ARTHROGRAPHY OF EXTREMITIES, HOW IS IT DONE?

Artrografía de las extremidades, ¿cómo se hace?

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Summary

Arthrography, despite being an old technique, has regained validity in recent years due to its usefulness in the assessment of structures that cannot be correctly assessed using non-invasive imaging techniques. The purpose of this article is to review the fluoroscopic arthrography techniques of the main joints in the extremities (shoulder, elbow, wrist, hip, knee and ankle), in order to provide the reader with multiple approaches for each of them, based on articular anatomy.

Resumen

La artrografía, a pesar de ser una técnica antigua, ha recobrado validez en los últimos años por su utilidad en la evaluación de estructuras que no se pueden valorar correctamente mediante técnicas de imagen no invasivas. El propósito de este artículo es realizar una revisión de las técnicas de artrografía por fluoroscopia de las principales articulaciones en las extremidades (hombro, codo, muñeca, cadera, rodilla y tobillo), con el fin de brindar al lector múltiples abordajes para cada una de ellas, con base en la anatomía articular.

Introduction

Arthrography is a technique that has been used for more than 100 years to evaluate joint structures, as well as the integrity and location of their components (1). Today, with little diagnostic value of its own, it is often used to inject intra-articular contrast medium for direct magnetic resonance imaging (MRI) and scans. Despite exposure to ionizing radiation, the use of fluoroscopy reduces the risk of extracapsular injection or injury to intra-articular structures. This article aims to review specific fluoroscopic techniques for addressing major joints, based on articular anatomy.

1. General technique

The technique of fluoroscopic arthrography varies depending on the joint being intervened. In general, the patient should be positioned in a comfortable position that allows him or her to remain immobile while the radiologist inserts the needle perpendicularly, without angulation of the x-ray tube.

All arthrography should be performed with a sterilization technique that includes asepsis and antisepsis at the puncture site. Prior to puncture, local anesthetic is recommended to reduce the pain of the procedure.

Under fluoroscopic vision, Spinocan® needle puncture size 21G-25G is performed in the selected anatomical location until contact with the bone structures, in which the tip of the needle should be visualized in contact with the bone and at 90º with respect to it. Confirmation of the intraarticular position is obtained by injecting contrast medium into the joint space and opacifying it. The dilution of paramagnetic medium used for arthroresonance is 1:200. A mixture of 250 cm^3 of 0.9% saline and 2 cm^3 of paramagnetic contrast medium can be made. Of this mixture 10 cm^3 are used.

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1.1 Shoulder

There are different approaches to perform fluoroscopy-guided shoulder arthrography, anterior and posterior. An inverted approach is recommended when instability is suspected (posterior instability, anterior approach and vice versa) (2). In the first, described by Berholzer and collaborators in 1930, the patient is positioned supine, the arm is rotated externally to avoid puncturing the long head of the biceps muscle; if this position is uncomfortable or very painful for the patient, the anterior approach can be performed with the arm in a neutral position, with the palm of the hand on the hips (3). The puncture site is marked in the upper and medial quadrant of the humeral head, between the supraspinatus and subscapular muscles (figure 1).

Under intermittent fluoroscopic vision, the needle is advanced parallel to the x-ray tube until contact with the humeral head. A test injection is performed with 1 cm^3 which must have a passage without resistance, for the subsequent injection of the contrast medium (5-10 cm^3), which must opacify the articular cavity (Figure 2).

The posterior approach consists of positioning the patient in prone position, with angulation of the shoulder to be intervened at 45 degrees on the vertical axis, filling the space between the patient and the fluoroscopy table with a triangular pillow (figure 3) so that the shoulder is in a neutral position (4). Fluoroscopic vision is used to verify a tangential position of the glenohumeral joint. Marking is performed in the inferomedial quadrant of the humeral head, followed by injection of the contrast medium. This approach has risk of vascular and nervous damage (5); however, in the literature there is no information on these complications during arthrography.

