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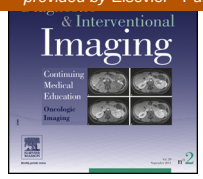

CONTINUING EDUCATION PROGRAM: FOCUS...

Spontaneous soft tissue hematomas

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KEYWORDS
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Hematomas of soft tissue;
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Abstract Spontaneous muscle hematomas are a common and serious complication of anticoagulant treatment. The incidence of this event has increased along with the rise in the number of patients receiving anticoagulants. Radiological management is both diagnostic and interventional. Computed tomography angiography (CTA) is the main tool for the detection of hemorrhage to obtain a positive, topographic diagnosis and determine the severity. Detection of an active leak of contrast material during the arterial or venous phase is an indication for the use of arterial embolization. In addition, the interventional radiological procedure can be planned with CTA. Arterial embolization of the pedicles that are the source of the bleeding is an effective technique. The rate of technical and clinical success is 90% and 86%, respectively.

Abbreviations: CTA, computed tomography angiography; SMH, spontaneous muscle hematomas; IEA, inferior epigastric arteries; SEA, superior epigastric arteries; CIA, ascending circumflex iliac arteries; LA, lumbar arteries; ILA, iliolumbar arteries; HAS, Haute Autorité de santé [French National Authority for Health].

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Background

Definition

Spontaneous muscle hematomas (SMH) are defined by the occurrence of extravasation of blood in a muscle group, most often in the abdominal waist. These hematomas can remain localized in the muscle head when they are contained by the fascia, or can diffuse into the peritoneal or retroperitoneal space [1]. SMH are not associated with trauma and are mainly located in the iliopsoas muscles and the rectus sheath of the anterior abdominal wall. Although it is a common, often benign pathology SMH can suddenly deteriorate and become life-threatening for patients.

Role of anticoagulants

The development of SMH is significantly associated with anticoagulant treatment, especially in the elderly [2—4]. The morbidity and mortality induced by these drugs is the leading cause of iatrogenic complications in France. One percent of the French population is on long-term anticoagulant treatment. Hemorrhagic complications from these treatments (all causes combined) occur in an estimated 5% of patients. The overall annual mortality from severe coagulant-induced hemorrhages is 0.65% [5,6]. The regular increase in the prescription of anticoagulants and platelet antiaggregants is probably largely responsible for the increase in the incidence of SMH [7—9]. The incidence of SMH in patients on anticoagulants is 0.6%. The prevalence of SMH is higher in women and elderly patients [6,8,9].

Factors of severity

Although it is a common entity, the factors of severity for SMH are not well known. To date, there are no criteria to distinguish non-severe SMH from those that may cause sudden deterioration of the patient's clinical condition and become life-threatening. Nevertheless, the radiologist plays a central role in the diagnostic and interventional management of this disease.

SMH are a single clinical entity with two categories:

- small hematomas are the most common. They can be found intramuscularly or extramuscularly but remain contained in the fascia. These hematomas resolve spontaneously and conservative treatment is indicated [8,10];
- voluminous hematomas are less frequent (Fig. 1a—b). They occur in at risk situations, and can result in hemodynamic instability. They can even be life-threatening, especially if the patient is fragile [8]. In this case bleeding is abundant with an active arterial leak of contrast material and selective embolization is indicated.

Physiopathology

The physiopathology of SMH is complex. It is based on a multifactorial microangiopathy [8]. The risk factors include hemostatic disorders, age, atheromatosis, vascular lesions from chronic arterial hypertension, and especially diabetes [3,11,12]. Furthermore, a genuine anticoagulant-induced immune microangiopathy has been reported to be a predisposing factor [11]. The occurrence of SMH is often associated with a microtrauma (closed glottis straining, isometric muscle contractions). This microtrauma could cause muscle and capillary tears which result in SMH [8,10]. Table 1 summarizes the known risk factors of SMH [13].

