver resection is technically difficult, especially when there is a bulky tumor or dense adhesion of right lobe of liver, with the risk of tumor dissemination and hepatic vein avulsion. The objectives of our study were to observe the technical safety, operative duration, operative blood loss, and perioperative complications of hanging maneuver in liver resection.

### Methods

This is a cross-sectional study on the patients who underwent hanging maneuver of liver resection at our center. The perioperative data were analyzed. Descriptive variables were described using frequency and percentage; continuous variables were described using mean and standard deviation.

### Results

A total of 15 patients underwent hanging maneuver of liver resection, majority were male (66.6%) with Child-Pugh score-A of 80%. The most common indication was complex hydatid cyst of liver (33%) and biliocutaneous fistula (13%) that occurred after previous intervention for hydatid cyst of liver. Mean intraoperative blood loss was 750±343.2 ml and complications grade IIIB were observed in 20% cases as per Clavien Dindo grading system.

### Conclusions

Hanging maneuver of liver resection is a technique that facilitates in elevating liver parenchyma away from IVC and helps in an easier anterior approach. A learning curve and assessment of background liver disease is necessary for its safety.

**Keywords:** Hanging maneuver; Hepatectomy; Liver.

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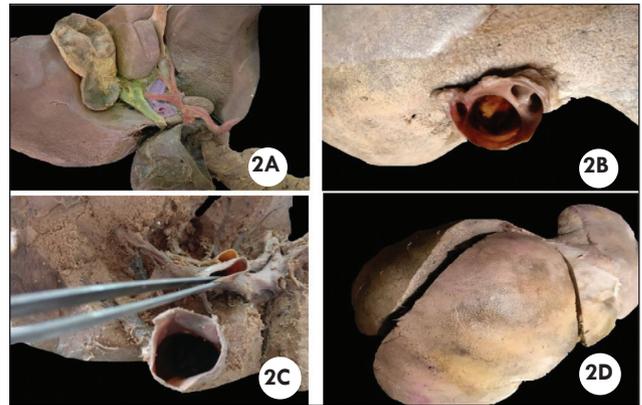
## INTRODUCTION

Liver has a complex blood supply and is closely related to the retrohepatic inferior vena cava (IVC), which drains hepatic veins (right, middle, and left). There are also a number of tiny short hepatic veins that drain directly into the IVC.<sup>1</sup> During conventional hepatic resection, a posterior approach is carried out where liver is reflected towards left side followed by inflow and outflow vascular control before parenchymal transection.<sup>2-4</sup>

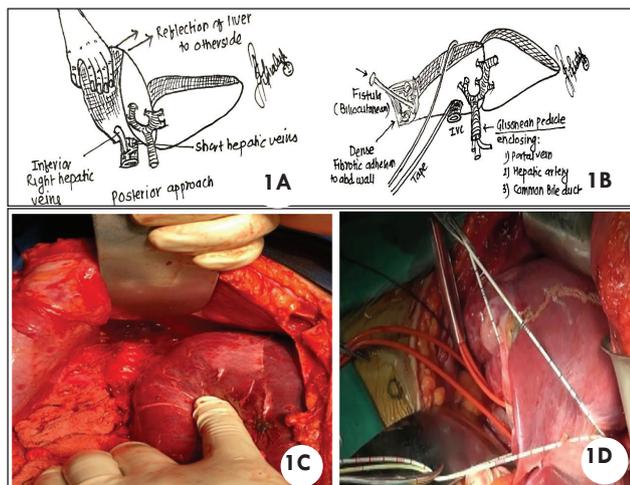
The posterior approach is technically difficult when there are dense adhesions of right lobe of liver and large tumor in right lobe. It is associated with the risk of avulsion of hepatic vein, tumor dissemination, and prolonged hepatic ischemia.<sup>5,6</sup>

Alternatively, the anterior approach was adopted.<sup>7</sup> However performing this anterior approach is technically difficult and it is associated with the risk of injury to IVC, wrong line of transection and difficulty in controlling of bleeding in deeper parenchymal plane. To address these issues, Belghiti simplified this

approach by introducing hanging maneuver.<sup>5</sup> This study describes our preliminary experience with this technique in terms of safety, operative blood loss, duration of surgery and post-operative complications.



**Figure 2.** shows Cadaveric dissection relevant to hanging maneuver liver resection. 2A: shows the structures in hepatoduodenal ligament, 2B: shows middle, right and left hepatic vein draining into IVC, 2C: shows interface of IVC and liver and its relation to portal vein, 2D: shows resection of liver along anatomical plane.

