

## Use of a Balloon and *N*-Butyl-2-Cyanoacrylate for Treatment of Arteriovenous Fistula

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**Abstract** We report a patient who developed a large arteriovenous fistula in right lower extremity after gunshot injury. Because other endovascular methods failed, the patient was successfully treated with concomitant use of detachable latex balloon and *N*-butyl-2-cyanoacrylate (NBCA). The combination of detachable balloon and NBCA can be effectively used for endovascular treatment of peripheral arteriovenous fistulas in selected cases when effective embolization could not be achieved with other embolizing agents or their various combinations.

**Keywords** Arteriovenous fistula · Endovascular embolization · *N*-Butyl-2-cyanoacrylate · Detachable balloon · Complication

An arteriovenous fistula (AVF) is an abnormal direct connection between an artery and a vein. Such lesions generally develop after trauma, which damages the artery and the vein. The flow through the fistula depends on the size and length of the shunt between the artery and the vein [1]. The aim of management is to occlude the fistula or the feeding artery, with preservation of the distal circulation.

Endovascular embolization is a safe and effective alternative to surgery. The embolizing material used in the endovascular therapy is a lesion-specific coil, detachable balloon, or various combinations of those agents [2]. We report the successful treatment of a large AVF with concomitant use of a detachable balloon and *N*-butyl-2-cyanoacrylate (NBCA).

### Case Report

A 73-year-old man with a history of gunshot injury to the right lower extremity 10 years previously was admitted to our center with complaints of right lower extremity swelling, pain, ulceration, and worsening dyspnea for 1 year. Physical examination revealed swelling and cyanosis of the right lower extremity. Varicose veins, venous ulcerations, thrill over the popliteal fossa, and findings of heart failure were also present. History and physical examination were compatible with AVF; the diagnosis was confirmed by color Doppler ultrasonography (CDUS). Angiography was planned for diagnostic and therapeutic purposes. A vascular introducer (8-Fr, 65-cm sheath; Arrow, Reading, PA, USA) was placed in the right common femoral artery via an antegrade route. Selective angiography revealed a giant AVF supplied by antegrade and retrograde filling from the posterior tibial artery (Fig. 1). The calibrations of the superficial femoral artery, popliteal artery, and proximal portion of the posterior tibial artery were increased. The draining veins of the lesion were also markedly dilated and tortuous.

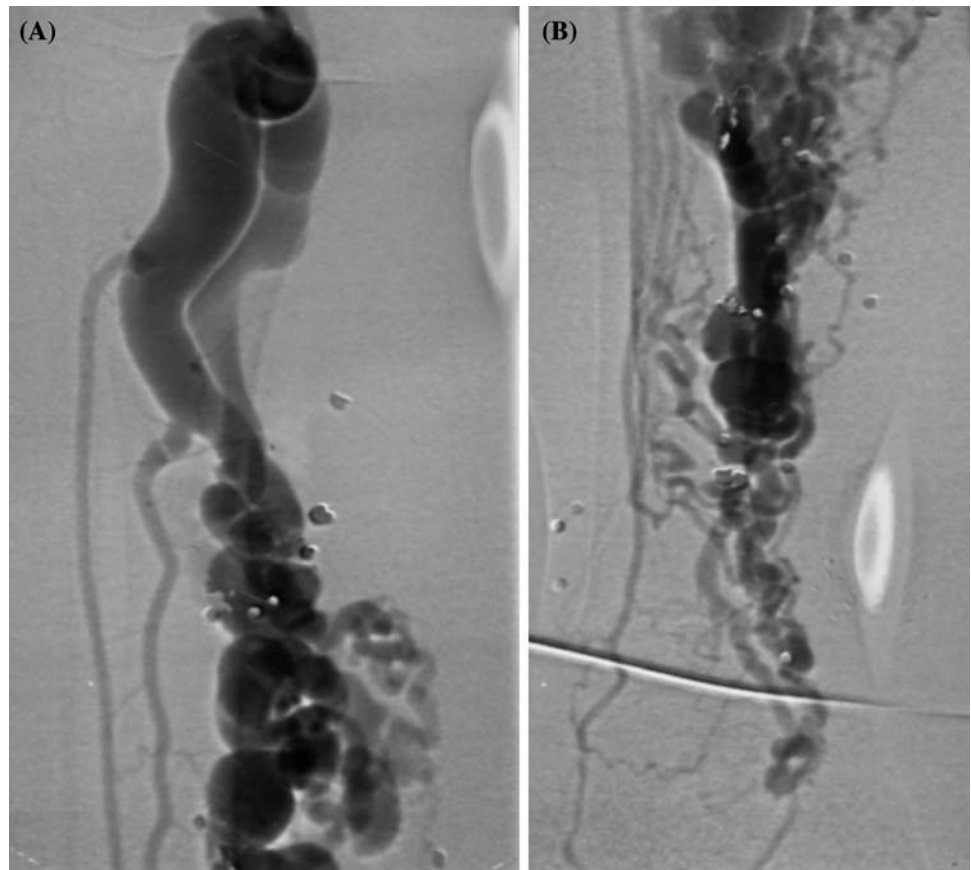
We first introduced a microcatheter (Rapid Transit; Cordis Neurovascular, Inc., Miami, FL, USA) and microguidewire (Radiofocus Guidewire GT; Terumo, Tokyo) into the distal posterior tibial artery that was feeding the