Anatomy

Vascular arterial anatomy

SMH mainly occur in three anatomical regions:

- there are 4 anterior abdominal wall muscles per side: the rectus, the external oblique, the internal oblique, and the transverse muscle. Vascularization of this muscle group is mainly provided by the deep inferior epigastric arteries (IEA), the superior epigastric arteries (SEA) and the deep circumflex iliac arteries (CIA). Fig. 1 shows the origin of the IEA and CIA located in relation to the inguinal ligament, where the external iliac artery becomes the common femoral artery. The IEA reaches the posterior aspect of the rectus muscle where they join the SEA coming from the internal thoracic arteries. The route of the first branch of the IEA, emerging near its origin, is primarily intrapelvic, anastomosing with the artery of the round ligament in women, or with the external pudendal artery in men (Fig. 2). The CIA pass along the iliac bone (Fig. 3a and b) ensuring vascularization of the external oblique, internal oblique, and transverse muscles as well as the iliac head of the iliopsoas;
- there are 3 posterior muscles per side: the iliac, the psoas, and the erector spinae muscles. These muscles are vascularized by the lumbar arteries (LA) and the iliolumbar arteries (ILA) (Fig. 3a and b). The ILA is the first ascending branch of the posterior gluteal trunk of the internal iliac artery that becomes the superior gluteal artery further on;
- there are 5 buttock muscles per side: the 3 gluteal muscles, the piriformis and the internal obturators. This muscle group is vascularized by the superior and inferior gluteal arteries, which are the terminal branches of the posterior trunk of the internal iliac artery (Fig. 4a and b).

Topographic anatomy

There is a transition zone, located at the junction of the medial and inferior third of the rectus muscles, made up of the arcuate ligament. At this point, the posterior sheath of the rectus muscles becomes anterior. The posterior aspect is now only covered by the transversalis fascia, which is not highly resistant. This is why SMH that occur above the

Table 1 Risk factors of spontaneous muscle hematoma.

Known risk factors [6—8,10,28]
Chronic renal insufficiency and hemodialysis
Cardiac, hepatic insufficiency
AHT
Closed glottis straining
Coagulation disorders
Degenerative muscle diseases
Congenital collagen diseases

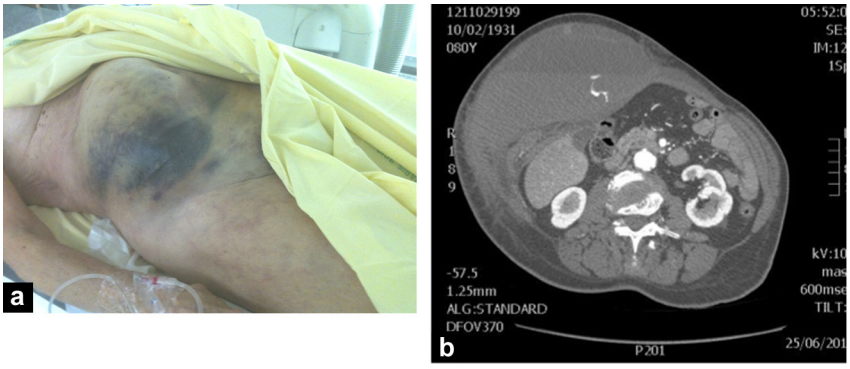

Figure 1. a and b: 72-year-old patient presenting with a voluminous hematoma of the right anterolateral abdominal wall, that occurred 3 days after starting anticoagulation at preventive doses with low molecular weight heparin following surgery for total knee prosthesis. (a) shows an extensive hematoma. Computed tomography (CT) angiography (b) confirms the presence of a hematoma in the anterior abdominal wall (rectus, external oblique, internal oblique and right transverse). CT angiography shows extravasation of contrast material through the inferior epigastric artery, clearly visible on (a) and (b). The patient will undergo selective embolization of the inferior epigastric artery.

arcuate ligament are contained. Above the arcuate ligament, SMH are secondary to distal lesions of the IEA and are often small. They are plugged in front and behind by the rectus sheath, thus blocking their diffusion (Fig. 5a). Hematomas located below the arcuate ligament are sometimes secondary to a lesion of the proximal IEA. They are more voluminous and the vascular lesion can sometimes be caused by the hematoma itself. They deeply dissect the muscle, crossing the median line and sometimes fuse near the posterior peritoneum and the retropubic space (Fig. 5b) [14].

