Technique of Percutaneous Direct Needle Puncture of Calcified Plaque in the Superficial Femoral Artery or Tibial Artery to Facilitate Balloon Catheter Passage and Balloon Dilation of Calcified Lesions

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ABSTRACT

Heavy calcified arterial lesions are challenging to endovascular treatment. Even if a guide wire passes the lesion, calcified plaque can inhibit passage or dilation of the balloon catheter. We developed a novel technique of *p*ercutaneous d*i*rect n*e*edle punctur*e* of *c*alcified plaqu*e* (PIERCE) to allow subsequent passage and dilation of the balloon. PIERCE was performed in three patients with superficial femoral artery (SFA) lesions and one patient with a tibial artery lesion. In all four cases, balloon passage and lesion dilatation were achieved. Minor hemorrhage from the punctured site occurred in two patients with SFA lesions, which resolved with stent placement.

ABBREVIATIONS

PIERCE = *p*ercutaneous d*i*rect n*e*edle punctur*e* of *c*alcified plaqu*e*, SFA = superficial femoral artery

The reported success rates of endovascular chronic total occlusion recanalization procedures are highly variable and largely dependent on operator experience and lesion morphology (1,2). Heavy calcification is one of the most challenging lesion characteristics for endovascular treatment (3–6). Recanalization of heavily calcified lesions fails in 20% of cases when using traditional guide wire and balloon technology (7). The main reasons for failure of chronic total occlusion recanalization are the inability to cross the occlusion with a guide wire or the inability to reenter the true lumen after subintimal tracking. Even if the guide wire is successfully passed across the lesion, heavy calcification can still inhibit balloon catheter or microcatheter passage or balloon or stent expansion (3), especially in patients who are undergoing hemodialysis.

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The more recent introduction of specially designed crossing catheters and balloons may improve the technical success rate (3,5,8), but these devices are expensive, are available in only some countries, and cannot address all calcified lesions. We developed a novel method of *p*ercutaneous d*i*rect n*e*edle punctur*e* of *c*alcified plaqu*e* (PIERCE). This technique creates cracks in the calcified plaque to facilitate the passage of the device through the calcified lesion and complete dilation of the lesion. This report describes four cases in which the PIERCE technique was performed, focusing on its technical steps.

MATERIALS AND METHODS

From May 2012 to February 2013, the PIERCE technique was used to treat three patients with superficial femoral artery (SFA) occlusion and one patient with posterior tibial artery occlusion. All patients had a history of chronic kidney disease, and three patients were undergoing long-term hemodialysis. Computed tomography showed calcified plaque occupying the entire lumen of the affected artery in all patients. All patients were taking aspirin (100 mg/d) before treatment. Heparin was not reversed before the PIERCE technique. Informed consent was obtained before endovascular treatment in cases 2–4 and before the PIERCE technique in case 1.

Access was obtained from the ipsilateral femoral artery in all cases, and a 6-F sheath was inserted in an antegrade manner. After sheath insertion, an intra-arterial bolus of heparin was administered at 50 U/kg body weight; an additional 1,000–2,000 U was given for interventions that lasted > 1 hour. Guide wire passage across the lesion was achieved intraluminally in all patients. After guide wire passage, a penetration catheter X support (tip diameter of 1.55 mm with stiff shaft; Zeon Medical, Tokyo, Japan) with 4-F CXI support (Cook Medical Japan, Tokyo, Japan) or 1.5-mm diameter coronary balloon (Sapphire; OrbusNeich Medical, Tokyo, Japan) was unable to advance through the lesion (cases 1, 2, and 4). Heavily calcified lesions blocked the passage of the catheter or balloon to the distal side (cases 1, 2, and 4), and heavily calcified lesions were resistant to balloon dilation in cases 3 and 4 despite the balloon being dilated up to 27 atm (both difficulties were encountered in case 4).

The PIERCE technique was performed. After local anesthesia was administered percutaneously, the calcified plaque was directly punctured using a 19-gauge needle (HAKKO ELASTER; Hakko, Nagano, Japan) in cases 1 and 2 and a 16-gauge needle in cases 3 and 4 under fluoroscopic guidance. The targeted plaque was easily identified because the tip of the microcatheter or balloon was next to the plaque. When the needle touched the calcified plaque, resistance to advancement of the needle could be felt manually. Further force while rotating the needle was applied to break the plaque. After the needle penetrated the plaque, the same motion was repeated two to three times after changing the direction of the needle tip by 2–3 mm. After penetration of the plaque, another attempt was made to advance the microcatheter or balloon and to dilate the lesion.

