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CLINICAL INVESTIGATIONS

Access to the Superficial Femoral Artery in the Presence of a ''Hostile Groin'': A Prospective Study

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Abstract

Purpose: Lower limb angioplasty is commonly performed via antegrade common femoral artery (CFA) puncture, followed by selective superficial femoral artery (SFA) catheterization. Arterial access can be complicated by a ''hostile groin'' (scarring, obesity, or previous failed CFA puncture). We prospectively investigated color duplex ultrasound (CDU)-guided SFA access for radiological interventions.
Methods: Antegrade CDU-guided CFA and SFA puncture were compared in 30 patients requiring intervention for severe leg ischemia who had hostile groins. Demographics, screen time, radiation dose, intervention, and complications were prospectively recorded.
Results: Treatment in 30 patients involved 44 angioplasties (40 transluminal, 4 subintimal) and 2 diagnostic angiograms. Fifteen of these patients had CDU-guided CFA punctures; in 8 of these patients CDU-guided CFA puncture ''failed'' (i.e., there was failure to pass a guidewire or catheter into the CFA or SFA), necessitating immediate direct CDU-guided SFA puncture. Overall, the mean screen time and radiation dosage, via direct CDU-guided SFA puncture in 30 patients, was 4.8 min and 464 Gy cm^2 respectively. With CDU-guided CFA puncture, mean screen time (10 min), radiation dose (2023 Gy cm^2), and complications (13%) were greater when compared with the SFA puncture results overall and in the same patients at subsequent similar procedures (2.7 min, 379 Gy cm^2 ($p < 0.05$), no complications in this subgroup). Five complications occurred: 2 each at CFA and SFA entry sites, and 1 angioplasty embolus.
Conclusions: The CDU-guided SFA puncture technique was both more effective than CDU-guided CFA access in patients with scarred groins, obesity, or failed CFA punctures and safer, with reduced screen times, radiation doses, and complications.

Key words: Angioplasty—Antegrade arterial puncture—Common femoral artery—Complications—Superficial femoral artery—Ultrasound guidance

Arterial access for angioplasty or thrombolysis of the lower limb is usually gained initially via an antegrade puncture of the common femoral artery (CFA) followed by selective catheterization of the superficial femoral artery (SFA). Due to the close proximity of the CFA entry site, subsequent catheterization of the SFA can be complicated, time-consuming, and thus uncomfortable for the patient. A number of different techniques have been developed to facilitate access to the SFA, including the use of more distant access sites such as contralateral CFA, transbrachial, transaxillary, transpopliteal, and even transperoneal arterial punctures [1]. However, these procedures are not without complication and can potentially involve difficult instrumentation over longer arterial lengths [2, 3]. Other authors have described methods via retrograde CFA punctures together with the use of specific needles [4], catheters with guidewire ''turning'' manipulations, such as with a ''90° angled tip catheter''[5], or specific guidewires with the sole purpose of facilitating access to the SFA [6, 7]. Retrograde CFA punctures and guidewire ''turning'' to catheterize the SFA have been reported to result in increased screen times, radiation doses, and number of puncture attempts [8].

The usefulness of antegrade SFA access is not in doubt: it is required for diagnostic and angioplasty procedures, thrombolysis, and intra-arterial chemoinfusion therapies [9]. However, what is in question is how to simplify and improve the SFA access, especially in the presence of ''hostile'' scarred groins and obesity. The increasing incidence of obesity and scarred groins (after vascular and endovascular

