Brazilian Journal of TRANSPLANTATION

https://doi.org/10.53855/bjt.v29i1.759_ENG

REVIEW ARTICLE

Splenic Embolization in the Management of Complications after Liver Transplantation: Integrative Review

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Seccion editor: Ilka de Fátima Santana F. Boin

Received: Nov. 15, 2025 | Approved: Jan. 13, 2026

ABSTRACT

Introduction: Liver transplantation is a definitive treatment for patients with end-stage liver disease and liver neoplasms. Vascular complications remain an important cause of morbidity and mortality in these patients. Splenic artery embolization is an alternative to improve the clinical and hemodynamic conditions of such patients. **Methods:** The research was conducted in October 2025 on the PubMed and Literatura Latino-Americana e do Caribe em Ciências da Saúde (LILACS) platforms, based on the descriptors: "Splenic artery," "Embolization, therapeutic," and "Liver Transplantation"; 15 articles were selected based on eligibility criteria. **Results:** Seven case reports and eight cohort studies, or retrospective case series were found, reflecting the current level of evidence on the application of splenic artery embolization in patients undergoing liver transplantation. Analysis of the articles allowed the data to be synthesized into three central thematic categories: indications for the procedure, techniques used, and clinical outcomes, including complications. **Conclusion:** Splenic artery embolization is a minimally invasive, safe, and effective therapeutic strategy for the management of selected complications after liver transplantation, such as splenic artery steal syndrome, refractory ascites, hydrothorax, and hypersplenism.

Descriptors: Splenic Artery; Embolization, Therapeutic; Liver Transplantation.

A Embolização Esplênica no Manejo das Complicações após o Transplante Hepático: Revisão Integrativa

RESUMO

Introdução: O transplante hepático é um tratamento definitivo para pacientes com doença hepática terminal e neoplasias hepáticas. As complicações vasculares mantêm-se como uma importante causa de morbimortalidade nesses pacientes. A embolização da artéria esplênica (EAE) é uma alternativa para melhorar as condições clínicas e hemodinâmicas de tais pacientes. **Métodos:** A pesquisa foi realizada em outubro de 2025 nas plataformas PubMed e Literatura Latino-Americana e do Caribe em Ciências da Saúde (LILACS), baseada nos descritores "Splenic artery", "Embolization, therapeutic" e "Liver Transplantation", sendo escolhidos 15 artigos com base nos critérios de elegibilidade. **Resultados:** Foram encontrados sete relatos de caso e oito estudos de coorte ou séries de casos retrospectivos, refletindo o nível de evidência atual sobre a aplicação da EAE em pacientes submetidos ao transplante hepático. A análise dos artigos permitiu a síntese dos dados em três categorias temáticas centrais: as indicações do procedimento, as técnicas empregadas e os desfechos clínicos, incluindo as complicações. **Conclusão:** A EAE é uma estratégia terapêutica minimamente invasiva, segura e eficaz para o manejo de complicações selecionadas após o transplante hepático, como a síndrome do roubo da artéria esplênica, a ascite refratária, o hidrotórax e o hiperesplenismo.

Descritores: Artéria Esplênica; Embolização Terapêutica; Transplante Hepático.

INTRODUCTION

Liver transplantation is a definitive treatment for patients with end-stage liver disease, as well as in specific situations involving certain neoplasms. Even with advances in currently employed techniques, vascular complications remain a significant cause of post-transplant morbidity and mortality. Therefore, interventional radiological procedures, such as splenic artery embolization (SAE), are important alternatives to improve the clinical and hemodynamic conditions of these patients[1].

The SAE consists of partial or complete occlusion of arterial flow to the spleen using embolic agents, such as vascular plugs, particles, or coils. The main objective of this technique is to redirect splenic flow to the liver by reducing the volume of blood directed to the portal system and, consequently, increasing hepatic arterial perfusion in a compensatory manner[2,3]. The main applications of this technique involve splenic artery steal syndrome (SASS)[3], hypersplenism[4], refractory ascites (RA), and hepatic hydrothorax[5].

