



# Comparison of surgical outcomes between shunt surgery and devascularization in non-cirrhotic portal hypertension

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## ABSTRACT

**Objective:** Non-cirrhotic portal hypertension (NCPH) is the most common cause of portal hypertension and upper gastro-intestinal bleeding in children and adolescents in developing nations. It is characterized by features of portal hypertension with preserved liver function. Proximal spleno-renal shunt (PSRS) and esophagogastric devascularization are the two most commonly performed surgeries for its management. The present study is aimed at comparison of surgical outcomes between these two procedures.

**Material and Methods:** Between April 2018 and March 2022, prospectively maintained data of consecutive NCPH cases who underwent surgical intervention was reviewed retrospectively. Cases were categorized into two groups- shunt surgery and devascularization. The pre-operative characteristics, peri-operative morbidity and long-term outcomes were compared between the groups.

**Results:** Of 112 cases who were treated during the study period, 54 cases which underwent surgery were included in the study. Of these, 20 cases underwent PSRS, and splenectomy and devascularization was performed in 34 cases. There was no difference in pre-operative variables between the two groups. Patients undergoing PSRS experienced longer duration of surgery (260 vs. 200 minutes,  $p < 0.001$ ), and those in the devascularization group had significantly greater operative blood loss (350 vs. 455 ml,  $p < 0.001$ ). Post-operative morbidity was comparable between the two groups. Hypersplenism was corrected in all cases and no cases reported rebleeding after median follow-up of 30 months. Three cases in each group developed features of portal biliopathy in follow up period.

**Conclusion:** Both PSRS and devascularization procedures have comparable efficacy and safety in the management of NCPH.

**Keywords:** Non-cirrhotic portal hypertension, extrahepatic portal venous obstruction, non-cirrhotic portal fibrosis, proximal spleno-renal shunt, devascularization

## INTRODUCTION

The term "non-cirrhotic portal hypertension" (NCPH) includes a diverse group of vascular conditions with features of portal hypertension and relatively preserved liver function. NCPH is the commonest cause of portal hypertension and upper gastro-intestinal bleeding in children in developing nations (1). The two common pathologies leading to NCPH are non-cirrhotic portal fibrosis (NCPF)/idiopathic portal hypertension (IPH) and extrahepatic portal venous obstruction (EHPVO). Both conditions are characterized by the early development of features of portal hypertension (1). The etiology remains idiopathic in up to 70% of the patients (2). EHPVO and NCPF are differentiated from each other by the presence or absence of portal cavernoma formation, respectively (3).

The clinical features and management of EHPVO and NCPF share certain common characteristics. The commonest presentation of NCPH is variceal hemorrhage followed by symptomatic splenomegaly/and portal biliopathy (1). The primary focus of management in both of these conditions involves control of the acute episode of variceal bleeding first, followed by measures to prevent rebleeding (secondary prophylaxis) (2). Both for control of acute bleeding episode and secondary prophylaxis, endoscopic management in the form of endoscopic variceal ligation (EVL) or endoscopic sclerotherapy are the preferred modes of treatment (2). However, the re-bleeding rate following endotherapy is 17% and requires a long duration of regular follow-up (1). Moreover, endotherapy is not

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useful in symptomatic splenomegaly, hypersplenism, growth failure and portal biliopathy (4). Surgery is indicated in these conditions besides failure of endoscopic therapy (3). Non-selective porto-systemic shunts are the preferred surgical treatment option. Of these, proximal splenorenal shunt (PSRS) is the most common surgery performed (1).

Splenectomy with esophago-gastric devascularization is another effective way to treat variceal hemorrhage in NCPH and is indicated in situations where shunt surgery is not feasible due to unfavorable venous anatomy (5). The morbidity and rebleeding rate of devascularization procedures have been reported to be higher than those of shunt surgeries (6,7). However, the majority of these procedures were carried out for emergency management of uncontrolled variceal bleeding, leading to a higher rate of postoperative morbidity and mortality. There is also heterogeneity in the results of these procedures due to carrying out the procedure with or without esophageal transection (5,7). There are no studies comparing the outcomes of shunt surgery and devascularization procedure in the management of NCPH, especially in elective settings. The present study aimed at comparing the surgical outcome between shunt surgery and devascularization procedure in the management of NCPH.