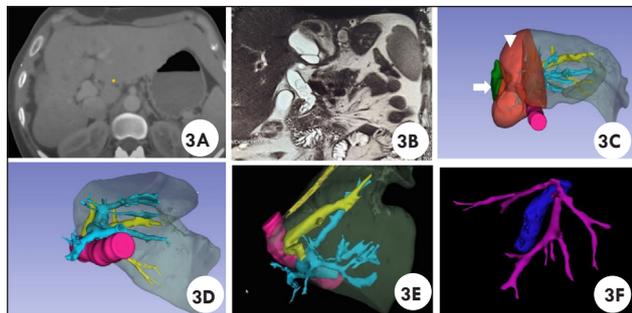


**Figure 1A.** Posterior approach, while performing right hepatectomy where right liver is reflected towards left side by hand, 1B: Anterior approach with hanging maneuver where tape is passed between the interface of IVC and liver 1C: Difficulty in posterior approach due to dense adhesion (shown by arrow) of liver with the abdominal wall 1D: Operative view of anterior approach by hanging maneuver.

## METHODS

A cross-sectional observational study was performed at the Department of GI and General surgery at the College of Medical Sciences (COMS), Bharatpur, Nepal from 1<sup>st</sup> April-2020 to 31<sup>st</sup> March- 2022. Ethical clearance was obtained from college of Medical Sciences Teaching Hospital Institutional Review Committee (Reference number: COMSTH-IRC/2022-022). Patients who underwent liver resection following anterior approach with the method of “hanging maneuver” with Child Pugh score A, and selected cases of score-B, no portal vein and IVC thrombosis or infiltration by tumor on CT were included. Patients with Child Pugh score-C, portal vein thrombosis and infiltration of IVC by tumor on CT were excluded. Data were analyzed in Statistical Package for the Social Sciences (SPSS) version-20.0. Descriptive variables were described using frequency and percentage; continuous variables were described using mean and standard deviation (SD). Preoperative

CT liver segmentation, volumetry, topography of hepatic veins, and portal veins were assessed and confirmed with radiologist. Pre-operative remnant liver volume, virtual liver resection, Child Pugh score calculation, and nutritional optimization were carried out. Intraoperative duration, blood loss, hemodynamic stability, duration of Pringle maneuver, inflow control, outflow control, blood transfusion, crystalloid volume transfusion, colloid volume transfusion and other surgical events were recorded.



**Figure 3A.** shows CT-Scan with dense adhesion of right lobe of liver with abdominal wall, 3B: Hydatid cyst with aborted multiple daughter cysts on common bile duct, 3C: liver segmentation and volume rendering green colored mass (arrow) shows adhesion and pocket of bilio-cutaneous fistula, saffron color (arrow head) shows right liver to be resected 3D: Shows virtual liver resection 3E: Shows the topography of portal vein, hepatic vein and IVC in relation to plane of transection produced by virtual liver resection 3F: Topography of hepatic veins.

### Operative Technique

For each patient, Makuuchi abdominal incision was given. Hepato duodenal ligament was dissected for passage of tape for future Pringle maneuver. Falciform ligament was incised upto coronary ligament. The attachment of coronary ligament to diaphragm was cautiously incised for the exposure of supra-hepatic IVC. A retro-hepatic tunnel was created between liver and IVC at 11 o'clock position of IVC. A tape was passed through this tunnel and was prepared for hanging maneuver.

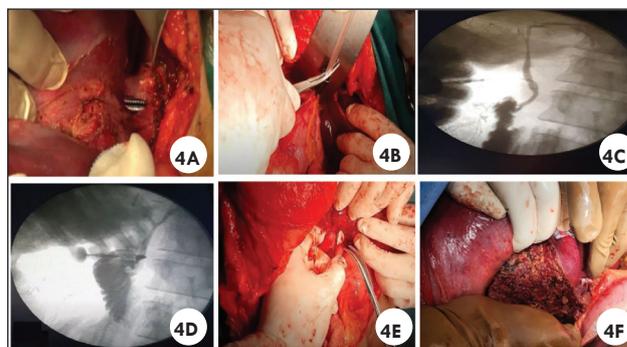
Glissonean pedicle approach was carried out for inflow control. Before clamping the Glissonean pedicle, intraoperative cholangiogram was performed to rule out central bile duct injury.

After clamping the pedicle, the vascular demarcation appeared on liver which was marked by electrocautery. Finally parenchymal transection was carried out. After completion of transection, the liver was reflected away from midline and detached from its attachments like triangular ligament and Makuuchi ligament. During such reflection in right Hepatectomy, inferior right hepatic vein was often encountered which was clipped and tied with silk. Utmost care was taken to prevent injury to right adrenal vein. Short hepatic veins draining into IVC directly from liver were taken care by metallic clips and sutures when required.