Diagnosis

Clinical symptoms

The clinical symptoms of SMH vary, they may be vague and SMH may sometimes be revealed by local pain. The medical history may include a report of closed glottis straining followed by more or less severe abdominal wall pain. The patient is usually taking anticoagulants. The clinical examination sometimes reveals subcutaneous sensitivity, which may be associated with signs of peritoneal

Figure 2. Arteriography of the right common iliofemoral axis with retrograde injection of contrast material in the right common femoral artery on Fig. 1: a: the long arrows show the route of the inferior epigastric artery [deviated by the hematoma that is clearly visible on (a)]. The short arrows show the ascending iliac circumflex artery; b: shows an addition image (white star) situated at the end of the inferior epigastric artery. This image is the active hemorrhage causing the hematoma.

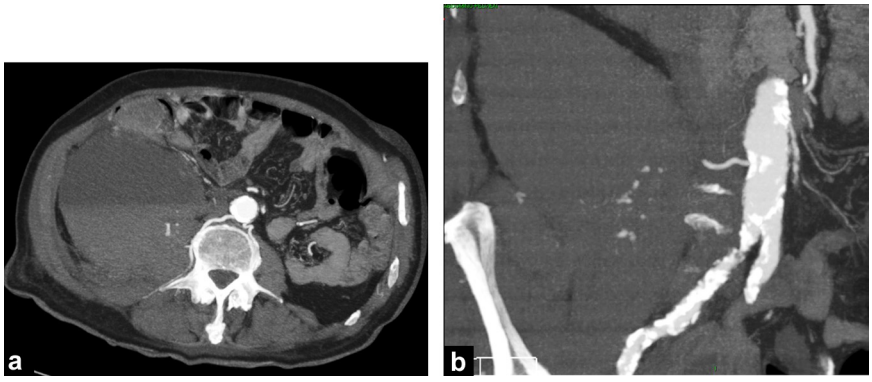

Figure 3. Computed tomography (CT) angiography of a 72-year-old patient with hemodynamic shock. This patient has taken an overdosage of anticoagulants. CT angiography reveals a voluminous hematoma of the right psoas muscle with an active leak of contrast material (a). Oblique coronal MIP reconstruction (3 mm thick) identifies the right L4 artery as the source of the hemorrhage (b).

tenderness (Fig. 1). The association of general symptoms such as tachycardia, hypotension or pallor should alert the physician because they are signs of blood loss. Biological tests show various degrees of anemia and functional renal failure is often present. In most cases, the INR remains within the therapeutic target. Anticoagulant overdose only occurs in 33% of cases [15].

Radiological diagnosis

Unenhanced MDCT

The first-line imaging test for the radiological diagnosis of SMH is based on non-enhanced multidetector computed tomography (MDCT). MDCT provides a positive and topographic diagnosis [16,17]. In 1996, Berna et al. described a classification combining unenhanced CT results and the clinical presentation. This classification helps guide patient management (Table 2) [18]. Grade I SMH are small and associated with pain and no decrease in hemoglobin levels. Grade II SMH are more voluminous and often bilateral. They extend between and dissect the muscle fascia. These hematomas remain confined, without peritoneal or subperitoneal effusion/extravasation. There is a decrease in hemoglobin levels. Finally, grade III SMH are large and often bilateral. They dissect the muscle fascia and extend into the peritoneum and the retropubic space. There is a significant decrease in hemoglobin levels and hemodynamic instability. The major limitation of this classification is that it does not take into account the presence or not of an active leak of contrast material on CTA.

This simple diagnostic classification is therefore adapted to small local hematomas located above the arcuate ligament in patients with normal hemostasis. On the other hand, it does not provide the origin or etiology of SMH or determine whether active bleeding is present, which is possible on CTA Scan.

