Retrospective Cohort Study

Segmental intrahepatic cholestasis as a technical complication of the transjugular intrahepatic porto-systemic shunt

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Abstract

BACKGROUND

Segmental intrahepatic cholestasis caused by transjugular intrahepatic portosystemic shunt (TIPS) (SIC-T), is a rare complication of this technique and only referred by case reports. Thus, we conducted a systematic, retrospective analysis to provide evidence regarding prevalence and consequences of this TIPS-induced bile duct compression.
AIM
To assess prevalence and outcome of SIC-T in a large TIPS-cohort.

METHODS
In this retrospective cohort study, we screened the institutional databases for all consecutive patients that were treated by TIPS-placement or TIPS-revision between January 2005 and August 2013. We analyzed radiologic images for signs of biliary congestion. Cases that were indicative of SIC-T were reviewed by two independent radiologists and additional patient data was collected. Descriptive statistics of patient demographics, indications for TIPS and procedural details were registered. Logistic regression analysis was performed to identify predictors for the development of SIC-T.

RESULTS
We analyzed 135 cirrhotic patients who underwent TIPS (mean age 55 years, 79% male gender). Etiology of cirrhosis was alcohol in most cases and indications for TIPS were mainly refractory ascites and recurrent variceal bleeding. TIPS revision was necessary in 31 patients. We identified 4 cases (2.9%) of SIC-T in direct proximity of the TIPS-stent. Diagnosis was confirmed by CT-scan, MRI or endoscopic retrograde cholangio pancreaticography (ERCP). In two patients TIPS was implanted via the right and in one through the medial hepatic vein. One patient received TIPS-prolongation by multiple revisions. Most patients were asymptomatic but one cholangitic abscess necessitated a transhepatic drain. Logistic regression analysis identified TIPS-placement other than from medial hepatic vein to right portal vein as risk factor (OR 21.0) for SIC-T.

CONCLUSION
SIC-T ads to (mostly late) complications in the interventional treatment of cirrhotic portal hypertensions and can lead to cholangitic abscesses. Patients, particularly with multiple interventions, should be screened for SIC-T.

Key words: Transjugular intrahepatic portosystemic shunt; Cirrhosis; Ascites; Bleeding; Cholestasis; Biliary congestion

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Core tip: Segmental intrahepatic cholestasis (SIC-T) is a rare and mostly late complication of transjugular intrahepatic portosystemic shunt (TIPS). Detection of SIC-T is performed by a combination of clinical, radiological and laboratory analyses. In the majority of patients, SIC-T requires no intervention but can lead to cholangitic abscesses. SIC-T contributes to late complications of TIPS-procedure. TIPS placement other than from the medial hepatic vein is an important risk factor for SIC-T development. Patients with atypical TIPS placements should be screened for SIC-T.

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INTRODUCTION
Portal hypertension is a consequence of chronic liver disease and the main cause of morbidity and mortality in patients with cirrhosis[1]. Although conservative therapy is an effective method to reduce portal hypertension[2], the implantation of a transjugular intrahepatic portosystemic shunt (TIPS) is the treatment of choice in refractory ascites (RA) and recurrent or refractory variceal bleeding (RVB)[3]. Moreover, recent data indicate that the use of a pre-emptive TIPS in variceal bleeding should be performed in all patients with end-stage liver disease[4].
Despite its convincing efficacy in reducing portal hypertension, a procedure related rate of major complications varies between less than 5% and up to 10%. Aside from life threatening acute complications that occur in less than 2%, post-interventional hepatic encephalopathy (up to 53.9%) and shunt-dysfunction (15-43.9%) are more frequent after TIPS. Rare chronic complications are isolated hyperbilirubinemia, stent migration, biliary fistula, migration and liver infarction. However, the use of covered and small diameter TIPS was associated with significantly less rates of complication but comparable efficacy and is now the standard of therapy.

Another rare complications of TIPS is a segmental intrahepatic cholestasis induced by TIPS-related compression of bile ducts (SIC-T). In order to identify prevalence and consequences of SIC-T in a large cohort, we evaluated all consecutive patients who underwent TIPS implantation or TIPS-revision at our institution since 2005. Moreover, we aimed to analyze risk factors for the development of SIC-T in regression analysis and described the management of SIC-T.