1.2 Elbow

Elbow arthrography can be performed by puncture of the various compartments of the elbow. The humeroradial compartment is approached with the patient in a supine position, placing the hand posterior to the dorsum, in such a way that the lateral aspect of the elbow is exposed.The radial head is placed and the proximal marking is made to this, to perform the puncture in the anterior portion of the humeroradial compartment (Figure 4). The syringe needle (usually with anaesthetic) is advanced under fluoroscopic guidance in a perpendicular direction, applying a constant low pressure until there is a decrease in resistance, which is produced when entering the capsule; then, approximately 2 mm more is advanced for the injection of the contrast medium (6) in order to obtain a complete opacification of the recess that confirms the adequate position (figure 5).

The other type is the posterior or transtriceps approach, in which the patient is positioned supine or prone with the semiflexed elbow in the lateral position; if the patient is in the supine position, the shoulder and elbow should be elevated to reduce external rotation. The medial, lateral and olecranon epicondyls are then palpated for marking at the point equidistant between the two epicondyls, proximal to the edge of the olecranon. Finally, after locating the anatomical repair point, the contrast medium is injected using the usual technique, bearing in mind that the maximum capacity of the elbow joint is 3 cm^3 (7).

1.3 Wrist

In the arthrography of the wrist there are different compartments, which are accessed by a dorsal approach (figure 6).

To perform arthrography of the distal radiocubital joint, the patient is positioned seated with the palm facing the fluoroscopy table. In some cases, a slight oblique rotation of the wrist with the ulna separated from the table is required to avoid supination due to the fact that the radial margin is superimposed on the ulnar head (8). Then, the puncture point is marked: on the head of the ulna 3 mm proximal to the distal horizontal margin of the ulna and 1-2 mm to the cortical margin of the articular aspect of the ulnar head (8). After marking the point, using the usual technique, with a 1-inch long 25G or 23G butterfly-type needle, the point is punctured perpendicularly until contact with the bone surface and the contrast material is injected. The joint has a low capacity, which ranges from 0.5-2 cm^3 under normal conditions (9).

To puncture the mediocarpal region (middle compartment) there are two marking sites. The first one is located between the scaphoid, the trapezoid and the large one. The second, between the crescent, the pyramidal, the large and the hooked. Finally, if the exploration of the radiocarpal joint is desired, the marking is made on the middle portion of the scaphoid (10, 11) (figure 7).

1.4 Hip

The objective in performing hip arthrography is to puncture the anterior recess of the joint, for which several approaches have been described: the supratrochanteric lateral approach and the anterior approach with direct puncture of the femoral head, which may be below the acetabular ridge or in the center of the head and in the lower or upper aspect of the edge of the acetabular neck. In paediatric patients, the inferomedial approach is the most commonly used (12) (Figure 8). In the institution where the study was performed, the anterior approach is used with direct puncture of the femoral head and the lateral approach with puncture in the lateral area of the femoral neck in the central part, which is preferred in obese patients or patients with abundant adipose panniculus in this area.

Anatomically, the anterior recess is divided into two compartments separated by the orbicular area corresponding to the annular ligament, as mentioned both compartments can be punctured for the procedure. In order to perform arthrography in the lateral compartment, the patient lies down in supine decubitus and the hip is positioned in a slight medial rotation to obtain a better presentation of this area, which is achieved by joining the patient's feet (13). Then, with a 3.5 inch 22G needle, the area of interest located lateral to the orbicular zone is punctured until contact with the bone is obtained, then the prepared contrast material is injected, without exceeding its maximum capacity of 10 cm^3 (Figure 9). This approach has the advantage of being less painful than the medial, but is associated with a higher rate of extraarticular extravasation (Figure 10).

In the approach of the medial area, the patient is positioned with a slight internal rotation to mark the puncture point located in the lateral aspect of the superolateral quadrant of the femoral head, in order to avoid injuring the neurovascular structures; then, a needle of equal dimensions is inserted until it comes into contact with the cartilage of the femoral head at which time the contrast material is injected without exceeding the maximum capacity.

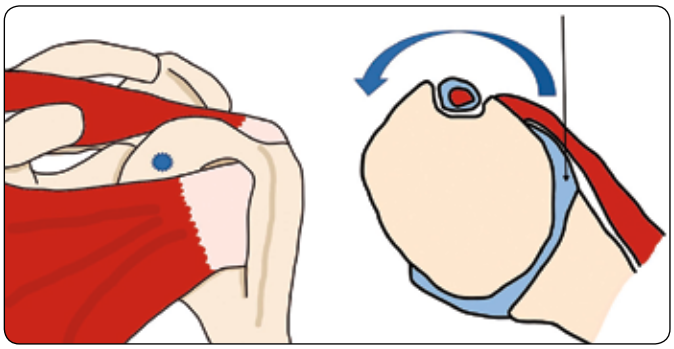

Figure 1. Scheme: anterior shoulder puncture.
Source: Faculty Archive, Clínica Universitaria Colombia, Keralty.

