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A Modification of the Warren Shunt

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A technical modification of the Warren distal splenorenal shunt is described. A segment of internal jugular vein is utilized to connect the distal splenic vein to the renal vein. This technical modification results in significant reduction in operating time and intraoperative blood loss and is technically easier to perform. These benefits accrue primarily by avoiding extensive mobilization of the splenic vein, a step otherwise necessary in performing the original Warren shunt. The modified shunt was successfully carried out in 10 patients. There was a single in-hospital death following the procedure. In a follow-up period ranging from 3 months to 5 years and 6 months, shunt patency was demonstrated to be excellent.

The distal splenorenal shunt was first described by Warren and colleagues in 1967 [1]. The operation was designed to decompress esophageal varices selectively without reduction of the portal vein flow, which was expected to result in better long-term survival. While this expectation does not appear to have been borne out with certainty [2–7], the Warren shunt has been shown to have other important advantages [1, 5, 8, 9] over portacaval shunts, chief of which is the lower incidence of postoperative encephalopathy [2–6, 10]. Better protein tolerance releases the patient from stringent food restrictions often required after performance of conventional shunts and the quality of postoperative life enjoyed by the patient is substantially better. Despite definite advantages, enthusiasm for the Warren shunt has tended to wane recently [11–20]. The major objection is that it is a technically formidable procedure not suited for the surgeon who performs an occasional shunt. It is best done in large referral centers that perform portal hypertension surgery in volume. Even in such centers, the surgical mortality rate of this procedure when initially performed [1, 3] has tended to be high, a reflection of the technical difficulties encountered during a surgeon's first experience with this procedure. The major technical difficulty centers around the numerous pancreatic branches of the splenic vein (Fig. 1). In the process of mobilizing the splenic vein in preparation for its anastomosis with the renal vein, the thin-walled stubby pancreatic branches are easily torn, resulting in considerable blood loss. Mobilization of the 3 inches or so of splenic vein, with painstaking ligation of the pancreatic branches, in fact, comprises the major time-consuming portion in the performance of the Warren shunt.

A technical modification of the Warren shunt utilizing a segment of internal jugular vein to connect the distal splenic vein with the renal vein is described below. This modification results in the elimination of extensive mobilization of the splenic vein and is relatively simple to perform. As a result, operating time and intraoperative blood loss are markedly reduced.

Technique

The patient is placed supine on the table with head turned slightly to one side. The exposed side of the neck and the abdomen are prepared and appropriately draped. The abdominal procedure is started first. A variety of incisions from midline to transverse can be utilized, but we have generally preferred a modified left subcostal incision (Fig. 2). The incision is placed 4 finger breadths below the left costal margin, somewhat lower than the classical Kocher incision. The medial portion of the incision is extended across the midline to meet the opposite costal margin. On entering the abdomen, the portal pressure is measured through one of the larger omental or mesenteric veins. This step may

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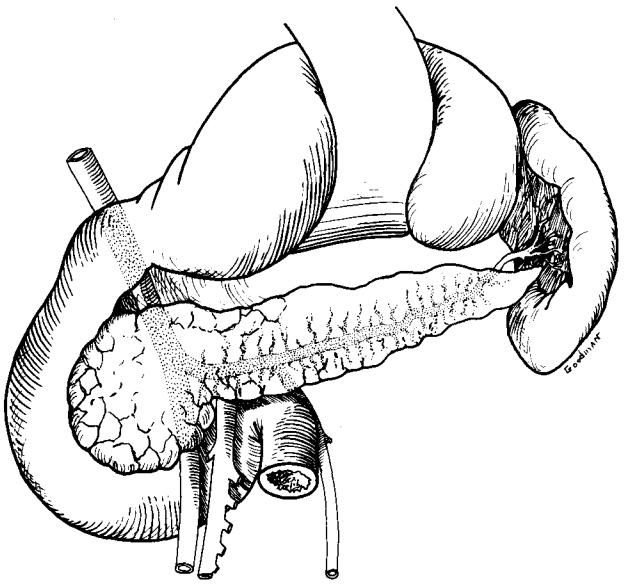

Fig. 1. The splenic vein has numerous pancreatic branches which are short and stubby. These may be easily torn during mobilization of splenic vein for the performance of a Warren shunt.