MATERIALS AND METHODS

Patient selection and procedure
The study protocol conforms to the ethical guidelines of the 1975 Declaration of Helsinki and was approved by the ethical review board of the Medical Faculty of the University of Leipzig (230/19-ek, June 16th 2019). In 2013 we reported a case of a segmental intrahepatic cholestasis caused by intrahepatic bile duct compression as a consequence of the TIPS-stent. Thus, all patients with TIPS were identified by screening our institutional databases. Then, all consecutive patients who were treated by TIPS-placement or revision with prolongation of formerly placed TIPS stents between January 2005 and August 2013 were included to this study. We identified 135 Patients (107 males, 28 female) that met the selection criteria. Medical records were evaluated for patient demographics including age, gender as well as etiology of cirrhosis and indication for TIPS. All patients received TIPS-implantations as recommended by current guidelines and Polytetrafluorethylene-(PTFE)-covered TIPS [VIATORR® TIPS-Stents (W.L. Gore, United States)] were used in all cases. Databases were also analyzed for the used techniques (puncture from the medial, right or left hepatic vein to the right or left portal vein). Here, the implantation of TIPS from the right hepatic vein to the right portal vein was considered as typical TIPS placement as described before. Also, the route from the medial hepatic vein to the right portal vein demonstrates an equivalent alternative. Revisions and indication for revision of TIPS were assessed and follow-up time with patient’s status at the end of follow-up was evaluated.

Imaging
All patients had at least one radiological imaging (ultrasound, contrast-enhanced CT or MRI) of the liver at our institution after TIPS-placement/-prolongation. The radiological imaging was reviewed by one radiologist who screened patients with TIPS for biliary congestion. Imaging, that showed signs of biliary congestion, was reviewed by a second radiologist and the diagnosis of SIC-T was either excluded or confirmed. For the patients with SIC-T we reviewed the medical history and the laboratory parameters that were indicative of biliary congestion in between the date of SIC-T diagnosis and the last imaging without signs of SIC-T. MRI was performed with 1.5 Tesla Siemens Symphony (Siemens Healthcare, Germany). For intravenous contrast, we used Gadoxetic acid (Bayer Healthcare Pharmaceuticals, Germany).

Statistical analysis
Statistical analysis was performed with SPSS 20 (IBM, Armonk, NY, United States). Data is presented with median as well as mean with lower and upper range or presented as “n” with a percentage (%) to each corresponding group. Logistic regression analysis was used to evaluate possible predictor for SIC-T. A P value ≤ 0.05 was considered statistically significant with except in regression analysis (P value less than 0.01 due to multiple testing). All statistical analyses were reviewed by an institutional biomedical statistician.

RESULTS

Patient cohort
Patients’ characteristics are presented in Table 1. Patients underwent 121 primary TIPS-placements and 30 TIPS-revisions (22.2%), of which in two patients multiple
revisions per patient were performed (\( n = 4 \) and \( n = 2 \)). Mean age was 54 years (19-84). The most frequent liver disease was alcoholic cirrhosis (84.3%) and the most frequent indications for TIPS-placement were RA (61.5%) and RVB (28.4%). In the majority of cases, the TIPS was placed from the medial hepatic vein to the right portal branch (79.3%). In 11.1% of the cases the TIPS was placed from the right hepatic vein to the right portal branch (together 90.4% typical TIPS placement) and in 2.2% an unconventional approach was performed for anatomical reasons. In 10 patients the anatomical route for TIPS-placement was not known because TIPS-placement was performed at another institution and follow-up was conducted by ultrasound. Indications for TIPS-revisions were hepatic encephalopathy because of high shunt-flow in 8 cases (26.7%) and RA because of low shunt flow or thrombosis in 8 and 14 cases (26.7% and 46.7% respectively). At the time of screening, the median retrospective follow-up after TIPS-placement per patient was 7 mo (mean/min/max = 19/0/148). Retrospective follow-up ended because of loss to clinical follow-up due to absence from our outpatient clinic or stop of retrospective follow up at the time of screening in 99 cases (73.3%), because of death with TIPS in 20 cases (14.8%) or because of consecutive liver transplantation in 17 cases (12.6%) (see Table 1). In 6 patients (4.4%) intrahepatic cholestasis was suspected in the initial screening because of tubular structures with fluid equivalent radiodensity converging in proximity to the TIPS stent. Two of these cases were identified as a hepatic vein obstruction by the reviewing radiologist while four cases of SIC-T (2.9%) were confirmed. Logistic regression analysis showed that TIPS-placement other than from the medial hepatic vein to the right portal branch was significantly associated with the occurrence of SIC-T (odds ratio 21.0, 95%CI: 0.7-5.4, \( P = 0.01 \)). In contrast, age, male gender, RVB as TIPS indication or etiology of cirrhosis other than alcohol could not be identified as predictors for SICT-T (Tables 1-3). In addition, multivariate logistic regression failed to identify prediction parameters for SICT-T (data not shown).