Figure 2. Fluoroscopy with anterior approach: opacification of the articular cavity by contrast.
Source: Archive, Clínica Universitaria Colombia, Keralty.

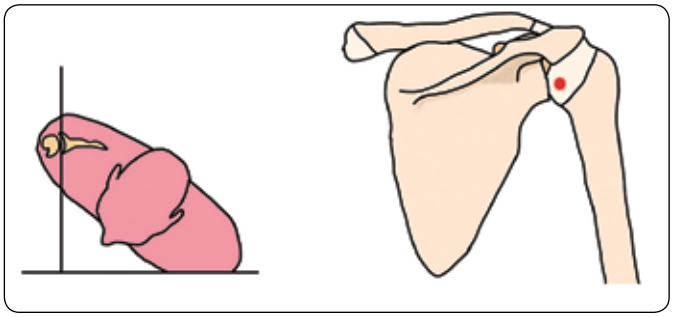

Figure 3. Posterior shoulder puncture
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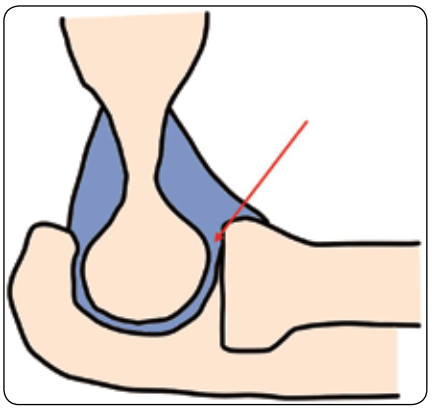

Figure 4. Insertion point (red arrow) of humeroradial arthroscopy.
Source: Faculty Archive, Clínica Universitaria Colombia, Keralty.

Figure 5. Fluoroscopic shot with opacification of the humeroradial cavity with contrast medium.
Source: Archive, Clínica Universitaria Colombia, Keralty.

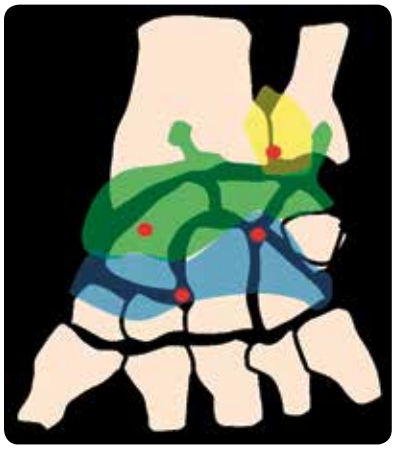

Figure 6. Location of dorsal approach to the different compartments of the wrist (yellow: radiocubital joint, blue: mediocarpal region, green: radiocarpal joint).
Source: Faculty Archive, Clínica Universitaria Colombia, Keralty.

Figure 7. Fluoroscopic image sequence to evaluate the radiocarpal joint: a) fluoroscopic image prior to contrast medium injection; b) needle location for contrast medium insertion in the middle portion of the scaphoid; c) fluoroscopic image after contrast medium injection.
Source: Archive, Clínica Universitaria Colombia, Keralty.

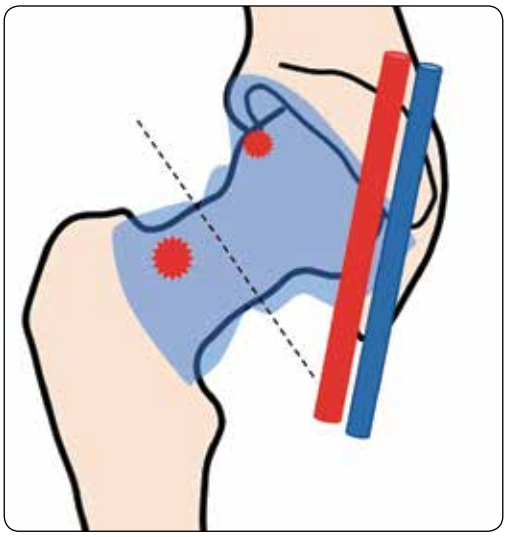

Figure 8. Graphic description of the approach points: supratrochanteric lateral and anterior approach with direct femoral head puncture below the acetabular ridge.
Source: Faculty Archive, Clínica Universitaria Colombia, Keralty.