## MATERIAL and METHODS

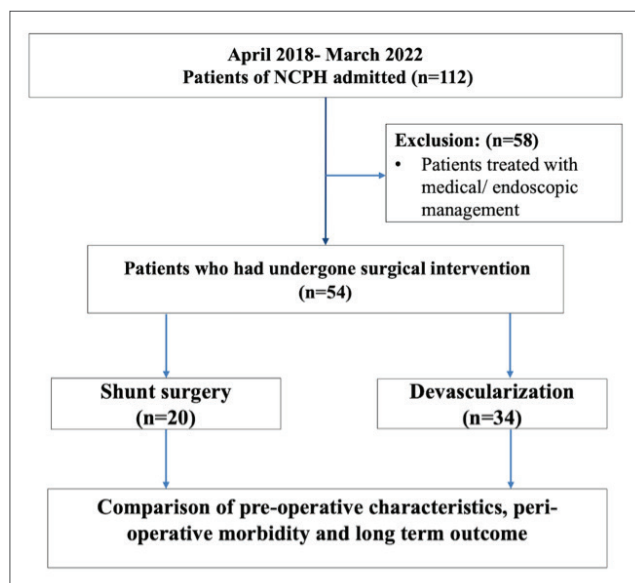
Between April 2018 and March 2022, the prospectively maintained data of 112 consecutive patients with NCPH who were treated at a tertiary care institute in eastern India was reviewed retrospectively. Of these, 54 cases that underwent surgical intervention were included in the study. These cases were categorized into two groups based upon the type of

surgery performed: shunt and devascularization groups (Figure 1). All cases were operated on an elective basis, and porto-systemic shunt surgery was the preferred mode of surgical intervention. Devascularization procedure was performed in situations where non-shuntable venous anatomy was identified either on preoperative imaging or as an intraoperative finding. Apart from these, devascularization was also carried out in NCPF with nodular liver. The two groups were compared in terms of surgical outcome and long-term follow-up. The study was conducted after prior approval of institutional research and ethical committee.

The cases of NCPH were diagnosed as EHPVO or NCPF/IPH based upon doppler ultrasonographic or computed tomography porto-venography findings. Detailed pre-operative data of history and clinical examination findings were recorded. Pre-operative esophagogastroduodenoscopy was carried out in all cases, and esophageal varices were graded according to Baveno classification. Cases with active variceal bleeding, having grade 2 or 3 esophageal varices, or having red color signs were subjected to endoscopic variceal ligation or sclerotherapy. Indications of surgery were uncontrolled variceal bleeding on endotherapy, symptomatic hypersplenism/splenomegaly, symptomatic portal biliopathy and growth retardation. During the initial phase of the study, we only performed transient elastography (fibroscan) in equivocal cases to differentiate between NCPF and child A cirrhosis. However, from July 2019 onward, it was regularly carried out in every case of NCPH. Hypersplenism was defined as cytopenias in any of cell lines associated with splenomegaly. Portal biliopathy (PB) or portal cavernoma cholangiopathy was defined as typical abnormalities of the biliary tract, including the gallbladder, cystic duct, and biliary ducts, in patients with portal hypertension.

## Surgical Technique

Cases were planned for either shunt surgery (PSRS) or esophago-gastric devascularization with splenectomy, depending on the presence or absence of shuntable venous anatomy, respectively. For intended shunt surgery, cases were explored by either abdominal incision (reverse Makuchi incision or L-incision) or left thoracoabdominal (TA) incision, depending upon the surgeon's preference. The procedure begins with the opening of the lesser sac by division of gastrocolic omentum, identification, and ligation-in-continuity of the splenic artery over the superior border of pancreas. Complete mobilization of the spleen was achieved by the division of the splenic ligaments and collateral vessels along with them. On dissection of the splenic hilum, the splenic artery was ligated and divided, the splenic vein was clamped, and splenectomy completed. For PSRS, a length of 5-7 cm of splenic vein was dissected, and small tributaries were carefully ligated and divided. Exposure of



**Figure 1.** Flow diagram of study protocol.  
NCPH: Non-cirrhotic portal hypertension.

the left renal vein was done away from the renal hilum, and partial clamping was achieved by using Satinsky clamp. An end-to-side splenorenal shunt was performed using polypropylene 6-0 double needle suture. In cases of pre-operatively identified non-shuntable venous anatomy, a left subcostal incision was utilized for the devascularization procedure. In this, devascularization of half of the lesser curvature and two-thirds of the greater curvature of the stomach was performed. Vessels along the lesser and greater curvature of the stomach, including short gastric, left gastroepiploic, and left gastric collaterals, were ligated. Retrogastric collaterals lying behind the gastro-esophageal junction were meticulously dissected and divided. Then, the lower 5-7 cm of esophagus was revascularized using a transhiatal approach without esophageal transection. Intra-operative core needle liver biopsy was taken in all cases for baseline liver histology. An abdominal drain was placed in all cases, and a left intercostal drain was placed when a thoraco-abdominal incision was used for surgery. The closure of incisions was carried out using delayed absorbable monofilament sutures (polydioxanone) in a continuous small-bites fashion. The bites were taken at a distance of 5 mm apart and about 5-9 mm from the wound edges.

