UPDATE

US-guided interventional procedures: what a radiologist needs to know

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Abstract

Ultrasound (US) has important advantages in guiding interventional procedures: it is cheap and widely available, it does not use ionizing radiation, and it takes less time than other techniques. US guidance can be carried out using devices adapted to probes or using the freehand technique (holding the needle in one hand and the probe in the other). US-guided procedures require careful planning, adequate hemostasis (or a compressible puncture site), patient’s informed consent, and appropriate measures to ensure asepsis and anesthesia.

The technique consists in introducing the needle or catheter following the plane of the US. The progression of the needle is controlled in real time. High resolution linear probes are ideal for interventional procedures in superficial tissues, but 3.5 MHz probes are required for procedures in deep tissues.

The most common procedures include biopsies, drainages, and percutaneous injections. Biopsies can be carried out using fine needles to obtain material for cytological study (fine-needle aspiration cytology) or using large needles to obtain specimens for histologic study (core biopsy). Core biopsy is more sensitive and more specific, and it has a low rate of complications. Drainage almost always involves placing a catheter in a fluid collection; it can be performed using the Seldinger technique, trocars, or pleural catheters. US-guided percutaneous injections are intended to inject substances into infectious lesions, tumors, or nerve plexuses, and they are especially useful in musculoskeletal disease.

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KEYWORDS
Interventional ultrasonography; Needle biopsy; Drainage; Puncture

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Intervencionismo guiado por ecografía: lo que todo radiólogo debe conocer

Resumen
La ecografía presenta importantes ventajas como guía de procedimientos: es barata, disponible, móvil, no utiliza radiaciones ionizantes, y requiere menos tiempo que otras técnicas. La guía ecográfica puede realizarse usando dispositivos adaptados a las sondas o mediante la técnica de manos libres (sosteniendo la aguja con una mano y la sonda con la otra).
La realización de procedimientos guiados por ecografía requiere una planificación previa cuidadosa, tener una hemostasia suficiente o que la zona de punción sea directamente compresible, obtener el consentimiento informado del paciente, y medidas de asepsia y anestesia apropiadas.
La técnica de los procedimientos supone introducir la aguja o el catéter a través del plano de corte del ecógrafo. El avance se controla en tiempo real, pudiendo dirigir la aguja. Los transductores ideales para realizar intervenciones en tejidos superfi ciales son los lineales de alta resolución, aunque en lesiones profundas es necesario utilizar sondas de 3,5 MHz.
Los procedimientos más habituales incluyen biopsias, drenajes e inyecciones percutáneas. Las biopsias pueden realizarse usando técnicas de punción con aguja fina (PAF), para citología, o gruesa, para obtener muestras histológicas. Esta última presenta mayor sensibilidad y especificidad con una tasa baja de complicaciones. El drenaje supone casi siempre colocar un catéter en una colección. Puede hacerse usando las técnicas de Seldinger, trócar o mediante catéteres de tipo pleural. Las inyecciones percutáneas con control ecográfico se pueden usar para inyectar sustancias en lesiones infecciosas, neoplásicas, en plexos nerviosos o en patología musculoesquelética sobre todo.
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PALABRAS CLAVE
Ecografía intervencionista;
Biopsia por aguja;
Drenaje;
Punciones

Ultrasound as a guiding procedural technique

Percutaneous procedures can be performed using any radiological imaging methods as a guide. The selection of a particular method depends on various factors, such as the location of the lesion, equipment availability, patient characteristics, and, above all, the personal experience or preferences of the radiologist. Perhaps because of the necessity of certain skills and practical training, the use of ultrasound as a procedural guide is not as widespread in radiology departments as CT or radioscopy. 

However, US has important advantages that make it preferable for guiding procedures when the lesion is visible using this technique. US is cheaper than CT and widely available in all imaging departments. It does not use ionizing radiation, which is an important point in longer procedures. It allows the procedure to be performed with real-time continuous monitoring of the position of the needle. US scanners are mobile, which makes them particularly suitable for procedures in patients in intensive care units or in the operating room. The time required for procedures guided by ultrasound is always less than that required for other techniques, as most of ultrasound procedures can be performed in only a few minutes. Finally, it is a versatile technique that permits multiple access routes to the lesion, not being limited to a plane, like other sectional techniques.