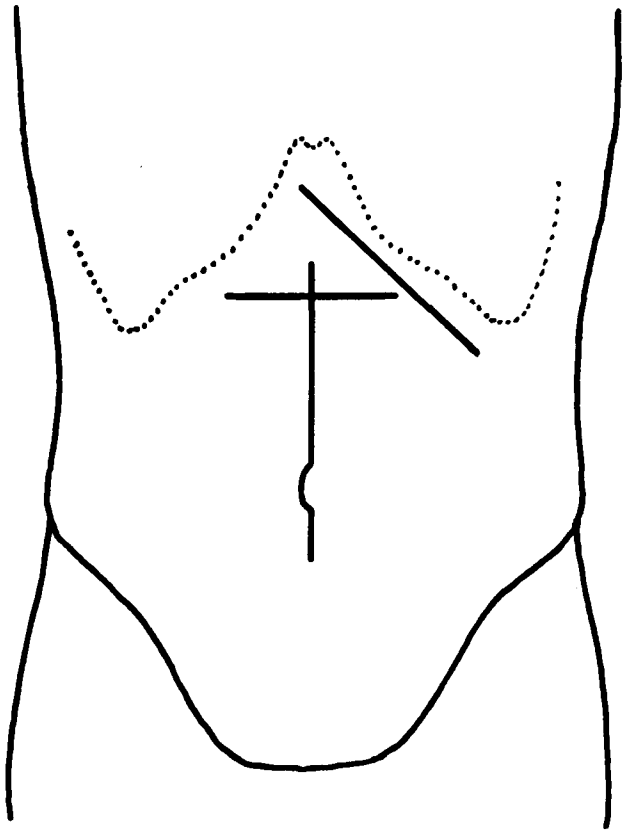

Fig. 2. Either a subcostal or a midline incision is satisfactory for performance of the modified technique. A transverse incision may also be utilized.

be omitted if incontrovertible proof of portal hypertension was obtained preoperatively by measurement of hepatic wedge pressure. The lesser sac is entered through the gastrocolic omentum and dissection is started at the junction of the transverse mesocolon and the posterior peritoneum covering the pancreatic body. A 2-inch long incision in this area will allow adequate exposure of the splenic vein by gentle elevation of the lower edge of the pancreas. This incision should be placed as far to the right as possible so as to reach the splenic vein at its junction with the superior mesenteric vein. An incision placed between the inferior mesenteric vein on the left and the superior mesenteric artery to the right is usually satisfactory (Fig. 3). If dissection is carried out in the correct plane, a fibrous adventitial sheath will be found to cover the splenic vein and bind it to the lower edge of the pancreas (Fig. 4). This sheath is carefully preserved, for it is useful in the subsequent anastomotic procedure. The splenic vein, however, is balloted through this sheath to assure the operator of its patency and adequacy of size for the procedure. This having been done, attention is turned to the left renal vein.

The left renal vein is approached from the infracolic compartment, with the transverse colon and mesentery retracted away. The ligament of Treitz is divided and the resulting opening in the posterior peritoneum extended between the duodenum and the inferior mesenteric vein to expose the aorta (Fig. 5). The surgeon will easily find the left renal vein by tracing the aorta in the cephalad direction with careful dissection of the overlying fibro-fatty tissue. This method of approaching the renal vein ensures its exposure well away from the renal hilum where a number of tributaries enter it. Dissection of the renal vein too close to the hilum will invariably result in unnecessary blood loss due to invasion of one or more of these tributaries. Having identified the left renal vein, an adequate tunnel to the previously identified splenic vein is made via the root of the transverse mesocolon. The renal vein pressure may now be measured and should be less than 12 mm Hg for a satisfactory distal splenorenal anastomosis. As soon as the suitability of the splenic and renal veins for the anastomosis is apparent, a cervical incision (Fig. 6) to harvest the internal jugular vein is started, while the abdominal dissection is still progressing. The cervical incision is approximately $2\frac{1}{2}$ inches in length along the anterior border of the sternocleidomastoid in the middle third of the neck. A longer incision is cosmetically poor and unnecessary, since extensive exposure of the neck structures can be obtained even through a small incision by appropriate retraction. The internal jugular vein is most readily identified at the root of the neck where it consistently lies between the 2 heads of the sternocleidomastoid. Once identified here, it is easily dissected in a cephalad direction

