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SCIENTIFIC ARTICLE

The posterolateral fluoroscopy-guided injection technique into the posterior subtalar joint: description of the procedure and pilot study on patient outcomes

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Abstract
Objective To describe a posterolateral fluoroscopy-guided injection technique into the posterior subtalar joint and to report patient outcomes 1 month post-injection.
Materials and methods Twenty-three consecutive adult patients who underwent fluoroscopy-guided injection into the posterior subtalar joint using a direct posterolateral approach and who returned an outcomes-based postal questionnaire after receiving this injection were included. Numerical pain rating scale (NRS) data were collected prior to injection. NRS and Patient's Global Impression of Change (PGIC) scales were completed 1 day, 1 week, and 1 month after injection. The proportion of patients who improved was calculated for each time period. Baseline NRS data were compared to each time point using the Wilcoxon test to assess differences. Spearman's correlation coefficient was used to compare the 20 min NRS score with all follow-up NRS scores. All available images were reviewed for the presence of subtalar osteoarthritis (OA). Patient charts were reviewed to identify characteristics of patients referred for subtalar injections. Risk ratios were calculated comparing presence of OA or other abnormalities with improvement.
Results A posterolateral approach for fluoroscopy-guided injections into the subtalar joint is described. There was a significant reduction in the mean NRS score at all time periods compared to baseline ($p \leq 0.004$). One-third of patients (7/21) reported clinically relevant improvement at 1 month.
Conclusions Fluoroscopy-guided puncture of the posterior subtalar joint using a posterolateral approach is possible. Clinically significant improvement is reported in 33% of patients after 1 month.

Keywords Arthrography · Foot · Posterior subtalar joint · Intraarticular steroid injection

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Introduction

Diagnostic or therapeutic injection procedures into the foot region have been used for many years to help diagnose a particular joint as a pain source or to provide treatment to a painful articulation [1–6]. Studies have shown that injections performed using imaging guidance (fluoroscopy, ultrasound, or CT) more accurately deliver the medications to the desired target joint compared to injections using palpation alone [1, 3–11].

The posterior subtalar joint is one of the most typically injected foot articulations [10–15]. There are various techniques described in the literature for injecting medication into this joint, including the anterolateral, posteromedial, lateral oblique, and posterolateral approaches [10–13, 15]. Previously the anterolateral approach was claimed to be the best for injecting the posterior subtalar

joint [11, 16] as this approach appeared to be comparably easy with less chance of contrast leakage or side effects. However, in most of these approaches the joint space is often difficult to visualize with fluoroscopy because of superimposed structures. A recent study comparing the anterolateral with a posterolateral subtalar injection approach determined that the posterolateral approach was much more accurate [16]. No imaging guidance was used in that study and it was done on cadaveric feet. Thus details about exact patient positioning and the ability to visualize the subtalar joint are missing.

Although a commonly performed procedure, little has been published about the effectiveness of anesthetic and corticosteroid injections specifically into the posterior subtalar articulation. Two prospective and one retrospective outcomes studies performed on patients with the specific diagnosis of juvenile chronic arthritis documented substantial clinical improvement in up to 44% of these patients. Sample sizes were rather small, consisting of 6, 10, and 38 subtalar joint injections, respectively [10, 12, 13]. A larger, prospective outcomes study (done recently from this orthopedic university hospital) demonstrated that 64% of the 118 adult patients who received subtalar injections reported at least a 50% reduction in their pain 20–30 min after injection [14]. These patients had a wide variety of clinical conditions ranging from trauma to degenerative or inflammatory arthropathies, and the injection technique used to target the subtalar joint differed from those reported in the literature to date. The procedure used at this facility is a direct posterolateral approach. With the direct posterolateral approach, the joint space is easy to identify without superimposed anatomical structures. To our knowledge, the technical details of this injection approach have not been published previously, although the recent study by Kraus et al. [16] on cadaveric specimens superficially appears quite similar. The purpose of this paper is to describe this technique and to report the patient outcomes up to 1 month post-injection from 23 consecutive patients who returned postal questionnaires.

