Femoral Artery Access Using the US-Determined Inguinal Ligament and Femoral Head as Reliable Landmarks: Prospective Study of Usefulness and Safety

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ABSTRACT

Purpose: To evaluate ultrasound (US)-guided femoral artery access using the US-determined inguinal ligament (IL; US-IL) and femoral head as anatomic landmarks to prevent "high stick" (ie, cannulation above the IL) of the common femoral artery (CFA).

Materials and Methods: Fifty consecutive US-guided femoral artery accesses for embolization of hepatocellular carcinoma (n = 49) or renal angiography (n = 1) between December 2008 and August 2009 were prospectively analyzed. Primary endpoints were evaluation of technical success and major/minor complications during the procedure and follow-up visits. Secondary endpoints were the relative locations of the US-IL, fluoroscopically determined IL (FL-IL), and origin site of the inferior epigastric artery (IEA) on completion angiography. Relationships were evaluated between CFA types and lengths on US, between CFA types on US, and between frequencies of low-lying US-IL on fluoroscopy. Spearman correlation, Student *t* test, and Fisher exact test were used for statistical analysis.

Results: Technical success of CFA access was achieved in all patients (100%), with no high stick of the CFA noted. No complications were noted. On fluoroscopy, US-IL was located significantly lower than FL-IL ($P = .002$). On fluoroscopy and completion angiography, US-IL was more strongly correlated ($\rho = 0.823$, $P < .001$) with the IEA origin site than with the FL-IL ($\rho = 0.287$, $P = .043$). Finally, a "slope-type" CFA was shorter than a "horizontal-type" CFA on US and was more common in patients with low-lying US-IL on fluoroscopy ($P = .001$).

Conclusions: US-guided CFA access with US-IL and femoral head guidance is safe and useful and can be helpful in preventing high stick.

ABBREVIATIONS

CFA = common femoral artery, EIA = external iliac artery, FL-IL = fluoroscopically determined inguinal ligament, IEA = inferior epigastric artery, SFA = superficial femoral artery, US-IL = ultrasound-determined inguinal ligament

The common femoral artery (CFA) is the most commonly accessed artery for angiography and is considered the safest artery in terms of potential complications (1,2). Puncturing the vessels above the inguinal ligament (IL) predisposes patients to retroperitoneal hemorrhage, whereas puncturing the superficial femoral artery (SFA) or deep femoral artery is associated with pseudoaneurysm, arteriovenous fistula, and arterial occlusion (1–3). The incidence of minor or major complications after accessing the femoral artery ranges from 2.1% to 10.3% (4–6). Clinicians must avoid puncturing the SFA and the external iliac artery (EIA), as well as any small or diseased vessels, to decrease the rate of femoral artery access complications.

Ultrasound (US)-guided femoral artery access via fluoroscopically determined IL (FL-IL) or bony landmarks is regarded as an excellent guide for vessel puncture (7–15). US-guided CFA access has several advantages, such as visualization of the CFA bifurcation, avoidance of posterior wall puncture, identification of atherosclerotic and calcified plaques, and avoidance

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of femoral vein puncture (12). However, "high stick," which refers to EIA access and cannulation above the IL, is not uncommon. In US-guided CFA cannulation, the incidence of high stick is reported to be 6.6% (12). Cannulation above the IL is associated with retroperitoneal hemorrhage, an infrequent but serious complication (3,16–18). For these reasons, a more reliable access method is needed to minimize complications related to high stick.

Although there is agreement that sheath placement below the anatomic IL is crucial for avoiding retroperitoneal hemorrhage, we are aware of no reports regarding visualization of the US-determined IL (US-IL) and US-guided femoral artery access with the guidance of the US-IL. In our experience, differences are often observed between US-IL and FL-IL locations. However, to the best of our knowledge, no reports to date have noted a difference in locations between US-IL and FL-IL or in relations of the locations among US-IL, FL-IL, and the origin site of the inferior epigastric artery (IEA). Therefore, the purposes of the present study were to prospectively assess US visualization of the IL and evaluate differences in locations of the US-IL versus the FL-IL, and to analyze the relationships between the FL-IL and the IEA origin site and between US-IL and the IEA origin site.

MATERIALS AND METHODS

Study Population

The institutional review board approved this study, and oral and written informed consent was obtained from each patient. A total of 67 consecutive femoral artery access procedures were prospectively performed under US guidance in 67 patients (42 men and 25 women) between December 2008 and August 2009. All procedures were performed by a board-certificated interventional radiologist with 8 years of experience.

Patients were eligible for the study if they underwent femoral artery access for angiography or transarterial intervention. The right femoral artery was selected for femoral artery access unless the right femoral artery exhibited severe stenosis or there was a history of right femoral artery access, in which cases the left femoral artery was used. Exclusion criteria included (i) both femoral arteries previously used for femoral artery access (n = 3), (ii) both femoral arteries exhibiting significant stenosis with calcified or noncalcified plaque (n = 5), and (iii) requirement of emergency procedures such as transarterial embolization for active bleeding resulting in insufficient time to perform US and angiography of the femoral artery (n = 9). Finally, 50 patients (mean age, 59.6 y ± 9.7; range, 38–80 y) were enrolled, including 36 men (mean age, 58.8 y ± 10.2; range, 38–80 y) and 14 women (mean age, 59.7 y ± 8.5; range, 48–75 y). Among these 50 patients, 49 were admitted for transarterial embolization for hepatocellular carcinoma and one was admitted for renal angiography. Table 1 shows the clinical characteristics of patients enrolled in the study.

Preprocedural US

The groin selected for retrograde puncture was evaluated by axial and longitudinal scanning with a linear probe (L12-5, En Visor HD; Philips, Best, The Netherlands), through which the CFA, its bifurcation, and the femoral head were visualized. The technique used to detect the IL on US was as follows. First, a linear probe was placed along the anatomic course of the IL between the anterior superior iliac spine and the pubic tubercle, and the probe was rotated approximately 90° so that it was parallel with the underlying vessel (Fig 1a). US was used strictly until the introducer sheath was inserted into the CFA. A mosquito hemostat was placed at the lowest point of the US-IL passing over the femoral artery in a longitudinal US view, and a one-spot image was taken to determine its location. The image intensifier was centered on the mosquito hemostat to avoid parallax. This point was compared with the FL-IL imaginary line. In addition, CFA length and type were evaluated. CFA length was defined as the distance between the lowest border of the US-IL and the femoral artery bifurcation under US. Caliper measurement was performed at the center of the CFA. The three types of CFAs were identified based on the angle between the CFA and the skin plane in longitudinal view under US (Fig 2). CFAs that were slanted forward and nearly parallel to the skin (0°–10°) were defined as "horizontal type." CFAs that were curved along the femoral head were considered "arch type." CFAs that were slanted forward more than 10° were defined as "slope type." The diameters of the CFA

Table 1. Baseline Demographics (N = 50)

Characteristic	Value
Sex	
Male	36 (72)
Female	14 (28)
Age (y)	
Mean ± SD	59.6 ± 9.7
Range	38–80
Diabetes mellitus	5 (10)
Hypercholesterolemia	11 (22)
Hypertension	8 (16)
BMI (kg/m^2)	24.0 ± 3.2
Peripheral vascular disease	2 (4)
Cerebrovascular disease	6 (12)
Blood coagulation factor	
Platelet count (/nL)	137.5 ± 61.9
Prothrombin time (s)	13.8 ± 1.58
INR	1.07 ± 0.16

Note.– Values are presented as number (%) or mean ± SD. BMI = body mass index, INR = International Normalized Ratio, SD = standard deviation.