Technical Note

Transhepatic tract hemostasis using thermal-ablation after percutaneous portal vein access

Mathilde Vermersch, MD, Alban Denys, MD, Florent Artru, MD, Georgia Tsoumakidou, MD, Nicolas Villard, MD, Rafael Duran, MD and Arnaud Hocquelet, MD, PhD

Department of Radiology, Lausanne University Hospital CHUV, Lausanne, Switzerland
Department of Radiology, Lille University Hospital, Lille, France
Department of Gastro-enterology, Lausanne University Hospital CHUV, Lausanne, Switzerland

Address correspondence to: Dr Mathilde Vermersch
E-mail: mathilde.vermersch.lille@gmail.com

INTRODUCTION

Treatment of portal vein stenosis/thrombosis or portal hypertension-related bleeding requires portal vein access, most often performed using percutaneous transhepatic portal vein approach. Removal of the sheath during the trans-hepatic approach can result in significant bleeding from the puncture tract, especially if an anticoagulant is used (recanalization) or if puncture tract closure is not performed. Embolization of the trans-parenchymal puncture tract has been described using various embolic agents including collagen, coils, Amplatz vascular plug, Gelfoam, and N-butyl cyanoacrylate, each with their own drawbacks. Thermal-ablation is commonly used by interventional radiologists for liver tumor ablation with coagulation of puncture tract to avoid bleeding and tumor dissemination. The purpose of the present study was to report the initial results of coagulation of the trans-hepatic puncture tract using thermal-ablation (radiofrequency or microwave ablation) after percutaneous transhepatic direct portal vein access.

PATIENTS AND METHODS

The Institutional Review Board approved this study (ID 2019–01409).

Patients

Between December 30, 2019 and July 16, 2020, 10 patients were treated for portal vein stenosis/thrombosis (n = 9) or bleeding from portal hypertension (n = 1) using transhepatic portal vein access. Treatment by the percutaneous transhepatic approach was decided by interdisciplinary consensus. Written informed consent was obtained from all patients. All patients were retrospectively analyzed. The patients’ medical records, radiological records and images were evaluated. Patient characteristics are presented in Table 1. The platelet count varied from 54 to 416 x 10^9/L and none of the patients had a prothrombin time under 65% or international normalized ratio upper than 1.2. Most patients received therapeutic doses of anti-coagulation during and immediately after the procedure (80%).

Objectives: Bleeding risk after percutaneous portal vein access procedures is not negligible. Various agents, coils and plug, have been used to minimize this risk, each with their own advantages and disadvantages. This study reports the results of coagulation using thermal-ablation (radiofrequency or microwave ablation) as an alternative to trans-hepatic puncture tract closure.

Methods: Ten patients who benefited from portal vein recanalization or portal hypertension-relative bleeding complication embolization using percutaneous portal vein access and who underwent thermal-ablation of the puncture tract between December 30, 2019 and July 16, 2020 were included. Early efficiency and safety were evaluated using imaging (ultrasound and/or CT scan) and laboratory data (hemoglobin, hepatic function) at 24h. Follow-up was performed until August 2020.

Results: No bleeding from the puncture tract and no embolization-related complications were observed in all 10 patients at 24h or during follow-up with median of 3 months (range 1-8 months), even in case of ascites or therapeutic coagulation.

Conclusion: Thermal-ablation seems to be a safe, effective and rapid technique to avoid bleeding after percutaneous transhepatic direct portal vein access.