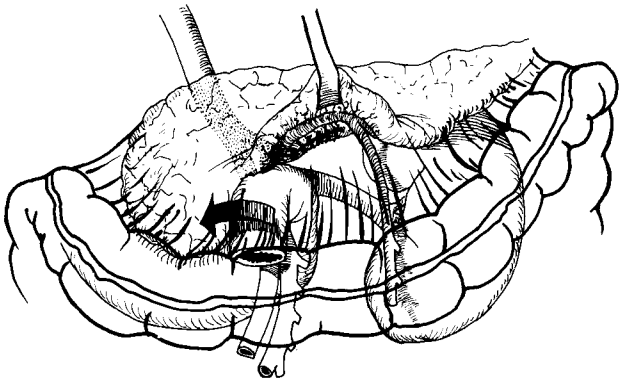

Fig. 3. The splenic vein is approached through an incision placed between the inferior mesenteric vein and the superior mesenteric artery.

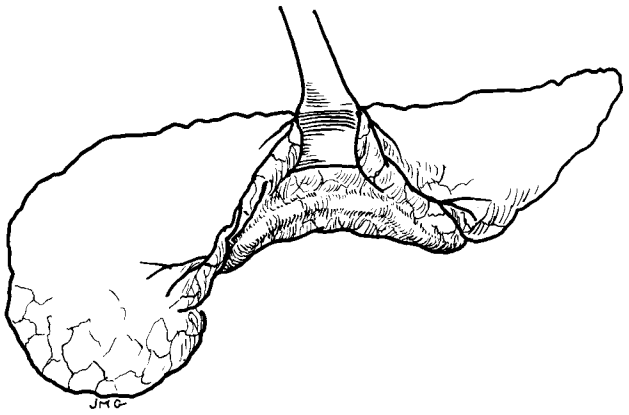

Fig. 4. Dissection in the correct plane will reveal a splenic vein covered by a fibrous sheath. The vein can be balloted through the sheath to assure patency. The sheath should be preserved for incorporation in the suture line.

since there are few branches entering this vein until the level of the thyroid cartilage is reached. A large facial vein which enters the internal jugular vein in this area may be ligated and divided. Since the lumen of the internal jugular vein begins to narrow cephalad to the entry of the facial vein, further dissection is usually unrewarding and unnecessary. The internal jugular vein is now ligated about 1 cm cephalad to the entry point of the facial vein and again at the root of the neck and harvested. This usually yields an internal jugular vein of more than adequate length (approximately 3 inches) for performance of the splenorenal anastomosis.

There are significant technical advantages and also a reduction of blood loss if the anastomosis between the jugular vein and the renal vein is carried out first, with the splenic vein anastomosis being performed later (see discussion). We have recently used systemic heparinization (10,000 units intravenously) during performance of these anastomoses to reduce in situ clotting in the splenic vein which had been encountered a number of times in