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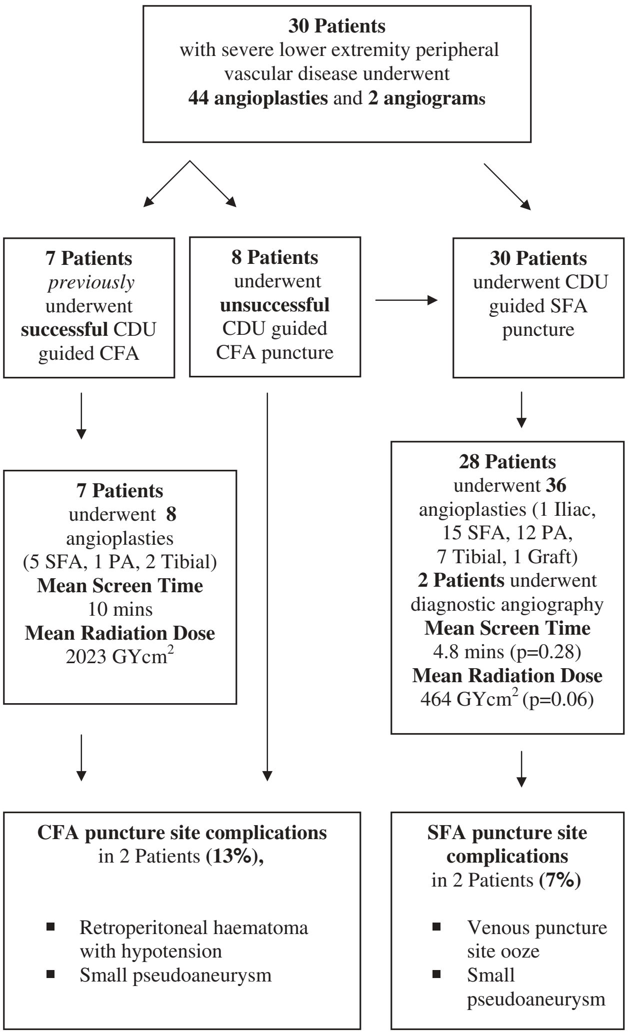

Fig. 1. Consort diagram of patients who underwent SFA and CFA punctures. CFA, common femoral artery; SFA, superficial femoral artery; PA, popliteal artery; CDU, color Doppler ultrasound.

interventions) leading to impalpable femoral pulses and obscured surface anatomy may further complicate the difficulties with the two-step procedure of CFA puncture and antegrade SFA catheterization. The simple solution is direct antegrade puncture of the proximal SFA; however, this needs to be performed without multiple puncture attempts, complication, or increased screen times and radiation dosage. Direct SFA puncture is indicated for patients with ''hostile groins'' due to scar tissue (secondary to previous surgery or arterial access, aneurysmal CFA, chronic groin infection or hip flexion deformity), obesity, and previously failed CFA punctures. The NICE (National Institute for Clinical Excellence, UK) guidelines recommend the use of ultrasound guidance for gaining vascular access [10]. Therefore we investigated whether the use of a direct antegrade SFA puncture technique performed under color duplex ultrasound (CDU) guidance was safe, practical, and an effective alternative to CDU-guided CFA puncture for radiological treatment of lower limb ischemia in the presence of a ''hostile groin.''

Materials and Methods

Prospective data were collected on 30 consecutive patients (with either scarred groins, obesity, or previous failed CFA punctures) who underwent CDU-guided SFA puncture for lower limb ischemia between 1999 and 2004 in our acute multidisciplinary hospital. Fifteen of these patients had previously undergone CDU-guided CFA punctures; 7 of the CFA punctures were successful and the results of these were compared with CDU-guided SFA punctures performed (between 1 and 15 months later) in the same patients for subsequent separate radiological interventions (Fig. 1). An information log was kept for each patient documenting the their age, gender, weight, screen time, radiation dose, interventional procedure, and complications. The patients were selected—after assessment with CDU—for SFA puncture in the following situations:

- Local CFA anatomy was unfavorable because of: flexion deformity of the hip, obesity, high CFA bifurcation, injected or erythematous groin skin crease, excessive scar tissue.
- Disease state of the CFA: severe atheromatous disease, CFA aneurysm, graft anastomosis.
- Previous failed CFA access.

Patients were selected for CFA puncture if there was severe atheromatous disease of the SFA.

Each patient was suitably prepared, positioned, draped, and administered local anesthetic for sterile arterial access to the proximal SFA. Color duplex ultrasound (Aloka SSD 2000, Tokyo, Japan) was used to identify the CFA, proximal SFA, and profunda femoris artery (PFA) and their equivalent venous structures. A sterile cover was applied to the ultrasound probe using a Tagaderm (3m Health Care, St. Paul, MN, USA) and an adhesive surgical drape. Ultrasonographic gel was placed between the probe and a 4 inch × 4.5 inch Tagaderm. The Tagaderm was folded around the probe and a standard small surgical drape was wrapped and sealed around the Tagaderm-covered probe by means of the adhesive strip on the drape. This set-up enabled ultrasound gel to be sealed within a sterile ultrasound probe cover. Sterile ultrasound gel was also applied to the skin surface.

Under ultrasound control, the proximal SFA puncture was performed using a single-wall technique with a one-part 19G needle. A standard guidewire was introduced into the proximal SFA, over which a 4, 5 or 6 Fr sheath was advanced into the vessel. The planned interventional procedure was then carried out routinely as for a conventional CFA puncture. At the end of the procedure, hemostasis was achieved by digital or ultrasound-guided probe compression over the proximal ''high'' SFA puncture site, against the femoral head.