Materials and methods

Fluoroscopy-guided direct posterolateral subtalar injection procedure

Patient and x-ray tube positioning

A fully digital C-arm fluoroscopy system was used (Ultimax-i, Toshiba Medical Systems, Tokyo, Japan). The patient was placed in a lateral position on the fluoroscopy table, similar to the recovery position of an emergency patient, with the involved foot on the upside and the leg fully extended. The bottom leg was flexed 90° at the knee and the foot was placed in the popliteal fossa of the upper leg. If necessary, the foot to be injected was further stabilized with pads. The patient had to feel comfortable enough to rest for at least 5 min without moving the involved foot.

The X-ray beam was then adjusted to the orientation of the posterior subtalar joint space. The posterior subtalar joint was centered in the image and the X-ray tube positioned for a lateral-medial view of the foot. The X-ray tube position was then fine-tuned until the very posterior joint space was visible as a line between the talar and calcaneal cortex (Fig. 1). The skin at the posterior contour of the distal ankle had to be included in the image (Fig. 1a) because the contour of the Achilles tendon served as a landmark for the correct entry site of the needle into the skin.

Normally, the X-ray beam was tilted approximately 15° in a caudal-cranial direction and slightly posterior-anteriorly. When performed by an experienced technician, it was possible to achieve this by only using fluoroscopy once for a quick control image.

Joint puncture

Intraarticular drugs were injected in a standardized fashion by fellowship-trained musculoskeletal radiologists with at least 3 years of experience in musculoskeletal injections. All injections were done under sterile conditions, involving disinfecting the overlying skin three times, and the use of sterile gloves and a mask by the radiologist doing the procedure. A fenestrated sterile surgical drape was placed on the ankle.

A 23 G needle 0.60×60 mm (B. Braun, Melsungen, Germany) was used. The needle was placed on the skin over the joint space and adjusted to the direction of the joint space under fluoroscopic control. The intersection of a projected line through the needle and the lateral contour of the Achilles tendon was identified as the puncture site on the skin (Fig. 2). The skin was punctured and the needle was advanced into the posterior subtalar joint under fluoroscopic control aiming at the posterior-most part of the joint (Fig. 1). The needle was directed from posterior to anterior. Additionally, care was taken to point the needle from lateral to central.

The correct position of the tip of the needle was verified by the linear dispersion of an initially injected small amount of contrast media (0.5–1 ml of iopamidol 200 mg/mL, Iopamiro 200, Bracco, Milan, Italy) within the posterior subtalar joint (Fig. 3). The various contrast filling patterns are found in Fig. 3.

If the referring physician asked for a therapeutic infiltration, 2 ml of crystal suspension of triamcinolone

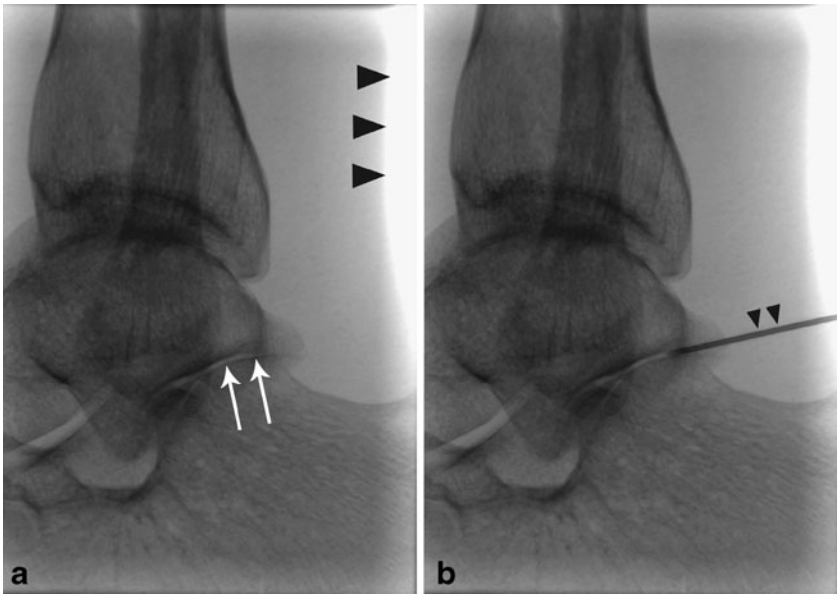

Fig. 1 Lateral fluoroscopy images of a phantom of the ankle joint consisting of the skeleton of a human distal lower leg and ankle joint embedded in acrylic glass. **a** The X-ray tube was adjusted to the joint space of the posterior subtalar joint (*arrows*). Especially in the very posterior part, the joint space has to be visible. The skin (acrylic glass contour of the phantom; *large arrowheads*) is needed on the image in order to identify the correct puncture site. **b** To identify the optimal puncture site of the skin, the needle (*small arrowheads*) is held over the joint space under fluoroscopy. The puncture site is found visually where a line along the needle crosses the lateral contour of the Achilles tendon (see also Fig. 2). The skin is punctured, and the needle is advanced with one quick movement into the joint under fluoroscopic control