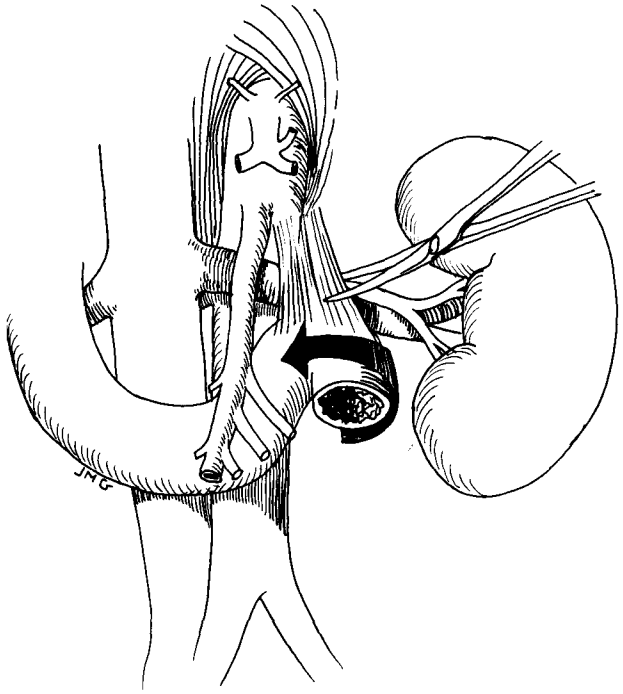

Fig. 5. The renal vein is best approached by dividing the ligament of Treitz and following the aorta in a cephalad direction.

earlier cases. Heparin is later reversed with protamine. Increased blood loss by heparinization, if any, has not been significant.

A partial occlusion clamp is placed across the renal vein to exclude a portion an inch or so in length. The venotomy in the renal vein should be approximately 15 mm long. An everting anastomosis between the larger end of the internal jugular vein and the renal vein is carried out. Prolene® sutures (5-0) are preferred; however, when this suture material is used, the final knot should be tied with the vein in the distended position to prevent constriction of the anastomosis (Fig. 7). The other end of the internal jugular vein is passed through the opening in the root of the transverse mesocolon and is trimmed to appropriate length. The fibrous adventitial covering of the splenic vein is now incised cleanly with a sharp knife, exposing the splenic vein. A partial occlusion clamp can now be placed across the splenic vein and sheath (Fig. 8); a venotomy approximately 15 mm in length is created. As the splenic vein is frequently thin-walled and friable, the incised adventitia should be included in the suture line to provide for strength and improved hemostasis. The posterior suture line between the jugular vein and splenic vein must be placed from inside. The sutures (5-0 Prolene®) are placed in a loose manner and later pulled tight to result in an everted anastomosis. After completion of the anterior suture line, the final knot should be placed with

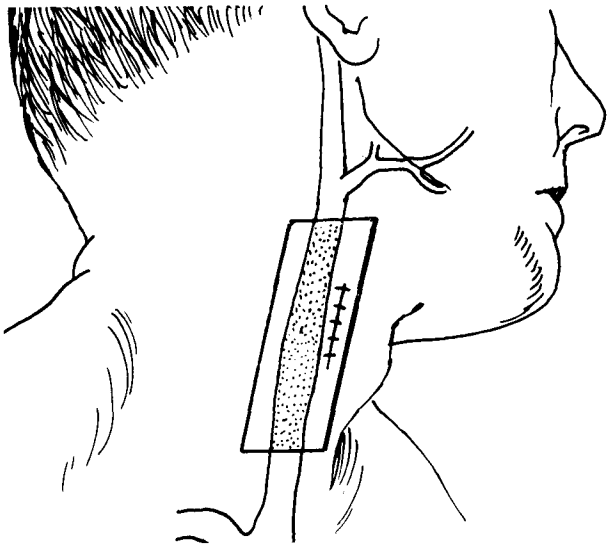

Fig. 6. A surprisingly large segment of internal jugular vein can be harvested through a relatively short cervical incision.

the anastomosis distended to prevent a purse-string effect. A 0 silk ligature is placed around the splenic vein on the hepatic side of the anastomosis with the help of a slim-bladed right-angle clamp. Inadvertent perforation of one of the deep pancreatic branches of the splenic vein should be avoided during this maneuver. A blunt-tipped liver needle was found to be admirably suited to go around the splenic vein without injuring the pancreatic branches. The ligature should be placed as close to the anastomosis as possible to prevent the formation of a blind pouch (Fig. 9). The usual series of pressure measurements may be recorded, including free portal pressure, occluded distal splenic vein pressure, and distal splenic vein pressure with the anastomosis open.

Ligation of the coronary vein and the right gastroepiploic vein to effect a porta-azygos disconnection as described by Warren completes the surgical procedure. Proper identification of the coronary vein is particularly important. The right gastric vein running along with its companion artery in the lesser omentum is often mistaken for the coronary vein by the unwary. The coronary vein is found in a deeper plane adjacent to the portal vein where it is more easily balloted than seen (Fig. 10).

