Original Article

A Vascular Obstacle in Ultrasound-Guided Hip Joint Injection

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Abstract

Background: We evaluated the risk of lateral circumflex femoral artery (LCFA) injury during ultrasound-guided intra-articular hip injections. **Methods:** This study was divided into three parts. (1) Four ultrasound-guided hip injections were performed on human cadavers. With needles in place, tissues were dissected to expose the LCFA. (2) Ultrasound-trained rheumatologists marked a planned needle trajectory from skin to hip joint on live human ultrasound images during an Observed Structured Clinical Examination (OSCE). Doppler was subsequently activated to locate the LCFA, and the distance between trajectory and arterial signal was recorded. (3) Rheumatologists certified in musculoskeletal ultrasound were surveyed about joint injection vascular complications. **Results:** (1) In one of the four cadaveric dissections, the needle made direct contact with the LCFA. (2) Of 27 OSCE participants, only two activated Doppler before marking simulated hip injection trajectories. Trajectories passed through LCFA Doppler signal in six (22%) cases. Mean minimal distance from trajectory to arterial signal was 4 mm (range, 0–11 mm). (3) Of 62 survey respondents, 24% stated that they did not use Doppler routinely. While none reported bleeding injuries with their patients, 16% knew of a hip injection-related vascular complication performed by another provider. **Conclusion:** There is a risk of LCFA injury during ultrasound-guided hip joint injection. Routine use of Doppler should be considered in standard hip injection protocols.

Keywords: Diagnostic imaging, hip, intra-articular injections, radiology, ultrasonography

Introduction

Ultrasound has become an increasingly utilized imaging tool for hip joint evaluation and therapeutic intervention.[1] Numerous studies have described the ease of ultrasound-guided hip joint injection for routine musculoskeletal procedures ranging from intra-articular corticosteroid to hyaluronic acid administration.[2-4] With proper technical training, it has been shown to be just as accurate as fluoroscopic-guided hip injection.[5,6] This noninvasive imaging modality eliminates the need for radiation and, as a result, can be easily accessed in the office setting.[7]

Most of the prior literatures advocating this sonographic technique for the hip joint describe an anterior approach where the needle is inserted lateral to the femoral neurovascular bundle.[7-12] Increased risk of vascular puncture during hip procedures (i.e., femoral nerve blockade) is a major concern. Injury of the lateral circumflex femoral artery (LCFA) is a proposed cause of bleeding in such procedures.[13] The LCFA, a branch of the profunda femoris artery, courses laterally in the femoral triangle in close proximity to the acetabulofemoral joint, with its three branches supplying the surrounding gluteal muscles and hip joint.[14] While various articles and textbooks on ultrasound-guided hip joint injection have advocated the use of Doppler imaging to avoid the femoral vascular bundle, to our knowledge, only one study[8] has cited the LCFA.[7-12,15-20] None recommend the routine use of Doppler for identifying and avoiding the LCFA. Studying the anatomy of the LCFA during intra-articular hip injections would provide a better understanding of vascular obstacles and promote safer injection techniques.

In this study, we attempted to determine if the LCFA is at risk for injury during intra-articular hip injections by performing real and simulated ultrasound-guided hip joint injections.

Methods

The study was divided into three parts: (1) performance of ultrasound-guided hip joint injections on human cadavers

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with subsequent dissection; (2) performance of simulated joint injections on live human subjects; and (3) survey of rheumatologists certified in musculoskeletal ultrasound about their knowledge of bleeding complications of hip joint needle placement. This study was approved by the participating university's Institutional Review Board. For all parts related to human study, informed consent was obtained from all participants and volunteers.