However, US also has limitations that should be mentioned. The US signal is attenuated with increasing depth, which limits its use in deeper lesions. Also, US has less spatial resolution than CT and MRI in deeper planes, and less sensitivity than these techniques in the detection of some lesions. Moreover, US waves do not pass through air or bone, which limits its use in air and bone structures or in air lesions.

Guidance procedures

Guidance systems attached to the probe

This devices are attached to the probe. The needle is introduced through them, following a set direction in the US plane. Some probes have specifically designed holes in them through which the needle can be inserted. These systems make the procedures more feasible in cases of limited experience at the expense of restricting the number of paths available and an added cost, also.

Hands-free techniques

This is performed by using one hand for the introduction of the needle or the catheter lateral to the probe while monitoring its trajectory with a probe held freely with the other hand (fig. 1).

Both instruments are handled while maintaining the path of the needle in the incisional plane and directing it towards its objective. This technique allows greater freedom in choosing the path to the lesion and for adjusting this path.
during the procedure; moreover, it does not require additional and costly devices. However, its use requires a longer learning curve\(^1\). This is the technique used usually in our faculty\(^10\).

**Prerequisites**

**Planning**

There are two conditions that a lesion should meet to be susceptible for any US-guided interventional procedure. The first one is to be visible by US and the second is to be accessible through an acoustic window so that the needle used can be visualized along its entire path and the procedure be monitored in real time. If these requirements are met, any lesion visible in US, even being situated in the chest or in the bone (fig. 2), is potentially accessible using interventional US techniques.

Before starting any procedure, it is necessary to characterize and accurately locate the lesion. This requires the review of every imaging study available and a careful US examination of the area of the lesion\(^2,11\). Thus, in general, the drainage of an abscess in the abdominal cavity of an adult is not performed without prior CT imaging. The procedure should be planned in advance. Main nerves or structures that could be damaged should be avoided. It is important to complement the examination with the use of Doppler to identify nearby vessels\(^2\). For example, in the procedures performed in the abdominal cavity, the epigastric artery should be identified whenever it can be located near the puncture site.

Several specific considerations should be made for the abdomen. Solid organs can be crossed to access a lesion situated beyond, with the exception of the spleen and pancreas (except to access lesions within these organs). Regarding hollow structures, the stomach can be crossed with both needles and catheters, whereas the rest of the digestive tract can be crossed with needles, but this should not be done with catheters\(^12\). The urinary tract and bladder should, in general, be avoided. The pleural space can be crossed, but the lung parenchyma should be avoided except for procedures directed at lesions in the lung itself. Ascites is not an absolute contraindication for procedures performed in the liver\(^13\), and, moreover, can be reduced by means of prior paracentesis.

As a general rule, the shortest path to the injury is the most appropriate. In general, but especially when needles are used, the ideal route of insertion is the one most parallel to the surface of the transducer. This orientation will

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**Figure 1** Hands-free techniques. Placement of a pleural type catheter to perform paracentesis in a patient with ascites. A) The probe is held over the objective with the left hand while the catheter is directed, following the incisional plane, with the other hand. B) In the ultrasound image the catheter was introduced in ascites following the incisional plane.

**Figure 2** Biopsy with ultrasound monitoring of squamous cell carcinoma of the lung contacting the pleura. Arrows indicate the location of the needle.
increase the echogenicity of the needle and will allow for better visualization.

**Hemostasis**

Hemostasis should be verified to be enough to avoid bleeding, which is the most frequent complication. Patients undergoing therapy with oral Coumadin derivatives should have these substituted for low-molecular-weight heparin before treatment. Coagulation tests should be ordered prior to every procedure, and these tests should include measurements of prothrombin time, international normalized ratio, and platelet count. Analyses should be obtained less than 24 h before performing the technique in patients with coagulopathy or on anticoagulant therapy. For biopsy or fine needle aspiration (FNA) of superficial lesions in which adequate hemostasis can be obtained by direct pressure, these requirements can be omitted.

Coagulation abnormalities are not necessarily an absolute contraindication. If the patient has less than 50,000 platelets/mL, a platelet transfusion can be performed before the procedure. Changes in prothrombin time can be treated by administering vitamin K in the days prior to the procedure. If the international normalized ratio is greater than 1.3, this indicates a need for administration of fresh plasma (2 units for every 0.1 points greater than 1.3) immediately before the procedure.

**Informed consent**

Patients (or their guardians) should always be previously informed in a clear and comprehensible manner about the procedure, explaining the objectives and possible complications. The patient should give signed consent.