Despite the numerous benefits of SAE associated with increased hepatic perfusion and decreased portal hypertension, this procedure is not without complications. Among these, fever, abdominal pain, abscesses, and in some cases, splenic infarction and sepsis stand out[6]. In the current context of patients undergoing liver transplantation, such complications are gaining prominence due to their negative impact on morbidity and mortality.

Although the results currently available in the literature are encouraging, most are from case series and retrospective studies, underscoring the need for integrative reviews capable of gathering and critically evaluating evidence on the indications, techniques used, and clinical outcomes of SAE. Therefore, this study aims to analyze, through an integrative literature review critically, the available studies on the role of SAE in the management of complications after liver transplantation, considering its indications, techniques used, clinical efficacy, and safety profile.

METHODS

This study was reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) Checklist. The methods used to conduct this integrative review were based on the analysis of articles in the PubMed and Latin American and Caribbean Literature in Health Sciences (Literatura Latino-Americana e do Caribe em Ciências da Saúde - LILACS) databases. To guide the study, the PICo strategy (acronym for population, interest, and context) was used to outline the following question: What is the role of splenic embolization in the management of post-liver transplant complications?

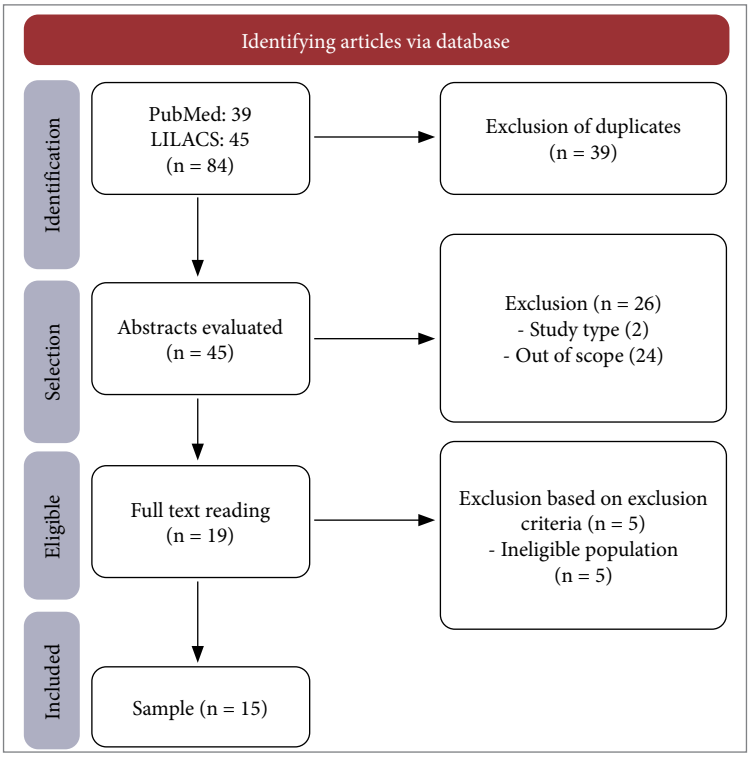
The search methodology, carried out in October 2025, was based on the combination of the following descriptors: "Splenic artery", "Embolization, therapeutic" and "Liver Transplantation", selected based on the Health Sciences Descriptors (Descritores em Ciências da Saúde - DeCS) and in Medical Subject Headings (MeSH) and combined with the Boolean operator "AND". The search strategy implemented in both search platforms, LILACS and PubMed, was "Splenic artery" AND "Embolization, therapeutic" AND "Liver Transplantation". No restrictions were applied regarding language or study type.

The inclusion criteria were studies published between 2015 and October 2025 that addressed the proposed theme and had full texts available in all languages. Exclusion criteria considered thematic focus not applicable to the content of this review, such as the use of embolization in patients not undergoing liver transplantation; the article format, such as editorials, letters, and clinical practice guidelines; and duplicate studies. As a result, 39 articles were found in PubMed and 45 in LILACS, totaling 84 articles (Table 1). To perform the selection process, the articles were imported into the RAYYAN® platform, where the abstracts were reviewed and analyzed against the aforementioned inclusion and exclusion criteria, yielding 15 articles (Fig. 1). The methodological quality of the articles was assessed using the Joanna Briggs Institute (JBI) tool, with the level of evidence evaluated according to the Oxford Classification (2011).

