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Original Article

Partial Splenic Artery Embolization with Polyvinyl Alcohol – Single Centre Experience

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Abstract

Introduction: Splenic arterial embolization is often performed for hypersplenism, portal hypertension in liver transplant recipients, and in neoplastic disease in the splenic parenchyma. Partial splenic artery embolization retains function of spleen as well as improves hematological parameters with significantly reduced complications, both in intensity and frequency as compared to complete embolization or splenectomy. Polyvinyl alcohol (PVA) is most commonly used agent for splenic artery embolization (SAE). In this study represent a detailed analysis of partial splenic artery embolization, rate of complications, and outcome patients of hypersplenism.

Purpose: The purpose of the study was to analysis of the hematologic response and outcome of partial splenic embolization with PVA in patients with hypersplenism.

Materials and Methods: Our study included all the patients presenting with complaints of hypersplenism without any contraindications. All the patients underwent routine serological and hematological investigations ultrasound of abdomen and upper tract computed tomography (CT) scan of abdomen for diagnosis, documentation of splenomegaly and as a guide to vascular anatomy, 3D orientation, and evaluation of etiologies. Procedure was performed through trans-femoral route, with eventual placement of a 5F sheath. Angiogram was performed to evaluate the splenic arterial branches and with micro catheter system selective embolization was performed. We typically use 500–700 μ particles suspended in contrast medium and embolized 40–80% of the spleen volume. Patients were followed up in clinic after 1 week and 6 months of procedure with complete blood count, ultrasound, and contrast CT examinations.

Results: We found significant increase in hemoglobin and platelet counts with reduction in spleen size without any recurrence of symptoms in 6 months follow-up period.

Conclusion: Partial SAE should be used as first-line treatment for hypersplenism as it satisfactorily raised blood counts, and preserved splenic function with fewer and milder complications. It is also cost effective and reserves the option of complete embolization or surgery as next alternative.

Key words: Hypersplenism, Platelets, Polyvinyl alcohol, Splenic artery embolization

INTRODUCTION

Splenic arterial interventions are increasingly used to treat various medical disorders and, when clinically appropriate, may be substituted for surgery. For example, embolization is often performed to treat post-traumatic splenic injuries and to improve hematologic parameters in patients with hypersplenism. Further, embolization may be performed to reduce portal pressure and prevent sequelae in patients with portal hypertension, to treat splenic artery steal syndrome and improve liver perfusion in liver transplant recipients, and to manage neoplastic disease in the splenic parenchyma. Hypersplenism related pancytopenia is a well-known phenomenon with various causes, the most common being portal hypertension due to cirrhosis.[11] An increase in platelet sequestration and destruction, however, renders platelet transfusion a temporary and impractical solution for patients with hypersplenism. Partial

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splenic embolization (PSE) has been used to treat patients with hypersplenism for more than 20 years. Although the efficacy of PSE for relieving pancytopenia is well-established, a review of the literature showed polyvinyl alcohol (PVA) as an optimal embolic agent. Here, we are describing our experience and analysis of the hematologic response and outcome of PSE in patients who presented to us with hypersplenism.

MATERIALS AND METHODS

All the patients referred to the Department of Radiodiagnosis, Pt. J.N.M. Medical College Raipur with different clinical complaints and signs of hypersplenism were included for the study. Toshiba Aplio MX ultrasound was used as first line tool for documenting splenomegaly along with hematological parameters for hypersplenism and then a pre-procedure contrast computed tomography (CT) abdomen with CT—Siemens Somatom Definition AS+ 128 slice CT system was performed as a baseline to compare with post-op procedure status. CT also served as a guide to vascular anatomy, 3D orientation, and also for additional pathologies. Procedure was performed in GE Innova 4100, using5F C1 Cobra catheter (assembled in Mexico Cordis Corporation Miami lakes Florida USA), 0.35 guide wire and PROGREAT microcatheter (Terumo Corporation Tokyo, Japan), and PVA particles (PVA 300 and 500) (Cook Medical Inc., Bloomington, IL, USA). Our study duration was from January 2016 to January 2020.

