Extravasation of intravenous contrast media: What every radiologist should know


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Abstract: The accidental release of intravenous contrast media (ICM) from the intravascular compartment to the adjacent soft tissues is one of the most frequent complications of the injection procedure in multi-slice CT (MSCT). Its incidence is low, occurring in between 0.1 and 0.9% of patients undergoing these studies. Affected areas usually present mild lesions characterized by swelling and local erythema and that tend to resolve spontaneously without sequelae. However, serious lesions may also occur, such as compartment syndrome. For these reasons it is essential to know patients at risk, precautionary measures, specific technical factors, early diagnosis and appropriate management of this complication. These elements constitute basic skills that every radiologist must possess.

Keywords: Contrast media (D003287), Extravasation of diagnostic and therapeutic materials (D005119), Quality control (D011786), Radiology (D011871).

Resumen: La salida accidental de medio de contraste intravenoso (MCI) desde el compartimento intravascular hacia los tejidos de partes blandas adyacentes es una de las complicaciones más frecuentes del procedimiento de inyección en tomografía computada multicorte (TCMC). Su incidencia es baja, ocurre entre el 0,1 y el 0,9% de los pacientes que se someten a estos estudios. Las zonas afectadas generalmente presentan lesiones leves caracterizadas por aumento de volumen y eritema local que tienden a remitir espontáneamente sin secuelas. Sin embargo, también pueden ocurrir lesiones graves, como un síndrome compartimental. Por estas razones es fundamental conocer los pacientes en riesgo, las medidas de precaución, los factores técnicos específicos, el diagnóstico precoz y el manejo oportuno de esta complicación. Estos elementos constituyen competencias básicas que todo radiólogo debe poseer.

Palabras clave: Control de Calidad(D011786), Extravasación de materiales terapéuticos y diagnósticos (D005119), Medio de contraste (D003287), Radiología (D011871).

Introduction

Extravasation of an ICM is defined as the accidental release of a variable volume of these solutions, from the intravascular compartment into the tissues, and adjacent soft area compartments. This phenomenon occurs during ICM injection with mechanical pump and corresponds to a procedure complication. It is a rare event, but potentially serious depending on the amount of volume extravasated and the characteristics of the affected patient.

This article will discuss the main aspects of this complication, since the completed and updated knowledge, especially in prevention, early diagnosis and management are essential skills for the daily practice of radiologists.

Incidence

Extravasation is one of the most common complications of intravenous injection of CM. However, its incidence is low, occurring in approximately 0.1 to 0.9%
of patients who undergo studies of contrasted computed
tomography (CT)\(^1\)\(^-\)\(^3\). Chew \textit{et al.}, in 2010 analyzed six
series of published cases of ICM extravasation in CT, from
1991 to 2007. He observed that of the 190,656 patients,
only 867 suffered extravasation, which corresponds to
an incidence rate of 0.45\%\(^4\).

In magnetic resonance (MR) ICM extravasation also
occurs, but the incidence of gadolinium chelate extrava-
sation is even lower (0.05\%), since smaller volumes are
used and most often the injection is manual\(^5\).

Gadolinium based ICM, on one hand, is less toxic
to the affected tissues, so it is uncommon to observe
adverse effects in patients.

In the CT Unit of our Imaging Department, of the total
number of patients subjected to contrast studies during
the years 2013 and 2014 (27,006 injections), 49 cases
of extravasation of ICM were recorded, corresponding
to an annual incidence of 0.09\%. During this same pe-
riod, only one gadolinium extravasation was recorded.

It is worth noting that of all the reported and registered
cases at our institution, only one required assessment by
vascular surgery for presenting symptoms suggestive of
a serious injury, however, it evolved favorably and was
maintained in symptomatic treatment.

Risk factors
Risk factors of extravasation of ICM are related
to the injection technique and characteristics of the patient
(Table I)\(^1\)\(^,\)\(^5\).

The use of ICM automated injectors, essential in the
age of CMCT is an important risk factor for extravasation
given the high flows of administered injection which can
easily overcome the resistance of the vein wall\(^3\)\(^,\)\(^5\)\(^-\)\(^8\).

Table I. Risk factors associated with extravasation
of ICM.