(Kenacort; triamcinolone acetate 40 mg/ml; Dermapharm, Huenenberg, Switzerland) was injected. Additionally, different volumes of mepivacaine hydrochloride 2% (Scandicain 2%; AstraZeneca, Södertälje, Sweden) were injected—normally about 2 ml—until the patient felt a sensation of fullness or resistance was determined by the radiologist. If the referring physician asked for a purely diagnostic infiltration, only mepivacaine hydrochloride 2% was injected.

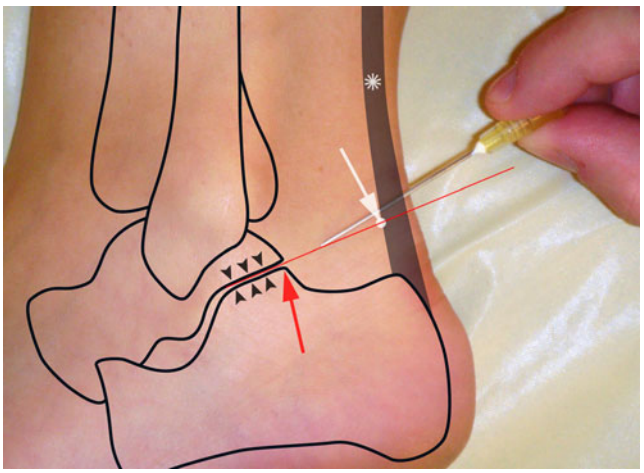

Fig. 2 Photograph of the lateral aspect of the ankle joint with superimposed schematic bony structures of a 25-year-old male volunteer. After optimal placement of the ankle and X-ray tube positioning, the posterior subtalar joint is nicely seen (*arrowheads*). The needle tip position is marked with a *red arrow*. The intersection of a projected line (*red line*) through the posterior subtalar joint (*arrowheads*) and the lateral contour of the Achilles tendon (*asterisk*) is identified as the correct puncture site on the skin (*white dot marked with the white arrow*). To identify the puncture site, the needle is placed on the skin over the joint space and adjusted to the direction of the joint space under fluoroscopic control

Local anesthetics for the skin and joint capsule were not used on a standardized basis by all radiologists. Local anesthetic administration produces a transient burning pain when injected in the skin, joint capsule, or any other tissue with sensitive nerve fibers. Performing the puncture without local anesthetics produces the same needle prick, but no additional pain caused by the local anesthetic.

Outcomes

Starting in January 2010, all patients receiving imaging-guided musculoskeletal injections at this institution were asked to participate in quality assurance studies on the effectiveness of these injections and were instructed in the study protocol. Ethics approval was received from the institutional ethics committee, and written informed consent was obtained from all patients. This paper focused only on the subtalar joint and is limited to the 23 patients receiving therapeutic injections.

The questionnaire used for this investigation included a numerical rating scale (NRS) for pain and the Patient's Global Impression of Change Scale (PGIC) [17]. The same