Advances in knowledge: Thermal-ablation could be an alternative for transhepatic puncture tract closure especially for patients with high bleeding risk.
| Patient Number | Sex | Age (years) | Intervention performed | Indication of treatment | Platelet Count (G/l) | Intervention time (min) | PT (%) | INR | Ascites | Portal Pressure (mmHg) | Portal branches punctured | Per procedural anticoagulation (IU of heparin) | Post-operative anticoagulation | Thermo-ablation needle | Complication |
|----------------|-----|-------------|------------------------|-------------------------|---------------------|------------------------|--------|-----|---------|----------------------|--------------------------|-----------------------------|-----------------------------|-----------------------|--------------|
| 1              | Male | 72          | Portal recanalization  | Pancreatic cancer with portal thrombosis Bleeding | 415                 | 80                      | 75     | 1.2 | No      | 15                   | VI                       | 6600                        | Yes                         | Microwave NeuWave PR probe | No           |
| 2              | Male | 62          | Portal recanalization  | Pancreatic cancer with portal thrombosis Abdominal pain | 236                 | 80                      | 90     | 1.1 | No      | 14                   | VI                       | 6600                        | Yes                         | Microwave NeuWave PR probe | No           |
| 3              | Male | 76          | Portal recanalization  | Pancreatic cancer with portal thrombosis Bleeding | 229                 | 50                      | 85     | 1.1 | No      | 9                    | VI                       | 5000                        | Yes                         | Microwave NeuWave PR probe | No           |
| 4              | Female | 70        | Portal recanalization  | Cholangiocarcinoma with portal thrombosis Bleeding | 185                 | 170                     | 85     | 1.1 | No      | .                    | III                      | 1000                        | Yes                         | Microwave NeuWave PR probe | No           |
| 5              | Male | 75          | Embolization of peristomial varices | Cirrhosis Peristomial varices bleeding | 111                 | 80                      | 65     | 1.2 | Yes     | .                    | VBI                      | .                           | No                          | Microwave NeuWave PR probe | No           |
| 6              | Male | 74          | Portal recanalization  | Pancreatic cancer with portal thrombosis Abdominal pain | 331                 | 80                      | 80     | 1.1 | Yes     | 12                   | V                       | 7500                        | Yes                         | Radiofrequency needle Covidien | No           |
| 7              | Male | 77          | Portal recanalization  | Pancreatic cancer Whipple with portal reconstruction Stenosis | 302                 | 70                      | 90     | 1.1 | Yes     | 26                   | V                       | 1000                        | Yes                         | Radiofrequency needle Covidien | Bloody fluid in the ascites drain without active bleeding or hemodynamic disorder |
| 8              | Male | 63          | Splenic vein recanalization | Pancreatitis with splenic and portal vein thrombosis Gastric varices bleeding | 54                  | 130                     | 65     | 1.2 | No      | 27                   | VI                       | 5000                        | Yes                         | Radiofrequency Cluster needle Covidien | No           |
| 9              | Female | 73       | Portal pressure measurement | Refractory ascites post Whipple | 304                 | 30                      | 100    | 1   | Yes     | 8                    | V                       | .                           | No                          | Microwave NeuWave PR probe | No           |
| 10             | Male | 57          | Portal recanalization  | Pancreatitis with portal stenosis Bleeding | 136                 | 75                      | 90     | 1.1 | No      | 11                   | V                       | 5000                        | Yes                         | Microwave NeuWave PR probe | No           |
Portal vein intervention
Based on the findings of contrast-enhanced CT of the abdomen performed before each intervention, the portal vein was accessed by a right transhepatic approach in nine patients (portal branch from segment V, VI or VIII) and by a left approach (portal branch from segment III) in one patient because of a prior right heptectomy. An attempt was made in each patient to puncture a peripheral branch of the right portal vein under ultrasound guidance using a 21G needle (CHIBA, Boston Scientific, Natick, MA, USA). A guide wire was advanced into the portal vein and a 6F 25 centimeter size sheath (Super Arrow-Flex, Teleflex Medical) was inserted using the Neff percutaneous access set (Cook Medical, USA) by the Seldinger technique (diameter was chosen as small as possible to allow procedure). Intrahepatic portal pressure after procedure varied from 8 to 27 mm Hg. Therapeutic coagulation during and after the procedure was required in eight patients in whom splenic and portal vein (n = 1) or portal vein (n = 7) stenting was performed. One of the two remaining patients underwent embolization for portal hypertension-related bleeding and portography and pressure measurement was performed in another, with no significant stenosis. After treatment of the portal vein was complete, operator performed occlusion of the transhepatic puncture tract using thermal-ablation.