The entire procedure can be performed in about 3 hours with an average blood loss of less than 1,200 ml.

Results

A total of 10 patients have undergone the modified technique since 1975. The single in-hospital death occurred in a patient in whom an emergency shunt

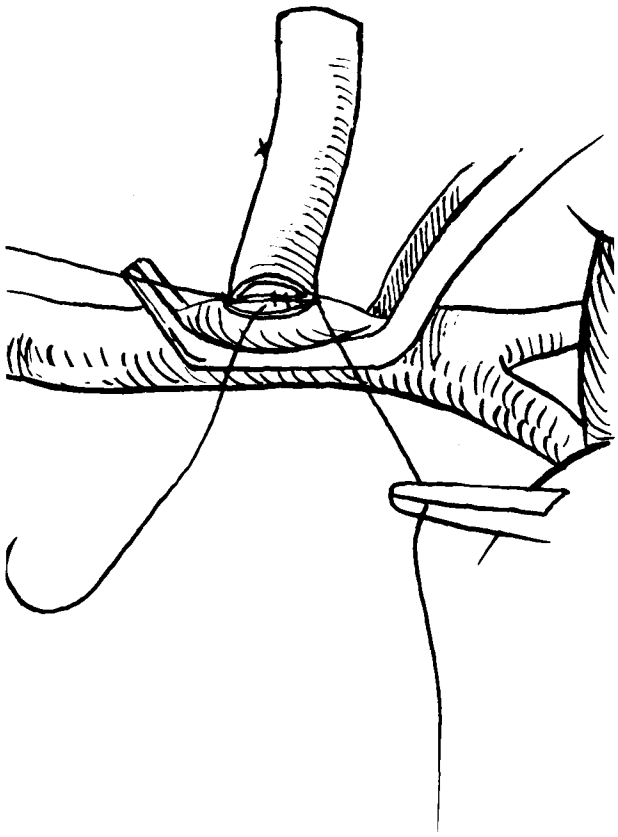

Fig. 7. The renal vein anastomosis is performed first. "Purse-stringing" effect should be avoided.

was performed for continued massive bleeding which was not responsive to the usual conventional methods including intra-arterial Pitressin®. At autopsy on the 19th postoperative day, massive liver necrosis was found. The shunt, however, was patent. The remaining 9 patients underwent the procedure on a semi-elective basis after the bleeding had been successfully controlled by conservative measures. There were no operative deaths in this group. Seven of these 9 patients have undergone postoperative angiography, and all but 1 were shown to have open shunts at periods ranging from 1 month to 5 years and 6 months postoperatively. We suspect that the single occluded shunt occurred intraoperatively as a result of in situ clotting within the splenic vein during the anastomotic procedure. Subsequently, intraoperative heparinization has been utilized in all patients as noted above. There have been 3 deaths in the follow-up period (Table 1), not an unsurprising finding in alcoholic cirrhosis [7].

Discussion

The distal splenorenal shunt as described by Warren and others is a time-consuming and technically

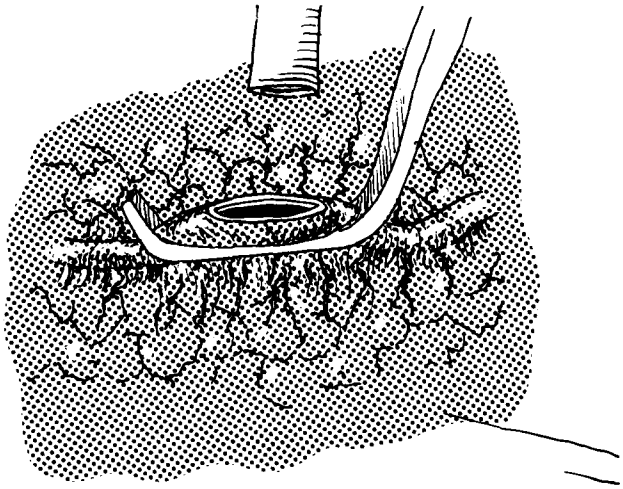

Fig. 8. A partial occlusion clamp can be placed across the splenic vein and the encompassing fibrous sheath without dissecting the posterior aspect of the vein.

