Introduction

Ultrasound-guided percutaneous biopsy is a well-established means for diagnosis of focal or diffuse disease in solid organs. It is generally safe and confers minimal risk of complications. However, it is contra-indicated in patients with bleeding tendencies, which means that histological diagnosis may be lacking and sometimes life-saving treatment cannot be commenced. Plugging of the biopsy tract is a promising technique to decrease the risk of post-biopsy haemorrhage, for which Gelfoam is the most commonly used agent. In this article, we share our experience in performing this procedure using Gelfoam slurry followed by Gelfoam torpedo in patients at high risk of post-procedure haemorrhage in our institution.

Methods

The Department of Radiology and Organ Imaging, United Christian Hospital, is the main radiology training centre of the Kowloon East Cluster, Hong Kong. Apart from diagnostic imaging, we provide both emergency and elective interventional radiology services. In the form of a retrospective study approved by our local ethics committee, since 2005, it has been our standard practice to plug the biopsy tract in all patients considered at risk of haemorrhage after having ultrasound-guided percutaneous biopsy.
of a solid organ. Our departmental registry recorded all the cases receiving plugged percutaneous biopsy (PPB) of solid organs performed from 1 January 2005 to 30 September 2012. There was no reported refusal of the procedure by any patient. Demographic data, indication for the biopsy and for plugging of the biopsy tract, details of the biopsy technique, biopsy results, and any episodes of post-biopsy haemorrhage treated by transfusion or any other type of intervention were reviewed for each patient. Relevant details are listed in Table 1.

### Technique

All PPBs were performed under strict aseptic conditions with instruments as shown in Figure 1. A biopsy path avoiding critical structures and major vessels was selected under ultrasound guidance. The length of the biopsy path starting from the organ capsule to the target region was measured (Fig 2a). A strip of Gelfoam of the same length and with a width of approximately 2 mm was cut from a sheet of Gelfoam. Before being cut, the sheet of Gelfoam was compressed manually to expel all air bubbles. A Gelfoam torpedo was formed by rolling the strip of Gelfoam into a rod-like structure (Fig 2b). The remaining Gelfoam sheet was then cut into tiny pledgets of around 2 mm x 2 mm in size. A syringe filled with Gelfoam pledgets and another syringe filled with saline were both connected to a 3-way stopcock. Macerating the suspension with two syringes and a 3-way stopcock allowed further decreases in size of the pledgets into a slurry (Fig 2c). After the Gelfoam torpedo and slurry were ready, the puncture site was injected with local anaesthetic (5-10 mL of 1-2% lignocaine) and a small skin incision was created. Patients were then instructed to hold their breath while a coaxial introducer needle (17G or 19G, 108 Hong Kong Med J Volume 20 Number 2 April 2014 www.hkmj.org

### TABLE 1. Details of patient demographic data, indication for plugged biopsy, biopsy site and technique, and pathological results

<table>
<thead>
<tr>
<th>Patient No.</th>
<th>Sex/age (years)</th>
<th>Indication of biopsy</th>
<th>Biopsy site</th>
<th>Reason for plugged biopsy age</th>
<th>Needle size (coaxial/ Tenmo needle in G)</th>
<th>No. of needle pass(es)</th>
<th>Complication</th>
<th>Pathology</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>F/66</td>
<td>Liver failure, suspected autoimmune hepatitis</td>
<td>Liver</td>
<td>INR=1.7, APTT=42.6 s</td>
<td>17/18</td>
<td>2</td>
<td>No</td>
<td>Autoimmune hepatitis</td>
</tr>
<tr>
<td>2</td>
<td>M/69</td>
<td>Liver mass</td>
<td>Liver</td>
<td>INR=1.4</td>
<td>19/20</td>
<td>3</td>
<td>No</td>
<td>Adenocarcinoma metastasis</td>
</tr>
<tr>
<td>3</td>
<td>M/58</td>
<td>Liver mass</td>
<td>Liver</td>
<td>Active oozing from biopsy tract</td>
<td>17/18</td>
<td>1</td>
<td>No</td>
<td>Hepatocellular carcinoma</td>
</tr>
<tr>
<td>4</td>
<td>F/72</td>
<td>Liver mass</td>
<td>Liver</td>
<td>Active oozing from biopsy tract</td>
<td>17/18</td>
<td>2</td>
<td>No</td>
<td>Stereo-hepatitis</td>
</tr>
<tr>
<td>5</td>
<td>F/54</td>
<td>Suspected autoimmune hepatitis</td>
<td>Liver</td>
<td>INR=1.3, APTT=37.2 s</td>
<td>19/20</td>
<td>3</td>
<td>No</td>
<td>Chronic hepatitis</td>
</tr>
<tr>
<td>6</td>
<td>F/40</td>
<td>Suspected cirrhosis</td>
<td>Liver</td>
<td>INR=1.4, Plt=90 x 10^9/L</td>
<td>17/18</td>
<td>3</td>
<td>No</td>
<td>Chronic hepatitis with cirrhosis</td>
</tr>
<tr>
<td>7</td>
<td>F/69</td>
<td>Suspected liver amyloidosis</td>
<td>Liver</td>
<td>Active oozing from biopsy tract</td>
<td>17/18</td>
<td>3</td>
<td>No</td>
<td>Cirrhosis</td>
</tr>
<tr>
<td>8</td>
<td>F/74</td>
<td>Splenic mass</td>
<td>Spleen</td>
<td>Hypervascular biopsy organ</td>
<td>19/20</td>
<td>1</td>
<td>No</td>
<td>Burkitt-like lymphoma</td>
</tr>
<tr>
<td>9</td>
<td>F/29</td>
<td>Suspected cirrhosis</td>
<td>Liver</td>
<td>INR=1.4, APTT=38 s, Plt=70 x 10^9/L</td>
<td>17/18</td>
<td>3</td>
<td>No</td>
<td>Lymphocytic infiltrates</td>
</tr>
<tr>
<td>10</td>
<td>M/47</td>
<td>PUO, PET-CT hypermetabolic liver</td>
<td>Liver</td>
<td>INR=1.5, APTT=50.6 s, Plt=62 x 10^9/L</td>
<td>17/18</td>
<td>4</td>
<td>No</td>
<td>Tuberculosis</td>
</tr>
<tr>
<td>11</td>
<td>F/58</td>
<td>Liver mass</td>
<td>Liver</td>
<td>Active oozing from biopsy tract</td>
<td>17/18</td>
<td>3</td>
<td>No</td>
<td>Hepatocellular carcinoma</td>
</tr>
</tbody>
</table>

