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ORIGINAL ARTICLE

Accuracy of Posterior Subtalar Joint Injection Without Fluoroscopy

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Abstract Injection into the posterior subtalar joint has not been validated for accuracy using radiographic end points. We asked whether needle placement into a normal posterior subtalar joint could be performed accurately and selectively by experienced surgeons without ßuoroscopic guidance. Three fellowship-trained orthopaedic foot and ankle surgeons each injected the posterior subtalar joint of 20 cadaveric specimens using an anterolateral approach. Fluoroscopic images were obtained by an independent investigator and blinded. A separate fellowship-trained foot and ankle surgeon interpreted the images. Of 60 injections, 58 were accurate and two were extraarticular based on interpretation by an independent foot and ankle surgeon. Extravasation into the ankle occurred in 14 samples and into the peroneal sheath in two samples. Experienced surgeons can place intraarticular injections into a radiographically normal posterior subtalar joint without ßuoroscopy with a high degree of accuracy. However, extravasation into the ankle or peroneal tendon sheath occurred in an unpredictable fashion, suggesting selectivity of injection placement is relatively limited without the use of ßuoroscopy. Fluoroscopy may not be necessary for injections used solely for therapeutic purposes. However, if the injection is intended for diagnostic purposes or to assist in surgical decision-making or if the joint is abnormal, we recommend ßuoroscopy to ensure the subtalar joint is the only anatomic structure impacted by the injection.

Introduction

Chronic pain in the subtalar joint typically is associated with arthritis, hindfoot deformity, impingement, synovitis, or underlying tarsal coalition. Localizing the origin of pain can be difÞcult with clinical examination alone because of the anatomic proximity of the hindfoot joints and adjacent soft tissue structures. Particularly after trauma, accurately identifying the painful joint is difÞcult and complicates surgical planning.

Intraarticular injections into hindfoot joints are used for therapeutic and diagnostic purposes. Injection of local anesthetic may provide temporary relief of pain and suggests the joint as the source of symptoms; inclusion of a corticosteroid in the injection may diminish inßammation from various causes to alleviate pain. Mitchell et al. reported selective intraarticular injections afford a direct method of conÞrming the site of hindfoot pain and may aid in surgical planning [8]. Khoury et al. reported injections performed under ßuoroscopic control allowed conÞrmation of the painful joint, which in turn led to successful patient outcomes after arthrodesis [6]. However, ßuoroscopic imaging may not be available in the ofÞce setting, requiring the clinician to perform injections using anatomic landmarks and tactile feedback to position the needle. Although injections into the posterior subtalar joint are performed commonly in the ofÞce setting without ßuoroscopic

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guidance, this process has not been validated for accuracy using radiographic end points. If the procedure could be performed in the office without compromising success rates, the savings in time, convenience, and resources might make it more attractive to clinicians.

Diagnostic and therapeutic benefits obtained from an injection depend on accurate intraarticular placement [5]. Selectivity of placement is important to ensure the intended joint is the only anatomic structure impacted by the injection. Further, corticosteroid injections placed in soft tissue structures may contribute to scarring, atrophy, or rupture [2, 3, 7]. Accuracy of needle placement with fluoroscopy into the knee [4] or glenohumeral joints [10, 11] with accuracy rates of 27% to 93%, depending on the approach used, have been reported. Injection into the posterior subtalar joint has not been validated for accuracy using radiographic end points.

We therefore asked whether injection into the normal posterior subtalar joint could be performed accurately and selectively by experienced surgeons using anatomic landmarks without fluoroscopic guidance.

Materials and Methods

Three fellowship-trained orthopaedic foot and ankle surgeons (L.S., J.C., and G.G.) performed injections into the posterior subtalar joint of 60 cadaveric specimens without fluoroscopic guidance (Fig. 1) and injection was confirmed fluoroscopically. The fresh-frozen specimens were free of obvious hindfoot deformity or trauma and thawed at room temperature immediately before the study. Twenty specimens were injected by each surgeon for a total of 60 specimens. Sample size was determined based on expected accuracy of needle placement and desired confidence limits. Assuming an expected accuracy of needle placement of 80% and a 95% confidence limit of absolute ± 10%, the sample size required would be 62. After consultation with our statistician, we used 60 samples, which was divisible by three.

Fig. 1 The illustration shows a posterior subtalar joint injection through the anterolateral approach used in this study.

Each of the three examiners performed injections with a 21-gauge needle with 3 mL of radiopaque contrast (50% Omnipaque [iohexol] solution, GE Healthcare, Buckinghamshire, UK) using palpation of anatomic landmarks to place the needle into the posterior subtalar joint. The examiners palpated the angle of Gissane and anterior edge of the lateral talar process and inserted the needle tip at angles 30 to 45 cephalad and 45 medial. It was also helpful to palpate the posterior junction of the tip of the fibula and the calcaneus, the site of the posterior aspect of the posterior facet, to assist in entering the joint. The anterolateral approach has been suggested as the best approach for injecting the posterior subtalar joint [9] and was used in our study. To simulate the clinical situation, only one skin puncture was performed, but one to three attempts at positioning the needle were permitted if there was difficulty depressing the plunger or if bone was encountered. The need for more than one positioning attempt was common.