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**Fig. 1** (A) Digital subtraction angiography reveals early venous filling via a fistula connecting the proximally posterior tibial artery and crural veins. (B) Late-phase angiographic image shows the brisk venous return of contrast via the deep and superficial crural veins to the popliteal vein



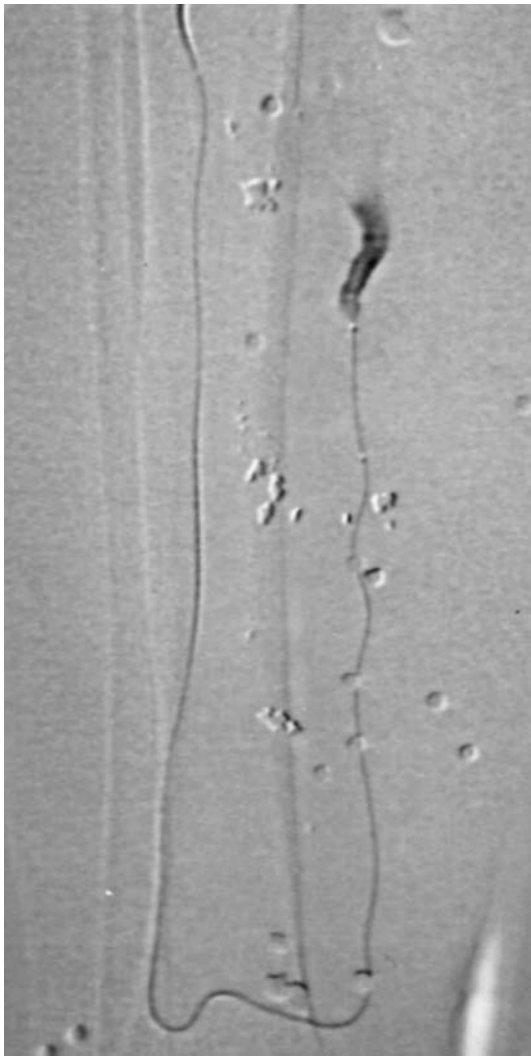
fistula via a retrograde route. The distal opening of the fistula was occluded with a 70% NBCA-lipiodol mixture (Fig. 2). Then we tried to occlude the major component of the fistula, which was supplied by the proximal posterior tibial artery, with detachable coils by filling from the venous pouch toward the proximal opening of the fistula. We abandoned the use of coils after the first two coils were detached because we could not position and stabilize the subsequent coils. We then tried to occlude the fistula with a detachable balloon (Goldballoon, 8 × 11 mm; Balt, Montmorency, France). The first balloon was detached prematurely because of the high flow rate and unstable position. It was suspended in the venous pouch. Therefore, manual compression was performed over the groin and the flow rate was reduced. Using this maneuver the second balloon was fully inflated and the fistula occluded.

