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Short-term outcomes following elective transcatheter arterial embolization for splenic artery aneurysms: data from a nationwide administrative database

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Abstract

Background: Splenic artery aneurysm (SAA) rupture is life-threatening. Although elective transcatheter arterial embolization (TAE) suggested low in-hospital death in previous studies, there has been no large multi-center study of elective TAE for SAA.

Purpose: To examine the short-term outcomes of TAE for splenic artery aneurysm (SAA) and analyze the factors associated with the outcomes, including liver cirrhosis, using a nationwide administrative inpatient database.

Material and Methods: We identified patients who received elective TAE with a principal diagnosis of SAA. We assessed the patient background characteristics, comprising age, sex, and specific co-morbidities, including liver cirrhosis. The outcomes included the rate of TAE-related complications (acute pancreatitis, splenic infarction, splenic abscess, or intraperitoneal hematoma), length of stay, and in-hospital mortality.

Results: Among 18.3 million inpatients in the database between July 2010 and March 2013, we identified 534 patients who received elective TAE for SAA at 229 participating hospitals. Fifty-four (10.1%) patients had liver cirrhosis. No in-hospital deaths were observed. Thirty-two (6.0%) patients had at least one TAE-related complication. A multivariate linear regression analysis revealed that liver cirrhosis was significantly associated with longer length of stay (9.5 days; 95% confidence interval [CI], 7.0–12.0 days; $P < 0.001$). A logistic regression analysis showed that liver cirrhosis was not significantly associated with TAE-related complications (odds ratio, 0.99; 95% CI, 0.29–3.39; $P = 0.980$).

Conclusion: The results revealed no in-hospital mortality and a low complication rate associated with elective TAE for SAA including liver cirrhosis patients.

Keywords

Splenic artery aneurysm, transcatheter arterial embolization, liver cirrhosis, in-hospital mortality, acute pancreatitis, splenic infarction

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Introduction

Splenic artery aneurysm (SAA) is a rare disease, but SAA rupture is life-threatening (1). Conventionally, surgical repair including aneurysm ligation with or without end-organ resection (i.e. splenectomy or distal pancreatectomy) has been performed for the treatment of SAA (1,2). Sclafani et al. reported transcatheter arterial embolization (TAE) for splenic injury more than three decades ago (3). Recently, transcatheter arterial embolization (TAE) for SAA has become widespread (1,4–8).

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Regarding TAE for SAA, there have been several single-center case-series studies (1,4–7). One study described that 50 of 63 SAA patients were treated with elective TAE, and reported that there were 10 patients with major splenic infarction, and two patients with splenic artery dissection, but there were no in-hospital deaths (4).

Although the previous reports suggested the rarity of in-hospital death and the possibility of organ ischemia or hemorrhagic events derived from vascular injury associated with TAE for SAA, they were limited because they were based on single-center studies. To our knowledge, only one study in the English literature has been published on TAE with 11 SAA in a multicenter setting (9). Furthermore, SAA was reported to be complicated with liver cirrhosis (10), while it remains unclear whether liver cirrhosis increases the risk of TAE for SAA.

The present study aimed to clarify the short-term outcomes of elective TAE for SAA and to analyze the factors associated with the outcomes, including liver cirrhosis, using the Diagnosis Procedure Combination (DPC) database, a nationwide administrative inpatient database in Japan.

Material and Methods

Data source

Details of the DPC database have been described elsewhere (11,12). Briefly, the database consists of administrative claims and discharge abstract data. In 2013, the database included about seven million inpatients from approximately 1000 hospitals, which represented approximately 50% of all acute-care inpatient hospitalizations in Japan. The data recorded include the following items: unique identifiers of hospitals; type of admission (elective or emergency); patient age and sex; diagnoses recorded with text data in the Japanese language and the International Classification of Diseases, 10th Revision (ICD-10) codes; smoking status; therapeutic procedures; discharge status; length of stay; and estimated total costs based on reference prices in the Japanese national fee schedule that determined item-by-item prices for surgical, pharmaceutical, laboratory, and other inpatient services. Study approval was obtained from the Institutional Review Board of The University of Tokyo. Given the anonymous nature of the data collection process, informed consent was not required.

