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RESEARCH ARTICLE

PERIPHERAL BLOOD CELL CHANGES AND OUTCOMES AFTER PARTIAL SPLENIC EMBOLIZATION FOR HYPERSPLENISM İN CIRRHOTIC PATIENTS

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ABSTRACT

Purpose: Partial splenic embolization is a common treatment for hypersplenism in patients with cirrhosis. In this investigation, we evaluated the effectiveness and safety of partial splenic embolization in patients with cirrhosis.
Materials and Methods: We retrospectively investigated 17 patients with hypersplenism secondary to cirrhosis who underwent partial splenic embolization. Following partial splenic embolization, peripheral blood cell counts were measured at regular intervals over a period of twelve months. Post-procedural complications were recorded.
Results: This study included 17 individuals, with a mean age of 54.5 ± 10 years. Hemoglobin, platelet, neutrophil, lymphocyte, and white blood cell counts showed statistically significant increases. When compared to the pre-procedure levels at each time point (pre-procedure vs. 1st day $p<0.001$; pre-procedure vs. 1st week $p<0.001$; pre-procedure vs. 1st month $p<0.001$; pre-procedure vs. 6th month $p<0.001$; pre-procedure vs. 1st year $p<0.001$). The most common complication was post-embolization syndrome (88.2%), which was managed with conservative treatment. One patient died of esophageal variceal bleeding.
Conclusion: Partial splenic embolization improves long-term hematological parameters with manageable side effects.

Keywords: Partial splenic embolization, cirrhosis, hypersplenism

INTRODUCTION

Splenomegaly and/or hypersplenism are frequent complications of portal hypertension in cirrhosis and are usually asymptomatic. These conditions result in hematological abnormalities, including thrombocytopenia, leukopenia, and anemia, due to the increased splenic sequestration of blood cells. Patients with cirrhosis have a worse prognosis due to these hematological abnormalities since they are more likely to experience bleeding, infections, and other related problems (1-4). Furthermore, this may result in a patient's ineligibility for some therapies,

including interferon therapy, antineoplastic chemotherapy, and major surgery (5-7).

For hypersplenism, surgical splenectomy is a useful therapy option. However, splenectomy is associated with serious complications (8,9). Partial splenic embolization (PSE) has emerged as a significant treatment for hypersplenism in patients with cirrhosis as a viable substitute for surgery (10). This is particularly true in individuals whose surgical risks preclude splenectomy (2,11,12). PSE works by selectively embolizing parts of the spleen, thereby reducing its volume and function and improving peripheral blood cell counts (1). Several investigations have revealed that PSE is safe and effective in this patient population and have reported the benefits of PSE (7,13,14). Another approach for patients who do not adequately respond to the initial procedure is repeated partial splenic embolization (RPSE) (15).

The most common complication of PSE is post-embolization syndrome (PES), which manifests as fever, nausea, and pain (10,16). Conservative therapy, however, can effectively reduce these symptoms (7,15,17). Septicemia and splenic abscess are uncommon but serious side effects that require immediate medical attention (18). PSE improves the hematological parameters in cirrhotic patients. Nevertheless, severe complications such as venous thrombosis, splenic infarction, and death have been published (1,2). The premise of this investigation was that PSE is a safe and efficient treatment for cirrhotic hypersplenism and has the benefit of being a nonsurgical intervention.

This study aimed to evaluate peripheral blood cell changes following PSE in patients with hypersplenism secondary to cirrhosis and investigate the clinical results after PSE.

MATERIALS AND METHODS

Study Design and Patient Population

This retrospective analysis included patients with hypersplenism and cirrhosis who underwent PSE at Dokuz Eylul University Hospital between January 2010 and March 2024. Seventeen patients were included in this study. Patients aged ≥ 18 years, diagnosed with confirmed cirrhosis, with evidence of hypersplenism with splenomegaly, and eligible for PSE based on a multidisciplinary team review were included in the study. The diagnosis of hypersplenism was made using clinical laboratory data, ultrasonography, and computed tomography examinations. Patients with prior splenectomy or splenic embolization, infections or sepsis, or other conditions that would exclude the procedure, such as severe portal vein thrombosis or irreversible coagulopathy, were excluded. Supporting therapies were administered to patients with severe anemia, thrombocytopenia, or coagulation disorders before PSE.

Previous medical records provided information on patient demographics and the etiology of cirrhosis. Biochemical data and peripheral blood cell counts were collected, and the severity of liver disease was evaluated by calculating the Child-Pugh score.

The study confirmed the tenets of the Declaration of Helsinki and was approved by the Non-Invasive Clinical Research Ethics Committee of Dokuz Eylul University (Date: 29/05/2024, Decision Number: 2024/19-16).