Abbreviations: APTT = activated partial thromboplastin time; INR = international normalised ratio; PET-CT = positron emission tomography–computed tomography; Plt = platelet count; PUO = pyrexia of unknown origin.
CareFusion; Waukegan [IL], US) was advanced to the target region. The stylet of the coaxial introducer needle was removed, with the outer sheath held firmly in place. A Temno biopsy needle (18G or 20G, CareFusion) was then inserted through the sheath under ultrasound guidance. Biopsy specimens were obtained in a standard manner. After removal of the Temno needle between passes, the stylet of the coaxial introducer needle was reinserted into the sheath to decrease the chance of haemorrhage. After adequate specimens were obtained by inspection, 1 to 2 mL of Gelfoam slurry was injected into the sheath of the coaxial introducer needle (Fig 3). The Gelfoam torpedo was then placed at the hub of the sheath of the coaxial introducer needle (Fig 4a) and pushed by the stylet until the echogenic tip of the stylet was advanced to the organ capsule (Fig 4b). The outer sheath was then withdrawn while keeping the stylet still (Fig 4c), so that the Gelfoam torpedo could be deployed along it and therefore sealing the biopsy tract. Finally, the entire coaxial introducer needle was removed.

Results
During a 7-year period, we performed 11 cases of plugged percutaneous solid organ biopsy in 11 patients, all of whom were considered at high risk of post-biopsy bleeding due to the reasons listed in Table 1. The mean patient age was 58 (standard deviation [SD], 14) years. Three patients were male and eight were female. The target organ was the liver in 10 cases and the spleen in one. The indications for biopsy were to achieve a diagnosis of a focal mass in five cases, and characterisation of diffuse hepatic diseases in six (Table 1). The number of needle passes ranged from one to four, with a mean of 2.5 (SD, 0.9). In all cases, the combination of a coaxial introducer needle and Temno needle (both by CareFusion) were used. The combination of a 17G coaxial introducer needle and 18G Temno needle was used in eight biopsies, while the combination of a 19G coaxial introducer needle and 20G Temno needle was used thrice. All the biopsies were technically successful in obtaining adequate specimens for a histological diagnosis. None of the patients experienced post-biopsy haemorrhage treated by transfusion or any other form of intervention.

Discussion
Ultrasound-guided percutaneous solid organ biopsy is a well-established means of diagnosing focal or diffuse disease in solid organs. In general, it is safe and confers minimal risk of complications. Major and minor complication (mainly bleeding) rates of 0.8% and 2-3.8%, respectively, have been reported.1,2 Many factors increase the risk of post-biopsy haemorrhage, which can be divided into lesional, technical, and patient-related. Lesional factors consist of
peripheral subcapsular location, close proximity to major vessels, hypervascularity, and hypervascular biopsy sites (such as the spleen). Technical factors include increased numbers of needle passes, large needle sizes, use of cutting needles, blind biopsies, and less-experienced operators. Patient factors include coagulopathy, platelet dysfunction or thrombocytopenia, medications (eg antiplatelet agents and anticoagulants), chronic liver disease, haematological malignancy, presence of moderate-to-severe ascites, and uncooperative patients. Some studies showed that peripheral blood coagulation indices have a poor correlation with liver bleeding time following laparoscopic biopsy, which might be caused by low regional platelet counts, clotting factor deficiencies in the liver parenchyma, and the lack of mechanical compression of the biopsy tract by inelastic tissue (eg cirrhotic liver). Therefore operators should always be prepared for the possibility of significant post-biopsy haemorrhage, even in patients with normal clotting profiles and platelet counts.