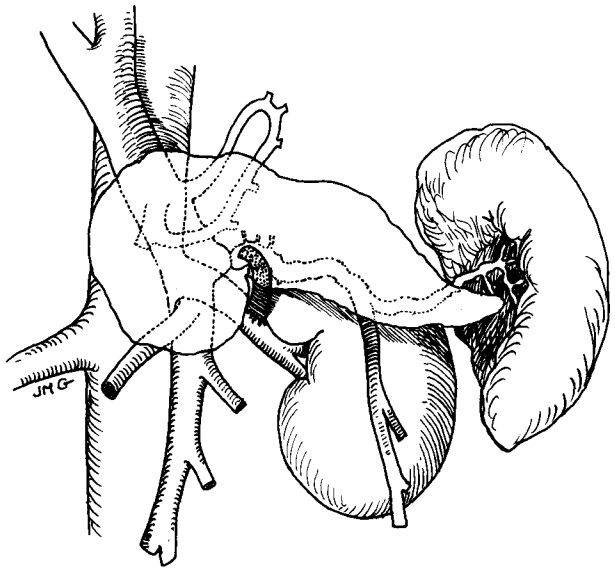

Fig. 9. Completed modified Warren shunt. A blind pouch of the splenic vein both proximal and distal to the ligature should be avoided.

difficult procedure [1–3, 12, 14] not easily mastered by the surgeon performing an occasional shunt. The major difficulty centers around the numerous pancreatic branches of the splenic vein which tether this structure to the body of the pancreas. These branches are frequently short and thin-walled. In the process of mobilizing the splenic vein, some of these pancreatic branches, especially those arising from the deep surface of the splenic vein, are easily torn, leading to considerable blood loss. Approximately 3 inches of the splenic vein has to be mobilized for performance of a distal splenorenal Warren shunt without tension. This extensive mobilization of the splenic vein is, in fact, the major

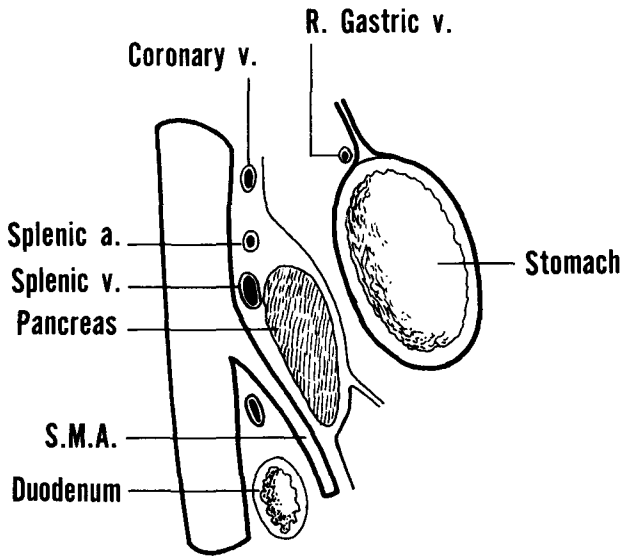

Fig. 10. The coronary vein is in a deep plane in the retroperitoneum. The right gastric vein which is more superficial should not be mistaken for the coronary vein.

time-consuming portion of the procedure and also the major source of blood loss. An additional technical difficulty in performance of the Warren shunt is the fact that the splenic vein may have to be divided at its junction with the portal vein prior to distal mobilization. The occluded distal splenic vein pressure is in the range of 60–80 mm Hg in the majority of patients undergoing the Warren shunt. This tremendous pressure in the venous system, approaching arterial pressure levels, only serves to aggravate the bleeding from inadvertently torn pancreatic branches of the splenic vein. The modification described here avoids these difficulties by eliminating the need for extensive mobilization of the splenic vein. Only an inch of splenic vein needs to be cleared and only anteriorly for the performance of the modified technique; the deep aspect of the splenic vein can be left undisturbed since a partial occlusion clamp applied to the anterolateral surface of the vein is satisfactory for performance of the modification. Operating time and blood loss are considerably reduced.