Medical history, imaging and management of patients with SIC-T

Patient 1 is a 59 year-old male with an alcoholic Child B cirrhosis, who received a TIPS from the right hepatic vein to the right portal branch for RA and hepatorenal syndrome (HRS). Lab values were unremarkable. One month after the procedure the patient was free of ascites and the renal function had returned to the patient’s baseline. No episode of hepatic encephalopathy occurred. A contrast enhanced abdominal CT scan for routine follow-up 6 years after TIPS-Placement incidentally showed the congestion of the intrahepatic bile ducts in segment VII. An MRI with liver specific, intravenous contrast and MRCP-sequence was performed to rule out hilar neoplasia and to clearly confirm the compression of the segmental bile duct by the TIPS-stent. It also showed a late contrast washout, that was highly suspicious for a hepatocellular carcinoma (HCC) in segment VIII unrelated to the biliopathy. Observational approach of the SIC-T was performed due to absence of cholangitis. The HCC was confirmed and treated by trans-arterial chemoembolisation and no episode of cholangitis or an attributable worsening of the cholestasis has occurred. After 2 years, a contrast enhanced CT-scan showed no signs of SIC-T. Unfortunately the patient developed bone metastases and had to be taken off the transplant waiting list.

Patient 2 is a 63 year old male with alcoholic Child B cirrhosis, who received a TIPS from the right hepatic vein to the right portal vein for RA. Lab values were inconspicuous. Reduction of ascites was sufficient and no episode of hepatic encephalopathy was registered. Although initial follow-up ultrasound was inconspicuous, a new, hypoechoic structure of 50 mm × 75 mm appeared 5 years after TIPS-placement in the right liver lobe. A contrast enhanced CT-scan revealed a tubular, cystic congestion of the intrahepatic bile ducts selectively in liver segment VII. The liver parenchyma in this segment was completely extinct by congested ducts. Tumorous compression was ruled out by MRCP with MRCP-sequence and the SIC-T was confirmed (see Figure 1). The patient negotiated complaints, thus an observational approach was conducted. In last follow-up, the patient was in a stable condition.

Patient 3 is a 50 year-old female with alcoholic Child C cirrhosis who received a TIPS from the medial hepatic vein to the right portal vein branch for RA and HRS. Initial ascites reduction and improvement of renal function were satisfying and hepatic encephalopathy was absent. One month after TIPS-placement, she was re-admitted with a relapse of ascites and spontaneous bacterial peritonitis (SBP). Relapse of alcoholic abuse was reported. The hydropic decompensation was caused by a low shunt flow due to a protrusion of the covered part of the portal TIPS-end that was diagnosed by TIPS-angiography. Multiple TIPS-revisions and a stent-in-TIPS procedure were performed to elongate the stent into the extrahepatic portal vein. A significant reduction of ascites and a sustained clinical stability was achieved. Follow-
Table 1 Patient demographics and clinical data of retrospectively screened cohort

| Characteristic                      | Value                        |
|------------------------------------|------------------------------|
| Age                                | 55 (19, 54, 84)              |
| Female                             | 28 (20.7)                    |
| Male                               | 107 (79.3)                   |
| Etiology of cirrhosis              |                              |
| Alcoholic                          | 114 (84.4)                   |
| NASH                               | 7 (5.2)                      |
| BCS                                | 4 (3.0)                      |
| Kryptogenic                        | 3 (2.2)                      |
| HCV                                | 2 (1.5)                      |
| PBC                                | 1 (0.7)                      |
| Autoimmune                         | 1 (0.7)                      |
| Hemochromatosis                    | 1 (0.7)                      |
| HBV                                | 1 (0.7)                      |
| Toxic                              | 1 (0.7)                      |
| Indications for TIPS               |                              |
| RA                                 | 83 (61.5)                    |
| RVB                                | 38 (28.4)                    |
| HRS                                | 10 (7.5)                     |
| BCS                                | 3 (2.2)                      |
| Others                             | 1 (0.7)                      |
| Technique                          |                              |
| MHV-RPV                            | 107 (79.3)                   |
| RHV-RPV                            | 15 (11.1)                    |
| LHV-LPV                            | 2 (1.5)                      |
| MHV-LPV                            | 1 (0.7)                      |
| Unknown                            | 10 (7.4)                     |
| Time with TIPS                     | 7 (0, 19, 148)               |
| Revision                           |                              |
| No revision                        | 105 (77.8)                   |
| 1 revision                         | 28 (20.7)                    |
| More than 1 revision               | 2 (1.5)                      |
| Indications for revision           |                              |
| Encephalopathy                     | 8 (26.7)                     |
| Low shunt flow                     | 8 (26.7)                     |
| Thrombosis                         | 14 (46.7)                    |
| End of follow-up                   |                              |
| Loss to follow-up                  | 99 (73.3)                    |
| Death with TIPS                    | 20 (14.8)                    |
| Consecutive LTx                    | 17 (12.6)                    |