RESULTS

After the PIERCE technique, advancement of the microcatheter or balloon was successfully achieved in three of three patients (Figs 1, 2), and favorable balloon dilatation of the lesion was achieved in two of two

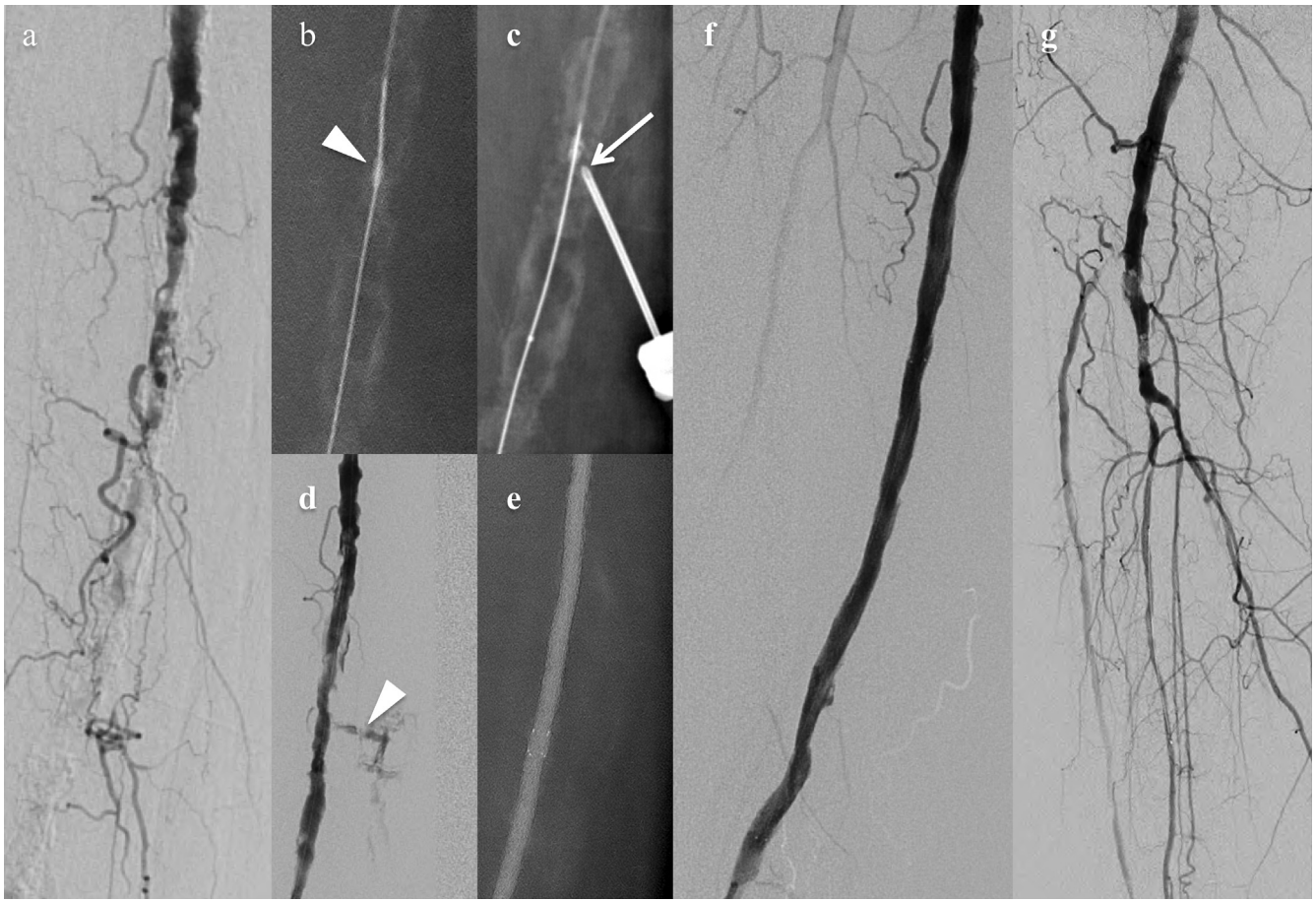

Figure 1. Case 2. **(a)** Angiogram showed chronic total occlusion in the middle portion of the SFA. **(b)** Tip of the balloon catheter (arrowhead) stuck in the calcified plaque. **(c)** The PIERCE technique was performed under fluoroscopic guidance (arrow indicates needle tip). **(d)** After predilation, at the time when blood flow was restored in the occluded SFA, hemorrhage from the punctured site was identified (arrowhead). **(e)** Stent placement and dilation was performed. **(f)** Bleeding from the punctured site disappeared. **(g)** No distal embolism was identified.