Data extraction

First, we identified the unique ICD-10 codes for SAA from the database. The diagnoses of these diseases were all coded with I728 (aneurysms of other specified arteries). Second, we performed a free text search with the term ''splenic artery aneurysm''. Third, we identified patients who received elective TAE with a principal diagnosis of SAA.

The patient background characteristics included age, sex, and specific co-morbidities including liver cirrhosis, cardiac diseases (ischemic heart disease, pulmonary embolism, endocarditis, or heart failure), history of cerebrovascular diseases (cerebral infarction, cerebral hemorrhage, or subarachnoid hemorrhage), lung diseases (chronic obstructive pulmonary disease, emphysema, chronic bronchitis, asthma, pneumonia, or respiratory failure), and renal failure.

Outcomes

We assessed the outcomes of TAE for SAA including TAE-related complications (acute pancreatitis, splenic infarction, splenic abscess, or intraperitoneal hematoma), immune system response following TAE (phlebitis, pneumonia, empyema, sinusitis, pyelonephritis, peritonitis, and septicemia), length of stay, in-hospital death, and total costs.

Statistical analysis

First, we compared the length of stay between the groups with or without liver cirrhosis by a *t*-test. Next, we conducted generalized linear regression analyses to model the concurrent effects of dependent variables (age, sex, liver cirrhosis, and cardiac diseases) on length of stay. Finally, a logistic regression analysis was conducted to analyze the effects of these variables on the occurrence of TAE-related complications. Values of $P < 0.05$ were considered statistically significant. All statistical analyses were conducted using SPSS version 22.0 (IBM SPSS Inc., Armonk, NY, USA).

Results

Among 18.3 million inpatients in the database between July 2010 and March 2013, we identified 783 patients who were admitted to 229 participating hospitals with a principal diagnosis of SAA. Of these, 721 patients had an elective admission, including 534 patients who received TAE during hospitalization. Twenty-five patients underwent elective splenectomy and nine patients underwent elective distal pancreatectomy along with splenectomy.

Table 1 shows the patient characteristics. The mean age was 62.6 years (age range, 12–89 years; standard deviation, 11.7 years). Overall, 54 (10.1%) patients had liver cirrhosis.

Table 2 shows the outcomes. No in-hospital deaths were identified. The median length of stay

Table 1. Patient background characteristics.

	Patients ($n = 534$)
Male, *n* (%)	236 (44.2)
Age (years), *n* (%)	
≤49	71 (13.2)
50–59	116 (21.7)
60–69	176 (33.0)
70–79	146 (27.3)
>80	25 (4.68)
Liver cirrhosis, *n* (%)	54 (10.1)
Cardiac diseases, *n* (%)	29 (5.4)
Cerebrovascular diseases, *n* (%)	4 (0.74)
Lung diseases, *n* (%)	13 (2.4)
Renal failure, *n* (%)	5 (0.94)

Table 2. Outcomes.

	Patients ($n = 534$)
In-hospital deaths, *n*	0
TAE-related complications, *n*	32
Acute pancreatitis, *n*	15
Splenic infarction, *n*	11
Splenic abscess, *n*	8
Intraperitoneal hematoma, *n*	1
Immune system response following TAE, *n*	5
Phlebitis, *n*	0
Pneumonia, *n*	3
Empyema, *n*	0
Sinusitis, *n*	0
Pyelonephritis, *n*	0
Peritonitis, *n*	1
Septicemia, *n*	1
Length of stay (days), median (interquartile range)	8.0 (5.0–12.0)
Total costs (US$), median (interquartile range)	15,191 (10,646–22,018)

(interquartile range) was 8 (5–12) days. Thirty-two patients (6.0%) had at least one TAE-related complication, including 15 patients with acute pancreatitis and 11 patients with splenic infarction. Five patients had immune system response following TAE. Of 54 patients with liver cirrhosis, two (3.7%) had post-TAE immune system response (one with peritonitis and the other with septicemia). Of 480 patients without liver cirrhosis, three (0.6%) had post-TAE immune system response (pneumonia). The difference in the proportions did not reach statistical significance ($P = 0.082$). The median total cost (interquartile range) was US$15,191 ($10,645–22,018). The median length of stay (interquartile range) with and without liver cirrhosis was 16 (10–21) days and8 (5–11) days, respectively.