### Postoperative Assessment

Postoperative liver enzymes on POD 5, surgical site infection, bile leak (day 1, day 3, day 7), post hepatectomy liver failure (based upon ISGLS 2011), respiratory complications (pleural effusion, lung consolidation), organ failure (based upon modified Marshall Score), length of hospital stay and mortality were recorded.

On follow up liver enzymes, ultrasound abdomen/pelvis and clinical examination were done at 14<sup>th</sup> and 28<sup>th</sup> post-operative days.

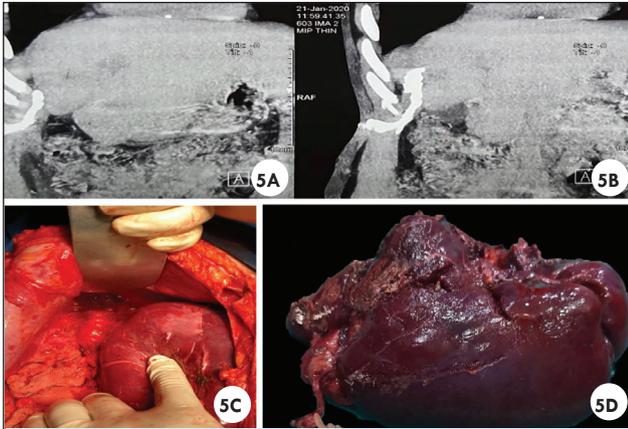


**Figure 4.** Showing step wise hanging maneuver liver resection. 4A shows the clamp passed through the tunnel created between the interface of liver and IVC, 4B: shows tape passed in hepatoduodenal ligament for Pringle maneuver 4C: shows cholangiogram before clamping the right Glissonean pedicle 4D: shows cholangiogram after clamping the Glissonean pedicle, 4E: shows clamping of right Glissonean pedicle and inflow control 4F: shows transection plane after liver resection.

**RESULTS**

Total number of patients who underwent the procedure was 15. Most of the patient in our study were male. The demographic profile of patients was as follows in Table 1.

The most common indication for surgery was complex hydatid cyst, accounting for one-third of total cases. It was followed by Hepatocellular Carcinoma (HCC) and Colorectal liver metastasis (CRLM), and hepatic adenoma respectively.



**Figure 5A and 5B.** Shows CT-Fistulogram showing fistulous tract connecting skin with bile duct in liver 5C shows an intraoperative image showing the dense adhesions between liver and abdominal wall along with a pocket of fistulous tract 5D shows a specimen of liver after resection.

Age, years (mean ± SD)		45.6±12.6
Sex	Male	10 (66.6%)
	Female	5 (33.3%)
BMI (Body Mass Index)	Normal	10 (66.6%)
	Class-I obesity	5 (33.3%)
Hypertension		11 (73.3%)
Diabetes mellitus		2 (13.3%)
Hypothyroidism		2 (13.3%)
Previous smoker		5 (33.3%)
Previous alcoholic		6 (40.0%)
Child Pugh's Score	Child A	12 (80%)
	Child B	3 (20%)

Complex hydatid cyst n=5 (33.3%)	With post-intervention bilio-cutaneous fistula	2 (13.3%)
	No previous intervention	3 (20%)
Giant hemangioma		2 (13.3%)
Hepatic adenoma		3 (20%)
HCC and CRLM (Hepato cellular carcinoma and colo rectal liver metastasis)		4 (26.7%)
Trauma with major vascular injury		1 (6.7%)

The average operative duration was 222.7±34.5 min with average intraoperative blood loss of 756.6±343.2 ml. Intra-operative hemodynamic instability occurred in 46.7% patients with 513.33±224 ml of mean perioperative blood transfusion and the average duration of Pringle maneuver was 37±13.1 min. Two-third of the case underwent Glissonean approach whereas remainder underwent intra-fascial approach. (Table 3)

Operative duration (min ± SD)	222.7±34.5
Intraoperative blood loss (ml ± SD)	756.6±343.2
Intraoperative hemodynamic instability	7 (46.7%)
Duration of Pringle maneuver (min ± SD)	37±13.1
Intra-fascial approach	5 (33.3%)
Extra-fascial approach (Glissonean approach)	10 (66.7%)
Mean perioperative blood transfusion (ml± SD)	513.33±224
Mean postoperative length of hospital stay	10.8±2.1