The Clavien-Dindo (C-D) classification was utilized for classifying the post-operative complications. After discharge, the cases were followed at three-monthly intervals, which included history and clinical examination, laboratory investigations including complete blood counts, and liver function tests. Doppler ultrasonography of the abdomen was carried out six

months post-operatively, and esophagogastroduodenoscopy was performed only when clinically indicated. A follow-up fibro-scan was also performed one year after the surgical procedure.

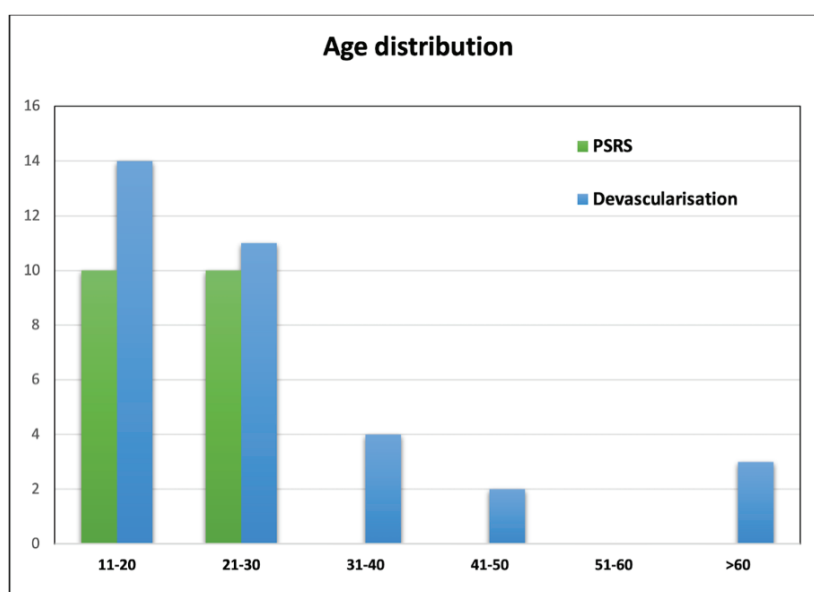
### Statistical Analysis

For categorical variables, depending on the number of observations, Chi-square and Fisher's exact tests were applied to study the relations. Continuous variables were compared using the Student's t test for normally distributed data and the Mann-Whitney U test for non-parametric variables. Statistical significance was determined by applying a p-value of lower than 0.05. All the analyses were carried out using SPSS version 22.0 (SPSS Inc.).

### RESULTS

The comparative analysis of pre-operative characteristics between the two groups is shown in the table (Table 1). Median age of the study population was 22.0 years (IQR= 15.5-28.5), and there was a slight female preponderance, as 28 (52%) of all cases were female. Participants in the shunt group had a lower age of onset of symptoms in comparison to devascularization group, and the majority of the cases underwent surgery in the second or third decade of life (Figure 2).

Of the total 54 cases, 45 (83.3%) were diagnosed as EHPVO, and the rest were NCPF (16.7%). The age of onset of symptoms was earlier in EHPVO than in NCPF (14.0 vs. 21.5 years). A history of bleeding and hypersplenism was present in 41 (76%) and 47 (87%) individuals, respectively.



**Figure 2.** Comparison of age distribution of study subjects between the two groups. PSRS: Proximal spleno renal shunt.