Table 3 shows the results of the generalized linear regression analysis for length of stay. After adjusting for the patient background data, liver cirrhosis was significantly associated with longer length of stay (9.5 days; 95% confidence interval [CI], 7.0–12.0 days; $P < 0.001$).

Table 4 shows the results of the logistic regression analysis for TAE-related complications. Liver cirrhosis was not significantly associated with TAE-related complications (odds ratio, 0.99; 95% CI, 0.29–3.39; $P = 0.980$).

Discussion

In a large multicenter study of 534 patients who received elective TAE for SAA, we identified 32 TAE-related complications without any in-hospital deaths. Liver cirrhosis was significantly associated with longer length of stay, but was not significantly associated with the occurrence of TAE-related complications.

Our results provide the first multicenter data on the mortality and morbidity of elective TAE for SAA including liver cirrhosis patients, using a nationwide inpatient database. Prior studies using single-center series have suggested that TAE for SAA has a benefit in terms of reducing the in-hospital mortality (4–7,13). Previous studies involving single-center series or case reports have reported the occurrence of splenic infarction, splenic abscess, acute pancreatitis, splenic artery dissection, and bleeding following TAE for SAA (1,4,14,15). However, these data were limited by the small sample sizes. In the present study, no in-hospital deaths were identified, but 6% of the patients had TAE-related complications among the 534 patients who received elective TAE for SAA from over 200 hospitals.

SAA includes two types with different etiologies: pseudoaneurysm and true aneurysm. Pseudoaneurysm, which is caused by, for example, acute pancreatitis, surgery, or trauma, can be fatal (16). With regard to true aneurysm, a ruptured aneurysm is a life-threatening condition (1). It is considered difficult to assess the safety of TAE for SAA by evaluating ruptured aneurysm or pseudoaneurysm patients, because these conditions are life-threatening in themselves. For that reason, the present study focused on cases with unruptured true aneurysm of the splenic artery in the elective setting, and confirmed the safety of elective TAE for SAA.

Liver cirrhosis is a known risk factor for general surgery (17,18). However, it remains unclear whether

Table 3. Generalized linear regression analysis for length of stay.

	Coefficient	95% confidence interval	*P*
Liver cirrhosis			
Without	Reference		
With	9.5	7.0 to 12.0	<0.001
Sex (female)	0.2	−1.3 to 1.7	0.825
Age (years)	0.01	−0.05 to 0.08	0.747
Cardiac diseases	−0.8	−4.2 to 2.5	0.632

Table 4. Logistic regression analysis for TAE-related complications.

	Odds ratio	95% confidence interval	*P*
Liver cirrhosis			
Without	Reference		
With	0.99	0.29–3.39	0.980
Sex (female)	1.39	0.56–2.92	0.390
Age (years)	0.98	0.95–1.01	0.146
Cardiac diseases	0.67	0.09–5.18	0.699

TAE, transcatheter arterial embolization.

liver cirrhosis is a risk factor when SAA is treated with TAE techniques. Our data showed that liver cirrhosis was associated with longer length of stay, but not with complications, suggesting that TAE for SAA can also be performed safely in liver cirrhosis patients. A possible reason for the extended length of stay in TAE patients may be that some of the cirrhosis patients received concurrent partial splenic artery embolization to increase their platelet counts (8), which may have prolonged their length of stay through induced splenic infarction.

Several limitations should be acknowledged. First, the technical success rate was not evaluated because of the lack of data in the DPC database. In addition, the long-term effectiveness of the treatment was not assessed because of the lack of data availability. Second, we were unable to evaluate the size, number, or location of the aneurysms, because the DPC database does not contain detailed information for patients. Third, there are several coil embolization techniques including isolation, coil packing, and their combination. However, we could not distinguish these procedures because of the lack of data in the database.

In conclusion, our data revealed no in-hospital mortality and a low complication rate associated with elective TAE for SAA, including liver cirrhosis patients, in a large multicenter series. The results suggest that elective TAE for SAA can be performed safely even in liver cirrhosis patients.

Declaration of conflicting interests

The authors declared no potential conflicts of interest with respect to research, authorship, and/or publication of this article.

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