Technique of puncture tract embolization
The puncture tract was coagulated using microwave (Neuwave PR probe 17G 15 cm, with emitting point at 1 cm proximal from the tip, Johnson and Johnson) in seven patients or with radiofrequency in the three remaining patients (Covidien Cool-Tip, with 2 cm active portion, Medtronic). The choice of microwave or radiofrequency was at the discretion of operator. The same operator who punctured the portal branch coagulated the puncture tract in all patients. A microwave or radiofrequency needle was introduced alongside the intrahepatic puncture tract under ultrasound guidance and advanced 2–3 cm into the liver parenchyma to close the capsular puncture site and limit the volume of ablated liver. Introduction of the thermal-ablation needle into the sheath, even if it is theoretically possible, was not retained because of the length of the sheath (too long, which would, therefore, have required an exchange over wire with risks of bleeding and loss of the path) and the coil-wire design (with risk of heat conduction). The sheath was then removed and thermal-ablation was performed using standard ablation parameters and stopped after one roll-off for radiofrequency and after 2 min at 65W for microwave. A power of 65W was chosen because only one shot was performed unlike a usual puncture tract ablation. An ultrasound was performed immediately after the procedure to check the intra hepatic and main portal vein patency and the absence of bleeding or subcapsular hematoma (Figure 1).

The day after the procedure, a formal abdominal ultrasound with hepatic Doppler or CT scan were performed by independent radiologist. Follow-up laboratory evaluation (hemoglobin and hepatic function) was also performed 24h after procedure.

Follow-up
The medical records (clinical and laboratory data) were evaluated to determine the technical and clinical success of the puncture tract embolization as well as local or general complications. Follow-up CT scans were evaluated to visualize the ablation zone.

RESULTS
Stenting for portal vein stenosis as well as for the embolization of portal hypertension-related varices was technically successful with no significant residual pressure gradient and no portal hypertension-related bleeding in all nine patients. The main portal vein was patent in all patients and no subcapsular hematomas were observed in the immediate post-operative ultrasound. No patient showed a decrease in hemoglobin level of more than 2 g.dl⁻¹. Bloody fluid in the ascites drain was observed in one patient, without decrease in hemoglobin level or hemodynamic instability. A CT scan performed 6h after the procedure did not find any active bleeding or hematoma.

There were no major biological complications. Significant transient cytolysis (five times above normal) occurred in one patient, which was entirely and spontaneously resolved in 3 days. Mild transient cytolysis (less than two times above normal) occurred in four patients and resolved spontaneously in 3 days. No cholestasis or hepatocellular insufficiency was observed. There were no infectious complications. Post-operative pain was mild-to-moderate and easily controlled by the usual analgesics. The ablation zone was easily visualized on CT scan as a subcapsular hypodense triangular patch. On subsequent scans, capsular retraction is seen with a decrease in the thermal-ablation zone (Figure 2).

One patient died during follow-up due to tumor progression with no complications from the intervention. The remaining nine patients were all still alive after a median follow-up of 3
Figure 2. Pre- and post-operative aspect a. Severe portal stenosis (black thick arrow) with collateral pathways (black arrow) b. Stent was deployed across the stenotic segment (black thick arrow) allowing satisfactory portal flow and disappearance of collateral pathways. c. Visualization of the puncture tract with the sheath (thin arrow) under ultrasound. d and e. Microwave probe (arrowhead) is inserted along the puncture tract and thermal-division is performed. f. Ultrasound control using Doppler showed the absence of active bleeding and a patent portal vein. g. First scan after intervention showed a sub capsular hypodense triangular patch corresponding to ablation zone (thick arrow). h. Second scan performed 5 months later with MIP reconstruction: patent stent without deviation route i. 5 months later, capsular retraction and decrease in the triangular patch (thick arrow).

months (1–8 months). No complications were observed in these patients.