CT angiography

CTA scan plays an essential role in the management of severe SMH. The diagnostic sensitivity of CTA scan is better than arteriography for most locations, particularly the abdomen. Bleeding with a flow rate $\geq$ 0.3 mL/min can be detected [19]. Identifying the location of the vascular source of bleeding is good on CTA (95.2% agreement between CT angiography and arteriography in SMH). The sensitivity and specificity are 80% and 67%, respectively, with arteriography as the gold

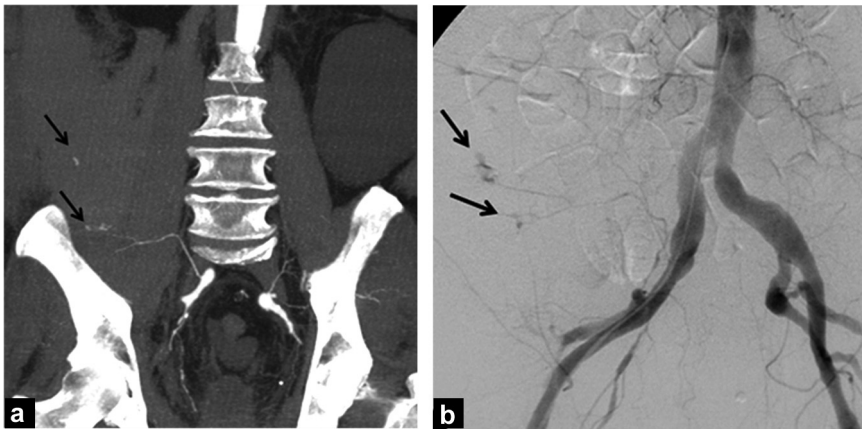

Figure 4. Computed tomography angiography (a) and arteriography (b) in a 78-year-old patient presenting with a hematoma of the right psoas muscle with no anticoagulant overdose (INR 2.2). (a) shows the active leak of contrast material (black arrows) and identifies the iliolumbar artery as the source of the hemorrhage. Selective arteriography of the right iliolumbar artery confirms extravasation (black arrows).