**Table 1.** Comparison of pre-operative characteristics between two groups

Variable	Shunt	Devascularization	Total	p
Age (median, years)	20.0 (16.8-23.3)	23.0 (18.0-31.5)	22.0 (17.0-27.0)	0.119
Sex			0.181	
Male	12	14	26	
Female	08	20	28	
Duration of symptoms (mean, years)	5.11 ± 3.7	5.71 ± 2.4	5.49 ± 5.6	0.711
Age of onset (median, years)	14.0 (9.5-17.5)	18.0 (11.8-25.0)	16.0 (10.5-22.0)	0.089
Diagnosis				0.801
EHPVO	17	28	45	
NCPF	3	6	9	
Bleeder				0.232
Yes	17	24	41	
No	3	10	13	
Hypersplenism				0.733
Yes	17	30	47	
No	3	4	7	
EVL history				0.780
Yes	14	25	39	
No	6	9	15	
Number of EVL (median)	2.0 (1.0-3.0)	1.5 (1.0-3.0)	2.0 (1.0-3.0)	0.618
History of blood transfusion				0.842
Yes	13	23	36	
No	7	11	18	
Units of blood transfusion (median)	2.0 (1.0-4.0)	3.0 (0-4.0)	2.0 (0-4.0)	0.431
Esophageal varices				0.780
Present	19	29	48	
Absent	01	05	06	
Esophageal varices grade				0.439
Grade 1	04	06	10	
Grade 2	06	05	11	
Grade 3	09	18	27	
Portal hypertensive gastropathy				0.463
Present	11	22	33	
Absent	9	12	21	
Portal biliopathy				0.740
Symptomatic	01	03	04	
Asymptomatic	07	09	16	
Absent	12	22	34	
Grade of splenomegaly				0.426
Mild	0	2	2	
Moderate	7	7	14	
Gross	13	25	38	
Comorbidity				0.145
Present	0	5	5	
Absent	20	29	49	

Values are presented as number or mean ± standard deviation or median (inter quartile range).  
EHPVO: Extra hepatic portal venous obstruction, NCPF: Non-cirrhotic portal fibrosis, EVL: Endoscopic variceal ligation.

A total of 39 (72%) cases underwent endotherapy (EVL) prior to surgery, with a comparatively higher number of median endotherapy sessions in the devascularization group (2.63 vs. 2.03). Esophageal varices were present in 48 (88.9%) cases, and half of the population had grade 3 esophageal varices. Features of clinical portal biliopathy were present in 20 (37%) cases. Of these, only four cases (7.5%) had symptomatic PB. A total of 38 (70.4%) cases had gross splenomegaly, with a mean splenic size of  $20.4 \pm 4.4$  cm. Pre-operative characteristics were comparable between the two groups. Transient elastography was performed in 35/45 EHPVO and 6/9 NCPF cases, respectively. Mean liver stiffness (LS) in NCPF and EHPVO were ( $7.90 \pm 1.17$  kPa) and ( $4.61 \pm 0.83$  kPa), respectively.

The commonest indication of surgery in both groups was variceal hemorrhage, followed by symptomatic hypersplenism (Table 2). Three cases in devascularization and one case in the shunt group underwent surgery for symptomatic PB. Thrombosed spleno-portal axis (SPA) was evident in 14 (25.9%) cases, and all of these cases underwent devascularization. Median duration of the surgery was significantly higher in the shunt group (260 min) than the devascularization group (200 min) ( $p < 0.001$ ). However, devascularization surgery was associated with significantly higher median blood loss (455 ml vs. 350 ml). No difference was found in other intra-operative parameters between the two groups.

**Table 2.** Comparison of intra-operative characteristics between two groups

Variable	Shunt	Devascularization	Total	p
Indication of surgery				0.676
Bleed	11	18	29	
Symptomatic hypersplenism (SH)	03	07	10	
Bleed + SH	05	04	09	
Portal biliopathy	01	03	04	
Splenomegaly	00	02	02	
Incision				<0.001
Abdominal	06	28	34	
Thoraco-abdominal (TA)	14	06	20	
Spleen size (cm)	$20.2 \pm 4.1$	$20.5 \pm 4.5$	$20.4 \pm 4.4$	0.844
Splenic vein diameter (mm)	$11.1 \pm 2.75$	$12.5 \pm 5.4$	$11.8 \pm 4.4$	0.371
Spleno-portal axis (SPA)				<0.001
Patent	20	20	40	
Thrombosed	0	14	14	
Spontaneous porto-systemic shunt				0.041
Present	02	12	14	
Absent	18	22	40	
Intra-operative blood transfusion				0.614
Yes	16	29	45	
No	04	05	09	
Pre-operative blood transfusion				0.273
Yes	01	05	06	
No	19	29	48	
Post-operative blood transfusion				0.801
Yes	03	06	09	
No	17	28	45	
Units of peri-operative BT	$1.93 \pm 1.3$	$2.86 \pm 2.9$	$2.49 \pm 2.4$	0.274
Duration of surgery (min) <sup>a</sup>	260 (250-270)	200 (180-208)	210 (196-250)	<0.001
Blood loss (ml) <sup>a</sup>	350 (328-373)	455 (450-480)	445 (353-460)	<0.001

Values are presented as number or mean  $\pm$  standard deviation or median (inter quartile range).

<sup>a</sup>Mann-Whitney U test, SH: Symptomatic hypersplenism, BT: Blood transfusion.