Joint injections in human cadavers

To characterize the relationship between the LCFA and needle during hip joint injection, four femoral triangle dissections were performed on human cadavers provided by the Department of Anatomy and Neurobiology, Boston University. For each human subject, the hip joint was first visualized by ultrasound using SonoSite M-Turbo with C60x transducer set at 5 MHz. An 18G spinal length needle (the size typically used for joint aspiration) was then inserted into the joint space using a standard anterior longitudinal approach, whereby the needle was directed along the longitudinal plane of the femoral neck aiming for the capsular space at the junction of the femoral head with the femoral neck. The needle was left in place while the surrounding tissues were subsequently removed to expose the LCFA. Once the vessel was located, the distance between needle shaft and artery was measured to assess for potential vascular injury. All imaging and needle placements were performed by a rheumatologist certified in musculoskeletal ultrasound with 13 years of ultrasound experience. The procedure allowed for three-dimensional visualization of the anatomic variability of the LCFA with respect to needle placement.

Simulated joint injections in live human subjects

Simulated hip injections were performed on a live human subject. This phase of the study was conducted on June 6, 2015, at the Ultrasound School of North American Rheumatologists (USSONAR) final Objective Structured Clinical Examination (OSCE). The OSCE was performed by rheumatologists who had trained during the prior 8 months in musculoskeletal ultrasound as part of the USSONAR course. Ultrasound trainees were specifically selected for this portion of the study to highlight the latest principles and techniques emphasized in hip ultrasound education.

On the day of examination, one healthy volunteer was scanned by each rheumatologist at the hip station. Following completion of their assigned examination task, each rheumatologist was asked to simulate a hip injection by using electronic calipers to mark a planned needle trajectory on the live ultrasound image of the hip joint. The proctor for this station then opened a Doppler box in the image (if not already prompted to do so by the examinee) to determine the location of the artery. The entire image (containing the hip joint, planned needle trajectory, and Doppler-imaged artery) was recorded. During subsequent analyses, images were assessed for virtual LCFA puncture. The closest distance between the planned needle trajectory and artery signal was also recorded. Ultrasound images obtained during the study were anonymized with respect to physician.

Rheumatologist survey

To assess the current practices in ultrasound-guided hip joint injection and knowledge of vascular complications related to this procedure, a survey was distributed to 140 rheumatologists and other medical professionals certified in Musculoskeletal Ultrasound by the American College of Rheumatology. Practitioners were asked how often they performed hip joint injections, the frequency at which they use Doppler, their bleeding complication rates, and whether they knew of such complications among their colleagues. All survey responses were kept anonymous.

Results

Joint injections in human cadavers

In all the four cadaveric dissections, the transverse branch of the LCFA passed anterior to the femoral neck, a path that coincided with needle trajectories during standard hip joint injections. One of the four needle insertions resulted in direct contact with the transverse branch of the LCFA [Figure 1]. Potential vessel injury appeared to depend on whether there was early or late branching of the transverse branch of the LCFA.

Simulated joint injections in live human subjects

Of the 39 USSONAR OSCE participants, 27 usable ultrasound images were obtained for subsequent analysis. Two OSCE participants activated Doppler imaging before attempting needle insertion. Participants who did not activate Doppler by themselves were later reminded to apply Doppler to scan for arteries, and needle trajectories were passed through the

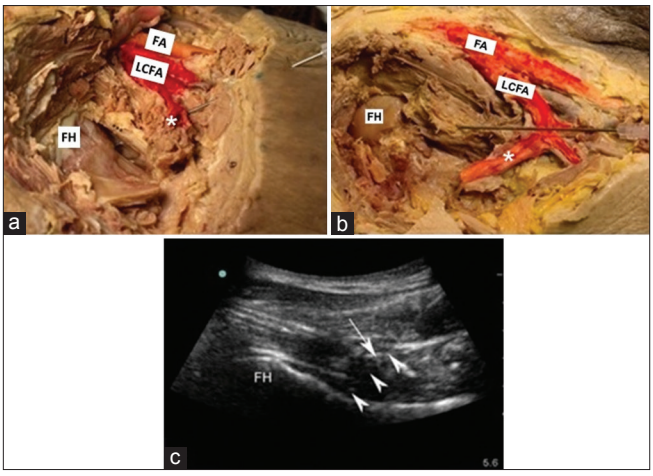

Figure 1: LCFA dissection in human cadavers. (a) Early branching of the transverse branch of LCFA – ultrasound-guided hip joint injection using anterior longitudinal approach with subsequent dissection. Needle comes in close proximity to the transverse branch of the LCFA (asterisk); FH and FA are also exposed. (b) Late branching of the transverse branch of LCFA. (c) Ultrasound of anterior longitudinal approach showing needle (arrowheads), femoral vessels (arrow), and FH. LCFA: Lateral circumflex femoral artery, FH: Femoral head, FA: Femoral artery