**Analgesia**

Most of the procedures can be performed under local anesthesia, which should be injected in the puncture site and along the path of the needle. We use 1 % lidocaine injected in the puncture site and the trajectory of the needle. Neural tumor biopsies or those in which the periosteum should be crossed, are very painful, so the entry point of the needle into the lesion should be carefully anesthetized.

The use of sedation is useful, and at times essential, in painful procedures and in pediatric patients. The drugs used for this purpose are benzodiazepines (generally midazolam), chloral hydrated or ketamine, associated to an analgesic (morphine, fentanyl, meperidine).

For some procedures it can also be useful to premedicate the patient with anxiolytics to avoid vagal reactions. The use of a fast-acting anxiolytic such as alprazolam is recommended.

**Asepsis**

It is crucial to maintain strict asepsis of the puncture site. It should be cleaned with antiseptic. US gel, even if it is sterile, should not contact the entrance point in the skin. Although not essential, the use of sterile covers for the transducer helps to maintain aseptic conditions.

**Technique**

The needle or catheter are directed towards the lesion along the plane of the US (fig. 3). Progress is monitored in real time in order to be able to direct the needle and change its path if necessary. The ideal transducers for performing interventions in superficial tissues are linear and high-resolution (at least 5-10 MHz). In deeper lesions, it is necessary to use 3.5 MHz probes, which bears the inconvenience that needles are less clearly visualized.

When parallel to the surface of the probe, a needle appears as a bright echogenic line, sometimes with associated reverberation artifacts (fig. 4). If the orientation is oblique, the echogenicity of the needle decreases, reaching its minimum when the angle of incidence makes only the tip visible, appearing as a bright echogenic point. If the needle is difficult to see, rapidly moving to and fro can help detect its location. It is convenient to select only one focal zone to avoid artifacts.

Catheters and thick needles pose no problems for monitoring. They can be directed linearly (for example, to direct the tip down, the cone of the needle must be pushed upward). However, such control is more difficult for longer and thinner needles. Thin needles, such as Chiba needles, can warp when they are introduced into the body and

![Figure 3](http://www.elsevier.es)
Core biopsy

It permits to obtain a specimen of tissue that can then be histologically analyzed, including histochemical or immunohistochemical techniques. Moreover, it allows to carry out imprints of the specimen for added cytological analysis. Thicker needles (usually 14-18 G) are used for this technique. The needles can be manual or spring-loaded. Spring-loaded needles are triggered by pressing a button and are generally more reliable but have the inconvenience of greater cost. Large needle experience paradoxical redirection (the tip can be directed downward when the cone is pushed down).

Basic procedures guided by ultrasound

The variety of procedures that can be performed under US guidance is broad (table 1). The following describes the most basic procedures; that is, those that every radiologist should be capable to perform.

Biopsies

Percutaneous biopsy is highly efficient for diagnosing any lesion visualized with US having low cost and minimal risk. Its goal is to place a needle into the lesion to obtain cellular or tissue samples and thus identify its nature. It is indicated to specifically diagnose any lesion of an unknown nature. It can be performed in practically all parts of the body with the exception of the central nervous system.

As a general rule, percutaneous biopsy is very sensitive for distinguishing between benign and malignant lesions and has a specificity close to 100%. Pathological analysis of the samples poses some difficulties for typing and subtyping some tumors, especially in the case of the cytological techniques, due to the fact that the samples are relatively scarce and may not be representative of the entire tumor.

Percutaneous biopsy techniques

1. Fine needle aspiration
   This is not strictly a biopsy technique. This technique yields a cellular aspirate, which is used for cytological analysis. Fine needles (20-25 G) that can obtain a cellular aspirate for analysis are used in this technique. Although the use of fine needles is theoretically less traumatic, it presents the inconvenience of having a significant number of non-diagnostic procedures, being very operator-dependent. Also, it usually provides less information than techniques done with a thick needle, frequently given only a classification of a lesion as benign or malignant.

2. Core biopsy
   It permits to obtain a specimen of tissue that can then be histologically analyzed, including histochemical or immunohistochemical techniques. Moreover, it allows to carry out imprints of the specimen for added cytological analysis. Thicker needles (usually 14-18 G) are used for this technique. The needles can be manual or spring-loaded. Spring-loaded needles are triggered by pressing a button and are generally more reliable but have the inconvenience of greater cost. Large needle experience paradoxical redirection (the tip can be directed downward when the cone is pushed down).