Our protocol included detailed clinical and laboratory work up for the patient. All the patients underwent ultrasound examination and contrast-enhanced CT scan of abdomen for diagnosis, documentation of splenomegaly and as a guide to vascular anatomy, 3D orientation and also for additional pathologies. These also served as baseline parameter for further comparison of the post procedural outcome. Our pre-procedural protocol included pre administration of broad-spectrum antibiotics 8–12 h before the procedure and for up to 2 weeks post-procedure depending on patient symptoms. Pyrexia or systemic infections are contraindications given the increased risk of post procedural abscess. Vaccination before the procedure was not included in protocol as we embolized partial splenic parenchyma. Vaccine affordability was also a limiting factor for many of the patients.

Procedure was performed through trans-femoral route, common femoral artery access was obtained by palpation of femoral artery with eventual placement of a 5F sheath into the femoral artery. A cobra (C1) catheter, or rarely a reverse curve catheter, was routinely used to select the celiac axis with an initial angiogram performed to evaluate the splenic arterial branches as well as the location of pancreatic branches. Depending on vascular anatomy, a microcatheter system was used to select the distal main splenic artery or splenic artery branches for embolization, with post embolization angiograms completed from the base catheter. We typically use 500–700 micron particles suspended in contrast medium and embolized 40–80% of the spleen volume.[32,33]

Post-procedure, routine groin access precautions were taken and adequate analgesia and antipyretics were administered. Routine hospital stays for 48 h, with the patients following up in clinic 1 week post-procedure and after 6 months. Complete blood count was again recorded at 1 week and 6 months after procedure. We also performed a post-procedure contrast CT abdomen on 7th day along with an ultrasound of abdomen 6 months after the procedure.

RESULTS

Total of 50 patients were taken with an M: F ratio of 9:16. The selection of the patient fit for partial splenic artery embolization (SAE) was done on the basis of ultrasound, clinical features and laboratory parameters. Embolizing agent was PVA selected on the basis of efficiency, availability, affordability, and review of available literatures. Following results can be inferred from the observations.

Tables 1 and 2 indicate general characteristics of study subjects. EHPVO with portal hypertension, cirrhosis with portal hypertension, and idiopathic hypersplenism were most common causes constituting majority of the cases.

Pain in the left hypochondrium was seen in 90% of the cases, followed by fever and mild left sided pleural effusion in 76% of cases as shown in Table 3. Major complications such as splenic abscess, pancreatitis, and splenic vein thrombosis were noted in very few to none.

Pre-procedure mean hemoglobin and platelet levels were 8.6 mg/dl and 64827/mm^3 which increased to 10.16 and 84404 respectively as shown insert Tables 4 and 5. These results were statistically significant with a $P < 0.0001$ as shown in Figures 1 and 2. On further *post-hoc* analysis it was

Table 1: General characteristics of study subjects

Characteristics	Frequency	Percent
Gender		
Female	32	64
Male	18	36
Diagnosis		
EHPVO with portal hypertension	9	18
Cirrhosis with portal hypertension	14	28
Idiopathic hypersplenism	23	46
Sickle cell disease	3	6
Budd Chiari syndrome	1	2

Table 2: Procedure related complications

Fever		
Absent	12	24
Present	38	76
Pain in left hypochondrium		
Absent	5	10
Present	45	90
Mild Pleural effusion		
Absent	38	76
Present	12	24
Splenic abscess		
Absent	47	94
Present	3	6
Pancreatitis		
Absent	50	100.0

Table 3: Hematological parameters of study subjects

Characteristics	Minimum	Maximum	Mean	Standard. Deviation
Age (Years)	8.00	65.00	29.7692	13.65081
Pre-procedure				
Hemoglobin (gm/dl)	7.00	11.00	8.6154	0.89697
Platelet (/mm^3)	35000.00	100000	64827	16374.94568
Post-procedure				
Hemoglobin (gm/dl) at 1 week	8.50	12.00	10.1692	0.91028
platelet (/mm^3) 1 week	41000.00	154000	84404	26152.63628
platelet (/mm^3) 6 month	76000.00	321000	143850	69838.49501