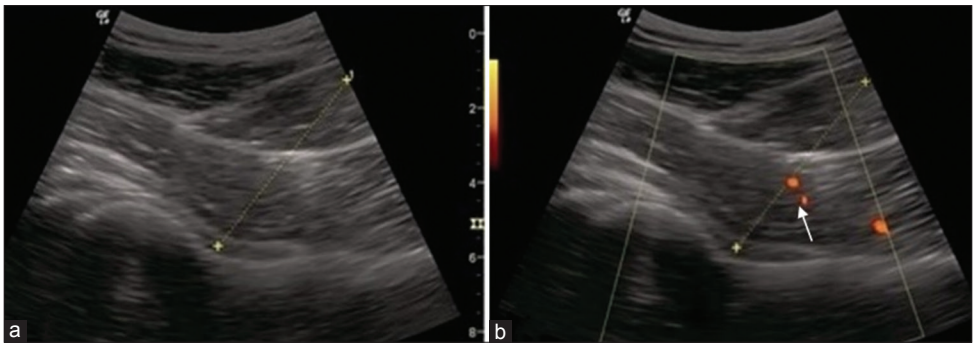

Figure 2: Simulated hip joint injection in Ultrasound School of North American Rheumatologists Observed Structured Clinical Examination (a) Simulated hip injection. Electronic calipers mark planned needle trajectory from skin to hip joint. (b) Doppler is then activated which reveals close proximity of lateral circumflex femoral artery (arrow) to needle

LCFA Doppler signal in six (22%) cases [Figure 2]. The mean minimal distance from needle to arterial signal was 4 mm (range, 0–11 mm).

Rheumatologist survey

Out of the 140 rheumatologists and other medical professionals who held Musculoskeletal Ultrasound Certification issued by the American College of Rheumatology, 70 practitioners (50%) responded. Sixty-two practitioners stated that they performed ultrasound-guided hip injections. Nearly 24% of these 62 responders stated that they did not use Doppler routinely. While none of the practitioners experienced bleeding injuries with their own patients, 16% realized the potential risk of vascular injuries through other's experience sharing.

Discussion

In this study, we examined the risk of LCFA injury through real and simulated joint injections. Our results reveal that the LCFA, particularly the transverse branch, which is difficult to visualize by gray scale alone, is at a considerable risk for injury when the Doppler mode is not activated to reveal arterial signals.

Few musculoskeletal training texts advocate routine Doppler use possibly because vascular complications are assumed to be rare. The number of case reports on vascular injuries during hip joint injection is limited; however, this small number of reports does not assure low incidence. Our survey results suggest that vascular injury during ultrasound-guided hip injection may be far more common than reported.

Similarly, the USSONAR portion of this study illustrated the current insufficiency in hip ultrasound training. While trainees were encouraged to incorporate Doppler use throughout their 8-month course, arterial identification with Doppler mode was not presented as part of standard practice. At the final OSCE, only two of the 39 participants activated Doppler imaging before needle insertion. Among those who did not apply Doppler to avoid arterial injuries, the LCFA puncture rate might be as high as 22%.

There are several limitations of this study. The cadaveric dissection phase involved a small study size which may limit its generalizability. The rheumatologists were aware of the study purpose before performing the cadaveric joint injections. Finally, in the simulated joint injections in a live human subject, several of the trainees' results had to be excluded due to incomplete image collection during the OSCE. This occurred at random however and was not related to the trainee's use of Doppler.

Our study identifies the LCFA as a potential site for accidental vascular injury during intra-articular hip injection. While the clinical significance of LCFA puncture remains unclear, we support the routine use of Doppler imaging as part of standard hip injection protocols, particularly for patients with bleeding tendency.

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Conflicts of interest

There are no conflicts of interest.

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