<table>
<thead>
<tr>
<th>Dependent on the injection technique of CM</th>
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<tbody>
<tr>
<td>- Use of metallic catheter</td>
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<td>- Using automated injector</td>
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<td>- Injection in distal and / or small veins</td>
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<tr>
<td>- High flow rate of injected CM</td>
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<td>- Multi-punctured Veins</td>
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<td>- V line of more than 48 hours</td>
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<td>- Lack of supervision during ICM injection</td>
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<thead>
<tr>
<th>Dependent on the patient</th>
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<tr>
<td>- Inability to communicate</td>
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<td>- Vascular fragility or damage to the venous system</td>
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<td>- Emaciating Diseases</td>
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<td>- Extreme Ages</td>
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<td>- Obesity</td>
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Metal and small caliber catheters present increased
risk of extravasation, because they can tear or puncture
the vein walls. In addition, with their rigid walls they cause
greater hemodynamic stress at the exit point of the needle.

Teflon or other plastic types of cannulas are recom-
ended as they offer less chance of local vascular damage
and compliance, which reduces the hemodynamic stress.

Those venous cannulas with more than 48 hours
installation, are also considered more risky, given the
greater probability of dislocation, phlebitis and/or focal
thrombosis\(^8\).

An important factor also is the venous territory chosen
for the injection. It is recommended that this is in veins
of the highest possible caliber (from the elbow crease
to the head) and without previous punctures\(^1\)\(^,\)\(^3\).

Regarding risk factors dependent on patients, it
should be taken into consideration that young children,
the elderly, people with cognitive or speech disorders,
with altered level of consciousness or under the influence
of sedatives, are less able to communicate symptoms
resulting from extravasation of ICM, during and/or after
the completion of the procedure, which makes them
more likely to present higher volumes of leakage and
thus greater complications\(^5\)\(^,\)\(^8\).

Emaciated patients with multiple comorbidities which
involve venous fragility should be the focus of special
attention.

Extravasation mechanisms
Extravasation of an ICM can occur as a result of
different mechanisms.

One is these is an inappropriate location of the
catheter tip, which can be found outside of the vein
or impacted on its wall\(^8\).

It can also occur via focal breakage of the vein wall
subjected to great hemodynamic stress by injecting
a large flow of contrast at high pressure, as happens
for example in angiographic studies.

Another mechanism is in the context of injured
veins as a result of repeated punctures, affected by
phlebitis or thrombotic events, wherein the wall provides
continuity solutions, less complaisance and greater
resistance of the lumen to the injection\(^5\)\(^,\)\(^8\).

The small caliber veins (distal veins like those of
the wrist, ankle, hands and feet) are fragile and more
susceptible to breakage and extravasation of ICM\(^3\)\(^,\)\(^8\).

Toxicity Mechanisms of intravenous contrast media
The ICM can damage various tissues or anatomical
planes to which it has access once extravasated\(^8\).

Several mechanisms are involved, one of the most
important corresponds to the compressive effect or
increase in local pressure on a small compartment
such as the hands, wrists or feet.

ICM osmolality is considered directly proportional
to its toxicity therefore hyperosmolar solutions have
a higher risk of causing tissue necrosis\(^8\).
The intrinsic toxicity of the molecules of the ICM has a controversial mechanism that has not been well defined as yet, but it is postulated that there might be a direct cytotoxic action of the affected tissues.

Types of extravasations

a) Subcutaneous extravasation

This is the most common and in it the ICM dissects the subcutaneous tissue. Radiologically it appears as a collection of amorphous ICM, irregular with small rounded images corresponding to subcutaneous fat lobules (Figure 1a and 1b).

Both the technical (health) personnel who monitor the injection as well as the patient may notice an increase in volume adjacent to the puncture site and a discoloration of the skin, which becomes red\(^6\).

\[\text{Figure 1a and 1b. Simple Radiograph of right forearm.}\]
\[\text{The venous line is observed in the elbow crease. Adjacent to this, the presence of a collection of irregular contrast is highlighted, with rounded radiolucent images denoting that the ICM has dissected the subcutaneous tissue.}\]

b) Subfascial or intracompartmental extravasation

ICM enters the deep planes, subfascial, within the muscle compartments, which radiographically appears as a collection of well-defined fusiform contrast outlining the muscle bundles (Figure 2a and 2b).