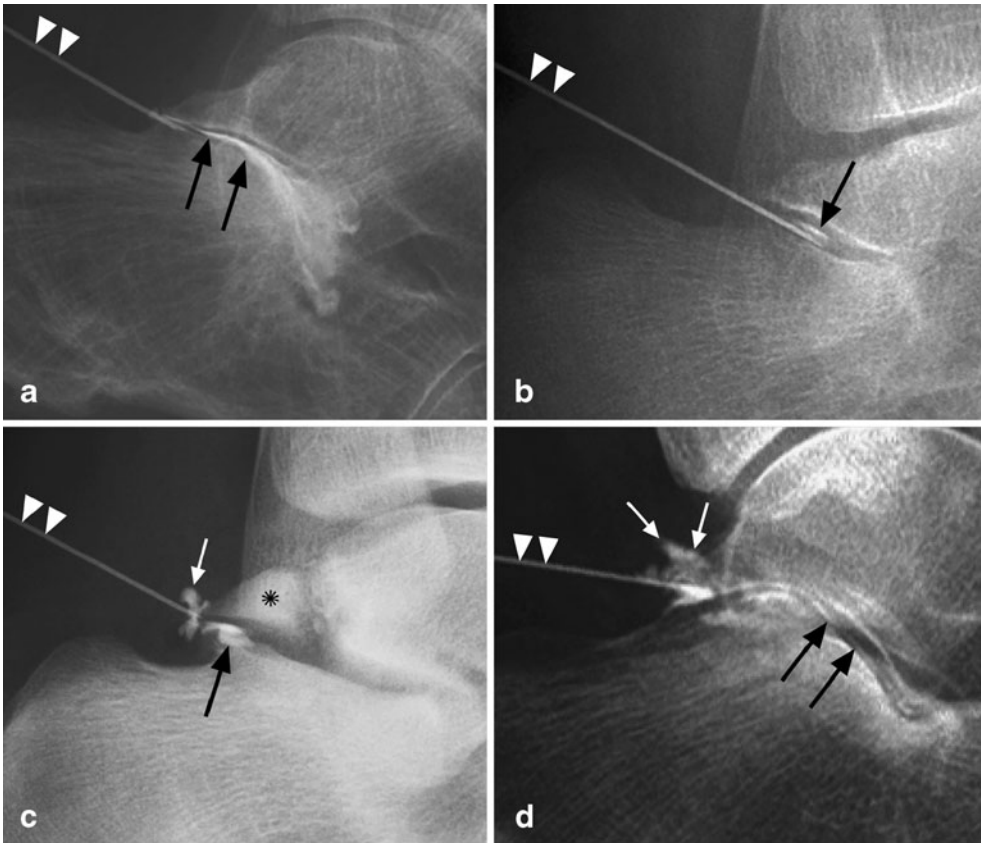

Fig. 3 Contrast media dispersion in the posterior subtalar joint space. Different patterns of contrast media dispersion are shown. The needle (*white arrowheads*) is placed in the joint space and the contrast media shows a linear dispersion pattern (*black arrows*). **a** A 45-year-old woman. Abundant contrast media injection. **b** A 55-year-old man. Injection of only a small amount of contrast media. **c** A 37-year-old man. Injection in the presence of an accessory ossicle (Os trigonum). The contrast media fills the posterior joint recess (*white arrow*). **d** A 48-year-old man. Contrast media dispersion can be confusing when the posterior joint recess is filled. Careful injection of more contrast media, however, confirms linear dispersion in the joint space (*black arrows*)

data were acquired 1 day, 1 week, and 1 month after the injection procedure. The NRS for pain is an 11-point scale ranging from 0 (no pain) to 10 (unbearable pain). The PGIC scale is a 7-point verbal scale assessing multiple aspects of the patient's quality of life and response to treatment. The response options include "much worse," "worse," "slightly worse," "no change," "slightly better," "better," and "much better." An addressed, stamped envelope was also given to each patient with instructions to return the completed questionnaire (for all time points) to the radiology department after 1 month. No postal or telephone reminders were given to patients who failed to return their questionnaires. As part of the standard procedures, all patients at this institution routinely complete a pre-injection NRS score as well as a 20–30 min post-injection NRS score whether or not they agreed to participate in the study.

One of the radiologists with 5 years of experience in musculoskeletal radiology who was also involved in the injections retrospectively reviewed all available diagnostic images that included the subtalar region after an interval of at least 2 months after the last injection. He was not aware of the clinical outcome. The presence or absence of osteoarthritis (yes/no) of the subtalar joint was recorded. Osteoarthritis of the subtalar joint was defined as the presence of osteophytes, subchondral osteosclerosis, and joint space narrowing. In addition, the presence of other potentially pain-generating abnormalities at the hindfoot such as bone marrow edema, Achilles tendinitis or paratenonitis, tendinitis or tenosynovitis of the tendons of the flexor muscles or peroneal muscles, and tarsal coalition was recorded. One of the referring clinicians retrospectively reviewed all patient files in an attempt to identify specific or common characteristics of patients referred for subtalar injections.