**DISCUSSION**

The percutaneous transhepatic approach is the common access route for portal vein angioplasty or balloon occluded antegrade venous obliteration of varices. Without transhepatic tract closure, this approach is complicated by hemorrhage in up to 30% of cases. Bleeding from the puncture tract is usually venous and most likely a result of blood running from the punctured portal vein through the hepatic puncture tract into the peritoneal cavity. Several techniques have been described to prevent post-interventional bleeding from the puncture tract including collagen cylinders, coils, Amplatzer vascular plugs, N-butyl cyanoacrylate or Gelfoam. With these techniques, post-procedure bleeding risk was decreased; however, there were some reports leading to surgical ligation. Moreover, embolic agents, when they are used by unexperienced radiologist, are not without risk: liquid agent migration, potentially leading to portal vein thrombosis, or incomplete tract embolization in case of high portal pressure; non-target embolization of coils when hepatic vein or bile duct have been traversed; transhepatic tract damage with oversized plug. Thermo-division, based on surgical cautery technique but without surgical approach, appears as an interesting alternative, this technology being commonly used and mastered by interventional radiologists for liver tumor ablation. The use of radiofrequency ablation to avoid bleeding complications after liver biopsy has already been described in *ex vivo* and *in vivo* experimental studies in pigs. These studies revealed a decrease in bleeding events even in a group receiving therapeutic coagulation. Recently, a letter was published reporting the emergency use of radiofrequency to stop active portal vein access bleeding in one patient after unsuccessful portal tract embolization.

Furthermore, with thermal-division, the ablation zone can be monitored under ultrasound guidance (as hyperechoic areas) avoiding peripheral portal vein thrombosis. Additional benefit, unlike other puncture tract closure techniques, this technique can be used in a second time, after sheath ablation, if ultrasound revealed bleeding.

Even if this technique have lots of advantages without major complications occurred in our cohort, some disadvantages should be mentioned. Firstly, this technique remains expensive, especially in comparison with others techniques and should be considered as an alternative in patients with high bleeding risk. Secondly, the usual contraindications to thermal-division, like biliodigestive anastomosis or concomitant biliary obstruction, should apply to this technique to avoid complication (abcess). Thirdly, thermal-division zone should be monitored to avoid unnecessary parenchymal loss or subcutaneous tissues damage.

Some limitations of this study should be mentioned. Firstly, the study cohort was retrospectively selected and limited to a single institution. Secondly, the study is limited to a small sample size. However, it is a pilot study describing a new technique.

In conclusion, bleeding complications from transhepatic puncture tracts are rare but possible and systematic occlusion of the tract is recommended. Thermal-division (radiofrequency or microwave) seems to be a safe, effective and rapid technique to avoid bleeding in these patients. Thus, interventional radiologists should be aware of this possible alternative.

**LEARNING POINTS**

- Thermal-division could be used as an alternative to coil/gelfoam for transhepatic tract hemostasis
- Thermal-division is effective and safe for avoiding bleeding, especially in patients with high risk of bleeding.

**REFERENCES**

1. Marot A, Barbosa JV, Duran R, Deltenre P. Percutaneous portal vein recanalization using self-expandable nitinol stents in patients with non-cirrhotic non-tumoral portal vein occlusion. *Diagn Interv Imaging* 2019; 100: 147–56. doi: https://doi.org/10.1016/j.diin.2018.07.009
2. Dollinger M, Goessler M, Mueller-Wille R, Wohlgemuth WA, Stroszczyński C, Heiss P. Percutaneous transhepatic and transsplenic portal vein access: embolization of the puncture tract using amplatz vascular plugs. *ROFO Fortschr Geb Rontgenstr Nuklearmed* 2014; 186: 142–50.
3. Adani GL, Baccarani U, Risaliti A, Sponza M, Gasparini D, Bresadola F, et al. Percutaneous transhepatic portography for the treatment of early portal vein thrombosis after surgery. Cardiovasc Intervent Radiol 2007; 30: 1222–6. doi: https://doi.org/10.1007/s00270-007-9056-z