Table 1. Number of articles per database/virtual library (n = 84).

Descriptor	PubMed	LILACS
Splenic artery, embolization, therapeutic and liver transplantation	39	45

Source: Elaborated by the authors.



Source: Elaborated by the authors.

Figure 1. Identification of articles.

RESULTS

After selecting 15 articles for more detailed analysis from the 84 articles preliminarily obtained, following the aforementioned criteria, a complete reading of these articles was carried out in accordance with the inclusion and exclusion criteria in the databases, and the information shown in Table 2 was obtained. The articles were grouped as follows: seven case reports[1,6-11] and eight cohort studies or retrospective case series[1-5,12-14], reflecting the current level of evidence on the application of SAE in patients undergoing liver transplantation. The analysis of the articles allowed the synthesis of the data into three central thematic categories: indications for the procedure, techniques employed, and clinical outcomes, including complications.

Table 2. Characteristics and primary considerations of the included studies

Title	Objective/ type of transplant	Authors/ year/country	Study design/ number of patients	Methodological quality/level of evidence	Considerations on the topic
1. Splenic artery embolization in patients after orthotopic liver transplant	To review the partial SAE treatment of three patients with hypersplenism and ascites following liver transplantation—two from living donors and one from a deceased donor.	Rysmakhanov et al./2015/ Kazakhstan	Retrospective case series / n = 3	Moderate/4	SAE is a safe and effective minimally invasive method for treating hypersplenism and ascites in orthotopic liver transplant recipients, offering an alternative to open splenectomy.
2. Efficacy and safety of splenic artery embolization for intractable ascites using Amplatzer vascular plug versus coil after living donor liver transplantation	To evaluate the efficacy and safety of SAE using a vascular plug versus coil embolization for intractable ascites after living donor liver transplantation.	Lee et al./2022/ Taiwan	Retrospective cohort / n = 15	Moderate to low/3	Embolization with vascular plugs and coils provides an effective and safe method for managing patients with intractable ascites after living donor liver transplantation. Embolization with plugs may be more efficient.

Continue...

Table 2. Continuation...

Title	Objective/ type of transplant	Authors/ year/country	Study design/ number of patients	Methodological quality/ level of evidence	Considerations on the topic
3. Splenic artery steal syndrome in patients with orthotopic liver transplant: where to embolize the splenic artery?	Compare proximal and distal splenic artery embolization in patients with RAS after orthotopic liver transplantation (transplant type not specified).	Fleckenstein et al./2022/ Germany	Single-center retrospective cohort/ n = 75	Moderate to high/3	There was no significant difference between proximal and distal splenic artery embolization. Experience and availability of materials should be used as a basis for choosing the method.
4. Efficacy and safety of partial splenic embolization for hypersplenism in pre- and post-liver transplant patients: a 16-year comparative analysis	To report the effect of partial splenic embolization on hematological indices and procedural safety in pre- and post-liver transplant patients (transplant type not specified).	DuBois et al./2019/ United States	Single-center retrospective cohort (n = 14 post-LT)	Moderate/3	Partial splenic embolization is effective in increasing white blood cell counts for up to 2 years, and platelet counts for up to 3.5 years in patients with hypersplenism. Efficacy and safety are independent of pre- or post-liver transplant status.
5. Proximal splenic artery embolization for refractory ascites and hydrothorax post-liver transplant	To determine the safety and efficacy of SAE in the treatment of RA and/or HH in the context of post-LT portal hyperperfusion (type of transplant not specified).	D'Amico et al./2023/ United States	Case series / n = 30	High/4	Proximal splenic artery embolization is safe and effective for treating ascites and HH due to portal hyperperfusion. This study suggests that clinical parameters indicating more severe portal hyperperfusion and better renal function are potential predictors of early response to embolization.
6. Non-invasive management of complications from splenic artery aneurysm embolization after liver transplant: a case report	To present a case of a patient who underwent liver transplantation with a deceased donor and embolization, who developed significant complications successfully treated with non-invasive radiological techniques.	Livingston et al./2021/ United States	Case report/ n = 1	High/4	The case report highlights the successful minimally invasive endovascular treatment of extensive portal vein thrombosis and splenic abscess following SAE in a patient who underwent LT.
7. Splenic artery embolization for splenic artery steal syndrome after living donor liver transplantation: a case report	To report a case and review recent advances in the diagnosis and treatment of splenic artery steal syndrome (SASS) following living donor OLT.	Jiang et al./2022/ China	Case report/ n = 1	High/4	SASS can occur in a comparable number of patients following liver transplantation. To avoid severe complications, patients must be diagnosed early and treated promptly with SAE.
8. Splenic artery syndrome as a possible cause of late-onset refractory ascites after liver transplantation: management with proximal splenic artery embolization	Splenic flow modulation and SAE as a therapeutic option for SASS after liver transplantation (deceased donor and piggyback technique)	Pravisani et al./2016/ Italy	Case series/ n = 23	High/4	SAE is a good therapeutic option for modulating hepatic blood flow, with low complication rates and a high clinical response rate.
9. Salvage splenic artery embolization for saving falling living donor graft due to portal overflow: a case report	To report the case of a patient who recovered from rapidly progressing hyperbilirubinemia caused by a small graft through portal overflow decompression with EAE after living donor LT.	Okabe et al./2016/ Japan	Case report/ n = 1	High/4	Additional splenic artery embolization after living donor LT may be a convenient option to reduce portal leakage in patients with splenomegaly, if portal decompression was not performed for some reason during surgery.