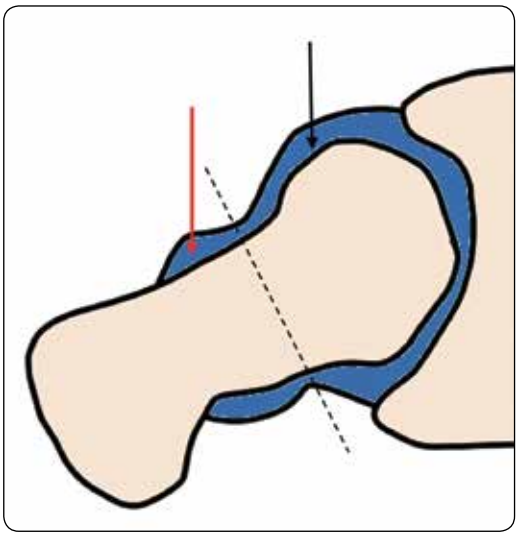

Figure 9. Drawing of an axial cut, with division by the annular ligament (dotted line), separating the anterior recess in the medial zone (black arrow) and in the lateral zone (red arrow).
Source: Faculty Archive, Clínica Universitaria Colombia, Keralty.

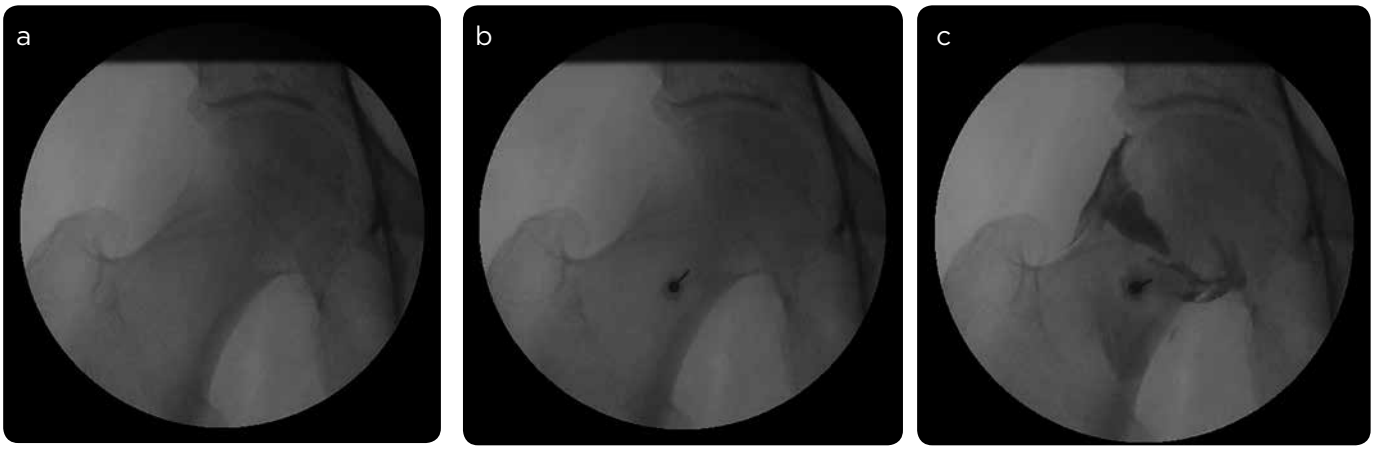

Figure 10. Fluoroscopic image sequence: a) prior to contrast medium injection; b) needle positioning with supratrochanteric anterior approach; c) opacification following contrast medium.
Source: Archive, Clínica Universitaria Colombia, Keralty.