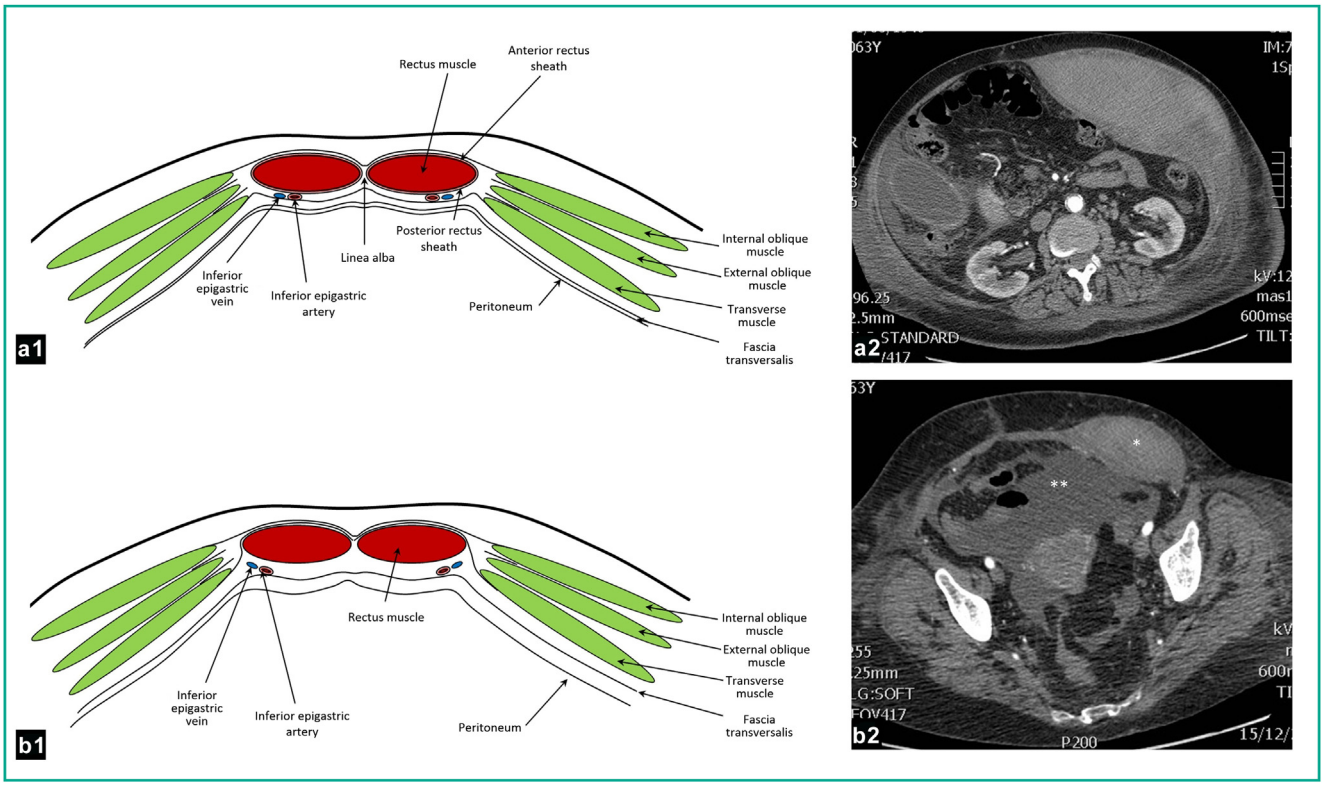

Figure 5. a and b: schematic diagram of anatomical relationship between the rectus muscles and their posterior sheath with the transversalis fascia according to Perry and Phillips (Hospital Physician, September 2001, p. 35—37, 56) below and above the arcuate line. Above the arcuate line (a) the rectus muscles are covered by the posterior musculotendinous sheath isolating them from the abdominal cavity. The hematoma visible on the CT angiography is contained in front of the sheath at this level. Below the arcuate line, the posterior sheath disappears, leaving the transversalis fascia as the only interface with the abdominal cavity. The hematoma at this level cannot be contained and fuses in the abdominal cavity (b) on the scan.

standard (kappa-value 0.75) (154). Active leaking of contrast material (in arterial phase sequences) or the enhancement of the hematoma in venous phase images identifies the source of bleeding of the SMH. Several studies have shown that the presence of active leaking of contrast material in an arterial phase CTA sequence is correlated with the severity of SMH, whatever the Berna grade. In addition, an active leak is associated with unsuccessful conservative treatment [6,15,18,20,21].

Therapeutic management

There is no consensus on the management of SMH and it is often based on that of traumatic hematomas. However in the latter, patients are often young with no hemostasis disorders. Bleeding can stop spontaneously when the hematoma creates a hemostatic plug in the muscle. If hemodynamic instability is present in these cases it is usually due to another associated traumatic visceral or bone lesion.

Table 2 Berna classification.

Grade	Anatomical extent	Symptoms	Management
I	Intramuscular Unilateral Does not dissect the fascia	Stable hemoglobin Moderate pain	Conservative Simple monitoring
II	± Bilateral Dissection between the right and the transversalis fascia No extension in Retzius' space	Minor drop in hemoglobin	Hospitalization ± Transfusion
III	± Bilateral Large dissection between the transversalis fascia and the muscle Intraperitoneal extension and in Retzius' space	Significant drop in hemoglobin Hemodynamic instability	Antagonization of anticoagulants Transfusion ± Angiography

However, unlike traumatic hematomas, SMH occurs in patients being treated by anticoagulants and with several comorbidities [12,18,21]. Hematomas, especially when they are voluminous, can be the site of active bleeding in these fragile patients, and they may not spontaneously resolve. Thus, CTA is very useful in this indication.

Conservative medical treatment includes management of hemostasis disorders, stopping and/or antagonization of anticoagulants, vascular filling and transfusion.

Surgical evacuation of hematomas is often discussed in the literature [1,22]. On the other hand, hemostatic surgery is complex and identifying the vascular pedicle that is the source of bleeding is difficult. Surgical evacuation is only indicated if the SMH is compressing the nerve structures or causing cutaneous ischemia. Recurrence is common following surgical evacuation [23].