Table 1 Main procedures that can be performed with guided ultrasound

<table>
<thead>
<tr>
<th>Biopsies</th>
<th>Drainage of collections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breast</td>
<td>Abscesses</td>
</tr>
<tr>
<td>Neck and face: thyroid,</td>
<td>Hematomas</td>
</tr>
<tr>
<td>adenopathies, salivary</td>
<td>Other collections: biloma, seroma, etc.</td>
</tr>
<tr>
<td>glands, soft tissues, etc.</td>
<td></td>
</tr>
<tr>
<td>Abdomen: liver, kidney,</td>
<td>Pseudocysts and pancreatic abscesses</td>
</tr>
<tr>
<td>spleen, mesentery,</td>
<td></td>
</tr>
<tr>
<td>peritoneum, retroperitoneum, adenopathies, ovary, pancreas, etc.</td>
<td></td>
</tr>
<tr>
<td>Chest: Pleura, chest wall, peripheral pulmonary nodules</td>
<td></td>
</tr>
<tr>
<td>Musculoskeletal and soft tissue: lesions of soft tissues, neural tumors, sarcomas, lipomas, nonspecific tumors, etc.</td>
<td></td>
</tr>
<tr>
<td>Adenopathies</td>
<td></td>
</tr>
</tbody>
</table>

Nephrostomy

Cholecystostomy

Pleural drainage

Peritoneal drainage

Sclerosis, cysts and cavities

Chemical neurolysis

Treatment of hydatid cysts

Thermal ablation

Liver tumors

Renal tumors

Breast carcinomas

Treatment of pseudoaneurysms

Treatment of arteriovenous malformations

Vascular accesses

Block anesthesia

Musculoskeletal treatments

Aspiration

Treatment of calcifying tendinitis

Ultrasound-guided Injections

Treatment of Morton’s neuroma

Treatment of plantar fibromatosis

Treatment of tendinosis

Intra-articular injection of hyaluronic acid

Treatment of ganglion and Baker cysts

Treatment of serious tennis leg

Figure 4 Reverberation artifacts behind the needle in ultrasound-guided arthrocentesis.
biopsy has both very high sensitivity and specificity, higher than that of FNA, with a very low rate of complications\(^1\).\(^{16}\).\(^{20}\).

Biopsy needles are divided into 2 categories:

- **Lateral-cutting needles**, also known as “tru-cut”. These consist of an outer cannula with a central stylet that has a gap in its distal portion (fig. 5). When fired, this stylet penetrates the lesion and the outer cannula is advanced, cutting the tissue and leaving a fragment in the gap\(^{3}\).\(^{15}\).

- **Frontal-cutting needles**. With these, the central stylet does not have a gap. When triggered, the outer cannula advances, leaving the central stylet behind and cutting a fragment of tissue, which remains in the interior (fig. 1). It allows to obtain larger specimens than lateral-cutting needles of similar diameter. It also allows for variation of the length of the sample without changing the needle. However, they are inferior to lateral-cutting needles for sampling soft or very hard lesions, or in tissues such as the breast or prostate\(^{1}\).\(^{15}\).

Both these needles can be introduced directly or along a coaxial needle, which is an outer cannula of greater caliber that is inserted to the edge of the target lesion and through which the biopsy needle is inserted. This permits the acquisition of various samples without having to introduce the needle again.

**Specific precautions**

Lesions suspicious of being pheochromocytomas should not be biopsied due to the risk of severe hypertensive crisis with cardiovascular complications. Lesions suspicious to correspond to hydatid cysts should not be biopsied due to the risk of anaphylaxis. There is not, however, a specific risk associated with biopsy of a hemangioma\(^{1}\).\(^{18}\).\(^{22}\).

A non-infectious lesion should never be biopsied through a zone of infection to avoid the extension of germs along the path of the needle\(^1\). When potentially malignant lesions are biopsied, it is advisable to cross only one anatomical compartment. In lesions situated on the surface of the liver it is recommended accessing the lesion through healthy parenchyma to prevent bleeding and tumor dissemination\(^1\).

To select the sampling site, it should be keep in mind that the center of many lesions is occupied by necrotic tissue, which is not useful for histological analysis. Thus, material should preferably be taken from the periphery of the lesion. In the lymph nodes, the area farthest from the hilum should be biopsied\(^1\). In lesions with cystic components, it should be sampled the areas of solid tissue. It is necessary to try and obtain samples representative of the entire lesion in order to avoid sampling errors, which is why it is necessary to perform several punctures of the lesion\(^1\).