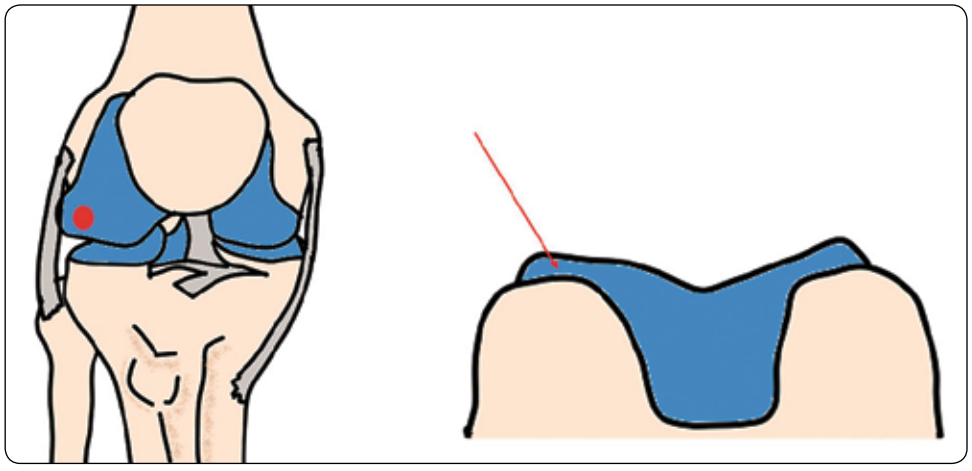

Figure 11. a) Anterior approach point; b) small angulation of the needle (red arrow) for anterior approach.
Source: Faculty Archive, Clínica Universitaria Colombia, Keralty.

1.5 Knee

The knee is a functionally complex joint, which can be compromised by degenerative injury, inflammatory processes, and trauma. The use of double contrast is currently recommended to evaluate meniscal tears with MRI (14).

The knee joint can be punctured infrapatellarly, with a medial or lateral approach, in order to reach the anterior recess; another type of approach is also described, called paramedian infrapatellar (15). The anterior approach with point in the anterior recess consists of placing the patient in a supine position with the knee in slight semiflexion, with a small pillow below the knee; then, the puncture is performed with a 1.5 inch needle caliber 22G at the target point located in the medial or lateral part with slight angulation until contact is made with the condyles of the femur (Figure 11). During the insertion of the needle, it is recommended that pressure be applied to the patella, in the lower direction, on the side opposite the puncture, in order to widen the space. The knee joint has a capacity of 40 cm^3; however, when diagnostic arthrography is performed, 10-15 cm^3 of contrast material is sufficient (Figure 12).

The other type of approach is the paramedian infrapatellar: the needle entry site is located immediately lateral or medial to the patellar tendon. If this approach is used, the needle should be inserted deep enough to penetrate the joint capsule located posterior to the inner margin of the Hoffa fat (Figure 13). It is important to mention that in cases where joint effusion exists, this effusion should be aspirated in the same amount as the prepared solution will be injected in order to maintain standard concentrations within the joint (16)

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1.6 Ankle

Different approaches to ankle arthrography have been described. The first of these is the anteromedial, for which the ankle is positioned in a slight plantiflexion, the puncture point is located medially to the tendon of the anterior tibial muscle and below the articular space. A variation of this approach is the anterolateral one, which has as reference point the same anterior tibial muscle; however, it is punctured immediately lateral to it. When these approaches are performed, there is a risk of colliding with structures, which avoids entering the articular space, and therefore it is necessary to puncture below the articular line, located immediately below the articular space (1) (Figure 14). In the case of the anteromedial approach, the needle should be slightly angulated towards the head in order to avoid the edge of the medial malleolus (17). The procedure is performed with a needle 1.5 inches long and with a caliber of 25G, which is inserted until it comes into contact with the surface of the astragalus bone, and then inject 8-15 cm^3 of contrast medium, which corresponds to the capacity of this joint (18) (Figure 15).

The lateral approach, "in mortise", is an alternative to the anteromedial approach, it consists of positioning the patient with the foot in moderate plantiflexion, under fluoroscopic guidance the foot is placed in a "mortise" projection to identify the talofibular joint, in which it will be injected in its upper three quarters (Figure 16). After identifying this area, we proceed to puncture with a 25G needle, which is advanced towards the medial edge of the fibula and then slightly medial from 5 to 10 mm to the lateral ankle mortise, once inside the space we proceed to inject the contrast material (19). This approach has the advantage that it rejects the anterior talofibular ligaments, which run from the anteroinferior part of the lateral malleolus to the body of the talus (20), as well as being more easily accessible in patients with ankle arthritis (21). Because the dorsal artery of the foot may have an aberrant location, it is always important to palpate at the puncture point to avoid injury to that structure (22) (Figure 17).

