CONTINUING EDUCATION PROGRAM: FOCUS...

Post-procedure bleeding in interventional radiology


Department of radiology, CHU Henri-Mondor, 51, avenue du Maréchal-de-Lattre-de-Tassigny, 94010 Créteil, France

KEYWORDS
Pseudoaneurysms; Bleeding risk factors; Interventional radiology

Abstract
Following interventional radiology procedures, bleeding can occur in 0.5 to 4% of the cases. Risk factors are related to the patient, to the procedure, and to the end organ. Bleeding is treated usually by interventional radiologists and consists mainly of embolization. Bleeding complications are preventable: before the procedure by checking hemostasis, during the procedure by ensuring the accurate puncture site (with ultrasound or fluoroscopy guidance) or by treating the puncture path using gelatin sponge, curaspon®, biological glue or thermocoagulation, and after the procedure by carefully monitoring the patients.

© 2015 Éditions françaises de radiologie. Published by Elsevier Masson SAS. All rights reserved.

With the development of interventional radiology in the field of oncology, bleeding complications have been observed. The incidence of vascular complications is between 0.5 and 4%, regardless whether the access is percutaneous or intravascular [1–3]. It is therefore important to know what the risk factors of post-interventional radiology bleeding are, where the bleeding sites are depending on the procedures, how to treat the bleeding and how to prevent it.

The goal of this review was threefold. First, we wished to analyze the different risk factors related to the patient, to the procedure, the lesion and the end organ. Second, we wanted to report the different types of bleeding, based on the intravascular and percutaneous access, and how to treat them. Third, we aimed to discuss how the bleeding risk can be anticipated and thus minimized using biological tests, ultrasound-guided puncture and percutaneous closure devices.

* Corresponding author.
E-mail address: jolymay@hotmail.com (J. Mayer).

http://dx.doi.org/10.1016/j.diii.2015.06.009
2211-5684/© 2015 Éditions françaises de radiologie. Published by Elsevier Masson SAS. All rights reserved.
Risk factors

Risk factors are listed in Table 1.

Patient-related risks

Some of the risk factors are observed with the arterial access route: patients over the age of 65 years, women, patients at risk for cardiovascular disease (atherosclerosis, obesity, diabetes, arterial hypertension) and chronic renal failure.

Other risk factors are observed with both percutaneous and intravascular access routes: blood coagulation disorders and the use of anticoagulant and antiplatelet agents.

Procedure-related risks

In case of arterial access, complex and long procedures are risk factors for complications. Additional risk factors are the number of punctures, an inappropriate puncture site as well as a size of sheath introducer larger than 6 French. For common femoral punctures, a puncture site too high (above the inguinal ligament, i.e. external iliac artery) increases the risk of retroperitoneal hematomas while a puncture site too low (superficial or even profunda femoral artery) increases the risk of pseudoaneurysms. We will look at the methods available to improve arterial punctures [1–3].

A retrospective study including 9861 coronary interventions carried out by the New York Presbyterian/Columbia University Medical Center reported the following significant risk factors: patient’s age above 70 years, chronic renal failure, the size of the introducer sheath (French size above 6), manual compression of the puncture site rather than a percutaneous closure system and a long procedure (longer than 1 hour) [4]. We will further discuss the use of percutaneous closure devices below when we’ll discuss how to reduce bleeding complications.

In case of percutaneous access, the size of the needle (higher than 18 gauge) and the number of punctures are risk factors [3].

Tumor- and end organ-related risks

Hypervascular tumors may be predictive of complications, although this is still debated. In case of subcapsular involvement, the risk of bleeding is increased. Kidney and a cirrhotic liver also are risk factors for bleeding. Finally, ascites is also a risk factor [3].

Different types of bleeding

Bleeding during a percutaneous puncture or radiofrequency ablation

At the end of a procedure, blood may flow through the coaxial during the removal of the biopsy or radiofrequency ablation needle. It is possible to dab the blood with the foam tip of a biopsy needle that can sometimes be found in the biopsy set, or to push gelita-spon® (biodegradable embolization material) into the coaxial. It is possible to cut small strips of gelita-spon® and to push them towards the site with a syringe of sterile water or with the needle used for the biopsy or the radiofrequency ablation. Some experts, instead, use biological glue that has the advantage to mark the lesion [3].

Finally, some experts recommend to thermocoagulate the needle track after a radiofrequency ablation, although whether this decreases the bleeding risk remains a matter of debate.

Bleeding during endovascular procedure (hepatic chemoembolization)

During an interventional radiology procedure in oncology, complications such as pseudoaneurysms or extravasation of contrast medium may be observed. It is possible to treat these complications (coil embolization or curaspon® gelatin sponge) (Fig. 1) and to continue the procedure depending on the hemodynamic state of the patient. Indeed, the arterial vessels of oncology patients may have become weaker by the different treatments (chemotherapy including Sorafenib) [5] and by repeated endovascular procedures [6].