Although arterial embolization is extensively used in the treatment of external hemorrhage (hemoptysis, postpartum hemorrhages, polytrauma), it is less often proposed for SMH [24—26]. It has the advantage of being less invasive and selective [12]. Technical and clinical success rates are 75 to 100% and 57 to 69%, respectively, depending on the series. Clinical failures mainly involve patients with Berna 3 SMH and major coagulation disorders (DIC) in a state of hemodynamic shock. Active hemorrhage occurs in 16% to 25% of cases [15,27]. Of course, although they may occur in previously embolized anastomotic vascular areas, recurrence in the same area is uncommon. No secondary embolization-related complications have been reported. The most common embolization technique is selective catheterization of the vascular pedicle causing the hemorrhage. Combined ''gelfoam torpedoes'' and coils are the most common embolization materials in the different series. Systematic embolization of anastomotic arteries can be considered to prevent recurrence. In the absence of visualization of an active leak of contrast material, but with enhancement of the hematoma on venous phase images, systematic embolization of the corresponding vascular areas can be considered.

Embolization alone will not result in clinical success. Appropriate reanimation measures to correct hemostatic disorders, anemia and hemodynamic instability must also be taken. Antagonization of anticoagulants must be discussed based on recommendations from the French National Authority for Health (HAS) for the management of complications from anticoagulants (Table 3 and Fig. 6) [28].

Management algorithm

The goal of our management algorithm (Fig. 7) is to help the radiologist in the diagnostic strategy. Renal failure (clearance < 30 mL/min) at diagnosis must be considered in relation to the severity of the patient's condition and should not be an absolute contraindication for the administration of contrast material. The diagnostic accuracy of CTA can reliably guide the radiologist to an indication for embolization.

Take-home messages

- SMH often occurs in patients receiving anticoagulants with or without overdoses.
- SMH mainly occurs in the muscles of the anterior abdominal wall and in the iliopsoas muscles.
- CTA provides a positive diagnosis of an active leak of contrast material.
- The value of CTA is robust: 95.2% agreement with arteriography for SMH.
- The sensitivity and specificity are 80% and 67%, respectively, with arteriography as the gold standard (kappa-value 0.75).
- The technical success rate of embolization is 75 to 100%.
- The clinical success rate of embolization is 57 to 69%.
- Recurrence of the active hemorrhage after embolization occurs in 16% to 25% of cases.

Table 3 Corrective measures of overdose in anticoagulants by the HAS.

Measured INR	Recommended corrective measures as a function of the measured INR measured INR and the target INR	
	Target INR 2.5 (window between 2 and 3)	Target INR ≥ 3 (window 2.5—3.5 or 3—4.5)
INR < 4	No missing of a dose No provisioning with vitamin K	
4 ≤ INR < 6	Missing of a dose No provisioning with vitamin K	No missing of a dose No provisioning with vitamin K
6 ≤ INR < 10	Stopping of treatment 1 to 2 mg of vitamin K	Missing of a dose Specialized opinion recommended discuss possible treatment with 1 to 2 mg of vitamin K
INR ≥ 10	Stopping of treatment 5 mg of vitamin K orally (1/2 vial adult form) (grade A)	Immediate specialized opinion or hospitalization is recommended

HAS: French National Authority for Health.