Continue...

Table 2. Continuation.

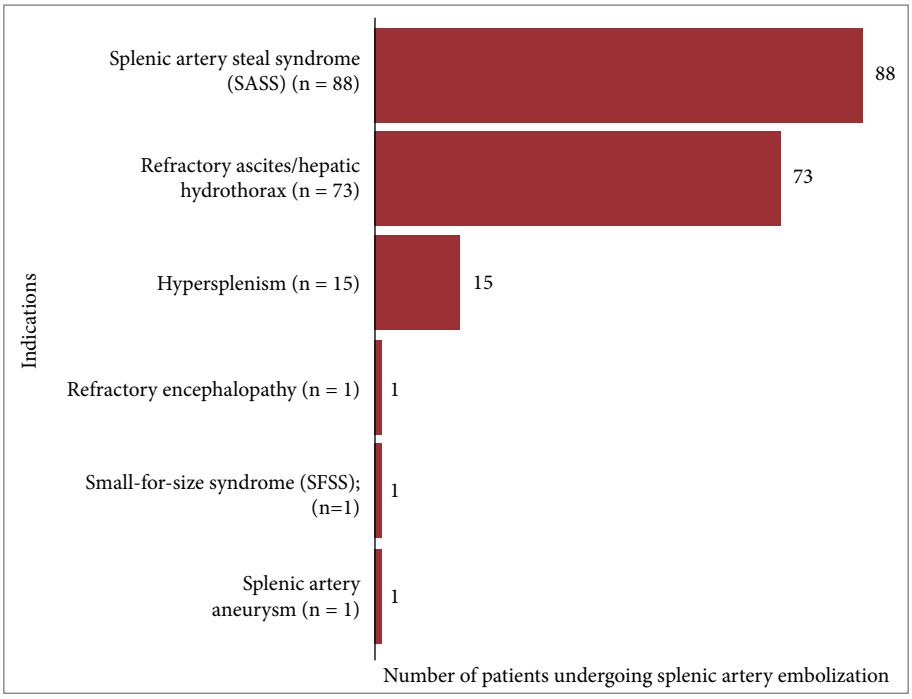
Title	Objective/ type of transplant	Authors/ year/country	Study design/ number of patients	Methodological quality/ level of evidence	Considerations on the topic
10. Splenic artery embolization for treatment of refractory ascites after liver transplantation	To report the successful use of therapeutic splenic artery embolization for RA following deceased donor liver transplantation	Meighani et al./2016/ United States	Case report/ n = 1	High/4	Further studies are needed to understand the long-term outcomes for patients undergoing SAE in the context of post-liver transplant RA.
11. Proximal total splenic artery embolization for refractory hepatic encephalopathy	To report a case of refractory hepatic encephalopathy treated with total embolization of the proximal splenic artery in a patient who had previously undergone liver transplantation with a living donor.	Maki et al./2018/ Japan	Case report/ n = 1	High/4	Total proximal splenic artery embolization may be a less invasive treatment option for selected patients with refractory HE.
12. Three case reports of splenic artery steal syndrome after liver transplantation	To reinforce the understanding of the development and progression of SASS, as well as to highlight splenic artery trunk embolization as an effective treatment (transplant type not specified).	Liu et al./2015/ China	Multiple case report/n = 3	High/4	Diagnosis is challenging, with Doppler ultrasound and angiography being the most valuable methods. The recommended treatment is SAE, as it is less invasive and effective in restoring hepatic blood flow, reducing complications and avoiding the need for reoperation.
13. Impact of Doppler ultrasound on diagnosis and therapy control of lienalis steal syndrome after liver transplantation	To investigate the performance of bedside ultrasound in patients after deceased donor orthotopic liver transplantation to monitor SAE treatment for SASS.	Teegen et al./2017/ Germany	Case series/ n = 8	High/4	Bedside ultrasound has been helpful for the rapid diagnosis and treatment of SASS. It has also proven beneficial for follow-up after the procedure.
14. Complete splenic embolization for the treatment of refractory ascites after liver transplantation	To report two cases of patients who underwent transplantation (deceased donor) due to cirrhosis secondary to idiopathic portal hypertension and presented with RA during the immediate postoperative period.	Nutu et al./2017/ Spain	Case reports/ n = 2	High/4	SAE is a therapeutic option for the treatment of RA after liver transplantation.
15. Transsplenic arterial embolization for splenic artery steal following liver transplant	To report a case of splenic embolization in a patient following a deceased donor liver transplant that progressed to SASS	Bulman et al./2021/ United States	Case report/ n = 1	Moderate to high/4	In the context of proximal splenic artery ligation, alternative approaches to splenic embolization may be necessary to salvage graft function in cases of splenic artery steal syndrome.