Results

Thirty patients underwent CDU-guided direct SFA punctures (Fig. 1). Seven of these patients had previously undergone CDU-guided CFA in separate procedures. In 8 other patients, ultrasound-guided CFA punctures had failed, necessitating immediate direct CDU-guided SFA puncture

Table 1. Comparison of CDU-guided CFA and subsequent SFA punctures for angioplasty procedures

			CFA puncture			SFA puncture		
Patient	Complaint	Age/sex	Angioplasty site	Screen time (min)	Radiation dose (Gy cm^2)	Angioplasty site	Screen time (min)	Radiation dose (Gy cm^2)
1	Ulcer	74/F	SFA	15.5	8269	SFA	2.1	189
2	Ulcer	80/F	SFA/tibial	4.3	439	SFA/iliac	0.8	345
3	Gangrene	81/M	Tibial	8.6	1016	SFA/PA	3.6	307
4	Ulcer	71/F	SFA	6.5	585	Tibial	6.8	683
5	Ulcer	93/F	SFA	8	587	SFA	1.8	517
6	Ulcer	85/M	PA	22.9	2542	PA	3.3	265
7	Rest pain	80/M	SFA	4.1	724	SFA	0.8	345
Mean		81		10	2023		2.7 (p = 0.28)	379 (p = 0.06)

CFA, common femoral artery; SFA, superficial femoral artery; PA, popliteal artery; *p*, Wilcoxon Sign test probability

to gain arterial access for the radiological procedure. Overall, the patient group was made up of 18 men and 12 women with a median age of 74 years (range 42–93 years) and a mean weight of 78 kg (range 55–98 kg); 9 had a body mass index greater than 30. Twenty-five patients presented with critical leg ischemia; specifically rest pain, ulceration and/or gangrene. The remaining 5 patients were severely compromised by short-distance claudication.

The radiological treatment of these patients, via CDU-guided direct SFA punctures, involved 44 angioplasties (40 transluminal and 4 subintimal) and 2 diagnostic angiograms. Angioplasty sites included: the SFA alone (n = 13), with 2 in the proximal SFA; the popliteal artery alone (n = 6); the SFA combined with popliteal angioplasties (n = 4); 1 iliac with SFA (retrograde approach); 2 SFA with tibial; 3 popliteal with tibial angioplasties; 1 vein graft; and 4 individual tibial angioplasties.

The mean screen time and radiation dosage, for the 38 angioplasties and 2 diagnostic angiograms performed via 30 direct CDU-guided SFA punctures in 30 patients, were 4.8 min and 464 Gy cm^2, respectively. As previously described, in 7 patients 7 CDU-guided CFA punctures were successfully performed. These patients underwent SFA, popliteal, and tibial angioplasty procedures. The results of these were compared with 7 subsequent angioplasty procedures, performed via CDU-guided SFA punctures in the same patients, at their next radiological intervention (Table 1, Fig. 1). For the 7 CDU-guided CFA punctures, the mean screen time was 10 min (range 4.1–23 min), the mean radiation dose was 2023 Gy cm^2 (range 439–8264 Gy cm^2), and 2 complications occurred at the groin site (complication rate 13%). Screen time, radiation dose, and the complication rate were all greater in the 7 CDU-guided CFA punctures than in the 7 CDU-guided direct SFA punctures subsequently performed in the same patients (mean screen time 2.7 min, range 0.8–6.8 min; mean radiation dose 379 Gy cm^2, range 189–683 Gy cm^2; no complications in this SFA subgroup (Wilcoxon Sign test, p = 0.28 and p = 0.06, respectively)). A similar reduction in screen time and radiation dose was also found with all the SFA puncture patients when compared with CDU-guided CFA puncture interventions, but this was not statistically assessed because the patients were not randomized to treatments. Statistical analysis was only performed on paired data for the subgroup of 7 patients who underwent both CFA and SFA punctures.

In total, 5 complications occurred in 30 patients: 2 at CFA puncture sites, 2 at SFA entry sites, and 1 related to the angioplasty intervention itself. With the successful and failed CFA punctures (n = 15), 1 patient suffered a hypotensive episode and a significant retroperitoneal hematoma, while the other developed a small pseudoaneurysm that resolved with conservative therapy (puncture site complication rate 13%). With the SFA punctures (n = 30), a venous ooze from the skin puncture site developed in 1 patient and in another a small pseudoaneurysm formed, both of which resolved with conservative treatment (puncture site complication rate 7%). The angioplasty-related complication involved a distal embolization to distal calf arteries after popliteal angioplasty; this complication was successfully treated by immediate aspiration thrombectomy. No other patients suffered pseudoaneurysm or other puncture site complications after these procedures or during follow-up in vascular outpatient clinics for between 2 and 5 years.