Overall, post-operative morbidity developed in 26 cases (48.1%). However, about two-thirds of these were C-D grade I and II (22 cases), and grade III and IV morbidities were reported in two and one cases, respectively (Table 3). One patient, who underwent surgery after failed endoscopic retrograde cholangiography (ERC) for PB with recurrent cholangitis, died in the post-operative period due to sepsis and multi-organ failure. The commonest morbidity was transient ascites, which developed in twenty-two cases (41%) and resolved through conservative management and pharmacotherapy in all the cases. No cases developed surgical site infection or wound dehiscence. There was no difference in the occurrence and grade of post-operative morbidity or length of hospital stay between the two groups. Liver histology was essentially normal in EHPVO cases while in NCPF, small portal vein branches were obliterated in all cases and nodular hyperplasia was evident in six (66.7%) cases.

Median duration of follow-up was 30 months (range= 24 to 66 months). Symptoms related to hypersplenism were corrected in

all cases (Table 4). There was no reported re-bleeding episode in any of the cases during the follow-up. In 16/19 (84%) cases, a patent shunt was identified on Doppler ultrasonography. Three cases in each group developed symptomatic portal biliopathy during follow-up. Of these, two cases in the shunt group and three cases in the devascularization group presented with features of cholangitis. Two cases in each group required ERC-stenting, and one case in the shunt group underwent Roux-en-Y hepaticojejunostomy two years after the index surgery. We observed no significant change in liver stiffness on transient elastography at one year of follow-up. Mean LS value in NCPF and EHPVO were  $7.97 \pm 1.12$  kPa ( $p= 0.187$ ) and  $4.75 \pm 0.85$  kPa ( $p= 0.477$ ), respectively.

### DISCUSSION

Porto-systemic shunt is the preferred surgical procedure in the management of NCPH. The most commonly performed shunt procedure is the PSRS (1). However, in the absence of shuntable venous anatomy, esophago-gastric devascularization procedures combined with splenectomy are employed (4).

**Table 3.** Comparison of post-operative morbidity between two groups

Variable	Shunt	Devascularization	Total	p
<b>Overall morbidity</b>				0.835
Present	10	16	26	
Absent	10	18	28	
<b>Transient ascites</b>				0.932
Present	08	14	22	
Absent	12	20	32	
<b>Post-operative bleeding<sup>a</sup></b>				1.000
Present	01	03	04	
Absent	19	31	50	
<b>Other morbidity<sup>b a</sup></b>				
Present	01	04	05	0.640
Absent	19	30	49	
<b>Post-operative blood transfusion<sup>a</sup></b>				1.000
Yes	03	06	09	
No	17	28	45	
<b>Clavien-Dindo grade<sup>a</sup></b>				0.606
Grade I	05	07	12	
Grade II	05	05	10	
Grade III	00	02	02	
Grade IV	00	01	01	
Grade V	01	00	01	
Hospital stay (median, days)	7 (5-10)	6 (4-22)	-	0.162
Values are presented as number or median (range)				
<sup>a</sup> Fischer's exact test, <sup>b</sup> Includes pancreatic fistula (2), chest infections (2) and urinary tract infection (1).				

**Table 4.** Comparison of follow-up results between two groups

Variable	Shunt	Devascularization	Total	p
Correction of hypersplenism				-
Yes	16	27	43	
No	0	0	0	
NA	3	7	10	
Rebleeding				-
Yes	0	0	0	
No	19	34	53	
Shunt thrombosis				
Yes	03	NA	-	-
No	16	NA		
Portal biliopathy				0.486
Yes	3	3	6	
No	16	31	47	
Cholangitis				0.885
Yes	2	3	5	
No	17	31	48	
Intervention for portal biliopathy				0.513
Conservative	1	1	2	
ERCP	1	2	3	
Surgery	1	0	1	
Mortality				-
Yes	0	0	0	
No	19	34	53	

Values are presented as number. ERCP: Endoscopic retrograde cholangiopancreatography, NA: Not applicable.

Even though there is ample literature on shunt surgery and selective devascularization, there is a paucity of literature comparing the two procedures. In the present study, we compared the surgical outcome between two main surgical procedures, namely shunt surgery (PSRS) and splenectomy with esophago-gastric devascularization. We demonstrated that the two procedures are safe and comparable for both short-term and long-term outcomes.