Partial Splenic Embolization Procedure

Two experienced interventional radiologists performed PSE under local anesthesia. Embolization was done using a distal technique (19). A catheter was inserted through the femoral artery and carefully placed inside the splenic artery under fluoroscopic guidance. After that, a coaxial microcatheter was placed into at least one lower pole pedicle, and embolization was performed from the microcatheter. Embolization involved injecting an embolic agent, polyvinyl alcohol particles or microspheres, into the branches of the splenic artery with the goal of partially infarcting between 50 and 80 percent of the spleen. The degree of embolization was estimated using pre-procedural imaging and the patient's clinical status. Postprocedural analgesics, antibiotics, and hospital monitoring were administered to all patients to reduce the risk of infection and post-embolization syndrome. Informed consent was obtained from all patients before the procedure.

Data Collection and Follow-up

The patients were hospitalized before the PSE procedure. Following PSE, all patients stayed at the hospital until PES or any other serious problems had disappeared. Subsequently, they were observed at an outpatient clinic. Peripheral blood cell counts (including platelet count, white blood cell count, lymphocyte and hemoglobin levels) were measured before the procedure, at 1 day, 1 week, 1 month, 3-month, 6 month and 1 year after PSE. Liver function tests and abdominal imaging were also repeated

during follow-up visits to monitor for complications such as splenic infarction, abscess formation, or ascites. Any post-procedural complications were recorded.

Statistical Analysis

Compliance with normal distribution was assessed with the Shapiro-Wilk test. Descriptive statistics were used to summarize baseline characteristics. Continuous variables were expressed as mean ± standard deviation (SD) or median-interquartile range (IQR), while categorical variables were expressed as frequencies and percentages. Wilcoxon signed-rank tests were used to compare pre-and post-procedural blood counts. A p-value of <0.05 was considered statistically significant. The data were evaluated and visualized using the SPSS (v29.0) package program.

RESULTS

Patients' characteristics

This cohort included 17 patients (mean age, 54.5 ± 10 years). Of these, 52.9% (n=9) were male and 47.1% (n=8) were female. The most common concomitant disease was diabetes mellitus, present in 23.5% (n=4) of patients. This was followed by hypertension in 17.6% (n=3), chronic kidney disease, and cancer, each present in 11.8% (n=2), while cardiac disease and cerebrovascular disease were observed in 5.9% (n=1) of patients. In terms of cirrhosis etiology, hepatitis B virus (HBV) infection and non-alcoholic fatty liver disease (NAFLD) were each responsible for 23.5% (n=4) of cases. Autoimmune hepatitis was found in 17.6% (n=3), primary biliary cholangitis and alcohol-related liver disease in 11.8% (n=2) of cases each, and HBV + hepatitis D virus (HDV) co-infection and Wilson's disease in 5.9% (n=1) of patients each. The Child-Pugh classifications of these 17 patients were Child A in 7 (41.1%), Child B in 6 (35.2%), and Child C in 4 (23.5%) patients. The patient characteristics are summarized in Table 1.

Efficacy of partial splenic embolization

Hematological parameters were monitored during the first year following PSE. Hemoglobin, platelet, neutrophil, lymphocyte, and white blood cell counts showed statistically significant increases when compared to pre-procedure levels at each time point (p<0.001). Table 2 lists the changes in the hematological parameters.

The median white blood cell count showed a significant increase from a baseline of 2.3 (IQR: 1.35–3.35) 103/uL to 5.4 (IQR: 4.4–10.9) 103/uL on the first-day post-PSE (p <0.001). The count further increased to 10.5 (IQR: 6.4–12.0) 103/uL at the first week and gradually stabilized over time, reaching 6.7 (IQR: 3.6–8.5) 103/uL by the first year (p <0.001). Neutrophil counts followed a similar trend.

Lymphocyte counts were 0.4 (IQR: 0.3–0.7) 103/uL pre-PSE and 1.1 (IQR: 0.6–1.3) 103/uL at the one-year mark (p <0.001), respectively. After a year (p <0.001), hemoglobin levels improved gradually, rising from 9.1 (IQR: 7.8–11.4) g/dL pre-PSE to 10.7 (IQR: 9.2–12.8) g/dL.

The most notable change was observed in platelet counts, which rose sharply from a baseline of 47 (IQR: 34–57) 103/uL to 142 (IQR: 87–187) 103/uL in the first week (p <0.001). Platelet counts continued to increase, peaking at 203 (IQR: 105–42) 103/uL by the first month before reaching 150 (IQR: 87–191) 103/uL by the first year.