Discussion

This prospective study suggests that CDU-guided SFA puncture is effective and safe (complication rate 7% at the local puncture site compared with 13% for CDU-guided CFA puncture) in patients with obesity, scarred groins, or previously failed CFA punctures, with the added benefit of reduced screen times and radiation dosages. All angioplasty procedures were successful via the SFA approach, even those performed in the proximal third of the SFA. The single embolic arterial complication was rectified immediately and related to the angioplasty procedure and not the SFA puncture site. A large randomized controlled trial would provide more evidence to reinforce the benefits found in this study. Our radiological unit now performs approximately 120 procedures annually utilizing a CDU-guided SFA access technique. The selection criteria of patients for primary SFA punctures are the same as those outlined above in Materials and Methods.

The cardiovascular literature highlights a number of reasons that have made direct SFA puncture techniques controversial [11, 12]. The incidence of pseudoaneurysm and arteriovenous fistula formation has been reported to be in the region of 0.02–0.2%, and together with superficial hematoma formation these complications lead to significant morbidity. However, these reports involved cardiac patients who received inadvertent SFA punctures during attempted retrograde CFA punctures in the presence of periprocedural anticoagulation with large-caliber catheters for coronary angiography. The occurrence of these complications was thought to be due to the more complex arteriovenous anatomy and difficulty with hemostatic control at the level of the proximal SFA. Similar complications have not been reported with antegrade SFA access for interventional radiological techniques for the lower extremity. The use of color Doppler ultrasound guidance to facilitate the puncture of the SFA can, firstly, clearly define the anatomy and thereby reduce accidental puncture of the nearby venous and arterial structures. Secondly, CDU guidance offers a minimally invasive alternative to surgical cut-down for perioperative angioplasty. Thirdly, the CDU imaging avoids the need in the majority of patients for computed tomography or magnetic resonance angiography to define unfavorable anatomy prior to an intervention. Finally, the use of the ultrasound probe can provide controlled and ultrasound-guided compression over the arterial puncture site to prevent hematoma formation at the end of the procedure. High SFA punctures have the benefit of the femoral head posterior to the SFA to facilitate hemostatic compression. Few other authors have described direct SFA puncture, very few with ultrasound guidance; however, their complication rate was also minimal [7, 13, 14]. We experienced one small pseudoaneurysm and one venous ooze with SFA puncture, both of which resolved with conservative treatment alone.

The main indications for direct SFA puncture are for arterial access after failed CFA puncture, in obese patients, and in those with scarred groins in whom access and hemostatic control may be difficult. The direct puncture of the CFA may be difficult, even in uncomplicated groins. Anatomic studies have demonstrated the varied surface anatomy that can complicate CFA puncture: the CFA lies at the level of the inguinal skin crease in only 3.5% and above the skin crease in three-quarters of patients [15]; in addition a high CFA bifurcation may make arterial puncture below the inguinal ligament very difficult. Inaccurate ''high'' CFA puncture can lead to the life-threatening complication of retroperitoneal hematoma.

Technical problems may potentially be found with very proximal SFA angioplasties; however, the close proximity of the CFA to a proximal SFA lesion would also lead to similar problems with CFA puncture. A pre-emptive arterial duplex examination would detect any proximal SFA lesions and help plan for an alternative ipsilateral or contralateral arterial entry site.

In this study ultrasound-guided direct access to the SFA for antegrade intervention was safe, rapid, and effective and had a number of procedural advantages over the conventional CFA puncture in patients with ''hostile groins.'' In summary, we found that CDU-guided SFA puncture:

- reduces screen times, radiation dose and complications;
- avoids scar tissue in a groin previously subjected to multiple episodes of vascular access;
- reduces anatomic difficulties—and thus the risk of retroperitoneal hematoma—experienced with CFA punctures in obese patients and reduces accidental puncture of venous or PFA vessels;
- improves the accuracy of arterial puncture in the absence of palpable pulses;
- offers a simple solution for continuation of the radiological procedure when a conventional CFA puncture fails;
- can achieve complete postprocedural hemostasis by means of ultrasound-guided compression applied with the ultrasound probe to the arterial puncture site.

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