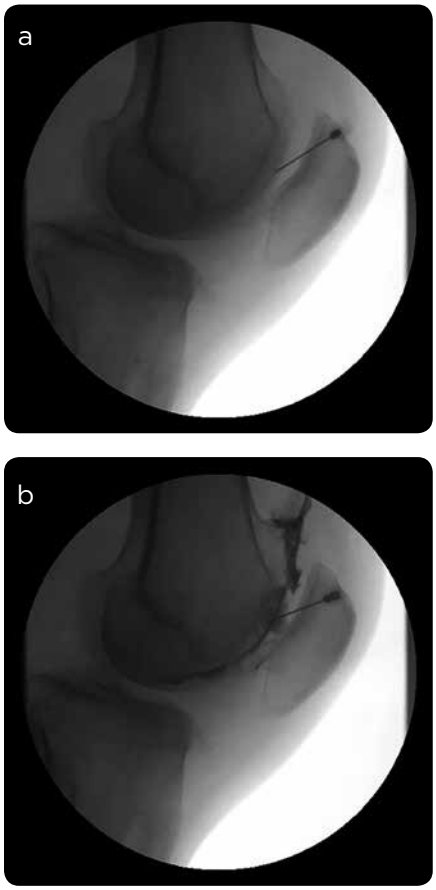

Figure 12. Fluoroscopy with anterior knee approach: a) needle direction with slight caudal inclination; b) opacification by contrast medium. in the articular cavity.
Source: Archive, Clínica Universitaria Colombia, Keralty.

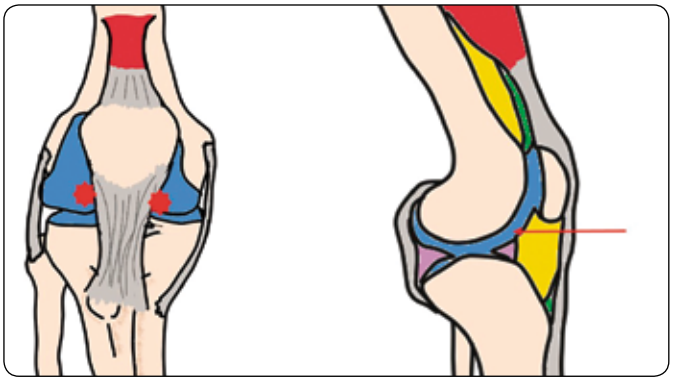

Figure 13. Paramedial infrapatellar approach: a) medial and lateral approach points (asterisk) to the patellar tendon; b) lateral image of the knee: Hoffa's fat (yellow) as an important anatomical reparo for infrapatellar approach.
Source: Faculty Archive, Clínica Universitaria Colombia, Keralty.

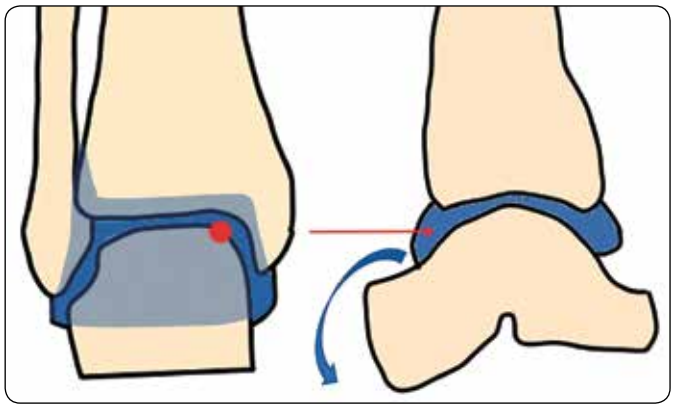

Figure 14. Anterolateral ankle approach: a) insertion point, lateral to the tendon of the anterior tibial muscle, below the articular line; b) lateral image with evidence of plantiflexion.
Source: Faculty Archive, Clínica Universitaria Colombia, Keralty.

