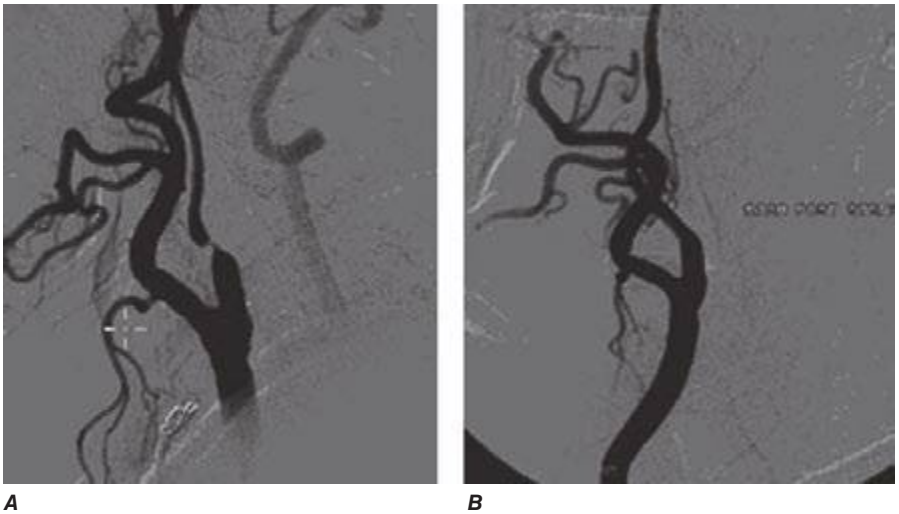
Percutaneous aortic valve replacement (TAVR) has been shown to be an effective treatment for high-risk and inoperable patients with aortic stenosis. Currently, two valve models, the Edwards SAPIEN valve (Edwards Lifescience, Irvine, California) and the CoreValve ReValving system (Medtronic, Minneapolis, Minnesota) are available. In more than 10,000 cases worldwide, follow-up shows no evidence of restenosis or severe prosthetic valve dysfunction in the midterm. The CoreValve is self-expanding, while the Edwards valve is balloon expanded. The cannulas are large (14–22 French), and retrograde access via the femoral artery is most commonly chosen, if possible. In patients with peripheral artery disease, access via the subclavian artery or transapically through a surgical incision can be used. Following balloon valvuloplasty, the valve is positioned across the valve and deployed with postdeployment balloon inflation to ensure full contact with the aortic annulus. The success rate is 80–90%, and the 30-day mortality rate is 10–15%, not unexpectedly as only high-risk patients are undergoing the procedure currently. The Placement of Aortic Transcatheter Valve (PARTNER) randomized trial of the Edwards valve showed a 55% reduction in 1-year mortality and major adverse events in the extreme-risk group randomized to TAVR compared to medical therapy. In a separate randomized trial, high-risk patients had a similar outcome to surgical valve replacement at 1 year. As a result, this valve is approved for both high-risk and extreme-risk patients with severe aortic stenosis.

Pulmonic stenosis can also be effectively treated with balloon valvuloplasty and percutaneously replaced with the Melody stent (Medtronic). Tricuspid valve interventions remain experimental.

PERIPHERAL ARTERY INTERVENTIONS

The use of percutaneous interventions to treat symptomatic patients with arterial obstruction in the carotid, renal, aortic, and peripheral vessels is also part of the field of interventional cardiology. Randomized clinical trial data already support the use of carotid stenting in patients at high risk of complications from carotid endarterectomy **(Fig. 296e-5)**. Recent trials suggest similar outcomes with carotid stenting and carotid endarterectomy in patients at average risk, although depending on the patient's risk for periprocedural stroke or myocardial infarction, one procedure may be preferred over the other. The success rate of peripheral artery interventional procedures has been improving, including for long segments of occlusive disease historically treated by peripheral bypass surgery **(Fig. 296e-6)**. Peripheral intervention is increasingly part of the training of an interventional cardiologist, and most programs now require an additional year of training after the interventional cardiology training year. The techniques and outcomes are described in detail in the chapter on peripheral vascular disease **(Chap. 302)**.