The patient was transferred to the intensive care unit. The next day physical examination revealed that the thrill reappeared over the popliteal fossa. Angiography was repeated for diagnostic and therapeutic purposes. The balloon was partially deflated, and displaced into the venous pouch. Then we decided to occlude the fistula permanently with the balloon and NBCA combination. Permanent occlusion was achieved by injecting a 70% NBCA-lipiodol mixture after inflating the balloon. NBCA

injection damaged and deflated the balloon in a few seconds. But the NBCA cast remained stable and effective (Fig. 3). One month after the endovascular therapy, the cardiovascular symptoms and ischemic findings disappeared, and the findings of venous congestion improved markedly. No recurrence of the fistula was observed during annual follow-up with CDUS for 2 years (Fig. 4). However, at the end of 2 years, varicose dilatations were observed in the posterior crural veins, and CDUS revealed weak arterialized flow in the superficial femoral vein. Control angiography showed that the fistula remained occluded but there were a few tiny collateral arteries medial to the knee that were filling the venous pouch (Figs. 4A and B). No further intravascular therapeutic intervention was planned since the patient was free of any symptoms.

## Discussion

AVFs may be congenital or may develop following trauma or surgical interventions [3, 4]. In AVFs the blood bypasses the capillaries and tissues and returns directly to the heart. Accordingly such lesions may cause high-output cardiac failure, neurological deficits, or ischemic symptoms [1, 5].

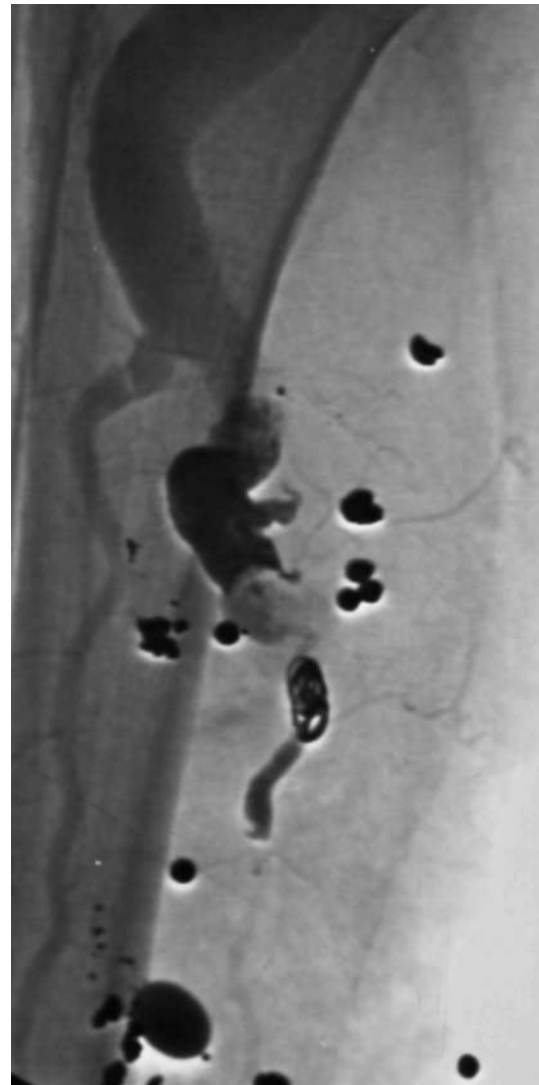


**Fig. 2** Hyperselective angiogram shows retrograde catheterization of the posterior tibial artery that is supplying the fistula, via retrograde direction, just before NBCA injection

The majority of the above-mentioned symptoms and signs were present in our patient since he had a large arteriovenous connection for a long period.