Statistical analysis

Patients responding better or much better on the PGIC were categorized as "improved" and the other patients as either "no change" or "worse." The response of "slightly better" was not considered "improved." The proportion (%) of patients improved or worse after the subtalar injection was calculated for each time period. Data were entered into the SPSS program (version 17.0, SPSS, Chicago, IL). Spearman's correlation coefficients for non-parametric data were calculated comparing the predictive value of the 20-min post-injection NRS score to each of the later follow-up time periods. The baseline NRS score was also compared to each of the follow-up time points using the Wilcoxon test for matched pairs to assess for differences. $P<0.05$ was considered significant.

Risk ratios with 95% confidence intervals (CI) were also calculated comparing (1) the presence of OA of the subtalar joint with patient improvement; and (2) the presence of other potentially pain-generating abnormalities on the images (other than at the subtalar joint) with patient improvement.

Results

A fluoroscopically guided subtalar joint injection with a posterolateral approach has been introduced. All patients received both an anaesthetic as well as corticosteroids. Of the 23 patients included in this study, 11 were male (48%) and 12 were female. The mean patient age was 52.0 years (SD 20.0) with an age range of 20–78 years. Two patients failed to answer the NRS and PGIC at 1 month, leaving 21 patients with data for that time point.

There was a statistically significant reduction in the mean NRS score at all time points compared to the baseline, pre-injection score (Table 1). This was most pronounced at the 20 min post-injection time period and least significant after 1 month. The correlation between the pain reduction at 20 min after injection to the 1 day, 1 week, and 1 month time points was only statistically significant 1 day after injection. The r values were 0.46 (p=0.03) at 1 day, 0.35 (p=0.115) at 1 week, and 0.40 (p=0.08) at 1 month. The results from the patient's global impression of change (PGIC) scale (Table 1) demonstrated that 43% (10/23) of patients reported being "better" or "much better" (clinically significantly improved) 1 day after injection, but 26% (6/23) reported being "worse" (31% unchanged). Similarly, at 1 week post-injection 43% (10/23) of patients were "better" or "much better" while 14% (3/23) reported being "worse" (43% unchanged). At 1 month after injection 33% (7/21) of patients stated that they were "better" or "much better," 17% (3/21) claimed to be worse, and 50% were unchanged compared to before the injection.

Table 1 Patient outcomes at various time points after imaging-guided subtalar injection

	NRS		PGIC
	Mean (SD)	p value	
Pre-injection	6.5 (2.0)		
20 min post-injection	2.7 (2.8)	0.0001*	
1 Day	4.4 (3.0)	0.004*	43% better, 26% worse
1 Week	4.2 (3.1)	0.001*	43% better, 14% worse
1 Month	4.7 (3.1)	0.004*	33% better, 17% worse

NRS Numerical pain rating scale, *PGIC* Patient's Global Impression of Change scale, *SD* standard deviation

*p<0.05 compared to baseline data

The risk ratio comparing patients with osteoarthritis of the subtalar joint and clinically significant improvement after injection was 2.8 (95% CI 0.25–30.91). The risk ratio comparing patients with other potential pain sources outside the subtalar joint, as viewed on imaging, with lack of clinically significant improvement after injection was 3.25 (95% CI 1.4–7.3).

Discussion

Joint injections need to be safe, associated with as little radiation exposure as possible, fast, and easy to learn. They should also require as little technical and staff effort as possible. The authors believe that fluoroscopically guided injections are superior in this regard when compared to CT guidance. CT may be useful for difficult injections. Ultrasonographic guidance does not cause radiation exposure, but identification of the individual joints and following the course of the injection are more difficult than with fluoroscopy.

Some radiologists do diagnostic and therapeutic blocks in the subtalar joint by simply injecting the ankle joint from an anterior approach, as there is very frequently communication between the two joints. Because this communication may not be present in a specific patient, direct injection is clearly superior.

Beaudet and Dixon [12] described a lateral approach to puncture the subtalar joint with the patient in a prone position using a straight lateral approach whereas our technique uses the most posterior approach possible without lacerating the Achilles tendon. This technique is based on measurements at the lateral aspect of the ankle in order to determine the correct puncture site. Using this technique, routine radiographs of the foot in lateral and medial oblique projections are performed, and the location where the needle should be placed is generally not as clearly seen as in our proposed technique using fluoroscopy and with the patient in a lateral position. In the posterolateral injection approach the posterior subtalar joint space is projected freely, allowing fast puncture and easy correction of the puncture direction during the forward movement of the needle. A previous study reported that the posteromedial approach to the subtalar joint was deemed more difficult compared to the other approaches [16]. Furthermore, 4 patients out of 24 (17%) injected from posteromedially had unwanted anesthesia of the toes. This may have been caused by drug leakage out of the joint and drug action at the medial or lateral plantar nerves, which run close to the puncture site.