Source: Elaborated by the authors.

Among the most debated indications (Fig. 2), the SASS stands out. In these cases, SAE has proven to be an effective strategy for improving arterial perfusion of the liver graft[4,7,11-14], as it can be performed simultaneously with diagnostic angiography, is minimally invasive and straightforward, and is associated with fewer complications. Among diagnostic methods, Doppler ultrasound has proven highly effective due to its wide availability and low cost[4,7,12]. However, angiography is considered the gold standard for diagnosing SASS, with computed tomography as an alternative, especially when Doppler ultrasound is inconclusive[4,12,13].

Complications of persistent portal hypertension, such as RA and refractory hydrothorax (HH), represent the second largest group of indications for SAE. This method has proven to be an efficient strategy for reducing ascites volume[1,2,5,8], reducing portal vein hyperflow, and improving hepatic artery inflow[2]. In DuBois et al.[4], 80% of patients undergoing SAE experienced resolution of RA and/or HH, with 6 patients requiring additional interventions for resolution, including high-dose diuretics, paracentesis, hemodialysis, and a transjugular intrahepatic portosystemic shunt (TIPS). Several factors were positive predictors of RA and HH resolution, including high portal vein velocity pre-SAE, high intraoperative portal flow,

and improved renal function[5]. Okabe et al.[9] report a case in which SAE was necessary for the management of small-for-size syndrome after liver transplantation with a living donor, where the graft was small and presented significant portal hyperflow. In this context, after embolization, the patient presented a reduction in portal flow and reversed a possible progression to fulminant liver failure.[8]



Source: Elaborated by the authors.

Figure 2. Indications for SAE in patients after liver transplantation.

In a smaller number of articles[1,2,4,11], SAE was used in the management of hypersplenism before and after liver transplantation, with the main indications being the correction of cytopenias[2,4] and the treatment of refractory hepatic encephalopathy[11]. Persistent hypersplenism after liver transplantation is a common finding that can complicate the use of immunosuppressive medications[4]. Performing SAE did not increase hemoglobin levels; however, platelet and white blood cell levels improved during the 2-year follow-up period after the procedure.[4] In Maki et al.[11], a post-liver transplant patient, presenting with cellular rejection and already with established liver cirrhosis, benefited from improved control of encephalopathy and hypersplenism after SAE. There was also the use of SAE for the treatment of a splenic artery aneurysm. On that occasion, the patient presented with splenic infarction and thrombosis of the central portal veins (right and left), the superior mesenteric vein, and the splenic vein[6].