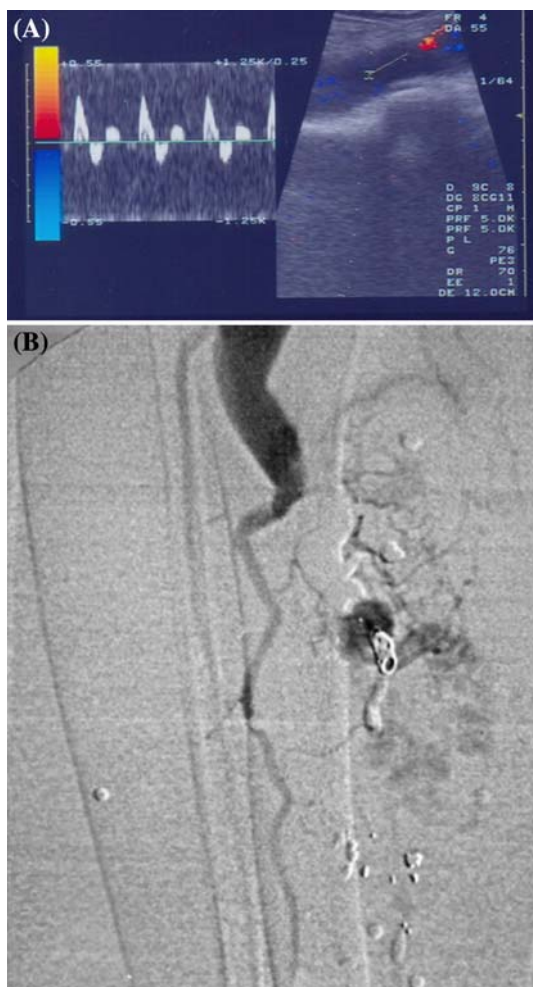
Some AVFs can close spontaneously or by external compression even with Doppler ultrasound probe [6]. However, large AVFs that develop secondary to penetrating injuries as in this patient need to be treated either by surgical repair or by an endovascular approach [7]. Endovascular treatment is minimally invasive. There is no need for general anesthesia or incision. The risk of infection is low, and the hospitalization period is short [2, 6]. Therefore, intra-arterial embolization was preferred in this case.

Different embolization techniques are preferable, depending on the size, localization, and hemodynamics of the lesion [1, 2, 7]. Coils, less commonly, detachable balloons, and liquid embolizing agents (NBCA) or various combinations of those agents are being successfully used



**Fig. 3** Anteroposterior-view nonsubtracted angiogram of the posterior tibial arteries, obtained after completion of the treatment, shows complete occlusion of the fistula, with a final crescent cast of glue (NBCA mixed with lipiodol) over the deflated balloon

for endovascular treatments of AVFs. Particulate or liquid agents are not routinely used as single agents for the treatment of large AVFs due to the risk of paradoxical embolization [8]. Covered stent-graft, NBCA, or coil–NBCA combinations were previously used for the treatment of AVFs. Detachable coils and balloons can be positioned optimally and controlled before they are detached. Therefore, they are used more frequently than other embolizing agents [5, 9, 10]. In this case, we tried to occlude the major component of the fistula with coils. But the coils could not be positioned stably in the opening of the fistula due to the high flow rate. A detachable balloon achieved only temporary occlusion. Therefore we used the combination of a balloon and a 70% NBCA–lipiodol mixture to achieve permanent occlusion. We observed that



**Fig. 4** Two years after the treatment color Doppler ultrasonography shows weak arterialized flow in the superficial femoral vein (A). A control angiogram of the right popliteal artery injection shows minimal venous filling by a few small collateral capillaries (B)

NBCA damaged the latex balloon in a few seconds, so to prevent inadvertent distal NBCA embolization, high concentrations of NBCA should be used for rapid polymerization.

Possible complications of endovascular treatment are bleeding, hematoma, distal embolization, thrombosis, infection, and deep venous thrombosis [6, 12]. Fortunately, these complications did not develop in our patient.

In conclusion, the combination of a detachable balloon and NBCA can be effectively used for endovascular treatment of peripheral AVFs in selected cases when effective embolization cannot be achieved with other embolizing agents or their various combinations.

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