**Complications**

- **Malignant seeding in the path of the needle**

  This is a very infrequent complication. To avoid it, a correct technique should be used, the path of the biopsy carefully chosen to avoid crossing healthy compartments\(^{21}\) and accessing the lesion crossing normal parenchyma before \(^1\). It is also desirable to surgically remove the path of the biopsy\(^{15}\).\(^{21}\). Some authors have described a lower rate of seeding using coaxial needles\(^{23}\).

- **Bleeding**

  In addition to measures to maintain hemostasis, after the procedure, and whenever possible, an adequate compression of the punctured area should be performed. In procedures performed in the torso, the patient should remain for 20-30 min lying on the side of the puncture, after which a new image exploration should be performed to confirm the absence of complications. If a solid organ has been crossed, a follow-up US one hour after the procedure is recommended and it is advisable to keep the patient at rest a few hours before discharged home. If uncontrollable bleeding occurs, percutaneous embolization can be used\(^{15}\).

**Drainage**

Despite improvements in antibiotherapy, abscesses continue to be a serious challenge whose solution requires direct intervention to drain them. Percutaneous drainage is presently, due to its simplicity and few complications, the treatment of choice for any symptomatic fluid collection except in immediate indication for surgery. Moreover, it can also be used in the treatment of any liquid collection, infected or not, in any part of the body, as well as to access hollow structures of the organism, as in the case of a cholecystostomy or nephrostomy (fig. 6)\(^9\).\(^{24}\).
Drainage can be performed for two reasons: diagnostic, for obtaining samples for culture and analysis, or therapeutic, as a means to avoid surgery or to improve the symptoms of the patient and his state to perform a scheduled surgical intervention.

**Drainage methods**

- **Needle aspiration**
  This entails aspirating collected fluid through a direct puncture with a large-gauge needle (14-18 G). Needles with an external vascular access catheter are very useful. In small collections needle aspiration may be enough to heal the lesion (associated with antibiotic treatment if abscesses are involved)\(^\text{10}\).

- **Placement of drainage catheters**
  Drainage catheters are plastic tubes with various holes in the distal portion to allow the liquid be drained. The catheter is introduced in the collection and its other end is fixed to the skin and connected to a bag to collect the drained fluid. The most common form for distal ends of catheters is “pigtail”, with holes in the internal edge, which prevents the collection walls from collapsing upon being emptied\(^\text{10}\).

  There are several types of catheters in terms of composition, diameter and morphology. The most useful caliber ranges from 7-10 F. Some more dense collections can require the placement of catheters up to 12 F. Many catheters have retention devices that prevent them from falling out. The most common is a loop that runs through the catheter and anchors it\(^\text{9,24,25}\).

**Placement techniques for drainage catheters**

a) **Seldinger technique**
   This consists of puncture of the collection with a thick needle (14-18 G), along which a metallic guide of caliber 0.0035″-0.038″ is passed. The catheter is introduced above this needle in the cavity, sometimes using previously dilators to facilitate its introduction.

b) **Trocar technique**
   The catheter is mounted on a hollow, rigid metallic guide through which a metallic stylus is inserted (fig. 7). The trocar, when assembled, appears as a pointed, rigid catheter. It is introduced into the collection by direct puncture from the skin and, upon arriving at the collection, the stylus is removed and the catheter slides over the metallic guide until its distal part is in the interior of the collection. This technique is faster and allows for draining in a single act. It also has an advantage in that it is simpler for more inexperienced practitioners\(^\text{24,25}\).

c) **Pleural catheter**
   This is a catheter that slides inside a metallic needle. Upon the needle’s entrance into the cavity, the blunt catheter slides into the interior to avoid damaging the structures situated there. When the needle is removed, the catheter remains in position\(^\text{24}\). We used this in pleural procedures (fig. 8) and to perform paracentesis (fig. 1).

**Maintenance of the drainage catheter**

It is important to ensure that all the holes of the catheter are situated within the collection area. If there are various independent collections, a catheter should be placed in each of these locations. Samples of the liquid...
obtained should be sent to the lab for analysis or culture. The catheter should be periodically checked (at least weekly) in the Radiology Department to verify proper placement and to ensure that it has not obstructed, to detect possible complications, to perform aspiration of the remaining collection and to wash it. The drained volumes should be daily registered. Guidelines should be set for periodic washes with physiological saline. In dense or hematic collections, intracavity fibrinolysis can be used to facilitate the drainage. As a general rule, the catheter should be maintained until the patient does not have a fever, has no infection, and presents less than 10 cc of drainage during 3 consecutive days10,25.