Regarding techniques, studies differ on the ideal approach. There is debate about the superiority of proximal embolization over distal embolization in SASS[3], as well as comparisons between Amplatzer vascular plugs and coils[2]. Fleckenstein et al.[3], in a retrospective study of 75 patients, found no significant differences between the proximal and distal splenic embolization groups in patients with SASS, especially after 30 days. Regarding the use of vascular plugs, Lee et al.[2] reported that the Amplatzer vascular plug may be more effective than coils, due to faster reduction in ascites volume, shorter procedure time, and improvement in pancytopenia.

Regarding outcomes and safety, SAE was described as a safe and effective procedure by all participants. The most commonly reported complication was post-embolization syndrome (fever and abdominal pain), which was generally self-limiting[1,2,5]. Other complications, although rarer, have been described, including splenic infarction[5], splenic abscess[6], portal vein thrombosis[6] and vascular complications[5].

The final sample consisted of 15 studies, predominantly characterized by retrospective observational designs, including case reports[6,7,9,10-12,14,15], case series[1,5,8,13] and comparative cohorts[2-4]. According to the Oxford Centre for Evidence-Based Medicine classification (2011), most studies were at evidence level 4, reflecting the nature of the intervention in rare complications; however, some studies[2-4] stood out by reaching evidence level 3, due to structuring comparative analyses between treatment groups or distinct clinical moments. The application of the JBI checklists demonstrated high overall methodological quality: reports and series showed rigor in defining criteria and clarity in protocols (proximal, distal, or total embolization), while cohorts presented

valid strategies for measuring outcomes and follow-up, with reservations only for the study[2], whose small sample size limited the control of confounding factors, in addition to having unbalanced groups.

DISCUSSION

This integrative review consolidates SAE as a versatile and minimally invasive therapeutic tool in the arsenal for managing post-liver transplant complications. Furthermore, it modulates the hemodynamics of the splenic, portal, and hepatic axes, promoting better graft perfusion by increasing hepatic artery flow and reducing portal hypertension.

SASS may be one of the indications for SAE and is the most debated in the studies analyzed. This vascular complication usually occurs 30 days after transplantation. It consists of a diversion of arterial flow from the hepatic artery to the splenic artery[12]. According to Jiang[7], the incidence of SASS, after liver transplantation, can vary considerably, ranging from 0.6 to 10.1%. Several theories explain this pathophysiology, including splenic artery dilation, common in patients with chronic liver disease; increased hepatic resistance due to cellular edema; and reduced adenosine concentration in the hepatic artery, leading to arteriolar vasoconstriction[12]. Patients with this syndrome may present with elevated liver enzymes, cholestatic syndrome, and even acute liver failure. Diagnosis can be made using Doppler ultrasound by evaluating hepatic artery velocity, waveforms, and vascular resistance index; however, the gold standard is angiography.[13] Treatment aims to restore arterial flow to the liver graft and can be performed through splenectomy, splenic artery ligation, or SAE; embolization plays a key role due to its less invasive nature.[7]

The management of refractory portal hypertension is a more complex application. RA is an uncommon and potentially serious complication that can develop post-liver transplant and is associated with reduced survival in the first year after transplantation. According to D'Amico et al.[5], the estimated incidence of RA in these patients is 5 to 7% and can increase recipient mortality by up to 8.6 times. Continuous portal hyperflow, precipitated by splenic circulation, leads to decreased hepatic arterial flow through the so-called hepatic arterial buffer response. This system promotes the release of adenosine, an important vasodilator, in the portal system under low-flow conditions. However, in the context of persistent portal hypertension, this system reverses, leading to vasoconstriction of the hepatic artery and, later, to ascites and HH[14]. In this sense, partially interrupting splenic arterial flow promotes a reduction in venous circulation and, consequently, in flow over the portal vein[8,9]. Studies show positive results with both partial and total embolization for patients with RA. However, partial embolization appears to offer a better safety profile.[3] This occurs because SAE, primarily if performed in the proximal portion, has a higher risk of developing splenic abscess, sepsis, splenic infarction, and portal vein thrombosis[10].