A *B*

FIGURE 296e-5 An example of a high-risk patient who requires carotid revascularization, but who is not a candidate for carotid endarterectomy. Carotid artery stenting resulted in an excellent angiographic result. *(From M Belkin, DL Bhatt: Circulation 119:2302, 2009; with permission.)*

CIRCULATORY SUPPORT TECHNIQUES

The use of circulatory support techniques is occasionally needed in order to safely perform PCI on hemodynamically unstable patients. It also can be useful in helping to stabilize patients before surgical interventions. The most commonly used device is the percutaneous intraaortic balloon pump developed in the early 1960s. A 7- to 10-French, 25- to 50-mL balloon catheter is placed retrograde from the femoral artery into the descending aorta between the aortic arch and the abdominal aortic bifurcation. It is connected to a helium gas inflation system that synchronizes the inflation to coincide with early diastole with deflation by mid-diastole. As a result, it increases early diastolic pressure, lowers systolic pressure, and lowers late diastolic pressure through displacement of blood from the descending aorta (counterpulsation). This results in an increase in coronary blood flow and a decrease in afterload. It is contraindicated in patients with aortic regurgitation, aortic dissection, or severe peripheral artery disease. The major complications are vascular and thrombotic. Intravenous heparin is given in order to reduce thrombotic complications.

Another potentially useful tool is the Impella device (Abiomed, Danvers, Massachusetts). The catheter is placed percutaneously from the femoral artery into the left ventricle. The catheter has a small microaxial pump at its tip that can pump up to 2.5–5 L/min from the left ventricle to the aorta. Other support devices include TandemHeart (CardiacAssist, Pittsburgh, Pennsylvania), which involves placement of a large 21-French catheter from the femoral vein through the right atrium into the left atrium using the transseptal technique and a catheter in the femoral artery. A centrifugal pump can deliver 5 L of blood per minute. It may be useful in patients in shock or with STEMI or very-high-risk PCI. Patients can also be placed on peripheral extracorporeal membrane oxygenation using large cannulas placed in the femoral artery and vein.

INTERVENTIONS FOR PULMONARY EMBOLISM

The treatment of deep vein thrombosis is intravenous anticoagulation, with placement of an inferior vena cava filter if recurrent pulmonary emboli occur. Postphlebitic syndrome is a serious condition due to chronic venous obstruction that can lead to chronic leg edema and venous ulcers. Preliminary studies suggest that mechanical treatments may have a role in treatment, and a large trial is ongoing.

Pulmonary emboli (PE) should be treated with fibrinolytic agents if massive and in some cases if submassive. Surgical pulmonary embolectomy is an option for the treatment of massive PE with hemodynamic instability in patients who have contraindications for systemic fibrinolysis or those in whom it has failed. Catheter-based therapies for submassive and massive PEs are still evolving, but studies have shown promise. The techniques employed include the use of aspiration of the clot with a large catheter (10 French), intraclot infusion of a thrombolytic agent followed by aspiration, ultrasound-assisted catheter-directed thrombolysis, and use of rheolytic thrombectomy. Success for these techniques has been reported to be 80–90%, with major complications occurring in 2–4% of patients.

INTERVENTIONS FOR REFRACTORY HYPERTENSION

The recent recognition of the importance of the renal sympathetic nerves in modulating blood pressure has led to a technique to selectively denervate renal sympathetic nerves in patients with refractory hypertension. The procedure involves applying low-power radiofrequency treatment via a catheter along the length of both renal arteries. In the randomized Symplicity HTN-2 trial, renal denervation significantly reduced blood pressure compared with medical therapy. The Symplicity device (Medtronic) is approved in Europe, though the randomized and blinded U.S. Symplicity HTN-3 trial showed no effect.