Bleeding after biopsy or radiofrequency ablation

After a biopsy or a radiofrequency ablation, pain and even acute bleeding may be observed. An enhanced scan obtained at arterial and venous phases can detect a possible pseudoaneurysm or active bleeding, which will be treated by endovascular embolization. In case of a pseudoaneurysm, it is possible to treat it with coils (Fig. 2) and also to place coils, according to the "sandwich" technique, distal and proximal to the aneurysm neck, thereby avoiding re-bleeding [7].

Table 1  Bleeding risk factors during procedures in interventional radiology.

<table>
<thead>
<tr>
<th>Patient-related</th>
<th>Procedure-related</th>
<th>Tumor- and organ-related</th>
</tr>
</thead>
<tbody>
<tr>
<td>Over the age of 65</td>
<td>Complexity/duration of procedure</td>
<td>Hypervascular tumor (under debate)</td>
</tr>
<tr>
<td>Female</td>
<td>Number of punctures</td>
<td>Subcapsular location</td>
</tr>
<tr>
<td>Cardiovascular risk factors</td>
<td>Inaccurate site of puncture</td>
<td>Kidney</td>
</tr>
<tr>
<td>Chronic renal failure</td>
<td>Introducer size above 6F</td>
<td>Cirrhotic liver</td>
</tr>
<tr>
<td>Hemostasis disorders</td>
<td>Needle size above 18G</td>
<td>Ascites</td>
</tr>
<tr>
<td>Anticoagulant/antiplatelet treatment</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Complications at arterial puncture site (femoral)

A complication (hematoma or pseudoaneurysm) at the arterial puncture site is diagnosed by arterial ultrasound Doppler or by CT scan with injection of contrast medium (Fig. 3).

Pseudoaneurysms smaller than 2 cm often thrombose spontaneously. The treatment for these pseudoaneurysms is manual compression, possibly ultrasound-guided. Pseudoaneurysms above the size of 2 cm usually require surgery, although they are increasingly treated by endovascular procedure [2].

Treatment of pseudoaneurysm at puncture site

Traditional treatment: surgery

The indications for surgical treatment of the Scarpa pseudoaneurysm are the following: rapidly expansive hematoma, infected pseudoaneurysm, nerve compression, ischemia, or unstable hemodynamic patient[2]. Treatment is by femoral approach (Scarpa) and surgical suture of the pseudoaneurysm neck[8].

Endovascular treatment by direct puncture

Thrombin injection: the pseudoaneurysm is visualized under ultrasound, and the distance between the skin and the superficial portion of the pseudoaneurysm is measured. Then, local anesthesia is applied, and we use the “three-way stopcock” technique: 2 syringes with a three-way stopcock. One syringe contains sodium chloride and the other the prepared thrombin. The puncture to the pseudoaneurysm cavity is ultrasound-guided, with slow aspiration of NaCl until getting blood in the syringe. Then, with slow injection of thrombin far of the pseudoaneurysm neck, with aliquots of 0.2 mL up to a maximum of 1 mL. Common, superficial and profunda femoral arteries must be checked for absence of embolization. The pseudoaneurysm is assessed by Doppler after 24 to 72 hours, and it is always possible to re-inject thrombin[2]. Rare complications such as embolic (arterial or pulmonary) complications, vasovagal, infectious and allergic reactions have been reported[2].

Injection of coils by direct puncture: since thrombin was prohibited in the 1990s (Creutzfeldt Jacob disease), Kobeiter et al. tried to inject coils instead of thrombin. The series of patients was small, 16, but the primary success rate reached 88%[9].

Injection of a saline/lidocaine (0.2%) solution: in a series of 11 patients, Périard et al. successfully injected the solution around the narrow neck of the pseudo-aneurysm. This was followed by a short echo-guided compression[10].

Endovascular catheterization by coils and stents

Coil embolization (Fig. 4): this technique requires contralateral puncture and crossover. An arteriography visualizes the pseudoaneurysm and its neck. The catheter is positioned in front of the neck (stability is improved by the use of a long introducer) and the neck is catheterized with a microcatheter. Microcoils are inserted. At the end of the procedure, the absence of pseudoaneurysm is checked. This technique has the following advantages: no material is left in the artery, it is possible to repuncture the access, and neither anticoagulant nor antiplatelet treatment is administered after the procedure. The disadvantages are the long and complex procedure and the need for a contralateral puncture with the risk of complications at this new site[7].

Treatment with covered stent (Fig. 5): the technique is the same as the one used with the coils, with a long introducer (5F-6F). After visualization of the pseudoaneurysm neck by arteriography, a balloon-expandable monorail covered stent is placed. The advantages are the short and relatively easy procedure. The disadvantages are the contralateral puncture, the risk of stent thrombosis (need for a long-term antiplatelet treatment) and stent fracture. In the future, the development of biodegradable covered stents could reduce these risks[11].