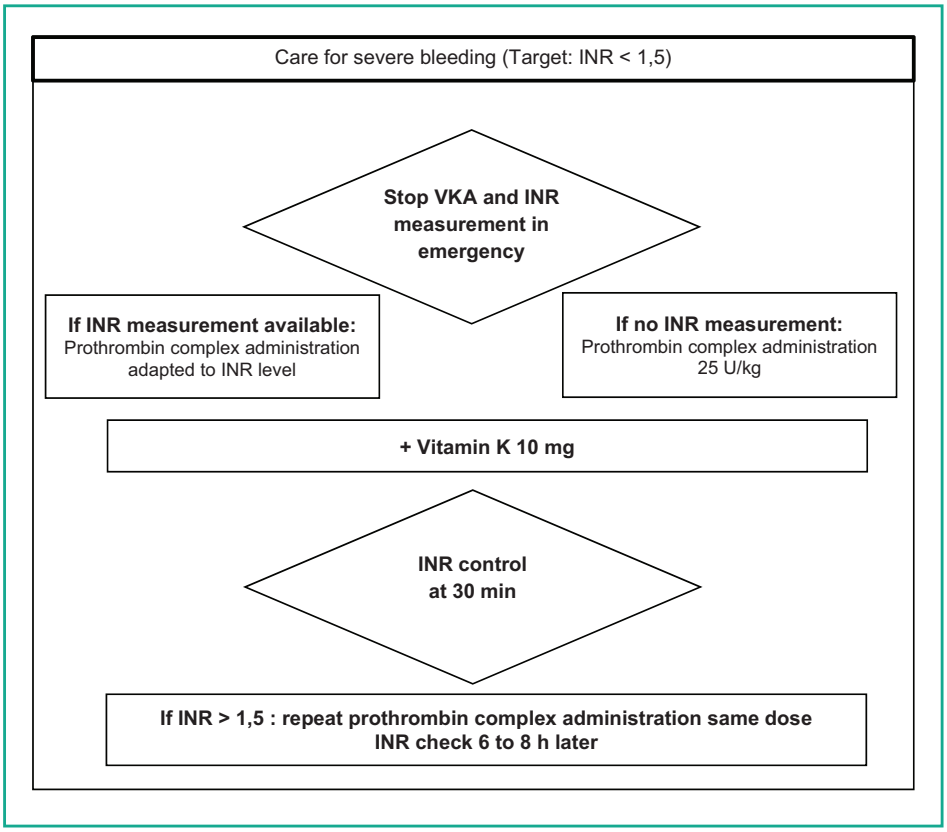

Figure 6. Management algorithm of hemorrhages in patients on anticoagulation proposed by the French National Authority for Health (HAS).

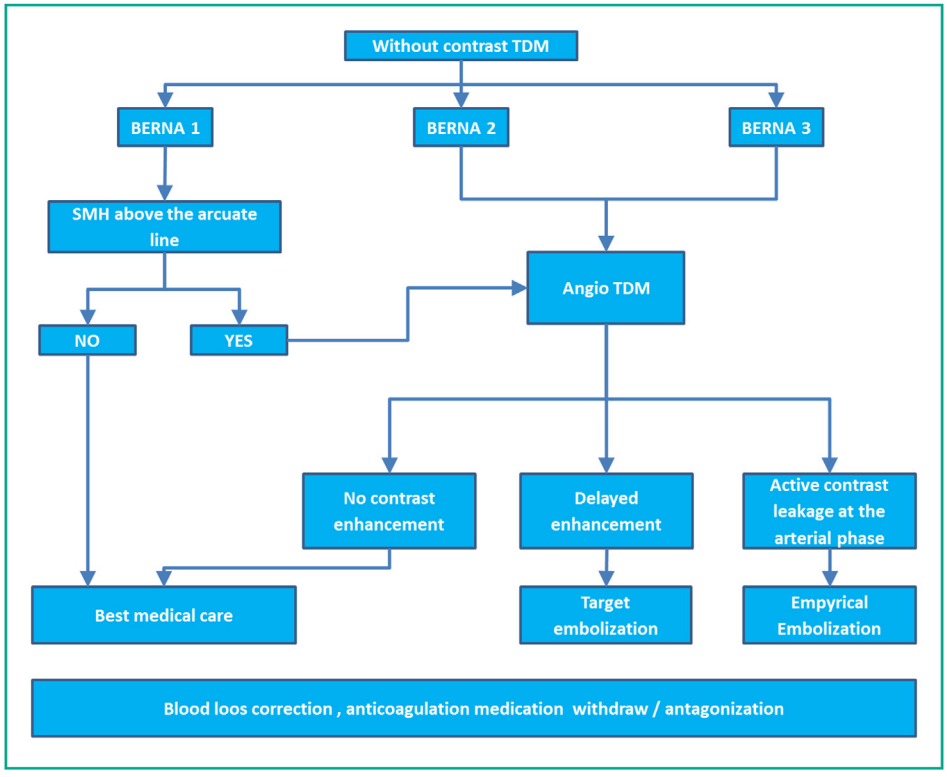

Figure 7. Radiological management algorithm of spontaneous muscle hematomas.

Disclosure of interest

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

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