Hypersplenism is reported less frequently in the literature. However, SAE has proven helpful in managing persistent cytopenias that hinder immunosuppression[2,4]. Following the procedure, there was a sustained increase in leukocyte and platelet counts; however, no significant impact on hemoglobin levels was demonstrated[4]. In isolation, in Maki et al.[11], SAE was used as a treatment for refractory encephalopathy in a patient who had undergone late liver transplantation, resulting in clinical and laboratory improvement.

Regarding safety, SAE has proven to be a well-tolerated procedure with a low rate of serious adverse events. The most frequent complication was post-embolization syndrome, characterized by abdominal pain and fever, which was self-limitin[g2,5,14]. More severe complications, such as splenic abscess, portal thrombosis, and splenic infarction, occurred sporadically and were generally associated with predisposing factors or extensive embolization[5,6,10]. In some selected cases, alternative approaches to SAE will be necessary to preserve the transplanted graft[15].

It is essential to distinguish prior theoretical knowledge from the clinical evidence presented in this review. Although the relationship between reduced portal hyperflow and improved hepatic perfusion is well established, current data validate SAE as a concrete therapeutic tool. The procedure has proven superior to conservative management, ensuring graft viability in critical scenarios. However, interpreting this efficacy should be cautious due to the inherent limitations of primary studies. The predominance of case reports and retrospective series introduces considerable publication bias, in which favorable outcomes are more often reported than therapeutic failures. Furthermore, significant methodological heterogeneity is observed, with substantial variations in indication criteria, materials used (coils versus vascular plugs), and technique (proximal versus distal embolization), which hinder the development of standardized protocols. These gaps highlight that, although the intervention is promising, prospective multicenter studies are still needed to define clear predictors of success and assess the real impact on long-term graft survival.

CONCLUSION

SAE is a minimally invasive, safe, and effective therapeutic strategy for managing selected complications after liver transplantation. The evidence reviewed reveals a viable alternative to surgical reintervention for the management of SASS, as well as being a viable option for the treatment of persistent manifestations of portal hypertension, notably RA, HH, and

hypersplenism. However, the current level of evidence warrants caution, as the literature analyzed consists chiefly of case reports and case series, with only three retrospective cohorts identified. This predominance of descriptive studies, coupled with technical heterogeneity, limits the generalizability of the findings. Therefore, although the immediate results are promising, the validation of robust clinical protocols depends on conducting future prospective, multicenter studies to standardize indications, optimize embolization techniques, and define the long-term outcomes of this procedure in the complex setting of post-liver transplantation.

CONFLICT OF INTEREST

Nothing to declare.

AUTHOR'S CONTRIBUTION

Substantive scientific and intellectual contributions to the study: Konrath AP, Maia GL, Fonseca Neto OCL; **Conception and design:** Konrath AP, Maia GL; **Data analysis and interpretation:** Konrath AP, Maia GL, Fonseca Neto OCL; **Article writing:** Konrath AP, Maia GL, Fonseca Neto OC; **Critical revision:** Fonseca Neto OC; **Final approval:** Konrath AP.

DATA AVAILABILITY STATEMENT

All dataset were generated or analyzed in the current study.

FUNDING

Not applicable.

DECLARATION OF USE OF ARTIFICIAL INTELIGENCE TOOLS

The authors declare that no artificial intelligence tools were used in the preparation, writing, data analysis, or review of this manuscript.

ACKNOWLEDGEMENT

Not applicable.