4. Cheng Y-F, Ou H-Y, Tsang LL-C, Yu C-Y, Huang T-L, Chen T-Y, et al. Vascular stents in the management of portal venous complications in living donor liver transplantation. American Journal of Transplantation 2010; 10: 1276–83. doi: https://doi.org/10.1111/j.1600-6143.2010.03076.x

5. G-Y K, Sung K-B, Yoon H-K, Lee S. Early posttransplantation portal vein stenosis following living donor liver transplantation: percutaneous transhepatic primary stent placement. Liver Transplant Off Publ Am Assoc Study Liver Dis Int Liver Transplant Soc 2007; 13: 530–6.

6. Wei B-J, Zhai R-Y, Wang J-F, Dai D-K, Yu P. Percutaneous transhepatic venoplasty and stenting for anastomotic stenosis after liver transplantation. World J Gastroenterol 2009; 15: 1880–5. doi: https://doi.org/10.3748/wjg.15.1880

7. Lundequist A, Vang J. Transhepatic catheterization and obliteration of the coronary vein in patients with portal hypertension and esophageal varices. N Engl J Med 1974; 291: 646–9. doi: https://doi.org/10.1056/NEJM197409262911130

8. Zhang CQ, Liu FL, Liang B, Xu HW, Xu L, Feng K, et al. A modified percutaneous transhepatic varices embolization with 2-octyl cyanoacrylate in the treatment of bleeding esophageal varices. J Clin Gastroenterol 2009; 43: 463–9. doi: https://doi.org/10.1097/MCG.0b013e31817f90f

9. Bruners P, Penzkofer T, Isfort P, Pfeffer J, Schmitz-Rode T, Günther RW, et al. A trucut biopsy needle for bipolar radiofrequency ablation of needle tract: a proof-of-concept experiment. Eur Radiol 2010; 20: 2000–4. doi: https://doi.org/10.1007/s00330-010-1739-1

10. Lim S, Rhim H, Lee MW, Song KD, Kang TW, Kim Y-sun, et al. New radiofrequency device to reduce bleeding after core needle biopsy: experimental study in a porcine liver model. Korean J Radiol 2017; 18: 173–9. doi: https://doi.org/10.3348/kjr.2017.18.1.173

11. Vermersch M, Duran R, Vietti Violi N, et al. Radiofrequency ablation to control bleeding from a percutaneous infrahepatic puncture tract of a large diameter portal vein: a simple and rapid solution to a potentially life-threatening bleeding. Cardiovasc Intervent Radiol 2020;

12. Jiang Z-B, Shan XY, Shen MS, Huang ZR, Li KS, Zhu SH. Transjugular intrahepatic portosystemic shunt for palliative treatment of portal hypertension secondary to portal vein tumor thrombosis. WJG 2004; 10: 1881–4. doi: https://doi.org/10.3748/wjg.v10.i13.1881

13. Perarnau J-M, Baju A, D’Alteroche L, Viguier J, Ayoub J. Feasibility and long-term evolution of tips in cirrhotic patients with portal thrombosis. Eur J Gastroenterol Hepatol 2010; 22: 1693–8. doi: https://doi.org/10.1097/MEG.0b013e328338d995

14. Senzolo M, Tibbals E, Cholongitas E, Triantos CK, Burroughs AK, PATCH D. Transjugular intrahepatic portosystemic shunt for portal vein thrombosis with and without cavernous transformation. Aliment Pharmacol Ther 2006; 23: 767–75. doi: https://doi.org/10.1111/j.1365-2036.2006.02820.x

15. Valentín N, Korrapati P, Constantino J, Young A, Weisberg I. The role of transjugular intrahepatic portosystemic shunt in the management of portal vein thrombosis: a systematic review and meta-analysis. Eur J Gastroenterol Hepatol 2018; 30: 1187–93. doi: https://doi.org/10.1097/MEG.0000000000001219