Table 4. Post-operative events.		
Complications		Frequency
Claviendindo Grading	Grade II	4 (26.7%)
	Grade IIIA	7 (46.7%)
	Grade IIIB	3 (20.0%)
	Grade IVA	1 (6.7%)
Post-hepatectomy liver failure		1 (6.7%)
Bile leak		6 (40%)
SSI		4 (26.7%)
Pneumonia		5 (33.3%)

## DISCUSSION

Anterior resection was first described by Lin et al. in 1997 where they passed a clamp blindly below liver and compressed the liver before carrying out parenchymal transection.<sup>16</sup> This procedure had the risk of injury to adrenal gland and vessels. In 1996 Edward C.S. published an article about anterior approach for difficult right Hepatectomy and claimed theoretical advantages of preventing hepatic venous avulsion, twisting of hepatoduodenal ligament while rotation during posterior approach.<sup>7</sup> In 2001, Belghiti invented an easy technique by passing a tape between liver and retro hepatic IVC and performing the hanging maneuver.<sup>5</sup> This technique provided ease in anterior approach. Several publications have been published regarding the viability of using the hanging maneuver in anterior liver resection.<sup>5,8-15</sup> The blunt tunneling between liver and retro-hepatic IVC could damage the short hepatic veins and lead to bleeding. For such tunneling, 11: 00 o'clock position of IVC provides a safer, avascular plane.<sup>5</sup>

Complex hydatid cysts of liver with bilio-cutaneous fistula following failed multiple surgical interventions require resection of liver for cure.<sup>12</sup> According to Satoshi et al. feasibility of hanging maneuver is not possible following

multiple surgical interventions in liver.<sup>8</sup> However, majority of cases we operated were complex hydatid cysts with previous surgical interventions. In our experience tunneling in hanging maneuver were possible even in cases with multiple previous surgical interventions for bilio cutaneous fistula or adhesion. It is probably because previous surgical adhesions were present along anterior and lateral surfaces of liver while doing percutaneous aspiration injection reaspiration (PAIR) or laparoscopic deroofting, and the posterior surface remained untouched by such procedures. Hence there was no hindrance in tunneling through the surface of retrohepatic IVC.

The average blood loss in our study was 756.6 ml  $\pm$  343.2 ml. In majority of other studies they have reported an average blood loss of less than 500 ml and suggest blood loss of more than 500 ml as an independent prognostic factor for morbidity and mortality.<sup>17</sup> Blood loss during hepatectomy at our center seems alarmingly high. This could be due to most cases having dense adhesions of liver following previous surgical interventions and we also have included a case of liver trauma. Our sample size is relatively small and also, probably due to learning curve of surgeons.

We experienced several complications, among which 20% had Clavien Dindo grade- IIIB and one patient with grade-IVa. In a study carried out by Li Ning Xu, Grad-IIIA complication occurred in 2.94 % of cases.<sup>18</sup> Our complication rate is too high and correlates with the operative blood loss. Majority of our cases were complex including trauma, dense adhesions, and atrophied liver in complex hydatid cyst with bilio-cutaneous fistula.

We abandoned hanging maneuver in one case due to avulsion of right hepatic vein while tunneling. This was due to dissection in wrong plane and over-enthusiastic instrumentation. Similar abandonment was also described by Satoshi et al. and we also realized for need of significant learning curve for hepatic resection.

No mortality was observed in 30 days period post hepatectomy in our study.

Post Hepatectomy liver failure (PHLF) occurred in one case. It was due to major hepatectomy. We consider definition of PHLF as per the International Study Group for Liver Surgery (ISGLS). This patient had persistent and major bile leak, and developed encephalopathy which was managed conservatively. The collected bile on drain was fed via a nasogastric tube, and encephalopathy was managed conservatively. N-acetylcysteine was prescribed for cytoprotection of remnant liver. Albumin and judicious transfusion of blood products were carried out. The clinical scenario of this patient was a nightmare, yet, patient could manage to recover. The incidence of PHLF is suggested to be 8-12%.<sup>19</sup> In our case, though the volumetry showed more than 30% remnant liver suggesting volumetric assessment may not be

always sufficient to predict PHLF. Patients with bilio-cutaneous fistula after multiple surgical interventions usually have an atrophied liver and there may be concomitant background disease of the remnant liver. So in selected cases, it may be necessary to assess functional liver volume like Indocyanine green (ICG) retention rate when there is a need for major hepatectomy.

## CONCLUSIONS

Hanging maneuver liver resection overcomes technical difficulties of anterior approach. This technique is safe with manageable blood loss, desirable operative duration and mean postoperative duration of hospital stay. Though previous surgical interventions are said to be unfeasible for hanging maneuver, in our experience there is feasibility of hanging maneuver, where posterior plane is intact. This technique of liver resection needs a significant learning curve.

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