1. At TIPS-placement in years; median; min; mean; max;
2. At end of screening; in months; median; min; mean; max. NASH: Non alcoholic steatohepatitis; BCS: Budd Chiari Syndrome; HCV: Hepatitis C; PBC: Primary biliary cholangitis; HBV: Hepatitis B; RA: Refractory ascites; HRS: Hepatorenal syndrome; MHV: Medial hepatic vein; RV: Right portal branch; RHV: Right hepatic vein; RVB: Refractory variceal bleeding; LHV: Left hepatic vein; LPV: Left portal branch; LTx: Liver transplantation; TIPS: Transjugular intrahepatic portosystemic shunt.

up ultrasound and CT-scan revealed a biliary congestion of the intrahepatic bile ducts in segment V converging and ending in direct proximity of the TIPS stent. By reason of elevated cholestasis parameters (sudden hyperbilirubinemia from 98 to 493 µmol/L), an endoscopic retrograde cholangio pancreatography (ERCP) was attempted but endoscopic access to the compressed bile duct could not be achieved. Decompression and biliary drainage through percutaneous transhepatic biliary drainage was not performed because of ascites. Thus, conservative therapy with antibiotic prophylaxis was initiated because the initial clinical deterioration of patient
Table 2  Characteristics of patients presenting with segmental intrahepatic cholestasis after intervention

| Patient | Age | Sex | Aetiology of cirrhosis | Indication for TIPS | TIPS-type | TIPS Localisation | Congested segments | Time from last imaging without SIC-T suspicion | SIC-T free interval with TIPS | MELD before SIC-T diagnosis | MELD at SIC-T diagnosis | Relevant complications |
|---------|-----|-----|-----------------------|--------------------|-----------|------------------|-------------------|---------------------------------|----------------------------|--------------------------|------------------------|------------------------|
| 1       | 51  | M   | Alcoholic RA & HRS    | PTFE-covered       | RHV-RPV   | VII              | 72                | 39                             | 11                        | 12                       | None                   | None                   |
| 2       | 55  | M   | Alcoholic RA          | PTFE-covered       | RHV-RPV   | VII              | 83                | 26                             | 19                        | 16                       | None                   | None                   |
| 3       | 49  | F   | alcoholic RA & HRS    | PTFE-covered       | MHV-RPV   | V                | 17                | <1                             | 18                        | 22                       | SBP                    | SBP                    |
| 4       | 44  | M   | BCS                   | RA                 | Atypical I | 0.4              | <1                | 10                             | 9                         | Hepatic abscess          | Hepatic abscess         | Hepatic abscess         |

1 At TIPS-placement in years; 2 In months. M: Male; F: Female; BCS: Budd Chiari Syndrome; RA: Therapy refractory ascites; HRS: Hepatorenal syndrome; PTFE: Polytetrafluoroethylene; MHV: Medial hepatic vein; RHV: Right hepatic vein; RPV: Right portal branch; SIC-T: Segmental intrahepatic cholestasis caused by intrahepatic bile duct compression by the TIPS-stent; MELD: Model of endstage liverdisease; SBP: Spontaneous bacterial peritonitis; TIPS: Transjugular intrahepatic portosystemic shunt.

3 was rather attributable to the development of SBP and the relapsing alcohol abuse than to the SIC-T. The patient was discharged but unfortunately, the patient did not keep follow-up appointment due to continued alcohol abuse.