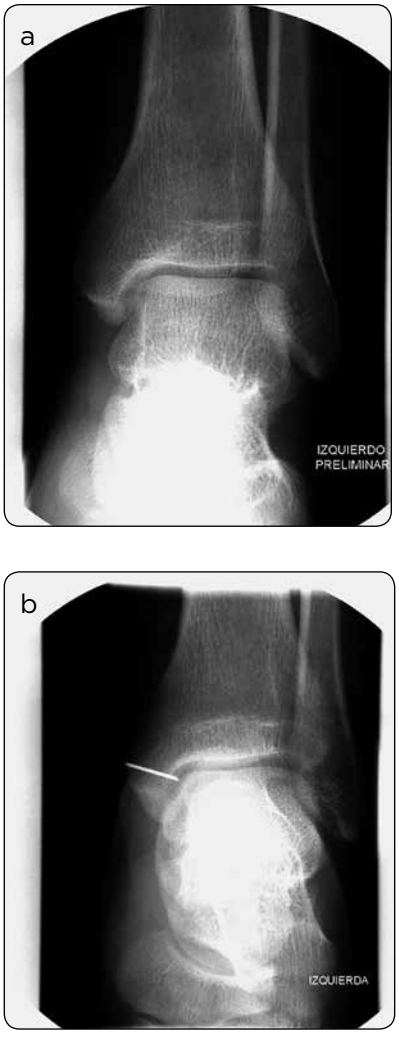

Figure 15.Projections with anterolateral approach: a) AP projection preliminary to insertion of the Spinocan® needle; b) projection evidence of the needle.
Source: Archive, Clínica Universitaria Colombia, Keralty.

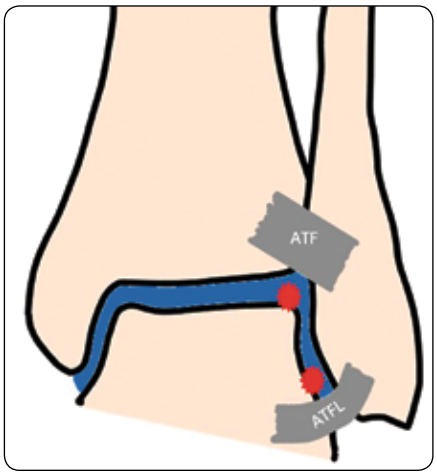

Figure 16. Lateral approach in ATF mortise (talofibular joint), the patient with plantiflexion, to avoid the talofibular ligament (ATFL).
Source: Faculty Archive, Clínica Universitaria Colombia, Keralty.

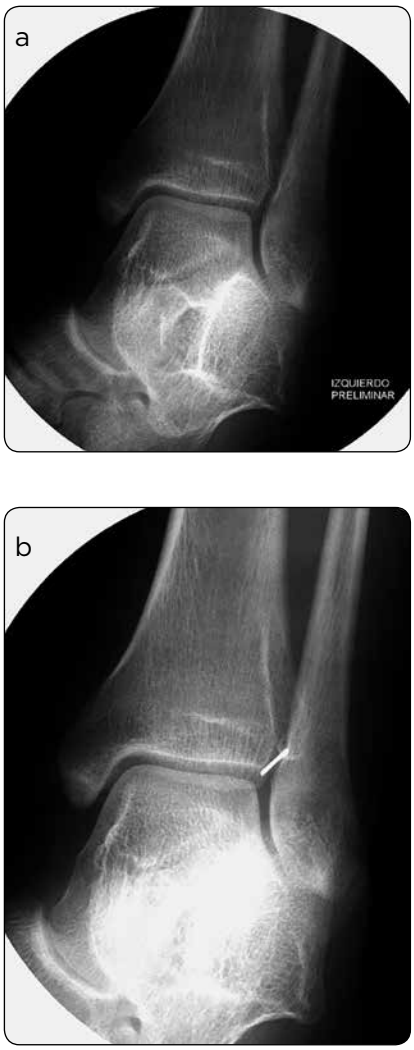

Figure 17. Lateral approach "in mortise": a) preliminary AP projection with Spinocan® needle insertion; b) AP projection with Spinocan®.
Source: Archive, Clínica Universitaria Colombia, Keralty.

