CASE REPORT

The Effectiveness of Skin Perfusion Pressure Measurements during Endovascular Therapy in Determining the Endpoint in Critical Limb Ischemia

Norihiko Shinozaki

Abstract

A 78-year-old man had right foot ulceration. The skin perfusion pressure (SPP) at the dorsum was 12 mmHg. Angiography revealed right iliac artery occlusion and diffuse stenosis of right superficial femoral artery. After stenting of the iliac arteries, the SPP was still 23 mmHg. Hence, we also inserted stents in the right superficial femoral artery. The anterior tibial artery remained stenosed, and the posterior tibial and fibular arteries were occluded. However, as the SPP had increased to 46 mmHg the treatment was discontinued. The ulcers improved. Measurement of SPP during a procedure may be useful in determining the treatment endpoint.

Key words: skin perfusion pressure, endovascular therapy, critical limb ischemia


DOI: 10.2169/internalmedicine.51.6988)

Introduction

In patients with critical limb ischemia (CLI), the most important therapeutic goal is limb salvage. Endovascular revascularization has been reported to be equally effective in limb salvage rate compared with bypass surgery in the treatment of severe lower limb ischemia caused by stenosis or occlusion of the leg arteries (1-3). We have grown to favor endovascular intervention against bypass surgery for CLI patients (2, 3). However, we sometimes worry about the endpoint of the procedure for CLI patients with multiple diffuse lesions. In the meantime, measurement of skin perfusion pressure (SPP) has been shown to be useful in the assessment of the severity of CLI, and it has been shown that the ischemic wound would be cured when the SPP is 30-40 mmHg or higher (4-8). Herein, we report a case in which SPP measurements obtained during endovascular treatment of the leg arteries were effective in determining the endpoint of the treatment, overcoming the need to amputate the patient’s leg. Measuring of SPP during a procedure may be extremely useful in determining the treatment endpoint, especially, as in the present case, when the patient has severe leg ischemia with multiple diffuse lesions.

Case Report

The patient was a 78-year-old man who complained of ulcers in his third, fourth, and fifth right toes (Fig. 1) and had no notable family history. His left leg had been amputated above the knee due to an infection that had developed from left leg gangrene as a consequence of peripheral arterial disease several years previously. The ulcers in his toes became apparent in May 2010. He was referred to our hospital in early July 2010 by his orthopedist who determined that local treatment would not improve his condition. The ankle brachial pressure index (ABI) on the right side could not be measured. The SPP at the dorsum and the sole of the foot was 12 mmHg and 11 mmHg, respectively. The SPP was measured with a laser Doppler probe using a LASERDOPP PV2000™ (Vasamedics, St. Paul, MN, USA). Infection was suspected because the white blood cell count was 13,200/μL and the C-reactive protein was 9.55 mg/dL. On admission, angiography performed via the right radial artery revealed 75% stenosis of the left external iliac artery, total occlusion of the left superficial femoral and right iliac arteries, and...
90% diffuse stenosis of the right superficial femoral artery (Fig. 2). The blood flow in the right leg was so poor that the arteries below the knee could not be evaluated. Angioplasty was performed via the right radial artery for the arteries of the right leg. It was very difficult to pass the guidewire through the occlusion of right iliac artery, but we were able to advance an Astato XS® 9-12 guidewire (Asahi Intecc, Aichi, Japan) through the occluded right iliac artery, followed by a 150-cm Finecross® microcatheter (Terumo, Tokyo, Japan). After changing the guidewire to a 300-cm Dejavu® support shaft (Cordis, Miami Lakes, FL, USA), we applied a 4.0-40-mm Sterling® balloon catheter (Boston Scientific, Natick, MA, USA) to predilate the iliac artery. Next, an 8.0-120-mm Luminexx® stent (Bard, Murray Hill, NJ, USA) and a 10.0-40-mm Luminexx® stent were placed along the external and common iliac arteries, respectively. Following post-dilation of the stent using a 5.0-40-mm Sterling® balloon catheter, favorable blood flow to the right common femoral artery was achieved, and the arteries below the knee became visible by angiography (Fig. 3). At this point, the SPP at the dorsum of foot was still below 30 mmHg (23 mmHg, which was only a small increase from the previous value). Hence, we considered that revascularization of the right superficial femoral artery would also be necessary. Because the device could not reach the target site via the right radial artery, we changed the approach point to the left femoral artery. After the artery was punctured, a 300-cm Dejavu® support shaft was advanced through the left common iliac artery, which was then directly stented using a 10.0-100-mm Luminexx® stent. After post-dilation of the stent using a 5.0-40-mm Sterling® balloon catheter, favorable blood flow was achieved. Subsequently, a 6 Fr Destination® guiding sheath (Terumo, Tokyo, Japan) was advanced through the right femoral artery, and revascularization was performed for the right superficial femoral artery. After the right superficial femoral artery was predilated using a 4.0-40-mm Sterling® catheter, two 6.0-100 mm SMART® stents (Cordis, Miami Lakes, FL, USA) were placed, with post-dilation using a Sterling® 5.0-40-mm catheter. Favorable blood flow was thus achieved. Long inflation using a 3.0-20-mm Angiosculpt® balloon catheter (AngioScore, Fremont, CA, USA) was applied to the 75% stenosed right popliteal artery. Blood flow was confirmed from the anterior tibial artery to the toes, but the anterior tibial artery remained stenosed, and the posterior tibial and fibular arteries were occluded (Fig. 4). However, at this point, the SPP at

**Figure 1.** A picture of the foot before the procedure. The foot had ulcers on the third, fourth, and fifth right toes complicated by infection.