NCPH has been described as a disease of children and young adults. The median age of our study population at the time of surgical intervention was 22.0 years (range= 12-64), which is consistent with the previous studies (8-10). Median age of population at the symptom's onset was 16.0 years (range= 4-43). There is a difference of a decade in terms of the onset of symptoms in NCPF as compared to EHPVO, and generally, in EHPVO, symptoms appear in the first and second decade of life, while in NCPF they appear in the third or fourth decade (2,11). Our results were also in line with previous studies. The reported incidence of esophageal varices in EHPVO and NCPF is

80-90% (10-12). In accordance with previous studies, the commonest presentation of NCPH was recurrent variceal bleeding with failed endotherapy (10,11,13). About two-thirds and three-fourths of our cases required blood transfusions and endotherapy, respectively. Median number of endotherapy sessions in our study was 2.43 before undergoing surgery. Both of these conditions are associated with moderate or massive splenomegaly (10). The reported incidence of hypersplenism is comparatively higher in NCPH than cirrhosis of the liver, and it varies from 22% to 80% (14,15). Similar to our findings, most of the cases of hypersplenism are asymptomatic (14). A high incidence of hypersplenism in surgical patients may be explained by the fact that endotherapy does not treat hypersplenism, and such cases are more likely to be referred for surgical intervention. Portal biliopathy occurs in about 80-100% of cases of EHPVO and about 9-40% of cases of NCPF, and the majority of the cases (62-95%) remain asymptomatic (16). No difference was found between the two groups in terms of pre-operative characteristics, including patient demographics, symptomatology, and the presence of comorbidities.

NCPH treatment is primarily focused on the management of acute variceal bleeding and the prevention of rebleeding (secondary prophylaxis). Although endoscopic therapy is the preferred mode of treatment for NCPH, the indications of surgery included failed endotherapy, symptomatic hypersplenism, portal biliopathy, and growth retardation (1). Among these, the primary indication of surgery is a recurrent variceal bleed with failed endoscopic management (17). In accordance with previous studies, recurrent variceal bleeding with failed endotherapy was the most common indication for surgery in our study. Surgeries for symptomatic hypersplenism and portal biliopathy were indicated in 10 (18.5%) and 4 (7.4%) cases, respectively.

There was a difference in the type of incisions between the two groups, as all planned devascularization procedures were performed with abdominal incisions, while PSRS was performed with both abdominal and thoraco-abdominal (TA) approaches, depending upon the surgeon's preferences. The TA approach for devascularization was only used in situations where the plan of surgery was changed intra-operatively with the identification of non-shuntable venous anatomy. Since the cases with thrombosed SPA could not undergo PSRS, it was only present in the devascularization group. In the current study, spontaneous shunts were present in about 26% of the cases, which was higher than a previous study (10). However, other studies reported a non-shuntable venous anatomy due to the occurrence of splenic vein thrombosis in 35% to 69.2% of cases (5,18,19). The reason could be the delayed presentation after the onset of symptoms. There was no difference between the two groups in indications of surgery, splenic size, splenic vein diameter, or the need for peri-operative blood transfusions. Mean duration of surgery was significantly higher in the shunt surgery group (260 vs. 200 minutes), and intra-operative blood loss was significantly higher in the devascularization group (455 vs. 350 ml). Saluja et al. have compared PSRS with splenectomy alone in NCPH patients and reported a higher operative duration (215 vs. 95 min) and higher blood loss (375 vs. 200 ml) in the PSRS group (20). However, meaningful comparisons could not be drawn as the authors did not perform esophago-gastric devascularization along with splenectomy. Das et al. have reported a similar duration of shunt surgery (275.9 min), operative blood loss (365.6 ml), and mean duration of hospital stay (7.35 days) in shunt surgeries (21). Chattopadhyay et al. have compared the outcome of portal biliopathy in NCPH patients between PSRS and splenectomy and devascularization but did not provide intra-operative details (22).

In our study, about 48% of the total cases developed post-operative complications. Post-operative transient ascites was the most common morbidity and was present in 22 (84.6%)

cases, which resulted in higher overall morbidity. Most of the complications were minor, and major complications (C-D grade  $\geq 3$ ) were evident only in four (7.4%) cases. The exact mechanism of post-operative ascites is unknown but a transient rise in portal pressure due to disruption of spontaneous shunts could be the possible mechanism. Das et al. have reported an overall complication rate of 20.8%, with minor complications in the majority of the cases. Pal et al. have reported an operative mortality rate of 0.9%, and 3/114 cases required re-exploration for bleeding complications (21). The median hospital stay in their study was seven days (9). Similarly, in a previous study of 160 PSRS procedures in EHPVO, the authors have reported an elective mortality rate of 0.7% (23). Devascularization procedures were associated with higher post-operative complications owing to combined esophageal transection, including anastomotic leaks and delayed esophageal strictures. However, devascularization without esophageal transection has been found to be equally effective in controlling variceal bleeding but with a reduced rate of post-operative complications (5,7). The development of post-operative ascites in these cases could result in wound dehiscence and incisional hernia formation. The recommended technique of wound closure of elective laparotomies is by a "continuous small-bites suturing technique". In this, delayed absorbable suture materials are used, and bites are taken at only aponeurosis 5-9 mm away from the wound margins and distance from each bite is kept at 5 mm. This technique results in adequate tissue perfusion. Due to lack of quality evidence, European hernia society recommends the utilization of similar principles for non-midline incisions too (24). In our study, we observed no wound dehiscence or incisional hernia formation utilizing this method of abdominal wall closure.