How to prevent bleeding

Checklist before the procedure

Today, it is no longer necessary to stop anticoagulant or antiplatelet treatment before most interventional radiology procedures (Table 2). Only deep biopsies or radiofrequency ablations as for kidney are still considered procedures at risk. At most, anticoagulant and antiplatelet treatment will be stopped 24 hours and 5 days, respectively, before procedures the most at risk (kidney and deep biopsy). Also, for some procedures such as superficial biopsies.
Figure 4. Arteriography showing (a) a pseudoaneurysm of the common femoral artery with a neck (white arrow); catheterization (b) of the neck with a microcatheter (white arrow); treatment with coils (c: white arrow) and disappearance of the pseudoaneurysm on the control image (d).

(lymph nodes), a hemostasis profile is no longer required [3].

During the procedure

For arterial punctures, the main factor of success and of absence of complications lies with a puncture at the “appropriate” site.

Puncture of the femoral artery

The ideal puncture site is the common femoral artery (Fig. 6), on a scopic marker below the inguinal ligament, in front of the inferior edge of the femoral head. Above the inguinal ligament, the main risk is retroperitoneal hematoma (puncture of the external iliac artery). If the puncture site is too low, there is a risk of hematoma and pseudoaneurysm (superficial or profunda femoral artery).

Figure 5. Arteriography (a) showing a pseudoaneurysm of the right superficial femoral artery (initial puncture too low) (white arrow); catheterization of the superficial femoral artery and placement of a short covered stent (b) (white arrow); control image shows the disappearance of the pseudoaneurysm (c).
since there is no underlying bony structure from the femoral head during compression [12].

Puncture of the humeral artery
The access for the humeral artery is located right above the elbow (lower end of the humerus) and is very narrow since it is close to the humeral vein and the median nerve. The material to be introduced may not exceed 6F. The main complications are hematoma, pseudoaneurysm, spasm, compression of nerves and vessels, strokes (the catheters pass in front of the supra-aortic vessels). To limit this risk, we prefer to proceed from the left side for procedures below the left subclavian artery.

Ultrasound-guided puncture
For both types of punctures, ultrasound Doppler is recommended especially in case of difficult access (in obese patients). Although ultrasound-guided Doppler for detection and puncture is increasingly used, there is relatively little information available. Systems where the needles are attached to the Doppler probe (smart-needle) are available; this makes the access easier but does not enable us to change the direction of the needle [12]. A sterile probe sleeve is used for this procedure.

An ultrasound-guided puncture improves the first-pass success rate, reduces the number of attempts, reduces the time to access, and also probably the risk of venipuncture. The puncture rate of success was not related to the expertise of the operator but the duration of puncture was significantly reduced. Finally, ultrasound-guided puncture makes it possible to reduce the number of complications for 5 cm hematomas or larger (0.6% with ultrasound versus 2.2% with radioscopy, \( p = 0.034 \) [2,13].

In fact, this technique allows us to return to the initial Seldinger technique with metallic needle, which recommended not to puncture the posterior wall of the artery [14].

Percutaneous closure devices
These devices are used routinely, although no prospective multicenter study has assessed their efficacy or safety.

They are used for accesses requiring material above 6F, for patients under anticoagulant treatment or with impaired blood coagulation.

They have the following advantages: a shorter time to hemostasis, shorter time to mobilization, shorter time to discharge (outpatient) and greater comfort for the patient (no long manual compression or compressive bandage) [4,12]. The disadvantage is their relatively high cost.

Their use significantly reduced the number of hematomas over 5 cm (0.20% versus 0.46% for manual compression, \( p = 0.03 \)) [4].

Table 3 summarizes the different types of closure devices. We present the devices for access up to 6F. Some closure devices are autosuture, used in post-closing, i.e. placed at the end of the procedure, up to 7F, Proglide (Abbot). Other systems with extravascular devices are also available, such as StarClose with a nitinol-based clip (Abbot) and Exoseal (Cordis) with a collagen-based plug. Finally, there are intra- and extravascular devices such as AngloSeal (Saint-Jude medical), with an intravascular collagen anchor and an extravascular collagen plug. For this system, it is recommended to wait 90 days before performing a new puncture at the site.