If the volume of drained liquid remains constant over a long period, it is probable that there is an associated fistula. In these cases, it is recommended that a fistulogram be performed through the catheter in order to confirm its existence and identify its path. If a fistula does exist, the drainage should be expected to occur for a long time, until it closes. This can take months in pancreatic fistulas, which is why great care and asepsis should be maximized in the monitoring of the catheter24.

Complications

- **Infection**
  Puncture of the infected tissue may allow for the passage of pathogenic agents into the bloodstream, producing bacteremia and possibly sepsis. Therefore, it is imperative that the drainage is performed with the patient undergoing a specific broad-spectrum antibiotic treatment (in case the pathogenic agent is unknown) and that this treatment is maintained afterwards9,24.

- **Bleeding**
  It is important to plan the procedure carefully, to avoid crossing main vessels and monitoring the hemostasis of the patient9.

- **Hollow visceral lesion**
  Upon inadvertently crossing an intestinal loop, hollow visceral lesions should be suspected if stercoral drainage appears in the absence of intestinal fistulas. If this occurs, the catheter should be left in position for two weeks so that the tract is mature before catheter withdrawal9.

- **Pneumothorax or pleural effusion**
  Some drains, especially those of subphrenic abscesses, are performed by crossing the rows below the pleural space, which can cause a pneumothorax or effusion9.

- **Drainage failure**
  This occurs in 10-20% of cases. In half of these cases, the drainage allows for control of the infection, making surgery elective. Failure is most frequently seen for in fungal abscesses or is associated with fistulas24,27.

Percutaneous injections

These consist of introducing a needle with ultrasound guidance to inject a substance into the interior of a lesion or a structure with a therapeutic aim. They can be used to inject substances in infectious or neoplastic lesions or in the nerve plexus, with analgesic purposes. They are good for destroying nerve plexuses (neurolysis) in cases of uncontrolled pain, or to perform selective anesthesia28,29. Therapeutic infiltrations are also used (mainly with corticosteroids) in musculoskeletal pathology to treat inflammatory or algid processes. The latter are usually carried out without image monitoring; however, the ultrasound guide avoids injecting outside of the objective (fig. 9), increasing its effectiveness and decreasing the pain caused25. These injections can even be used to wash the calcifications in calcifying tendinitis25,14.

For these procedures it is preferable to use fine needles (22-25 G) that are less painful for the patient. For injections in superficial structures, subcutaneous or intramuscular needles are appropriate. For injections of deeper structures, needles of greater length, like spinal or Chiba needles, should be used.

The guidance technique and its performance are similar to that used for biopsies. It is recommended that one confirms the correct location of the substance injected in the objective. This is simple, as the distribution of liquid injected can be seen in real time. Injections of ethanol and similar substances are usually painful and, even though it is not essential, they should be performed under sedation25.
a patient with epicondilitis.

Figure 9  Infiltration of corticosteroids guided by ultrasound in a patient with epicondilitis.

Conclusions

Ultrasound guidance is currently underused among radiologists during procedures. However, due to its low cost, safety, accessibility, speed and efficiency, it should be the technique of choice in procedures performed on lesions visible with ultrasound. The knowledge of its possibilities, technical requirements, and adequate training to achieve the most basic procedures with this technique should be part of the skills common to all radiologists.

Conflict of interests

The authors declare no conflict of interest.

Authorship

Jose Luis del Cura contributed to the conception and design of the revision, to obtaining data, to analysis and interpretation and in the drafting of the work and has given his final approval for the version sent for publication.

Rosa Zabala contributed to obtaining the data, was involved in critical review and gave her final approval for the version sent for publication. Igone Corta contributed to obtaining the data, has been involved in critical revision and giving the final approval for the version sent for publication. Igone Corta contributed to obtaining the data, has been involved in critical revision and giving the final approval for the version sent for publication. Igone Corta contributed to obtaining the data, has been involved in critical revision and giving the final approval for the version sent for publication. Igone Corta contributed to obtaining the data, has been involved in critical revision and giving the final approval for the version sent for publication.

All the authors have read and approved the final version of the article.

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