Mesenterico-left portal vein bypass (rex-shunt) is regarded as the most physiological surgical option, but it is mostly feasible in young children, and comparative data with non-selective shunts is still lacking (3). Although, at present, porto-systemic shunts are the preferred surgical intervention in NCPH, devascularization is employed in situations where shunts are not possible owing to unfavorable venous anatomy, inadvertent venous injury, or venous thrombosis. Rebleeding rate after PSRS varies from 0.6% to 11% (9,15,21,23). Rebleeding rates of devascularization have been reported to be somewhat higher in older studies, i.e., 11%-17%; a newer study from India observed no rebleeding after a follow-up of 12-60 months (6,7,25). In our study, no patient in either arm reported a rebleeding episode after a median follow-up of 30 months. These favorable results could be because of meticulous esophago-gastric devascularization, which includes ligation of retrogastric and left gastric veins. An incomplete devascularization is known to increase re-bleeding rates substantially (26). The other reason could be a comparatively



shorter follow-up period, as a median bleed-free period of 45 months has been reported in a previous study (9). Similar to other studies, we observed resolution of hypersplenism in all cases (18,27). We observed one post-operative mortality in a case of EHPVO accompanied by portal biliopathy and recurrent cholangitis because of severe cholangitis, sepsis, and multi-organ failure. Up to 10% of individuals with PB may die because of various complications (2).

The shunt patency rate in EHPVO varies from 84% to 98% in different studies (14,15,21). However, a recent study from India questioned the long-term patency of shunts and reported a patency rate of 60% between one and five years after the procedure and observed a higher shunt patency in cases of NCPF (28). There are variable results of shunt obliteration in NCPF. Saluja et al. reported a shunt block in 6.25% of cases, while in another study from India, it was 25% (20,28). We observed patent shunts in 17/20 (85%) cases using clinical and doppler ultrasonography. We did not encounter any cases of encephalopathy in the follow-up period. Moreover, conditions specifically defined for NCPF after shunt surgery (myelopathy, encephalopathy, and nephropathy) were not observed in our study. Saluja et al. found hepatic encephalopathy in 12.5% of NCPF cases that underwent shunt surgery (20). Similarly, Pal et al. have reported a 13% incidence of post-shunt encephalopathy, and 9.7% of cases in their series developed post-shunt nephropathy (29). The authors have found shunt surgery effective in terms of variceal bleed control but questioned the feasibility of shunt surgery in NCPF due to its high long-term morbidity (45%) (29). We did not observe any of these complications, probably due to the selection of shunt surgery in very few NCPF cases and comparatively shorter duration of follow-up.

Chattopadhyay et al. have compared the outcomes of shunt surgery and devascularization in NCPH-associated portal biliopathy and found equal efficacy of both procedures in relieving PB (22). We also observed similar findings in our study. Shunt surgeries are known to decrease the portal pressure by diverting the portal blood and, hence, alleviate the symptoms of portal biliopathy. However, there are studies that have shown a reduction of portal blood flow by splenectomy in liver transplant cases (30). This was also observed in another study concerning NCPF, in which the authors found regression of varices after splenectomy alone in NCPF-associated PB (20). Therefore, splenectomy with devascularization is effective in relieving PB in NCPH and may be opted for in cases where shunt surgery is not possible. Six cases in the follow-up period developed PB (three in each group), and most of these cases responded to conservative (2) or ERC-stenting (3). One patient in the shunt group had recurrent cholangitis despite ERC intervention, was diagnosed

as having biliary stricture, and required Roux-en-Y hepaticojejunostomy two years after the index surgery. Portal cavernoma of long duration exerts ischemic changes in bile ducts, resulting in biliary strictures that are not amenable to endoscopic therapy and often require surgical biliary bypass (31).