Several steps in the modified technique deserve emphasis. The renal anastomosis should be performed first. This difficult anastomosis, often carried out in the depths of the wound, is somewhat easier when the other end of the jugular vein is free. The vein can be pivoted freely for placement of both the anterior and posterior suture lines from outside. When the splenic vein anastomosis is done first, the posterior suture line of the renal vein anastomosis has to be performed from inside and cannot be inspected easily for hemostasis after completion. Also, when the splenic vein anastomo-

Table 1. Modified Warren Shunt. Data on 10 patients on whom the modified Warren shunt was performed.

Patient	Diagnosis	Follow-up Period	Status of shunt on arteriogram	Remarks
J.H.	Alcoholic cirrhosis	3 months	Open at 1 month	Asymptomatic; shunt presumed open
G.F.	Alcoholic cirrhosis	9 months	Open at 1 month	
B.H.	Alcoholic cirrhosis	1 year, 9 months	Arteriogram not performed	
M.S.	Nonalcoholic cirrhosis	2 years, 3 months	Open at 3 months	No bleeding until death from "coma"
J.C.	Alcoholic cirrhosis	3 years	Open at 1 year	
A.F.	Alcoholic cirrhosis	3 years, 9 months	Arteriogram not performed	Cardiopulmonary death at 5 years, 6 months following surgery for gastritis bleeding; shunt open at surgery
T.C.	Alcoholic cirrhosis	5 years, 6 months	Open at 5 years, 6 months	Died in hepatic coma
J.Ca.	Alcoholic cirrhosis	9 months	Occluded at 8 months	Died 17th postoperative day because of massive liver necrosis
R.R.	Alcoholic cirrhosis	19 days	Shunt open at autopsy	Distal end of shunt was sewn to vena cava rather than renal vein because of anatomical variation
R.S.	Alcoholic cirrhosis	3 months	Shunt open at 1 month	

sis is done first, it has been our experience that retraction and inadvertent manipulation of the splenic vein anastomosis often occurs while the renal vein anastomosis is being performed in the depths of the wound. This often results in a disturbance of the hemostasis of the splenic vein anastomosis, leading to avoidable blood loss and time delay. Special care should be taken in preserving the adventitious sheath envelope surrounding the splenic vein. Incorporation of this sheath in the suture line permits a more secure anastomosis. We prefer 5-0 Prolene® for the vascular anastomoses because of its "slick" nature. Tension is uniformly distributed throughout the anastomosis and the sutures can be pulled tight at the end even when loosely placed initially for technical ease. These same qualities of this suture material will result in purse-stringing of the anastomsis unless care is taken to secure the knots with the anastomoses distended (Fig. 7).

Recent long-term survival data indicate that there is no clearly significant advantage for the Warren shunt over more conventional shunts [2–7]. While this is disappointing in view of the original expectation for this procedure [1], an important finding has been the low incidence of portal encephalopathy after the Warren shunt. Encephalopathy is a significant source of morbidity after conventional portosystemic shunts and confines the patient to a rigorous diet. The patient undergoing a Warren shunt or our modification can be relatively free of this constraint. This advantage alone, in our view, makes the Warren type of shunt a superior choice for portal decompression. The Warren shunt as originally described is not an acceptable emergency procedure [12], since it is time-consuming and attended with significant intraoperative blood loss. While the need for emergency shunts has declined in recent years because of more efficient medical management of bleeding varices, our modification of the Warren shunt should be useful as an emergency procedure when required. Several other constraints that apply to the performance of the Warren shunt, however, would also apply to our modification. It should not be used in the presence of marked ascites [1]. Likewise, its use in the presence of significant hypersplenism is questionable even though favorable short-term results have been reported with the Warren shunt in a small group of patients [21].

Both Dacron® and autogenous internal jugular vein have been used in the portal venous system [11, 13, 14, 18, 22]. Even though the use of prosthetic shunt is more convenient than autogenous vein, the latter is expected to perform better in the portal venous system because of its low thrombogenicity. In fact, a recent careful study [22] indicates that a quarter of prosthetic interposition shunts occlude within a relatively short period of time in the portal system.