The change of platelet count during the 1st year after PSE is demonstrated in Figure.

Complications

To minimize the complication rate, most patients had a splenic infarction rate of 50%-70%. The complications after PSE in our study were varied.

Table 1. Characteristics partial splenic embolizationin 17 patients with cirrhosis

Characteristics	Total patients (n = 17)
Age, years, mean±SD	54.5 ± 10
Sex, n (%)	
Male	9 (52.9)
Female	8 (47.1)
Comorbidities, n (%)	
Cardiac disease,	1 (5.9)
Chronic kidney disease	2 (11.8)
Cerebrovascular disease	1 (5.9)
Diabetes mellitus	4(23.5)
Hypertension	3 (17.6)
Cancer	2 (11.8)
Cirrhosis etiology, n (%)	
HBV	4(23.5)
HBV+HDV	1 (5.9)
Autoimmune hepatitis	3 (17.6)
Primary Biliary Cholangitis	2 (11.8)
Alcohol	2 (11.8)
Wilson	1 (5.9)
NAFLD	4(23.5)
Child's classification, n (%)	
A	7(41.1)
B	6(35.2)
C	4(23.5)

SD: standard deviation, HBV, hepatitis B; HDV, hepatitis D; NAFLD, Non-alcoholic fatty liver disease

Table 2. Changes in hematological parameters in the first year

	Pre-PSE	1st day	1st week	1st month	3rd month	6th month	1st year
WBC (10^3/uL), median (IQR)	2.3 (1.35-3.35)	5.4 (4.4-10.9)	10.5 (6.4-12)	6 (4.9-7.5)	6.5 (4.5-10.3)	5.7 (4.4-7.1)	6.7 (3.6-8.5)
Neu (10^3/uL), median (IQR)	1.2 (0.9-2.1)	3.6 (3.1-9.8)	6.5 (4.3-8.4)	4.4 (2.3-5.5)	3.3 (2.8-7.8)	3.2 (2.5-4.7)	3.9 (1.6-5.9)
Lym (10^3/uL), median (IQR)	0.4 (0.3-0.7)	0.4 (0.3-0.6)	0.7 (0.4-0.9)	0.7 (0.6-1.2)	1 (0.6-1.8)	1.1 (0.8-1.5)	1.1 (0.6-1.3)
Hb (g/dL), median (IQR)	9.1 (7.8-11.4)	10.7 (8.8-11.4)	10.2 (8.4-11.9)	10.3 (9.3-12.3)	11.3 (9.4-12.2)	11.7 (10-12.8)	10.7 (9.2-12.8)
PLT (10^3/uL), median (IQR)	47 (34-57)	72 (60-102)	142 (87-187)	203 (105-42)	136 (100-213)	149 (124-195)	150 (87-191)

PSE: Partial splenic embolization, WBC: White blood cell, Neu: neutrophil, Lym: lymphocytes, Hb: hemoglobin, PLT: platelets
** The change in hematological parameters levels was statistically significant between pre-PSE and all the time points (pre-PSE vs 1st day p<0.001; pre-PSE vs 1st week p<0.001; pre-PSE vs 1st month p<0.001; pre-PSE vs. 6th month p<0.001; pre-PSE vs. 1st year p<0.001). Wilcoxon Signed Rank test was used for statistical analysis and data was provided as median (interquartile range (IQR)). Two-sided p value <0.05 was considered statistically significant.*

PES was the most common complication, affecting 88.2% (n=15) of patients. These symptoms were easily controlled via conservative therapy. Pleural effusion or ascites was seen in 35.2% (n=6), which spontaneously resolved. Splenic hematoma and peritonitis were each observed in 11.8% (n=2). There were no cases of splenic abscess. Hepatic encephalopathy developed in 11.8% (n=2) of patients. 0ne patient (5.9%) developed esophageal variceal bleeding 10 days after PSE and was admitted for endoscopic treatment but died of hypovolemic shock. The mean hospital stay was 13.7 ± 10.8 days. Patient complications are listed in Table 3.

DISCUSSION

This study was conducted on 17 patients who underwent partial splenic embolization with hypersplenism secondary to chronic liver disease. A less invasive therapeutic approach for treating hypersplenism in cirrhotic patients is partial splenic embolization. Hematological indicators were significantly improved in our study as a result of PSE. These results corroborate those of other studies showing that PSE is effective in treating hypersplenic cytopenia (20,21). Postembolization syndrome was the most common side effect; however, it resolved with conservative therapy in almost all patients. However, one patient died from bleeding after PSE.