The role of liver biopsy is limited in the diagnosis of EHPVO and is only indicated when there is suspicion of chronic liver disease (1,32). However, in NCPF, it is required to rule out underlying cirrhosis and differentiate it from other causes of cirrhosis (1). An intraoperative liver biopsy is also recommended for documenting baseline liver histology for follow-up. Liver histology usually remains normal in patients with EHPVO (1). In accordance with the previous studies, an obliterative sclerosis of medium caliber portal vein branches was present in all cases, and there was no evidence of liver cirrhosis in NCPF (10). Transient elastography has emerged as a promising tool to differentiate NCPF from other causes of portal hypertension (33). A previous study from Spain has reported a significantly lower mean liver stiffness value in NCPF/IPH than cirrhosis but higher than in EHPVO (33). Similar findings have also been reported by another study from India (34). We also found a higher mean LS value in NCPF than EHPVO. A stable LS value at the one-year follow-up in our study also indicates that liver parenchyma is not involved in the pathogenesis of NCPH.

There are certain limitations to our study. Firstly, it is a retrospective and single-center study with an inherent risk of referral bias. Secondly, devascularization was carried out only in cases in which shunt surgery was not possible, and many of these cases had thrombosed SPA. The results should be interpreted cautiously, especially with regards to portal biliopathy, as devascularization may augment PB in cases with patent SPA. Lastly, we did not evaluate minimal hepatic encephalopathy. Nevertheless, this is the first study to compare the surgical outcomes between these two procedures on an elective basis. Most of the previous studies either performed a very small number of devascularization procedures in comparison to shunt surgeries or carried out them in emergency settings. Therefore, meaningful comparisons are difficult to interpret based on the findings of those studies.

In conclusion, both proximal spleno-renal shunt and devascularization procedures have comparable short-term and long-term outcomes in the management of non-cirrhotic portal hypertension. Although shunt surgery remains the preferred procedure when surgery is indicated, devascularization procedure is reasonably safe and should be performed when shunt surgery is not possible for various reasons.

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### ORJİNAL ÇALIŞMA-ÖZET

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## Sirotik olmayan portal hipertansiyonda şant cerrahisi ile devaskularizasyon arasındaki cerrahi sonuçların karşılaştırılması

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### ÖZET

**Giriş ve Amaç:** Sirotik olmayan portal hipertansiyon (NCPH), gelişmekte olan ülkelerdeki çocuk ve ergenlerde portal hipertansiyon ve üst gastrointestinal kanamanın en yaygın nedenidir. Karaciğer fonksiyonu korunmuş portal hipertansiyon özellikleri ile karakterizedir. Proksimal splenorenal şant (PSRS) ve özofagogastrik devaskularizasyon, bu durumun tedavisinde en sık kullanılan cerrahi tedavi yöntemleridir. Bu çalışma, bu iki prosedür arasındaki cerrahi sonuçların karşılaştırılmasını amaçlamaktadır.

**Gereç ve Yöntem:** Nisan 2018 - Mart 2022 tarihleri arasında cerrahi girişim uygulanan ardışık NCPH olgularının prospektif olarak tutulan verileri retrospektif olarak incelendi. Olgular şant cerrahisi ve devaskularizasyon olmak üzere iki gruba ayrıldı. Gruplar arasında ameliyat öncesi özellikler, peri-operatif morbidite ve uzun vadeli sonuçlar karşılaştırıldı.

**Bulgular:** Çalışma süresi boyunca tedavi edilen 112 olgudan cerrahi uygulanan 54 olgu çalışmaya dahil edildi. Bunlardan 20 olguya PSRS, 34 olguya splenektomi ve devaskularizasyon uygulandı. İki grup arasında ameliyat öncesi değişkenler açısından fark yoktu. Proksimal splenorenal şant uygulanan hastalarda daha uzun ameliyat süresi (260'a karşı 200 dakika,  $p < 0,001$ ) ve devaskularizasyon grubundakilerde anlamlı olarak daha fazla ameliyat kan kaybı (350'ye karşı 455 ml,  $p < 0,001$ ) yaşandı. Ameliyat sonrası morbidite iki grup arasında karşılaştırılabilir düzeydeydi. Hipersplenizm tüm olgularda düzeltildi ve 30 aylık medyan takip sonrasında hiçbir olguda tekrarlayan kanama bildirilmedi. Her iki gruptaki üç olguda takip döneminde portal biliyopati özellikleri gelişti.

**Sonuç:** Hem PSRS hem de devaskularizasyon prosedürleri NCPH tedavisinde karşılaştırılabilir etkinlik ve güvenliğe sahiptir.

**Anahtar Kelimeler:** Sirotik olmayan portal hipertansiyon, ekstrahepatik portal venöz obstrüksiyon, sirotik olmayan portal fibrozis, proksimal spleno-renal şant, devaskularizasyon

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