In a multicenter registry with 1107 patients, performed by the CIRSE between January and August 2009, a closure device type AngloSeal (Saint-Jude medical) was used. The deployment success rate was 97%, with 8.8% more failure

### Table 2 Checklist before an interventional radiology procedure.

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Platelets</th>
<th>PR (%)</th>
<th>APTT (LMWH)</th>
<th>INR (VKA)</th>
<th>Antiplatelet</th>
<th>Anticoagulant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superficial biopsy</td>
<td>&gt; 50,000</td>
<td>&lt;2</td>
<td>&lt;2</td>
<td>Not stopped</td>
<td>Skipped dose</td>
<td></td>
</tr>
<tr>
<td>Deep biopsy (moderate risk)</td>
<td>&gt; 50,000</td>
<td>&gt;1.5</td>
<td>&gt;1.5</td>
<td>Stopped 5 days before</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kidney biopsy (high risk)</td>
<td>&gt; 50,000</td>
<td>&gt;50</td>
<td>&gt;1.5</td>
<td>Stop of Plavix (and aspirin) 5 days before</td>
<td>Stopped 24 hours</td>
<td></td>
</tr>
<tr>
<td>Percutaneous ablation</td>
<td>&gt; 50,000</td>
<td>&gt;50</td>
<td>&gt;1.5</td>
<td>Not stopped</td>
<td>Skipped dose</td>
<td></td>
</tr>
<tr>
<td>Chemoembolization</td>
<td>&gt; 50,000</td>
<td>&gt;30</td>
<td>&gt;1.5</td>
<td>Not stopped</td>
<td>Skipped dose</td>
<td></td>
</tr>
</tbody>
</table>

Figure 6. Common femoral artery access: under the inguinal ligament and in front of the femoral head bone. EIA: external iliac artery; IEA: inferior epigastric artery; CFA: common femoral artery; SFA: superficial femoral artery; PFA: profunda femoral artery.
for the antegrade access. This closure device has no marketing authorization in France for antegrade access. Moreover, obesity, the size of the sheath introducer and calcification were not factors of failure. Time to hemostasis was reduced and patients could be discharged 9 to 24 hours after the procedure [15].

There is no absolute contraindication to use these systems, only safety measures. These involve puncture sites that are too high or too low, patients with atherosclerosis, arteries with a diameter smaller than 4–5 mm (risk of ischemia), patients with diabetes and with immunodeficiency (risk of infections) [12].

Post-procedure complication was bleeding (6%) which could be managed by gentle compression in 50% of the cases. During follow-up, complications were hematoma (1%), embolus by material (1%), occlusion or dissection, infection (less than 1%) and thrombosis at the suture site [15].

After the procedure

Patients must be monitored for 6 to 24 hours after the procedure, for pain and signs of acute bleeding.

Conclusion

Risk factors for bleeding during interventional radiology procedures in oncology are related to the patient, the procedure and the end organ.

Bleeding may occur at the site of puncture or bleeding of an end organ during catheterization.

Bleeding may be prevented before the procedure by checking hemostasis. During the procedure, bleeding may be prevented by ensuring a puncture at the appropriate site (endovascular or ultrasound guidance), a possible use of the end organ of the procedure of coagulation, biological glue or by thromboocoagulation on the needle track, by appropriate manual compression or the use of a cutaneous closure device. Following the procedure, patients must be carefully monitored.

In case of complications, endovascular treatment is based on the access (arterial puncture or percutaneous access), the size of the hematoma and the symptoms.

Treatment may be symptomatic (manual compression, monitoring), endovascular by embolization or covered stent or surgical.

• Anticoagulant and antiplatelet treatments are not systematically stopped anymore before an interventional radiology procedure. The decision to stop depends on the bleeding risk and the end organ.

• Bleeding risk is prevented by the accurate puncture in the common femoral artery under fluoroscopic or ultrasound guidance and possibly with a percutaneous closure device.

• Interventional radiology can be used to treat bleeding complications by embolization or stenting depending on the bleeding site.

Clinical case

A patient presents a pulsatile hematoma of the right Scarpa. Doppler imaging shows a pseudoaneurysm of 3.5 cm, affecting the superficial femoral artery, 10 days after an arterial angioplasty. The patient has no deficiency in red blood cells and does not suffer from pain.

Questions

1. Do you believe that the arterial puncture was:
   a. Too high.
   b. Too low.
   c. At the appropriate site.

2. What are the possible treatments?
   a. Direct puncture and thrombin injection.
   b. Endovascular treatment and insertion of coils in the pseudoaneurysm.
   c. Endovascular treatment and insertion of coils in the superficial femoral artery.
   d. Endovascular treatment and insertion of a covered stent in front of the neck of the pseudoaneurysm.
   e. Endovascular treatment and insertion of an uncovered stent in front of the neck of the pseudoaneurysm.

   The patient refuses treatment and leaves the hospital against medical advice. He returns 3 days later. He has deficiency in red blood cells, fever and a level of CRP at 70 mg/dL. Scan imaging is performed (Fig. 7).

3. What treatments would you recommend?
   a. Monitoring.
   b. Antibiotics based on hemocultures.
   c. Endovascular treatment.
   d. Direct puncture and thrombin injection.
   e. Surgery.

Responses

1. Response b.
3. References

The Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

References