Patient 4 is a 44 year-old male with a Child B cirrhosis and Budd-Chiari syndrome. A first TIPS-attempt in another hospital for RA failed because of an atypical portal and hepatic venous anatomy. A single hepatic vein drained mainly the right liver lobe with multiple collaterals combined with an atypical portal-venous anatomy. A TIPS-placement was achieved through an atypical approach from the sole right hepatic vein into an atypically located portal branch. Ascites reduction was acceptable and the patient did not suffer from hepatic encephalopathy. Nevertheless, lab values showed increased inflammatory markers and a subtle but relevant peak in bilirubin (22.3 µmol/L), alkaline phosphatase (AP) and gamma-glutamyl transferase (gGT) (peak at 5.2 and 2.9 µkat/L). CT-scan indicated a segmental cholestasis and a cholangitic abscess in liver segment I that was treated with a percutaneous drain. Antibiotics were prescribed. An angiography of the drain showed a connection of the abscess with the segmental bile duct that appeared to be compressed by the TIPS-Stent (see Figure 2). A consecutively performed ERCP showed an abrupt ending of the segment I bile duct next to the TIPS-stent but internal stent-placement was not possible. Nevertheless, hilar neoplasia could be excluded. Lab values decreased at baseline levels after two weeks. Further follow-up was unremarkable.

Details of the patients with SIC-T can be found in Table 2. Additionally, all patients were instructed in detail about signs and symptoms of cholangitis and the necessity to urgently admit in our emergency room if these were present.

DISCUSSION

TIPS-placement is a well-established option to treat complications of portal hypertension secondary to cirrhosis[1]. Major complications related to the TIPS-procedure occur in 5 up to 10%[7] and minor complications in up to 53% of the cases. These can be stratified into acute complications through accidental damage of hepatic structures resulting in vascular occlusion, hemorrhage or bile-leak. Chronic complications result from the partial liver bypass or a progressive tissue proliferation that lead to stent occlusion[8,11,12]. In most cases chronic complications develop after an initial clinical improvement whereas acute challenges mostly present with immediate symptoms.

We described a segmental intrahepatic cholestasis as a new type of TIPS-related complication as case report before[18]. In our current study, we identified in our TIPS-cohort 4 cases of segmental intrahepatic cholestasis caused by the TIPS-stent (SIC-T), which can be assigned to the group of complications that result from damage of intrahepatic structures, yet in case of SIC-T without causing immediate symptoms in...
Table 3  Univariate regression analysis for prediction of segmental intrahepatic cholestasis

| Variable                                | OR  | Univariate 95%CI | P value |
|-----------------------------------------|-----|------------------|---------|
| Age                                     | 0.96| -0.1 - 0.1       | 0.40    |
| Male gender                             | 0.78| -2.6 - 2.1       | 0.83    |
| Other than alcoholic cirrhosis          | 0.54| -2.9 - 1.7       | 0.60    |
| RVB as TIPS indication                  | < 0.01| -5654.8 - 5620.0| 0.99    |
| TIPS placement other than MHV-RPV       | 21.0| 0.7 - 5.4        | 0.01    |

RVB: Recurrent variceal bleeding; MHV: Medial hepatic vein; RPV: Right portal branch.

In our retrospective analysis, SIC-T was detected with a relevant prevalence at our center (2.9%). Most cases could only be identified by a detailed review of the whole population that was treated with a TIPS or a TIPS-revision. Moreover, SIC-T was a late complication of TIPS (time from TIPS to SIC-T up to 83 mo). The reason for the delayed diagnosis could be explained on the one hand by the absence of distinct symptoms or conspicuous lab values in the majority of the cases (3 out of 4 cases; 75%) and on the other hand in the long period from TIPS-placement to development of SIC-T. Even in patients with regularly follow-up imaging, the interval from last inconspicuous imaging to diagnosis of SIC-T was up to 39 mo. However, one patient developed a cholangitic abscess immediately after onset of a symptomatic SIC-T and its severe clinical course. Remarkably, the TIPS-placement in this case was performed by an unconventional approach from one single hepatic vein to an atypically situated right portal branch because of anatomic variation. Consecutively, this results in a rather straight and central direction of the TIPS stent, which is suspected to have caused the interference with the segment I bile duct. In 3 out of 4 patients with SIC-T, TIPS-placement could not be performed out of the preferred medial hepatic vein. This finding was confirmed in the logistic regression analysis that identified TIPS-placement other than from medial hepatic vein as significant risk factor for SIC-T (OR 21.0). We are aware, that the preferred TIPS route in most centers is from the right hepatic vein to the right portal vein as described before[19,20] and is seen as the standard of procedure. Nevertheless, a TIPS placement from the medial hepatic vein to the right portal vein is an accepted alternative with equal results[21]. Moreover, our data also indicate that the MHV-RPV route might help to prevent the occurrence of SIC-T.