Obviously, the main contra-indication to image-guided percutaneous solid organ biopsy is a bleeding diathesis. However, histological diagnosis is critical and even lifesaving, by means of achieving correct treatment. In the past, transjugular liver biopsy had been advocated in patients with bleeding diathesis, massive ascites, and poor respiratory control. It was first described by Riley et al in 1984. In plugged biopsy, the tract is embolised (plugged) after the percutaneous biopsy, thus decreasing the risk of haemorrhage. Multiple studies on PPB have demonstrated at least a 95% success rate in obtaining adequate specimens for histological diagnoses. It is also a safe procedure with a complication rate of less than 2% (Table 27-9). It has the obvious advantages of being direct and can be used to biopsy focal hepatic lesions away from major hepatic veins and in other organs. Also, a larger biopsy needle can be used, which increases the chance of obtaining adequate specimens. Finally, it does not involve the vascular system or passage through the right atrium and thus the relevant complications can be avoided.

FIG 3. After adequate specimens are taken, 1-2 mL of Gelfoam slurry is injected to the sheath of coaxial introducer needle

FIG 4. (a) Gelfoam torpedo (arrow) is placed at the hub of the coaxial introducer needle. (b) Gelfoam torpedo is then pushed by the stylet of the coaxial introducer needle (arrowheads). (c) The outer sheath of the coaxial introducer needle is withdrawn with the stylet stays still so that the Gelfoam torpedo can be deployed and seals the biopsy tract.
The most commonly used embolic agent is Gelfoam, which is an absorbable compressed gelatin sponge prepared from purified porcine skin. It is capable of absorbing up to 45 times its weight of whole blood, and induces haemostasis by speeding up thrombus formation and providing structural support for the clot. Gelfoam is a temporary embolic agent, which is usually completely absorbed within a few days or weeks, depending on the amount used, the degree of saturation with blood, and the application site. It is widely used in tract plugging as it is relatively inexpensive and readily available. It is easy to use and can be prepared in different forms, depending on the site of application. In our centre, Gelfoam was prepared in the form of torpedo and slurry. The Gelfoam torpedo was made from tight rolling of a small strip and used at the site of active bleeding. Due to their larger size, Gelfoam torpedoes can remain at the site of deployment instead of being flushed away by blood. The drawback of the torpedo is that distal embolisation cannot be achieved. In contrast, Gelfoam slurry is suitable for distal embolisation. It can be prepared by mixing tiny Gelfoam pledgets with contrast or saline. Further decrease in size of the pledgets can be created by macerating the suspension with two syringes and a 3-way stopcock. The syringe should be held nose up as Gelfoam floats in fluid. The disadvantage of slurry is that it is difficult to deploy at sites of active bleeding, as the suspension can be flushed away by blood. In our centre, we injected Gelfoam slurry first for distal embolisation and then filled up the rest of the biopsy tract with a torpedo. To the best of our knowledge, plugging of the biopsy tract with Gelfoam slurry followed by a Gelfoam torpedo is a new technique that has not been previously described. Gelfoam is safe to use most of the time, although there is a minute risk of non-targeted embolisation of the biliary or vascular systems and of becoming a nidus for microbial growth.

Apart from plugging of the biopsy tract, there are other measures to decrease the risk of bleeding in patients undergoing solid organ biopsy. First, as appropriate, we should try to correct any coagulopathy by administration of fresh frozen plasma, platelets, coagulation factors, and vitamin K, whilst also withholding antiplatelet or anticoagulant medications if at all feasible. Although not related to the bleeding risk, red cell or whole blood transfusion should be given before the biopsy to significantly anaemic patients. Next, careful planning of the method of biopsy is important. A safe biopsy path not traversing vessels or critical structures should be sought. Leaving adequate distance of normal parenchyma from the organ capsule and the biopsy site can also help mechanical compression of the biopsy tract by virtue of tissue elasticity, after the needle is removed. We have to strike a balance between the tissue yield and the use of smaller needles. The use of a coaxial system allows multiple needle passes with just a single puncture. Reducing ascites, if present with diuretics or paracentesis, can also decrease the risk of haemorrhage.

One limitation of our study was the small sample size. Second, it was a retrospective observational study without a control group. A large-scale prospective randomised controlled study may be ideal to validate the efficacy and safety of PPB. We share our experience in this small-scale study to raise the awareness of this procedure (especially for those not specialised in interventional radiology), as it shows that PPB is a simple and safe method with a high technical success rate that can help prevent post-biopsy haemorrhage.

**Conclusion**

Plugging of the biopsy tract with Gelfoam slurry followed by a Gelfoam torpedo is a direct, simple, safe, and effective means of preventing haemorrhage in patients at high risk of post-biopsy haemorrhage.

**References**

2. Albéniz Arbizu E, López San Román A, García González...