After injection of contrast by the surgeon, one investigator (K.K.) immediately obtained oblique and lateral fluoroscopic images of each specimen using a large C-arm (Siremobil 2000; Siemens Corp, Erlangen, Germany). The surgeon remained blinded and did not participate in acquisition of the fluoroscopic images. A random number was assigned to each specimen for blinding purposes during subsequent interpretation.

Radiographic interpretation of the fluoroscopic images was performed after completion of all 60 specimens. Interpretation was based on sample images showing an intraarticular injection (Fig. 2A) and extraarticular placement (Fig. 2B) indicated by soft tissue extravasation with the absence of a linear arthrogram in the posterior subtalar joint. An independent fellowship-trained foot and ankle surgeon then blindly interpreted the 60 sets of fluoroscopic images to determine whether the injection was intraarticular or extraarticular. The interpretation of each specimen was recorded on a sheet with specimens labeled by random numbers.

The primary investigator (K.K.) determined the following outcomes for all surgeons: (1) total intraarticular injections and total injections for all surgeons; (2) total intraarticular injections and total injections for each surgeon; (3) total extraarticular injections and total injections for all surgeons; and (4) total extraarticular injections and total injections for each surgeon. We used a chi square analysis to compare the rates of accuracy.

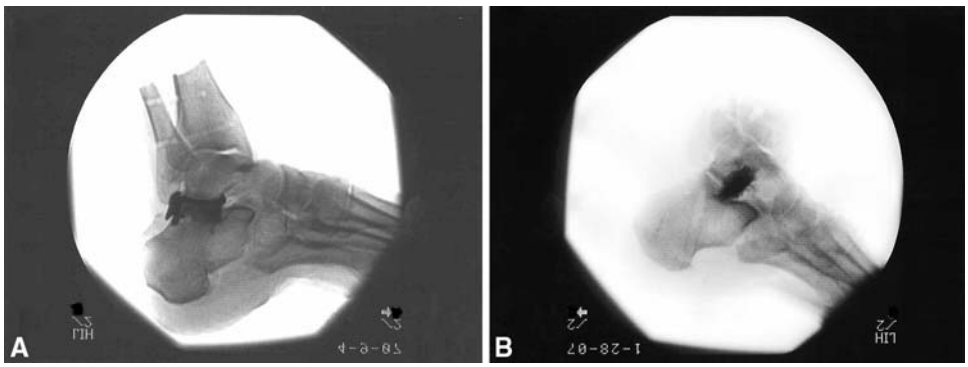

Fig. 2A–B A ßuoroscopy image shows (A) intraarticular and (B) extraarticular injection placement.

Results

Based on interpretations by the independent observer, 58 of 60 injections (97%) (95% conÞdence interval, 92Ð100) were inserted accurately into the posterior subtalar joint. Of the 60 injections, two were extraarticular. The percents of accurate injections for Surgeons 1, 2, and 3 were 19 of 20 (95%), 19 of 20 (95%), and 20 of 20 (100%), respectively. These percentages were similar.

Several injections had extravasations outside the posterior subtalar joint. An ankle arthrogram was performed in 14 of 60 specimens (23%) (Fig 3), and two (3.3%) had a peroneal tenogram (Fig 4). Therefore, even with accurate intraarticular placement of the needle in the joint, 16 of 60 specimens (27%) had extension into surrounding structures outside the subtalar joint.

Fig. 3 An ankle arthrogram is shown.

Discussion

Although a common clinical procedure, injection into the posterior subtalar joint has not been validated for accuracy using radiographic end points. We asked whether injection into the posterior subtalar joint can be accomplished accurately and selectively by experienced surgeons using anatomic landmarks without ßuoroscopic guidance. Our accuracy for injection using anatomic landmarks was approximately 97%. We also noted substantial concerns for surrounding structures in the Þndings of 14 ankle arthrograms and two peroneal tenograms of 60 specimens injected.