Résumé

Une modification technique de l'opération de Warren est décrite. Elle consiste à interposer un seg-

ment de la veine jugulaire interne entre la veine splénique et la veine rénale. Le procédé réduit la difficulté de l'intervention, sa durée et la perte de sang. Il évite en effet la mobilisation étendue de la veine splénique, étape délicate de l'opération de Warren.

L'interposition veineuse a été pratiquée chez 10 opérés, 1 est mort au décours de l'opération. Chez les survivants suivis de 3 mois à 5 ans et 6 mois la perméabilité de l'anastomose est restée excellente.

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Invited Commentary

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The use of an interposition H-graft in construction of a selective distal splenorenal (Warren) shunt as recommended by Dr. Seshadri Raju is a useful variation, one that we have performed in the Emory University portal hypertension experience on 7 patients over the last 10 years. This technical modification preserves the essential elements of the operation as described originally by Warren, Zeppa and Fomon, while providing an alternative method for connection of the splenic vein to the left renal vein [1]. We have seldom resorted to this modification in more than 350 selective distal splenorenal shunts, as a sufficient length of splenic vein usually can be mobilized with little difficulty. In certain circumstances, however, it is very convenient to

have an alternative to the direct vein-to-vein anastomosis [2]. These infrequent, technically difficult situations include patients with an intrapancreatic splenic vein; those with peripancreatic fibrosis due to previous episodes of pancreatitis; and those in whom an operative injury occurs to the splenic vein, rendering it too short to reach the renal vein without an interposed graft. We have used both PTFE grafts and autogenous internal jugular vein with equal success for this purpose [3]. Dacron prostheses, however, should not be used in the portal system except in very unusual circumstances, because of the high late occlusion rate with this material [4].

The customary distal splenorenal shunt procedure performed by members of the Emory group differs from the technique recommended by the author in a number of other features. We seldom find it necessary to move inferior to the transverse mesocolon to approach the left renal vein; usually, this vessel can be exposed readily by proceeding directly posteriorly through the retroperitoneal tissues just caudad to the inferior border of the pancreas. We have resorted to the infracolic approach described by Dr. Raju occasionally in obese patients or in those with previous upper abdominal surgery. His admonition to the surgeon to stay central in dissection of the renal vein is well taken, as it reduces the likelihood of unnecessary bleeding from hilar venous branches. We recommend, in addition, excision of an ellipse of renal vein wall to assure that the anastomosis will stand fully open when completed. Systemic heparinization has not been necessary in our experience with portal decompression procedures, but it is advisable to allow the occluded splenic vein to flush just prior to completion of the anastomosis. Dr. Raju's concern with the possibility of pursestringing the continuous prolene suture is a very real consideration in venous anastomoses, but it can be readily avoided by using an interrupted suture technique on the front row of each suture line.

We are pleased to see that the author advocates completion of the portal-azygos disconnection by ligation of the coronary vein and the right gastroepiploic vein, steps that are felt to be vitally important to the correct performance of the Warren operation. Not mentioned specifically by the author, but probably of equal importance, is ligation of the umbilical vein and of the inferior mesenteric vein if the latter joins the splenic vein directly. We share his disdain for emergency shunting procedures in general, but do not hesitate to perform a selective distal splenorenal shunt in the emergency situation if the other factors of selection are appropriate. Just as he describes, medically intractable ascites is a contraindication to performance of the Warren shunt in our institution; but contrary to his suggestion, hypersplenism is in no way an impediment to the preferred operation.

The author is to be congratulated on his low operative mortality and shunt occlusion rate. A final point in criticism of the paper must be offered, however, in regard to the late patency confirmation. Dr. Raju rightly emphasizes the importance of angiography to confirm late patency, but then describes only 1 patient among 8 at risk who had angiographic confirmation of a patent shunt more than 1 year after the operation. In our experience with Dacron interposition shunts at Emory, the mean occlusion was at 20 months following operation [4]. A number of those late closures were discovered on routine angiographic studies in patients with no clinical evidence of shunt failure. We submit, therefore, that any innovation in portal decompression techniques should be followed for a minimum of 2 years and that late angiography should be an important element of the functional assessment of each new operation.

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