Table 4: Comparison of Pre-procedure hemoglobin and post-procedure hemoglobin

Characteristics	Mean	*n*	SD	Std. Error Mean	*P*-value
Pre- procedure hemoglobin (gm/dl)	8.6154	50	0.89697	0.17591	<0.0001
Post-procedure hemoglobin (gm/dl) at 1 week	10.1692	50	0.91028	0.17852	

Table 5: Comparison of platelet count at different interval of treatment

Platelet count (/cumm)	*n*	Mean	SD	Minimum	Maximum	*P*-value
Pre-procedure	50	64827	16374.94	35000.00	100000	
Post-procedure 1 week[a]	50	84404	26152.63	41000.00	154000	<0.0001
Post-procedure 6 months[a,b]	50	143850	69838.49	76000.00	321000	

(a): *P*<0.05 versus pre-procedure, (b): *P*<0.05 versus post-procedure 1 week

found that platelet count on 1 week post-procedure day was significantly higher compared to pre-procedure platelet count and platelet count on post-procedure 6 month was significantly higher compared to both pre-procedure and post-procedure day 2 platelet count.

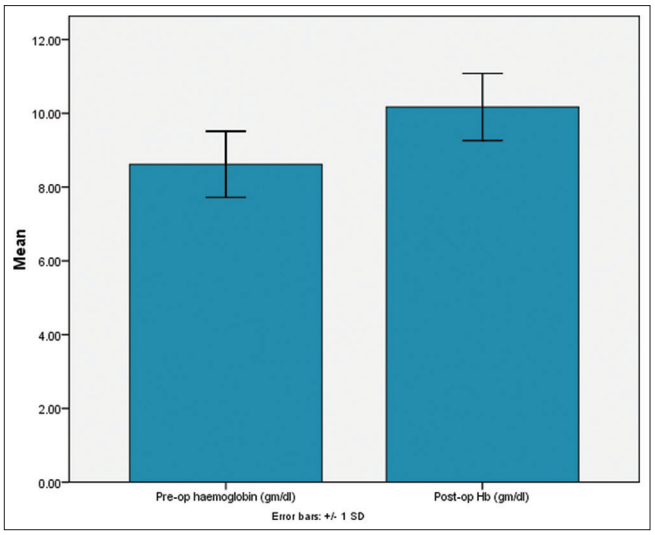

Figure 1: Graph showing comparison of pre-procedure hemoglobin and post-procedure hemoglobin along with standard deviation

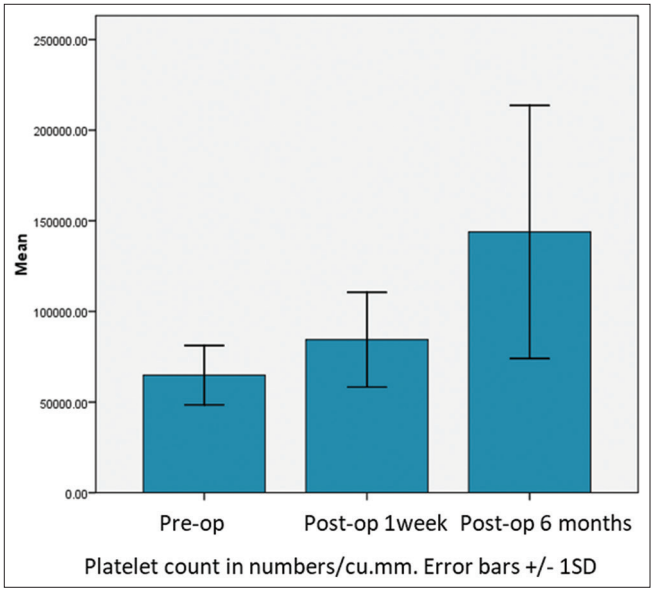

Figure 2: Graph showing comparison of platelet count at different interval of treatment

Significant decrease was noted between pre-procedure and post-procedure spleen size in study subjects ($P < 0.0001$) is shown in Table 6 which was likely due to resolution of the infarcted parenchyma.