The clinical presentation is atypical, because the characteristic increase of superficial volume adjacent to the injection site is not observed. The clinical diagnosis is based on measuring the diameter of the affected limb with a tape measure and comparing it with the contralateral limb.

\[\text{Figure 2a. Simple Radiograph of left arm. The accumulated contrast is spindle-shaped, typical of the muscle compartments that indicate a subfascial extravasation or in the biceps muscle compartment. At the lower point of the extravasation, the subcutaneous component is observed, from which it has penetrated into the deeper layers.}\]

\[\text{Figure 2b. Simple Radiograph of left arm. Same as in the previous image, the presence of contrast in the biceps muscle compartment is observed.}\]

To confirm this kind of extravasation it is imperative to take a radiograph of the affected limb. This type of extravasation can cause a sudden increase of pressure in the affected anatomic space and give rise to a compartment syndrome, which can eventually be treated with fasciotomy\(^3\).
c) Mixed extravasation

A mixed form can be seen with extravasation dissecting the subcutaneous tissue and also affecting a neighboring muscular compartment (Figure 3).

Figure 3. Simple radiograph of right arm and forearm. Mixed elements are observed, that is, there are signs of subcutaneous and also subfascial or compartment extravasation. Also highlighted, linear images representing the muscle bundles inside the biceps compartment.

Clinical presentation of extravasation of ICM

The diagnostic of contrast media extravasation is clinical. In general, when extravasation occurs patients often report symptoms such as discomfort, pain, burning, numbness, feeling compression or stiffness in the injection site, decreased mobility of the affected limb and others. However, some patients are asymptomatic and extravasation is investigated because of the increase in volume seen and/or palpable at the injection site or sometimes on finding the absence of ICM in the study images obtained.

On physical examination the most common observation is increase of surface volume at the injection site that can be accompanied by discreet erythema, swelling of adjacent skin and/or increased local heat (Figures 4a, 4b, 5a and 5b). Other cases may be as severe as the compartment syndrome in that both the volume of CM injected as well as the secondary inflammation generated, apply pressure on the muscles, blood vessels and nerves, causing a large increase in the diameter of the affected limb, intense pain, numbness, paresthesia, paresis and cold skin.

The vast majority of these events are limited to the immediately adjacent tissue, typically skin and...
subcutaneous tissue and usually cause no permanent sequelae. However, there are patients with associated risk factors or comorbidities that not only make them prone to suffer extravasation but also to damage by the ICM (Table II).

**Table II. Risk factors of tissue damage due to extravasation of ICM.**

<table>
<thead>
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<th>Dependent on CM</th>
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<td>ICM hyperosmolar</td>
<td>Large extravasated volumes (&gt; 100 ml)</td>
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<table>
<thead>
<tr>
<th>Dependent on the injection technique</th>
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<tr>
<td>Small compartments (hand, wrist, feet)</td>
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<table>
<thead>
<tr>
<th>Dependent on patient</th>
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<tr>
<td>Arterial insufficiency (atherosclerosis, DM)</td>
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<td>Venous insufficiency</td>
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<tr>
<td>Lymphatic insufficiency</td>
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<tr>
<td>Collagen Diseases</td>
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<td>Renal failure</td>
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**Evolution**

The great majority of patients suffering extravasation of an ICM evolve toward spontaneous resolution and the symptoms and signs will be resolved within 24 to 48 hours (Figures 6 and 7)(1,3,5).

![Figures 6 and 7. Photos of the upper limb of the same patient from Figure 4, twenty-four hours after extravasation. Remission of the erythema and previously observed swelling can be seen, leaving only a small area of redness in the elbow crease. Highlighted is the marking of the initial injury on the skin with a permanent pen, which is useful to objectively evaluate its progress.](image)

Fortunately, there are very few patients who evolve unfavorably, possibly presenting serious lesions such as blisters and ulceration of the skin, subcutaneous tissue necrosis and/or compartment syndrome(3,8).

The larger the volume of ICM extravasation and the smaller the affected compartment in a patient with risk factors, greater is the likelihood of damage.

**Prevention**

To reduce the incidence of this complication in outpatients, some basic measures should be considered (Table III). One of the more important is to make a suitable choice for the injection site, puncturing thick veins from the elbow crease to proximal.