2. Conclusion

A review of the simplest and most commonly used approaches to fluoroscopic arthrography of the extremities was undertaken, with an emphasis on the use of anatomical repairs as a guide to puncture site marking, in order to reduce the time of fluoroscopic exposure. The use of arthrography is not limited to the injection of contrast media for diagnostic purposes, but also for therapeutic purposes

References

1. Lungu E, Moser TP. A practical guide for performing arthrography under fluoroscopic or ultrasound guidance. Insights Imaging. 2015;6(6):601-10.
2. Stoller DW. MR arthrography of the glenohumeral joint. Radiol Clin North Am. 1997;35(1):97-116.
3. Dépelteau H, Bureau NJ, Cardinal E, Aubin B, Brassard P. Arthrography of the Shoulder: A simple fluoroscopically guidedapproach for targeting the rotator cuff interval. Am J Roentgenol. 2004;182(2):329-32.
4. Farmer KD, Hughes PM. MR arthrography of the shoulder: Fluoroscopically guided technique using a posterior approach. Am J Roentgenol. 2002;178(2):433-4.
5. Hulstyn MJ, Fadale PD. Arthroscopic anatomy of the shoulder. Orthop Clin North Am. 1995;26(4):597-612.
6. Steinbach LS, Schwartz M. Elbow arthrography. Radiol Clin North Am. 1998;36(4):635-49.
7. Lohman M, Borrero C, Casagranda B, Rafiee B, Towers J. The posterior transtriceps approach for elbow arthrography: A forgotten technique? Skeletal Radiol. 2009;38(5):513-6.
8. Gilula LA, Hardy DC, Totty WG. Distal radioulnar joint arthrography. AJR Am J Roentgenol. 1988;150(4):864-6.
9. Lomasney LM, Cooper RA. Distal radioulnar joint arthrography: Simplified technique. Radiology. 1996;199(1):278-9.
10. Moser T, Dosch J-C, Moussaoui A, Buy X, Gangi A, Dietemann J-L. Multidetector CT arthrography of the wrist joint: how to do it. Radiographics. 2008;28(3):787-800; quiz 911.
11. Levisnsohn M, Rosen D. Wrist arthrography: Value of the three-compartment injection method. Radiology. 1991;179:231-9.
12. Duc SR, Hodler J, Schmid MR, Zanetti M, Mengiardi B, Dora C, et al. Prospective evaluation of two different injection techniques for MR arthrography of the hip. Eur Radiol. 2006;16(2):473-8.
13. Petersilge C. From the RSNA refresher courses. Radiological Society of North America. Chronic adult hip pain: MR arthrography of the hip. Radiographics. 2000;20 Spec No:S43-52.
14. Coumas JM, Palmer WE. Knee arthrography. Evolution and current status. Radiol Clin North Am. 1998;36(4):703-28.
15. Moser T, Moussaoui A, Dupuis M, Douzal V, Dosch J-C. Anterior approach for knee arthrography: tolerance evaluation and comparison of two routes. Radiology. 2008;246(1):193-7.
16. Chung CB, Isaza IL, Angulo M, Boucher R, Hughes T. MR arthrography of the knee: How, why, when. Radiol Clin North Am. 2005;43(4):733-46.
17. Şahin G, Demirtaş M. An overview of MR arthrography with emphasis on the current technique and applicational hints and tips. Eur J Radiol. 2006;58(3):416-30.
18. Robinson P, White LM, Salonen D, Ogilvie-Harris D. Anteromedial impingement of the ankle. Am J Roentgenol. 2002;178(3):601-4.
19. Fox MG, Wright PR, Alford B, Patrie JT, Anderson MW. Lateral mortise approach for therapeutic ankle injection: An alternative to the anteromedial approach. Am J Roentgenol. 2013;200(5):1096-100.
20. Olson RW. Arthrography of the ankle: its use in the evaluation of ankle sprains. Radiology. 1969;92(7):1439-46.
21. Moon JS, Shim JC, Suh JS, Lee WC. Radiographic predictability of cartilage damage in medial ankle osteoarthritis. Clin Orthop Relat Res. 2010;468(8):2188-97.
22. Vázquez T, Rodríguez-Niedenfuhr M, Parkin I, Viejo F, Sanudo J. Anatomic study of blood supply of the dorsum of the foot and ankle. Arthroscopy. 2006;22(3):287-90.

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