Here, we present case of a patient presented with mild dull aching pain in abdomen with distension and single episode of hematemesis which on investigation confirmed as a case of extra-hepatic portal vein obstruction with gross splenomegaly and pancytopenia. The patient underwent endovascular embolization of segmental branch of splenic artery as shown in Figure 3a-c.

Figure 3: A case of extrahepatic portal venous obstruction showing pre-embolization splenic angiogram (a). Pre-procedural computed tomography (CT) scan showing enlarged spleen with ascites (b). Post-embolization CT shows focal areas of hypodensity representing infarcted tissue along with hyperdense dots representing embolic material (c).

Table 6: Comparison of pre-procedure spleen size and post-procedure spleen size

Characteristics	Mean	*n*	SD	Std. Error Mean	*P*-value
Pre- procedure spleen size (cm)	20.23	50	2.17	0.31	<0.001
Post-procedure spleen size (cm)	15.6	50	2.70	0.38	

DISCUSSION

Hypersplenism may be seen in many disorders, including cirrhosis with portal hypertension;[1,2] hematologic abnormalities such as idiopathic thrombocytopenic purpura, thalassemia major, and hereditary spherocytosis;[3-6] and diffuse splenic infiltration from primary malignancies such as leukemia and lymphoma.[7,8] Signs of hypersplenism include splenomegaly, thrombocytopenia, leukopenia, and anemia, and symptoms may include abdominal discomfort, pain, respiratory distress, and early satiety.[9,10] Decreased hematologic indices can have significant clinical manifestations. Leukopenia decreases the patient's ability to overcome infection. Thrombocytopenia increases the risk of spontaneous bleeding, anemic patients are at the increased risk for high output cardiac failure and can leave a patient dependent on transfusions.[4] (Bashour *et al*.)

Total splenectomy may be an effective treatment for hypersplenism, but it impairs the body's ability to produce antibodies against encapsulated microorganisms and predisposes patients to sepsis. Patients who have comorbid conditions and severe cytopenia may not be considered candidates for this surgery.[12,13]

To overcome consumptive activity in hypersplenism intentional infarction of spleen by trans-arterial embolization has been advocated. First SAE was done in 1973, by Maddison using autologous clot to treat recurrent gastrointestinal hemorrhage arising from esophageal varices.[14] But patients treated with complete splenic embolization had complications that included abscess, splenic rupture, sepsis, pneumonia, and death.[15-18] Since then, many authors have advocated incomplete or partial splenic arterial embolization, in which a portion of the splenic parenchyma is left viable to preserve the spleen's immunologic function. Although proximal arterial occlusion is ineffective for the management of hypersplenism, it is useful as a preoperative technique for reducing intraoperative blood loss in thrombocytopenic patients undergoing open or laparoscopic splenectomy.[19,20] Spigos *et al*. treated 13 patients with PSE using antibiotic coverage and post-embolization pain control and concluded in their studies that following the adoption of partial embolization with antibiotic coverage there is significant reduction in both morbidity and mortality rates compared with complete splenic embolization.[21,22] Hematologic response and the severity of complications well correlate with the amount of infarcted splenic tissue. A lesser extent of infarction preserves spleen's immunologic function and antegrade flow in the splenic vein and also reducing sequestration and destruction of the blood elements (e.g. red blood cells and platelets), Infarction of more than 80% of the splenic mass has been reported, but most interventionists have attempted to achieve infarction in 60–70% of the splenic mass.[23,24] On the basis of his study on 137 PSE, Mozes *et al*. concluded that, PSE offers an acceptably safe alternative to surgery in selected high-risk patients in whom both the surgical intervention and the resulting asplenic state carry a prohibitive risk.[23]

Splenic embolization is currently indicated in treatment of portal hypertension, patients with idiopathic thrombocytopenic purpura, to treat the sequelae of hypersplenism, and control of splenic hemorrhage from trauma or before surgical resection.[25-29]

Partial SAE can be performed by two ways. First by super selective catheterization of distal splenic artery branches with sparing of other branches, other method includes non-selective embolization of the splenic artery by placing the catheter tip more proximally in the main splenic artery branch but distal to the origin of major pancreatic branches and embolization is performed till the parenchymal blush is reduced. First method is more controlled with fewer

complications, that is why preferred whenever possible. As shown in Figure 4a and b there is peripheral necrosis of parenchyma with central sparing.