**Figure 2.** Angiogram before the procedure. Angiography revealed total occlusion of the right iliac arteries, and 90% diffuse stenosis of the right superficial femoral artery. The blood flow in the right leg was so poor that the arteries below the knee could not be evaluated. At this point the skin perfusion pressure at the dorsum of the right foot was 12 mmHg.

**Figure 3.** Angiogram after the iliac artery stenting. After the iliac artery stenting, favorable blood flow to the right common femoral artery was achieved, and the arteries below the knee became visible. At this point, the SPP at the dorsum of foot was still below 30 mmHg.
the dorsum of the foot had increased to 46 mmHg; the treatment was therefore stopped without attempting to revascularize the arteries below the knee. One day after the procedure, the ABI was 0.94, and the SPP had increased to as high as 76 mmHg. The signs of infection improved with antibiotics. The ulcer in the toes also improved gradually (Fig. 5), and leg amputation was avoided.

Discussion

SPP measurement was first reported in 1970 (9). Initially, blood pressure was measured at the capillary vascular bed by topical injection of a radioactive substance and the application of pressure with a blood pressure manometer. Subsequently, a laser Doppler technique for measuring SPP was established to evaluate skin tissue viability (10, 11). As this method can measure SPP at very low levels, more simply, less invasively, with greater reproducibility, and in a shorter time, it has been widely used. In particular, this method is useful for patients with severe calcification of the arterial wall, for whom the ankle pressure or toe pressure is not reliable. Several reports have indicated that SPP is of value in predicting the healing of ischemic ulcerations and amputation wounds (4-8). SPP measurement using the laser Doppler technique is an easy and noninvasive process; it can be performed during endovascular revascularization without difficulty or invasion. It does not interfere with the procedure or cause any discomfort to the patient.

Some reports have shown that the ischemic wound can be considered to be cured when the SPP is 30-40 mmHg or higher (4-8). When revascularization must be performed to treat CLI, a postprocedural SPP value of 40 mmHg or higher may be a reasonable target for treatment. However, an additional revascularization procedure would be difficult even if the SPP measured after the withdrawal of the sheath is below 40 mmHg. ACCF/AHA guideline recommends staged intervention strategy in patients with CLI (12), but my strategy would be advantageous if the necessary revascularization were completed on one occasion rather than repeating the treatment several times. Dividing the treatment and performing revascularization on several occasions may elevate the risk of complications and prolong the time required for wound healing. Therefore, it is important to achieve satisfactory blood flow above a target level during a single treatment. SPP, which can be measured during the procedure and allows objective interpretation of the appropriate treatment endpoint, is a useful marker to ensure satisfactory blood flow. In particular, as in the present case, when the patient has multiple diffuse stenosed or occluded lesions, it is often difficult and impractical to treat all the lesions. In such cases, measuring SPP during the procedure and treating only those lesions that require immediate attention based on the corresponding SPP value would allow us to avoid excessive or inadequate treatment. Measuring SPP during a procedure may be extremely useful in determining the treatment endpoint, especially, as in the present case, when the patient has severe leg ischemia with multiple diffuse lesions. However, patients must rest during measurement of SPP. My strategy cannot be adapted for patients who are not able to rest.

In the present case, the patient had multiple diffuse stenosed or occluded lesions in the iliac artery, superficial femoral artery, popliteal artery, and in the arteries below the knee; in addition, the SPP at the dorsum of foot before the procedure was as low as 12 mmHg. Initially, the lesion in the iliac artery was revascularized, but the SPP at the dorsum of foot remained low (23 mmHg), despite restoration of blood flow to the periphery. If the procedure had been terminated at this point, the wound might not have healed and the ulcer in the toes might have persisted. Based upon the
SPP value, revascularization of the iliac artery was considered insufficient and superficial femoral artery revascularization was deemed necessary. Revascularization of the superficial femoral artery resulted in an SPP of 46 mmHg, which was above the target value of 40 mmHg. Because a satisfactory SPP was achieved, the treatment was terminated, even though lesions persisted below the knee. The ulcers and those lesions disappeared after the procedure. Measurement of SPP at several points is ideal, but this would be time consuming, therefore, we measured SPP only at the dorsum of foot.

A postprocedural SPP of 40 mmHg or higher has been reported to be associated with a significantly reduced rate of leg amputation, as noted above. However, it remains unclear how high the SPP on one side should be in order to ensure sufficient blood flow to the stenosed or occluded vessels immediately after revascularization. In the present case, the SPP was 46 mmHg immediately after the completion of revascularization, but it increased to 76 mmHg on the following day. Elevation of SPP after endovascular repair appears to require time, and therefore, the target value required to end the procedure (i.e., the lowest) could be lower than 40 mmHg. Further studies are needed to determine the appropriate SPP value immediately after the procedure.

**Conclusion**

The experience of treating a case in which revascularization was performed for multiple diffuse lesions in the leg arteries in a patient with CLI is reported. The SPP was measured during the procedure in order to determine the endpoint of the treatment; the SPP value was set at a value of 40 mmHg or higher. The use of a noninvasive SPP measurement during revascularization may be very helpful. To my knowledge, this is the first report of an intraprocedural SPP measurement to determine the endpoint of treatment.

The author states that he has no Conflict of Interest (COI).

**References**