**Table III. Measures to prevent ICM extravasation.**

<table>
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<th>Prevention in Outpatient</th>
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<tr>
<td>Proper choice of puncture site</td>
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<td>Adequate caliber catheter</td>
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<tr>
<td>Use plastic venous lines</td>
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<tr>
<td>Supervised Injection</td>
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<tr>
<th>Prevention in hospitalized patients</th>
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<tbody>
<tr>
<td>Use of venous line no longer than 48 hours</td>
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<tr>
<td>Use a catheter with a good gauge and permeable</td>
</tr>
<tr>
<td>Look for signs of phlebitis</td>
</tr>
<tr>
<td>Install a new venous line in the presence of phlebitis and/or thrombosis</td>
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<tr>
<td>Supervised Injection</td>
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Special caution should be taken with patients that have been subjected to axillary lymphadenectomy (axillary dissection) which predisposes extravasation damage, for example patients operated for mammary neoplasia(8).

A catheter must be chosen with an adequate gauge for the patient depending on the volume of injection. Generally it is suggested to use 18 G to 20 G plastic catheters(1,9).

In hospitalized patients is not recommended to use venous lines with 48 hours or more of use(8). The catheter caliber and permeability must be verified. If there are signs of phlebitis or evidence of multiple punctures it is preferable to install a new line.

Monitoring the venous line during the injection of ICM is fundamental and indispensable(8). The technician in charge, should palpate the puncture site until the end of injection and should extravasation occur, immediately stop the injection.

In the last decade two technological advances
have been developed that reduce the probability of extravasation occurring. One of these is multifenestrated venous lines that not only have an outlet at the distal end of the catheter, but also multiple side holes. The lateral fenestration act by slowing the flow of ICM, thereby reducing the hemodynamic stress on the vein walls\(^9,10\).

Another breakthrough is the development and use of automatic extravasation detection devices such as IV-pole patches that are placed at the site of injection and measure the local impedance. In the presence of impedance changes caused by extravasation the injector is stopped autonomously\(^11\).

**Management**

Currently there is consensus that the management of ICM extravasation should be conservative\(^6\). Each Imaging Department performing ICM injections should have an action and management protocol (Figure 8). Taking into account the recommendations of the various international guidelines and the experience of our own Imaging Department, the following is suggested:

1) After the investigation for ICM extravasation the injection should be stopped and the venous line removed, at the same time aspirating gently, to try to extract the maximum amount of contrast adjacent to the catheter.

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**Figure 8. Algorithm for the management of ICM extravasation in our center.**
2) Una vez esto esté hecho, se recomienda delimitar el área con un bolígrafo de tinta permanente para extender el área de la lesión, evaluando así el tamaño y la evolución de la lesión.

3) En algunos casos, cuando se detecta la salida de líquido por debajo de la piel, es útil medir la distancia desde la piel expuesta a la piel sana y compararla con la parte del antebrazo opuesto.

4) Se recomienda el uso de radiografías simples del área afectada, lo que nos permite confirmar la presencia de ICM en cualquier de los compartimentos (zona de extravasación), además de proporcionar una estimación más precisa de la cantidad de ICM extravasada.

5) Seguidamente, se debe levantar el miembro afectado a una altura igual o superior a la del corazón, que ayuda a reducir la presión capilar cutánea, y facilita la reabsorción desde el área afectada y el drenaje del ICM extravasado, junto con los edemas que acompañan en respuesta inflamatoria.

6) Se puede aplicar frío localmente en forma de vendas de hielo o de gel congelado, que alivia los malestares de la piel. Teóricamente, causa la vasoconstricción, reduciendo la inflamación y el dolor.

7) En los pacientes hospitalizados, debe notarse cualquier complicación en la historia clínica y en los cuadros de los pacientes, y comunicarse con el personal de salud responsable.

8) En el caso de los pacientes ambulatorios, debe comunicarse con el personal de salud responsable por teléfono para verificar la presencia de ICM en cualquier posible área de extravasación.

9) La consulta de cirugía plástica se recomienda en los casos de sospecha de extravasación, para evitar complicaciones o para prevenir en caso de extravasación entre compartimentos.

Conclusión
Extravasación de contrastes iónicos en TC es una complicación rara que puede tener un efecto favorable, pero puede evolucionar a lesiones más serias, por lo que se requiere la colaboración de los radiólogos y el personal de salud en el departamento de imagenología.