This study is limited in that the use of cadaver specimens does not allow for exact replication of the clinical situation. We allowed one or two repositionings of the needle without removal of the needle in one injection as is done clinically in our experience without causing pain to the patient. Previous clinical studies in other joints have deÞned accurate injection as correct needle placement in

Fig. 4 The image shows a peroneal tenogram.

one attempt because adjustments would be painful [4, 11]. Therefore, our accuracy rates for the posterior subtalar joint may be higher than those in studies of accurate injection to other joints. Additionally, none of the specimens had radiographically noteworthy arthritis, a common diagnosis in which a posterior subtalar joint injection may be indicated. Computed tomography is considered the gold standard for determining accurate placement of injections and its use in this experiment might have altered the rates of accuracy, but we presume the rates would not be substantially different. Furthermore, most physicians would rely on radiographic or ßuoroscopic images to determine successful injection placement. Arthritic narrowing, osteophyte formation, deformity, and indwelling hardware may limit the success of intraarticular placement of the needle tip. For these patients, ßuoroscopic or other imaging guidance is required. This study provides data for the best-case scenario for posterior subtalar joint injection. It is possible 3 mL of ßuid is too great a volume for the subtalar joint, causing ßuid to leak out into adjacent structures. However, this volume is commonly used successfully and without apparent difÞculty in the clinical setting. We examined the accuracy of only one approach for injection. Finally, only experienced fellowship-trained surgeons performed the injections, limiting the ability to generalize to less experienced clinicians.

Limited accuracy of injection has been documented previously. One radiograph was used to evaluate accuracy of injections of a steroid mixture and radiopaque medium into various joints by Þve rheumatologists of differing seniority [5]. Of 108 injections, 56 were intraarticular, 31 were extraarticular, and 21 were uncertain because of lack of contrast in the radiograph. The injection method was not described. The response to steroid therapy was similar regardless whether the injection was intraarticular or extraarticular. In another study, accuracy of intraarticular injection of the knee was evaluated using real-time ßuoroscopic imaging [4]. Using three different injection sites, these investigators reported accuracy of needle placement by the same orthopaedic surgeon ranged from 71% to 93% depending on the portal of the knee used. The authors recommended clinicians reÞne injection techniques for delivering intraarticular therapeutic substances. A study of 41 consecutive patients receiving anterior intraarticular injection of the glenohumeral joint without radiographic guidance found an accurate injection rate of only 27% [14]. These authors recommended against use of this technique without radiographic assistance. Yamakado reported a success rate of 70% in a study of unassisted subacromial injection to the shoulder, with similar pain relief observed from accurate injection and inaccurate intradeltoid injection [14]. He noted these Þndings question common use of this injection for diagnosis of impingement syndrome.

We found an accuracy rate of injection without ßuoroscopy into the posterior subtalar joint by experienced surgeons of 97%. There was little variability between surgeons in their ability to perform the injection accurately. Our accuracy rates show the ability of an experienced surgeon to place an intraarticular injection in the posterior subtalar joint.

However, the Þndings suggest limitations of selectivity of injection into the posterior subtalar joint without ßuoroscopic guidance. The 27% rate of extravasations into other joints or adjacent structures of the hindfoot calls into question the use of this technique for determining the source of pain for selective arthrodesis of the hindfoot. The injection may be placed accurately, but extravasations into other structures may falsely localize the pain to the posterior subtalar joint rather than the true source of the pathologic process. The Þndings of two peroneal tenograms of 60 specimens suggest the potential for damage to surrounding structures from unassisted injection. Corticosteroid injections placed in soft tissue structures may contribute to scarring, atrophy, or rupture [2, 3, 7]. The Þndings of peroneal tenograms suggest caution must be used in administering corticosteroid injections to the posterior subtalar joint without ßuoroscopic guidance.

The reasons for these extravasations are unclear. As reported previously, the normal arthrographic image of the posterior subtalar joint can be deÞned as a continuous narrow line of the articular surface, and microrecesses in the sinus tarsi region and communications with the ankle may be normal variants [1]. Communication between the subtalar joint and the peroneal tendons was not observed [1]. Other investigators reported the subtalar joint may be divided into the anterior (sinus tarsi) and posterior subtalar joint and noted a posterior subtalar arthrogram can be helpful to determine the condition of articular cartilage in the joint [13]. These authors reported the posterior subtalar joint communicates with the ankle in 10% of the population [13]. A study using subtalar arthrography in recurrent ankle instability showed communication between the ankle and subtalar joints in 25% of patients with chronic anterior talofibular ligament disruption [12]. These investigators believed this communication was characteristic of rupture of the capsule of the joints or of the septum dividing them. In addition, communication occurred between the subtalar joint and peroneal tendon sheath in 27% of their patients. Whether these communications in the posterior subtalar joint are normal variants or the result of pathologic communications, the important point is that communications do exist.

Our Þndings suggest experienced surgeons may be able to place intraarticular injections without ßuoroscopy in a normal posterior subtalar joint with a 97% accuracy rate. Fluoroscopy may not be necessary for injections used

solely for therapeutic purposes. However, if the injection is intended for diagnostic purposes and surgical decision-making for potential arthrodesis or if the joint is abnormal, we recommend ßuoroscopy to ensure accurate placement without extension or extravasations into nearby structures that also might be potential sources of pain. Concerns for surrounding soft tissues may warrant use of ßuoroscopy in cases of arthrosis and indwelling hardware.

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