The embolic agents most commonly used for splenic arterial embolization are gelatin sponge, PVA particles and coils. Yoshioka *et al*.[30] showed excellent increases in platelet counts when coils were placed in the intrasplenic branches of the artery, and Hickman *et al*.[31] successfully used gelatin sponge, PVA particles, and/or coils for preoperative embolization. In our study on the basis of review of literature we used PVA as an embolizing agent. PVA-500-700 was used for partial SAE as a definitive procedure and not as a pre-surgical embolization.

Post-embolization there was significant improvement of pancytopenia with decrease in size of spleen. Post-operative patient had mild fever, pleural effusion, and pain which responded to conventional pain killer. Resolution of pleural effusion was seen after 15 days.

Partial splenic arterial embolization and proximal embolization may be associated with splenic abscess, splenic rupture, septicemia, splenic vein thrombosis, and unremitting bronchopneumonia but these procedures are better tolerated than is complete splenic ablation.[14] In addition, patients may develop pleural effusions, paralytic ileus, pancreatitis (non-target embolization of the dorsal pancreatic or greater pancreatic artery) or post-embolization syndrome, which consists of fever, leukocytosis, and abdominal pain.[34]

In our experience out of 50 embolization, there were three patients who developed splenic abscess. One was managed with percutaneous drainage and two required splenectomy despite percutaneous abscess drainage. Similar findings were shown in study by Owman, Torben, in which out of 30 patients two developed splenic abscess while splenic vein thrombosis was noted in 4 patients.[35]

Our study showed significant improvement in platelet count and hemoglobin was noted following 7 days and 6 months after surgery ($P < 0.0001$). On further *post hoc* analysis it was found that platelet count on 7th post-procedure day was significantly higher compared to pre- procedure platelet count and platelet count on 6 months after procedure was significantly higher compared to both pre-procedure and post-procedure day 7 platelet count. Harned *et al*. and Alzen *et al*. evaluated the effect of partial splenic arterial embolization in their separate studies and concluded that reduced extent of embolization resulted in significantly lower morbidity, although with a less impressive correction of thrombocytopenia patients maintained a platelet count above baseline.[36,37] Initial conservative approach may be prudent which can be followed by a second more extensive

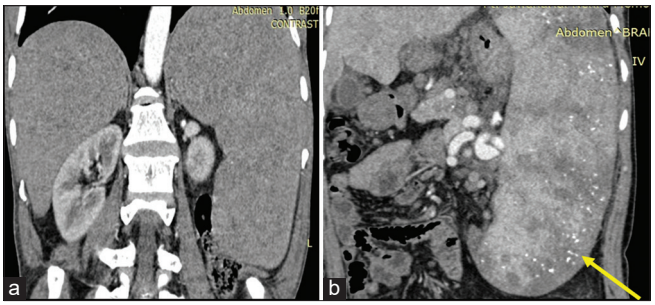

Figure 4: 20 year old patient presented with idiopathic hypersplenism and a huge spleen reaching up to iliac blades. Pre-procedure computed tomography (CT) scan shows homogenous parenchyma (a). Post-procedure CT scan shows areas of infarction (Arrow) along with hyperdense embolic materials (b)

embolization procedure if necessary. Various earlier studies have already proven that partial SAE is better than total SAE and splenectomy, since it helps in increasing the blood count and does not present with symptoms and complications of total spleen loss. Amin *et al*. in their study concluded that PSE is an effective therapeutic modality for the treatment of hypersplenism secondary to chronic liver disease. It is a simple, rapid procedure that is easily performed under local anesthesia; and it allows preservation of adequate splenic tissue to safeguard against overwhelming infection.[38]

CONCLUSION

Partial SAE should be used as first-line treatment for hypersplenism as it satisfactorily raised blood counts, reduced hospital stay, and preserved splenic function with fewer and milder side effects. It is also cost effective and reserves the option of complete embolization or surgery as next alternative.

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