The pathophysiological etiology for the development of (late) SIC-T remains multifactorial and not elucidated yet. Three patients (1-3) had multiple unsuspicious imaging including contras-enhanced CT-scan between TIPS-placement and the detection of SIC-T. Thus, the biliopathy must have developed several months after TIPS-placement in the majority of the patients. Other factors that can lead to a segmental biliary congestion such as portal hypertensive biliopathy, cavernoma or tumor were ruled out by CT, MRI or ERCP. A combined interplay of a mechanical compression, ischemia through compression of the segmental artery or tissue encasement through a proliferative stimulus is assumable. Also, one could hypothesize that SIC-T will result from stent placement through the segmental bile duct. Before the use of covered stents, this would have resulted in a biliary fistula as previously described[12]. In this regard, again an atypical TIPS-placement is very likely to be associated with SIC-T. Moreover, other factors that could influence a TIPS-induced compression of the bile ducts or liver tissue, for instance the diameter of dilution or the length of the TIPS, but were not analyzed in our cohort. In addition, transient bacteremia during TIPS-implantation or pathologies of the bile duct system should also be considered to contribute to SIC-T.

However, our analysis showed some limitations. First this is a retrospective analysis and in the most patients with SIC-T no interventions was needed (but one cholangitic abscess). Moreover, statistical analysis was based on 4 cases with SIC-T that could have impacted the results as a consequence of a low patient number.

In conclusion, the unusual etiology of segmental intrahepatic cholestasis caused by intrahepatic bile duct compression due to TIPS-stent ads, with a remarkable prevalence of 2.9%, to the variety of TIPS-related complications. Furthermore, SIC-T could be relevant for the management of the affected patients and may lead to cholangitic abscesses. Therefore, we propose that TIPS-patients, in particular with TIPS-placement other than from the medial hepatic vein or multiple interventions,
Figure 1 Transversal T2w magnetic resonance imaging of the liver of patient 2 who presented with segmental intrahepatic cholestasis caused by intrahepatic bile duct compression after transjugular intrahepatic portosystemic shunt. The arrow indicates the intrahepatic portion of the stent. Note the tubular structure with fluid typical high T2w signal converging in direct proximity of the transjugular intrahepatic portosystemic shunt which represents the congested, intrahepatic bile ducts of liver segment VII. The segments’ liver parenchyma is completely extinct by the dilated ducts. Other causes for bile duct obstruction were ruled out by T1w with liver specific contrast.

should be screened for SIC-T in their routine follow-ups.
ARTICLE HIGHLIGHTS

Research background
Transjugular intrahepatic portosystemic shunt (TIPS) is an accepted and emerging intervention in ascites and variceal bleeding related to portal hypertension. Several complications have been described so far but a segmental intrahepatic cholestasis caused by TIPS (SIC-T) was only described as case report so far.

Research motivation
We aimed to perform a retrospective cohort analysis to obtain prevalence and consequences of SIC-T.

Research objectives
Our analysis aimed at prevalence, outcome and risk factors for development of SIC-T.

Research methods
This is a monocentric retrospective cohort analysis. All TIPS patients between January 2005 and August 2013 were screened for signs of biliary congestion. Cases that were conspicuous for SIC-T were reviewed by two independent radiologists. Patients data and procedural details were registered. Logistic regression analysis was performed to identify predictors for the development of SIC-T.

Research results
Out of 135 cirrhotic TIPS patients we identified 4 cases (2.9%) of SIC-T in direct proximity of the TIPS-stent. Main indications for TIPS were refractory ascites and variceal bleeding. Most patients were asymptomatic but one patient suffered from a cholangitic abscess. Logistic regression analysis identified TIPS-placement other than from medial hepatic vein to right portal vein as risk factor (OR 21.0) for SIC-T.

Research conclusions
SIC-T is a relatively rare and late complication of TIPS. Most patient do not require an intervention but severe infectious complications can occur. Patients with multiple interventions or atypical TIPS implantation should be screened for SIC-T.

Research perspectives
Future studies analyzing safety and complications of TIPS should include SIC-T as possible late complication of TIPS.

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