Table 3. Complications after PSE

Parameter	n:17
PES,n(%)	15(88.2)
Splenic hematoma,n(%)	2(11.8)
Pleural effusion/ascites,n(%)	6(35.2)
Peritonitis,n(%)	2(11.8)
Splenic abscess,n(%)	0 (0)
Length of hospital stay, (day) Mean±SD	13.7±10.8
Hepatic encephalopathy,n(%)	2(11.8)
Variceal bleeding,n(%)	1 (5.9)
Death,n(%)	1 (5.9)

Patients with different cirrhosis stages and comorbidities were included in the study population, which could have affected the results and unfavorable consequences of PSE. The mean age of the cirrhosis patients in our study was 54.5 years, and there were several different causes of the illness. Furthermore, the majority of patients showed reasonably intact liver function based on the distribution of their Child-Pugh classifications. These features provide a basis for understanding the possible impacts of PSE on different patient attributes.

White blood cell and neutrophil counts increased dramatically following the PSE, reaching a peak during the first week. Throughout the year, lymphocyte levels, which had started out low, progressively increased. Moreover, hemoglobin demonstrated consistent improvement, reaching notable heights by the one-year milestone. The most notable difference was in the platelet counts, which increased quickly following the treatment and peaked in the first month before continuing to rise by the end of the year. These results are consistent with those of the previous studies (1,2,4,21). Patients with cirrhosis who have thrombocytopenia have a high risk of bleeding, while those with neutropenia are more

prone to infection. Furthermore, it is more challenging to administer vital drugs such as cancer therapy or antivirals. It is especially crucial that the immune cell and platelet counts are restored after PSE. The assumption that PSE offers long-lasting benefits in treating anemia, a condition that typically worsens the prognosis of patients with cirrhosis, is supported by the long-term stability of hemoglobin levels in this study. PSE contributed to patients with cirrhosis having lower infection rates and improved immune function following PSE.

RPSE has been proposed as a feasible option for patients whose blood counts do not improve following initial PSE. According to a study by Tan et al., patients who underwent repeated PSE treatments demonstrated greater gains in platelet counts than those who underwent a single procedure (15). While RPSE was not used in our investigation, it is important to consider its potential benefits for some patients. Another crucial aspect to consider is the durability of long-term hematological improvements following PSE. Our results show that blood counts at one year are still significantly higher than the pre-PSE values, despite the fact that they frequently peak and then decline. In line with these results, PSE has been demonstrated to result in long-lasting elevations in blood counts, allowing patients to manage cirrhosis-related issues better.

In our study, the most frequent side effect affecting 88.2% of patients was PES, which is characterized by pain, fever, and nausea. PES rates following PSE have been recorded in previous studies, suggesting that this is a common but controllable issue (1,2,22). Pleural effusion or ascites, which are acknowledged consequences of PSE, occurred in 35.2% of patients in our study. Splenic hematoma and peritonitis occurred in two individuals (11.8%) in our group, but both conditions were well treated. One patient had esophageal variceal bleeding and died due to this reason. A study of 23 cases reported one patient developing bacterial peritonitis 12 days after PSE, leading to death from septicemia despite intensive care (1). Similarly, Wu et al. described a patient who died of acute myocardial infarction linked to esophageal bleeding 32 months post-PSE (21). N'Kontchou et al. found splenic necrosis in over 70% of patients who died from septic shock (2), highlighting that serious complications tend to be more common when infarctions in the splenic parenchyma exceed 70% (4). In our study, we tried to keep the splenic infarction rate between 50%-70%. Careful procedure planning is crucial for reducing these hazards.

This study has several limitations. First, the sample size was relatively small, with only 17 patients included in the analysis. Second, this was a retrospective study in which short-term complications were monitored, but the long-term complications of PSE, such as portal vein thrombosis or splenic infarction, were not sufficiently analyzed despite being followed for a year.

CONCLUSION

In conclusion, partial splenic embolization for hypersplenism is a percutaneous interventional method that offers patients with cirrhosis a viable alternative to surgery. PSE provides long-term improvements in the hematological parameters of patients with cirrhosis and hypersplenism. Compared to splenectomy, PSE is a less invasive alternative, particularly suitable for patients at high surgical risk, with advantages such as the ability to perform the procedure under local anesthesia. However, complications, such as post-embolization syndrome and variceal bleeding, should be considered. When it comes to treating hypersplenism in cirrhotic individuals, partial splenic embolization should be the first choice due to its effectiveness and safety

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Conflict of Interest: The authors have no conflict of interest to declare.

Ethical Approval: The study confirmed the tenets of the Declaration of Helsinki and was approved by the Non-Invasive Clinical Research Ethics Committee of Dokuz Eylul University (Date: 29/05/2024, Decision Number: 2024/19-16).

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