In this manuscript a subtalar injection technique is described using a posterolateral approach to the posterior subtalar articulation. The authors believe that this technique

is fast, easy to learn, and safe. Because of the posterolateral approach, no major nerves or vessels are at risk of being incidentally punctured. Kraus et al. [16] reported that the posterolateral injection approach is also more accurate than the anterolateral approach even when imaging guidance is not used.

This pilot study of short and medium term outcomes shows that there was a significant reduction in the mean NRS scores at all follow-up time points, particularly at 20–30 min after injection, but that only approximately one-third of patients reported clinically relevant improvement at 1 month on the PGIC scale. Clinically relevant improvement incorporates a variety of factors beyond simply the measurement of pain. Function and the patient's quality of life are also included and thus this PGIC result is a more useful determinant of overall improvement. Additionally, a relevant number of patients were actually worse 1 day after injection. Interestingly, the amount of pain reduction reported 20–30 min after injection does not consistently predict the outcome at the later time points. These findings could possibly be explained by the pharmacodynamics of the injected drugs. The manufacturer's information states that mepivacain has an elimination half-life of about 2 h. Triamcinolone, on the other hand, takes about 3–7 days to become effective and has a mean clinical effect of approximately 3 weeks. Therefore, at 1 day post injection, the anesthetic is no longer present and the corticosteroid has not yet started to be effective. This could explain the fact that a significant number of patients complain of being worse 1 day post-injection. Additionally, after a period of 24 days the triamcinolone is no longer detectable in the tissues (product insert, section concerning pharmacokinetics and elimination; Kenacort, Dermapharm). This may explain why fewer patients report being clinically significantly improved at 1 month compared to 1 week after injection.

Comparing these results with the few small studies on injections into the subtalar joint published previously is encouraging however. The best outcome reported before this current study was that up to 44% of children suffering from juvenile chronic arthritis (JCA) reported substantial improvement [13] over a long follow-up period. JCA is an inflammatory arthropathy, and thus the injection of a corticosteroid would be expected to reduce their symptoms. The patients in our study suffered from a variety of conditions including osteoarthritis, but inflammatory conditions were not common. This is likely the reason why the most pronounced pain reduction observed in this current study happened 20 min after injection as a result of the anaesthetic, but by 1 day post-injection was substantially less as the anaesthetic affect was no longer present.

The review of the diagnostic images as well as the patient charts confirmed that patients with osteoarthritis located at the subtalar joint were more likely to have a favorable response to the injection (i.e., 2.8 times more likely to improve), when compared to patients with potentially pain-generating pathologies at sites other than the subtalar joint. However, with the small numbers of subjects and the very wide confidence interval as a result, these findings should not be over-interpreted at this time. Our results support those reported previously by Mitchel at al. [6] who found that the degree of pain relief after subtalar injection correlated with the severity of degenerative changes found in this joint. Although all of these injections included a corticosteroid, some were performed for a diagnostic rather than a therapeutic purpose.

There are limitations to this study other than the small sample size. Only patients who returned their postal questionnaire were included in this pilot study. A review of the imaging database revealed that only 40% of patients with subtalar joint injections complied with the request. Patients who continue to experience pain and disability may be more likely to return these questionnaires compared to patients who feel substantially better. This is only a hypothesis however and requires follow-up studies. The cost implications of hiring research assistants to telephone patients who did not return their postal questionnaires precluded this being part of the current study. Even if only 43% of patients are clinically significantly improved at 1 day and 1 week post-injection with 33% improved at 1 month, this is important information for referring clinicians. For clinicians, it is important to know that patients with osteoarthritis of the posterior subtalar joint may have a better response to these injections than patients with normal imaging findings.

In conclusion, fluoroscopy-guided posterolateral puncture of the posterior subtalar joint is not only possible, but relatively easy to use and probably preferable to an anterolateral approach. Clinically significant improvement is reported in 33% of patients after 1 month.

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