REFERENCES

1. Rysmakhanov M, Doskali M, Taganova A, Kulmagambetov A, Smagulov A, Seidakhmetov A, et al. Splenic artery embolization in patients after orthotopic liver transplant. Exp Clin Transplant, 2015; 13 (Suppl. 3): 52-4. https://doi.org/10.6002/ect.tdtd2015.O43
2. Lee CY, Lim WX, Chen CL, Yong CC, Yu CY, Tsang LL, et al. Efficacy and safety of splenic artery embolization for intractable ascites using Amplatzer vascular plug versus coil after living donor liver transplantation. Diagn Interv Radiol, 2022; 28(5): 478-85. https://doi.org/10.5152/dir.2022.21027
3. Fleckenstein FN, Luedemann WM, Kücükkaya A, Auer TA, Plewe J, Hamm B, et al. Splenic artery steal syndrome in patients with orthotopic liver transplant: where to embolize the splenic artery? PLOS ONE, 2025; 17(3): e0263832. https://doi.org/10.1371/journal.pone.0263832
4. DuBois B, Mobley D, Chick JF, Srinivasa RN, Wilcox C, Weintraub J. Efficacy and safety of partial splenic embolization for hypersplenism in pre- and post-liver transplant patients: a 16-year comparative analysis. Clin Imaging, 2019; 54: 71-7. https://doi.org/10.1016/j.clinimag.2018.11.012
5. D'Amico G, Partovi S, Del Prete L, Matsushima H, Diago-Uso T, Hashimoto K, et al. Proximal splenic artery embolization for refractory ascites and hydrothorax post-liver transplant. Cardiovasc Interv Radiol, 2023; 46. https://doi.org/10.1007/s00270-023-03376-3
6. Livingston AJ, Hickman L, Imani RA, Alexopoulos SP, Matsuoka L. Noninvasive management of complications from splenic artery aneurysm embolization after liver transplant: a case report. Exp Clin Transplant, 2021; 20(2). https://doi.org/10.6002/ect.2020.0531

7. Jiang J, Ji Y, Liang Y, Ou Y, Zhang L. Splenic artery embolization for splenic artery steal syndrome after living donor liver transplantation: a case report. Transplant Proc, 2022; 54(10). https://doi.org/10.1016/j.transproceed.2022.09.020

8. Pravisani R, Baccarani U, Adani G, Lorenzin D, Vit A, Cherchi V, et al. Splenic artery syndrome as a possible cause of late onset refractory ascites after liver transplantation: management with proximal splenic artery embolization. Transplant Proc, 2016; 48(2): 377-9. https://doi.org/10.1016/j.transproceed.2016.01.013

9. Okabe H, Yoshizumi T, Ikegami T, Uchiyama H, Harimoto N, Itoh S, et al. Salvage splenic artery embolization for saving falling living donor graft due to portal overflow: a case report. Transplant Proc, 2016; 48(9): 3171-3. https://doi.org/10.1016/j.transproceed.2016.07.023

10. Meighani A, Jafri SM, Raoufi M, Salgia R. Splenic artery embolization for treatment of refractory ascites after liver transplantation. ACG Case Rep J, 2016; 3(2): 136-8. Available at https://doi.org/10.14309/crj.2016.25

11. Maki H, Kaneko J, Arita J, Akamatsu N, Sakamoto Y, Hasegawa K, et al. Proximal total splenic artery embolization for refractory hepatic encephalopathy. Clin J Gastroenterol, 2017; 11(2): 156-60. https://doi.org/10.1007/s12328-017-0805-5

12. Liu DY, Yi ZJ, Tang Y, Niu NN, Li JX. Three case reports of splenic artery steal syndrome after liver transplantation. Transplant Proc, 2015; 47(10): 2939-43. https://doi.org/10.1016/j.transproceed.2015.10.037

13. Teegen EM, Denecke T, Schmuck RB, Öllinger R, Geisel D, Pratschke J, et al. Impact of Doppler ultrasound on diagnosis and therapy control of lienalis steal syndrome after liver transplantation. Ann Transplant, 2017; 22: 440-5. https://doi.org/10.12659/aot.903526

14. Nutu OA, Justo Alonso I, Marcacuzco Quinto AA, Calvo Pulido J, Jiménez Romero LC. Complete splenic embolization for the treatment of refractory ascites after liver transplantation. Rev Espanola Enfermedades Dig, 2018; 110(4). https://doi.org/10.17235/reed.2018.5338/2017

15. Bulman JC, Weinstein JL, Moussa M, Ahmed M. Transsplenic arterial embolization for splenic artery steal following liver transplant. J Vasc Interv Radiol, 2021; 32(3): 474-5. https://doi.org/10.1016/j.jvir.2020.11.013